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# **Matplotlib**

***Release 1.1.0***

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# **Part I**

## **User's Guide**





---

# INTRODUCTION

matplotlib is a library for making 2D plots of arrays in [Python](#). Although it has its origins in emulating the MATLAB®<sup>1</sup> graphics commands, it is independent of MATLAB, and can be used in a Pythonic, object oriented way. Although matplotlib is written primarily in pure Python, it makes heavy use of [NumPy](#) and other extension code to provide good performance even for large arrays.

matplotlib is designed with the philosophy that you should be able to create simple plots with just a few commands, or just one! If you want to see a histogram of your data, you shouldn't need to instantiate objects, call methods, set properties, and so on; it should just work.

For years, I used to use MATLAB exclusively for data analysis and visualization. MATLAB excels at making nice looking plots easy. When I began working with EEG data, I found that I needed to write applications to interact with my data, and developed an EEG analysis application in MATLAB. As the application grew in complexity, interacting with databases, http servers, manipulating complex data structures, I began to strain against the limitations of MATLAB as a programming language, and decided to start over in Python. Python more than makes up for all of MATLAB's deficiencies as a programming language, but I was having difficulty finding a 2D plotting package (for 3D [VTK](#) more than exceeds all of my needs).

When I went searching for a Python plotting package, I had several requirements:

- Plots should look great - publication quality. One important requirement for me is that the text looks good (antialiased, etc.)
- Postscript output for inclusion with TeX documents
- Embeddable in a graphical user interface for application development
- Code should be easy enough that I can understand it and extend it
- Making plots should be easy

Finding no package that suited me just right, I did what any self-respecting Python programmer would do: rolled up my sleeves and dived in. Not having any real experience with computer graphics, I decided to emulate MATLAB's plotting capabilities because that is something MATLAB does very well. This had the added advantage that many people have a lot of MATLAB experience, and thus they can quickly get up to speed plotting in python. From a developer's perspective, having a fixed user interface (the pylab interface) has been very useful, because the guts of the code base can be redesigned without affecting user code.

---

<sup>1</sup> MATLAB is a registered trademark of The MathWorks, Inc.

The matplotlib code is conceptually divided into three parts: the *pylab interface* is the set of functions provided by `matplotlib.pylab` which allow the user to create plots with code quite similar to MATLAB figure generating code (*Pyplot tutorial*). The *matplotlib frontend* or *matplotlib API* is the set of classes that do the heavy lifting, creating and managing figures, text, lines, plots and so on (*Artist tutorial*). This is an abstract interface that knows nothing about output. The *backends* are device dependent drawing devices, aka renderers, that transform the frontend representation to hardcopy or a display device (*What is a backend?*). Example backends: PS creates **PostScript®** hardcopy, SVG creates **Scalable Vector Graphics** hardcopy, Agg creates PNG output using the high quality **Anti-Grain Geometry** library that ships with matplotlib, GTK embeds matplotlib in a **Gtk+** application, GTKAgg uses the Anti-Grain renderer to create a figure and embed it a Gtk+ application, and so on for **PDF**, **WxWidgets**, **Tkinter** etc.

matplotlib is used by many people in many different contexts. Some people want to automatically generate PostScript files to send to a printer or publishers. Others deploy matplotlib on a web application server to generate PNG output for inclusion in dynamically-generated web pages. Some use matplotlib interactively from the Python shell in Tkinter on Windows™. My primary use is to embed matplotlib in a Gtk+ EEG application that runs on Windows, Linux and Macintosh OS X.

# INSTALLING

There are many different ways to install matplotlib, and the best way depends on what operating system you are using, what you already have installed, and how you want to use it. To avoid wading through all the details (and potential complications) on this page, the easiest thing for you to do is use one of the pre-packaged python distributions that already provide matplotlib built-in. The Enthought Python Distribution (EPD) for Windows, OS X or Redhat is an excellent choice that “just works” out of the box. Another excellent alternative for Windows users is [Python \(x, y\)](#) which tends to be updated a bit more frequently. Both of these packages include matplotlib and pylab, and *lots* of other useful tools. matplotlib is also packaged for almost every major Linux distribution. So if you are on Linux, your package manager will probably provide matplotlib prebuilt.

## 2.1 Manually installing pre-built packages

### 2.1.1 General instructions

For some people, the prepackaged pythons discussed above are not an option. That’s OK, it’s usually pretty easy to get a custom install working. You will first need to find out if you have python installed on your machine, and if not, install it. The official python builds are available for download [here](#), but OS X users please read [Which python for OS X?](#).

Once you have python up and running, you will need to install [numpy](#). numpy provides high-performance array data structures and mathematical functions, and is a requirement for matplotlib. You can test your progress:

```
>>> import numpy
>>> print numpy.__version__
```

matplotlib requires numpy version 1.1 or later. Although it is not a requirement to use matplotlib, we strongly encourage you to install [ipython](#), which is an interactive shell for python that is matplotlib-aware.

Next, we need to get matplotlib installed. We provide prebuilt binaries for OS X and Windows on the matplotlib [download](#) page. Click on the latest release of the “matplotlib” package, choose your python version (e.g., 2.5, 2.6 or 2.7) and your platform (macosx or win32). If you have any problems, please check the [Installation](#), search using Google, and/or post a question to the [mailing list](#).

If you are on Debian/Ubuntu Linux, it suffices to do:

```
> sudo apt-get install python-matplotlib
```

Instructions for installing our OSX binaries are found in the FAQ *Installing OSX binaries*.

Once you have ipython, numpy and matplotlib installed, you can use ipython's "pylab" mode to have a MATLAB-like environment that automatically handles most of the configuration details for you, so you can get up and running quickly:

```
johnh@flag:~> ipython -pylab
Python 2.4.5 (#4, Apr 12 2008, 09:09:16)
IPython 0.9.0 -- An enhanced Interactive Python.

Welcome to pylab, a matplotlib-based Python environment.
For more information, type 'help(pylab)'.
```

```
In [1]: x = randn(10000)
```

```
In [2]: hist(x, 100)
```

Note that when testing matplotlib installations from the interactive python console, there are some issues relating to user interface toolkits and interactive settings that are discussed in *Using matplotlib in a python shell*.

### 2.1.2 Installing on Windows

If you don't already have python installed, you may want to consider using the Enthought edition of python, which has scipy, numpy, and wxpython, plus many other useful packages, preinstalled - *Enthought Python*. With the Enthought edition of python + matplotlib installer, the following backends should work out of the box: agg, wx, wxagg, tkagg, ps, pdf and svg.

For standard python installations, you will also need to install numpy in addition to the matplotlib installer. On some systems you will also need to download msvcp71.dll library, which you can download from <http://www.dll-files.com/dllindex/dll-files.shtml?msvcp71> or other sites. You will need to unzip the archive and drag the dll into c:\windowssystem32.

All of the GUI backends run on Windows, but TkAgg is probably the best for interactive use from the standard python shell or ipython. The Windows installer (\*.exe) on the download page contains all the code you need to get up and running. However, there are many examples that are not included in the Windows installer. If you want to try the many demos that come in the matplotlib source distribution, download the zip file and look in the `examples` subdirectory.

## 2.2 Installing from source

If you are interested in contributing to matplotlib development, running the latest source code, or just like to build everything yourself, it is not difficult to build matplotlib from source. Grab the latest *tar.gz* release file from [sourceforge](http://sourceforge), or if you want to develop matplotlib or just need the latest bugfixed version, grab the latest git version *Source install from git*.

Once you have satisfied the requirements detailed below (mainly python, numpy, libpng and freetype), you can build matplotlib:

```
cd matplotlib
python setup.py build
python setup.py install
```

We provide a `setup.cfg` file that goes with `setup.py` which you can use to customize the build process. For example, which default backend to use, whether some of the optional libraries that matplotlib ships with are installed, and so on. This file will be particularly useful to those packaging matplotlib.

If you have installed prerequisites to nonstandard places and need to inform matplotlib where they are, edit `setuptools.py` and add the base dirs to the `basedir` dictionary entry for your `sys.platform`. e.g., if the header to some required library is in `/some/path/include/someheader.h`, put `/some/path` in the `basedir` list for your platform.

## 2.3 Build requirements

These are external packages which you will need to install before installing matplotlib. Windows users only need the first two (python and numpy) since the others are built into the matplotlib Windows installers available for download at the sourceforge site. If you are building on OSX, see [Building on OSX](#). If you are installing dependencies with a package manager on Linux, you may need to install the development packages (look for a “-dev” postfix) in addition to the libraries themselves.

**Note:** If you are on debian/ubuntu, you can get all the dependencies required to build matplotlib with:

```
sudo apt-get build-dep python-matplotlib
```

If you are on Fedora/RedHat, you can get all the dependencies required to build matplotlib by first installing `yum-builddep` and then running:

```
su -c "yum-builddep python-matplotlib"
```

This does not build matplotlib, but it does get the install the build dependencies, which will make building from source easier.

**python 2.4 (or later but not python3)** matplotlib requires python 2.4 or later ([download](#))

**numpy 1.1 (or later)** array support for python ([download](#))

**libpng 1.2 (or later)** library for loading and saving *PNG* files ([download](#)). libpng requires zlib. If you are a Windows user, you can ignore this because we build support into the matplotlib single-click installer

**freetype 1.4 (or later)** library for reading true type font files. If you are a windows user, you can ignore this since we build support into the matplotlib single click installer.

### Optional

These are optional packages which you may want to install to use matplotlib with a user interface toolkit. See [What is a backend?](#) for more details on the optional matplotlib backends and the capabilities they provide.

***tk* 8.3 or later** The TCL/Tk widgets library used by the TkAgg backend

***pyqt* 3.1 or later** The Qt3 widgets library python wrappers for the QtAgg backend

***pyqt* 4.0 or later** The Qt4 widgets library python wrappers for the Qt4Agg backend

***pygtk* 2.4 or later** The python wrappers for the GTK widgets library for use with the GTK or GTKAgg backend

***wxpython* 2.8 or later** The python wrappers for the wx widgets library for use with the WX or WXAgg backend

***pyfltk* 1.0 or later** The python wrappers of the FLTK widgets library for use with FLTKAgg

### **Required libraries that ship with matplotlib**

***agg* 2.4** The antigrain C++ rendering engine. matplotlib links against the agg template source statically, so it will not affect anything on your system outside of matplotlib.

***pytz* 2007g or later** timezone handling for python datetime objects. By default, matplotlib will install pytz if it isn't already installed on your system. To override the default, use `setup.cfg` to force or prevent installation of pytz.

***dateutil* 1.1 or later** provides extensions to python datetime handling. By default, matplotlib will install dateutil if it isn't already installed on your system. To override the default, use `setup.cfg` to force or prevent installation of dateutil.

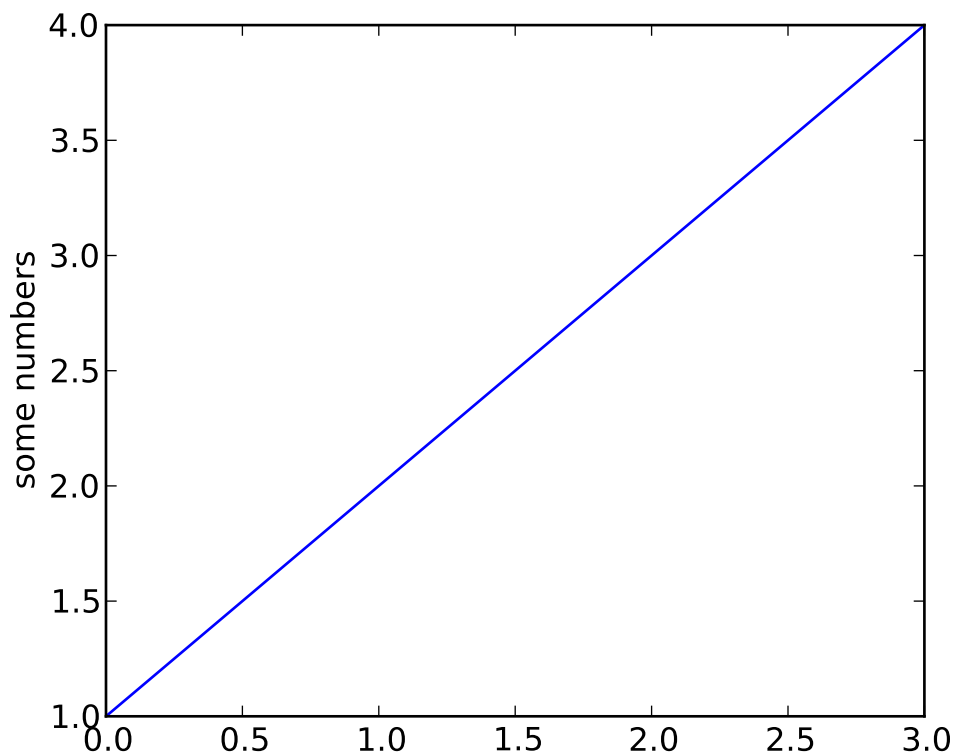
## **2.4 Building on OSX**

The build situation on OSX is complicated by the various places one can get the libpng and freetype requirements (darwinports, fink, /usr/X11R6) and the different architectures (e.g., x86, ppc, universal) and the different OSX version (e.g., 10.4 and 10.5). We recommend that you build the way we do for the OSX release: get the source from the tarball or the git repository and follow the instruction in `README.osx`.

# PYPLOT TUTORIAL

`matplotlib.pyplot` is a collection of command style functions that make matplotlib work like MATLAB. Each pyplot function makes some change to a figure: eg, create a figure, create a plotting area in a figure, plot some lines in a plotting area, decorate the plot with labels, etc.... `matplotlib.pyplot` is stateful, in that it keeps track of the current figure and plotting area, and the plotting functions are directed to the current axes

```
import matplotlib.pyplot as plt
plt.plot([1,2,3,4])
plt.ylabel('some numbers')
plt.show()
```



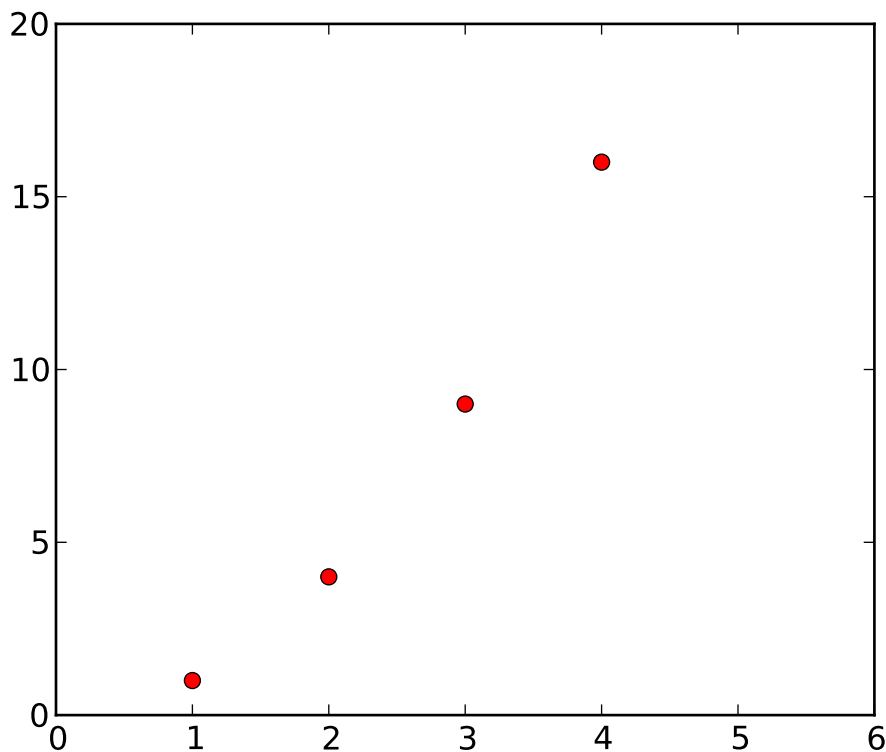
You may be wondering why the x-axis ranges from 0-2 and the y-axis from 1-3. If you provide a single list or array to the `plot()` command, matplotlib assumes it is a sequence of y values, and automatically generates the x values for you. Since python ranges start with 0, the default x vector has the same length as y but starts with 0. Hence the x data are `[0, 1, 2]`.

`plot()` is a versatile command, and will take an arbitrary number of arguments. For example, to plot x versus y, you can issue the command:

```
plt.plot([1,2,3,4], [1,4,9,16])
```

For every x, y pair of arguments, there is an optional third argument which is the format string that indicates the color and line type of the plot. The letters and symbols of the format string are from MATLAB, and you concatenate a color string with a line style string. The default format string is 'b-', which is a solid blue line. For example, to plot the above with red circles, you would issue

```
import matplotlib.pyplot as plt
plt.plot([1,2,3,4], [1,4,9,16], 'ro')
plt.axis([0, 6, 0, 20])
```



See the `plot()` documentation for a complete list of line styles and format strings. The `axis()` command in the example above takes a list of `[xmin, xmax, ymin, ymax]` and specifies the viewport of the axes.

If matplotlib were limited to working with lists, it would be fairly useless for numeric processing. Generally, you will use `numpy` arrays. In fact, all sequences are converted to numpy arrays internally. The example

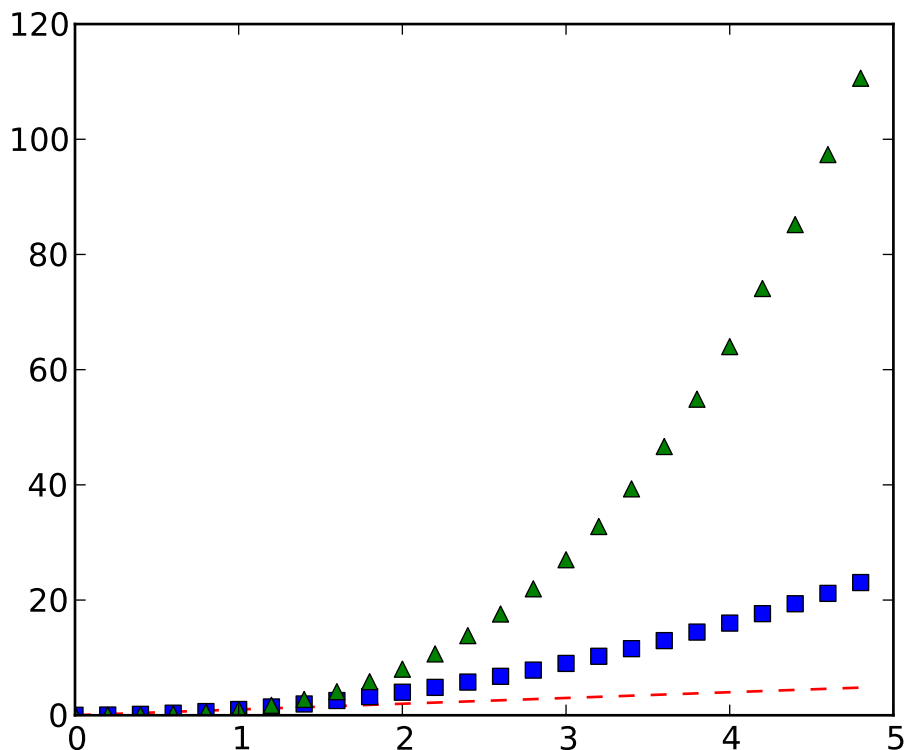


below illustrates a plotting several lines with different format styles in one command using arrays.

```
import numpy as np
import matplotlib.pyplot as plt

# evenly sampled time at 200ms intervals
t = np.arange(0., 5., 0.2)

# red dashes, blue squares and green triangles
plt.plot(t, t, 'r--', t, t**2, 'bs', t, t**3, 'g^')
```



### 3.1 Controlling line properties

Lines have many attributes that you can set: linewidth, dash style, antialiased, etc; see `matplotlib.lines.Line2D`. There are several ways to set line properties

- Use keyword args:

```
plt.plot(x, y, linewidth=2.0)
```

- Use the setter methods of the `Line2D` instance. `plot` returns a list of lines; eg `line1, line2 = plot(x1,y1,x2,x2)`. Below I have only one line so it is a list of length 1. I use tuple unpacking in the line, = `plot(x, y, 'o')` to get the first element of the list:

```
line, = plt.plot(x, y, '-')
line.set_antialiased(False) # turn off antialiasing
```

- Use the `setp()` command. The example below uses a MATLAB-style command to set multiple properties on a list of lines. `setp` works transparently with a list of objects or a single object. You can either use python keyword arguments or MATLAB-style string/value pairs:

```
lines = plt.plot(x1, y1, x2, y2)
# use keyword args
plt.setp(lines, color='r', linewidth=2.0)
# or MATLAB style string value pairs
plt.setp(lines, 'color', 'r', 'linewidth', 2.0)
```

Here are the available [Line2D](#) properties.

| Property               | Value Type  |
|------------------------|---|
| alpha                  | float   |
| animated               | [True   False]                                    |
| antialiased or aa      | [True   False]                                    |
| clip_box               | a matplotlib.transform.Bbox instance              |
| clip_on                | [True   False]                                    |
| clip_path              | a Path instance and a Transform instance, a Patch |
| color or c             | any matplotlib color                              |
| contains               | the hit testing function                          |
| dash_capstyle          | ['butt'   'round'   'projecting']                 |
| dash_joinstyle         | ['miter'   'round'   'bevel']                     |
| dashes                 | sequence of on/off ink in points                  |
| data                   | (np.array xdata, np.array ydata)                  |
| figure                 | a matplotlib.figure.Figure instance               |
| label                  | any string  |
| linestyle or ls        | ['-'   '-'   '-'   ':'   'steps'   ...]           |
| linewidth or lw        | float value in points                             |
| lod                    | [True   False]                                    |
| marker                 | ['+'   ','   '.'   '1'   '2'   '3'   '4']         |
| markeredgecolor or mec | any matplotlib color                              |
| markeredgewidth or mew | float value in points                             |
| markerfacecolor or mfc | any matplotlib color                              |
| markersize or ms       | float   |
| markevery              | None   integer   (startind, stride)               |
| picker                 | used in interactive line selection                |
| pickradius             | the line pick selection radius                    |
| solid_capstyle         | ['butt'   'round'   'projecting']                 |
| solid_joinstyle        | ['miter'   'round'   'bevel']                     |
| transform              | a matplotlib.transforms.Transform instance        |
| visible                | [True   False]                                    |
| xdata                  | np.array  |
| ydata                  | np.array  |
| Continued on next page |   |

Table 3.1 – continued from previous page

|        |            |
|--------|------------|
| zorder | any number |
|--------|------------|

To get a list of settable line properties, call the `setp()` function with a line or lines as argument

```
In [69]: lines = plt.plot([1,2,3])
```

```
In [70]: plt.setp(lines)
alpha: float
animated: [True | False]
antialiased or aa: [True | False]
...snip
```

## 3.2 Working with multiple figures and axes

MATLAB, and `pyplot`, have the concept of the current figure and the current axes. All plotting commands apply to the current axes. The function `gca()` returns the current axes (a `matplotlib.axes.Axes` instance), and `gcf()` returns the current figure (`matplotlib.figure.Figure` instance). Normally, you don't have to worry about this, because it is all taken care of behind the scenes. Below is a script to create two subplots.

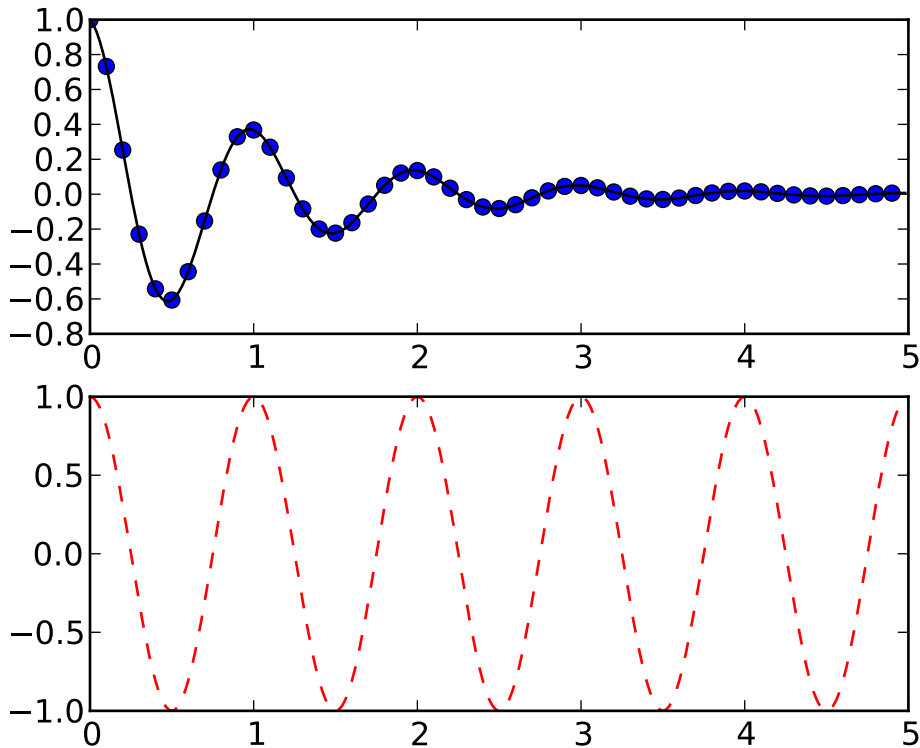
```
import numpy as np
import matplotlib.pyplot as plt

def f(t):
    return np.exp(-t) * np.cos(2*np.pi*t)

t1 = np.arange(0.0, 5.0, 0.1)
t2 = np.arange(0.0, 5.0, 0.02)

plt.figure(1)
plt.subplot(211)
plt.plot(t1, f(t1), 'bo', t2, f(t2), 'k')

plt.subplot(212)
plt.plot(t2, np.cos(2*np.pi*t2), 'r--')
```



The `figure()` command here is optional because `figure(1)` will be created by default, just as a `subplot(111)` will be created by default if you don't manually specify an axes. The `subplot()` command specifies `numrows`, `numcols`, `fignum` where `fignum` ranges from 1 to `numrows*numcols`. The commas in the subplot command are optional if `numrows*numcols < 10`. So `subplot(211)` is identical to `subplot(2,1,1)`. You can create an arbitrary number of subplots and axes. If you want to place an axes manually, ie, not on a rectangular grid, use the `axes()` command, which allows you to specify the location as `axes([left, bottom, width, height])` where all values are in fractional (0 to 1) coordinates. See *pylab\_examples example code: axes\_demo.py* for an example of placing axes manually and *pylab\_examples example code: line\_styles.py* for an example with lots-o-subplots.

You can create multiple figures by using multiple `figure()` calls with an increasing figure number. Of course, each figure can contain as many axes and subplots as your heart desires:

```
import matplotlib.pyplot as plt
plt.figure(1)                # the first figure
plt.subplot(211)             # the first subplot in the first figure
plt.plot([1,2,3])
plt.subplot(212)             # the second subplot in the first figure
plt.plot([4,5,6])

plt.figure(2)                # a second figure
plt.plot([4,5,6])            # creates a subplot(111) by default
```

```
plt.figure(1)           # figure 1 current; subplot(212) still current
plt.subplot(211)        # make subplot(211) in figure1 current
plt.title('Easy as 1,2,3') # subplot 211 title
```

You can clear the current figure with `clf()` and the current axes with `cla()`. If you find this statefulness, annoying, don't despair, this is just a thin stateful wrapper around an object oriented API, which you can use instead (see *Artist tutorial*)

If you are making a long sequence of figures, you need to be aware of one more thing: the memory required for a figure is not completely released until the figure is explicitly closed with `close()`. Deleting all references to the figure, and/or using the window manager to kill the window in which the figure appears on the screen, is not enough, because pyplot maintains internal references until `close()` is called.

### 3.3 Working with text

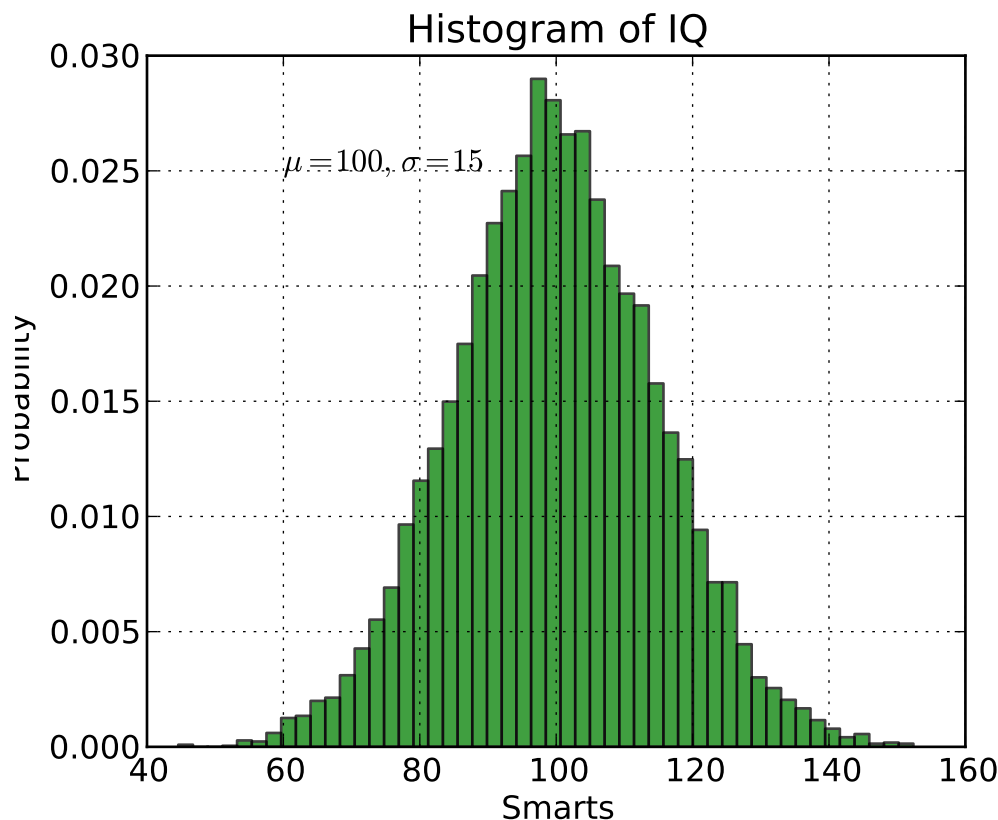
The `text()` command can be used to add text in an arbitrary location, and the `xlabel()`, `ylabel()` and `title()` are used to add text in the indicated locations (see *Text introduction* for a more detailed example)

```
import numpy as np
import matplotlib.pyplot as plt

mu, sigma = 100, 15
x = mu + sigma * np.random.randn(10000)

# the histogram of the data
n, bins, patches = plt.hist(x, 50, normed=1, facecolor='g', alpha=0.75)

plt.xlabel('Smarts')
plt.ylabel('Probability')
plt.title('Histogram of IQ')
plt.text(60, .025, r'$\mu=100,\ \sigma=15$')
plt.axis([40, 160, 0, 0.03])
plt.grid(True)
```



All of the `text()` commands return an `matplotlib.text.Text` instance. Just as with with lines above, you can customize the properties by passing keyword arguments into the text functions or using `setp()`:

```
t = plt.xlabel('my data', fontsize=14, color='red')
```

These properties are covered in more detail in *Text properties and layout*.

### 3.3.1 Using mathematical expressions in text

matplotlib accepts TeX equation expressions in any text expression. For example to write the expression  $\sigma_i = 15$  in the title, you can write a TeX expression surrounded by dollar signs:

```
plt.title(r'$\sigma_i=15$')
```

The `r` preceeding the title string is important – it signifies that the string is a *raw* string and not to treat backslashes and python escapes. matplotlib has a built-in TeX expression parser and layout engine, and ships its own math fonts – for details see *Writing mathematical expressions*. Thus you can use mathematical text across platforms without requiring a TeX installation. For those who have LaTeX and dvipng installed, you can also use LaTeX to format your text and incorporate the output directly into your display figures or saved postscript – see *Text rendering With LaTeX*.

### 3.3.2 Annotating text

The uses of the basic `text()` command above place text at an arbitrary position on the Axes. A common use case of text is to annotate some feature of the plot, and the `annotate()` method provides helper functionality to make annotations easy. In an annotation, there are two points to consider: the location being annotated represented by the argument `xy` and the location of the text `xytext`. Both of these arguments are `(x,y)` tuples.

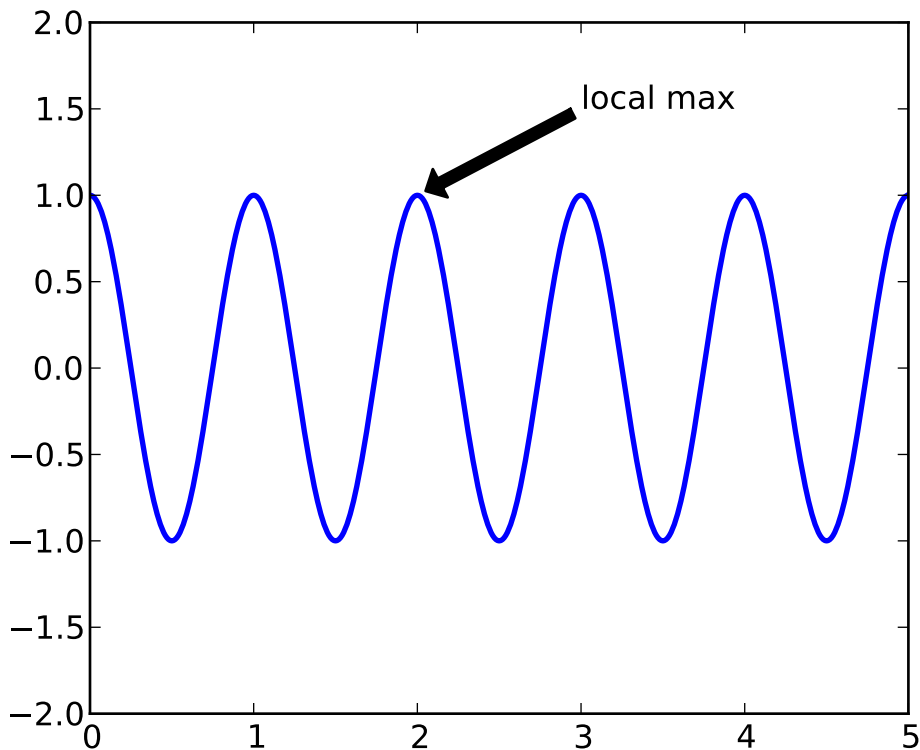
```
import numpy as np
import matplotlib.pyplot as plt

ax = plt.subplot(111)

t = np.arange(0.0, 5.0, 0.01)
s = np.cos(2*np.pi*t)
line, = plt.plot(t, s, lw=2)

plt.annotate('local max', xy=(2, 1), xytext=(3, 1.5),
            arrowprops=dict(facecolor='black', shrink=0.05),
            )

plt.ylim(-2,2)
plt.show()
```



In this basic example, both the `xy` (arrow tip) and `xytext` locations (text location) are in data coordinates. There are a variety of other coordinate systems one can choose – see [Annotating text](#) and [Annotating Axes](#) for details. More examples can be found in *pylab\_examples* example code: `annotation_demo.py`.



# INTERACTIVE NAVIGATION



All figure windows come with a navigation toolbar, which can be used to navigate through the data set. Here is a description of each of the buttons at the bottom of the toolbar



**The Forward and Back buttons** These are akin to the web browser forward and back buttons. They are used to navigate back and forth between previously defined views. They have no meaning unless you have already navigated somewhere else using the pan and zoom buttons. This is analogous to trying to click Back on your web browser before visiting a new page –nothing happens. Home always takes you to the first, default view of your data. For Home, Forward and Back, think web browser where data views are web pages. Use the pan and zoom to rectangle to define new views.



**The Pan/Zoom button** This button has two modes: pan and zoom. Click the toolbar button to activate panning and zooming, then put your mouse somewhere over an axes. Press the left mouse button and hold it to pan the figure, dragging it to a new position. When you release it, the data under the point where you pressed will be moved to the point where you released. If you press ‘x’ or ‘y’ while panning the motion will be constrained to the x or y axis, respectively. Press the right mouse button to zoom, dragging it to a new position. The x axis will be zoomed in proportionate to the rightward movement and zoomed out proportionate to the leftward movement. Ditto for the y axis and up/down motions. The point under your mouse when you begin the zoom remains stationary, allowing you to zoom to an arbitrary point in the figure. You can use the modifier keys ‘x’, ‘y’ or ‘CONTROL’ to constrain the zoom to the x axis, the y axis, or aspect ratio preserve, respectively.

With polar plots, the pan and zoom functionality behaves differently. The radius axis labels can be dragged using the left mouse button. The radius scale can be zoomed in and out using the right mouse button.



**The Zoom-to-rectangle button** Click this toolbar button to activate this mode. Put your mouse somewhere over an axis and press the left mouse button. Drag the mouse while holding the button to a new location and release. The axes view limits will be zoomed to the rectangle you have defined. There is also an experimental ‘zoom out to rectangle’ in this mode with the right button, which will place your entire axes in the region defined by the zoom out rectangle.



**The Subplot-configuration button** Use this tool to configure the parameters of the subplot: the left, right, top, bottom, space between the rows and space between the columns.



**The Save button** Click this button to launch a file save dialog. You can save files with the following extensions: png, ps, eps, svg and pdf.

## 4.1 Navigation Keyboard Shortcuts

The following table holds all the default keys, which can be overwritten by use of your matplotlibrc (`#keymap.*`).

| Command                          | Keyboard Shortcut(s)                              |
|----------------------------------|---|
| Home/Reset                       | <b>h</b> or <b>r</b> or <b>home</b>               |
| Back                             | <b>c</b> or <b>left arrow</b> or <b>backspace</b> |
| Forward                          | <b>v</b> or <b>right arrow</b>                    |
| Pan/Zoom                         | <b>p</b>  |
| Zoom-to-rect                     | <b>o</b>  |
| Save                             | <b>s</b>  |
| Toggle fullscreen                | <b>f</b>  |
| Constrain pan/zoom to x axis     | hold <b>x</b>                                     |
| Constrain pan/zoom to y axis     | hold <b>y</b>                                     |
| Preserve aspect ratio            | hold <b>CONTROL</b>                               |
| Toggle grid                      | <b>g</b>  |
| Toggle x axis scale (log/linear) | <b>L</b> or <b>k</b>                              |
| Toggle y axis scale (log/linear) | <b>l</b>  |

If you are using `matplotlib.pyplot` the toolbar will be created automatically for every figure. If you are writing your own user interface code, you can add the toolbar as a widget. The exact syntax depends on

your UI, but we have examples for every supported UI in the `matplotlib/examples/user_interfaces` directory. Here is some example code for GTK:

```
from matplotlib.figure import Figure
from matplotlib.backends.backend_gtkagg import FigureCanvasGTKAgg as FigureCanvas
from matplotlib.backends.backend_gtkagg import NavigationToolbar2GTKAgg as NavigationToolbar

win = gtk.Window()
win.connect("destroy", lambda x: gtk.main_quit())
win.set_default_size(400,300)
win.set_title("Embedding in GTK")

vbox = gtk.VBox()
win.add(vbox)

fig = Figure(figsize=(5,4), dpi=100)
ax = fig.add_subplot(111)
ax.plot([1,2,3])

canvas = FigureCanvas(fig) # a gtk.DrawingArea
vbox.pack_start(canvas)
toolbar = NavigationToolbar(canvas, win)
vbox.pack_start(toolbar, False, False)

win.show_all()
gtk.main()
```



---

# CUSTOMIZING MATPLOTLIB

## 5.1 The matplotlibrc file

matplotlib uses matplotlibrc configuration files to customize all kinds of properties, which we call *rc settings* or *rc parameters*. You can control the defaults of almost every property in matplotlib: figure size and dpi, line width, color and style, axes, axis and grid properties, text and font properties and so on. matplotlib looks for matplotlibrc in three locations, in the following order:

1. matplotlibrc in the current working directory, usually used for specific customizations that you do not want to apply elsewhere.
2. .matplotlib/matplotlibrc, for the user's default customizations. See *matplotlib directory location*.
3. INSTALL/matplotlib/mpl-data/matplotlibrc, where INSTALL is something like /usr/lib/python2.5/site-packages on Linux, and maybe C:\Python25\Lib\site-packages on Windows. Every time you install matplotlib, this file will be overwritten, so if you want your customizations to be saved, please move this file to you .matplotlib directory.

To display where the currently active matplotlibrc file was loaded from, one can do the following:

```
>>> import matplotlib
>>> matplotlib.matplotlib_fname()
'/home/foo/.matplotlib/matplotlibrc'
```

See below for a sample *matplotlibrc file*.

## 5.2 Dynamic rc settings

You can also dynamically change the default rc settings in a python script or interactively from the python shell. All of the rc settings are stored in a dictionary-like variable called matplotlib.rcParams, which is global to the matplotlib package. rcParams can be modified directly, for example:

```
import matplotlib as mpl
mpl.rcParams['lines.linewidth'] = 2
mpl.rcParams['lines.color'] = 'r'
```

Matplotlib also provides a couple of convenience functions for modifying rc settings. The `matplotlib.rc()` command can be used to modify multiple settings in a single group at once, using keyword arguments:

```
import matplotlib as mpl
mpl.rc('lines', linewidth=2, color='r')
```

There `matplotlib.rcdefaults()` command will restore the standard matplotlib default settings.

There is some degree of validation when setting the values of rcParams, see `matplotlib.rcsetup` for details.

### 5.2.1 A sample matplotlibrc file

```
### MATPLOTLIBRC FORMAT
```

```
# This is a sample matplotlib configuration file - you can find a copy
# of it on your system in
# site-packages/matplotlib/mpl-data/matplotlibrc. If you edit it
# there, please note that it will be overridden in your next install.
# If you want to keep a permanent local copy that will not be
# over-written, place it in HOME/.matplotlib/matplotlibrc (unix/linux
# like systems) and C:\Documents and Settings\yourname\.matplotlib
# (win32 systems).
#
# This file is best viewed in a editor which supports python mode
# syntax highlighting. Blank lines, or lines starting with a comment
# symbol, are ignored, as are trailing comments. Other lines must
# have the format
#   key : val # optional comment
#
# Colors: for the color values below, you can either use - a
# matplotlib color string, such as r, k, or b - an rgb tuple, such as
# (1.0, 0.5, 0.0) - a hex string, such as ff00ff or #ff00ff - a scalar
# grayscale intensity such as 0.75 - a legal html color name, eg red,
# blue, darkslategray
```

```
#### CONFIGURATION BEGINS HERE
```

```
# the default backend; one of GTK GTKAgg GTKCairo CocoaAgg FltkAgg
# MacOSX QtAgg Qt4Agg TkAgg WX WXAgg Agg Cairo GDK PS PDF SVG Template
# You can also deploy your own backend outside of matplotlib by
# referring to the module name (which must be in the PYTHONPATH) as
# 'module://my_backend'
backend      : TkAgg
```

```

# If you are using the Qt4Agg backend, you can choose here
# to use the PyQt4 bindings or the newer PySide bindings to
# the underlying Qt4 toolkit.
#backend.qt4 : PyQt4          # PyQt4 | PySide

# Note that this can be overridden by the environment variable
# QT_API used by Enthought Tool Suite (ETS); valid values are
# "pyqt" and "pyside". The "pyqt" setting has the side effect of
# forcing the use of Version 2 API for QString and QVariant.

# if you are running pyplot inside a GUI and your backend choice
# conflicts, we will automatically try to find a compatible one for
# you if backend_fallback is True
#backend_fallback: True

#interactive : False
#toolbar      : toolbar2    # None | classic | toolbar2
#timezone      : UTC        # a pytz timezone string, eg US/Central or Europe/Paris

# Where your matplotlib data lives if you installed to a non-default
# location. This is where the matplotlib fonts, bitmaps, etc reside
#datapath : /home/jdhunter/mpldata

### LINES
# See http://matplotlib.sourceforge.net/api/artist\_api.html#module-matplotlib.lines for more
# information on line properties.
#lines.linewidth : 1.0      # line width in points
#lines.linestyle : -        # solid line
#lines.color      : blue
#lines.marker      : None    # the default marker
#lines.markeredgewidth : 0.5 # the line width around the marker symbol
#lines.markersize : 6        # markersize, in points
#lines.dash_joinstyle : miter # miter|round|bevel
#lines.dash_capstyle : butt   # butt|round|projecting
#lines.solid_joinstyle : miter # miter|round|bevel
#lines.solid_capstyle : projecting # butt|round|projecting
#lines.antialiased : True     # render lines in antialiased (no jaggies)

### PATCHES
# Patches are graphical objects that fill 2D space, like polygons or
# circles. See
# http://matplotlib.sourceforge.net/api/artist\_api.html#module-matplotlib.patches
# information on patch properties
#patch.linewidth : 1.0      # edge width in points
#patch.facecolor : blue
#patch.edgecolor : black
#patch.antialiased : True   # render patches in antialiased (no jaggies)

### FONT
#
# font properties used by text.Text. See
# http://matplotlib.sourceforge.net/api/font\_manager\_api.html for more

```

```
# information on font properties. The 6 font properties used for font
# matching are given below with their default values.
#
# The font.family property has five values: 'serif' (e.g. Times),
# 'sans-serif' (e.g. Helvetica), 'cursive' (e.g. Zapf-Chancery),
# 'fantasy' (e.g. Western), and 'monospace' (e.g. Courier). Each of
# these font families has a default list of font names in decreasing
# order of priority associated with them.
#
# The font.style property has three values: normal (or roman), italic
# or oblique. The oblique style will be used for italic, if it is not
# present.
#
# The font.variant property has two values: normal or small-caps. For
# TrueType fonts, which are scalable fonts, small-caps is equivalent
# to using a font size of 'smaller', or about 83% of the current font
# size.
#
# The font.weight property has effectively 13 values: normal, bold,
# bolder, lighter, 100, 200, 300, ..., 900. Normal is the same as
# 400, and bold is 700. bolder and lighter are relative values with
# respect to the current weight.
#
# The font.stretch property has 11 values: ultra-condensed,
# extra-condensed, condensed, semi-condensed, normal, semi-expanded,
# expanded, extra-expanded, ultra-expanded, wider, and narrower. This
# property is not currently implemented.
#
# The font.size property is the default font size for text, given in pts.
# 12pt is the standard value.
#
#font.family      : sans-serif
#font.style       : normal
#font.variant     : normal
#font.weight      : medium
#font.stretch     : normal
# note that font.size controls default text sizes. To configure
# special text sizes tick labels, axes, labels, title, etc, see the rc
# settings for axes and ticks. Special text sizes can be defined
# relative to font.size, using the following values: xx-small, x-small,
# small, medium, large, x-large, xx-large, larger, or smaller
#font.size        : 12.0
#font.serif       : Bitstream Vera Serif, New Century Schoolbook, Century Schoolbook L, Utopia, ITC L
#font.sans-serif  : Bitstream Vera Sans, Lucida Grande, Verdana, Geneva, Lucid, Arial, Helvetica, Av
#font.cursive     : Apple Chancery, Textile, Zapf Chancery, Sand, cursive
#font.fantasy     : Comic Sans MS, Chicago, Charcoal, Impact, Western, fantasy
#font.monospace   : Bitstream Vera Sans Mono, Andale Mono, Nimbus Mono L, Courier New, Courier, Fixe

### TEXT
# text properties used by text.Text. See
# http://matplotlib.sourceforge.net/api/artist\_api.html#module-matplotlib.text for more
# information on text properties
```



```

#text.color          : black

### LaTeX customizations. See http://www.scipy.org/Wiki/Cookbook/Matplotlib/UsingTex
#text.usetex         : False # use latex for all text handling. The following fonts
                             # are supported through the usual rc parameter settings:
                             # new century schoolbook, bookman, times, palatino,
                             # zapf chancery, charter, serif, sans-serif, helvetica,
                             # avant garde, courier, monospace, computer modern roman,
                             # computer modern sans serif, computer modern typewriter
                             # If another font is desired which can loaded using the
                             # LaTeX \usepackage command, please inquire at the
                             # matplotlib mailing list
#text.latex.unicode : False # use "ucs" and "inputenc" LaTeX packages for handling
                             # unicode strings.
#text.latex.preamble : # IMPROPER USE OF THIS FEATURE WILL LEAD TO LATEX FAILURES
                             # AND IS THEREFORE UNSUPPORTED. PLEASE DO NOT ASK FOR HELP
                             # IF THIS FEATURE DOES NOT DO WHAT YOU EXPECT IT TO.
                             # preamble is a comma separated list of LaTeX statements
                             # that are included in the LaTeX document preamble.
                             # An example:
                             # text.latex.preamble : \usepackage{bm},\usepackage{euler}
                             # The following packages are always loaded with usetex, so
                             # beware of package collisions: color, geometry, graphicx,
                             # typelcm, textcomp. Adobe Postscript (PSSNFS) font packages
                             # may also be loaded, depending on your font settings

#text.dvipnghack : None      # some versions of dvipng don't handle alpha
                             # channel properly. Use True to correct
                             # and flush ~/.matplotlib/tex.cache
                             # before testing and False to force
                             # correction off. None will try and
                             # guess based on your dvipng version

#text.hinting : True # If True, text will be hinted, otherwise not. This only
                     # affects the Agg backend.

# The following settings allow you to select the fonts in math mode.
# They map from a TeX font name to a fontconfig font pattern.
# These settings are only used if mathtext.fontset is 'custom'.
# Note that this "custom" mode is unsupported and may go away in the
# future.
#mathtext.cal : cursive
#mathtext.rm  : serif
#mathtext.tt  : monospace
#mathtext.it  : serif:italic
#mathtext.bf  : serif:bold
#mathtext.sf  : sans
#mathtext.fontset : cm # Should be 'cm' (Computer Modern), 'stix',
                       # 'stixsans' or 'custom'
#mathtext.fallback_to_cm : True # When True, use symbols from the Computer Modern
                                # fonts when a symbol can not be found in one of
                                # the custom math fonts.

```

```
#mathtext.default : it # The default font to use for math.
                        # Can be any of the LaTeX font names, including
                        # the special name "regular" for the same font
                        # used in regular text.

### AXES
# default face and edge color, default tick sizes,
# default fontsizes for ticklabels, and so on. See
# http://matplotlib.sourceforge.net/api/axes_api.html#module-matplotlib.axes
#axes.hold            : True      # whether to clear the axes by default on
#axes.facecolor       : white     # axes background color
#axes.edgecolor       : black     # axes edge color
#axes.linewidth       : 1.0      # edge linewidth
#axes.grid            : False     # display grid or not
#axes.titlesize       : large     # fontsize of the axes title
#axes.labelsize       : medium    # fontsize of the x and y labels
#axes.labelweight     : normal    # weight of the x and y labels
#axes.labelcolor      : black
#axes.axisbelow       : False     # whether axis gridlines and ticks are below
                                # the axes elements (lines, text, etc)
#axes.formatter.limits : -7, 7    # use scientific notation if log10
                                # of the axis range is smaller than the
                                # first or larger than the second
#axes.formatter.use_locale : False # When True, format tick labels
                                # according to the user's locale.
                                # For example, use ',' as a decimal
                                # separator in the fr_FR locale.
#axes.unicode_minus   : True      # use unicode for the minus symbol
                                # rather than hypen. See
                                # http://en.wikipedia.org/wiki/Plus_sign
#axes.color_cycle     : b, g, r, c, m, y, k # color cycle for plot lines
                                # as list of string colorspecs:
                                # single letter, long name, or
                                # web-style hex

#polaraxes.grid       : True      # display grid on polar axes
#axes3d.grid          : True      # display grid on 3d axes

### TICKS
# see http://matplotlib.sourceforge.net/api/axis_api.html#matplotlib.axis.Tick
#xtick.major.size     : 4         # major tick size in points
#xtick.minor.size     : 2         # minor tick size in points
#xtick.major.pad      : 4         # distance to major tick label in points
#xtick.minor.pad      : 4         # distance to the minor tick label in points
#xtick.color           : k        # color of the tick labels
#xtick.labelsize      : medium    # fontsize of the tick labels
#xtick.direction      : in       # direction: in or out

#ytick.major.size     : 4         # major tick size in points
#ytick.minor.size     : 2         # minor tick size in points
#ytick.major.pad      : 4         # distance to major tick label in points
#ytick.minor.pad      : 4         # distance to the minor tick label in points
#ytick.color          : k        # color of the tick labels
```

```

#ytick.labelsize      : medium # fontsize of the tick labels
#ytick.direction      : in     # direction: in or out

### GRIDS
#grid.color           : black  # grid color
#grid.linestyle       : :      # dotted
#grid.linewidth       : 0.5    # in points

### Legend
#legend.fancybox      : False  # if True, use a rounded box for the
                                # legend, else a rectangle

#legend.isaxes        : True
#legend.numpoints     : 2      # the number of points in the legend line
#legend.fontsize      : large
#legend.pad           : 0.0    # deprecated; the fractional whitespace inside the legend border
#legend.borderpad     : 0.5    # border whitespace in fontsize units
#legend.markerscale   : 1.0    # the relative size of legend markers vs. original
# the following dimensions are in axes coords
#legend.labelsep      : 0.010  # deprecated; the vertical space between the legend entries
#legend.labelspacing  : 0.5    # the vertical space between the legend entries in fraction of fontsize
#legend.handlelen     : 0.05   # deprecated; the length of the legend lines
#legend.handlelength  : 2.     # the length of the legend lines in fraction of fontsize
#legend.handleheight  : 0.7    # the height of the legend handle in fraction of fontsize
#legend.handletextsep : 0.02   # deprecated; the space between the legend line and legend text
#legend.handletextpad : 0.8    # the space between the legend line and legend text in fraction of fontsize
#legend.axespad       : 0.02   # deprecated; the border between the axes and legend edge
#legend.borderaxespad : 0.5    # the border between the axes and legend edge in fraction of fontsize
#legend.columnspacing : 2.     # the border between the axes and legend edge in fraction of fontsize
#legend.shadow        : False
#legend.frameon       : True   # whether or not to draw a frame around legend

### FIGURE
# See http://matplotlib.sourceforge.net/api/figure\_api.html#matplotlib.figure.Figure
#figure.figsize       : 8, 6   # figure size in inches
#figure.dpi           : 80     # figure dots per inch
#figure.facecolor     : 0.75   # figure facecolor; 0.75 is scalar gray
#figure.edgecolor     : white  # figure edgecolor

# The figure subplot parameters. All dimensions are fraction of the
# figure width or height
#figure.subplot.left   : 0.125 # the left side of the subplots of the figure
#figure.subplot.right  : 0.9    # the right side of the subplots of the figure
#figure.subplot.bottom : 0.1    # the bottom of the subplots of the figure
#figure.subplot.top    : 0.9    # the top of the subplots of the figure
#figure.subplot.wspace : 0.2    # the amount of width reserved for blank space between subplots
#figure.subplot.hspace : 0.2    # the amount of height reserved for white space between subplots

### IMAGES
#image.aspect : equal          # equal | auto | a number
#image.interpolation : bilinear # see help(imshow) for options
#image.cmap    : jet           # gray | jet etc...
#image.lut     : 256           # the size of the colormap lookup table

```

```
#image.origin : upper          # lower | upper
#image.resample : False

### CONTOUR PLOTS
#contour.negative_linestyle : dashed # dashed | solid

### Agg rendering
### Warning: experimental, 2008/10/10
#agg.path.chunksize : 0        # 0 to disable; values in the range
                                # 10000 to 100000 can improve speed slightly
                                # and prevent an Agg rendering failure
                                # when plotting very large data sets,
                                # especially if they are very gappy.
                                # It may cause minor artifacts, though.
                                # A value of 20000 is probably a good
                                # starting point.

### SAVING FIGURES
#path.simplify : True          # When True, simplify paths by removing "invisible"
                                # points to reduce file size and increase rendering
                                # speed
#path.simplify_threshold : 0.1 # The threshold of similarity below which
                                # vertices will be removed in the simplification
                                # process
#path.snap : True              # When True, rectilinear axis-aligned paths will be snapped to
                                # the nearest pixel when certain criteria are met. When False,
                                # paths will never be snapped.

# the default savefig params can be different from the display params
# Eg, you may want a higher resolution, or to make the figure
# background white
#savefig.dpi : 100             # figure dots per inch
#savefig.facecolor : white      # figure facecolor when saving
#savefig.edgecolor : white      # figure edgecolor when saving
#savefig.extension : auto       # what extension to use for savefig('foo'), or 'auto'

#cairo.format : png            # png, ps, pdf, svg

# tk backend params
#tk.window_focus : False       # Maintain shell focus for TkAgg

# ps backend params
#ps.papersize : letter          # auto, letter, legal, ledger, A0-A10, B0-B10
#ps.useafm : False              # use of afm fonts, results in small files
#ps.usedistiller : False        # can be: None, ghostscript or xpdf
                                # Experimental: may produce smaller files.
                                # xpdf intended for production of publication quality files,
                                # but requires ghostscript, xpdf and ps2eps

#ps.distiller.res : 6000        # dpi
#ps.fonttype : 3                # Output Type 3 (Type3) or Type 42 (TrueType)

# pdf backend params
#pdf.compression : 6            # integer from 0 to 9
                                # 0 disables compression (good for debugging)
```

```

#pdf.fonttype      : 3          # Output Type 3 (Type3) or Type 42 (TrueType)

# svg backend params
#svg.image_inline : True        # write raster image data directly into the svg file
#svg.image_noscale : False      # suppress scaling of raster data embedded in SVG
#svg.fonttype : 'path'         # How to handle SVG fonts:
#   'none': Assume fonts are installed on the machine where the SVG will be viewed.
#   'path': Embed characters as paths -- supported by most SVG renderers
#   'svgfont': Embed characters as SVG fonts -- supported only by Chrome,
#              Opera and Safari

# docstring params
#docstring.hardcopy = False    # set this when you want to generate hardcopy docstring

# Set the verbose flags. This controls how much information
# matplotlib gives you at runtime and where it goes. The verbosity
# levels are: silent, helpful, debug, debug-annoying. Any level is
# inclusive of all the levels below it. If your setting is "debug",
# you'll get all the debug and helpful messages. When submitting
# problems to the mailing-list, please set verbose to "helpful" or "debug"
# and paste the output into your report.
#
# The "fileo" gives the destination for any calls to verbose.report.
# These objects can a filename, or a filehandle like sys.stdout.
#
# You can override the rc default verbosity from the command line by
# giving the flags --verbose-LEVEL where LEVEL is one of the legal
# levels, eg --verbose-helpful.
#
# You can access the verbose instance in your code
#   from matplotlib import verbose.
#verbose.level : silent        # one of silent, helpful, debug, debug-annoying
#verbose.fileo : sys.stdout    # a log filename, sys.stdout or sys.stderr

# Event keys to interact with figures/plots via keyboard.
# Customize these settings according to your needs.
# Leave the field(s) empty if you don't need a key-map. (i.e., fullscreen : '')

#keymap.fullscreen : f          # toggling
#keymap.home : h, r, home      # home or reset mnemonic
#keymap.back : left, c, backspace # forward / backward keys to enable
#keymap.forward : right, v     # left handed quick navigation
#keymap.pan : p                # pan mnemonic
#keymap.zoom : o               # zoom mnemonic
#keymap.save : s               # saving current figure
#keymap.grid : g               # switching on/off a grid in current axes
#keymap.yscale : l             # toggle scaling of y-axes ('log'/'linear')
#keymap.xscale : L, k          # toggle scaling of x-axes ('log'/'linear')
#keymap.all_axes : a           # enable all axes

# Control downloading of example data. Various examples download some
# data from the Matplotlib git repository to avoid distributing extra
# files, but sometimes you want to avoid that. In that case set

```

```
# examples.download to False and examples.directory to the directory
# where you have a checkout of https://github.com/matplotlib/sample_data

examples.download : False # False to bypass downloading mechanism
examples.directory : '/usr/share/matplotlib/sampledata' # absolute directory to look in if download i
```

# USING MATPLOTLIB IN A PYTHON SHELL

By default, matplotlib defers drawing until the end of the script because drawing can be an expensive operation, and you may not want to update the plot every time a single property is changed, only once after all the properties have changed.

But when working from the python shell, you usually do want to update the plot with every command, eg, after changing the `xlabel()`, or the marker style of a line. While this is simple in concept, in practice it can be tricky, because matplotlib is a graphical user interface application under the hood, and there are some tricks to make the applications work right in a python shell.

## 6.1 Ipython to the rescue

Fortunately, `ipython`, an enhanced interactive python shell, has figured out all of these tricks, and is matplotlib aware, so when you start `ipython` in the *pylab* mode.

```
johnh@flag:~> ipython -pylab
Python 2.4.5 (#4, Apr 12 2008, 09:09:16)
IPython 0.9.0 -- An enhanced Interactive Python.

Welcome to pylab, a matplotlib-based Python environment.
For more information, type 'help(pylab)'.
```

```
In [1]: x = randn(10000)
```

```
In [2]: hist(x, 100)
```

it sets everything up for you so interactive plotting works as you would expect it to. Call `figure()` and a figure window pops up, call `plot()` and your data appears in the figure window.

Note in the example above that we did not import any matplotlib names because in *pylab* mode, `ipython` will import them automatically. `ipython` also turns on *interactive* mode for you, which causes every pyplot command to trigger a figure update, and also provides a matplotlib aware `run` command to run matplotlib scripts efficiently. `ipython` will turn off interactive mode during a `run` command, and then restore the interactive state at the end of the run so you can continue tweaking the figure manually.

There has been a lot of recent work to embed ipython, with pylab support, into various GUI applications, so check on the ipython mailing [list](#) for the latest status.

## 6.2 Other python interpreters

If you can't use ipython, and still want to use matplotlib/pylab from an interactive python shell, eg the plain-ole standard python interactive interpreter, or the interpreter in your favorite IDE, you are going to need to understand what a matplotlib backend is *What is a backend?*.

With the TkAgg backend, that uses the Tkinter user interface toolkit, you can use matplotlib from an arbitrary python shell. Just set your backend : TkAgg and interactive : True in your matplotlibrc file (see *Customizing matplotlib*) and fire up python. Then:

```
>>> from pylab import *
>>> plot([1,2,3])
>>> xlabel('hi mom')
```

should work out of the box. Note, in batch mode, ie when making figures from scripts, interactive mode can be slow since it redraws the figure with each command. So you may want to think carefully before making this the default behavior.

For other user interface toolkits and their corresponding matplotlib backends, the situation is complicated by the GUI mainloop which takes over the entire process. The solution is to run the GUI in a separate thread, and this is the tricky part that ipython solves for all the major toolkits that matplotlib supports. There are reports that upcoming versions of pygtk will place nicely with the standard python shell, so stay tuned.

## 6.3 Controlling interactive updating

The *interactive* property of the pyplot interface controls whether a figure canvas is drawn on every pyplot command. If *interactive* is *False*, then the figure state is updated on every plot command, but will only be drawn on explicit calls to `draw()`. When *interactive* is *True*, then every pyplot command triggers a draw.

The pyplot interface provides 4 commands that are useful for interactive control.

`isinteractive()` returns the interactive setting *True|False*

`ion()` turns interactive mode on

`ioff()` turns interactive mode off

`draw()` forces a figure redraw

When working with a big figure in which drawing is expensive, you may want to turn matplotlib's interactive setting off temporarily to avoid the performance hit:

```
>>> #create big-expensive-figure
>>> ioff()          # turn updates off
>>> title('now how much would you pay?')
>>> xticklabels(fontsize=20, color='green')
```



```
>>> draw()          # force a draw
>>> savefig('alldone', dpi=300)
>>> close()
>>> ion()           # turn updating back on
>>> plot(rand(20), mfc='g', mec='r', ms=40, mew=4, ls='--', lw=3)
```



# WORKING WITH TEXT

## 7.1 Text introduction

matplotlib has excellent text support, including mathematical expressions, truetype support for raster and vector outputs, newline separated text with arbitrary rotations, and unicode support. Because we embed the fonts directly in the output documents, eg for postscript or PDF, what you see on the screen is what you get in the hardcopy. `freetype2` support produces very nice, antialiased fonts, that look good even at small raster sizes. matplotlib includes its own `matplotlib.font_manager`, thanks to Paul Barrett, which implements a cross platform, W3C compliant font finding algorithm.

You have total control over every text property (font size, font weight, text location and color, etc) with sensible defaults set in the rc file. And significantly for those interested in mathematical or scientific figures, matplotlib implements a large number of TeX math symbols and commands, to support *mathematical expressions* anywhere in your figure.

## 7.2 Basic text commands

The following commands are used to create text in the pyplot interface

- `text()` - add text at an arbitrary location to the Axes; `matplotlib.axes.Axes.text()` in the API.
- `xlabel()` - add an axis label to the x-axis; `matplotlib.axes.Axes.set_xlabel()` in the API.
- `ylabel()` - add an axis label to the y-axis; `matplotlib.axes.Axes.set_ylabel()` in the API.
- `title()` - add a title to the Axes; `matplotlib.axes.Axes.set_title()` in the API.
- `figtext()` - add text at an arbitrary location to the Figure; `matplotlib.figure.Figure.text()` in the API.
- `suptitle()` - add a title to the Figure; `matplotlib.figure.Figure.suptitle()` in the API.
- `annotate()` - add an annotation, with optional arrow, to the Axes ; `matplotlib.axes.Axes.annotate()` in the API.

All of these functions create and return a `matplotlib.text.Text()` instance, which can be configured with a variety of font and other properties. The example below shows all of these commands in action.

```
# -*- coding: utf-8 -*-
import matplotlib.pyplot as plt

fig = plt.figure()
fig.suptitle('bold figure supitle', fontsize=14, fontweight='bold')

ax = fig.add_subplot(111)
fig.subplots_adjust(top=0.85)
ax.set_title('axes title')

ax.set_xlabel('xlabel')
ax.set_ylabel('ylabel')

ax.text(3, 8, 'boxed italics text in data coords', style='italic',
        bbox={'facecolor':'red', 'alpha':0.5, 'pad':10})

ax.text(2, 6, r'an equation:  $E=mc^2$ ', fontsize=15)

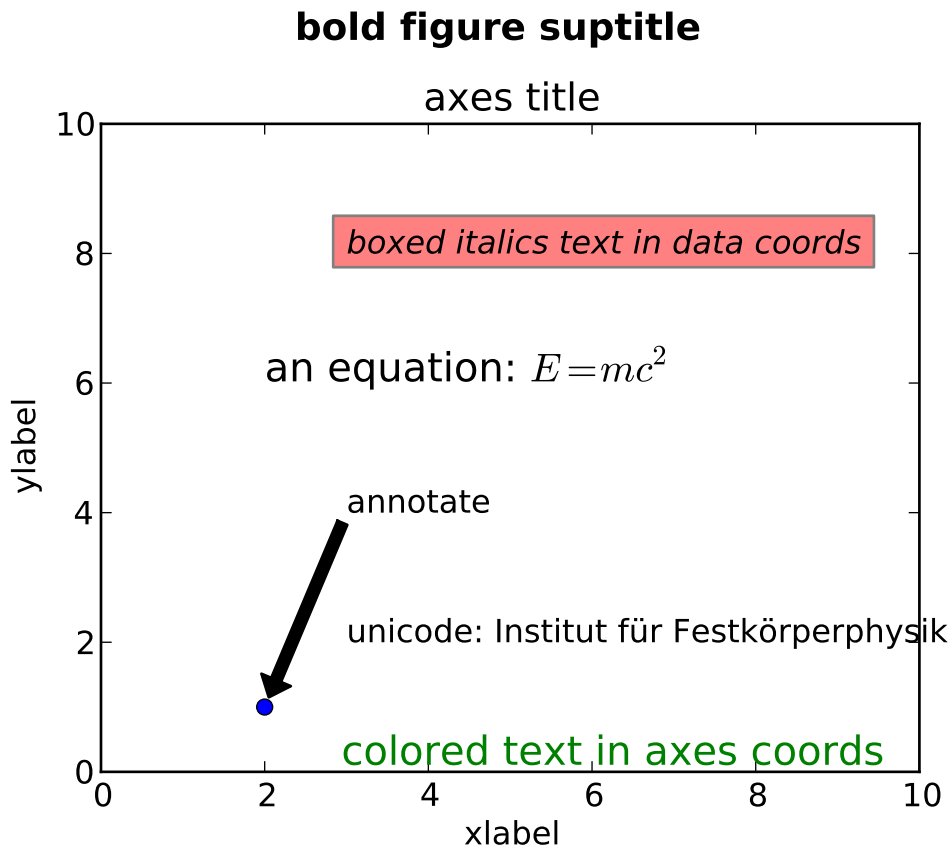
ax.text(3, 2, unicode('unicode: Institut f\374r Festk\366rperphysik', 'latin-1'))

ax.text(0.95, 0.01, 'colored text in axes coords',
        verticalalignment='bottom', horizontalalignment='right',
        transform=ax.transAxes,
        color='green', fontsize=15)

ax.plot([2], [1], 'o')
ax.annotate('annotate', xy=(2, 1), xytext=(3, 4),
            arrowprops=dict(facecolor='black', shrink=0.05))

ax.axis([0, 10, 0, 10])

plt.show()
```



### 7.3 Text properties and layout

The `matplotlib.text.Text` instances have a variety of properties which can be configured via keyword arguments to the text commands (eg `title()`, `xlabel()` and `text()`).

| Property                  | Value Type   |
|---------------------------|--|
| alpha                     | float  |
| backgroundcolor           | any matplotlib color   |
| bbox                      | rectangle prop dict plus key 'pad' which is a pad in points            |
| clip_box                  | a matplotlib.transform.Bbox instance                                   |
| clip_on                   | [True   False]   |
| clip_path                 | a Path instance and a Transform instance, a Patch                      |
| color                     | any matplotlib color   |
| family                    | [ 'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]       |
| fontproperties            | a matplotlib.font_manager.FontProperties instance                      |
| horizontalalignment or ha | [ 'center'   'right'   'left' ]  |
| label                     | any string   |
| linespacing               | float  |
| multialignment            | [ 'left'   'right'   'center' ]  |
| name or fontname          | string eg, [ 'Sans'   'Courier'   'Helvetica' ...]                     |
| picker                    | [None float boolean callable]  |
| position                  | (x,y)  |
| rotation                  | [ angle in degrees 'vertical'   'horizontal'                           |
| size or fontsize          | [ size in points   relative size eg 'smaller', 'x-large' ]             |
| style or fontstyle        | [ 'normal'   'italic'   'oblique' ]                                    |
| text                      | string or anything printable with '%s' conversion                      |
| transform                 | a matplotlib.transform transformation instance                         |
| variant                   | [ 'normal'   'small-caps' ]  |
| verticalalignment or va   | [ 'center'   'top'   'bottom'   'baseline' ]                           |
| visible                   | [True   False]   |
| weight or fontweight      | [ 'normal'   'bold'   'heavy'   'light'   'ultrabold'   'ultralight' ] |
| x                         | float  |
| y                         | float  |
| zorder                    | any number   |

You can layout text with the alignment arguments `horizontalalignment`, `verticalalignment`, and `multialignment`. `horizontalalignment` controls whether the `x` positional argument for the text indicates the left, center or right side of the text bounding box. `verticalalignment` controls whether the `y` positional argument for the text indicates the bottom, center or top side of the text bounding box. `multialignment`, for newline separated strings only, controls whether the different lines are left, center or right justified. Here is an example which uses the `text()` command to show the various alignment possibilities. The use of `transform=ax.transAxes` throughout the code indicates that the coordinates are given relative to the axes bounding box, with 0,0 being the lower left of the axes and 1,1 the upper right.

```
import matplotlib.pyplot as plt
import matplotlib.patches as patches

# build a rectangle in axes coords
left, width = .25, .5
bottom, height = .25, .5
right = left + width
top = bottom + height

fig = plt.figure()
```

---

```

ax = fig.add_axes([0,0,1,1])

# axes coordinates are 0,0 is bottom left and 1,1 is upper right
p = patches.Rectangle(
    (left, bottom), width, height,
    fill=False, transform=ax.transAxes, clip_on=False
)

ax.add_patch(p)

ax.text(left, bottom, 'left top',
        horizontalalignment='left',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(left, bottom, 'left bottom',
        horizontalalignment='left',
        verticalalignment='bottom',
        transform=ax.transAxes)

ax.text(right, top, 'right bottom',
        horizontalalignment='right',
        verticalalignment='bottom',
        transform=ax.transAxes)

ax.text(right, top, 'right top',
        horizontalalignment='right',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(right, bottom, 'center top',
        horizontalalignment='center',
        verticalalignment='top',
        transform=ax.transAxes)

ax.text(left, 0.5*(bottom+top), 'right center',
        horizontalalignment='right',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

ax.text(left, 0.5*(bottom+top), 'left center',
        horizontalalignment='left',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

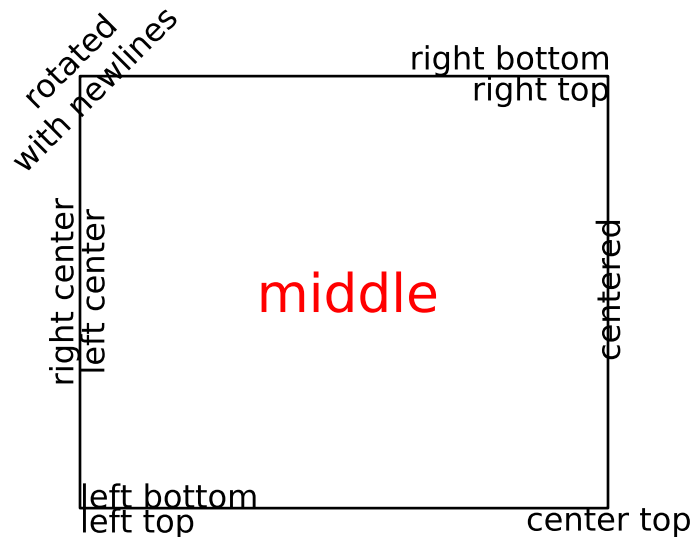
ax.text(0.5*(left+right), 0.5*(bottom+top), 'middle',
        horizontalalignment='center',
        verticalalignment='center',
        fontsize=20, color='red',
        transform=ax.transAxes)

```

```
ax.text(right, 0.5*(bottom+top), 'centered',
        horizontalalignment='center',
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

ax.text(left, top, 'rotated\nwith newlines',
        horizontalalignment='center',
        verticalalignment='center',
        rotation=45,
        transform=ax.transAxes)

ax.set_axis_off()
plt.show()
```



## 7.4 Writing mathematical expressions

You can use a subset TeX markup in any matplotlib text string by placing it inside a pair of dollar signs (\$).

Note that you do not need to have TeX installed, since matplotlib ships its own TeX expression parser, layout engine and fonts. The layout engine is a fairly direct adaptation of the layout algorithms in Donald Knuth's TeX, so the quality is quite good (matplotlib also provides a `usetex` option for those who do want to call out to TeX to generate their text (see [Text rendering With LaTeX](#)).



Any text element can use math text. You should use raw strings (precede the quotes with an `'r'`), and surround the math text with dollar signs (`$`), as in TeX. Regular text and mathtext can be interleaved within the same string. Mathtext can use the Computer Modern fonts (from (La)TeX), **STIX** fonts (which are designed to blend well with Times) or a Unicode font that you provide. The mathtext font can be selected with the customization variable `mathtext.fontset` (see [Customizing matplotlib](#))

**Note:** On “**narrow**” builds of Python, if you use the STIX fonts you should also set `ps.fonttype` and `pdf.fonttype` to 3 (the default), not 42. Otherwise [some characters will not be visible](#).

Here is a simple example:

```
# plain text
plt.title('alpha > beta')
```

produces “alpha > beta”.

Whereas this:

```
# math text
plt.title(r'$\alpha > \beta$')
```

produces “ $\alpha > \beta$ ”.

**Note:** Mathtext should be placed between a pair of dollar signs (`$`). To make it easy to display monetary values, e.g. “\$100.00”, if a single dollar sign is present in the entire string, it will be displayed verbatim as a dollar sign. This is a small change from regular TeX, where the dollar sign in non-math text would have to be escaped (`$`).

**Note:** While the syntax inside the pair of dollar signs (`$`) aims to be TeX-like, the text outside does not. In particular, characters such as:

```
# $ % & ~ _ ^ \ { } \ ( \ ) \ [ \ ]
```

have special meaning outside of math mode in TeX. Therefore, these characters will behave differently depending on the rcParam `text.usetex` flag. See the [usetex tutorial](#) for more information.

### 7.4.1 Subscripts and superscripts

To make subscripts and superscripts, use the `'_'` and `'^'` symbols:

```
r'$\alpha_i > \beta_i$'
```

$$\alpha_i > \beta_i \tag{7.1}$$

Some symbols automatically put their sub/superscripts under and over the operator. For example, to write the sum of  $x_i$  from 0 to  $\infty$ , you could do:

```
r'$\sum_{i=0}^{\infty} x_i$'
```

$$\sum_{i=0}^{\infty} x_i \tag{7.2}$$

### 7.4.2 Fractions, binomials and stacked numbers

Fractions, binomials and stacked numbers can be created with the `\frac{ }{ }`, `\binom{ }{ }` and `\stackrel{ }{ }` commands, respectively:

```
r'$\frac{3}{4} \binom{3}{4} \stackrel{3}{4}$'
```

produces

$$\frac{3}{4} \binom{3}{4} \stackrel{3}{4} \quad (7.3)$$

Fractions can be arbitrarily nested:

```
r'$\frac{5 - \frac{1}{x}}{4}$'
```

produces

$$\frac{5 - \frac{1}{x}}{4} \quad (7.4)$$

Note that special care needs to be taken to place parentheses and brackets around fractions. Doing things the obvious way produces brackets that are too small:

```
r'$(\frac{5 - \frac{1}{x}}{4})$'
```

$$\left(\frac{5 - \frac{1}{x}}{4}\right) \quad (7.5)$$

The solution is to precede the bracket with `\left` and `\right` to inform the parser that those brackets encompass the entire object:

```
r'$\left(\frac{5 - \frac{1}{x}}{4}\right)$'
```

$$\left(\frac{5 - \frac{1}{x}}{4}\right) \quad (7.6)$$

### 7.4.3 Radicals

Radicals can be produced with the `\sqrt[ ]{ }` command. For example:

```
r'$\sqrt{2}$'
```

$$\sqrt{2} \quad (7.7)$$

Any base can (optionally) be provided inside square brackets. Note that the base must be a simple expression, and can not contain layout commands such as fractions or sub/superscripts:

```
r'$\sqrt[3]{x}$'
```

$$\sqrt[3]{x} \quad (7.8)$$

### 7.4.4 Fonts

The default font is *italics* for mathematical symbols.

**Note:** This default can be changed using the `mathtext.default rcParam`. This is useful, for example, to use the same font as regular non-math text for math text, by setting it to `regular`.

To change fonts, eg, to write “sin” in a Roman font, enclose the text in a font command:

```
r'$s(t) = \mathcal{A}\mathrm{sin}(2 \omega t)$'
```

$$s(t) = \mathcal{A}\sin(2\omega t) \quad (7.9)$$

More conveniently, many commonly used function names that are typeset in a Roman font have shortcuts. So the expression above could be written as follows:

```
r'$s(t) = \mathcal{A}\sin(2 \omega t)$'
```

$$s(t) = \mathcal{A}\sin(2\omega t) \quad (7.10)$$

Here “s” and “t” are variable in italics font (default), “sin” is in Roman font, and the amplitude “A” is in calligraphy font. Note in the example above the calligraphy A is squished into the sin. You can use a spacing command to add a little whitespace between them:

```
s(t) = \mathcal{A}\ /\sin(2 \omega t)
```

$$s(t) = \mathcal{A}\sin(2\omega t) \quad (7.11)$$

The choices available with all fonts are:

| Command                            | Result             |
|------------------------------------|--------------------|
| <code>\mathrm{Roman}</code>        | Roman              |
| <code>\mathit{Italic}</code>       | <i>Italic</i>      |
| <code>\mathtt{Typewriter}</code>   | Typewriter         |
| <code>\mathcal{CALLIGRAPHY}</code> | <i>CALLIGRAPHY</i> |

When using the **STIX** fonts, you also have the choice of:

| Command                                   | Result         |
|---|----------------|
| <code>\mathbb{blackboard}</code>          | $\mathbb{A}$   |
| <code>\mathrm{\mathbb{blackboard}}</code> | $\mathbb{A}$   |
| <code>\mathfrak{Fraktur}</code>           | $\mathfrak{A}$ |
| <code>\mathsf{sansserif}</code>           | sansserif      |
| <code>\mathrm{\mathsf{sansserif}}</code>  | sansserif      |

There are also three global “font sets” to choose from, which are selected using the `mathtext.fontset` parameter in *matplotlibrc*.

cm: Computer Modern (TeX)

$$\mathcal{R} \prod_{i=\alpha_i+1}^{\infty} a_i \sin(2\pi f x_i)$$

stix: STIX (designed to blend well with Times)

$$\mathcal{R} \prod_{i=\alpha_{i+1}}^{\infty} a_i \sin(2\pi f x_i)$$

stixsans: STIX sans-serif

$$\mathcal{R} \prod_{i=\alpha_{i+1}}^{\infty} a_i \sin(2\pi f x_i)$$

Additionally, you can use `\mathdefault{...}` or its alias `\mathregular{...}` to use the font used for regular text outside of `mathtext`. There are a number of limitations to this approach, most notably that far fewer symbols will be available, but it can be useful to make math expressions blend well with other text in the plot.

## Custom fonts

`mathtext` also provides a way to use custom fonts for math. This method is fairly tricky to use, and should be considered an experimental feature for patient users only. By setting the rcParam `mathtext.fontset` to `custom`, you can then set the following parameters, which control which font file to use for a particular set of math characters.

| Parameter                 | Corresponds to                                |
|---------------------------|---|
| <code>mathtext.it</code>  | <code>\mathit{}</code> or default italic      |
| <code>mathtext.rm</code>  | <code>\mathrm{}</code> Roman (upright)        |
| <code>mathtext.tt</code>  | <code>\mathtt{}</code> Typewriter (monospace) |
| <code>mathtext.bf</code>  | <code>\mathbf{}</code> bold italic            |
| <code>mathtext.cal</code> | <code>\mathcal{}</code> calligraphic          |
| <code>mathtext.sf</code>  | <code>\mathsf{}</code> sans-serif             |

Each parameter should be set to a fontconfig font descriptor (as defined in the yet-to-be-written font chapter).

The fonts used should have a Unicode mapping in order to find any non-Latin characters, such as Greek. If you want to use a math symbol that is not contained in your custom fonts, you can set the rcParam `mathtext.fallback_to_cm` to `True` which will cause the `mathtext` system to use characters from the default Computer Modern fonts whenever a particular character can not be found in the custom font.

Note that the math glyphs specified in Unicode have evolved over time, and many fonts may not have glyphs in the correct place for `mathtext`.

### 7.4.5 Accents

An accent command may precede any symbol to add an accent above it. There are long and short forms for some of them.

| Command                                   | Result           |
|---|------------------|
| <code>\acute a</code> or <code>\'a</code> | $\acute{a}$      |
| <code>\bar a</code>                       | $\bar{a}$        |
| <code>\breve a</code>                     | $\breve{a}$      |
| <code>\ddot a</code> or <code>\"a</code>  | $\ddot{a}$       |
| <code>\dot a</code> or <code>\.a</code>   | $\dot{a}$        |
| <code>\grave a</code> or <code>\`a</code> | $\grave{a}$      |
| <code>\hat a</code> or <code>\^a</code>   | $\hat{a}$        |
| <code>\tilde a</code> or <code>\~a</code> | $\tilde{a}$      |
| <code>\vec a</code>                       | $\vec{a}$        |
| <code>\overline{abc}</code>               | $\overline{abc}$ |

In addition, there are two special accents that automatically adjust to the width of the symbols below:

| Command                      | Result            |
|------------------------------|-------------------|
| <code>\widehat{xyz}</code>   | $\widehat{xyz}$   |
| <code>\widetilde{xyz}</code> | $\widetilde{xyz}$ |

Care should be taken when putting accents on lower-case i's and j's. Note that in the following `\imath` is used to avoid the extra dot over the i:

```
r"$\hat i\ \ \hat \imath$"
```

$$\hat{i} \quad \hat{\imath} \quad (7.12)$$

## 7.4.6 Symbols

You can also use a large number of the TeX symbols, as in `\infty`, `\leftarrow`, `\sum`, `\int`.

### Lower-case Greek

|                                  |                                  |  |                                    |                                |
|----------------------------------|----------------------------------|--|------------------------------------|--------------------------------|
| $\alpha$ <code>\alpha</code>     | $\beta$ <code>\beta</code>       | $\chi$ <code>\chi</code>               | $\delta$ <code>\delta</code>       | $F$ <code>\digamma</code>      |
| $\epsilon$ <code>\epsilon</code> | $\eta$ <code>\eta</code>         | $\gamma$ <code>\gamma</code>           | $\iota$ <code>\iota</code>         | $\kappa$ <code>\kappa</code>   |
| $\lambda$ <code>\lambda</code>   | $\mu$ <code>\mu</code>           | $\nu$ <code>\nu</code>                 | $\omega$ <code>\omega</code>       | $\phi$ <code>\phi</code>       |
| $\pi$ <code>\pi</code>           | $\psi$ <code>\psi</code>         | $\rho$ <code>\rho</code>               | $\sigma$ <code>\sigma</code>       | $\tau$ <code>\tau</code>       |
| $\theta$ <code>\theta</code>     | $\upsilon$ <code>\upsilon</code> | $\varepsilon$ <code>\varepsilon</code> | $\varkappa$ <code>\varkappa</code> | $\varphi$ <code>\varphi</code> |
| $\varpi$ <code>\varpi</code>     | $\varrho$ <code>\varrho</code>   | $\varsigma$ <code>\varsigma</code>     | $\vartheta$ <code>\vartheta</code> | $\xi$ <code>\xi</code>         |
| $\zeta$ <code>\zeta</code>       |                                  |  |                                    |                                |

### Upper-case Greek

|                              |                              |                                |                                  |                          |                              |
|------------------------------|------------------------------|--------------------------------|----------------------------------|--------------------------|------------------------------|
| $\Delta$ <code>\Delta</code> | $\Gamma$ <code>\Gamma</code> | $\Lambda$ <code>\Lambda</code> | $\Omega$ <code>\Omega</code>     | $\Phi$ <code>\Phi</code> | $\Pi$ <code>\Pi</code>       |
| $\Psi$ <code>\Psi</code>     | $\Sigma$ <code>\Sigma</code> | $\Theta$ <code>\Theta</code>   | $\Upsilon$ <code>\Upsilon</code> | $\Xi$ <code>\Xi</code>   | $\Upsilon$ <code>\mho</code> |
| $\nabla$ <code>\nabla</code> |                              |                                |                                  |                          |                              |

### Hebrew

|                              |                            |                                |                              |
|------------------------------|----------------------------|--------------------------------|------------------------------|
| $\aleph$ <code>\aleph</code> | $\beth$ <code>\beth</code> | $\daleth$ <code>\daleth</code> | $\gimel$ <code>\gimel</code> |
|------------------------------|----------------------------|--------------------------------|------------------------------|

### Delimiters

|              |           |              |             |             |              |
|--------------|-----------|--------------|-------------|-------------|--------------|
| //           | [ [       | ↓ \Downarrow | ↑ \Uparrow  | \Vert       | \ \backslash |
| ↓ \downarrow | < \langle | ⌈ \lceil     | ⌊ \lfloor   | ⌞ \llcorner | ⌟ \lrcorner  |
| > \rangle    | ⌋ \rceil  | ⌋ \rfloor    | ⌜ \ulcorner | ↑ \uparrow  | ⌞ \urcorner  |
| \vert        | { \{      | \            | } \}        | ] \]        | \            |

### Big symbols

|                       |                   |                       |                       |                         |
|-----------------------|-------------------|-----------------------|-----------------------|-------------------------|
| $\bigcap$ \bigcap     | $\bigcup$ \bigcup | $\bigodot$ \bigodot   | $\bigoplus$ \bigoplus | $\bigotimes$ \bigotimes |
| $\biguplus$ \biguplus | $\bigvee$ \bigvee | $\bigwedge$ \bigwedge | $\coprod$ \coprod     | $\int$ \int             |
| $\oint$ \oint         | $\prod$ \prod     | $\sum$ \sum           |                       |                         |

### Standard function names

|                 |                 |                |                |
|-----------------|-----------------|----------------|----------------|
| Pr \Pr          | arccos \arccos  | arcsin \arcsin | arctan \arctan |
| arg \arg        | cos \cos        | cosh \cosh     | cot \cot       |
| coth \coth      | csc \csc        | deg \deg       | det \det       |
| dim \dim        | exp \exp        | gcd \gcd       | hom \hom       |
| inf \inf        | ker \ker        | lg \lg         | lim \lim       |
| lim inf \liminf | lim sup \limsup | ln \ln         | log \log       |
| max \max        | min \min        | sec \sec       | sin \sin       |
| sinh \sinh      | sup \sup        | tan \tan       | tanh \tanh     |

### Binary operation and relation symbols

|                                 |   |   |
|---------------------------------|---|---|
| $\approx$ \Bumpeq               | $\cap$ \Cap                             | $\cup$ \Cup                               |
| $\doteq$ \Doteq                 | $\Join$ \Join                           | $\subseteq$ \Subset                       |
| $\supseteq$ \Supset             | $\Vdash$ \Vdash                         | $\Vdash$ \Vdash                           |
| $\approx$ \approx               | $\approx$ \approxeq                     | $*$ \ast                                  |
| $\asymp$ \asymp                 | $\backepsilon$ \backepsilon             | $\sim$ \backsim                           |
| $\backsimeq$ \backsimeq         | $\bar{\wedge}$ \barwedge                | $\because$ \because                       |
| $\between$ \between             | $\bigcirc$ \bigcirc                     | $\bigtriangledown$ \bigtriangledown       |
| $\bigtriangleup$ \bigtriangleup | $\blacktriangleleft$ \blacktriangleleft | $\blacktriangleright$ \blacktriangleright |
| $\bot$ \bot                     | $\bowtie$ \bowtie                       | $\boxdot$ \boxdot                         |
| $\boxminus$ \boxminus           | $\boxplus$ \boxplus                     | $\boxtimes$ \boxtimes                     |
| $\bullet$ \bullet               | $\bumpeq$ \bumpeq                       | $\cap$ \cap                               |
| $\cdot$ \cdot                   | $\circ$ \circ                           | $\circ$ \circ                             |
| $\coloneqq$ \coloneqq           | $\cong$ \cong                           | $\cup$ \cup                               |
| $\curlyeqprec$ \curlyeqprec     | $\curlyeqsucc$ \curlyeqsucc             | $\curlyvee$ \curlyvee                     |
| $\curlywedge$ \curlywedge       | $\dagger$ \dag                          | $\dashv$ \dashv                           |
| $\ddag$ \ddag                   | $\diamond$ \diamond                     | $\div$ \div                               |
| $\divideontimes$ \divideontimes | $\doteq$ \doteq                         | $\doteqdot$ \doteqdot                     |
| $\dotplus$ \dotplus             | $\doublebarwedge$ \doublebarwedge       | $\eqcirc$ \eqcirc                         |
| $\eqcolon$ \eqcolon             | $\eqsim$ \eqsim                         | $\eqslantgtr$ \eqslantgtr                 |
| $\eqslantless$ \eqslantless     | $\equiv$ \equiv                         | $\fallingdotseq$ \fallingdotseq           |

|  |                                      |  |
|--|--------------------------------------|--|
| $\frown$ <code>\frown</code>           | $\geq$ <code>\geq</code>             | $\geq$ <code>\geqq</code>                      |
| $\geq$ <code>\geqslant</code>          | $\gg$ <code>\gg</code>               | $\ggg$ <code>\ggg</code>                       |
| $\approx$ <code>\gnapprox</code>       | $\gtrapprox$ <code>\gneqq</code>     | $\gtrsim$ <code>\gnsim</code>                  |
| $\gtrapprox$ <code>\gtrapprox</code>   | $\gtrdot$ <code>\gtrdot</code>       | $\gtrless$ <code>\gtreqless</code>             |
| $\gtreqless$ <code>\gtreqless</code>   | $\gtrless$ <code>\gtrless</code>     | $\gtrsim$ <code>\gtrsim</code>                 |
| $\in$ <code>\in</code>                 | $\intercal$ <code>\intercal</code>   | $\leftthreetimes$ <code>\leftthreetimes</code> |
| $\leq$ <code>\leq</code>               | $\leq$ <code>\leqq</code>            | $\leq$ <code>\leqslant</code>                  |
| $\lessapprox$ <code>\lessapprox</code> | $\lessdot$ <code>\lessdot</code>     | $\lesseqgtr$ <code>\lesseqgtr</code>           |
| $\lesseqgtr$ <code>\lesseqgtr</code>   | $\lessgtr$ <code>\lessgtr</code>     | $\lesssim$ <code>\lesssim</code>               |
| $\ll$ <code>\ll</code>                 | $\lll$ <code>\lll</code>             | $\lnapprox$ <code>\lnapprox</code>             |
| $\lneqq$ <code>\lneqq</code>           | $\lnsim$ <code>\lnsim</code>         | $\ltimes$ <code>\ltimes</code>                 |
| $\mid$ <code>\mid</code>               | $\models$ <code>\models</code>       | $\mp$ <code>\mp</code>                         |
| $\nVDash$ <code>\nVDash</code>         | $\nVdash$ <code>\nVdash</code>       | $\napprox$ <code>\napprox</code>               |
| $\ncong$ <code>\ncong</code>           | $\neq$ <code>\neq</code>             | $\neq$ <code>\neq</code>                       |
| $\neq$ <code>\neq</code>               | $\nequiv$ <code>\nequiv</code>       | $\ngeq$ <code>\ngeq</code>                     |
| $\ngtr$ <code>\ngtr</code>             | $\ni$ <code>\ni</code>               | $\nleq$ <code>\nleq</code>                     |
| $\nless$ <code>\nless</code>           | $\nmid$ <code>\nmid</code>           | $\notin$ <code>\notin</code>                   |
| $\nparallel$ <code>\nparallel</code>   | $\nprec$ <code>\nprec</code>         | $\nsim$ <code>\nsim</code>                     |
| $\nsubset$ <code>\nsubset</code>       | $\nsubseteq$ <code>\nsubseteq</code> | $\nsucc$ <code>\nsucc</code>                   |
| $\nsupset$ <code>\nsupset</code>       | $\nsubseteq$ <code>\nsubseteq</code> | $\ntriangleleft$ <code>\ntriangleleft</code>   |

|  |  |  |
|--|--|--|
| $\ntrianglelefteq$ <code>\ntrianglelefteq</code> | $\ntriangleright$ <code>\ntriangleright</code>   | $\ntrianglerighteq$ <code>\ntrianglerighteq</code> |
| $\nvDash$ <code>\nvDash</code>                   | $\nvDash$ <code>\nvDash</code>                   | $\odot$ <code>\odot</code>                         |
| $\ominus$ <code>\ominus</code>                   | $\oplus$ <code>\oplus</code>                     | $\oslash$ <code>\oslash</code>                     |
| $\otimes$ <code>\otimes</code>                   | $\parallel$ <code>\parallel</code>               | $\perp$ <code>\perp</code>                         |
| $\pitchfork$ <code>\pitchfork</code>             | $\pm$ <code>\pm</code>                           | $\prec$ <code>\prec</code>                         |
| $\preccurlyeq$ <code>\preccurlyeq</code>         | $\preccurlyeq$ <code>\preccurlyeq</code>         | $\preceq$ <code>\preceq</code>                     |
| $\precnapprox$ <code>\precnapprox</code>         | $\precnsim$ <code>\precnsim</code>               | $\precsim$ <code>\precsim</code>                   |
| $\propto$ <code>\propto</code>                   | $\rightthreetimes$ <code>\rightthreetimes</code> | $\risingdotseq$ <code>\risingdotseq</code>         |
| $\rtimes$ <code>\rtimes</code>                   | $\sim$ <code>\sim</code>                         | $\simeq$ <code>\simeq</code>                       |
| $\slash$ <code>\slash</code>                     | $\smile$ <code>\smile</code>                     | $\sqcap$ <code>\sqcap</code>                       |
| $\sqcup$ <code>\sqcup</code>                     | $\sqsubset$ <code>\sqsubset</code>               | $\sqsubset$ <code>\sqsubset</code>                 |
| $\sqsubseteq$ <code>\sqsubseteq</code>           | $\sqsupset$ <code>\sqsupset</code>               | $\sqsupset$ <code>\sqsupset</code>                 |
| $\sqsupseteq$ <code>\sqsupseteq</code>           | $\star$ <code>\star</code>                       | $\subset$ <code>\subset</code>                     |
| $\subseteq$ <code>\subseteq</code>               | $\subseteq$ <code>\subseteq</code>               | $\subsetneq$ <code>\subsetneq</code>               |
| $\subsetneqq$ <code>\subsetneqq</code>           | $\succ$ <code>\succ</code>                       | $\succapprox$ <code>\succapprox</code>             |
| $\succcurlyeq$ <code>\succcurlyeq</code>         | $\succeq$ <code>\succeq</code>                   | $\succnapprox$ <code>\succnapprox</code>           |
| $\succsim$ <code>\succsim</code>                 | $\succsim$ <code>\succsim</code>                 | $\supset$ <code>\supset</code>                     |
| $\supseteq$ <code>\supseteq</code>               | $\supseteq$ <code>\supseteq</code>               | $\supsetneq$ <code>\supsetneq</code>               |
| $\supsetneqq$ <code>\supsetneqq</code>           | $\therefore$ <code>\therefore</code>             | $\times$ <code>\times</code>                       |
| $\top$ <code>\top</code>                         | $\triangleleft$ <code>\triangleleft</code>       | $\trianglelefteq$ <code>\trianglelefteq</code>     |

|  |  |  |
|--|--|--|
| $\trianglelefteq$ <code>\trianglelefteq</code>   | $\triangleright$ <code>\triangleright</code>       | $\trianglerighteq$ <code>\trianglerighteq</code> |
| $\uplus$ <code>\uplus</code>                     | $\vDash$ <code>\vDash</code>                       | $\varpropto$ <code>\varpropto</code>             |
| $\vartriangleleft$ <code>\vartriangleleft</code> | $\vartriangleright$ <code>\vartriangleright</code> | $\vdash$ <code>\vdash</code>                     |
| $\vee$ <code>\vee</code>                         | $\veebar$ <code>\veebar</code>                     | $\wedge$ <code>\wedge</code>                     |
| $\wr$ <code>\wr</code>                           |  |  |

### Arrow symbols

|  |  |
|--|--|
| $\Downarrow$ <code>\Downarrow</code>                     | $\Leftarrow$ <code>\Leftarrow</code>                   |
| $\Leftrightarrow$ <code>\Leftrightarrow</code>           | $\Lleftarrow$ <code>\Lleftarrow</code>                 |
| $\Longleftarrow$ <code>\Longleftarrow</code>             | $\Longleftrightarrow$ <code>\Longleftrightarrow</code> |
| $\Longrightarrow$ <code>\Longrightarrow</code>           | $\Lsh$ <code>\Lsh</code>                               |
| $\nearrow$ <code>\nearrow</code>                         | $\Nrightarrow$ <code>\Nrightarrow</code>               |
| $\Rightarrow$ <code>\Rightarrow</code>                   | $\Rrightarrow$ <code>\Rrightarrow</code>               |
| $\Rsh$ <code>\Rsh</code>                                 | $\searrow$ <code>\searrow</code>                       |
| $\swarrow$ <code>\swarrow</code>                         | $\Uparrow$ <code>\Uparrow</code>                       |
| $\Updownarrow$ <code>\Updownarrow</code>                 | $\circlearrowleft$ <code>\circlearrowleft</code>       |
| $\circlearrowright$ <code>\circlearrowright</code>       | $\curvearrowleft$ <code>\curvearrowleft</code>         |
| $\curvearrowright$ <code>\curvearrowright</code>         | $\dashleftarrow$ <code>\dashleftarrow</code>           |
| $\dashrightarrow$ <code>\dashrightarrow</code>           | $\downarrow$ <code>\downarrow</code>                   |
| $\downdownarrows$ <code>\downdownarrows</code>           | $\Downharpoonleft$ <code>\Downharpoonleft</code>       |
| $\downharpoonright$ <code>\downharpoonright</code>       | $\hookleftarrow$ <code>\hookleftarrow</code>           |
| $\hookrightarrow$ <code>\hookrightarrow</code>           | $\leadsto$ <code>\leadsto</code>                       |
| $\leftarrow$ <code>\leftarrow</code>                     | $\leftarrowtail$ <code>\leftarrowtail</code>           |
| $\leftharpoondown$ <code>\leftharpoondown</code>         | $\leftharpoonup$ <code>\leftharpoonup</code>           |
| $\leftleftarrows$ <code>\leftleftarrows</code>           | $\leftrightarrow$ <code>\leftrightarrow</code>         |
| $\leftrightarrows$ <code>\leftrightarrows</code>         | $\leftrightharpoons$ <code>\leftrightharpoons</code>   |
| $\leftrightsquigarrow$ <code>\leftrightsquigarrow</code> | $\leftsquigarrow$ <code>\leftsquigarrow</code>         |

|  |  |
|--|--|
| $\longleftarrow$ <code>\longleftarrow</code>       | $\longleftrightarrow$ <code>\longleftrightarrow</code> |
| $\longmapsto$ <code>\longmapsto</code>             | $\longrightarrow$ <code>\longrightarrow</code>         |
| $\looparrowleft$ <code>\looparrowleft</code>       | $\looparrowright$ <code>\looparrowright</code>         |
| $\mapsto$ <code>\mapsto</code>                     | $\multimap$ <code>\multimap</code>                     |
| $\nLeftarrow$ <code>\nLeftarrow</code>             | $\nLeftrightarrow$ <code>\nLeftrightarrow</code>       |
| $\nRightarrow$ <code>\nRightarrow</code>           | $\nearrow$ <code>\nearrow</code>                       |
| $\nleftarrow$ <code>\nleftarrow</code>             | $\nleftrightarrow$ <code>\nleftrightarrow</code>       |
| $\rightarrow$ <code>\rightarrow</code>             | $\nwarrow$ <code>\nwarrow</code>                       |
| $\rightarrowtail$ <code>\rightarrowtail</code>     | $\rightarrowtail$ <code>\rightarrowtail</code>         |
| $\rightharpoondown$ <code>\rightharpoondown</code> | $\rightharpoonup$ <code>\rightharpoonup</code>         |
| $\rightrightarrows$ <code>\rightrightarrows</code> | $\rightleftarrows$ <code>\rightleftarrows</code>       |
| $\rightsquigarrow$ <code>\rightsquigarrow</code>   | $\rightleftharpoons$ <code>\rightleftharpoons</code>   |
| $\swarrow$ <code>\swarrow</code>                   | $\righttrightarrows$ <code>\righttrightarrows</code>   |
| $\twoheadleftarrow$ <code>\twoheadleftarrow</code> | $\searrow$ <code>\searrow</code>                       |
| $\uparrow$ <code>\uparrow</code>                   | $\rightarrow$ <code>\rightarrow</code>                 |
| $\updownarrow$ <code>\updownarrow</code>           | $\twoheadrightarrow$ <code>\twoheadrightarrow</code>   |
| $\upharpoonright$ <code>\upharpoonright</code>     | $\Updownarrow$ <code>\Updownarrow</code>               |
|  | $\Upharpoonleft$ <code>\Upharpoonleft</code>           |
|  | $\Upuparrows$ <code>\Upuparrows</code>                 |



### Miscellaneous symbols



|                              |                                 |                            |
|------------------------------|---------------------------------|----------------------------|
| $\$ \backslash \$$           | $\AA \backslash AA$             | $\Finv \backslash Finv$    |
| $\Game \backslash Game$      | $\Im \backslash Im$             | $\P \backslash P$          |
| $\Re \backslash Re$          | $\S \backslash S$               | $\angle \backslash angle$  |
| $\backprime \backprime$      | $\bigstar \backprime$           | $\blacksquare \backprime$  |
| $\blacktriangle \backprime$  | $\blacktriangledown \backprime$ | $\cdots \backprime$        |
| $\checkmark \backprime$      | $\circledR \backprime$          | $\circledS \backprime$     |
| $\clubsuit \backprime$       | $\complement \backprime$        | $\copyright \backprime$    |
| $\ddots \backprime$          | $\diamondsuit \backprime$       | $\ell \backprime$          |
| $\emptyset \backprime$       | $\eth \backprime$               | $\exists \backprime$       |
| $\flat \backprime$           | $\forall \backprime$            | $\hbar \backprime$         |
| $\heartsuit \backprime$      | $\hslash \backprime$            | $\iiint \backprime$        |
| $\iint \backprime$           | $\iint \backprime$              | $\imath \backprime$        |
| $\infty \backprime$          | $\jmath \backprime$             | $\ldots \backprime$        |
| $\measuredangle \backprime$  | $\natural \backprime$           | $\neg \backprime$          |
| $\nexists \backprime$        | $\oiint \backprime$             | $\partial \backprime$      |
| $\prime \backprime$          | $\sharp \backprime$             | $\spadesuit \backprime$    |
| $\sphericalangle \backprime$ | $\ss \backprime$                | $\triangledown \backprime$ |
| $\varnothing \backprime$     | $\vartriangle \backprime$       | $\vdots \backprime$        |
| $\wp \backprime$             | $\yen \backprime$               |                            |

If a particular symbol does not have a name (as is true of many of the more obscure symbols in the STIX fonts), Unicode characters can also be used:

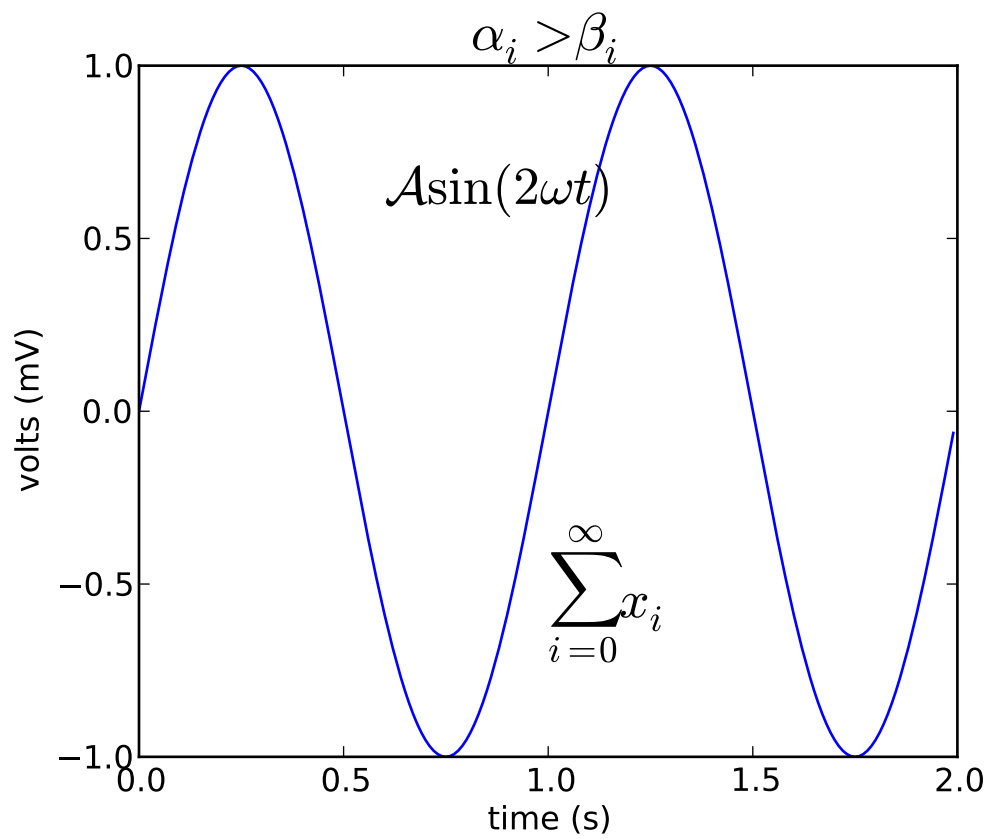
```
ur'$\u23ce$'
```

### 7.4.7 Example

Here is an example illustrating many of these features in context.

```
import numpy as np
import matplotlib.pyplot as plt
t = np.arange(0.0, 2.0, 0.01)
s = np.sin(2*np.pi*t)

plt.plot(t,s)
plt.title(r'$\alpha_i > \beta_i$', fontsize=20)
plt.text(1, -0.6, r'$\sum_{i=0}^{\infty} x_i$', fontsize=20)
plt.text(0.6, 0.6, r'$\mathcal{A} \mathrm{sin}(2 \omega t)$',
         fontsize=20)
plt.xlabel('time (s)')
plt.ylabel('volts (mV)')
```



## 7.5 Text rendering With LaTeX

Matplotlib has the option to use LaTeX to manage all text layout. This option is available with the following backends:

- Agg
- PS
- PDF

The LaTeX option is activated by setting `text.usetex : True` in your rc settings. Text handling with matplotlib's LaTeX support is slower than matplotlib's very capable *mathtext*, but is more flexible, since different LaTeX packages (font packages, math packages, etc.) can be used. The results can be striking, especially when you take care to use the same fonts in your figures as in the main document.

Matplotlib's LaTeX support requires a working LaTeX installation, *dvipng* (which may be included with your LaTeX installation), and *Ghostscript* (GPL Ghostscript 8.60 or later is recommended). The executables for these external dependencies must all be located on your **PATH**.

There are a couple of options to mention, which can be changed using *rc settings*. Here is an example matplotlibrc file:

```
font.family      : serif
font.serif       : Times, Palatino, New Century Schoolbook, Bookman, Computer Modern Roman
font.sans-serif   : Helvetica, Avant Garde, Computer Modern Sans serif
font.cursive     : Zapf Chancery
font.monospace   : Courier, Computer Modern Typewriter

text.usetex      : true
```

The first valid font in each family is the one that will be loaded. If the fonts are not specified, the Computer Modern fonts are used by default. All of the other fonts are Adobe fonts. Times and Palatino each have their own accompanying math fonts, while the other Adobe serif fonts make use of the Computer Modern math fonts. See the [PSNFSS](#) documentation for more details.

To use LaTeX and select Helvetica as the default font, without editing `matplotlibrc` use:

```
from matplotlib import rc
rc('font', **{'family': 'sans-serif', 'sans-serif': ['Helvetica']})
## for Palatino and other serif fonts use:
#rc('font', **{'family': 'serif', 'serif': ['Palatino']})
rc('text', usetex=True)
```

Here is the standard example, `tex_demo.py`:

```
#!/usr/bin/env python
"""
You can use TeX to render all of your matplotlib text if the rc
parameter text.usetex is set. This works currently on the agg and ps
backends, and requires that you have tex and the other dependencies
described at http://matplotlib.sf.net/matplotlib.texmanager.html
properly installed on your system. The first time you run a script
you will see a lot of output from tex and associated tools. The next
time, the run may be silent, as a lot of the information is cached in
~/.tex.cache
"""
from matplotlib import rc
from numpy import arange, cos, pi
from matplotlib.pyplot import figure, axes, plot, xlabel, ylabel, title, \
    grid, savefig, show

rc('text', usetex=True)
rc('font', family='serif')
figure(1, figsize=(6,4))
ax = axes([0.1, 0.1, 0.8, 0.7])
t = arange(0.0, 1.0+0.01, 0.01)
s = cos(2*2*pi*t)+2
plot(t, s)

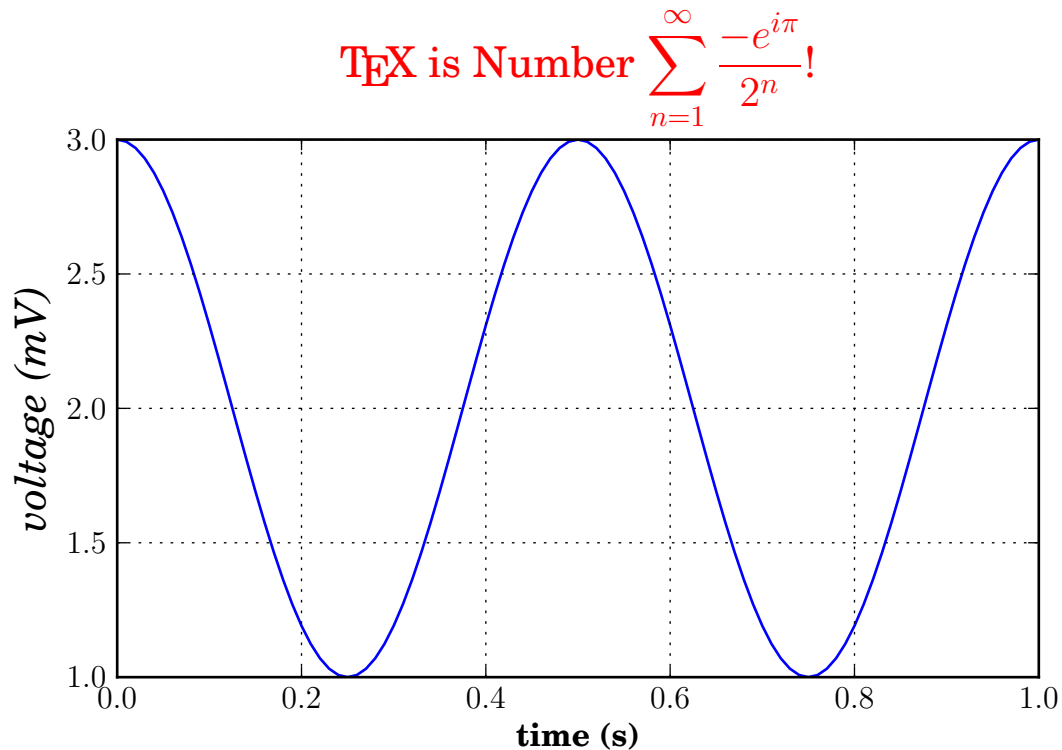
xlabel(r'\textbf{time (s)}')
ylabel(r'\textit{voltage (mV)}', fontsize=16)
title(r"\TeX\ is Number $\displaystyle\sum_{n=1}^{\infty}\frac{-e^{i\pi}}{2^n}$!",
```

```

    fontsize=16, color='r')
grid(True)
savefig('tex_demo')

```

```
show()
```



Note that display math mode ( $e=mc^2$ ) is not supported, but adding the command `\displaystyle`, as in `tex_demo.py`, will produce the same results.

**Note:** Certain characters require special escaping in TeX, such as:

```
# $ % & ~ _ ^ \ { } \ ( \ ) \ [ \ ]
```

Therefore, these characters will behave differently depending on the rcParam `text.usetex` flag.

### 7.5.1 usetex with unicode

It is also possible to use unicode strings with the LaTeX text manager, here is an example taken from `tex_unicode_demo.py`:

```
#!/usr/bin/env python
# -*- coding: utf-8 -*-
"""
This demo is tex_demo.py modified to have unicode. See that file for
more information.

```

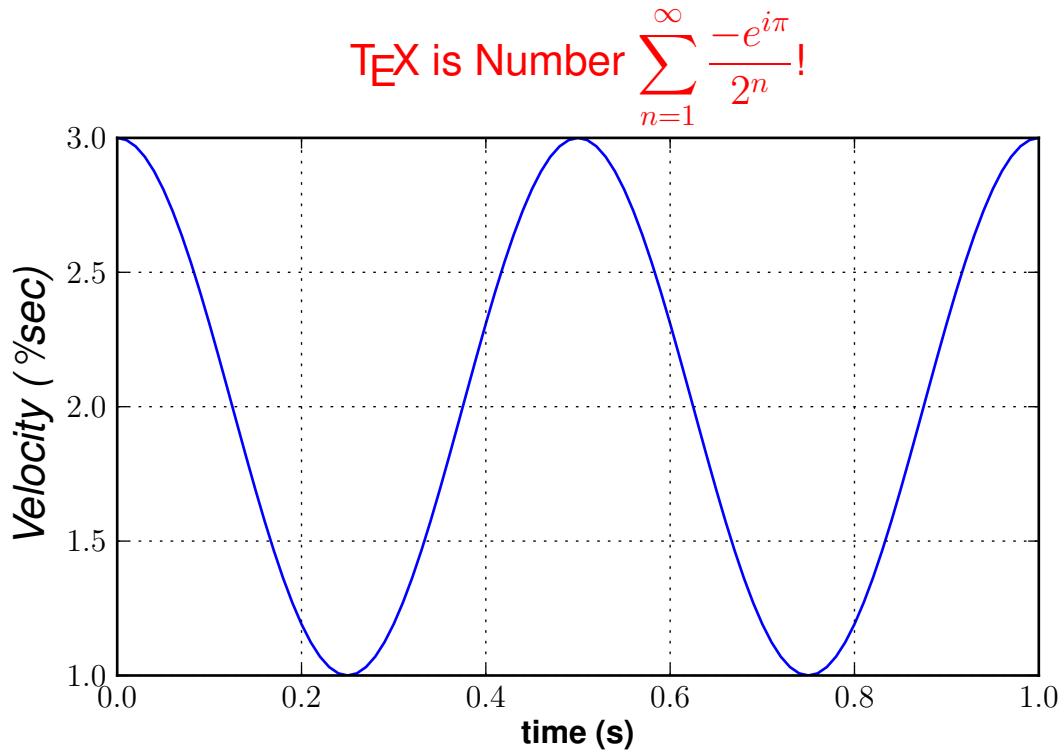
```

"""
from matplotlib import rcParams
rcParams['text.usetex']=True
rcParams['text.latex.unicode']=True
from numpy import arange, cos, pi
from matplotlib.pyplot import figure, axes, plot, xlabel, ylabel, title, \
    grid, savefig, show

figure(1, figsize=(6,4))
ax = axes([0.1, 0.1, 0.8, 0.7])
t = arange(0.0, 1.0+0.01, 0.01)
s = cos(2*2*pi*t)+2
plot(t, s)

xlabel(r'\textbf{time (s)}')
ylabel(ur'\textit{Velocity (\u00B0/sec)}', fontsize=16)
title(r"\TeX\ is Number $\displaystyle\sum_{n=1}^{\infty}\frac{-e^{i\pi}}{2^n}$!",
      fontsize=16, color='r')
grid(True)
show()

```



### 7.5.2 Postscript options

In order to produce encapsulated postscript files that can be embedded in a new LaTeX document, the default behavior of matplotlib is to distill the output, which removes some postscript operators used by LaTeX that are illegal in an eps file. This step produces results which may be unacceptable to some users, because

the text is coarsely rasterized and converted to bitmaps, which are not scalable like standard postscript, and the text is not searchable. One workaround is to set `ps.distiller.res` to a higher value (perhaps 6000) in your rc settings, which will produce larger files but may look better and scale reasonably. A better workaround, which requires [Poppler](#) or [Xpdf](#), can be activated by changing the `ps.usedistiller` rc setting to `xpdf`. This alternative produces postscript without rasterizing text, so it scales properly, can be edited in Adobe Illustrator, and searched text in pdf documents.

### 7.5.3 Possible hangups

- On Windows, the **PATH** environment variable may need to be modified to include the directories containing the latex, dvipng and ghostscript executables. See [Environment Variables](#) and [Setting environment variables in windows](#) for details.
- Using MiKTeX with Computer Modern fonts, if you get odd \*Agg and PNG results, go to MiKTeX/Options and update your format files
- The fonts look terrible on screen. You are probably running Mac OS, and there is some funny business with older versions of dvipng on the mac. Set `text.dvipnghack : True` in your matplotlibrc file.
- On Ubuntu and Gentoo, the base texlive install does not ship with the type1cm package. You may need to install some of the extra packages to get all the goodies that come bundled with other latex distributions.
- Some progress has been made so matplotlib uses the dvi files directly for text layout. This allows latex to be used for text layout with the pdf and svg backends, as well as the \*Agg and PS backends. In the future, a latex installation may be the only external dependency.

### 7.5.4 Troubleshooting

- Try deleting your `.matplotlib/tex.cache` directory. If you don't know where to find `.matplotlib`, see [matplotlib directory location](#).
- Make sure LaTeX, dvipng and ghostscript are each working and on your **PATH**.
- Make sure what you are trying to do is possible in a LaTeX document, that your LaTeX syntax is valid and that you are using raw strings if necessary to avoid unintended escape sequences.
- Most problems reported on the mailing list have been cleared up by upgrading [Ghostscript](#). If possible, please try upgrading to the latest release before reporting problems to the list.
- The `text.latex.preamble` rc setting is not officially supported. This option provides lots of flexibility, and lots of ways to cause problems. Please disable this option before reporting problems to the mailing list.
- If you still need help, please see [Report a problem](#)

## 7.6 Annotating text

For a more detailed introduction to annotations, see [Annotating Axes](#).

The uses of the basic `text()` command above place text at an arbitrary position on the Axes. A common use case of text is to annotate some feature of the plot, and the `annotate()` method provides helper functionality to make annotations easy. In an annotation, there are two points to consider: the location being annotated represented by the argument `xy` and the location of the text `xytext`. Both of these arguments are `(x,y)` tuples.

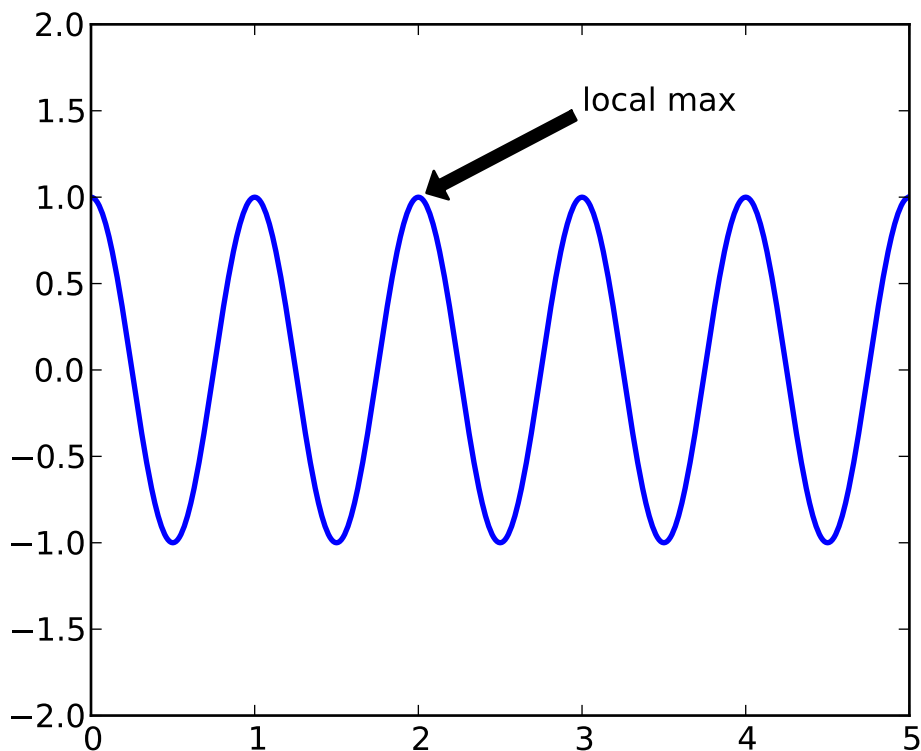
```
import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_subplot(111)

t = np.arange(0.0, 5.0, 0.01)
s = np.cos(2*np.pi*t)
line, = ax.plot(t, s, lw=2)

ax.annotate('local max', xy=(2, 1), xytext=(3, 1.5),
            arrowprops=dict(facecolor='black', shrink=0.05),
            )

ax.set_ylim(-2,2)
plt.show()
```



In this example, both the `xy` (arrow tip) and `xytext` locations (text location) are in data coordinates. There are a variety of other coordinate systems one can choose – you can specify the coordinate system of `xy` and

xytext with one of the following strings for xycoords and textcoords (default is 'data')

| argument          | coordinate system                                   |
|-------------------|---|
| 'figure points'   | points from the lower left corner of the figure     |
| 'figure pixels'   | pixels from the lower left corner of the figure     |
| 'figure fraction' | 0,0 is lower left of figure and 1,1 is upper, right |
| 'axes points'     | points from lower left corner of axes               |
| 'axes pixels'     | pixels from lower left corner of axes               |
| 'axes fraction'   | 0,1 is lower left of axes and 1,1 is upper right    |
| 'data'            | use the axes data coordinate system                 |

For example to place the text coordinates in fractional axes coordinates, one could do:

```
ax.annotate('local max', xy=(3, 1), xycoords='data',
            xytext=(0.8, 0.95), textcoords='axes fraction',
            arrowprops=dict(facecolor='black', shrink=0.05),
            horizontalalignment='right', verticalalignment='top',
            )
```

For physical coordinate systems (points or pixels) the origin is the (bottom, left) of the figure or axes. If the value is negative, however, the origin is from the (right, top) of the figure or axes, analogous to negative indexing of sequences.

Optionally, you can specify arrow properties which draws an arrow from the text to the annotated point by giving a dictionary of arrow properties in the optional keyword argument `arrowprops`.

| arrowprops key | description   |
|----------------|---|
| width          | the width of the arrow in points  |
| frac           | the fraction of the arrow length occupied by the head                             |
| headwidth      | the width of the base of the arrow head in points                                 |
| shrink         | move the tip and base some percent away from the annotated point and text         |
| **kwargs       | any key for <code>matplotlib.patches.Polygon</code> , e.g. <code>facecolor</code> |

In the example below, the xy point is in native coordinates (xycoords defaults to 'data'). For a polar axes, this is in (theta, radius) space. The text in this example is placed in the fractional figure coordinate system. `matplotlib.text.Text` keyword args like `horizontalalignment`, `verticalalignment` and `fontsize` are passed from the `~matplotlib.Axes.annotate` to the `Text` instance

```
import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_subplot(111, polar=True)
r = np.arange(0, 1, 0.001)
theta = 2*2*np.pi*r
line, = ax.plot(theta, r, color='#ee8d18', lw=3)

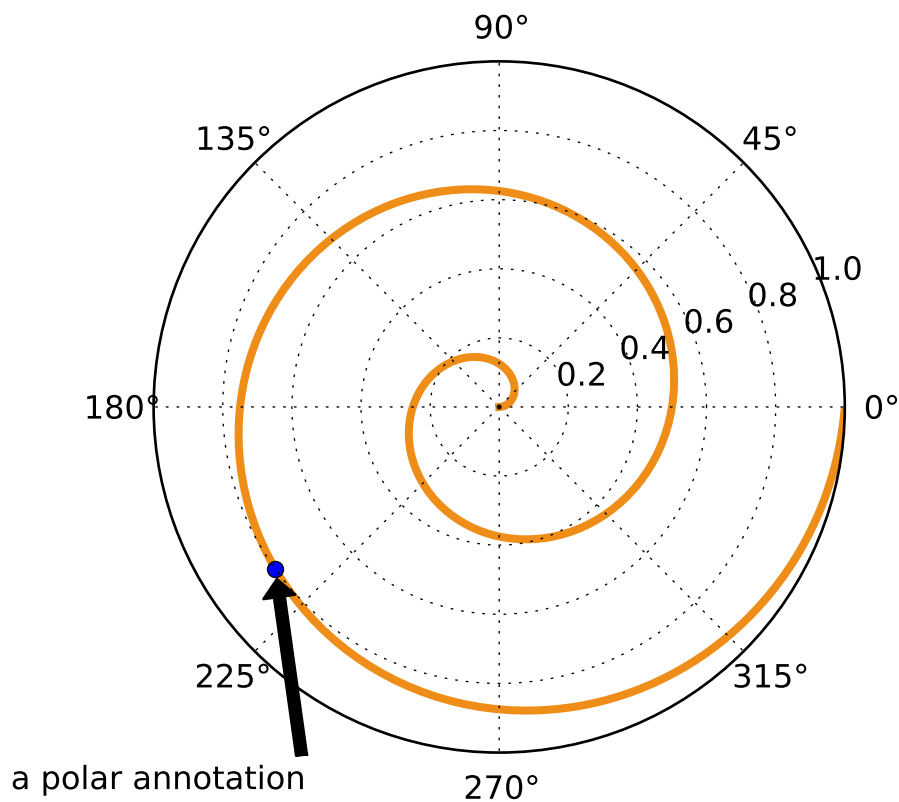
ind = 800
thisr, thistheta = r[ind], theta[ind]
ax.plot([thistheta], [thisr], 'o')
ax.annotate('a polar annotation',
            xy=(thistheta, thisr), # theta, radius
```



```

xytext=(0.05, 0.05),    # fraction, fraction
textcoords='figure fraction',
arrowprops=dict(facecolor='black', shrink=0.05),
horizontalalignment='left',
verticalalignment='bottom',
)
plt.show()

```



For more on all the wild and wonderful things you can do with annotations, including fancy arrows, see [Annotating Axes](#) and `pylab_examples/example_code/annotation_demo.py`.



# IMAGE TUTORIAL

## 8.1 Startup commands

At the very least, you'll need to have access to the `imshow()` function. There are a couple of ways to do it. The easy way for an interactive environment:

```
$ipython -pylab
```

The `imshow` function is now directly accessible (it's in your `namespace`). See also *Pyplot tutorial*.

The more expressive, easier to understand later method (use this in your scripts to make it easier for others (including your future self) to read) is to use the matplotlib API (see *Artist tutorial*) where you use explicit namespaces and control object creation, etc...

```
In [1]: import matplotlib.pyplot as plt
In [2]: import matplotlib.image as mpimg
In [3]: import numpy as np
```

Examples below will use the latter method, for clarity. In these examples, if you use the `-pylab` method, you can skip the “`mpimg`.” and “`plt`.” prefixes.

## 8.2 Importing image data into Numpy arrays

Plotting image data is supported by the Python Image Library ([PIL](#)), . Natively, matplotlib only supports PNG images. The commands shown below fall back on PIL if the native read fails.

The image used in this example is a PNG file, but keep that PIL requirement in mind for your own data.

Here's the image we're going to play with:



It's a 24-bit RGB PNG image (8 bits for each of R, G, B). Depending on where you get your data, the other kinds of image that you'll most likely encounter are RGBA images, which allow for transparency, or single-channel grayscale (luminosity) images. You can right click on it and choose "Save image as" to download it to your computer for the rest of this tutorial.

And here we go...

```
In [4]: img=mpimg.imread('stinkbug.png')
Out[4]:
array([[ 0.40784314,  0.40784314,  0.40784314],
       [ 0.40784314,  0.40784314,  0.40784314],
       [ 0.40784314,  0.40784314,  0.40784314],
       ...,
       [ 0.42745098,  0.42745098,  0.42745098],
       [ 0.42745098,  0.42745098,  0.42745098],
       [ 0.42745098,  0.42745098,  0.42745098]],

      [[ 0.41176471,  0.41176471,  0.41176471],
       [ 0.41176471,  0.41176471,  0.41176471],
       [ 0.41176471,  0.41176471,  0.41176471],
       ...,
       [ 0.42745098,  0.42745098,  0.42745098],
       [ 0.42745098,  0.42745098,  0.42745098],
       [ 0.42745098,  0.42745098,  0.42745098]])
```

```

[ 0.42745098, 0.42745098, 0.42745098]],

[[ 0.41960785, 0.41960785, 0.41960785],
 [ 0.41568628, 0.41568628, 0.41568628],
 [ 0.41568628, 0.41568628, 0.41568628],
 ...,
 [ 0.43137255, 0.43137255, 0.43137255],
 [ 0.43137255, 0.43137255, 0.43137255],
 [ 0.43137255, 0.43137255, 0.43137255]],

...,
[[ 0.43921569, 0.43921569, 0.43921569],
 [ 0.43529412, 0.43529412, 0.43529412],
 [ 0.43137255, 0.43137255, 0.43137255],
 ...,
 [ 0.45490196, 0.45490196, 0.45490196],
 [ 0.4509804 , 0.4509804 , 0.4509804 ],
 [ 0.4509804 , 0.4509804 , 0.4509804 ]],

[[ 0.44313726, 0.44313726, 0.44313726],
 [ 0.44313726, 0.44313726, 0.44313726],
 [ 0.43921569, 0.43921569, 0.43921569],
 ...,
 [ 0.4509804 , 0.4509804 , 0.4509804 ],
 [ 0.44705883, 0.44705883, 0.44705883],
 [ 0.44705883, 0.44705883, 0.44705883]],

[[ 0.44313726, 0.44313726, 0.44313726],
 [ 0.4509804 , 0.4509804 , 0.4509804 ],
 [ 0.4509804 , 0.4509804 , 0.4509804 ],
 ...,
 [ 0.44705883, 0.44705883, 0.44705883],
 [ 0.44705883, 0.44705883, 0.44705883],
 [ 0.44313726, 0.44313726, 0.44313726]]], dtype=float32)

```

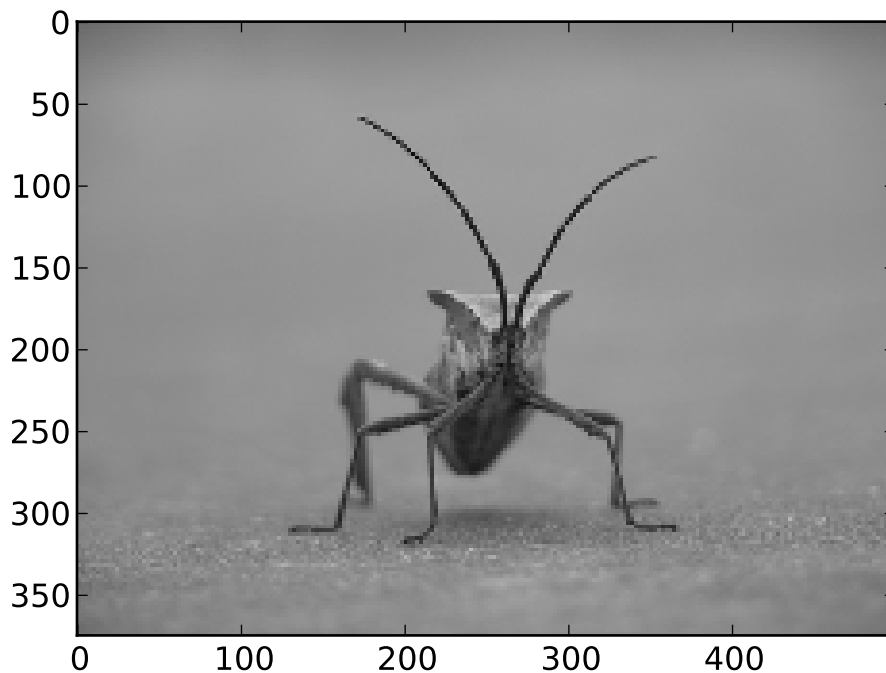
Note the dtype there - float32. Matplotlib has rescaled the 8 bit data from each channel to floating point data between 0.0 and 1.0. As a side note, the only datatype that PIL can work with is uint8. Matplotlib plotting can handle float32 and uint8, but image reading/writing for any format other than PNG is limited to uint8 data. Why 8 bits? Most displays can only render 8 bits per channel worth of color gradation. Why can they only render 8 bits/channel? Because that's about all the human eye can see. More here (from a photography standpoint): [Luminous Landscape bit depth tutorial](#).

Each inner list represents a pixel. Here, with an RGB image, there are 3 values. Since it's a black and white image, R, G, and B are all similar. An RGBA (where A is alpha, or transparency), has 4 values per inner list, and a simple luminance image just has one value (and is thus only a 2-D array, not a 3-D array). For RGB and RGBA images, matplotlib supports float32 and uint8 data types. For grayscale, matplotlib supports only float32. If your array data does not meet one of these descriptions, you need to rescale it.

## 8.3 Plotting numpy arrays as images

So, you have your data in a numpy array (either by importing it, or by generating it). Let's render it. In Matplotlib, this is performed using the `imshow()` function. Here we'll grab the plot object. This object gives you an easy way to manipulate the plot from the prompt.

```
In [5]: imgplot = plt.imshow(img)
```



You can also plot any numpy array - just remember that the datatype must be float32 (and range from 0.0 to 1.0) or uint8.

### 8.3.1 Applying pseudocolor schemes to image plots

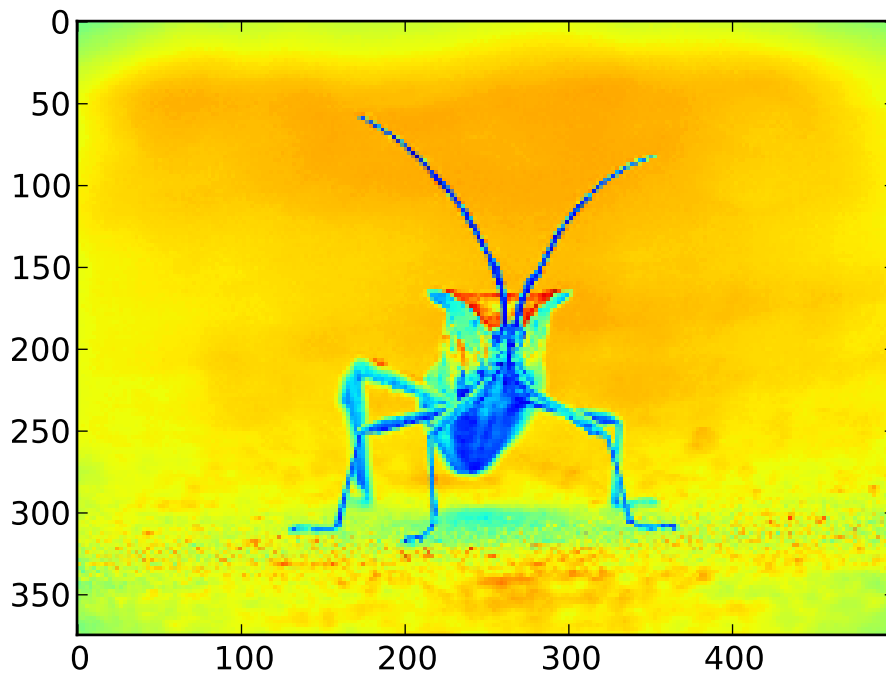
Pseudocolor can be a useful tool for enhancing contrast and visualizing your data more easily. This is especially useful when making presentations of your data using projectors - their contrast is typically quite poor.

Pseudocolor is only relevant to single-channel, grayscale, luminosity images. We currently have an RGB image. Since R, G, and B are all similar (see for yourself above or in your data), we can just pick on channel of our data:

```
In [6]: lum_img = img[:, :, 0]
```

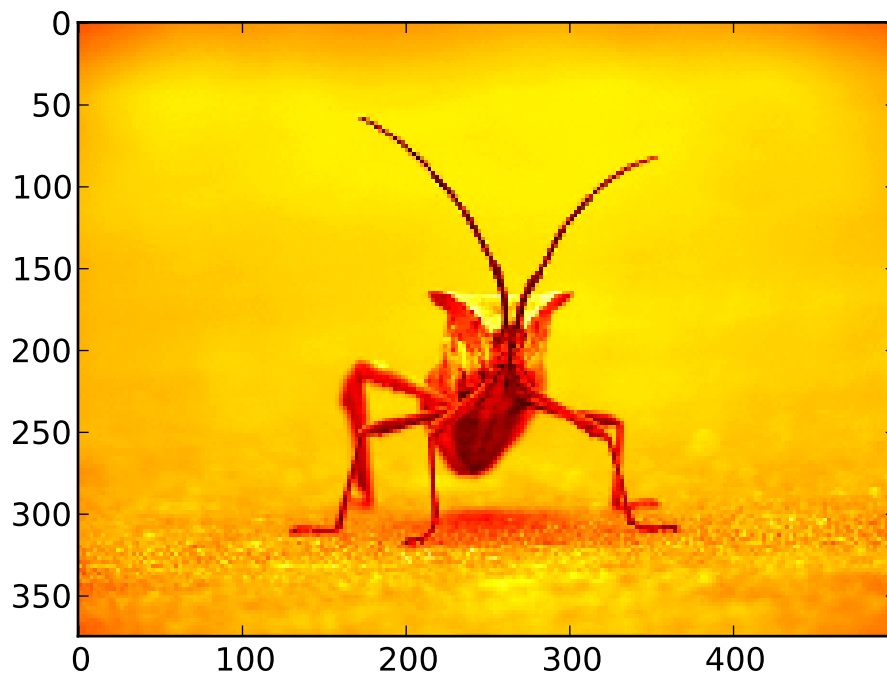
This is array slicing. You can read more in the [Numpy tutorial](#).

```
In [7]: imgplot = mpimg.imshow(lum_img)
```



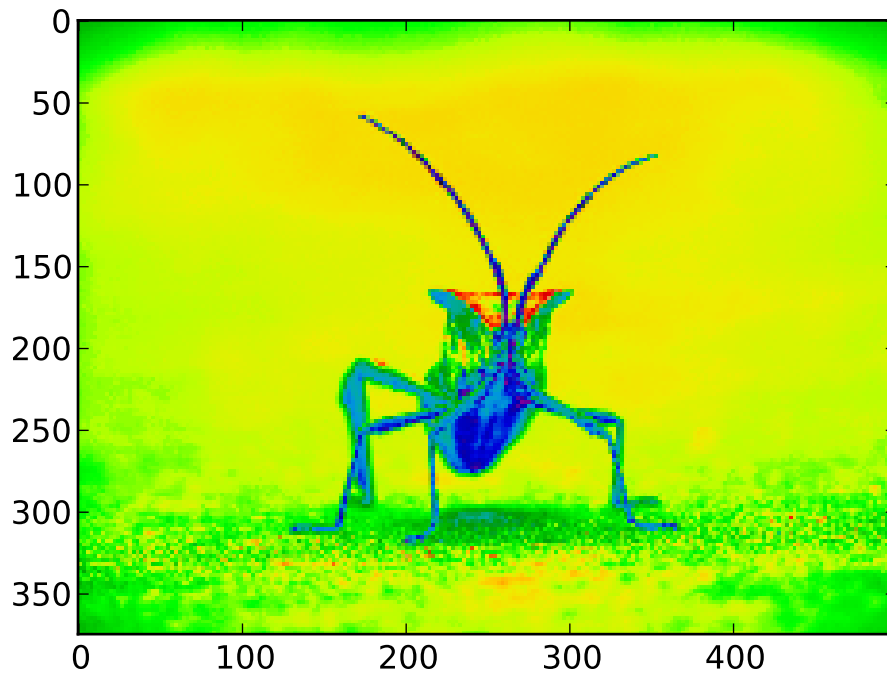
Now, with a luminosity image, the default colormap (aka lookup table, LUT), is applied. The default is called jet. There are plenty of others to choose from. Let's set some others using the `set_cmap()` method on our image plot object:

```
In [8]: imgplot.set_cmap('hot')
```



```
In [9]: imgplot.set_cmap('spectral')
```



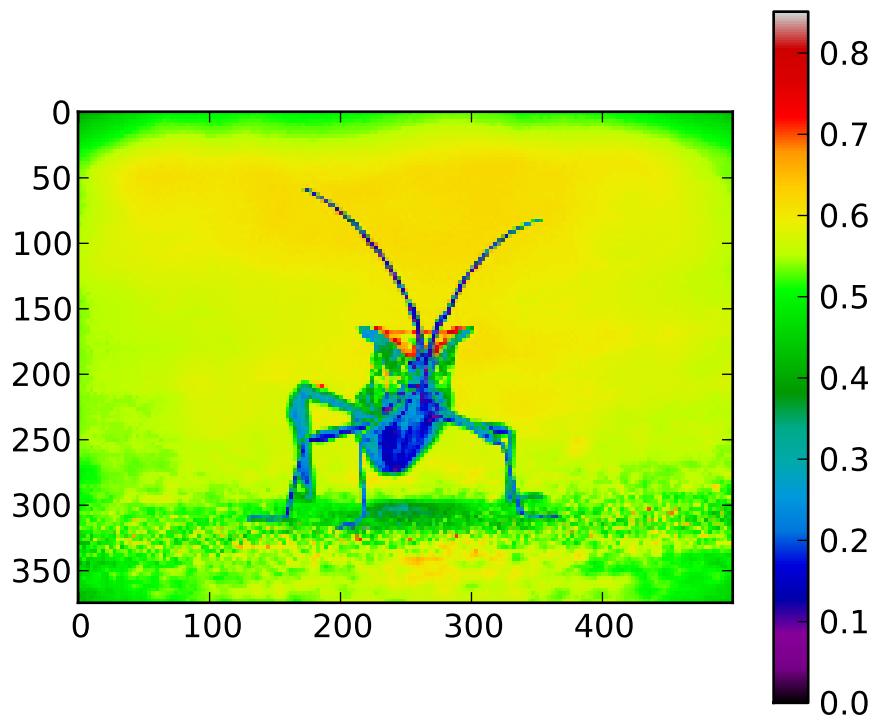


There are many other colormap schemes available. See the [list and images of the colormaps](#).

### 8.3.2 Color scale reference

It's helpful to have an idea of what value a color represents. We can do that by adding color bars. It's as easy as one line:

```
In [10]: plt.colorbar()
```

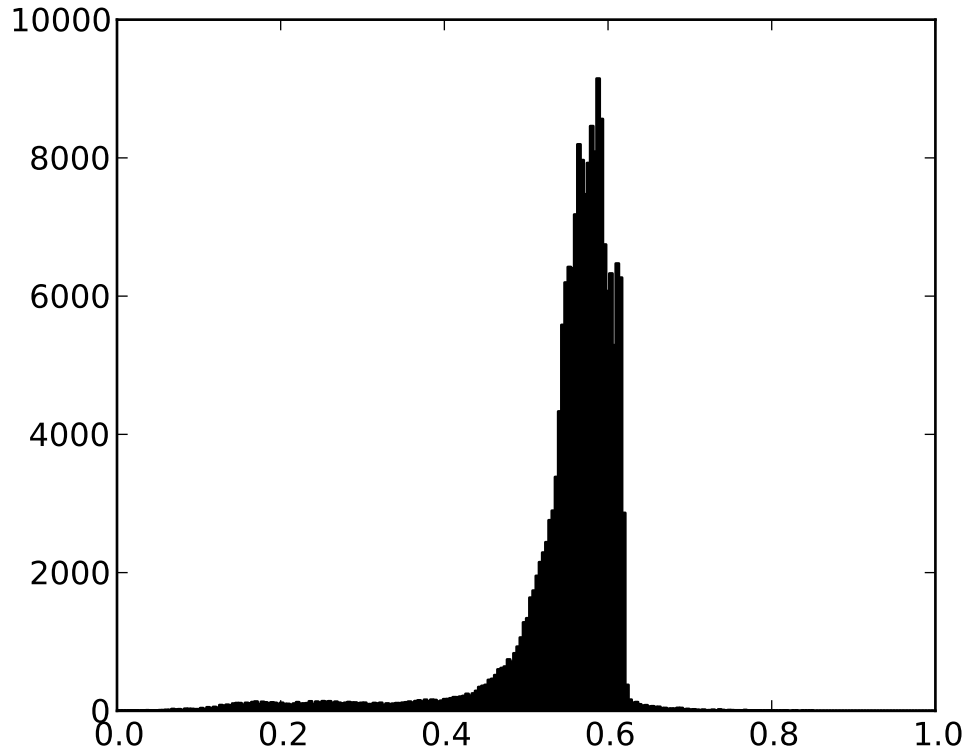


This adds a colorbar to your existing figure. This won't automatically change if you change you switch to a different colormap - you have to re-create your plot, and add in the colorbar again.

### 8.3.3 Examining a specific data range

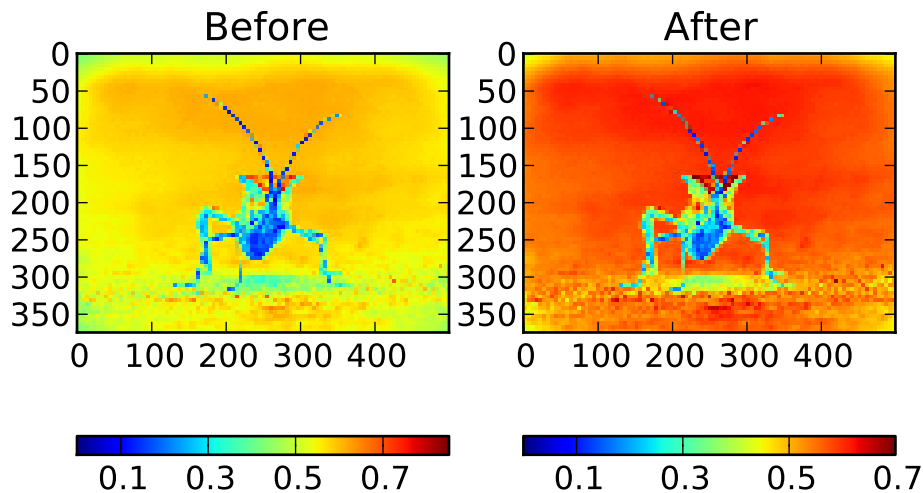
Sometimes you want to enhance the contrast in your image, or expand the contrast in a particular region while sacrificing the detail in colors that don't vary much, or don't matter. A good tool to find interesting regions is the histogram. To create a histogram of our image data, we use the `hist()` function.

```
In[10]: plt.hist(lum_img.flatten(), 256, range=(0.0,1.0), fc='k', ec='k')
```



Most often, the “interesting” part of the image is around the peak, and you can get extra contrast by clipping the regions above and/or below the peak. In our histogram, it looks like there’s not much useful information in the high end (not many white things in the image). Let’s adjust the upper limit, so that we effectively “zoom in on” part of the histogram. We do this by calling the `set_clim()` method of the image plot object.

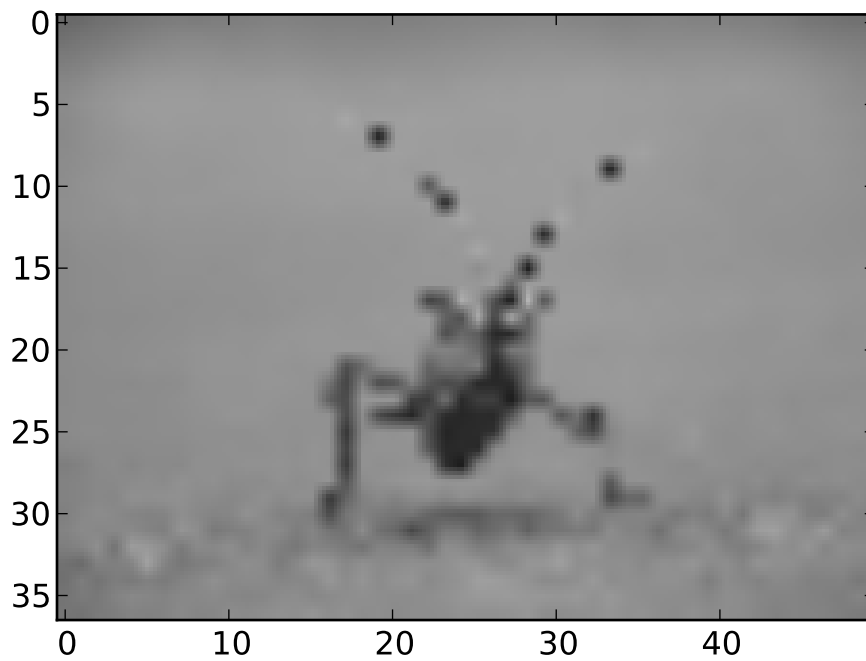
```
In[11]: imgplot.set_clim=(0.0,0.7)
```



### 8.3.4 Array Interpolation schemes

Interpolation calculates what the color or value of a pixel “should” be, according to different mathematical schemes. One common place that this happens is when you resize an image. The number of pixels change, but you want the same information. Since pixels are discrete, there’s missing space. Interpolation is how you fill that space. This is why your images sometimes come out looking pixelated when you blow them up. The effect is more pronounced when the difference between the original image and the expanded image is greater. Let’s take our image and shrink it. We’re effectively discarding pixels, only keeping a select few. Now when we plot it, that data gets blown up to the size on your screen. The old pixels aren’t there anymore, and the computer has to draw in pixels to fill that space.

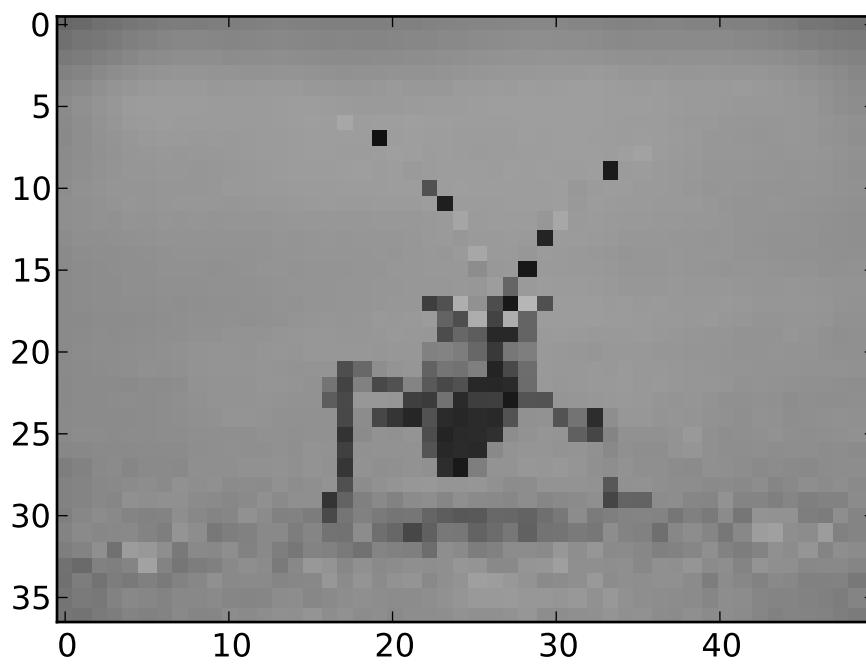
```
In [8]: import Image
In [9]: img = Image.open('stinkbug.png')      # Open image as PIL image object
In [10]: rsize = img.resize((img.size[0]/10,img.size[1]/10)) # Use PIL to resize
In [11]: rsizeArr = np.asarray(rsize)         # Get array back
In [12]: imgplot = mpimg.imshow(rsizeArr)
```



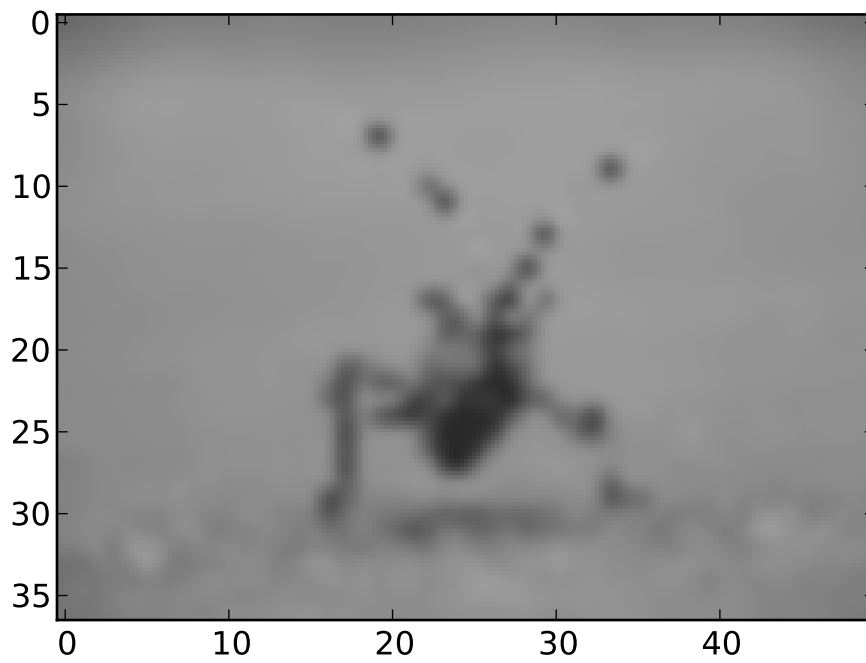
Here we have the default interpolation, bilinear, since we did not give `imshow()` any interpolation argument.

Let's try some others:

```
In [10]: imgplot.set_interpolation('nearest')
```



```
In [10]: imgplot.set_interpolation('bicubic')
```



Bicubic interpolation is often used when blowing up photos - people tend to prefer blurry over pixelated.





---

# ARTIST TUTORIAL

There are three layers to the matplotlib API. The `matplotlib.backend_bases.FigureCanvas` is the area onto which the figure is drawn, the `matplotlib.backend_bases.Renderer` is the object which knows how to draw on the `FigureCanvas`, and the `matplotlib.artist.Artist` is the object that knows how to use a renderer to paint onto the canvas. The `FigureCanvas` and `Renderer` handle all the details of talking to user interface toolkits like `wxPython` or drawing languages like `PostScript®`, and the `Artist` handles all the high level constructs like representing and laying out the figure, text, and lines. The typical user will spend 95% of his time working with the `Artists`.

There are two types of `Artists`: primitives and containers. The primitives represent the standard graphical objects we want to paint onto our canvas: `Line2D`, `Rectangle`, `Text`, `AxesImage`, etc., and the containers are places to put them (`Axis`, `Axes` and `Figure`). The standard use is to create a `Figure` instance, use the `Figure` to create one or more `Axes` or `Subplot` instances, and use the `Axes` instance helper methods to create the primitives. In the example below, we create a `Figure` instance using `matplotlib.pyplot.figure()`, which is a convenience method for instantiating `Figure` instances and connecting them with your user interface or drawing toolkit `FigureCanvas`. As we will discuss below, this is not necessary – you can work directly with `PostScript`, `PDF` `Gtk+`, or `wxPython` `FigureCanvas` instances, instantiate your `Figures` directly and connect them yourselves – but since we are focusing here on the `Artist` API we'll let `pyplot` handle some of those details for us:

```
import matplotlib.pyplot as plt
fig = plt.figure()
ax = fig.add_subplot(2,1,1) # two rows, one column, first plot
```

The `Axes` is probably the most important class in the matplotlib API, and the one you will be working with most of the time. This is because the `Axes` is the plotting area into which most of the objects go, and the `Axes` has many special helper methods (`plot()`, `text()`, `hist()`, `imshow()`) to create the most common graphics primitives (`Line2D`, `Text`, `Rectangle`, `Image`, respectively). These helper methods will take your data (eg. `numpy` arrays and strings) and create primitive `Artist` instances as needed (eg. `Line2D`), add them to the relevant containers, and draw them when requested. Most of you are probably familiar with the `Subplot`, which is just a special case of an `Axes` that lives on a regular rows by columns grid of `Subplot` instances. If you want to create an `Axes` at an arbitrary location, simply use the `add_axes()` method which takes a list of [`left`, `bottom`, `width`, `height`] values in 0-1 relative figure coordinates:

```
fig2 = plt.figure()
ax2 = fig2.add_axes([0.15, 0.1, 0.7, 0.3])
```

Continuing with our example:

```
import numpy as np
t = np.arange(0.0, 1.0, 0.01)
s = np.sin(2*np.pi*t)
line, = ax.plot(t, s, color='blue', lw=2)
```

In this example, `ax` is the `Axes` instance created by the `fig.add_subplot` call above (remember `Subplot` is just a subclass of `Axes`) and when you call `ax.plot`, it creates a `Line2D` instance and adds it to the `Axes.lines` list. In the interactive `ipython` session below, you can see that the `Axes.lines` list is length one and contains the same line that was returned by the `line, = ax.plot...` call:

```
In [101]: ax.lines[0]
Out[101]: <matplotlib.lines.Line2D instance at 0x19a95710>

In [102]: line
Out[102]: <matplotlib.lines.Line2D instance at 0x19a95710>
```

If you make subsequent calls to `ax.plot` (and the hold state is “on” which is the default) then additional lines will be added to the list. You can remove lines later simply by calling the list methods; either of these will work:

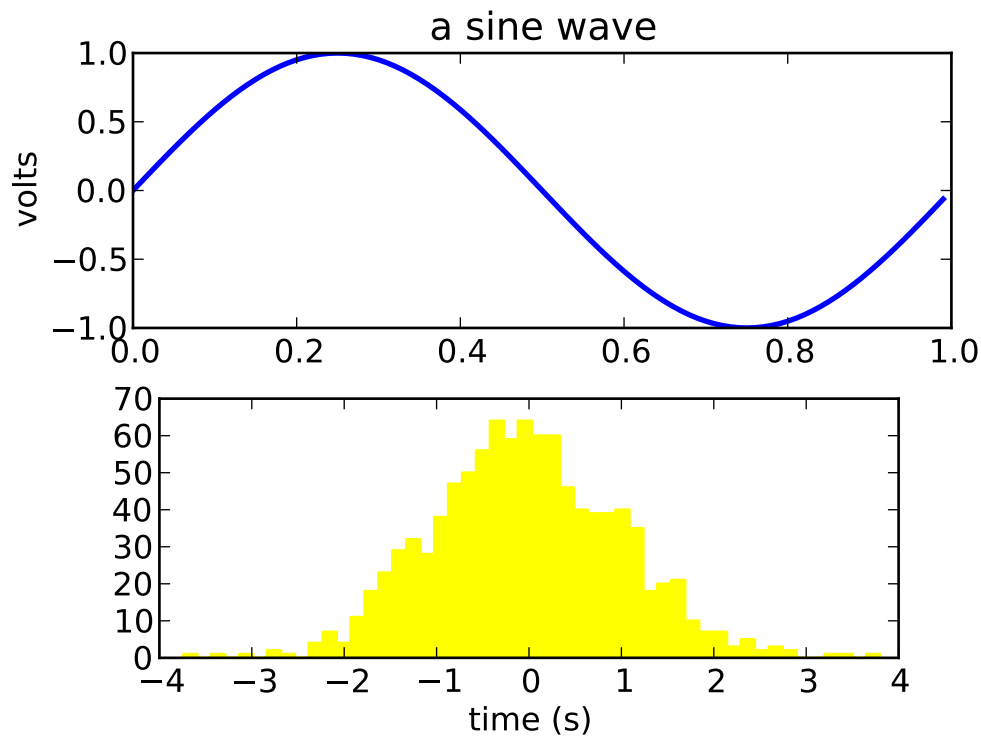
```
del ax.lines[0]
ax.lines.remove(line)  # one or the other, not both!
```

The `Axes` also has helper methods to configure and decorate the x-axis and y-axis tick, tick labels and axis labels:

```
xtext = ax.set_xlabel('my xdata') # returns a Text instance
ytext = ax.set_ylabel('my ydata')
```

When you call `ax.set_xlabel`, it passes the information on the `Text` instance of the `XAxis`. Each `Axes` instance contains an `XAxis` and a `YAxis` instance, which handle the layout and drawing of the ticks, tick labels and axis labels.

Try creating the figure below.



## 9.1 Customizing your objects

Every element in the figure is represented by a matplotlib [Artist](#), and each has an extensive list of properties to configure its appearance. The figure itself contains a [Rectangle](#) exactly the size of the figure, which you can use to set the background color and transparency of the figures. Likewise, each [Axes](#) bounding box (the standard white box with black edges in the typical matplotlib plot, has a [Rectangle](#) instance that determines the color, transparency, and other properties of the Axes. These instances are stored as member variables `Figure.patch` and `Axes.patch` (“Patch” is a name inherited from MATLAB, and is a 2D “patch” of color on the figure, eg. rectangles, circles and polygons). Every matplotlib [Artist](#) has the following properties

| Property  | Description   |
|-----------|---|
| alpha     | The transparency - a scalar from 0-1                                  |
| animated  | A boolean that is used to facilitate animated drawing                 |
| axes      | The axes that the Artist lives in, possibly None                      |
| clip_box  | The bounding box that clips the Artist                                |
| clip_on   | Whether clipping is enabled   |
| clip_path | The path the artist is clipped to                                     |
| contains  | A picking function to test whether the artist contains the pick point |
| figure    | The figure instance the artist lives in, possibly None                |
| label     | A text label (eg. for auto-labeling)                                  |
| picker    | A python object that controls object picking                          |
| transform | The transformation  |
| visible   | A boolean whether the artist should be drawn                          |
| zorder    | A number which determines the drawing order                           |

Each of the properties is accessed with an old-fashioned setter or getter (yes we know this irritates Pythonistas and we plan to support direct access via properties or traits but it hasn't been done yet). For example, to multiply the current alpha by a half:

```
a = o.get_alpha()
o.set_alpha(0.5*a)
```

If you want to set a number of properties at once, you can also use the `set` method with keyword arguments. For example:

```
o.set(alpha=0.5, zorder=2)
```

If you are working interactively at the python shell, a handy way to inspect the `Artist` properties is to use the `matplotlib.artist.getp()` function (simply `getp()` in pylab), which lists the properties and their values. This works for classes derived from `Artist` as well, eg. `Figure` and `Rectangle`. Here are the `Figure` rectangle properties mentioned above:

```
In [149]: matplotlib.artist.getp(fig.patch)
alpha = 1.0
animated = False
antialiased or aa = True
axes = None
clip_box = None
clip_on = False
clip_path = None
contains = None
edgecolor or ec = w
facecolor or fc = 0.75
figure = Figure(8.125x6.125)
fill = 1
hatch = None
height = 1
label =
linewidth or lw = 1.0
picker = None
```

```

transform = <Affine object at 0x134cca84>
verts = ((0, 0), (0, 1), (1, 1), (1, 0))
visible = True
width = 1
window_extent = <Bbox object at 0x134acbcc>
x = 0
y = 0
zorder = 1

```

The docstrings for all of the classes also contain the `Artist` properties, so you can consult the interactive “help” or the [artists](#) for a listing of properties for a given object.

## 9.2 Object containers

Now that we know how to inspect and set the properties of a given object we want to configure, we need to now how to get at that object. As mentioned in the introduction, there are two kinds of objects: primitives and containers. The primitives are usually the things you want to configure (the font of a `Text` instance, the width of a `Line2D`) although the containers also have some properties as well – for example the `Axes` `Artist` is a container that contains many of the primitives in your plot, but it also has properties like the `xscale` to control whether the xaxis is ‘linear’ or ‘log’. In this section we’ll review where the various container objects store the `Artists` that you want to get at.

## 9.3 Figure container

The top level container `Artist` is the `matplotlib.figure.Figure`, and it contains everything in the figure. The background of the figure is a `Rectangle` which is stored in `Figure.patch`. As you add subplots (`add_subplot()`) and axes (`add_axes()`) to the figure these will be appended to the `Figure.axes`. These are also returned by the methods that create them:

```

In [156]: fig = plt.figure()

In [157]: ax1 = fig.add_subplot(211)

In [158]: ax2 = fig.add_axes([0.1, 0.1, 0.7, 0.3])

In [159]: ax1
Out[159]: <matplotlib.axes.Subplot instance at 0xd54b26c>

In [160]: print fig.axes
[<matplotlib.axes.Subplot instance at 0xd54b26c>, <matplotlib.axes.Axes instance at 0xd3f0b2c>]

```

Because the figure maintains the concept of the “current axes” (see `Figure.gca` and `Figure.sca`) to support the pylab/pyplot state machine, you should not insert or remove axes directly from the axes list, but rather use the `add_subplot()` and `add_axes()` methods to insert, and the `delaxes()` method to delete. You are free however, to iterate over the list of axes or index into it to get access to `Axes` instances you want to customize. Here is an example which turns all the axes grids on:

```
for ax in fig.axes:  
    ax.grid(True)
```

The figure also has its own text, lines, patches and images, which you can use to add primitives directly. The default coordinate system for the Figure will simply be in pixels (which is not usually what you want) but you can control this by setting the transform property of the Artist you are adding to the figure.

More useful is “figure coordinates” where (0, 0) is the bottom-left of the figure and (1, 1) is the top-right of the figure which you can obtain by setting the Artist transform to `fig.transFigure`:

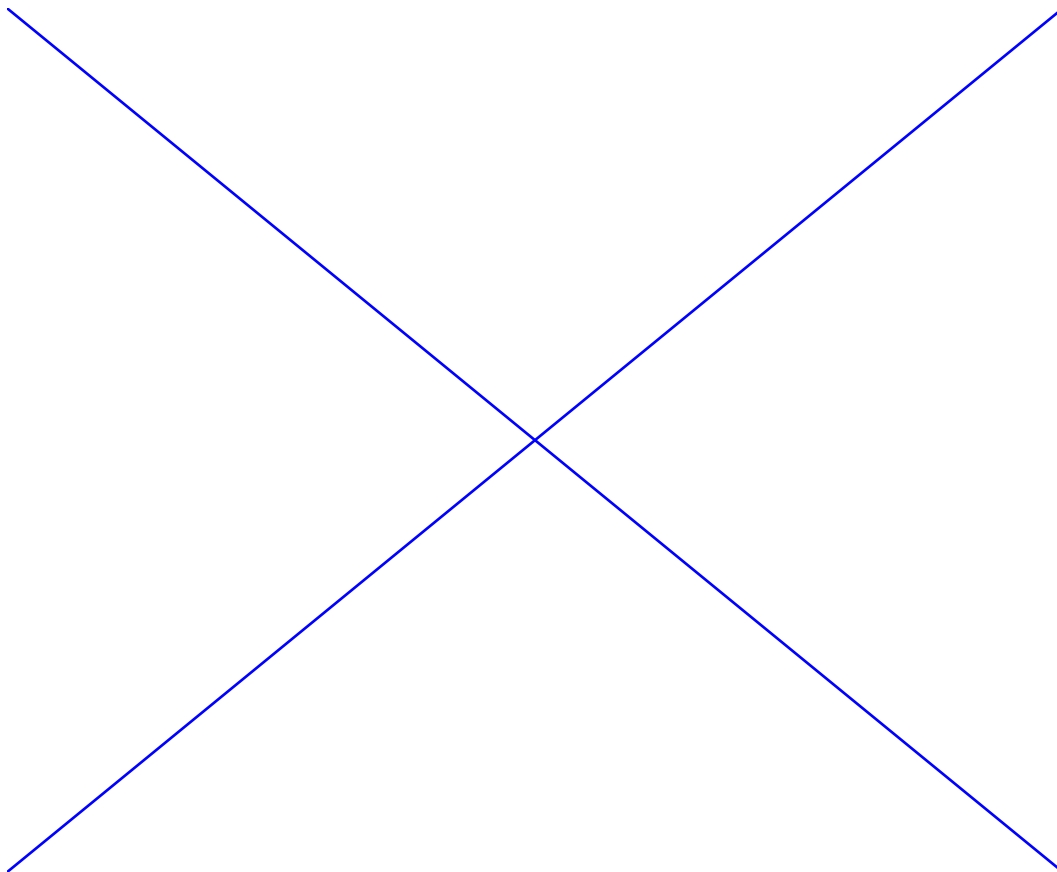
```
In [191]: fig = plt.figure()
```

```
In [192]: l1 = matplotlib.lines.Line2D([0, 1], [0, 1],  
    transform=fig.transFigure, figure=fig)
```

```
In [193]: l2 = matplotlib.lines.Line2D([0, 1], [1, 0],  
    transform=fig.transFigure, figure=fig)
```

```
In [194]: fig.lines.extend([l1, l2])
```

```
In [195]: fig.canvas.draw()
```



Here is a summary of the Artists the figure contains

| Figure attribute | Description   |
|------------------|---|
| axes             | A list of Axes instances (includes Subplot)                     |
| patch            | The Rectangle background  |
| images           | A list of FigureImages patches - useful for raw pixel display   |
| legends          | A list of Figure Legend instances (different from Axes.legends) |
| lines            | A list of Figure Line2D instances (rarely used, see Axes.lines) |
| patches          | A list of Figure patches (rarely used, see Axes.patches)        |
| texts            | A list Figure Text instances                                    |

## 9.4 Axes container

The `matplotlib.axes.Axes` is the center of the matplotlib universe – it contains the vast majority of all the `Artists` used in a figure with many helper methods to create and add these `Artists` to itself, as well as helper methods to access and customize the `Artists` it contains. Like the `Figure`, it contains a `Patch` patch which is a `Rectangle` for Cartesian coordinates and a `Circle` for polar coordinates; this patch determines the shape, background and border of the plotting region:

```
ax = fig.add_subplot(111)
rect = ax.patch # a Rectangle instance
rect.set_facecolor('green')
```

When you call a plotting method, eg. the canonical `plot()` and pass in arrays or lists of values, the method will create a `matplotlib.lines.Line2D()` instance, update the line with all the `Line2D` properties passed as keyword arguments, add the line to the `Axes.lines` container, and returns it to you:

```
In [213]: x, y = np.random.rand(2, 100)
```

```
In [214]: line, = ax.plot(x, y, '--', color='blue', linewidth=2)
```

`plot` returns a list of lines because you can pass in multiple x, y pairs to plot, and we are unpacking the first element of the length one list into the line variable. The line has been added to the `Axes.lines` list:

```
In [229]: print ax.lines
[<matplotlib.lines.Line2D instance at 0xd378b0c>]
```

Similarly, methods that create patches, like `bar()` creates a list of rectangles, will add the patches to the `Axes.patches` list:

```
In [233]: n, bins, rectangles = ax.hist(np.random.randn(1000), 50, facecolor='yellow')
```

```
In [234]: rectangles
Out[234]: <a list of 50 Patch objects>
```

```
In [235]: print len(ax.patches)
```

You should not add objects directly to the `Axes.lines` or `Axes.patches` lists unless you know exactly what you are doing, because the `Axes` needs to do a few things when it creates and adds an object. It sets the figure and axes property of the `Artist`, as well as the default `Axes` transformation (unless a transformation is

set). It also inspects the data contained in the `Artist` to update the data structures controlling auto-scaling, so that the view limits can be adjusted to contain the plotted data. You can, nonetheless, create objects yourself and add them directly to the Axes using helper methods like `add_line()` and `add_patch()`. Here is an annotated interactive session illustrating what is going on:

```
In [261]: fig = plt.figure()

In [262]: ax = fig.add_subplot(111)

# create a rectangle instance
In [263]: rect = matplotlib.patches.Rectangle( (1,1), width=5, height=12)

# by default the axes instance is None
In [264]: print rect.get_axes()
None

# and the transformation instance is set to the "identity transform"
In [265]: print rect.get_transform()
<Affine object at 0x13695544>

# now we add the Rectangle to the Axes
In [266]: ax.add_patch(rect)

# and notice that the ax.add_patch method has set the axes
# instance
In [267]: print rect.get_axes()
Axes(0.125,0.1;0.775x0.8)

# and the transformation has been set too
In [268]: print rect.get_transform()
<Affine object at 0x15009ca4>

# the default axes transformation is ax.transData
In [269]: print ax.transData
<Affine object at 0x15009ca4>

# notice that the xlimits of the Axes have not been changed
In [270]: print ax.get_xlim()
(0.0, 1.0)

# but the data limits have been updated to encompass the rectangle
In [271]: print ax.dataLim.bounds
(1.0, 1.0, 5.0, 12.0)

# we can manually invoke the auto-scaling machinery
In [272]: ax.autoscale_view()

# and now the xlim are updated to encompass the rectangle
In [273]: print ax.get_xlim()
(1.0, 6.0)

# we have to manually force a figure draw
In [274]: ax.figure.canvas.draw()
```



There are many, many **Axes** helper methods for creating primitive **Artists** and adding them to their respective containers. The table below summarizes a small sampling of them, the kinds of **Artist** they create, and where they store them

| Helper method                  | Artist               | Container               |
|--------------------------------|----------------------|-------------------------|
| ax.annotate - text annotations | Annotate             | ax.texts                |
| ax.bar - bar charts            | Rectangle            | ax.patches              |
| ax.errorbar - error bar plots  | Line2D and Rectangle | ax.lines and ax.patches |
| ax.fill - shared area          | Polygon              | ax.patches              |
| ax.hist - histograms           | Rectangle            | ax.patches              |
| ax.imshow - image data         | AxesImage            | ax.images               |
| ax.legend - axes legends       | Legend               | ax.legend               |
| ax.plot - xy plots             | Line2D               | ax.lines                |
| ax.scatter - scatter charts    | PolygonCollection    | ax.collections          |
| ax.text - text                 | Text                 | ax.texts                |

In addition to all of these **Artists**, the **Axes** contains two important **Artist** containers: the **XAxis** and **YAxis**, which handle the drawing of the ticks and labels. These are stored as instance variables `xaxis` and `yaxis`. The **XAxis** and **YAxis** containers will be detailed below, but note that the **Axes** contains many helper methods which forward calls on to the **Axis** instances so you often do not need to work with them directly unless you want to. For example, you can set the font size of the **XAxis** ticklabels using the **Axes** helper method:

```
for label in ax.get_xticklabels():
    label.set_color('orange')
```

Below is a summary of the **Artists** that the **Axes** contains

| Axes attribute | Description                            |
|----------------|--|
| artists        | A list of Artist instances             |
| patch          | Rectangle instance for Axes background |
| collections    | A list of Collection instances         |
| images         | A list of AxesImage                    |
| legends        | A list of Legend instances             |
| lines          | A list of Line2D instances             |
| patches        | A list of Patch instances              |
| texts          | A list of Text instances               |
| xaxis          | matplotlib.axis.XAxis instance         |
| yaxis          | matplotlib.axis.YAxis instance         |

## 9.5 Axis containers

The `matplotlib.axis.Axis` instances handle the drawing of the tick lines, the grid lines, the tick labels and the axis label. You can configure the left and right ticks separately for the y-axis, and the upper and lower ticks separately for the x-axis. The **Axis** also stores the data and view intervals used in auto-scaling, panning and zooming, as well as the **Locator** and **Formatter** instances which control where the ticks are placed and how they are represented as strings.

Each `Axis` object contains a `label` attribute (this is what `pylab` modifies in calls to `xlabel()` and `ylabel()`) as well as a list of major and minor ticks. The ticks are `XTick` and `YTick` instances, which contain the actual line and text primitives that render the ticks and ticklabels. Because the ticks are dynamically created as needed (eg. when panning and zooming), you should access the lists of major and minor ticks through their accessor methods `get_major_ticks()` and `get_minor_ticks()`. Although the ticks contain all the primitives and will be covered below, the `Axis` methods contain accessor methods to return the tick lines, tick labels, tick locations etc.:

```
In [285]: axis = ax.xaxis
```

```
In [286]: axis.get_ticklocs()
```

```
Out[286]: array([ 0.,  1.,  2.,  3.,  4.,  5.,  6.,  7.,  8.,  9.])
```

```
In [287]: axis.get_ticklabels()
```

```
Out[287]: <a list of 10 Text major ticklabel objects>
```

```
# note there are twice as many ticklines as labels because by  
# default there are tick lines at the top and bottom but only tick  
# labels below the xaxis; this can be customized
```

```
In [288]: axis.get_ticklines()
```

```
Out[288]: <a list of 20 Line2D ticklines objects>
```

```
# by default you get the major ticks back
```

```
In [291]: axis.get_ticklines()
```

```
Out[291]: <a list of 20 Line2D ticklines objects>
```

```
# but you can also ask for the minor ticks
```

```
In [292]: axis.get_ticklines(minor=True)
```

```
Out[292]: <a list of 0 Line2D ticklines objects>
```

Here is a summary of some of the useful accessor methods of the `Axis` (these have corresponding setters where useful, such as `set_major_formatter`)

| Accessor method                  | Description   |
|----------------------------------|---|
| <code>get_scale</code>           | The scale of the axis, eg 'log' or 'linear'                           |
| <code>get_view_interval</code>   | The interval instance of the axis view limits                         |
| <code>get_data_interval</code>   | The interval instance of the axis data limits                         |
| <code>get_gridlines</code>       | A list of grid lines for the Axis                                     |
| <code>get_label</code>           | The axis label - a Text instance                                      |
| <code>get_ticklabels</code>      | A list of Text instances - keyword <code>minor=True False</code>      |
| <code>get_ticklines</code>       | A list of Line2D instances - keyword <code>minor=True False</code>    |
| <code>get_ticklocs</code>        | A list of Tick locations - keyword <code>minor=True False</code>      |
| <code>get_major_locator</code>   | The <code>matplotlib.ticker.Locator</code> instance for major ticks   |
| <code>get_major_formatter</code> | The <code>matplotlib.ticker.Formatter</code> instance for major ticks |
| <code>get_minor_locator</code>   | The <code>matplotlib.ticker.Locator</code> instance for minor ticks   |
| <code>get_minor_formatter</code> | The <code>matplotlib.ticker.Formatter</code> instance for minor ticks |
| <code>get_major_ticks</code>     | A list of Tick instances for major ticks                              |
| <code>get_minor_ticks</code>     | A list of Tick instances for minor ticks                              |
| <code>grid</code>                | Turn the grid on or off for the major or minor ticks                  |

Here is an example, not recommended for its beauty, which customizes the axes and tick properties

```

import numpy as np
import matplotlib.pyplot as plt

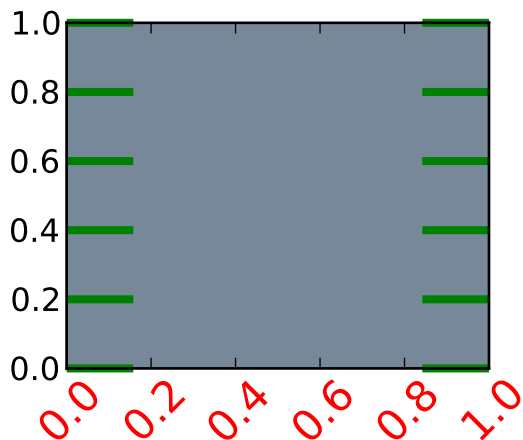
# plt.figure creates a matplotlib.figure.Figure instance
fig = plt.figure()
rect = fig.patch # a rectangle instance
rect.set_facecolor('lightgoldenrodyellow')

ax1 = fig.add_axes([0.1, 0.3, 0.4, 0.4])
rect = ax1.patch
rect.set_facecolor('lightslategray')

for label in ax1.xaxis.get_ticklabels():
    # label is a Text instance
    label.set_color('red')
    label.set_rotation(45)
    label.set_fontsize(16)

for line in ax1.yaxis.get_ticklines():
    # line is a Line2D instance
    line.set_color('green')
    line.set_markersize(25)
    line.set_mkeredgewidth(3)

```



## 9.6 Tick containers

The `matplotlib.axis.Tick` is the final container object in our descent from the [Figure](#) to the [Axes](#) to the [Axis](#) to the [Tick](#). The `Tick` contains the tick and grid line instances, as well as the label instances for the upper and lower ticks. Each of these is accessible directly as an attribute of the `Tick`. In addition, there are boolean variables that determine whether the upper labels and ticks are on for the x-axis and whether the right labels and ticks are on for the y-axis.

| Tick attribute         | Description   |
|------------------------|---|
| <code>tick1line</code> | Line2D instance   |
| <code>tick2line</code> | Line2D instance   |
| <code>gridline</code>  | Line2D instance   |
| <code>label1</code>    | Text instance   |
| <code>label2</code>    | Text instance   |
| <code>gridOn</code>    | boolean which determines whether to draw the tickline     |
| <code>tick1On</code>   | boolean which determines whether to draw the 1st tickline |
| <code>tick2On</code>   | boolean which determines whether to draw the 2nd tickline |
| <code>label1On</code>  | boolean which determines whether to draw tick label       |
| <code>label2On</code>  | boolean which determines whether to draw tick label       |

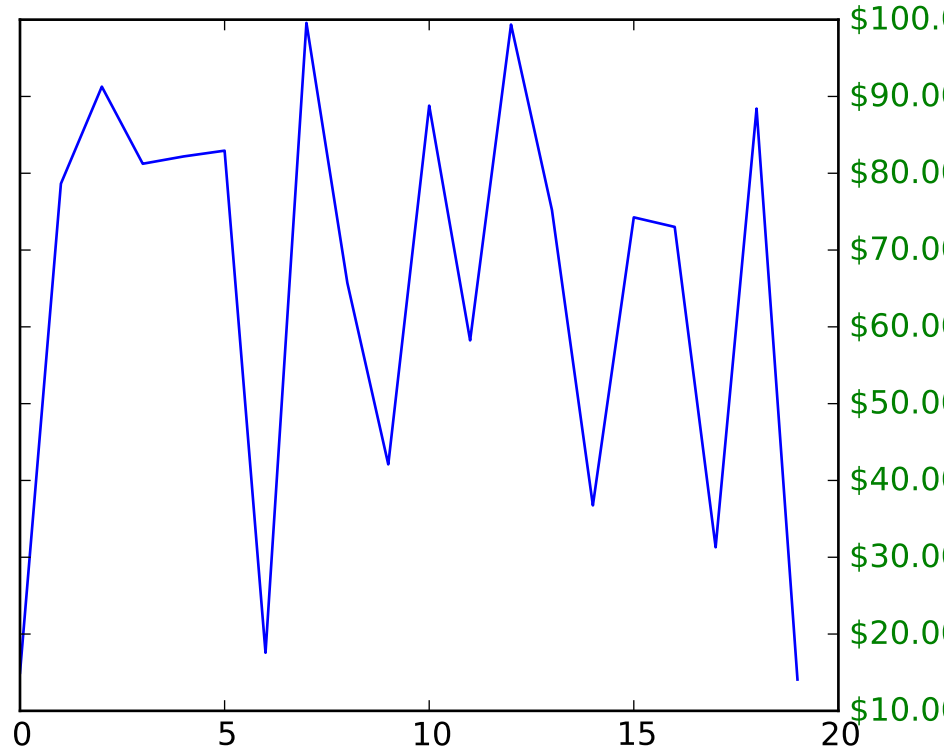
Here is an example which sets the formatter for the right side ticks with dollar signs and colors them green on the right side of the yaxis

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.ticker as ticker

fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(100*np.random.rand(20))

formatter = ticker.FormatStrFormatter('%$1.2f')
ax.yaxis.set_major_formatter(formatter)

for tick in ax.yaxis.get_major_ticks():
    tick.label1On = False
    tick.label2On = True
    tick.label2.set_color('green')
```





---

# CUSTOMIZING LOCATION OF SUBPLOT USING GRIDSPEC

**GridSpec** specifies the geometry of the grid that a subplot will be placed. The number of rows and number of columns of the grid need to be set. Optionally, the subplot layout parameters (e.g., left, right, etc.) can be tuned.

**SubplotSpec** specifies the location of the subplot in the given *GridSpec*.

**subplot2grid** a helper function that is similar to “`pyplot.subplot`” but uses 0-based indexing and let subplot to occupy multiple cells.

## 10.1 Basic Example of using subplot2grid

To use `subplot2grid`, you provide geometry of the grid and the location of the subplot in the grid. For a simple single-cell subplot:

```
ax = plt.subplot2grid((2,2),(0, 0))
```

is identical to

```
ax = plt.subplot(2,2,1)
```

Note that, unlike matplotlib’s `subplot`, the index starts from 0 in `gridspec`.

To create a subplot that spans multiple cells,

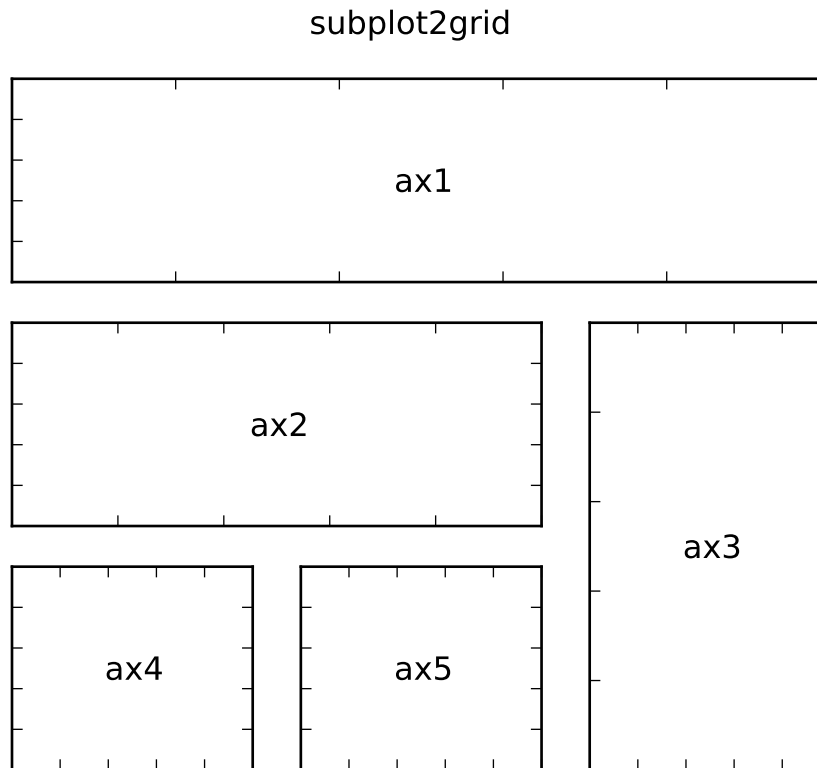
```
ax2 = plt.subplot2grid((3,3), (1, 0), colspan=2)
ax3 = plt.subplot2grid((3,3), (1, 2), rowspan=2)
```

For example, the following commands

```
ax1 = plt.subplot2grid((3,3), (0,0), colspan=3)
ax2 = plt.subplot2grid((3,3), (1,0), colspan=2)
ax3 = plt.subplot2grid((3,3), (1, 2), rowspan=2)
```

```
ax4 = plt.subplot2grid((3,3), (2, 0))
ax5 = plt.subplot2grid((3,3), (2, 1))
```

creates



## 10.2 GridSpec and SubplotSpec

You can create `GridSpec` explicitly and use them to create a `Subplot`.

For example,

```
ax = plt.subplot2grid((2,2),(0, 0))
```

is equal to

```
import matplotlib.gridspec as gridspec
gs = gridspec.GridSpec(2, 2)
ax = plt.subplot(gs[0, 0])
```

A `gridspec` instance provides array-like (2d or 1d) indexing that returns the `SubplotSpec` instance. For, `SubplotSpec` that spans multiple cells, use slice.

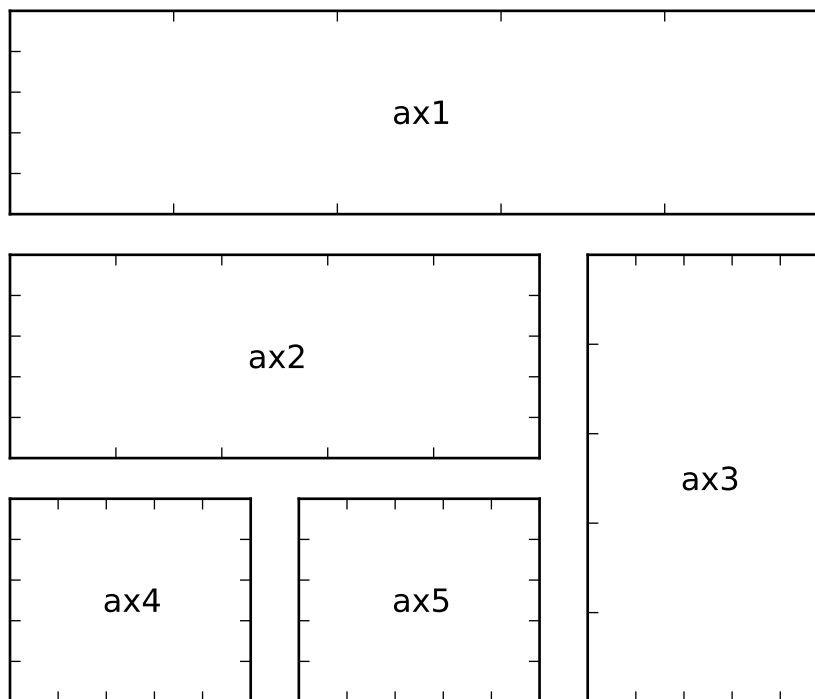


```
ax2 = plt.subplot(gs[1, :-1])
ax3 = plt.subplot(gs[1:, -1])
```

The above example becomes

```
gs = gridspec.GridSpec(3, 3)
ax1 = plt.subplot(gs[0, :])
ax2 = plt.subplot(gs[1, :-1])
ax3 = plt.subplot(gs[1:, -1])
ax4 = plt.subplot(gs[-1, 0])
ax5 = plt.subplot(gs[-1, -2])
```

GridSpec



## 10.3 Adjust GridSpec layout

When a GridSpec is explicitly used, you can adjust the layout parameters of subplots that are created from the gridspec.

```
gs1 = gridspec.GridSpec(3, 3)
gs1.update(left=0.05, right=0.48, wspace=0.05)
```

This is similar to *subplots\_adjust*, but it only affects the subplots that are created from the given GridSpec.

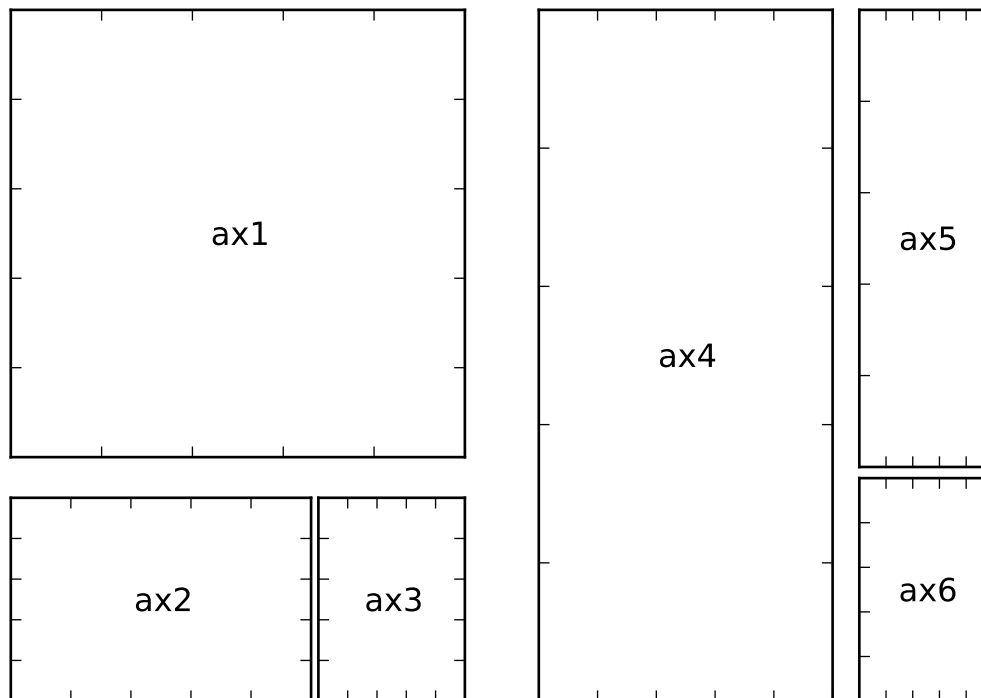
The code below

```
gs1 = gridspec.GridSpec(3, 3)
gs1.update(left=0.05, right=0.48, wspace=0.05)
ax1 = plt.subplot(gs1[:-1, :])
ax2 = plt.subplot(gs1[-1, :-1])
ax3 = plt.subplot(gs1[-1, -1])

gs2 = gridspec.GridSpec(3, 3)
gs2.update(left=0.55, right=0.98, hspace=0.05)
ax4 = plt.subplot(gs2[:, :-1])
ax5 = plt.subplot(gs2[-1, -1])
ax6 = plt.subplot(gs2[-1, -1])
```

creates

GirdSpec w/ different subplotpars



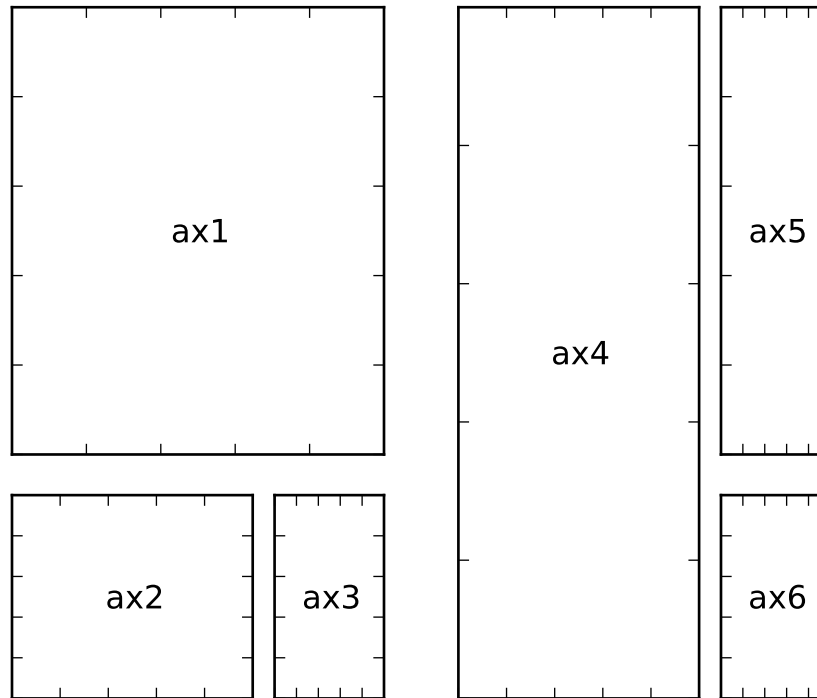
## 10.4 GridSpec using SubplotSpec

You can create GridSpec from the SubplotSpec, in which case its layout parameters are set to that of the location of the given SubplotSpec.

```
gs0 = gridspec.GridSpec(1, 2)
```

```
gs00 = gridspec.GridSpecFromSubplotSpec(3, 3, subplot_spec=gs0[0])
gs01 = gridspec.GridSpecFromSubplotSpec(3, 3, subplot_spec=gs0[1])
```

### GirdSpec Inside GridSpec



## 10.5 A Complex Nested GridSpec using SubplotSpec

Here's a more sophisticated example of nested gridspec where we put a box around each cell of the outer 4x4 grid, by hiding appropriate spines in each of the inner 3x3 grids.

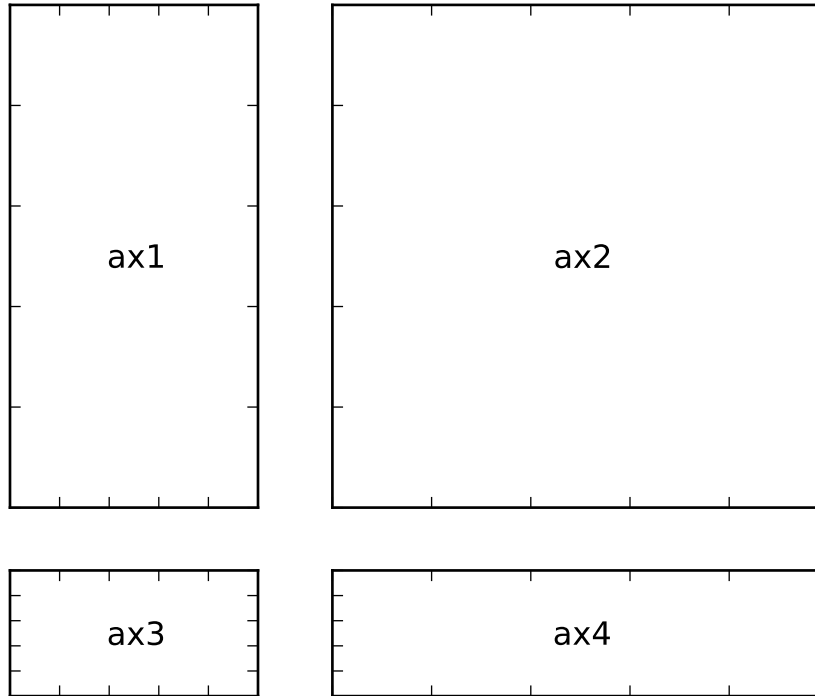
```
.. plot:: users/plotting/examples/demo_gridspec06.py
```

## 10.6 GridSpec with Varying Cell Sizes

By default, GridSpec creates cells of equal sizes. You can adjust relative heights and widths of rows and columns. Note that absolute values are meaningless, only their relative ratios matter.

```
gs = gridspec.GridSpec(2, 2,
                       width_ratios=[1,2],
                       height_ratios=[4,1]
                      )
```

```
ax1 = plt.subplot(gs[0])  
ax2 = plt.subplot(gs[1])  
ax3 = plt.subplot(gs[2])  
ax4 = plt.subplot(gs[3])
```



# TIGHT LAYOUT GUIDE

*tight\_layout* automatically adjusts subplot params so that the subplot(s) fits in to the figure area. This is an experimental feature and may not work for some cases. It only checks the extents of ticklabels, axis labels, and titles.

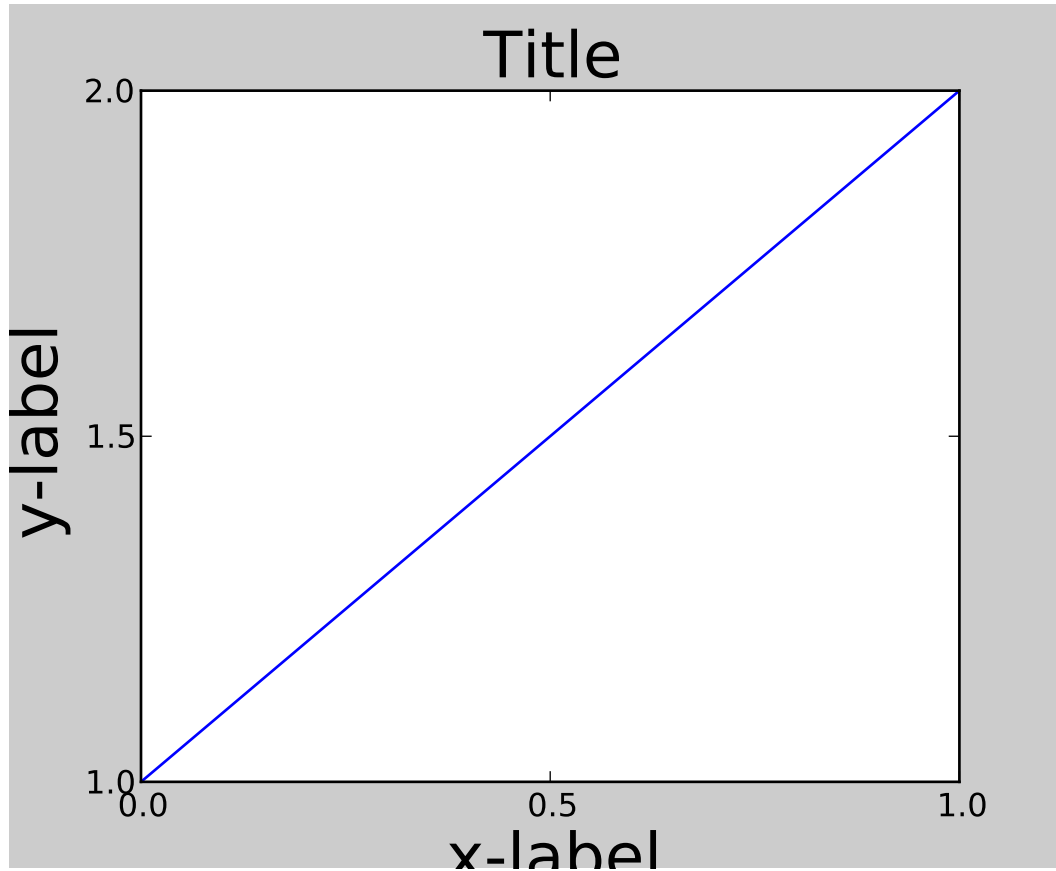
## 11.1 Simple Example

In matplotlib location of axes (including subplots) are specified in normalized figure coordinate. It can happen that your axis labels or titles (or sometimes even ticklabels) go outside the figure area thus clipped.

```
plt.rcParams['savefig.facecolor'] = "0.8"

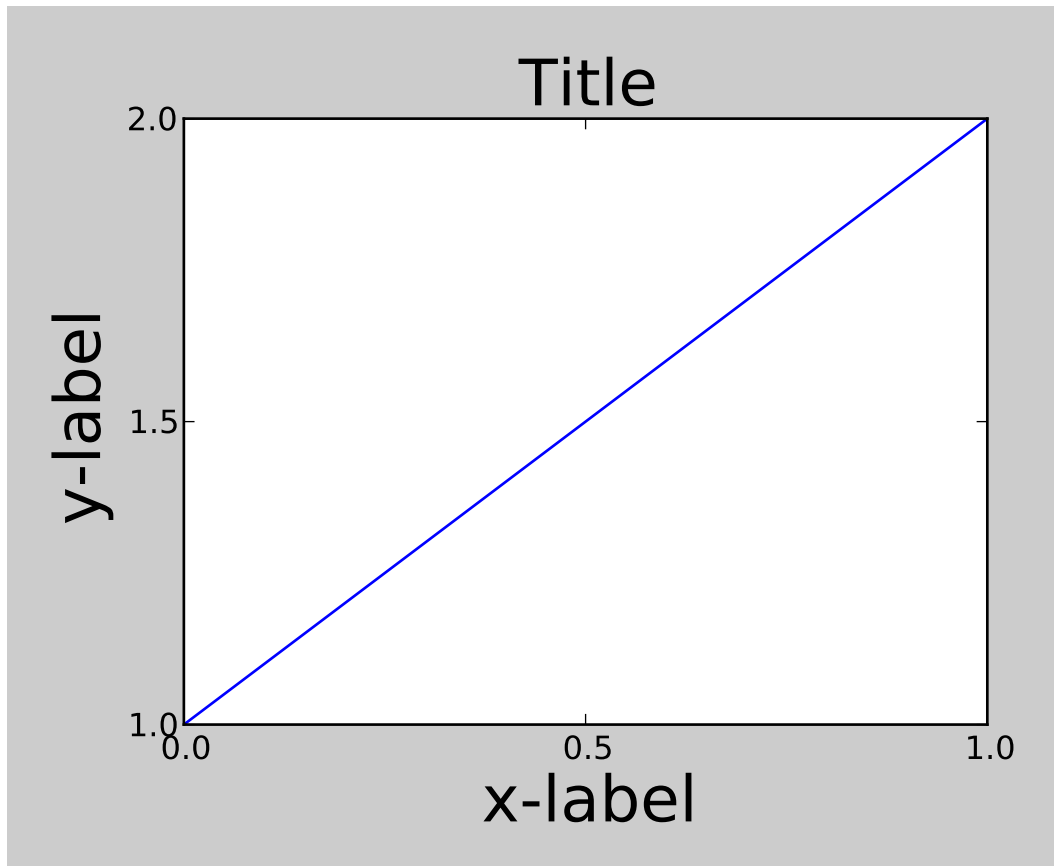
def example_plot(ax, fontsize=12):
    ax.plot([1, 2])
    ax.locator_params(nbins=3)
    ax.set_xlabel('x-label', fontsize=fontsize)
    ax.set_ylabel('y-label', fontsize=fontsize)
    ax.set_title('Title', fontsize=fontsize)

plt.close('all')
fig, ax = plt.subplots()
example_plot(ax, fontsize=24)
```



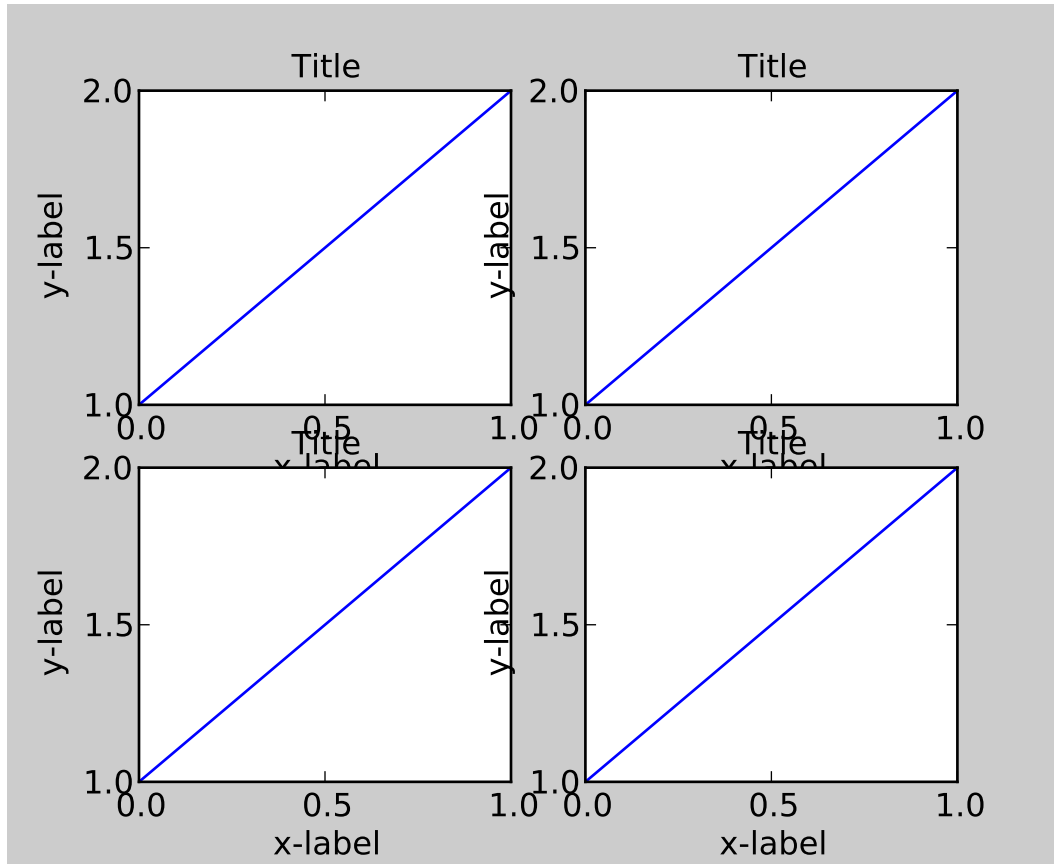
To prevent this, the location of axes need to be adjusted. For subplots, this can be done by adjusting the subplot params (*Move the edge of an axes to make room for tick labels*). Matplotlib v1.1 introduces a new command `plt.tight_layout()` that does this automatically for you.

```
plt.tight_layout()
```



When you have multiple subplots, often you see labels of different axes overlaps each other.

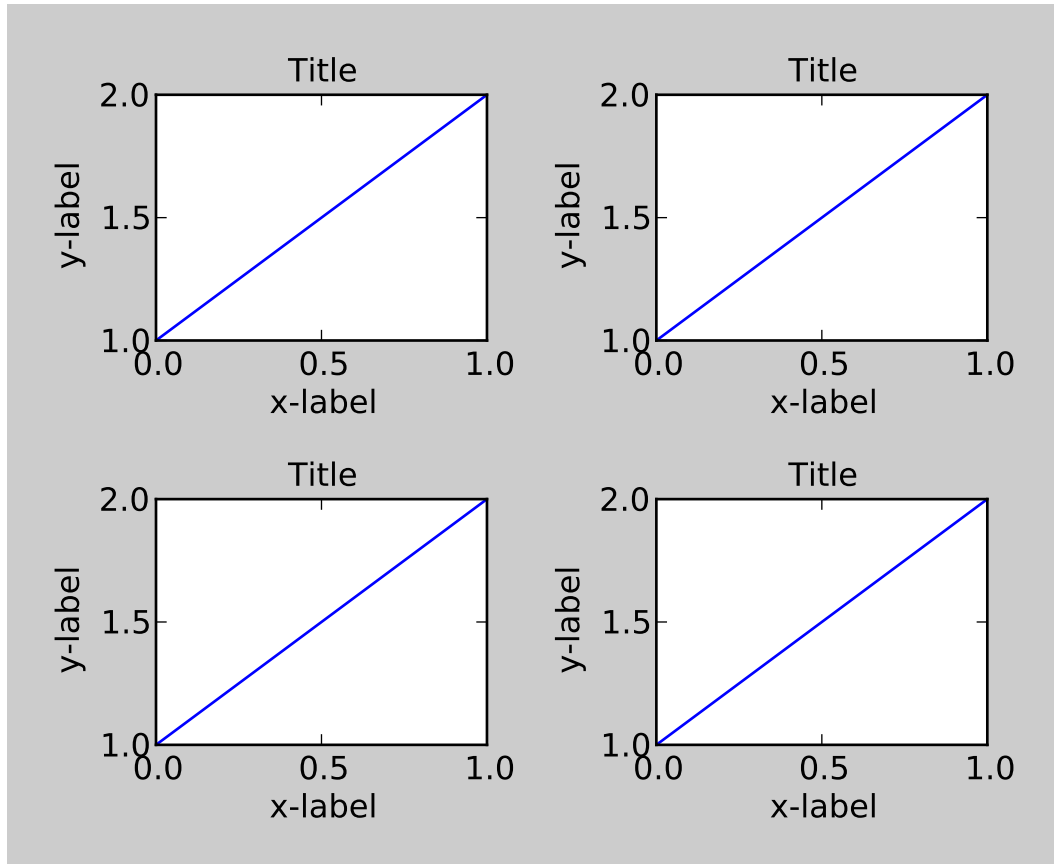
```
plt.close('all')
fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(nrows=2, ncols=2)
example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
```



*tight\_layout* will also adjust spacing between subplots to minimize the overlaps.

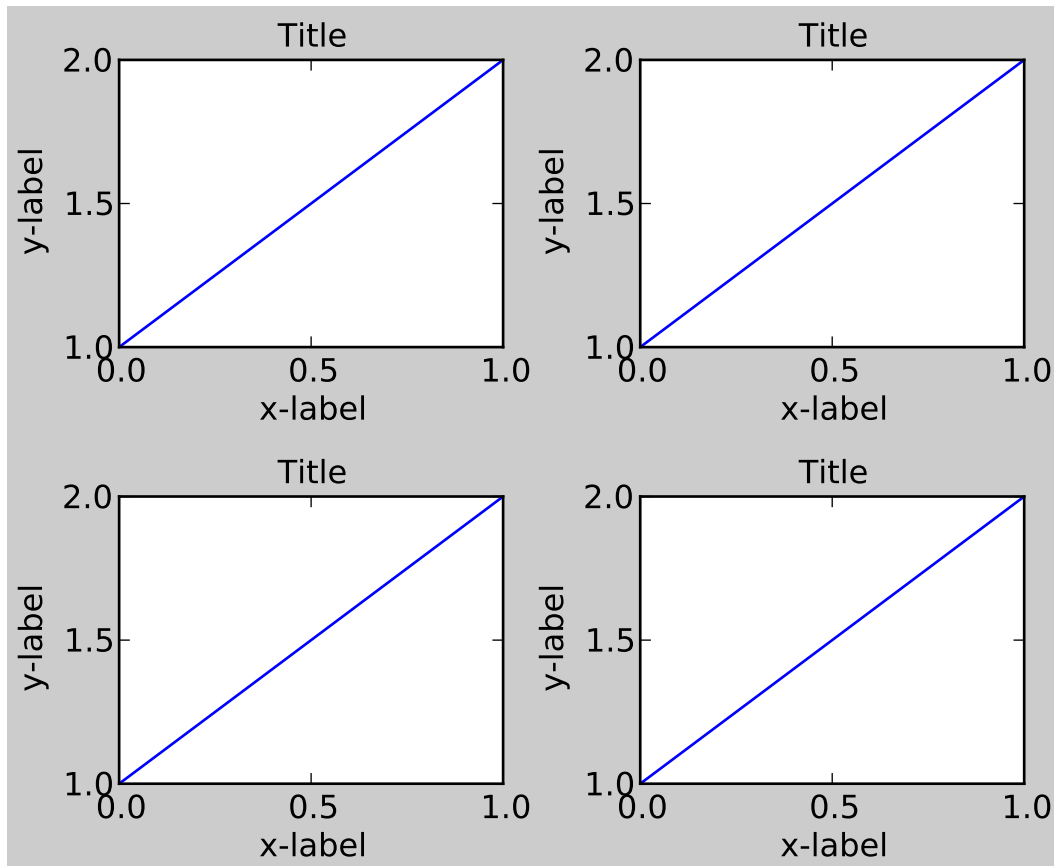
```
plt.tight_layout()
```





`tight_layout()` can take keyword arguments of *pad*, *w\_pad* and *h\_pad*. These controls the extra pad around the figure border and between subplots. The pads are specified in fraction of fontsize.

```
plt.tight_layout(pad=0.4, w_pad=0.5, h_pad=1.0)
```



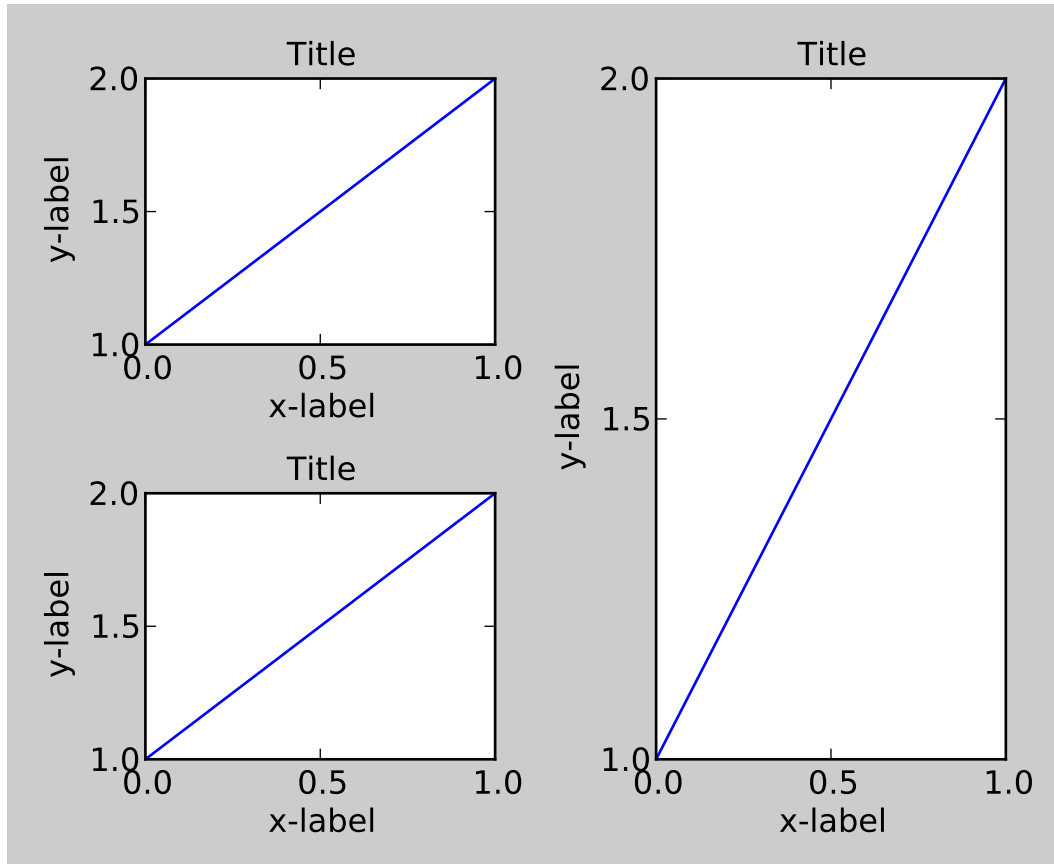
`tight_layout()` will work even if the sizes of subplot are different as far as their grid specification is compatible. In the example below, *ax1* and *ax2* are subplots of 2x2 grid, while *ax3* is of 1x2 grid.

```
plt.close('all')
fig = plt.figure()

ax1 = plt.subplot(221)
ax2 = plt.subplot(223)
ax3 = plt.subplot(122)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)

plt.tight_layout()
```



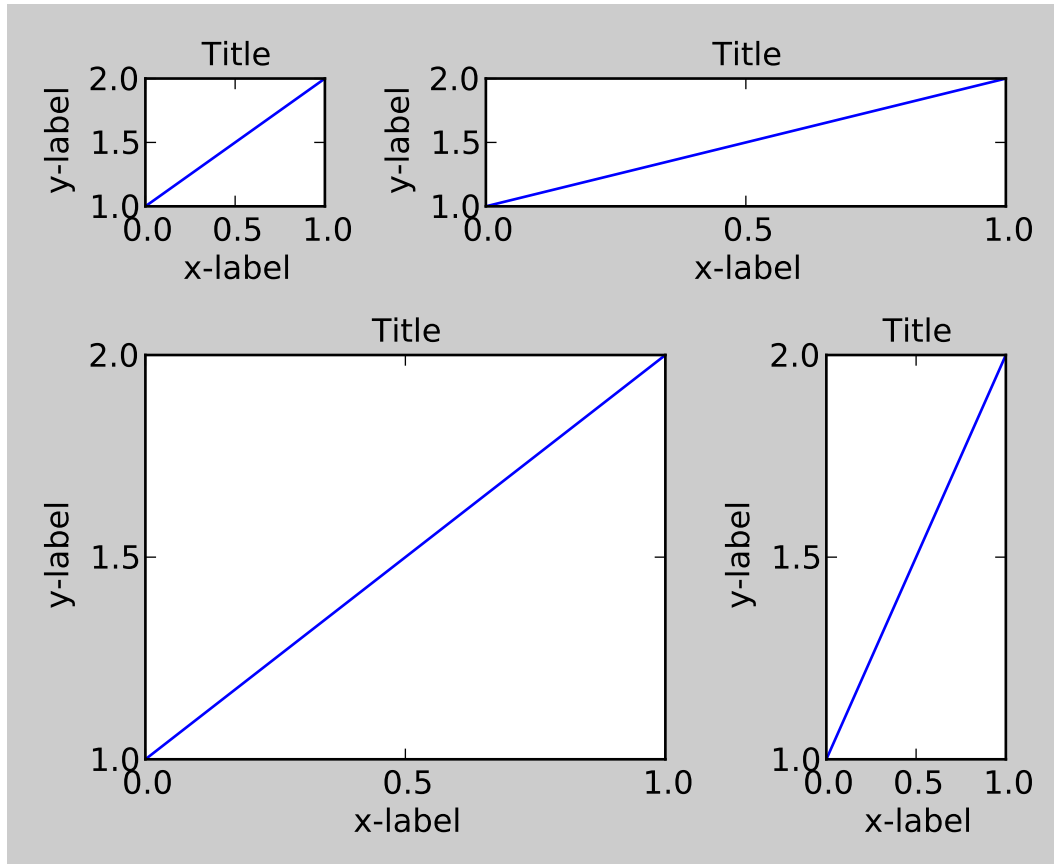
It works with subplots created with `subplot2grid()`. In general, subplots created from the gridspec (*Customizing Location of Subplot Using GridSpec*) will work.

```
plt.close('all')
fig = plt.figure()

ax1 = plt.subplot2grid((3, 3), (0, 0))
ax2 = plt.subplot2grid((3, 3), (0, 1), colspan=2)
ax3 = plt.subplot2grid((3, 3), (1, 0), colspan=2, rowspan=2)
ax4 = plt.subplot2grid((3, 3), (1, 2), rowspan=2)

example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)

plt.tight_layout()
```



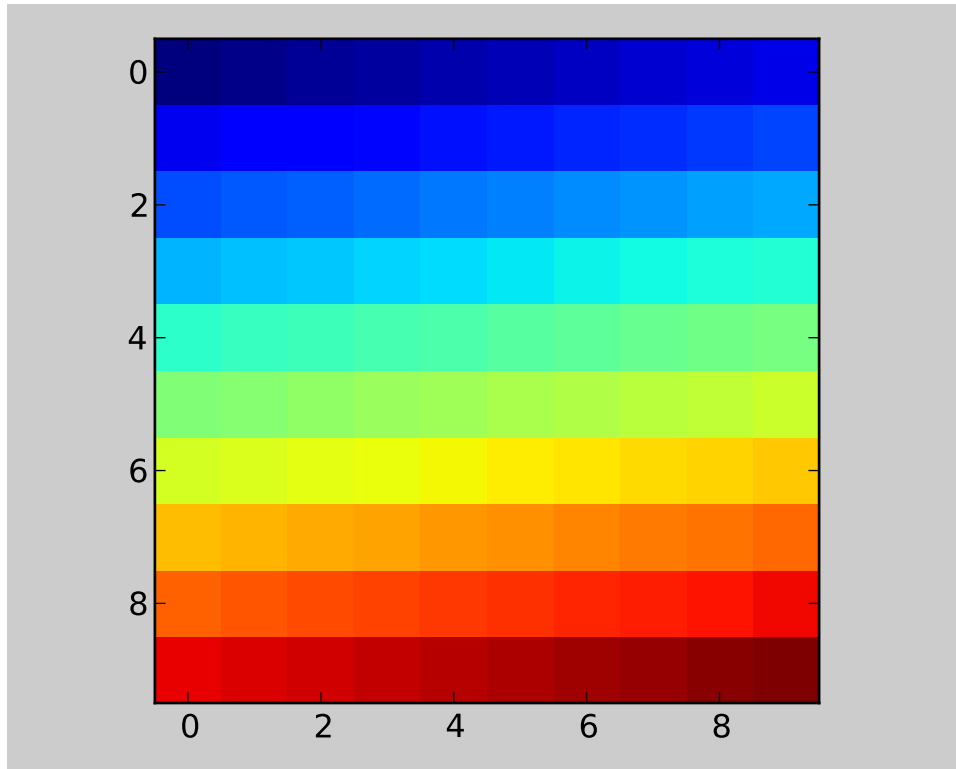
Although not thoroughly tested, it seems to work for subplots with `aspect != "auto"` (e.g., axes with images).

```
arr = np.arange(100).reshape((10,10))

plt.close('all')
fig = plt.figure(figsize=(5,4))

ax = plt.subplot(111)
im = ax.imshow(arr, interpolation="none")

plt.tight_layout()
```



### 11.1.1 Caveats

- *tight\_layout* only considers ticklabels, axis labels, and titles. Thus, other artists may be clipped and also may overlap.
- It assumes that the extra space needed for ticklabels, axis labels, and titles is independent of original location of axes. This is often True, but there are rare cases it is not.
- `pad=0` clips some of the texts by a few pixels. This may be a bug or a limitation of the current algorithm and it is not clear why it happens. Meanwhile, use of `pad` at least larger than 0.3 is recommended.

### 11.1.2 Use with GridSpec

GridSpec has its own `tight_layout` method (the pyplot api `tight_layout()` also works).

```
plt.close('all')
fig = plt.figure()

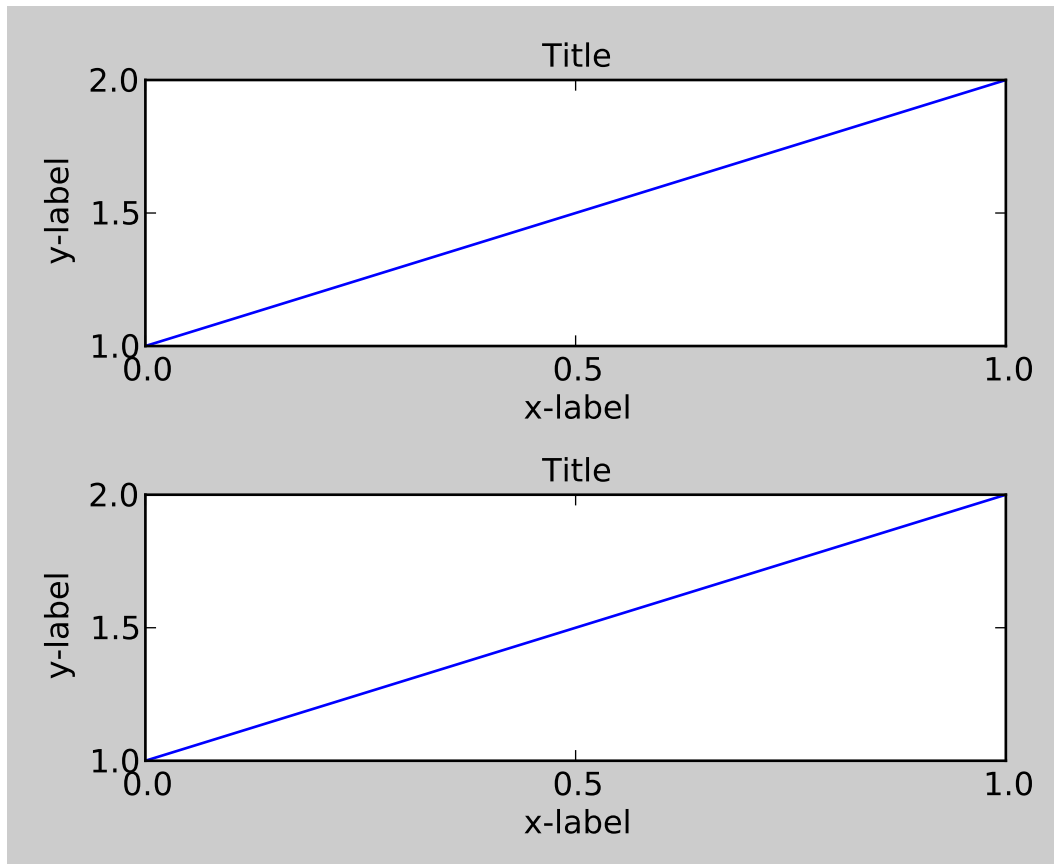
import matplotlib.gridspec as gridspec

gs1 = gridspec.GridSpec(2, 1)
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
```

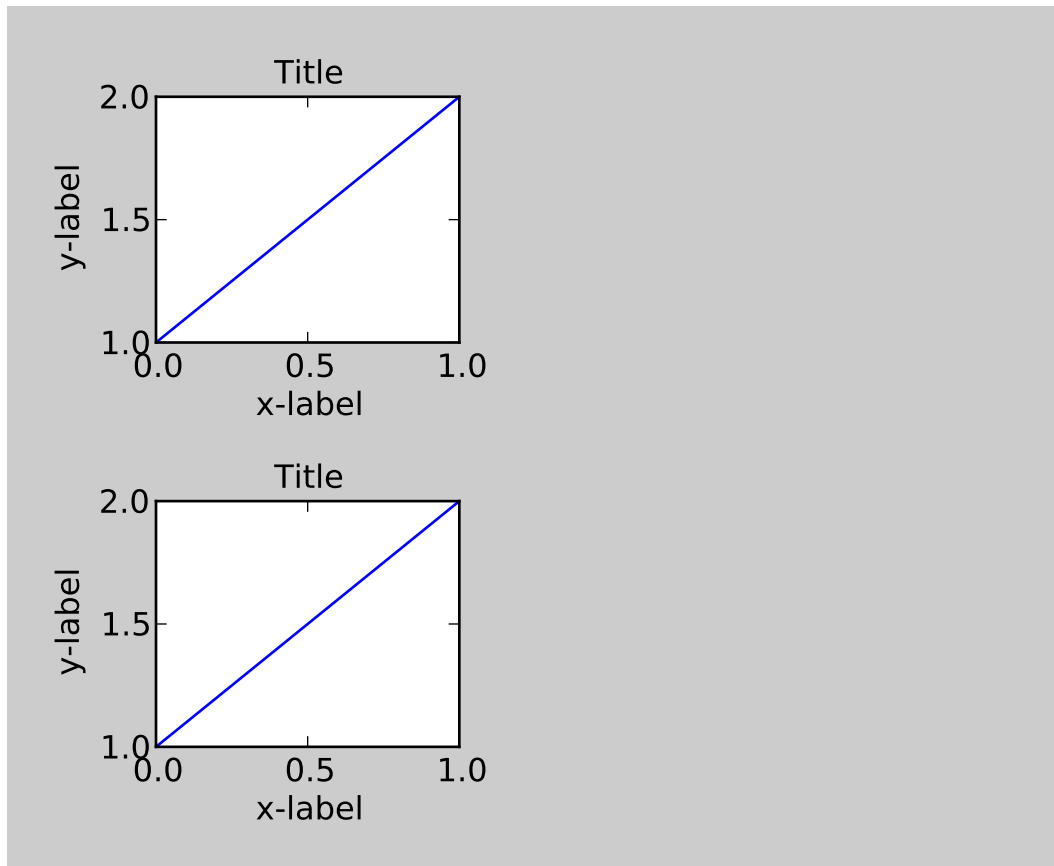
```
example_plot(ax2)
```

```
gs1.tight_layout(fig)
```



You may provide an optional *rect* parameter, which specify the bbox that the subplots will be fit in. The coordinate must be in normalized figure coordinate and the default is (0, 0, 1, 1).

```
gs1.tight_layout(fig, rect=[0, 0, 0.5, 1])
```



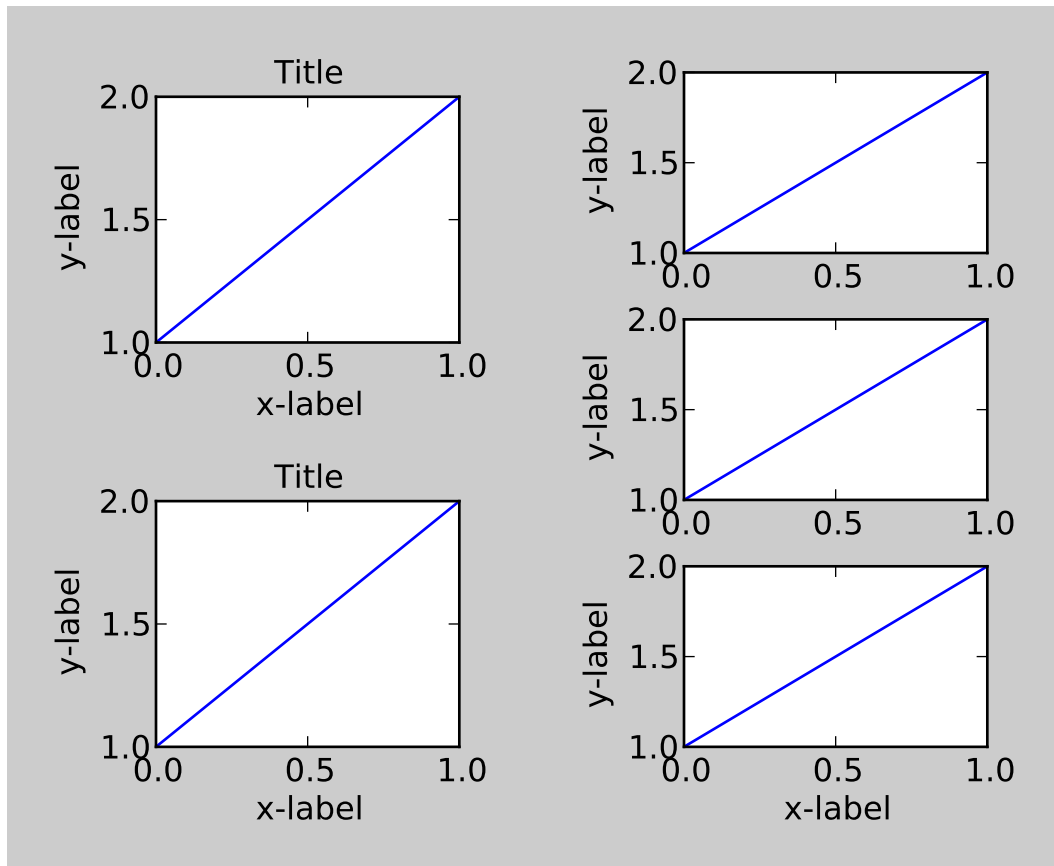
For example, this can be used for a figure with multiple `grid_spec`'s.

```
gs2 = gridspec.GridSpec(3, 1)

for ss in gs2:
    ax = fig.add_subplot(ss)
    example_plot(ax)
    ax.set_title("")
    ax.set_xlabel("")

ax.set_xlabel("x-label", fontsize=12)

gs2.tight_layout(fig, rect=[0.5, 0, 1, 1], h_pad=0.5)
```



We may try to match the top and bottom of two grids

```
top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)
```

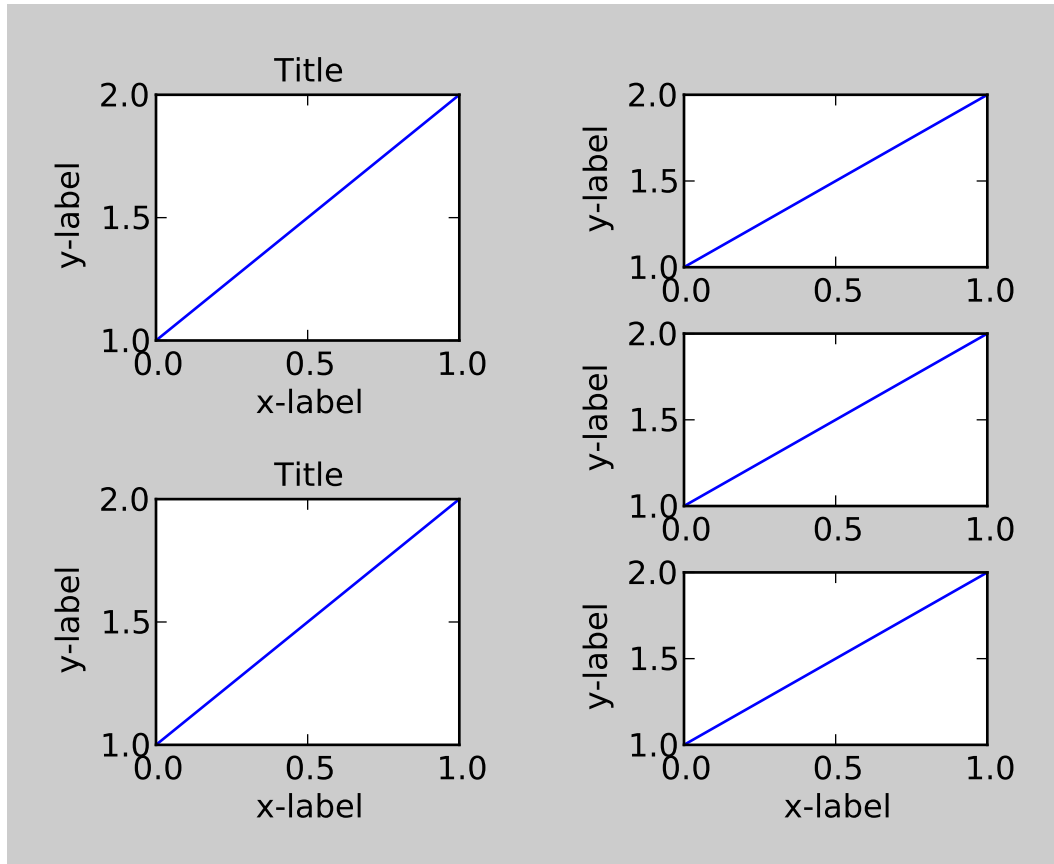
```
gs1.update(top=top, bottom=bottom)
gs2.update(top=top, bottom=bottom)
```

While this should be mostly good enough, but adjusting top and bottom may requires adjustment in hspace also. To update hspace & vspace, we call `tight_layout` again with updated `rect` argument. Note the `rect` argument specifies area including the ticklabels etc. Thus we will increase the bottom (which is 0 in normal case) by the difference between the *bottom* from above and bottom of each gridspec. Same thing for top.

```
top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)

gs1.tight_layout(fig, rect=[None, 0 + (bottom-gs1.bottom),
                           0.5, 1 - (gs1.top-top)])
gs2.tight_layout(fig, rect=[0.5, 0 + (bottom-gs2.bottom),
                           None, 1 - (gs2.top-top)],
                 h_pad=0.5)
```





### 11.1.3 Use with AxesGrid1

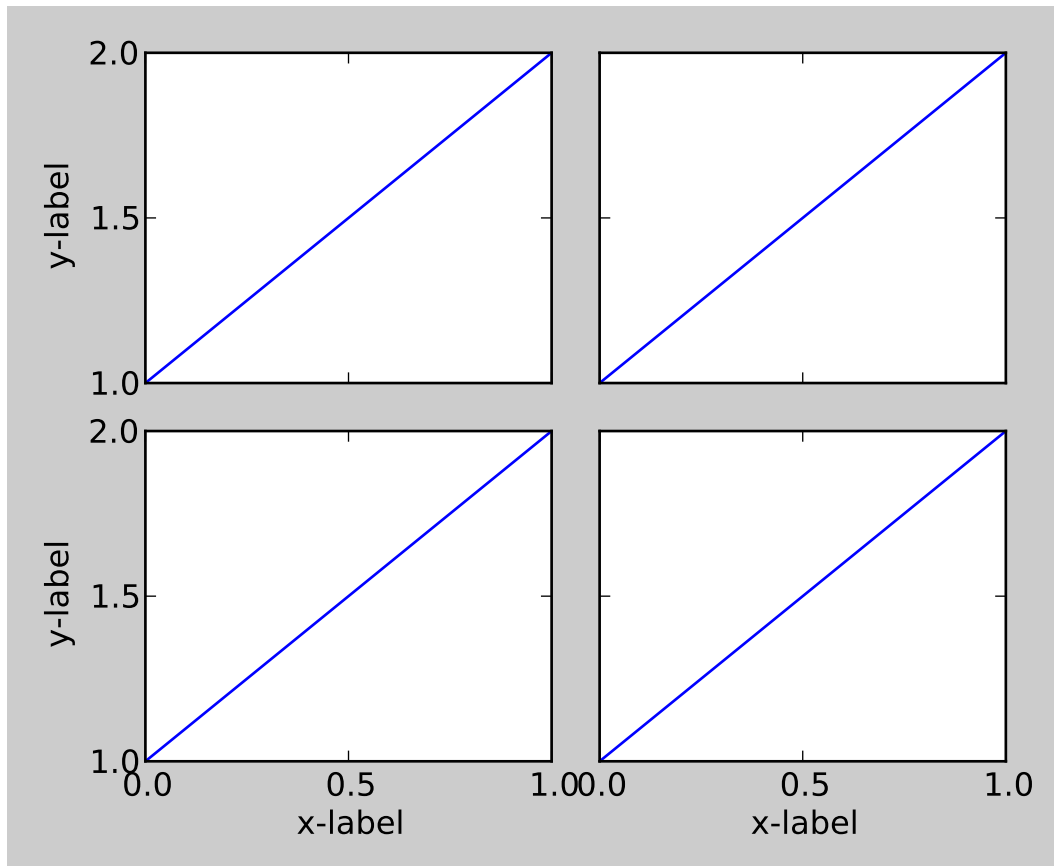
While limited, axes\_grid1 toolkit is also supported.

```
plt.close('all')
fig = plt.figure()

from mpl_toolkits.axes_grid1 import Grid
grid = Grid(fig, rect=111, nrows_ncols=(2,2),
            axes_pad=0.25, label_mode='L',
            )

for ax in grid:
    example_plot(ax)
    ax.title.set_visible(False)

plt.tight_layout()
```



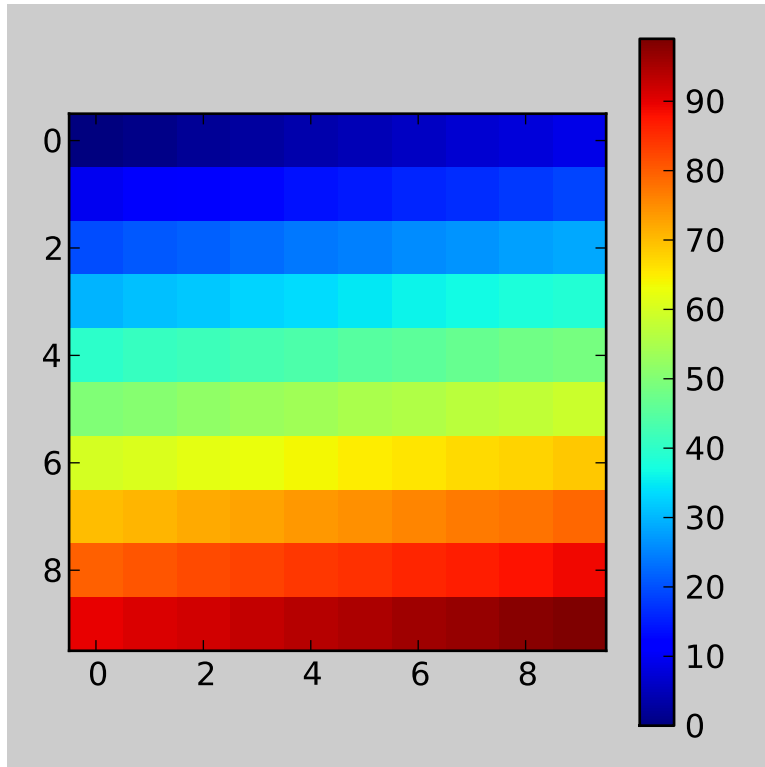
### 11.1.4 Colorbar

If you create colorbar with `colorbar()` command, the created colorbar is an instance of `Axes` not `Subplot`, thus `tight_layout` does not work. With Matplotlib v1.1, you may create a colorbar as a subplot using the `gridspec`.

```
plt.close('all')
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

plt.colorbar(im, use_gridspec=True)

plt.tight_layout()
```

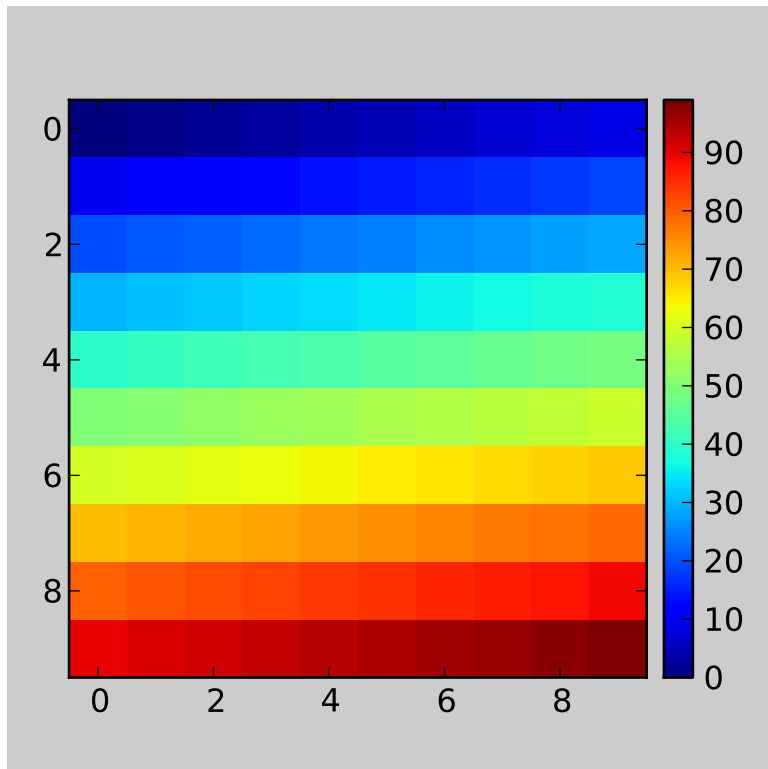


Another option is to use AxesGrid1 toolkit to explicitly create an axes for colorbar.

```
plt.close('all')
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

from mpl_toolkits.axes_grid1 import make_axes_locatable
divider = make_axes_locatable(plt.gca())
cax = divider.append_axes("right", "5%", pad="3%")
plt.colorbar(im, cax=cax)

plt.tight_layout()
```



# LEGEND GUIDE

Do not proceed unless you already have read `legend()` and `matplotlib.legend.Legend!`

## 12.1 What to be displayed

The legend command has a following call signature:

```
legend(*args, **kwargs)
```

If `len(args)` is 2, the first argument should be a list of artist to be labeled, and the second argument should a list of string labels. If `len(args)` is 0, it automatically generate the legend from label properties of the child artists by calling `get_legend_handles_labels()` method. For example, `ax.legend()` is equivalent to:

```
handles, labels = ax.get_legend_handles_labels()
ax.legend(handles, labels)
```

The `get_legend_handles_labels()` method returns a tuple of two lists, i.e., list of artists and list of labels (python string). However, it does not return all of its child artists. It returns artists that are currently supported by matplotlib.

For matplotlib v1.0 and earlier, the supported artists are as follows.

- `Line2D`
- `Patch`
- `LineCollection`
- `RegularPolyCollection`
- `CircleCollection`

And, `get_legend_handles_labels()` returns all artists in `ax.lines`, `ax.patches` and artists in `ax.collection` which are instance of `LineCollection` or `RegularPolyCollection`. The label attributes (returned by `get_label()` method) of collected artists are used as text labels. If label attribute is empty string or starts with “\_”, those artists will be ignored.

Therefore, plots drawn by some *pyplot* commands are not supported by legend. For example, `fill_between()` creates `PolyCollection` that is not supported. Also support is limited for some commands that create multiple artists. For example, `errorbar()` creates multiple `Line2D` instances.

Unfortunately, there is no easy workaround when you need legend for an artist not supported by matplotlib (You may use one of the supported artist as a proxy. See below)

In newer version of matplotlib (v1.1 and later), the matplotlib internals are revised to support

- complex plots that create multiple artists (e.g., bar, errorbar, etc)
- custom legend handles

See below for details of new functionality.

### 12.1.1 Adjusting the Order of Legend items

When you want to customize the list of artists to be displayed in the legend, or their order of appearance. There are two options. First, you can keep lists of artists and labels, and explicitly use these for the first two arguments of the legend call.:

```
p1, = plot([1,2,3])
p2, = plot([3,2,1])
p3, = plot([2,3,1])
legend([p2, p1], ["line 2", "line 1"])
```

Or you may use `get_legend_handles_labels()` to retrieve list of artist and labels and manipulate them before feeding them to legend call.:

```
ax = subplot(1,1,1)
p1, = ax.plot([1,2,3], label="line 1")
p2, = ax.plot([3,2,1], label="line 2")
p3, = ax.plot([2,3,1], label="line 3")

handles, labels = ax.get_legend_handles_labels()

# reverse the order
ax.legend(handles[::-1], labels[::-1])

# or sort them by labels
import operator
hl = sorted(zip(handles, labels),
            key=operator.itemgetter(1))
handles2, labels2 = zip(*hl)

ax.legend(handles2, labels2)
```

### 12.1.2 Using Proxy Artist

When you want to display legend for an artist not supported by matplotlib, you may use another artist as a proxy. For example, you may create a proxy artist without adding it to the axes (so the proxy artist will not

be drawn in the main axes) and feed it to the legend function.:

```
p = Rectangle((0, 0), 1, 1, fc="r")
legend([p], ["Red Rectangle"])
```

## 12.2 Multicolumn Legend

By specifying the keyword argument *ncol*, you can have a multi-column legend. Also, *mode="expand"* horizontally expand the legend to fill the axes area. See [legend\\_demo3.py](#) for example.

## 12.3 Legend location

The location of the legend can be specified by the keyword argument *loc*, either by string or a integer number.

| String       | Number |
|--------------|--------|
| upper right  | 1      |
| upper left   | 2      |
| lower left   | 3      |
| lower right  | 4      |
| right        | 5      |
| center left  | 6      |
| center right | 7      |
| lower center | 8      |
| upper center | 9      |
| center       | 10     |

By default, the legend will anchor to the bbox of the axes (for legend) or the bbox of the figure (figlegend). You can specify your own bbox using *bbox\_to\_anchor* argument. *bbox\_to\_anchor* can be an instance of [BboxBase](#), a tuple of 4 floats (x, y, width, height of the bbox), or a tuple of 2 floats (x, y with width=height=0). Unless *bbox\_transform* argument is given, the coordinates (even for the bbox instance) are considered as normalized axes coordinates.

For example, if you want your axes legend located at the figure corner (instead of the axes corner):

```
l = legend(bbox_to_anchor=(0, 0, 1, 1), transform=gcf().transFigure)
```

Also, you can place above or outer right-hand side of the axes,

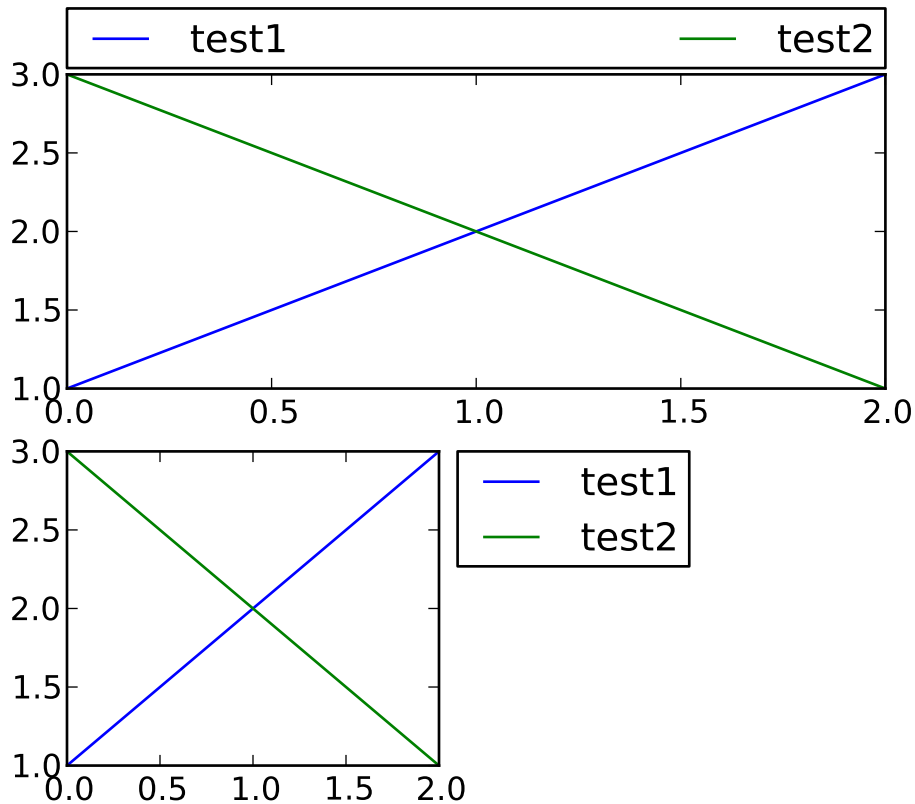
```
from matplotlib.pyplot import *

subplot(211)
plot([1,2,3], label="test1")
plot([3,2,1], label="test2")
legend(bbox_to_anchor=(0., 1.02, 1., .102), loc=3,
       ncol=2, mode="expand", borderaxespad=0.)

subplot(223)
```

```
plot([1,2,3], label="test1")
plot([3,2,1], label="test2")
legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
```

```
show()
```



## 12.4 Multiple Legend

Sometime, you want to split the legend into multiple ones.:

```
p1, = plot([1,2,3])
p2, = plot([3,2,1])
legend([p1], ["Test1"], loc=1)
legend([p2], ["Test2"], loc=4)
```

However, the above code only shows the second legend. When the legend command is called, a new legend instance is created and old ones are removed from the axes. Thus, you need to manually add the removed legend.

```
from matplotlib.pyplot import *
```



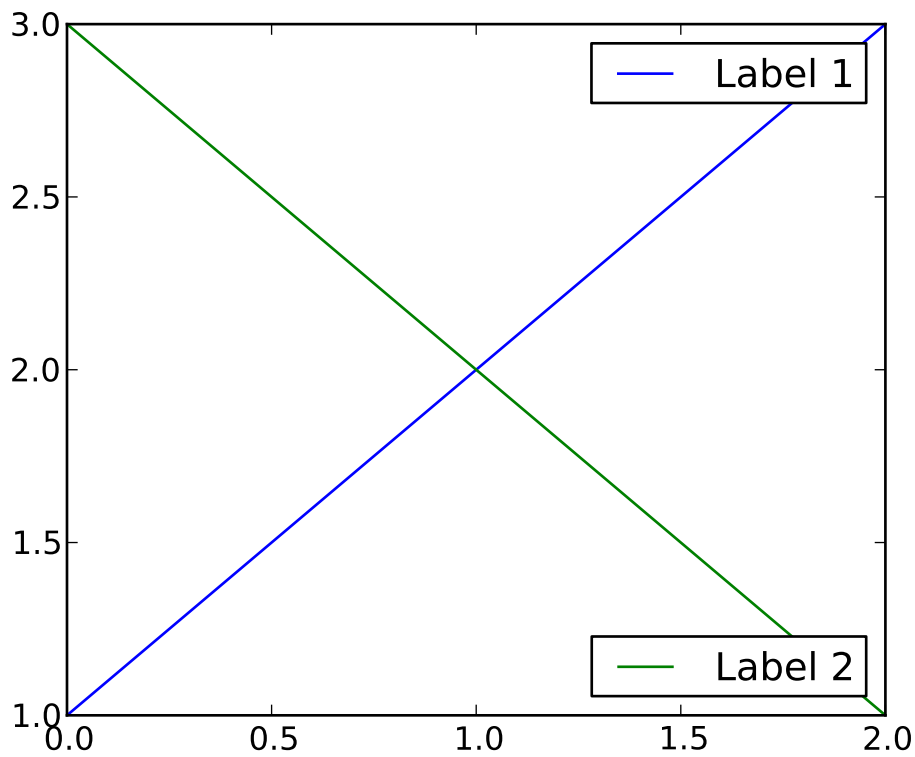
```

p1, = plot([1,2,3], label="test1")
p2, = plot([3,2,1], label="test2")

l1 = legend([p1], ["Label 1"], loc=1)
l2 = legend([p2], ["Label 2"], loc=4) # this removes l1 from the axes.
gca().add_artist(l1) # add l1 as a separate artist to the axes

show()

```



## 12.5 Legend of Complex Plots

In matplotlib v1.1 and later, the legend is improved to support more plot commands and ease the customization.

### 12.5.1 Artist Container

The Artist Container is simple class (derived from tuple) that contains multiple artists. This is introduced primarily to support legends for complex plot commands that create multiple artists.

Axes instances now have a “containers” attribute (which is a list, and this is only intended to be used for generating a legend). The items in this attribute are also returned by `get_legend_handles_labels()`.

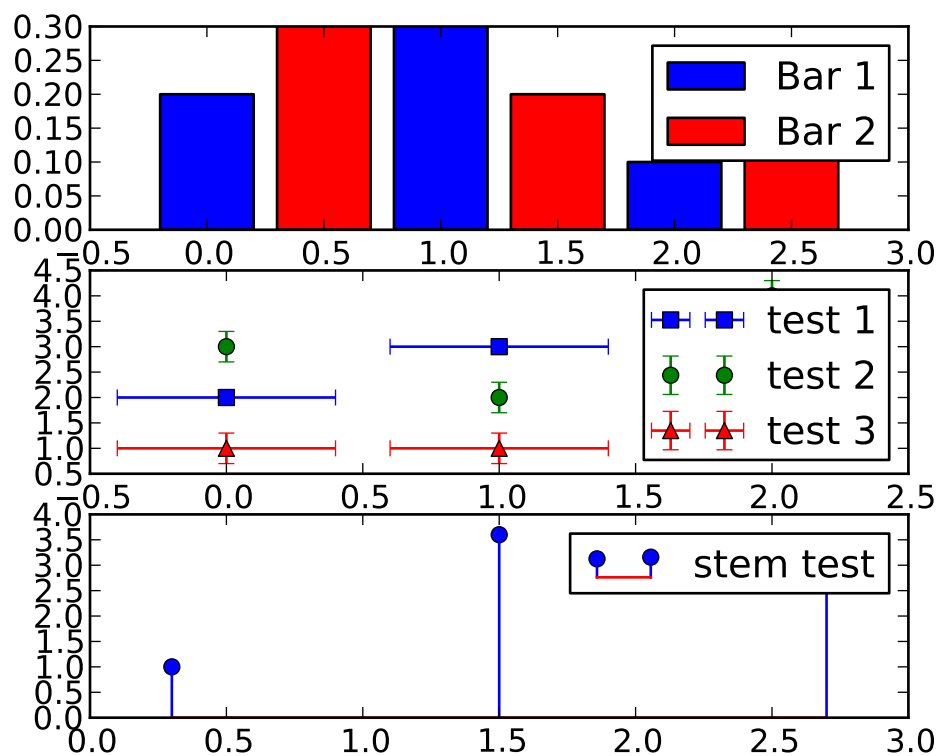
For example, “bar” command creates a series of Rectangle patches. Previously, it returned a list of these patches. With the current change, it creates a container object of these rectangle patches (and these patches are added to Axes.patches attribute as before) and return it instead. As the container class is derived from a tuple, it should be backward-compatible. Furthermore, the container object is added to the Axes.containers attributes so that legend command can properly create a legend for the bar. Thus, you may do

```
b1 = bar([0, 1, 2], [0.2, 0.3, 0.1], width=0.4,
        label="Bar 1", align="center")
legend()
```

or

```
b1 = bar([0, 1, 2], [0.2, 0.3, 0.1], width=0.4, align="center")
legend([b1], ["Bar 1"])
```

At this time of writing, however, only “bar”, “errorbar”, and “stem” are supported (hopefully the list will increase). Here is an example.



## 12.5.2 Legend Handler

One of the changes is that drawing of legend handles has been delegated to legend handlers. For example, `Line2D` instances are handled by `HandlerLine2D`. The mapping between the artists and their corresponding

handlers are defined in a `handler_map` of the legend. The `handler_map` is a dictionary of key-handler pair, where key can be an artist instance or its class. And the handler is a `Handler` instance.

Let's consider the following sample code,

```
legend([p_1, p_2, ..., p_i, ...], ["Test 1", "Test 2", ..., "Test i",...])
```

For each  $p_i$ , matplotlib

1. check if  $p_i$  is in the `handler_map`
2. if not, iterate over `type(p_i).mro()` until a matching key is found in the `handler_map`

Unless specified, the default `handler_map` is used. Below is a partial list of key-handler pairs included in the default handler map.

- `Line2D` : `legend_handler.HandlerLine2D()`
- `Patch` : `legend_handler.HandlerPatch()`
- `LineCollection` : `legend_handler.HandlerLineCollection()`
- ...

The `legend()` command takes an optional argument of “`handler_map`”. When provided, the default handler map will be updated (using `dict.update` method) with the provided one.

```
p1, = plot(x, "ro", label="test1")
p2, = plot(y, "b+", ms=10, label="test2")

my_handler = HandlerLine2D(numpoints=1)

legend(handler_map={Line2D:my_handler})
```

The above example will use *my\_handler* for any `Line2D` instances (`p1` and `p2`).

```
legend(handler_map={p1:HandlerLine2D(numpoints=1)})
```

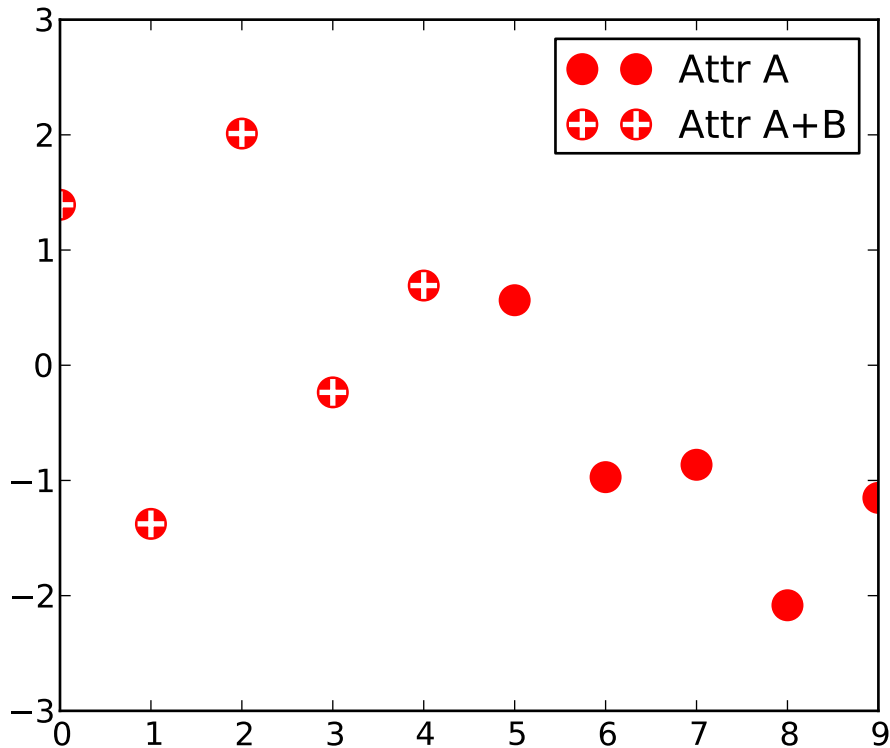
In the above example, only *p1* will be handled by *my\_handler*, while others will be handled by default handlers.

The current default `handler_map` has handlers for errorbar and bar plots. Also, it includes an entry for *tuple* which is mapped to *HandlerTuple*. It simply plots over all the handles for items in the given tuple. For example,

```
z = np.random.randn(10)

p1a, = plt.plot(z, "ro", ms=10, mfc="r", mew=2, mec="r") # red filled circle
p1b, = plt.plot(z[5:], "w+", ms=10, mec="w", mew=2) # white cross

plt.legend([p1a, (p1a, p1b)], ["Attr A", "Attr A+B"])
```



### 12.5.3 Implement a Custom Handler

Handler can be any callable object with following signature.

```
def __call__(self, legend, orig_handle,  
             fontsize,  
             handlebox):
```

Where *legend* is the legend itself, *orig\_handle* is the original plot (*p\_i* in the above example), *fontsize* is the fontsize in pixels, and *handlebox* is a `OffsetBox` instance. Within the call, you create relevant artists (using relevant properties from the *legend* and/or *orig\_handle*) and add them into the *handlebox*. The artists needs to be scaled according to the fontsize (note that the size is in pixel, i.e., this is dpi-scaled value). See `legend_handler` for more details.

# EVENT HANDLING AND PICKING

matplotlib works with 6 user interface toolkits (wxpython, tkinter, qt, gtk, fltk and macosx) and in order to support features like interactive panning and zooming of figures, it is helpful to the developers to have an API for interacting with the figure via key presses and mouse movements that is “GUI neutral” so we don’t have to repeat a lot of code across the different user interfaces. Although the event handling API is GUI neutral, it is based on the GTK model, which was the first user interface matplotlib supported. The events that are triggered are also a bit richer vis-a-vis matplotlib than standard GUI events, including information like which `matplotlib.axes.Axes` the event occurred in. The events also understand the matplotlib coordinate system, and report event locations in both pixel and data coordinates.

## 13.1 Event connections

To receive events, you need to write a callback function and then connect your function to the event manager, which is part of the `FigureCanvasBase`. Here is a simple example that prints the location of the mouse click and which button was pressed:

```
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(np.random.rand(10))

def onclick(event):
    print 'button=%d, x=%d, y=%d, xdata=%f, ydata=%f'%(
        event.button, event.x, event.y, event.xdata, event.ydata)

cid = fig.canvas.mpl_connect('button_press_event', onclick)
```

The `FigureCanvas` method `mpl_connect()` returns a connection id which is simply an integer. When you want to disconnect the callback, just call:

```
fig.canvas.mpl_disconnect(cid)
```

**Note:** The canvas retains only weak references to the callbacks. Therefore if a callback is a method of a class instance, you need to retain a reference to that instance. Otherwise the instance will be garbage-collected and the callback will vanish.

Here are the events that you can connect to, the class instances that are sent back to you when the event occurs, and the event descriptions

| Event name             | Class and description   |
|------------------------|---|
| 'button_press_event'   | <a href="#">MouseEvent</a> - mouse button is pressed            |
| 'button_release_event' | <a href="#">MouseEvent</a> - mouse button is released           |
| 'draw_event'           | <a href="#">DrawEvent</a> - canvas draw                         |
| 'key_press_event'      | <a href="#">KeyEvent</a> - key is pressed                       |
| 'key_release_event'    | <a href="#">KeyEvent</a> - key is released                      |
| 'motion_notify_event'  | <a href="#">MouseEvent</a> - mouse motion                       |
| 'pick_event'           | <a href="#">PickEvent</a> - an object in the canvas is selected |
| 'resize_event'         | <a href="#">ResizeEvent</a> - figure canvas is resized          |
| 'scroll_event'         | <a href="#">MouseEvent</a> - mouse scroll wheel is rolled       |
| 'figure_enter_event'   | <a href="#">LocationEvent</a> - mouse enters a new figure       |
| 'figure_leave_event'   | <a href="#">LocationEvent</a> - mouse leaves a figure           |
| 'axes_enter_event'     | <a href="#">LocationEvent</a> - mouse enters a new axes         |
| 'axes_leave_event'     | <a href="#">LocationEvent</a> - mouse leaves an axes            |

## 13.2 Event attributes

All matplotlib events inherit from the base class `matplotlib.backend_bases.Event`, which store the attributes:

**name** the event name

**canvas** the `FigureCanvas` instance generating the event

**guiEvent** the GUI event that triggered the matplotlib event

The most common events that are the bread and butter of event handling are key press/release events and mouse press/release and movement events. The [KeyEvent](#) and [MouseEvent](#) classes that handle these events are both derived from the `LocationEvent`, which has the following attributes

**x** x position - pixels from left of canvas

**y** y position - pixels from bottom of canvas

**inaxes** the [Axes](#) instance if mouse is over axes

**xdata** x coord of mouse in data coords

**ydata** y coord of mouse in data coords

Let's look a simple example of a canvas, where a simple line segment is created every time a mouse is pressed:

```
from matplotlib import pyplot as plt

class LineBuilder:
    def __init__(self, line):
        self.line = line
        self.xs = list(line.get_xdata())
```

```

self.ys = list(line.get_ydata())
self.cid = line.figure.canvas.mpl_connect('button_press_event', self)

def __call__(self, event):
    print 'click', event
    if event.inaxes!=self.line.axes: return
    self.xs.append(event.xdata)
    self.ys.append(event.ydata)
    self.line.set_data(self.xs, self.ys)
    self.line.figure.canvas.draw()

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click to build line segments')
line, = ax.plot([0], [0]) # empty line
linebuilder = LineBuilder(line)

plt.show()

```

The `MouseEvent` that we just used is a `LocationEvent`, so we have access to the data and pixel coordinates in `event.x` and `event.xdata`. In addition to the `LocationEvent` attributes, it has

- button** button pressed: None, 1, 2, 3, 'up', 'down' (up and down are used for scroll events)
- key** the key pressed: None, any character, 'shift', 'win', or 'control'

### 13.2.1 Draggable rectangle exercise

Write draggable rectangle class that is initialized with a `Rectangle` instance but will move its x,y location when dragged. Hint: you will need to store the original xy location of the rectangle which is stored as `rect.xy` and connect to the press, motion and release mouse events. When the mouse is pressed, check to see if the click occurs over your rectangle (see `matplotlib.patches.Rectangle.contains()`) and if it does, store the rectangle xy and the location of the mouse click in data coords. In the motion event callback, compute the `deltax` and `deltay` of the mouse movement, and add those deltas to the origin of the rectangle you stored. The redraw the figure. On the button release event, just reset all the button press data you stored as `None`.

Here is the solution:

```

import numpy as np
import matplotlib.pyplot as plt

class DraggableRectangle:
    def __init__(self, rect):
        self.rect = rect
        self.press = None

    def connect(self):
        'connect to all the events we need'
        self.cidpress = self.rect.figure.canvas.mpl_connect(
            'button_press_event', self.on_press)

```

```
self.cidrelease = self.rect.figure.canvas.mpl_connect(
    'button_release_event', self.on_release)
self.cidmotion = self.rect.figure.canvas.mpl_connect(
    'motion_notify_event', self.on_motion)

def on_press(self, event):
    'on button press we will see if the mouse is over us and store some data'
    if event.inaxes != self.rect.axes: return

    contains, attrd = self.rect.contains(event)
    if not contains: return
    print 'event contains', self.rect.xy
    x0, y0 = self.rect.xy
    self.press = x0, y0, event.xdata, event.ydata

def on_motion(self, event):
    'on motion we will move the rect if the mouse is over us'
    if self.press is None: return
    if event.inaxes != self.rect.axes: return
    x0, y0, xpress, ypress = self.press
    dx = event.xdata - xpress
    dy = event.ydata - ypress
    #print 'x0=%f, xpress=%f, event.xdata=%f, dx=%f, x0+dx=%f'%(x0, xpress, event.xdata, dx, x0+dx)
    self.rect.set_x(x0+dx)
    self.rect.set_y(y0+dy)

    self.rect.figure.canvas.draw()

def on_release(self, event):
    'on release we reset the press data'
    self.press = None
    self.rect.figure.canvas.draw()

def disconnect(self):
    'disconnect all the stored connection ids'
    self.rect.figure.canvas.mpl_disconnect(self.cidpress)
    self.rect.figure.canvas.mpl_disconnect(self.cidrelease)
    self.rect.figure.canvas.mpl_disconnect(self.cidmotion)

fig = plt.figure()
ax = fig.add_subplot(111)
rects = ax.bar(range(10), 20*np.random.rand(10))
drs = []
for rect in rects:
    dr = DraggableRectangle(rect)
    dr.connect()
    drs.append(dr)

plt.show()
```

**Extra credit:** use the animation blit techniques discussed in the [animations recipe](#) to make the animated drawing faster and smoother.



Extra credit solution:

```
# draggable rectangle with the animation blit techniques; see
# http://www.scipy.org/Cookbook/Matplotlib/Animations
import numpy as np
import matplotlib.pyplot as plt

class DraggableRectangle:
    lock = None # only one can be animated at a time
    def __init__(self, rect):
        self.rect = rect
        self.press = None
        self.background = None

    def connect(self):
        'connect to all the events we need'
        self.cidpress = self.rect.figure.canvas.mpl_connect(
            'button_press_event', self.on_press)
        self.cidrelease = self.rect.figure.canvas.mpl_connect(
            'button_release_event', self.on_release)
        self.cidmotion = self.rect.figure.canvas.mpl_connect(
            'motion_notify_event', self.on_motion)

    def on_press(self, event):
        'on button press we will see if the mouse is over us and store some data'
        if event.inaxes != self.rect.axes: return
        if DraggableRectangle.lock is not None: return
        contains, attrd = self.rect.contains(event)
        if not contains: return
        print 'event contains', self.rect.xy
        x0, y0 = self.rect.xy
        self.press = x0, y0, event.xdata, event.ydata
        DraggableRectangle.lock = self

        # draw everything but the selected rectangle and store the pixel buffer
        canvas = self.rect.figure.canvas
        axes = self.rect.axes
        self.rect.set_animated(True)
        canvas.draw()
        self.background = canvas.copy_from_bbox(self.rect.axes.bbox)

        # now redraw just the rectangle
        axes.draw_artist(self.rect)

        # and blit just the redrawn area
        canvas.blit(axes.bbox)

    def on_motion(self, event):
        'on motion we will move the rect if the mouse is over us'
        if DraggableRectangle.lock is not self:
            return
        if event.inaxes != self.rect.axes: return
        x0, y0, xpress, ypress = self.press
```

```
dx = event.xdata - xpress
dy = event.ydata - ypress
self.rect.set_x(x0+dx)
self.rect.set_y(y0+dy)

canvas = self.rect.figure.canvas
axes = self.rect.axes
# restore the background region
canvas.restore_region(self.background)

# redraw just the current rectangle
axes.draw_artist(self.rect)

# blit just the redrawn area
canvas.blit(axes.bbox)

def on_release(self, event):
    'on release we reset the press data'
    if DraggableRectangle.lock is not self:
        return

    self.press = None
    DraggableRectangle.lock = None

    # turn off the rect animation property and reset the background
    self.rect.set_animated(False)
    self.background = None

    # redraw the full figure
    self.rect.figure.canvas.draw()

def disconnect(self):
    'disconnect all the stored connection ids'
    self.rect.figure.canvas.mpl_disconnect(self.cidpress)
    self.rect.figure.canvas.mpl_disconnect(self.cidrelease)
    self.rect.figure.canvas.mpl_disconnect(self.cidmotion)

fig = plt.figure()
ax = fig.add_subplot(111)
rects = ax.bar(range(10), 20*np.random.rand(10))
drs = []
for rect in rects:
    dr = DraggableRectangle(rect)
    dr.connect()
    drs.append(dr)

plt.show()
```

## 13.3 Mouse enter and leave

If you want to be notified when the mouse enters or leaves a figure or axes, you can connect to the figure/axes enter/leave events. Here is a simple example that changes the colors of the axes and figure background that the mouse is over:

```

"""
Illustrate the figure and axes enter and leave events by changing the
frame colors on enter and leave
"""
import matplotlib.pyplot as plt

def enter_axes(event):
    print 'enter_axes', event.inaxes
    event.inaxes.patch.set_facecolor('yellow')
    event.canvas.draw()

def leave_axes(event):
    print 'leave_axes', event.inaxes
    event.inaxes.patch.set_facecolor('white')
    event.canvas.draw()

def enter_figure(event):
    print 'enter_figure', event.canvas.figure
    event.canvas.figure.patch.set_facecolor('red')
    event.canvas.draw()

def leave_figure(event):
    print 'leave_figure', event.canvas.figure
    event.canvas.figure.patch.set_facecolor('grey')
    event.canvas.draw()

fig1 = plt.figure()
fig1.suptitle('mouse hover over figure or axes to trigger events')
ax1 = fig1.add_subplot(211)
ax2 = fig1.add_subplot(212)

fig1.canvas.mpl_connect('figure_enter_event', enter_figure)
fig1.canvas.mpl_connect('figure_leave_event', leave_figure)
fig1.canvas.mpl_connect('axes_enter_event', enter_axes)
fig1.canvas.mpl_connect('axes_leave_event', leave_axes)

fig2 = plt.figure()
fig2.suptitle('mouse hover over figure or axes to trigger events')
ax1 = fig2.add_subplot(211)
ax2 = fig2.add_subplot(212)

fig2.canvas.mpl_connect('figure_enter_event', enter_figure)
fig2.canvas.mpl_connect('figure_leave_event', leave_figure)
fig2.canvas.mpl_connect('axes_enter_event', enter_axes)
fig2.canvas.mpl_connect('axes_leave_event', leave_axes)

```

```
plt.show()
```

## 13.4 Object picking

You can enable picking by setting the `picker` property of an [Artist](#) (eg a matplotlib [Line2D](#), [Text](#), [Patch](#), [Polygon](#), [AxesImage](#), etc...)

There are a variety of meanings of the `picker` property:

**None** picking is disabled for this artist (default)

**boolean** if True then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist

**float** if `picker` is a number it is interpreted as an epsilon tolerance in points and the the artist will fire off an event if its data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, eg the indices of the data within epsilon of the pick event.

**function** if `picker` is callable, it is a user supplied function which determines whether the artist is hit by the mouse event. The signature is `hit, props = picker(artist, mouseevent)` to determine the hit test. If the mouse event is over the artist, return `hit=True` and `props` is a dictionary of properties you want added to the [PickEvent](#) attributes

After you have enabled an artist for picking by setting the `picker` property, you need to connect to the figure canvas `pick_event` to get pick callbacks on mouse press events. Eg:

```
def pick_handler(event):  
    mouseevent = event.mouseevent  
    artist = event.artist  
    # now do something with this...
```

The [PickEvent](#) which is passed to your callback is always fired with two attributes:

**mouseevent** the mouse event that generate the pick event. The mouse event in turn has attributes like `x` and `y` (the coords in display space, eg pixels from left, bottom) and `xdata`, `ydata` (the coords in data space). Additionally, you can get information about which buttons were pressed, which keys were pressed, which [Axes](#) the mouse is over, etc. See [matplotlib.backend\\_bases.MouseEvent](#) for details.

**artist** the [Artist](#) that generated the pick event.

Additionally, certain artists like [Line2D](#) and [PatchCollection](#) may attach additional meta data like the indices into the data that meet the picker criteria (eg all the points in the line that are within the specified epsilon tolerance)

### 13.4.1 Simple picking example

In the example below, we set the line picker property to a scalar, so it represents a tolerance in points (72 points per inch). The onpick callback function will be called when the pick event is within the tolerance distance from the line, and has the indices of the data vertices that are within the pick distance tolerance. Our onpick callback function simply prints the data that are under the pick location. Different matplotlib Artists can attach different data to the PickEvent. For example, Line2D attaches the ind property, which are the indices into the line data under the pick point. See pick() for details on the PickEvent properties of the line. Here is the code:

```
import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click on points')

line, = ax.plot(np.random.rand(100), 'o', picker=5) # 5 points tolerance

def onpick(event):
    thisline = event.artist
    xdata = thisline.get_xdata()
    ydata = thisline.get_ydata()
    ind = event.ind
    print 'onpick points:', zip(xdata[ind], ydata[ind])

fig.canvas.mpl_connect('pick_event', onpick)

plt.show()
```

### 13.4.2 Picking exercise

Create a data set of 100 arrays of 1000 Gaussian random numbers and compute the sample mean and standard deviation of each of them (hint: numpy arrays have a mean and std method) and make a xy marker plot of the 100 means vs the 100 standard deviations. Connect the line created by the plot command to the pick event, and plot the original time series of the data that generated the clicked on points. If more than one point is within the tolerance of the clicked on point, you can use multiple subplots to plot the multiple time series.

Exercise solution:

```
"""
compute the mean and stddev of 100 data sets and plot mean vs stddev.
When you click on one of the mu, sigma points, plot the raw data from
the dataset that generated the mean and stddev
"""

import numpy as np
import matplotlib.pyplot as plt

X = np.random.rand(100, 1000)
```

```
xs = np.mean(X, axis=1)
ys = np.std(X, axis=1)

fig = plt.figure()
ax = fig.add_subplot(111)
ax.set_title('click on point to plot time series')
line, = ax.plot(xs, ys, 'o', picker=5) # 5 points tolerance

def onpick(event):

    if event.artist!=line: return True

    N = len(event.ind)
    if not N: return True

    figi = plt.figure()
    for subplotnum, dataind in enumerate(event.ind):
        ax = figi.add_subplot(N,1,subplotnum+1)
        ax.plot(X[dataind])
        ax.text(0.05, 0.9, 'mu=%1.3f\nsigma=%1.3f'%(xs[dataind], ys[dataind]),
                transform=ax.transAxes, va='top')
        ax.set_ylim(-0.5, 1.5)
    figi.show()
    return True

fig.canvas.mpl_connect('pick_event', onpick)

plt.show()
```

# TRANSFORMATIONS TUTORIAL

Like any graphics packages, matplotlib is built on top of a transformation framework to easily move between coordinate systems, the userland *data* coordinate system, the *axes* coordinate system, the *figure* coordinate system, and the *display* coordinate system. In 95% of your plotting, you won't need to think about this, as it happens under the hood, but as you push the limits of custom figure generation, it helps to have an understanding of these objects so you can reuse the existing transformations matplotlib makes available to you, or create your own (see `matplotlib.transforms`). The table below summarizes the existing coordinate systems, the transformation object you should use to work in that coordinate system, and the description of that system. In the *Transformation Object* column, `ax` is a `Axes` instance, and `fig` is a `Figure` instance.

| Coordinate     | Transformation Object        | Description  |
|----------------|------------------------------|--|
| <i>data</i>    | <code>ax.transData</code>    | The userland data coordinate system, controlled by the <code>xlim</code> and <code>ylim</code>   |
| <i>axes</i>    | <code>ax.transAxes</code>    | The coordinate system of the <code>Axes</code> ; (0,0) is bottom left of the axes, and (1,1) is top right of the axes                                      |
| <i>figure</i>  | <code>fig.transFigure</code> | The coordinate system of the <code>Figure</code> ; (0,0) is bottom left of the figure, and (1,1) is top right of the figure                                |
| <i>display</i> | <i>None</i>                  | This is the pixel coordinate system of the display; (0,0) is the bottom left of the display, and (width, height) is the top right of the display in pixels |

All of the transformation objects in the table above take inputs in their coordinate system, and transform the input to the *display* coordinate system. That is why the *display* coordinate system has *None* for the *Transformation Object* column – it already is in display coordinates. The transformations also know how to invert themselves, to go from *display* back to the native coordinate system. This is particularly useful when processing events from the user interface, which typically occur in display space, and you want to know where the mouse click or key-press occurred in your data coordinate system.

## 14.1 Data coordinates

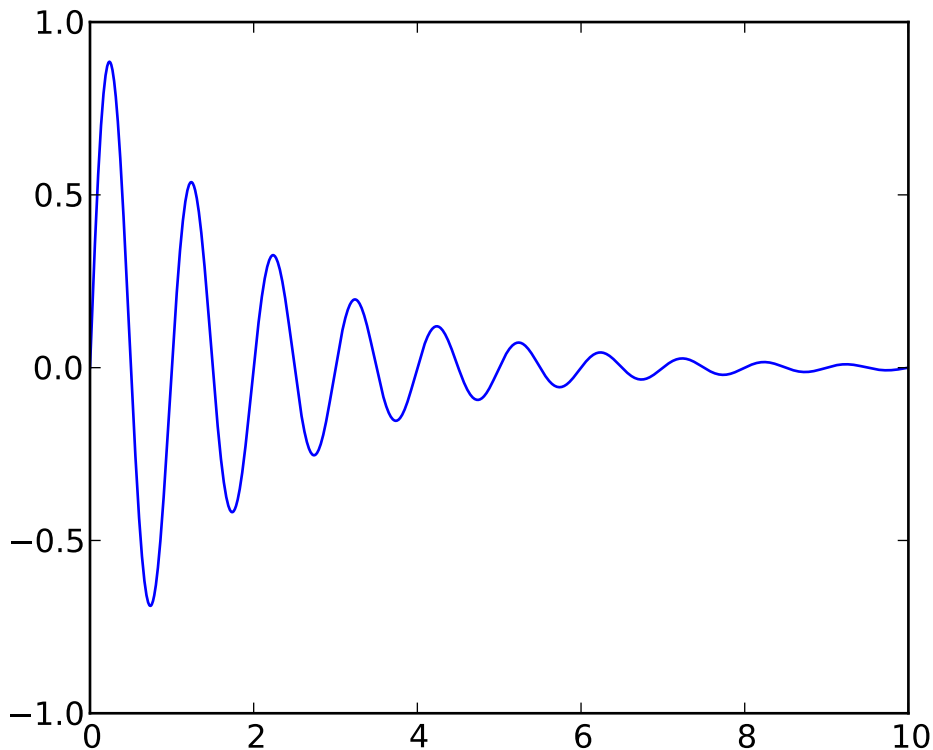
Let's start with the most commonly used coordinate, the *data* coordinate system. Whenever you add data to the axes, matplotlib updates the datalimits, most commonly updated with the `set_xlim()` and `set_ylim()` methods. For example, in the figure below, the data limits stretch from 0 to 10 on the x-axis, and -1 to 1 on the y-axis.

```
import numpy as np
import matplotlib.pyplot as plt

x = np.arange(0, 10, 0.005)
y = np.exp(-x/2.) * np.sin(2*np.pi*x)

fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(x, y)
ax.set_xlim(0, 10)
ax.set_ylim(-1, 1)

plt.show()
```



You can use the `ax.transData` instance to transform from your *data* to your *display* coordinate system, either a single point or a sequence of points as shown below:

```
In [14]: type(ax.transData)
Out[14]: <class 'matplotlib.transforms.CompositeGenericTransform'>

In [15]: ax.transData.transform((5, 0))
Out[15]: array([ 335.175,  247.   ])

In [16]: ax.transData.transform([(5, 0), (1,2)])
```



```
Out[16]:
array([[ 335.175,  247.   ],
       [ 132.435,  642.2   ]])
```

You can use the `inverted()` method to create a transform which will take you from display to data coordinates:

```
In [41]: inv = ax.transData.inverted()
```

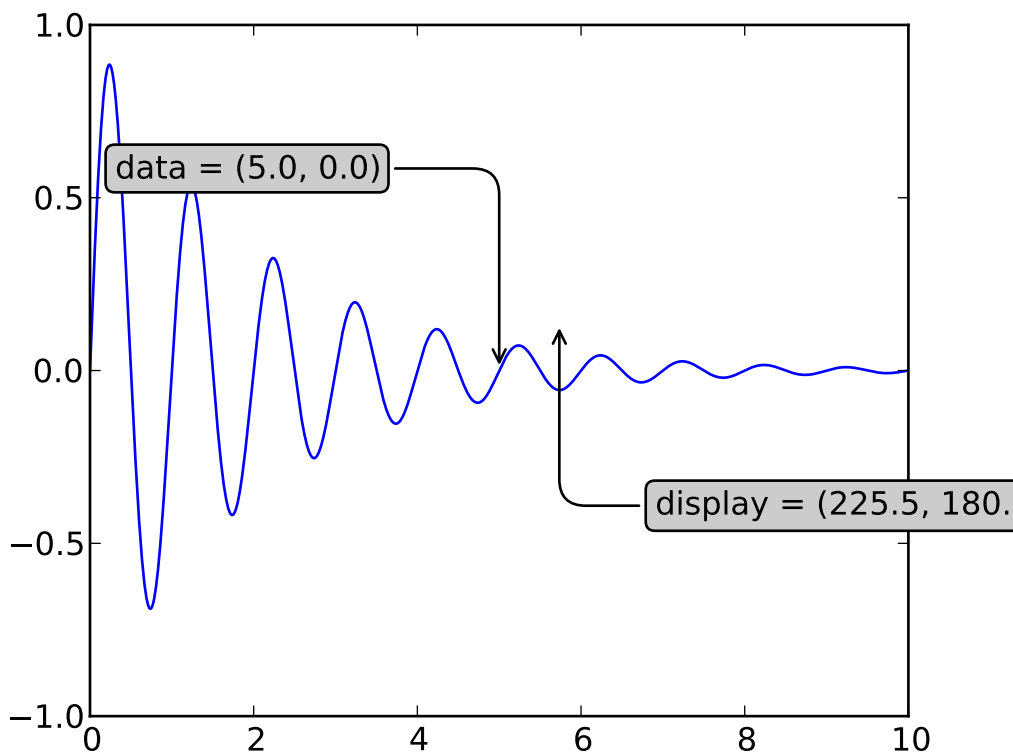
```
In [42]: type(inv)
```

```
Out[42]: <class 'matplotlib.transforms.CompositeGenericTransform'>
```

```
In [43]: inv.transform((335.175, 247.))
```

```
Out[43]: array([ 5.,  0.])
```

If you are typing along with this tutorial, the exact values of the display coordinates may differ if you have a different window size or dpi setting. Likewise, in the figure below, the display labeled points are probably not the same as in the ipython session because the documentation figure size defaults are different.



**Note:** If you run the source code in the example above in a GUI backend, you may also find that the two arrows for the *data* and *display* annotations do not point to exactly the same point. This is because the display point was computed before the figure was displayed, and the GUI backend may slightly resize the figure when it is created. The effect is more pronounced if you resize the figure yourself. This is one good reason why you rarely want to work in display space, but you can connect to the `'on_draw'` [Event](#) to

update figure coordinates on figure draws; see *Event handling and picking*.

When you change the x or y limits of your axes, the data limits are updated so the transformation yields a new display point. Note that when we just change the ylim, only the y-display coordinate is altered, and when we change the xlim too, both are altered. More on this later when we talk about the **Bbox**.

```
In [54]: ax.transData.transform((5, 0))
Out[54]: array([ 335.175,  247.   ])

In [55]: ax.set_ylim(-1,2)
Out[55]: (-1, 2)

In [56]: ax.transData.transform((5, 0))
Out[56]: array([ 335.175      , 181.13333333])

In [57]: ax.set_xlim(10,20)
Out[57]: (10, 20)

In [58]: ax.transData.transform((5, 0))
Out[58]: array([-171.675      , 181.13333333])
```

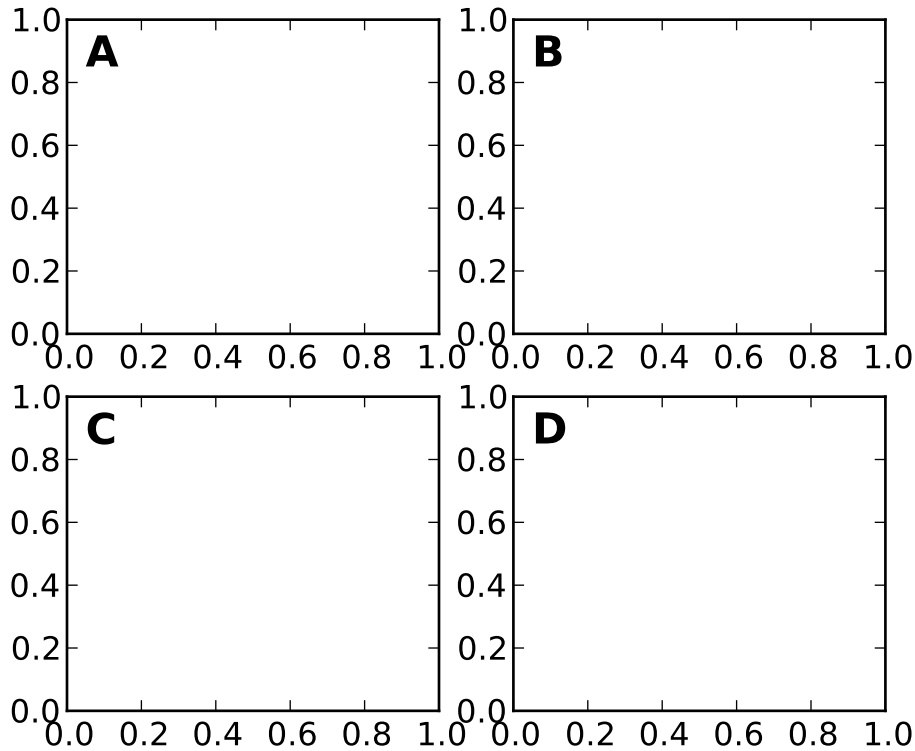
## 14.2 Axes coordinates

After the *data* coordinate system, *axes* is probably the second most useful coordinate system. Here the point (0,0) is the bottom left of your axes or subplot, (0.5, 0.5) is the center, and (1.0, 1.0) is the top right. You can also refer to points outside the range, so (-0.1, 1.1) is to the left and above your axes. This coordinate system is extremely useful when placing text in your axes, because you often want a text bubble in a fixed, location, eg. the upper left of the axes pane, and have that location remain fixed when you pan or zoom. Here is a simple example that creates four panels and labels them 'A', 'B', 'C', 'D' as you often see in journals.

```
import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure()
for i, label in enumerate(('A', 'B', 'C', 'D')):
    ax = fig.add_subplot(2,2,i+1)
    ax.text(0.05, 0.95, label, transform=ax.transAxes,
           fontsize=16, fontweight='bold', va='top')

plt.show()
```

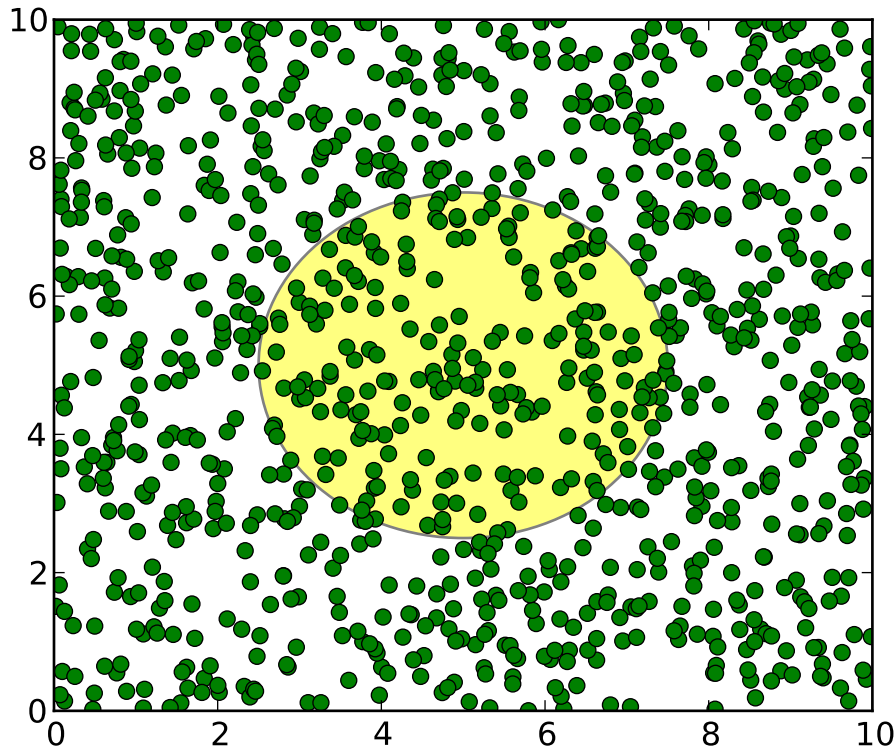


You can also make lines or patches in the axes coordinate system, but this is less useful in my experience than using `ax.transAxes` for placing text. Nonetheless, here is a silly example which plots some random dots in *data* space, and overlays a semi-transparent `Circle` centered in the middle of the axes with a radius one quarter of the axes – if your axes does not preserve aspect ratio (see `set_aspect()`), this will look like an ellipse. Use the pan/zoom tool to move around, or manually change the data xlim and ylim, and you will see the data move, but the circle will remain fixed because it is not in *data* coordinates and will always remain at the center of the axes.

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as patches
fig = plt.figure()
ax = fig.add_subplot(111)
x, y = 10*np.random.rand(2, 1000)
ax.plot(x, y, 'go') # plot some data in data coordinates

circ = patches.Circle((0.5, 0.5), 0.25, transform=ax.transAxes,
                      facecolor='yellow', alpha=0.5)
ax.add_patch(circ)

plt.show()
```



### 14.3 Blended transformations

Drawing in *blended* coordinate spaces which mix *axes* with *data* coordinates is extremely useful, for example to create a horizontal span which highlights some region of the y-data but spans across the x-axis regardless of the data limits, pan or zoom level, etc. In fact these blended lines and spans are so useful, we have built in functions to make them easy to plot (see `axhline()`, `axvline()`, `axhspan()`, `axvspan()`) but for didactic purposes we will implement the horizontal span here using a blended transformation. This trick only works for separable transformations, like you see in normal Cartesian coordinate systems, but not on inseparable transformations like the `PolarTransform`.

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.patches as patches
import matplotlib.transforms as transforms

fig = plt.figure()
ax = fig.add_subplot(111)

x = np.random.randn(1000)

ax.hist(x, 30)
ax.set_title(r'$\sigma=1 \setminus \dots \setminus \sigma=2$', fontsize=16)
```

```

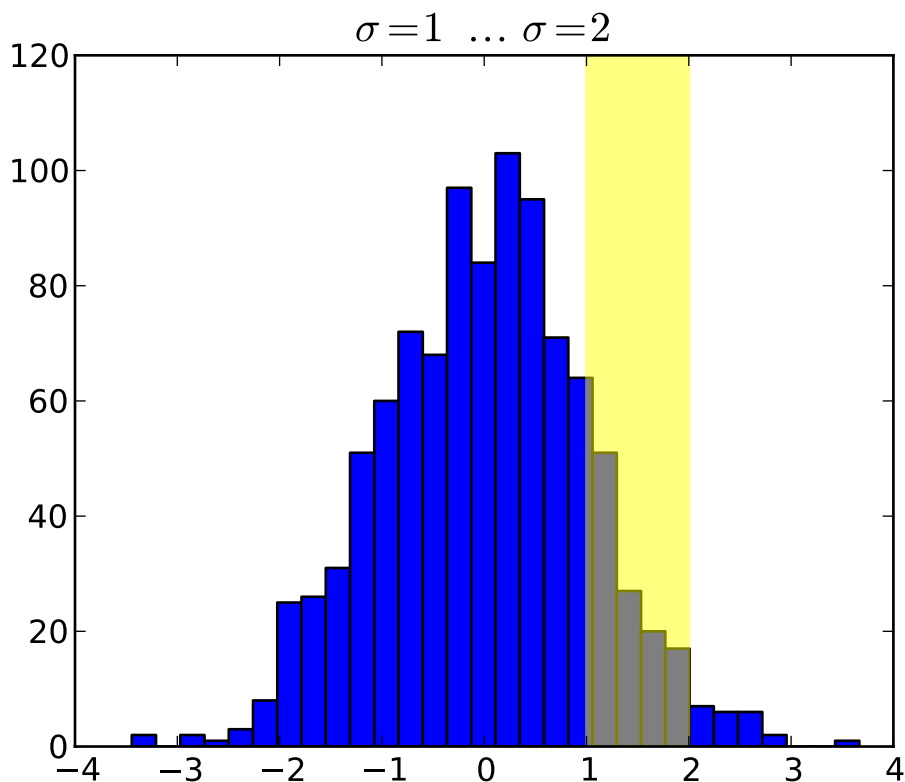
# the x coords of this transformation are data, and the
# y coord are axes
trans = transforms.blended_transform_factory(
    ax.transData, ax.transAxes)

# highlight the 1..2 stddev region with a span.
# We want x to be in data coordinates and y to
# span from 0..1 in axes coords
rect = patches.Rectangle((1,0), width=1, height=1,
                        transform=trans, color='yellow',
                        alpha=0.5)

ax.add_patch(rect)

plt.show()

```



**Note:** The blended transformations where  $x$  is in data coords and  $y$  in axes coordinates is so useful that we have helper methods to return the versions `mpl` uses internally for drawing ticks, ticklabels, etc. The methods are `matplotlib.axes.Axes.get_xaxis_transform()` and `matplotlib.axes.Axes.get_yaxis_transform()`. So in the example above, the call to `blended_transform_factory()` can be replaced by `get_xaxis_transform`:

```
trans = ax.get_xaxis_transform()
```

## 14.4 Using offset transforms to create a shadow effect

One use of transformations is to create a new transformation that is offset from another transformation, eg to place one object shifted a bit relative to another object. Typically you want the shift to be in some physical dimension, like points or inches rather than in data coordinates, so that the shift effect is constant at different zoom levels and dpi settings.

One use for an offset is to create a shadow effect, where you draw one object identical to the first just to the right of it, and just below it, adjusting the zorder to make sure the shadow is drawn first and then the object it is shadowing above it. The transforms module has a helper transformation `ScaledTranslation`. It is instantiated with:

```
trans = ScaledTranslation(xt, yt, scale_trans)
```

where *xt* and *yt* are the translation offsets, and *scale\_trans* is a transformation which scales *xt* and *yt* at transformation time before applying the offsets. A typical use case is to use the figure `fig.dpi_scale_trans` transformation for the *scale\_trans* argument, to first scale *xt* and *yt* specified in points to *display* space before doing the final offset. The dpi and inches offset is a common-enough use case that we have a special helper function to create it in `matplotlib.transforms.offset_copy()`, which returns a new transform with an added offset. But in the example below, we'll create the offset transform ourselves. Note the use of the plus operator in:

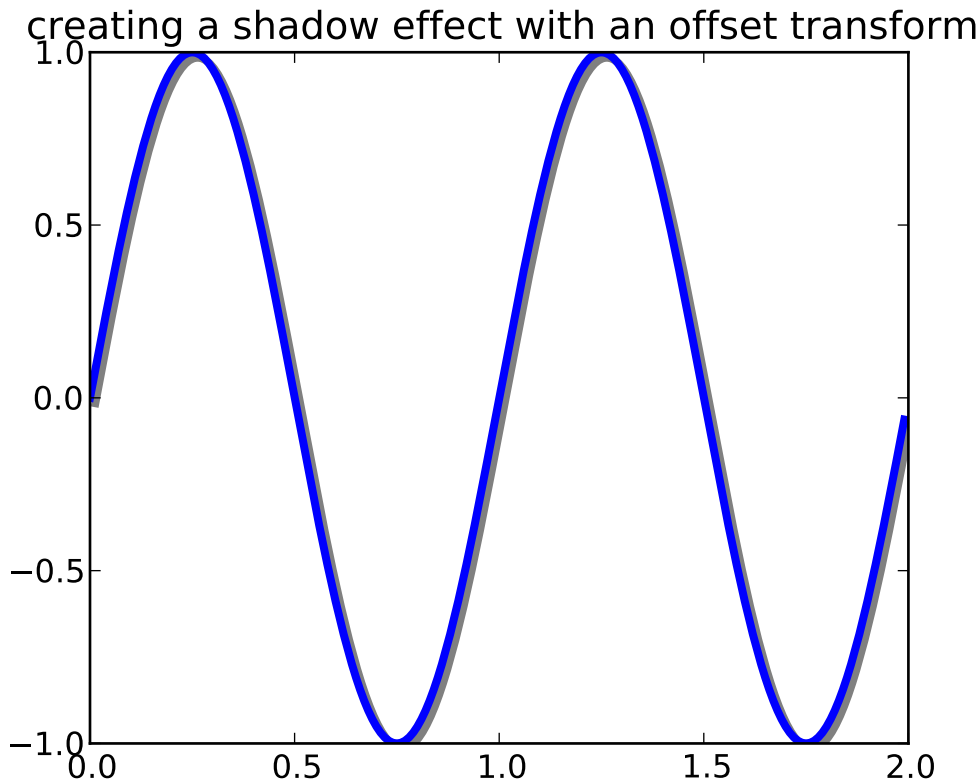
```
offset = transforms.ScaledTranslation(dx, dy,  
    fig.dpi_scale_trans)  
shadow_transform = ax.transData + offset
```

showing that can chain transformations using the addition operator. This code says: first apply the data transformation `ax.transData` and then translate the data by *dx* and *dy* points. In typography, a ‘point’ [http://en.wikipedia.org/wiki/Point\\_%28typography%29](http://en.wikipedia.org/wiki/Point_%28typography%29) is 1/72 inches, and by specifying your offsets in points, your figure will look the same regardless of the dpi resolution it is saved in.

```
import numpy as np  
import matplotlib.pyplot as plt  
import matplotlib.patches as patches  
import matplotlib.transforms as transforms  
  
fig = plt.figure()  
ax = fig.add_subplot(111)  
  
# make a simple sine wave  
x = np.arange(0., 2., 0.01)  
y = np.sin(2*np.pi*x)  
line, = ax.plot(x, y, lw=3, color='blue')  
  
# shift the object over 2 points, and down 2 points  
dx, dy = 2/72., -2/72.  
offset = transforms.ScaledTranslation(dx, dy,  
    fig.dpi_scale_trans)  
shadow_transform = ax.transData + offset
```

```
# now plot the same data with our offset transform;
# use the zorder to make sure we are below the line
ax.plot(x, y, lw=3, color='gray',
        transform=shadow_transform,
        zorder=0.5*line.get_zorder())

ax.set_title('creating a shadow effect with an offset transform')
plt.show()
```



## 14.5 The transformation pipeline

The `ax.transData` transform we have been working with in this tutorial is a composite of three different transformations that comprise the transformation pipeline from *data* -> *display* coordinates. Michael Droettboom implemented the transformations framework, taking care to provide a clean API that segregated the nonlinear projections and scales that happen in polar and logarithmic plots, from the linear affine transformations that happen when you pan and zoom. There is an efficiency here, because you can pan and zoom in your axes which affects the affine transformation, but you may not need to compute the potentially expensive nonlinear scales or projections on simple navigation events. It is also possible to multiply affine transformation matrices together, and then apply them to coordinates in one step. This is not true of all possible transformations.

Here is how the `ax.transData` instance is defined in the basic separable axis `Axes` class:

```
self.transData = self.transScale + (self.transLimits + self.transAxes)
```

We've been introduced to the `transAxes` instance above in [Axes coordinates](#), which maps the (0,0), (1,1) corners of the axes or subplot bounding box to *display* space, so let's look at these other two pieces.

`self.transLimits` is the transformation that takes you from data to axes coordinates; i.e., it maps your view `xlim` and `ylim` to the unit space of the axes (and `transAxes` then takes that unit space to display space). We can see this in action here

```
In [80]: ax = subplot(111)
```

```
In [81]: ax.set_xlim(0, 10)
Out[81]: (0, 10)
```

```
In [82]: ax.set_ylim(-1,1)
Out[82]: (-1, 1)
```

```
In [84]: ax.transLimits.transform((0,-1))
Out[84]: array([ 0.,  0.])
```

```
In [85]: ax.transLimits.transform((10,-1))
Out[85]: array([ 1.,  0.])
```

```
In [86]: ax.transLimits.transform((10,1))
Out[86]: array([ 1.,  1.])
```

```
In [87]: ax.transLimits.transform((5,0))
Out[87]: array([ 0.5,  0.5])
```

and we can use this same inverted transformation to go from the unit *axes* coordinates back to *data* coordinates.

```
In [90]: inv.transform((0.25, 0.25))
Out[90]: array([ 2.5, -0.5])
```

The final piece is the `self.transScale` attribute, which is responsible for the optional non-linear scaling of the data, eg. for logarithmic axes. When an `Axes` is initially setup, this is just set to the identity transform, since the basic matplotlib axes has linear scale, but when you call a logarithmic scaling function like `semilogx()` or explicitly set the scale to logarithmic with `set_xscale()`, then the `ax.transScale` attribute is set to handle the nonlinear projection. The scales transforms are properties of the respective `xaxis` and `yaxis` [Axis](#) instances. For example, when you call `ax.set_xscale('log')`, the `xaxis` updates its scale to a `matplotlib.scale.LogScale` instance.

For non-separable axes the `PolarAxes`, there is one more piece to consider, the projection transformation. The `transData` `matplotlib.projections.polar.PolarAxes` is similar to that for the typical separable matplotlib `Axes`, with one additional piece `transProjection`:

```
self.transData = self.transScale + self.transProjection + \
    (self.transProjectionAffine + self.transAxes)
```



`transProjection` handles the projection from the space, eg. latitude and longitude for map data, or radius and theta for polar data, to a separable Cartesian coordinate system. There are several projection examples in the `matplotlib.projections` package, and the best way to learn more is to open the source for those packages and see how to make your own, since matplotlib supports extensible axes and projections. Michael Droettboom has provided a nice tutorial example of creating a hammer projection axes; see *api example code: `custom_projection_example.py`*.



# PATH TUTORIAL

The object underlying all of the `matplotlib.patch` objects is the `Path`, which supports the standard set of `moveto`, `lineto`, `curveto` commands to draw simple and compound outlines consisting of line segments and splines. The `Path` is instantiated with a (N,2) array of (x,y) vertices, and a N-length array of path codes. For example to draw the unit rectangle from (0,0) to (1,1), we could use this code

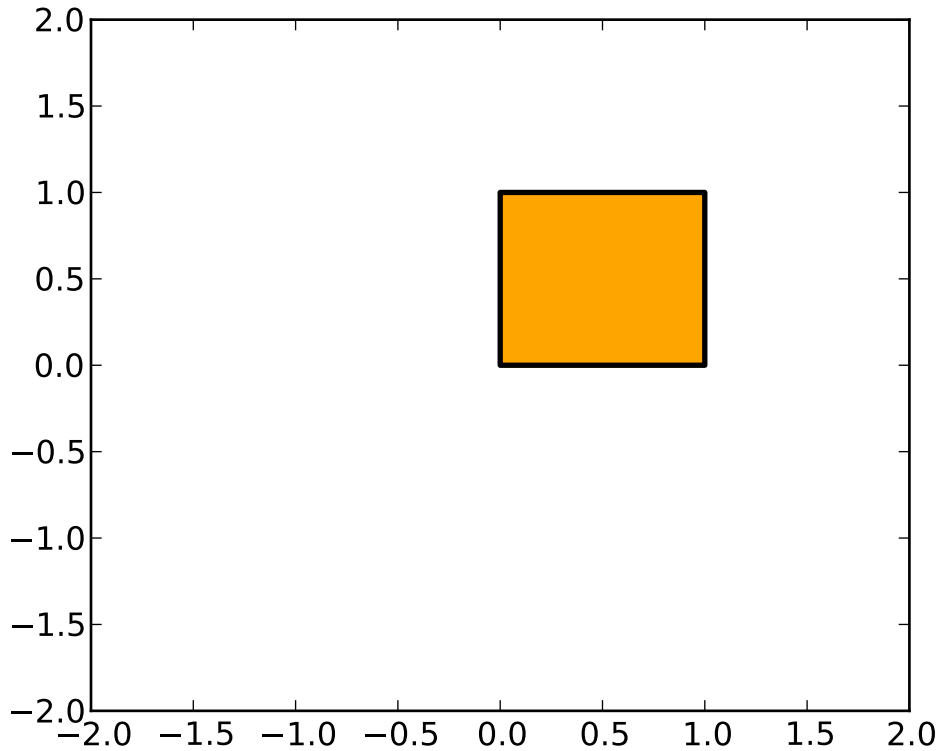
```
import matplotlib.pyplot as plt
from matplotlib.path import Path
import matplotlib.patches as patches

verts = [
    (0., 0.), # left, bottom
    (0., 1.), # left, top
    (1., 1.), # right, top
    (1., 0.), # right, bottom
    (0., 0.), # ignored
]

codes = [Path.MOVETO,
         Path.LINETO,
         Path.LINETO,
         Path.LINETO,
         Path.CLOSEPOLY,
         ]

path = Path(verts, codes)

fig = plt.figure()
ax = fig.add_subplot(111)
patch = patches.PathPatch(path, facecolor='orange', lw=2)
ax.add_patch(patch)
ax.set_xlim(-2,2)
ax.set_ylim(-2,2)
plt.show()
```



The following path codes are recognized

| Code      | Vertices                         | Description  |
|-----------|----------------------------------|--|
| STOP      | 1 (ignored)                      | A marker for the end of the entire path (currently not required and ignored)                                   |
| MOVETO    | 1                                | Pick up the pen and move to the given vertex.  |
| LINETO    | 1                                | Draw a line from the current position to the given vertex.   |
| CURVE3    | 2 (1 control point, 1 endpoint)  | Draw a quadratic Bézier curve from the current position, with the given control point, to the given end point. |
| CURVE4    | 3 (2 control points, 1 endpoint) | Draw a cubic Bézier curve from the current position, with the given control points, to the given end point.    |
| CLOSEPOLY | (point itself is ignored)        | Draw a line segment to the start point of the current polyline.  |

## 15.1 Bézier example

Some of the path components require multiple vertices to specify them: for example CURVE 3 is a [Bézier](#) curve with one control point and one end point, and CURVE4 has three vertices for the two control points and the end point. The example below shows a CURVE4 Bézier spline – the Bézier curve will be contained in the convex hull of the start point, the two control points, and the end point

```

import matplotlib.pyplot as plt
from matplotlib.path import Path
import matplotlib.patches as patches

verts = [
    (0., 0.), # P0
    (0.2, 1.), # P1
    (1., 0.8), # P2
    (0.8, 0.), # P3
]

codes = [Path.MOVETO,
         Path.CURVE4,
         Path.CURVE4,
         Path.CURVE4,
         ]

path = Path(verts, codes)

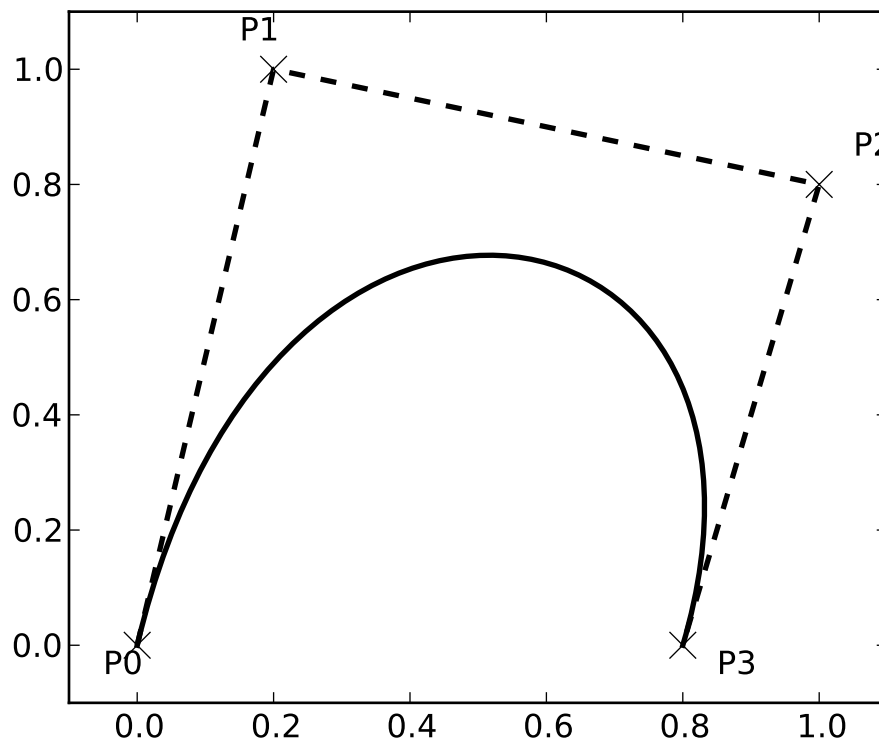
fig = plt.figure()
ax = fig.add_subplot(111)
patch = patches.PathPatch(path, facecolor='none', lw=2)
ax.add_patch(patch)

xs, ys = zip(*verts)
ax.plot(xs, ys, 'x--', lw=2, color='black', ms=10)

ax.text(-0.05, -0.05, 'P0')
ax.text(0.15, 1.05, 'P1')
ax.text(1.05, 0.85, 'P2')
ax.text(0.85, -0.05, 'P3')

ax.set_xlim(-0.1, 1.1)
ax.set_ylim(-0.1, 1.1)
plt.show()

```



## 15.2 Compound paths

All of the simple patch primitives in matplotlib, Rectangle, Circle, Polygon, etc, are implemented with simple path. Plotting functions like `hist()` and `bar()`, which create a number of primitives, eg a bunch of Rectangles, can usually be implemented more efficiently using a compound path. The reason `bar` creates a list of rectangles and not a compound path is largely historical: the `Path` code is comparatively new and `bar` predates it. While we could change it now, it would break old code, so here we will cover how to create compound paths, replacing the functionality in `bar`, in case you need to do so in your own code for efficiency reasons, eg you are creating an animated bar plot.

We will make the histogram chart by creating a series of rectangles for each histogram bar: the rectangle width is the bin width and the rectangle height is the number of datapoints in that bin. First we'll create some random normally distributed data and compute the histogram. Because numpy returns the bin edges and not centers, the length of `bins` is 1 greater than the length of `n` in the example below:

```
# histogram our data with numpy
data = np.random.randn(1000)
n, bins = np.histogram(data, 100)
```

We'll now extract the corners of the rectangles. Each of the `left`, `bottom`, etc, arrays below is `len(n)`, where `n` is the array of counts for each histogram bar:

```
# get the corners of the rectangles for the histogram
left = np.array(bins[:-1])
right = np.array(bins[1:])
bottom = np.zeros(len(left))
top = bottom + n
```

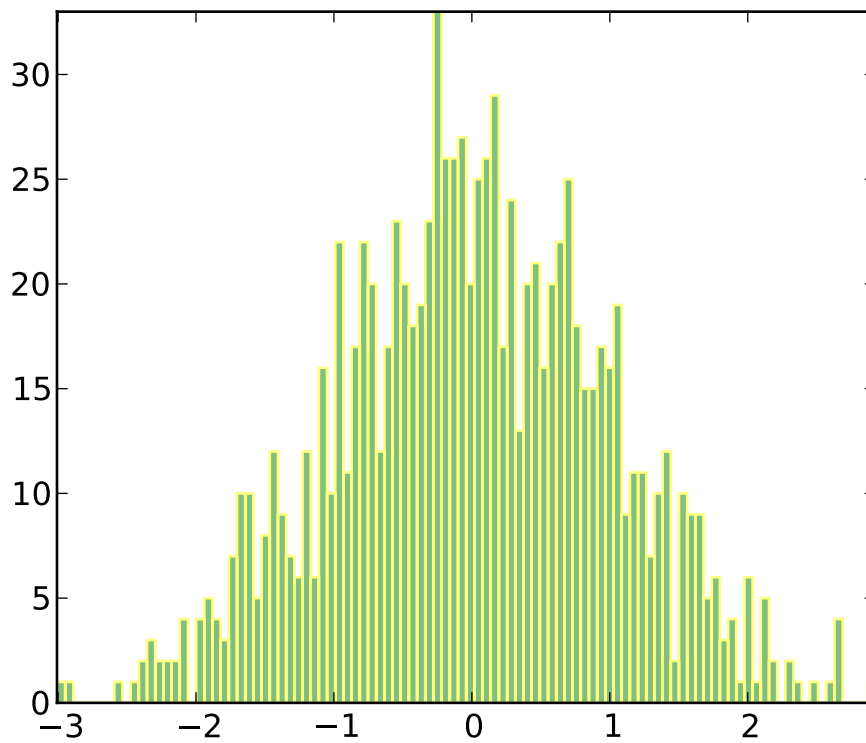
Now we have to construct our compound path, which will consist of a series of MOVETO, LINETO and CLOSEPOLY for each rectangle. For each rectangle, we need 5 vertices: 1 for the MOVETO, 3 for the LINETO, and 1 for the CLOSEPOLY. As indicated in the table above, the vertex for the closepoly is ignored but we still need it to keep the codes aligned with the vertices:

```
nverts = nrects*(1+3+1)
verts = np.zeros((nverts, 2))
codes = np.ones(nverts, int) * path.Path.LINETO
codes[0::5] = path.Path.MOVETO
codes[4::5] = path.Path.CLOSEPOLY
verts[0::5,0] = left
verts[0::5,1] = bottom
verts[1::5,0] = left
verts[1::5,1] = top
verts[2::5,0] = right
verts[2::5,1] = top
verts[3::5,0] = right
verts[3::5,1] = bottom
```

All that remains is to create the path, attach it to a PathPatch, and add it to our axes:

```
barpath = path.Path(verts, codes)
patch = patches.PathPatch(barpath, facecolor='green',
    edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)
```

Here is the result



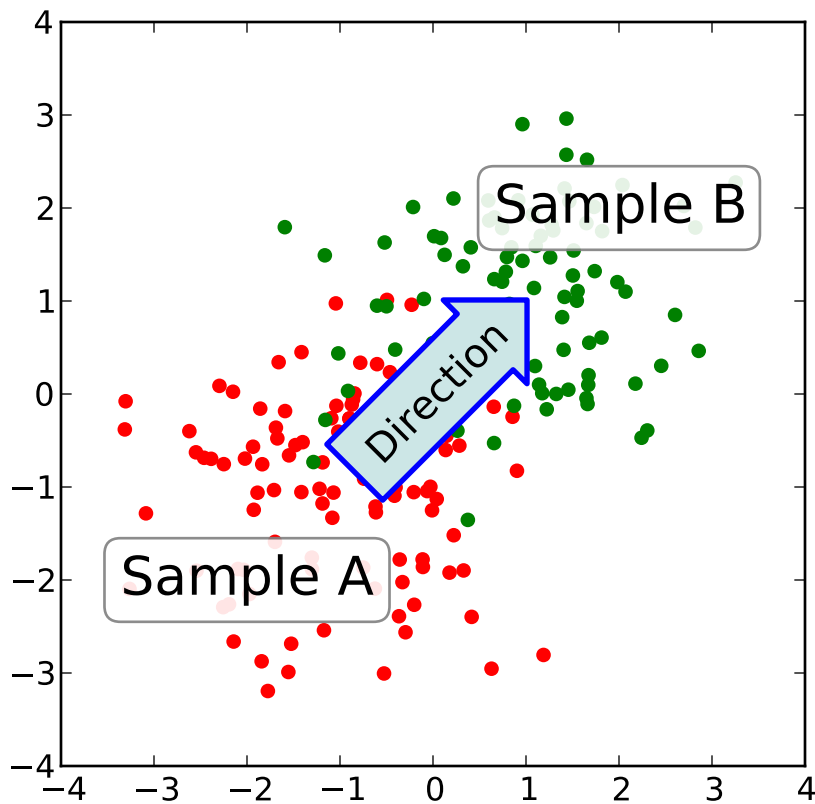


# ANNOTATING AXES

Do not proceed unless you already have read *Annotating text*, `text()` and `annotate()`!

## 16.1 Annotating with Text with Box

Let's start with a simple example.



The `text()` function in the pyplot module (or text method of the Axes class) takes `bbox` keyword argument, and when given, a box around the text is drawn.

```
bbox_props = dict(boxstyle="rarrow,pad=0.3", fc="cyan", ec="b", lw=2)
t = ax.text(0, 0, "Direction", ha="center", va="center", rotation=45,
            size=15,
            bbox=bbox_props)
```

The patch object associated with the text can be accessed by:

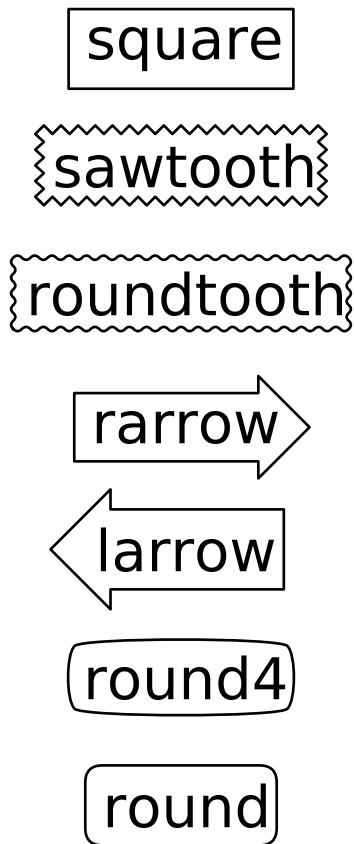
```
bb = t.get_bbox_patch()
```

The return value is an instance of `FancyBboxPatch` and the patch properties like facecolor, edgewidth, etc. can be accessed and modified as usual. To change the shape of the box, use `set_boxstyle` method.

```
bb.set_boxstyle("rarrow", pad=0.6)
```

The arguments are the name of the box style with its attributes as keyword arguments. Currently, following box styles are implemented.

| Class      | Name       | Attrs                      |
|------------|------------|----------------------------|
| LArrow     | larrow     | pad=0.3                    |
| RArrow     | rarrow     | pad=0.3                    |
| Round      | round      | pad=0.3,rounding_size=None |
| Round4     | round4     | pad=0.3,rounding_size=None |
| Roundtooth | roundtooth | pad=0.3,tooth_size=None    |
| Sawtooth   | sawtooth   | pad=0.3,tooth_size=None    |
| Square     | square     | pad=0.3                    |



Note that the attributes arguments can be specified within the style name with separating comma (this form can be used as “boxstyle” value of `bbox` argument when initializing the text instance)

```
bb.set_boxstyle("rarrow,pad=0.6")
```

## 16.2 Annotating with Arrow

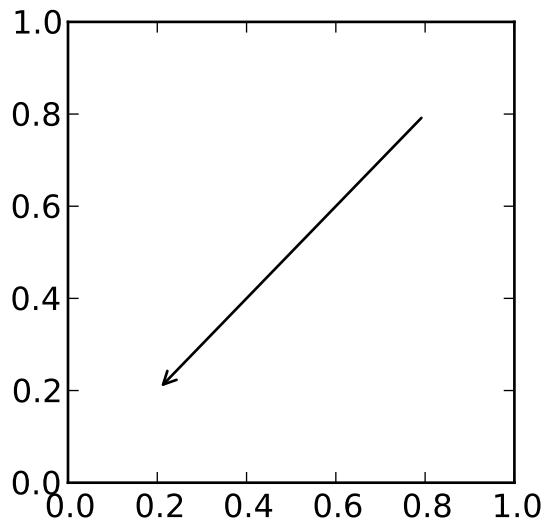
The `annotate()` function in the `pyplot` module (or `annotate` method of the `Axes` class) is used to draw an arrow connecting two points on the plot.

```
ax.annotate("Annotation",
            xy=(x1, y1), xycoords='data',
            xytext=(x2, y2), textcoords='offset points',
            )
```

This annotates a point at `xy` in the given coordinate (`xycoords`) with the text at `xytext` given in `textcoords`. Often, the annotated point is specified in the *data* coordinate and the annotating text in *offset points*. See `annotate()` for available coordinate systems.

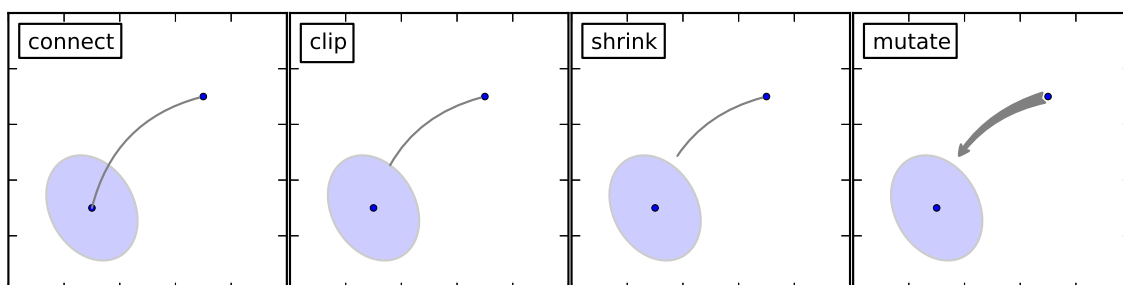
An arrow connecting two point (xy & xytext) can be optionally drawn by specifying the `arrowprops` argument. To draw only an arrow, use empty string as the first argument.

```
ax.annotate("",
            xy=(0.2, 0.2), xycoords='data',
            xytext=(0.8, 0.8), textcoords='data',
            arrowprops=dict(arrowstyle="->",
                           connectionstyle="arc3"),
            )
```



The arrow drawing takes a few steps.

1. a connecting path between two points are created. This is controlled by `connectionstyle` key value.
2. If patch object is given (*patchA* & *patchB*), the path is clipped to avoid the patch.
3. The path is further shrunk by given amount of pixels (*shrinkA* & *shrinkB*)
4. The path is transmuted to arrow patch, which is controlled by the `arrowstyle` key value.

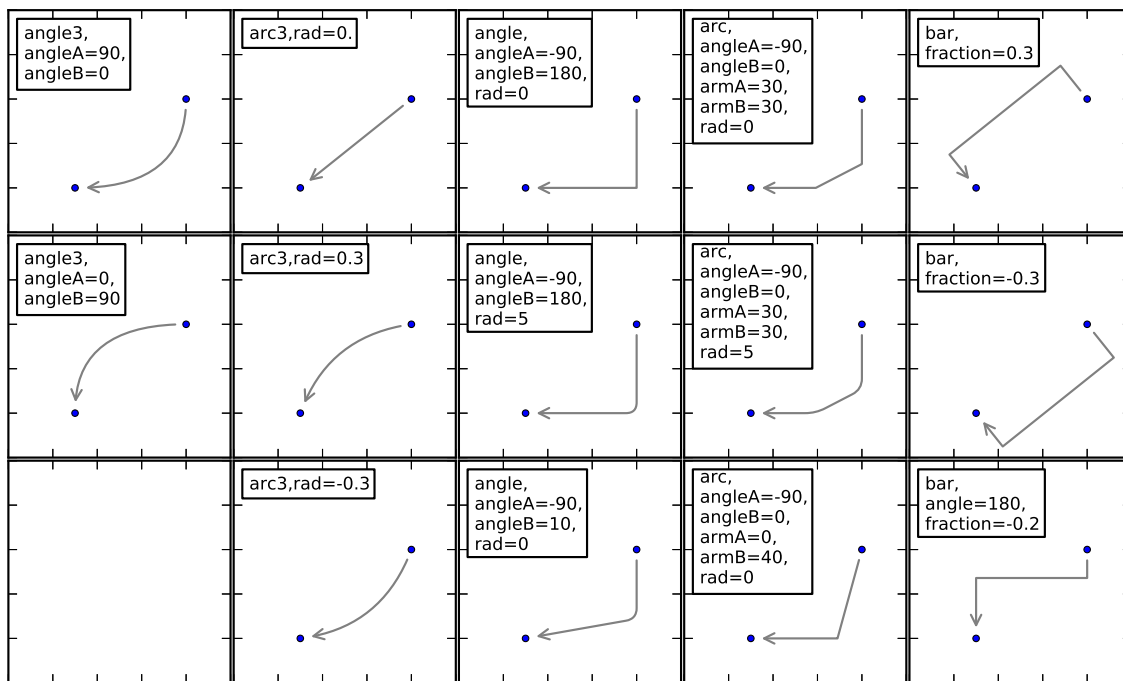


The creation of the connecting path between two points is controlled by `connectionstyle` key and following styles are available.

| Name                | Attrs  |
|---------------------|--|
| <code>angle</code>  | <code>angleA=90,angleB=0,rad=0.0</code>                    |
| <code>angle3</code> | <code>angleA=90,angleB=0</code>                            |
| <code>arc</code>    | <code>angleA=0,angleB=0,armA=None,armB=None,rad=0.0</code> |
| <code>arc3</code>   | <code>rad=0.0</code>                                       |
| <code>bar</code>    | <code>armA=0.0,armB=0.0,fraction=0.3,angle=None</code>     |

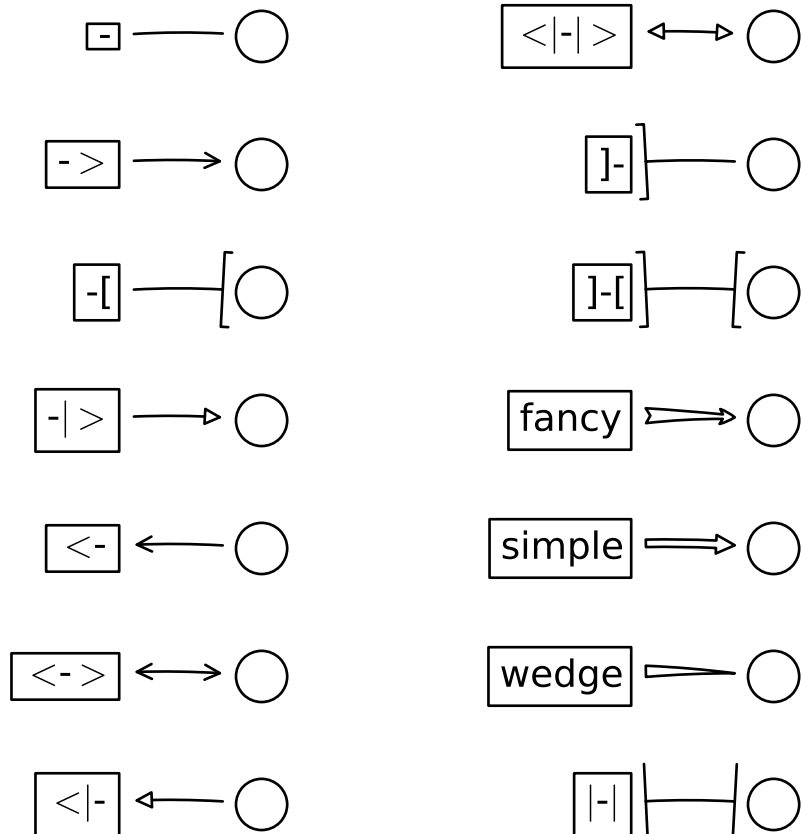
Note that “3” in `angle3` and `arc3` is meant to indicate that the resulting path is a quadratic spline segment (three control points). As will be discussed below, some arrow style option only can be used when the connecting path is a quadratic spline.

The behavior of each connection style is (limitedly) demonstrated in the example below. (Warning : The behavior of the `bar` style is currently not well defined, it may be changed in the future).



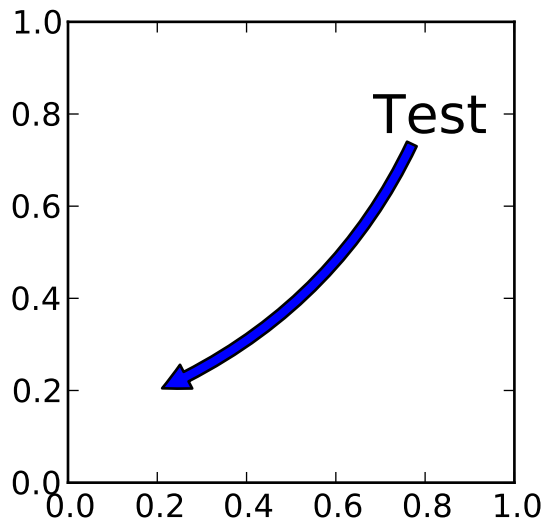
The connecting path (after clipping and shrinking) is then mutated to an arrow patch, according to the given `arrowstyle`.

| Name   | Attrs   |
|--------|---|
| -      | None  |
| ->     | head_length=0.4,head_width=0.2                |
| -[     | widthB=1.0,lengthB=0.2,angleB=None            |
| -      | widthA=1.0,widthB=1.0                         |
| - >    | head_length=0.4,head_width=0.2                |
| <-     | head_length=0.4,head_width=0.2                |
| <->    | head_length=0.4,head_width=0.2                |
| < -    | head_length=0.4,head_width=0.2                |
| < - >  | head_length=0.4,head_width=0.2                |
| fancy  | head_length=0.4,head_width=0.4,tail_width=0.4 |
| simple | head_length=0.5,head_width=0.5,tail_width=0.2 |
| wedge  | tail_width=0.3,shrink_factor=0.5              |

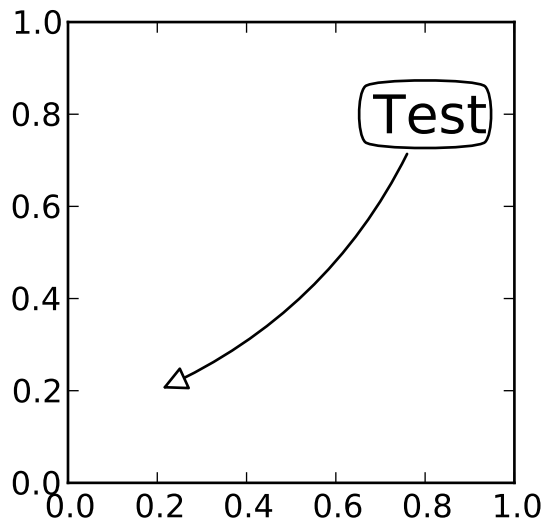


Some arrowstyles only work with connection style that generates a quadratic-spline segment. They are `fancy`, `simple`, and `wedge`. For these arrow styles, you must use “`angle3`” or “`arc3`” connection style.

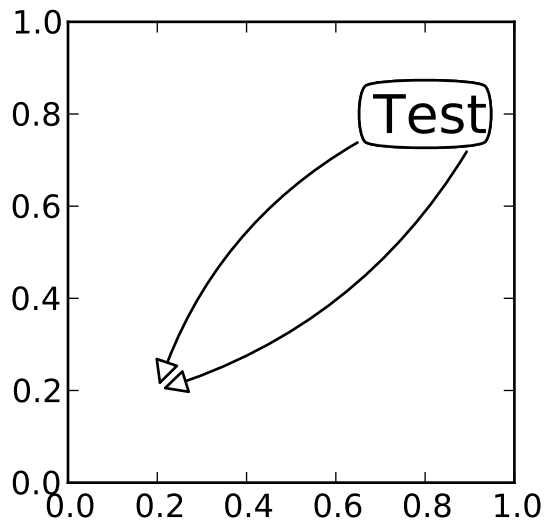
If the annotation string is given, the `patchA` is set to the `bbox` patch of the text by default.



As in the text command, a box around the text can be drawn using the `bbox` argument.



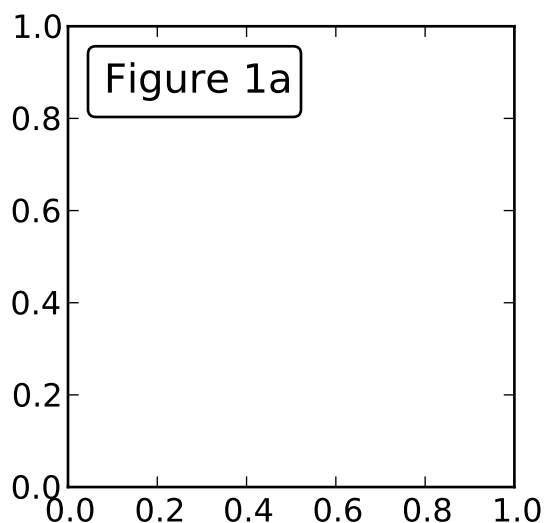
By default, the starting point is set to the center of the text extent. This can be adjusted with `relpos` key value. The values are normalized to the extent of the text. For example, (0,0) means lower-left corner and (1,1) means top-right.



## 16.3 Placing Artist at the anchored location of the Axes

There are class of artist that can be placed at the anchored location of the Axes. A common example is the legend. This type of artists can be created by using the `OffsetBox` class. A few predefined classes are available in `mpl_toolkits.axes_grid.anchored_artists`.

```
from mpl_toolkits.axes_grid.anchored_artists import AnchoredText
at = AnchoredText("Figure 1a",
                  prop=dict(size=8), frameon=True,
                  loc=2,
                  )
at.patch.set_boxstyle("round,pad=0.,rounding_size=0.2")
ax.add_artist(at)
```





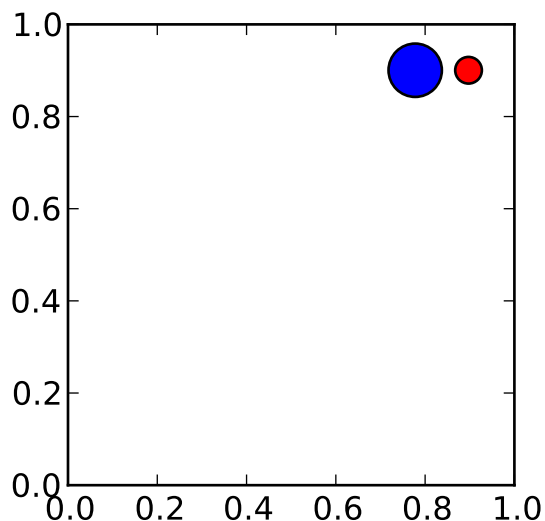
The *loc* keyword has same meaning as in the legend command.

A simple application is when the size of the artist (or collection of artists) is known in pixel size during the time of creation. For example, If you want to draw a circle with fixed size of 20 pixel x 20 pixel (radius = 10 pixel), you can utilize `AnchoredDrawingArea`. The instance is created with a size of the drawing area (in pixel). And user can add arbitrary artist to the drawing area. Note that the extents of the artists that are added to the drawing area has nothing to do with the placement of the drawing area itself. The initial size only matters.

```
from mpl_toolkits.axes_grid.anchored_artists import AnchoredDrawingArea

ada = AnchoredDrawingArea(20, 20, 0, 0,
                          loc=1, pad=0., frameon=False)
p1 = Circle((10, 10), 10)
ada.drawing_area.add_artist(p1)
p2 = Circle((30, 10), 5, fc="r")
ada.drawing_area.add_artist(p2)
```

The artists that are added to the drawing area should not have transform set (they will be overridden) and the dimension of those artists are interpreted as a pixel coordinate, i.e., the radius of the circles in above example are 10 pixel and 5 pixel, respectively.

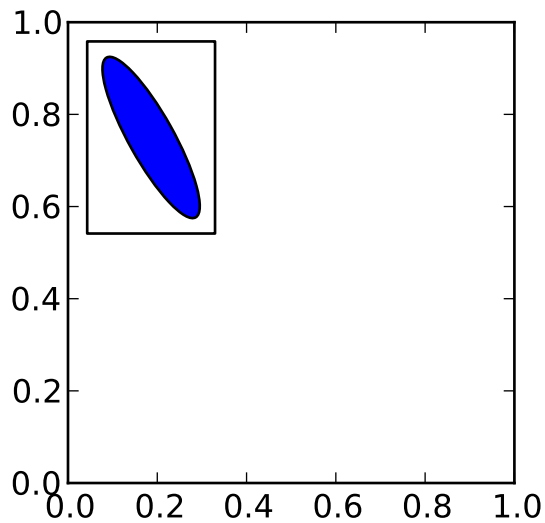


Sometimes, you want to your artists scale with data coordinate (or other coordinate than canvas pixel). You can use `AnchoredAuxTransformBox` class. This is similar to `AnchoredDrawingArea` except that the extent of the artist is determined during the drawing time respecting the specified transform.

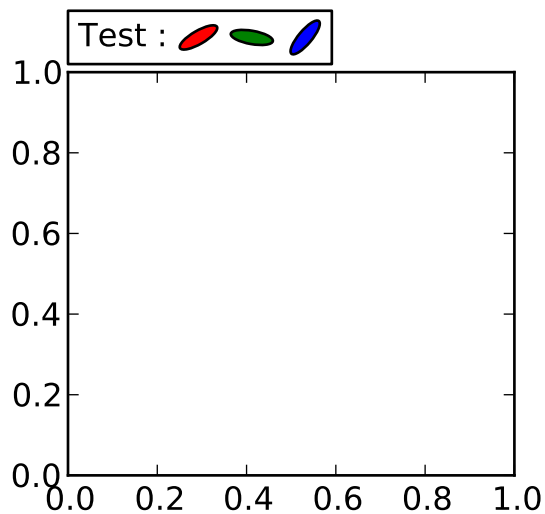
```
from mpl_toolkits.axes_grid.anchored_artists import AnchoredAuxTransformBox

box = AnchoredAuxTransformBox(ax.transData, loc=2)
el = Ellipse((0,0), width=0.1, height=0.4, angle=30) # in data coordinates!
box.drawing_area.add_artist(el)
```

The ellipse in the above example will have width and height corresponds to 0.1 and 0.4 in data coordinate and will be automatically scaled when the view limits of the axes change.



As in the legend, the `bbox_to_anchor` argument can be set. Using the `Hpacker` and `Vpacker`, you can have an arrangement(?) of artist as in the legend (as a matter of fact, this is how the legend is created).



Note that unlike the legend, the `bbox_transform` is set to `IdentityTransform` by default.

## 16.4 Using Complex Coordinate with Annotation

The Annotation in matplotlib support several types of coordinate as described in *Annotating text*. For an advanced user who wants more control, it supports a few other options.

1. `Transform` instance. For example,

```
ax.annotate("Test", xy=(0.5, 0.5), xycoords=ax.transAxes)
```

is identical to

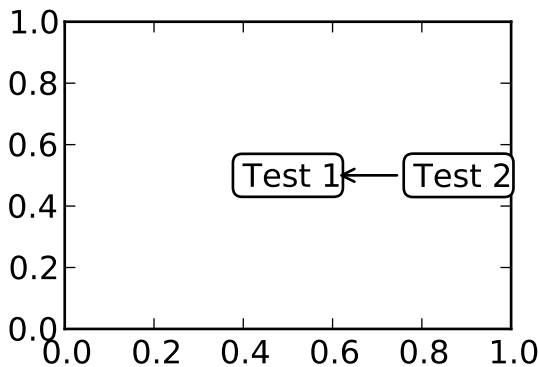
```
ax.annotate("Test", xy=(0.5, 0.5), xycoords="axes fraction")
```

With this, you can annotate a point in other axes.

```
ax1, ax2 = subplot(121), subplot(122)
ax2.annotate("Test", xy=(0.5, 0.5), xycoords=ax1.transData,
             xytext=(0.5, 0.5), textcoords=ax2.transData,
             arrowprops=dict(arrowstyle="->"))
```

2. **Artist** instance. The `xy` value (or `xytext`) is interpreted as a fractional coordinate of the `bbox` (return value of `get_window_extent`) of the artist.

```
an1 = ax.annotate("Test 1", xy=(0.5, 0.5), xycoords="data",
                  va="center", ha="center",
                  bbox=dict(boxstyle="round", fc="w"))
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1, # (1,0.5) of the an1's bbox
                  xytext=(30,0), textcoords="offset points",
                  va="center", ha="left",
                  bbox=dict(boxstyle="round", fc="w"),
                  arrowprops=dict(arrowstyle="->"))
```



Note that it is your responsibility that the extent of the coordinate artist (*an1* in above example) is determined before *an2* gets drawn. In most cases, it means that *an2* needs to be drawn later than *an1*.

3. A callable object that returns an instance of either **BboxBase** or **Transform**. If a transform is returned, it is same as 1 and if `bbox` is returned, it is same as 2. The callable object should take a single argument of `renderer` instance. For example, following two commands give identical results

```
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1,
                  xytext=(30,0), textcoords="offset points")
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1.get_window_extent,
                  xytext=(30,0), textcoords="offset points")
```

4. A tuple of two coordinate specification. The first item is for x-coordinate and the second is for y-coordinate. For example,

```
annotate("Test", xy=(0.5, 1), xycoords=("data", "axes fraction"))
```

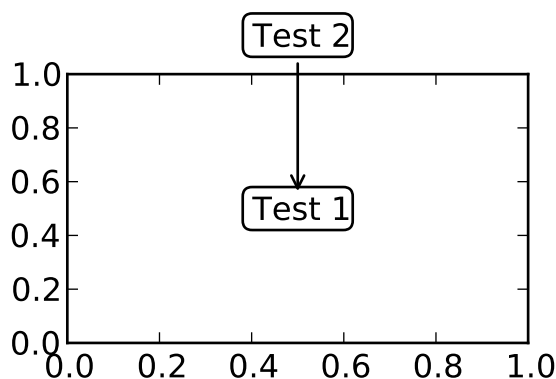
0.5 is in data coordinate, and 1 is in normalized axes coordinate. You may use an artist or transform as with a tuple. For example,

```
import matplotlib.pyplot as plt

plt.figure(figsize=(3,2))
ax=plt.axes([0.1, 0.1, 0.8, 0.7])
an1 = ax.annotate("Test 1", xy=(0.5, 0.5), xycoords="data",
                  va="center", ha="center",
                  bbox=dict(boxstyle="round", fc="w"))

an2 = ax.annotate("Test 2", xy=(0.5, 1.), xycoords=an1,
                  xytext=(0.5,1.1), textcoords=(an1, "axes fraction"),
                  va="bottom", ha="center",
                  bbox=dict(boxstyle="round", fc="w"),
                  arrowprops=dict(arrowstyle="->"))

plt.show()
```



5. Sometimes, you want your annotation with some “offset points”, but not from the annotated point but from other point. `OffsetFrom` is a helper class for such case.

```
import matplotlib.pyplot as plt

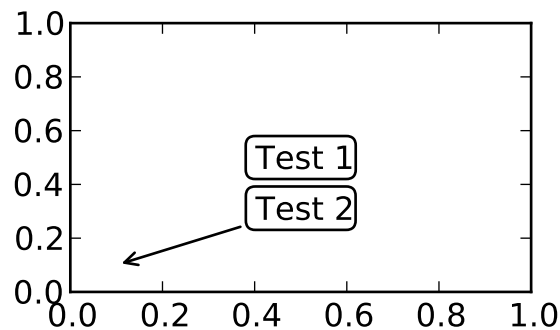
plt.figure(figsize=(3,2))
ax=plt.axes([0.1, 0.1, 0.8, 0.7])
an1 = ax.annotate("Test 1", xy=(0.5, 0.5), xycoords="data",
                  va="center", ha="center",
                  bbox=dict(boxstyle="round", fc="w"))

from matplotlib.text import OffsetFrom
offset_from = OffsetFrom(an1, (0.5, 0))
an2 = ax.annotate("Test 2", xy=(0.1, 0.1), xycoords="data",
                  xytext=(0, -10), textcoords=offset_from,
                  # xytext is offset points from "xy=(0.5, 0), xycoords=an1"
```

```

va="top", ha="center",
bbox=dict(boxstyle="round", fc="w"),
arrowprops=dict(arrowstyle="->"))
plt.show()

```



You may take a look at this example *pylab\_examples example code: annotation\_demo3.py*.

## 16.5 Using ConnectorPatch

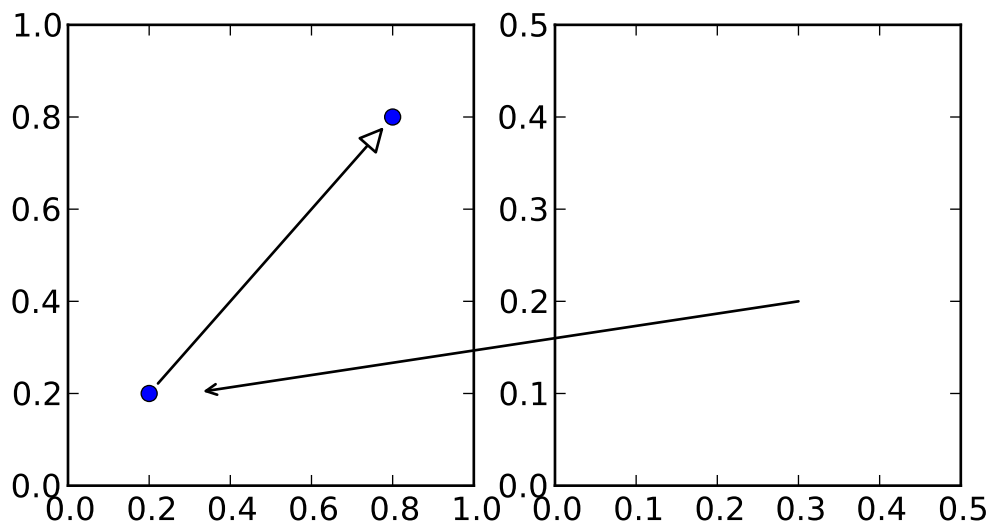
The ConnectorPatch is like an annotation without a text. While the `annotate` function is recommended in most of situation, the ConnectorPatch is useful when you want to connect points in different axes.

```

from matplotlib.patches import ConnectionPatch
xy = (0.2, 0.2)
con = ConnectionPatch(xyA=xy, xyB=xy, coordsA="data", coordsB="data",
                     axesA=ax1, axesB=ax2)
ax2.add_artist(con)

```

The above code connects point `xy` in data coordinate of `ax1` to point `xy` in data coordinate of `ax2`. Here is a simple example.

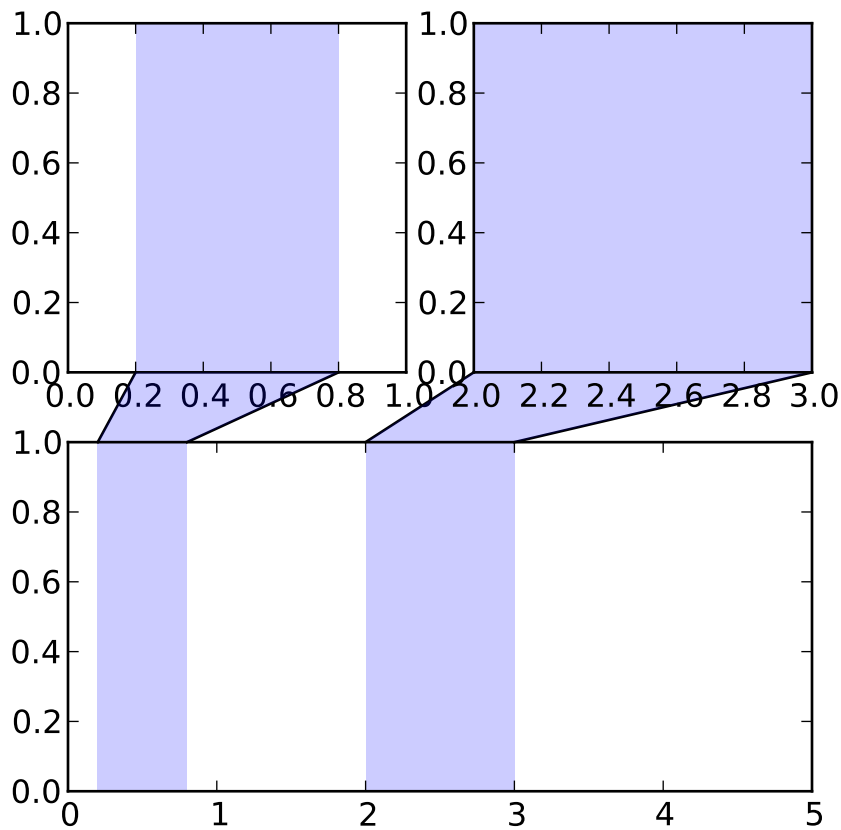


While the `ConnectorPatch` instance can be added to any axes, but you may want it to be added to the axes in the latter (?) of the axes drawing order to prevent overlap (?) by other axes.

### 16.5.1 Advanced Topics

## 16.6 Zoom effect between Axes

`mpl_toolkits.axes_grid.inset_locator` defines some patch classes useful for interconnect two axes. Understanding the code requires some knowledge of how mpl's transform works. But, utilizing it will be straight forward.



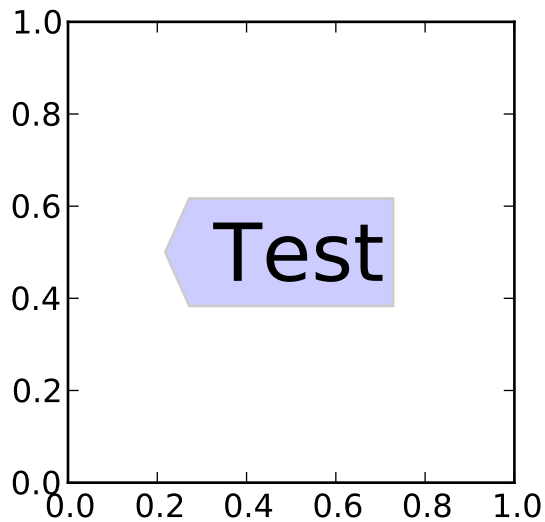
## 16.7 Define Custom BoxStyle

You can use a custom box style. The value for the boxstyle can be a callable object in following forms.:

```
def __call__(self, x0, y0, width, height, mutation_size,
              aspect_ratio=1.):
    """
    Given the location and size of the box, return the path of
    the box around it.

    - *x0*, *y0*, *width*, *height* : location and size of the box
    - *mutation_size* : a reference scale for the mutation.
    - *aspect_ratio* : aspect-ratio for the mutation.
    """
    path = ...
    return path
```

Here is a complete example.



However, it is recommended that you derive from the `matplotlib.patches.BoxStyle._Base` as demonstrated below.

```
from matplotlib.path import Path
from matplotlib.patches import BoxStyle
import matplotlib.pyplot as plt

# we may derive from matplotlib.patches.BoxStyle._Base class.
# You need to override transmute method in this case.

class MyStyle(BoxStyle._Base):
    """
    A simple box.
    """

    def __init__(self, pad=0.3):
        """
        The arguments need to be floating numbers and need to have
        default values.

        *pad*
            amount of padding
        """
        self.pad = pad
        super(MyStyle, self).__init__()

    def transmute(self, x0, y0, width, height, mutation_size):
        """
        Given the location and size of the box, return the path of
        the box around it.

        - *x0*, *y0*, *width*, *height* : location and size of the box
        - *mutation_size* : a reference scale for the mutation.
```



*Often, the `*mutation_size*` is the font size of the text.  
You don't need to worry about the rotation as it is  
automatically taken care of.*

```

# padding
pad = mutation_size * self.pad

# width and height with padding added.
width, height = width + 2.*pad, \
                height + 2.*pad,

# boundary of the padded box
x0, y0 = x0-pad, y0-pad,
x1, y1 = x0+width, y0 + height

cp = [(x0, y0),
      (x1, y0), (x1, y1), (x0, y1),
      (x0-pad, (y0+y1)/2.), (x0, y0),
      (x0, y0)]

com = [Path.MOVETO,
      Path.LINETO, Path.LINETO, Path.LINETO,
      Path.LINETO, Path.LINETO,
      Path.CLOSEPOLY]

path = Path(cp, com)

return path

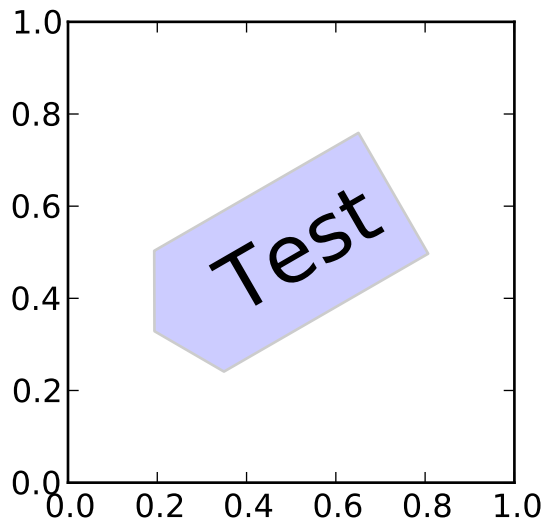
# register the custom style
BoxStyle._style_list["angled"] = MyStyle

plt.figure(1, figsize=(3,3))
ax = plt.subplot(111)
ax.text(0.5, 0.5, "Test", size=30, va="center", ha="center", rotation=30,
       bbox=dict(boxstyle="angled,pad=0.5", alpha=0.2))

del BoxStyle._style_list["angled"]

plt.show()

```



Similarly, you can define custom `ConnectionStyle` and custom `ArrowStyle`. See the source code of `lib/matplotlib/patches.py` and check how each style class is defined.

# OUR FAVORITE RECIPES

Here is a collection of short tutorials, examples and code snippets that illustrate some of the useful idioms and tricks to make snazzier figures and overcome some matplotlib warts.

## 17.1 Sharing axis limits and views

It's common to make two or more plots which share an axis, eg two subplots with time as a common axis. When you pan and zoom around on one, you want the other to move around with you. To facilitate this, matplotlib Axes support a `sharex` and `sharey` attribute. When you create a `subplot()` or `axes()` instance, you can pass in a keyword indicating what axes you want to share with

```
In [96]: t = np.arange(0, 10, 0.01)

In [97]: ax1 = plt.subplot(211)

In [98]: ax1.plot(t, np.sin(2*np.pi*t))
Out[98]: [<matplotlib.lines.Line2D object at 0x98719ec>]

In [99]: ax2 = plt.subplot(212, sharex=ax1)

In [100]: ax2.plot(t, np.sin(4*np.pi*t))
Out[100]: [<matplotlib.lines.Line2D object at 0xb7d8fec>]
```

## 17.2 Easily creating subplots

In early versions of matplotlib, if you wanted to use the pythonic API and create a figure instance and from that create a grid of subplots, possibly with shared axes, it involved a fair amount of boilerplate code. Eg

```
# old style
fig = plt.figure()
ax1 = fig.add_subplot(221)
ax2 = fig.add_subplot(222, sharex=ax1, sharey=ax1)
ax3 = fig.add_subplot(223, sharex=ax1, sharey=ax1)
ax3 = fig.add_subplot(224, sharex=ax1, sharey=ax1)
```

Fernando Perez has provided a nice top level method to create in `subplots()` (note the “s” at the end) everything at once, and turn off x and y sharing for the whole bunch. You can either unpack the axes individually:

```
# new style method 1; unpack the axes
fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(2, 2, sharex=True, sharey=True)
ax1.plot(x)
```

or get them back as a numrows x numcolumns object array which supports numpy indexing:

```
# new style method 2; use an axes array
fig, axs = plt.subplots(2, 2, sharex=True, sharey=True)
axs[0,0].plot(x)
```

## 17.3 Fixing common date annoyances

matplotlib allows you to natively plots python datetime instances, and for the most part does a good job picking tick locations and string formats. There are a couple of things it does not handle so gracefully, and here are some tricks to help you work around them. We’ll load up some sample date data which contains `datetime.date` objects in a numpy record array:

```
In [63]: datafile = cbook.get_sample_data('goog.npy')

In [64]: r = np.load(datafile).view(np.recarray)

In [65]: r.dtype
Out[65]: dtype([('date', '<|04'), ('', '<|V4'), ('open', '<f8'),
                ('high', '<f8'), ('low', '<f8'), ('close', '<f8'),
                ('volume', '<i8'), ('adj_close', '<f8')])

In [66]: r.date
Out[66]:
array([2004-08-19, 2004-08-20, 2004-08-23, ..., 2008-10-10, 2008-10-13,
       2008-10-14], dtype=object)
```

The dtype of the numpy record array for the field date is `|04` which means it is a 4-byte python object pointer; in this case the objects are `datetime.date` instances, which we can see when we print some samples in the ipython terminal window.

If you plot the data,

```
In [67]: plot(r.date, r.close)
Out[67]: [<matplotlib.lines.Line2D object at 0x92a6b6c>]
```

you will see that the x tick labels are all squashed together.

### Default date handling can cause overlapping labels

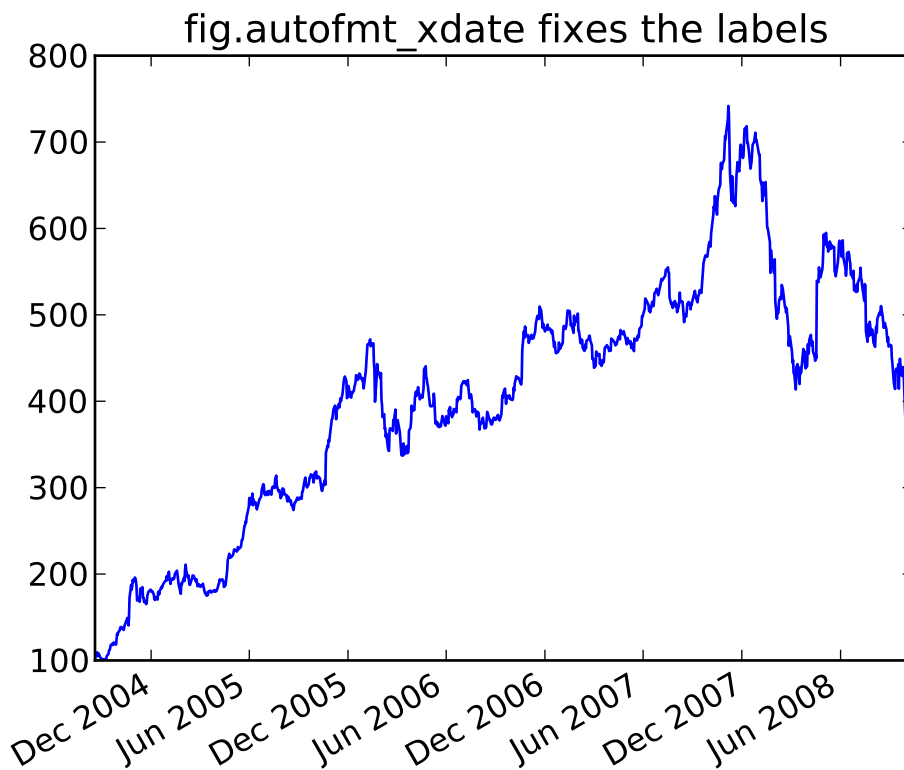


Another annoyance is that if you hover the mouse over a the window and look in the lower right corner of the matplotlib toolbar (*Interactive navigation*) at the x and y coordinates, you see that the x locations are formatted the same way the tick labels are, eg “Dec 2004”. What we’d like is for the location in the toolbar to have a higher degree of precision, eg giving us the exact date out mouse is hovering over. To fix the first problem, we can use `matplotlib.figure.Figure.autofmt_xdate()` and to fix the second problem we can use the `ax.fmt_xdata` attribute which can be set to any function that takes a scalar and returns a string. matplotlib has a number of date formatters built in, so we’ll use one of those.

```
plt.close('all')
fig, ax = plt.subplots(1)
ax.plot(r.date, r.close)

# rotate and align the tick labels so they look better
fig.autofmt_xdate()

# use a more precise date string for the x axis locations in the
# toolbar
import matplotlib.dates as mdates
ax.fmt_xdata = mdates.DateFormatter('%Y-%m-%d')
plt.title('fig.autofmt_xdate fixes the labels')
```



Now when you hover your mouse over the plotted data, you'll see date format strings like 2004-12-01 in the toolbar.

## 17.4 Fill Between and Alpha

The `fill_between()` function generates a shaded region between a min and max boundary that is useful for illustrating ranges. It has a very handy `where` argument to combine filling with logical ranges, eg to just fill in a curve over some threshold value.

At its most basic level, `fill_between` can be used to enhance a graph's visual appearance. Let's compare two graphs of a financial time series with a simple line plot on the left and a filled line on the right.

```
import matplotlib.pyplot as plt
import numpy as np

import matplotlib.cbook as cbook

# load up some sample financial data
datafile = cbook.get_sample_data('goog.npy')
r = np.load(datafile).view(np.recarray)

# create two subplots with the shared x and y axes
fig, (ax1, ax2) = plt.subplots(1, 2, sharex=True, sharey=True)
```

```

pricemin = r.close.min()

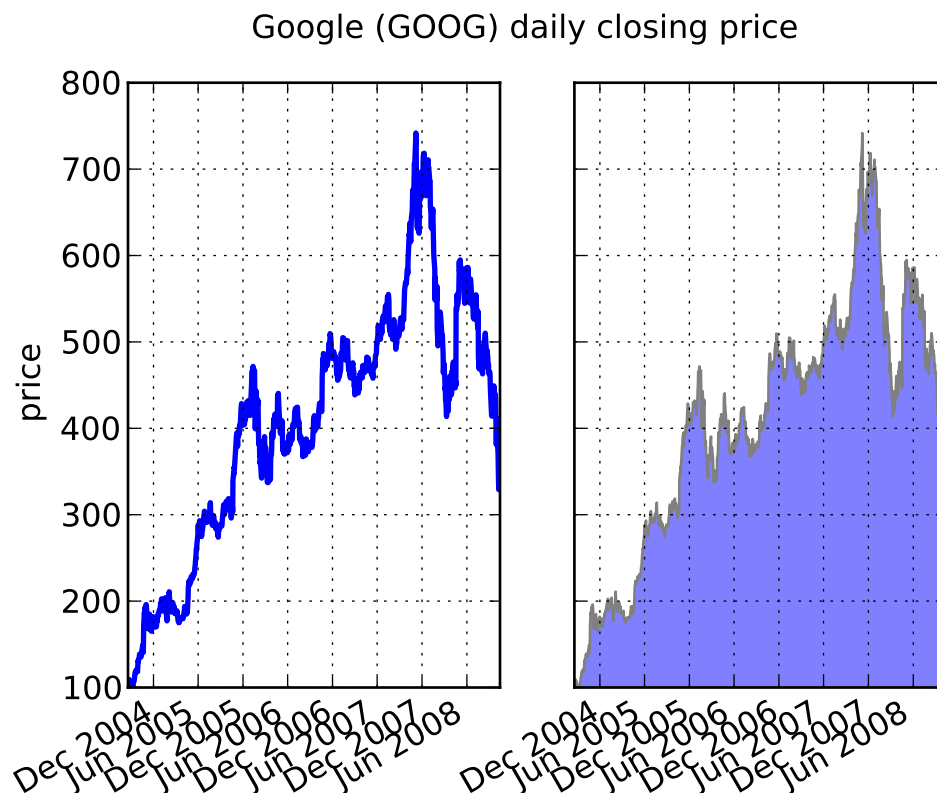
ax1.plot(r.date, r.close, lw=2)
ax2.fill_between(r.date, pricemin, r.close, facecolor='blue', alpha=0.5)

for ax in ax1, ax2:
    ax.grid(True)

ax1.set_ylabel('price')
for label in ax2.get_yticklabels():
    label.set_visible(False)

fig.suptitle('Google (GOOG) daily closing price')
fig.autofmt_xdate()

```



The alpha channel is not necessary here, but it can be used to soften colors for more visually appealing plots. In other examples, as we'll see below, the alpha channel is functionally useful as the shaded regions can overlap and alpha allows you to see both. Note that the postscript format does not support alpha (this is a postscript limitation, not a matplotlib limitation), so when using alpha save your figures in PNG, PDF or SVG.

Our next example computes two populations of random walkers with a different mean and standard deviation of the normal distributions from which the steps are drawn. We use shared regions to plot  $\pm$  one standard deviation of the mean position of the population. Here the alpha channel is useful, not just aesthetic.

```
import matplotlib.pyplot as plt
import numpy as np

Nsteps, Nwalkers = 100, 250
t = np.arange(Nsteps)

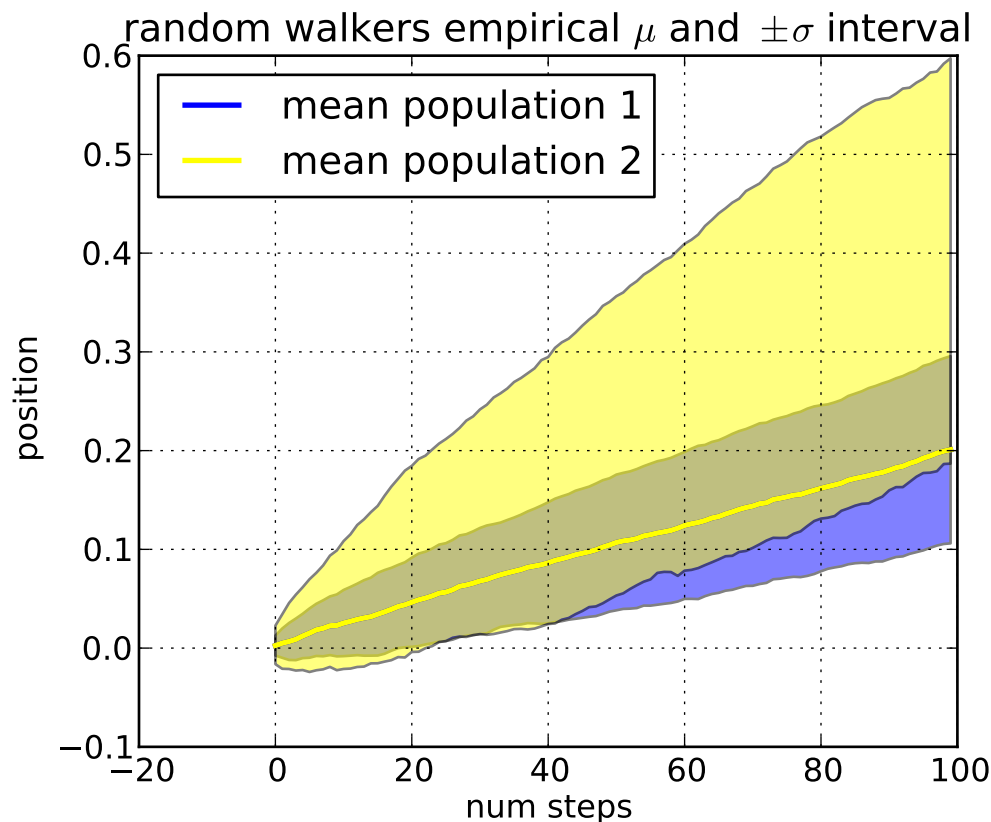
# an (Nsteps x Nwalkers) array of random walk steps
S1 = 0.002 + 0.01*np.random.randn(Nsteps, Nwalkers)
S2 = 0.004 + 0.02*np.random.randn(Nsteps, Nwalkers)

# an (Nsteps x Nwalkers) array of random walker positions
X1 = S1.cumsum(axis=0)
X2 = S2.cumsum(axis=0)

# Nsteps length arrays empirical means and standard deviations of both
# populations over time
mu1 = X1.mean(axis=1)
sigma1 = X1.std(axis=1)
mu2 = X2.mean(axis=1)
sigma2 = X2.std(axis=1)

# plot it!
fig, ax = plt.subplots(1)
ax.plot(t, mu1, lw=2, label='mean population 1', color='blue')
ax.plot(t, mu2, lw=2, label='mean population 2', color='yellow')
ax.fill_between(t, mu1+sigma1, mu1-sigma1, facecolor='blue', alpha=0.5)
ax.fill_between(t, mu2+sigma2, mu2-sigma2, facecolor='yellow', alpha=0.5)
ax.set_title('random walkers empirical  $\mu$  and  $\pm \sigma$  interval')
ax.legend(loc='upper left')
ax.set_xlabel('num steps')
ax.set_ylabel('position')
ax.grid()
```





The `where` keyword argument is very handy for highlighting certain regions of the graph. `where` takes a boolean mask the same length as the `x`, `ymin` and `ymax` arguments, and only fills in the region where the boolean mask is `True`. In the example below, we simulate a single random walker and compute the analytic mean and standard deviation of the population positions. The population mean is shown as the black dashed line, and the plus/minus one sigma deviation from the mean is shown as the yellow filled region. We use the `where` mask `X > upper_bound` to find the region where the walker is above the one sigma boundary, and shade that region blue.

```
np.random.seed(1234)

Nsteps = 500
t = np.arange(Nsteps)

mu = 0.002
sigma = 0.01

# the steps and position
S = mu + sigma*np.random.randn(Nsteps)
X = S.cumsum()

# the 1 sigma upper and lower analytic population bounds
lower_bound = mu*t - sigma*np.sqrt(t)
upper_bound = mu*t + sigma*np.sqrt(t)

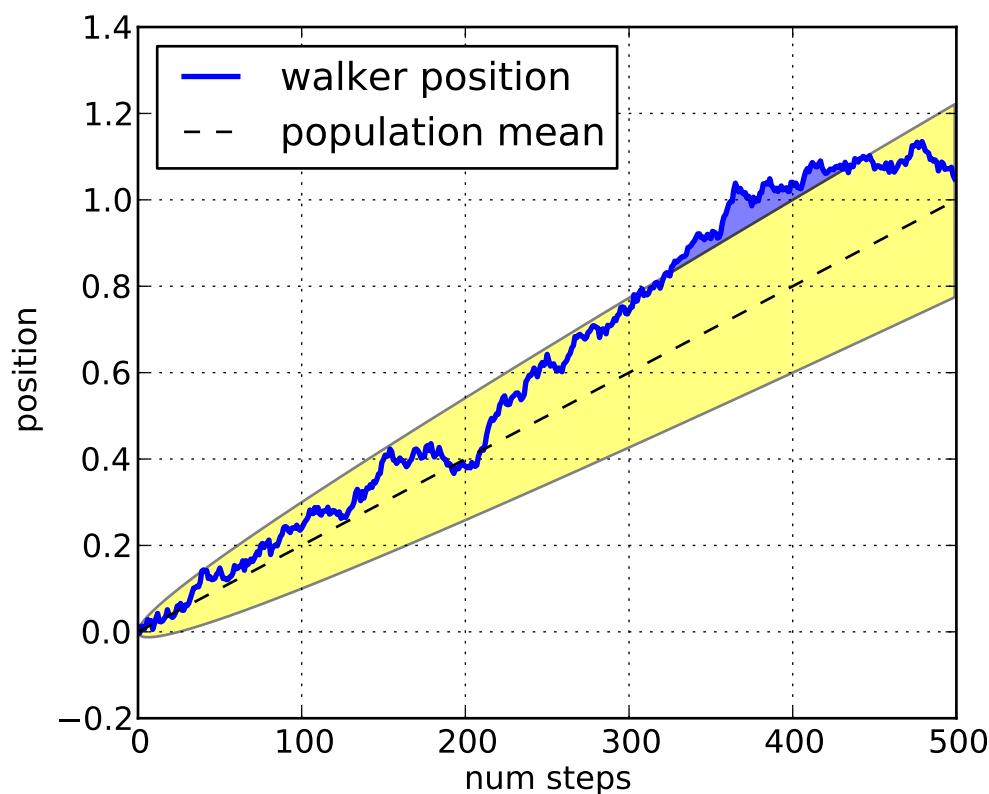
fig, ax = plt.subplots(1)
```

```

ax.plot(t, X, lw=2, label='walker position', color='blue')
ax.plot(t, mu*t, lw=1, label='population mean', color='black', ls='--')
ax.fill_between(t, lower_bound, upper_bound, facecolor='yellow', alpha=0.5,
               label='1 sigma range')
ax.legend(loc='upper left')

# here we use the where argument to only fill the region where the
# walker is above the population 1 sigma boundary
ax.fill_between(t, upper_bound, X, where=X>upper_bound, facecolor='blue', alpha=0.5)
ax.set_xlabel('num steps')
ax.set_ylabel('position')
ax.grid()

```



Another handy use of filled regions is to highlight horizontal or vertical spans of an axes – for that matplotlib has some helper functions `axhspan()` and `axvspan()` and example `pylab_examples example code: axhspan_demo.py`.

## 17.5 Transparent, fancy legends

Sometimes you know what your data looks like before you plot it, and you know for instance that there won't be much data in the upper right hand corner. Then you can safely create a legend that doesn't overlay your data:

```
ax.legend(loc='upper right')
```

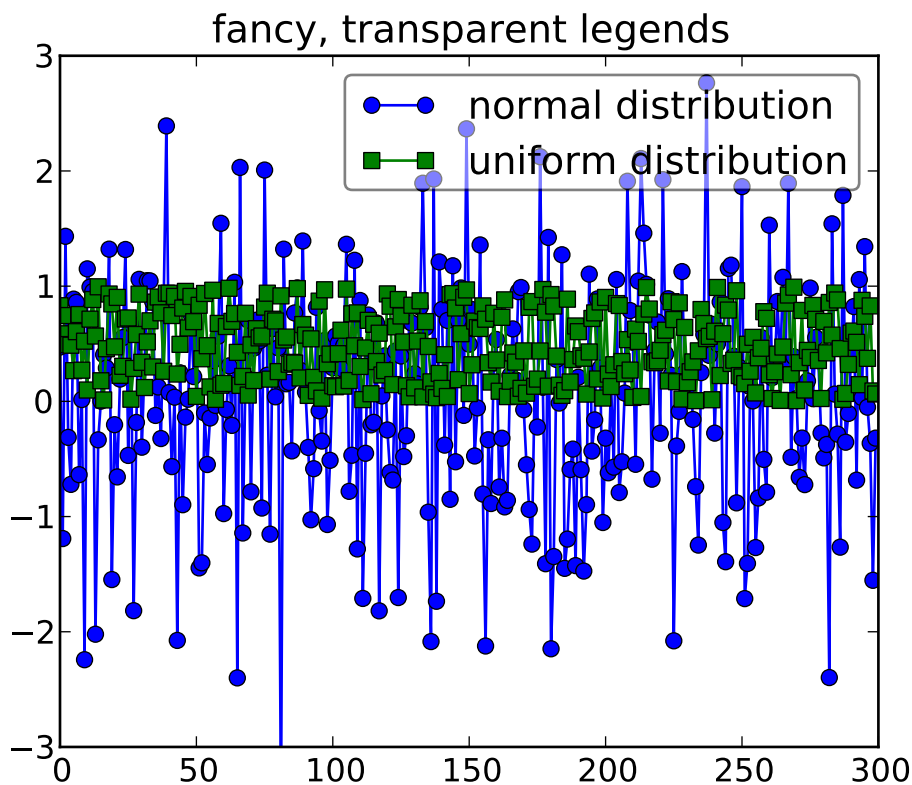
Other times you don't know where your data is, and `loc='best'` will try and place the legend:

```
ax.legend(loc='upper right')
```

but still, your legend may overlap your data, and in these cases it's nice to make the legend frame transparent.

```
np.random.seed(1234)
fig, ax = plt.subplots(1)
ax.plot(np.random.randn(300), 'o-', label='normal distribution')
ax.plot(np.random.rand(300), 's-', label='uniform distribution')
ax.set_ylim(-3, 3)
leg = ax.legend(loc='best', fancybox=True)
leg.get_frame().set_alpha(0.5)

ax.set_title('fancy, transparent legends')
```



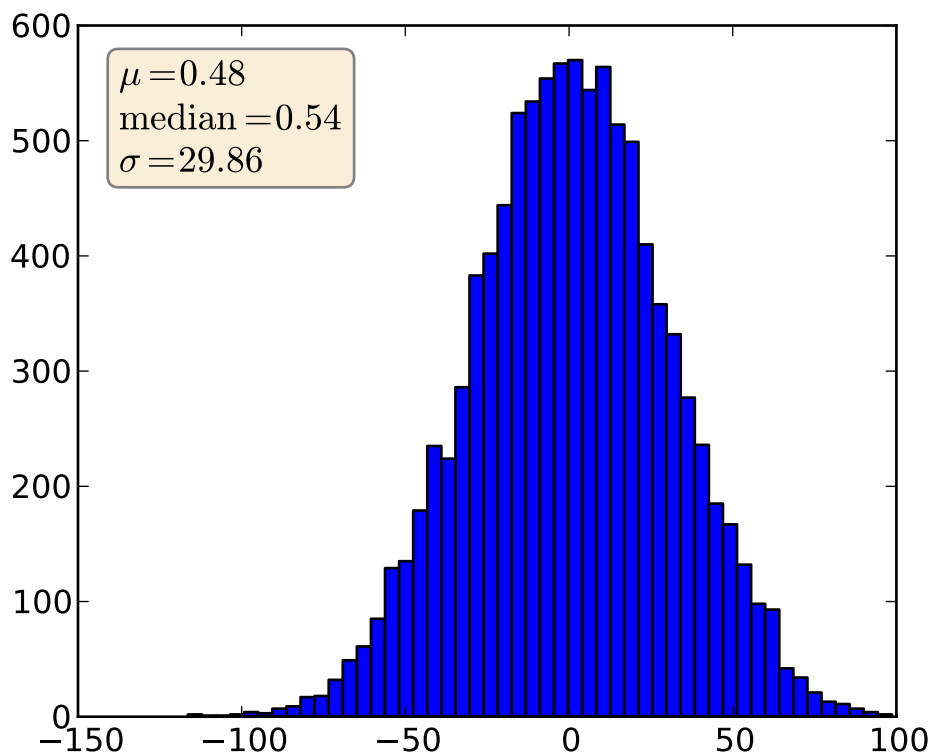
## 17.6 Placing text boxes

When decorating axes with text boxes, two useful tricks are to place the text in axes coordinates (see [Transformations Tutorial](#)), so the text doesn't move around with changes in x or y limits. You can also use the `bbox` property of text to surround the text with a `Patch` instance – the `bbox` keyword argument takes a dictionary with keys that are Patch properties.

```
np.random.seed(1234)
fig, ax = plt.subplots(1)
x = 30*np.random.randn(10000)
mu = x.mean()
median = np.median(x)
sigma = x.std()
textstr = '$\mu=%.2f$\n$\mathrm{median}=%.2f$\n$\sigma=%.2f$'%(mu, median, sigma)

ax.hist(x, 50)
# these are matplotlib.patch.Patch properties
props = dict(boxstyle='round', facecolor='wheat', alpha=0.5)

# place a text box in upper left in axes coords
ax.text(0.05, 0.95, textstr, transform=ax.transAxes, fontsize=14,
        verticalalignment='top', bbox=props)
```

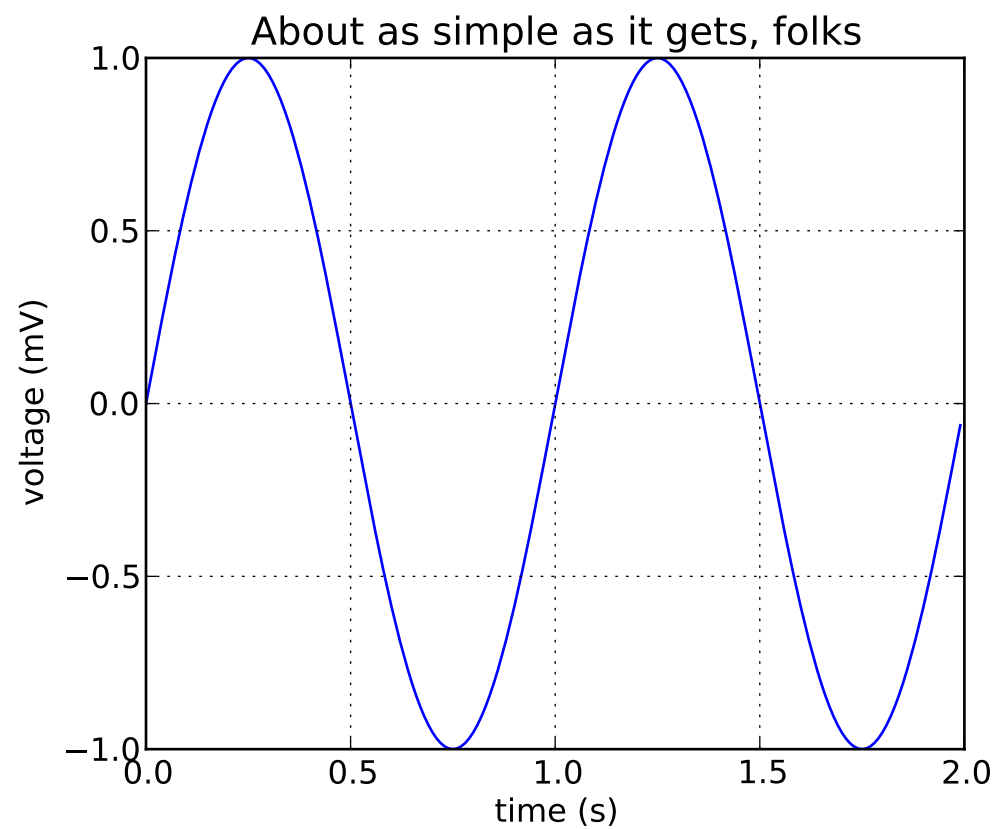


# SCREENSHOTS

Here you will find a host of example figures with the code that generated them

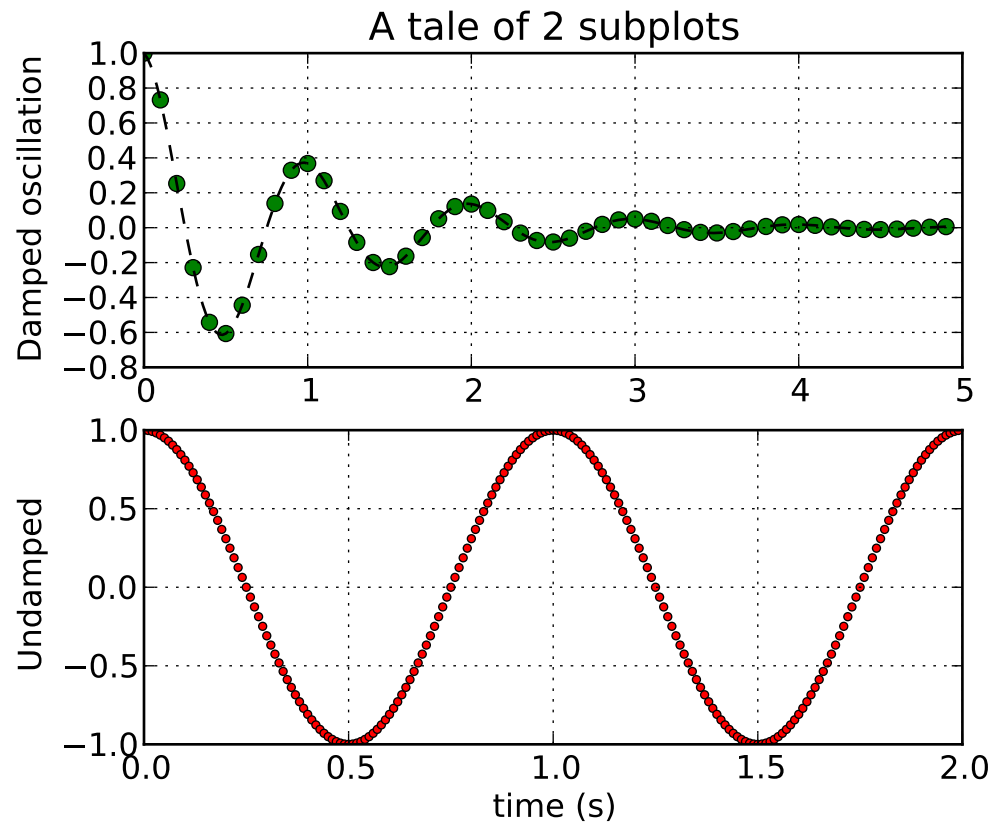
## 18.1 Simple Plot

The most basic `plot()`, with text labels



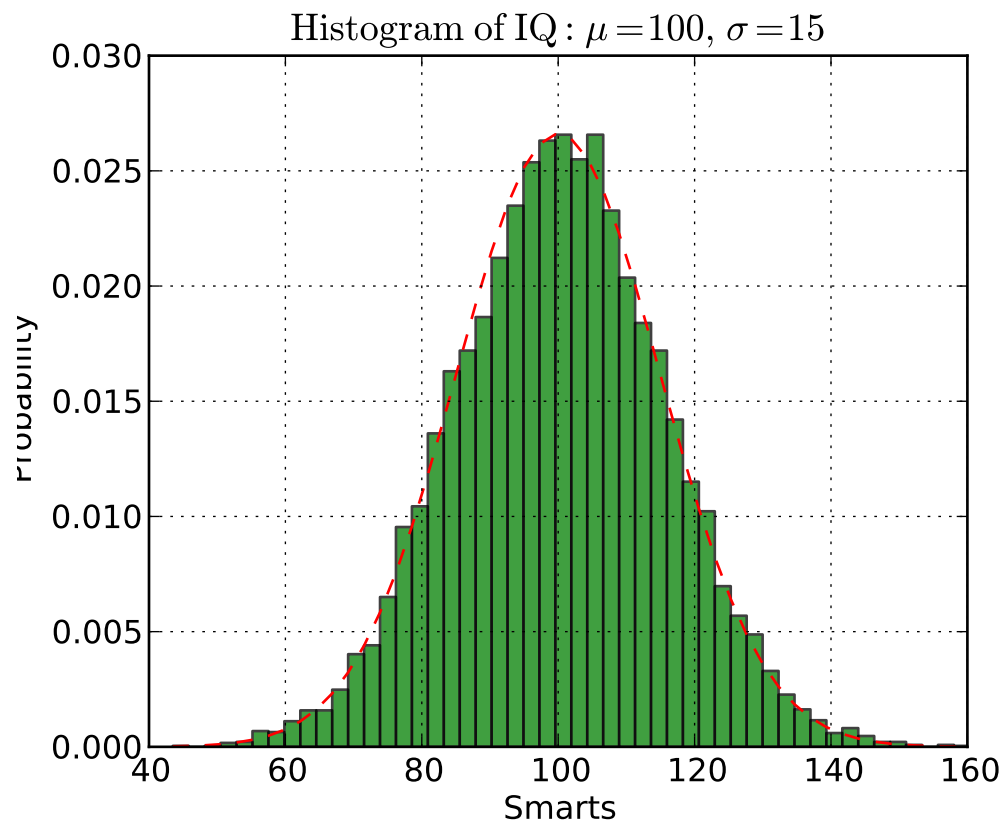
## 18.2 Subplot demo

Multiple regular axes (numrows by numcolumns) are created with the `subplot()` command.



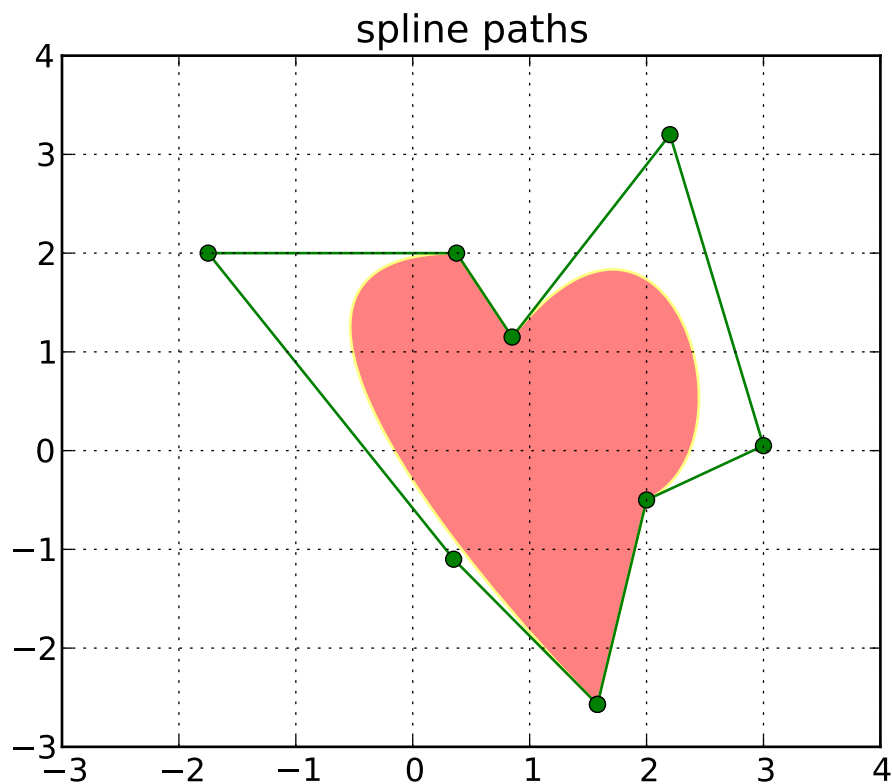
## 18.3 Histograms

The `hist()` command automatically generates histograms and will return the bin counts or probabilities



## 18.4 Path demo

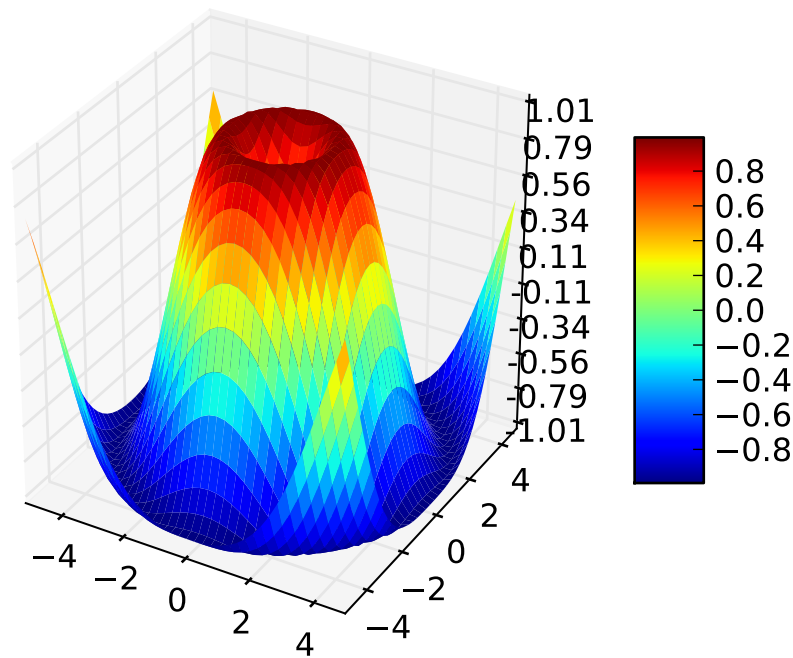
You can add arbitrary paths in matplotlib as of release 0.98. See the [matplotlib.path](#).



## 18.5 mplot3d

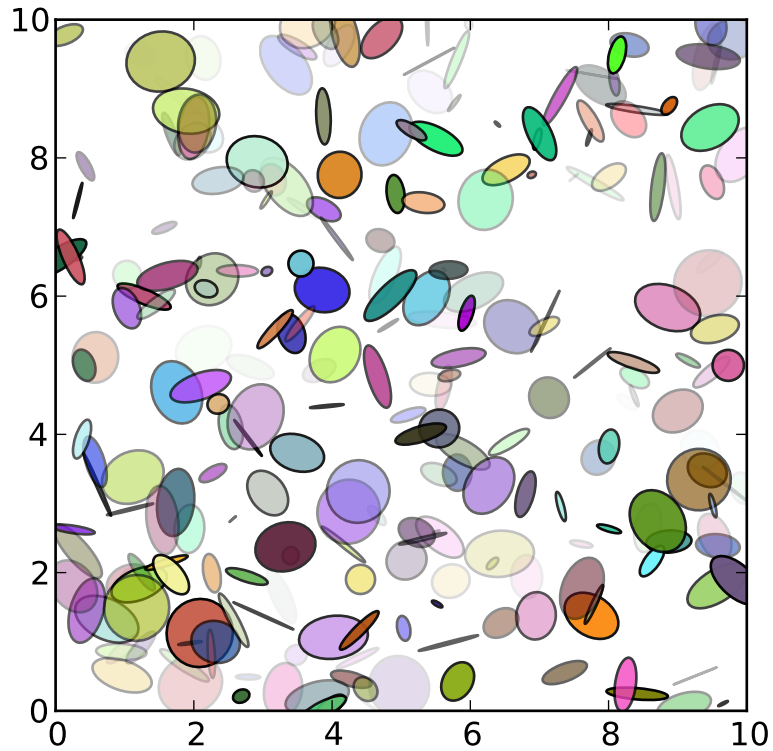
The `mplot3d` toolkit (see *mplot3d tutorial* and *mplot3d Examples*) has support for simple 3d graphs including surface, wireframe, scatter, and bar charts (added in matplotlib-0.99). Thanks to John Porter, Jonathon Taylor and Reinier Heeres for the `mplot3d` toolkit. The toolkit is included with all standard matplotlib installs.





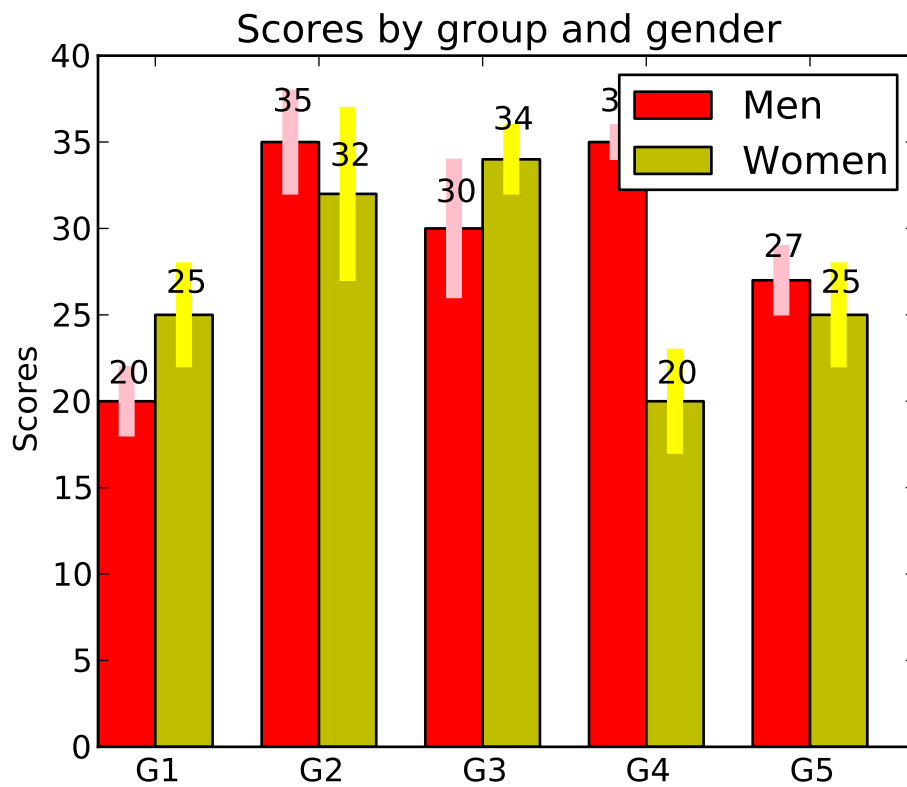
## 18.6 Ellipses

In support of the [Phoenix](#) mission to Mars, which used matplotlib in ground tracking of the spacecraft, Michael Droettboom built on work by Charlie Moad to provide an extremely accurate 8-spline approximation to elliptical arcs (see [Arc](#)) in the viewport. This provides a scale free, accurate graph of the arc regardless of zoom level



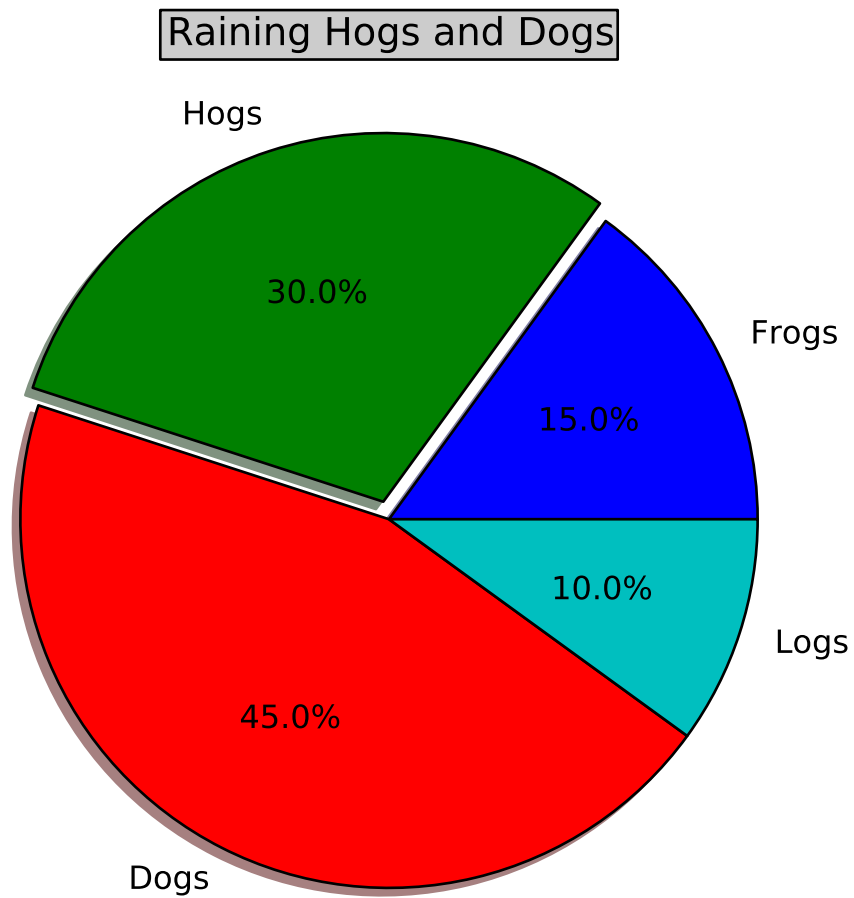
## 18.7 Bar charts

The `bar()` command takes error bars as an optional argument. You can also use up and down bars, stacked bars, candlestick bars, etc, ... See `bar_stacked.py` for another example. You can make horizontal bar charts with the `barh()` command.



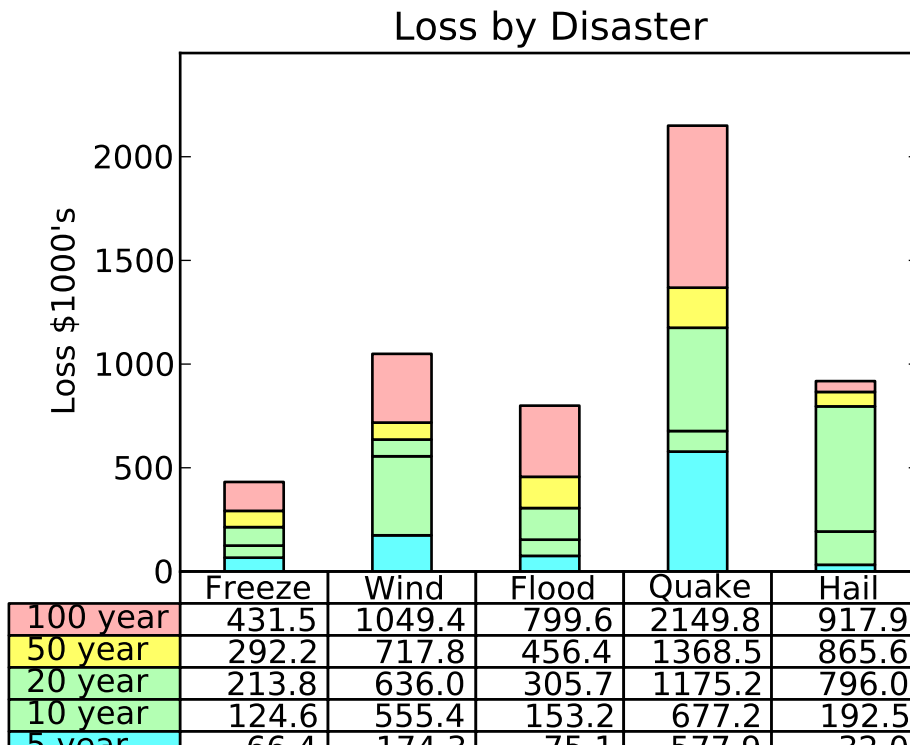
## 18.8 Pie charts

The `pie()` command uses a MATLAB compatible syntax to produce pie charts. Optional features include auto-labeling the percentage of area, exploding one or more wedges out from the center of the pie, and a shadow effect. Take a close look at the attached code that produced this figure; nine lines of code.



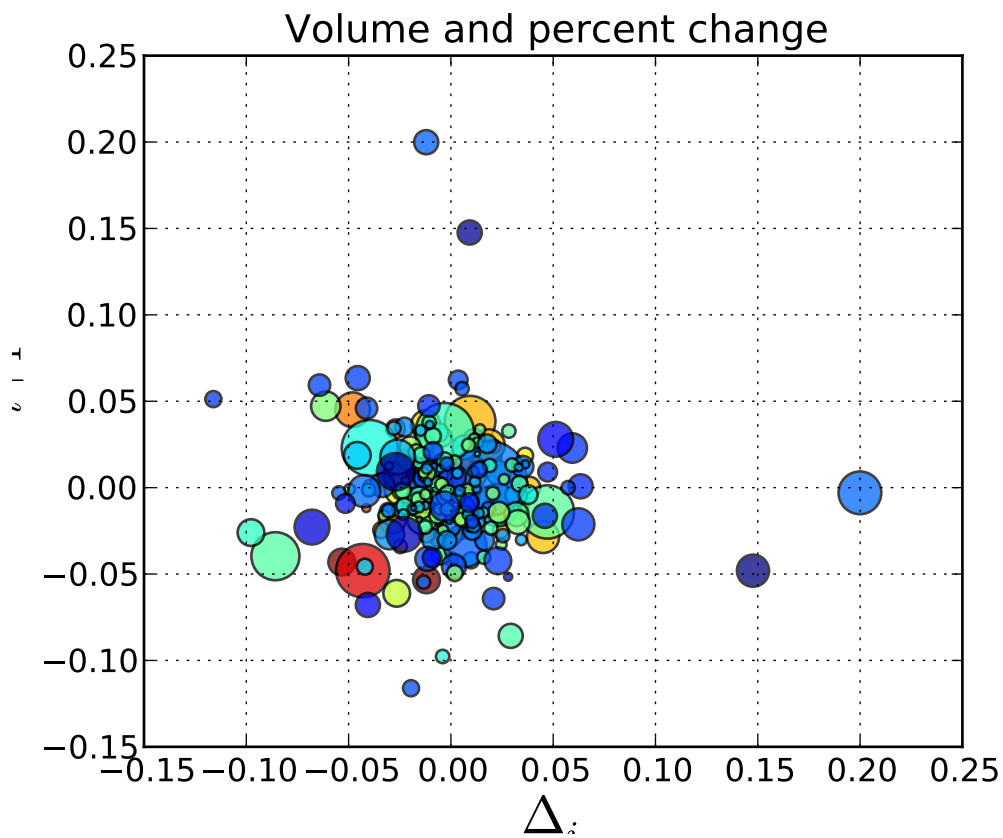
## 18.9 Table demo

The `table()` command will place a text table on the axes



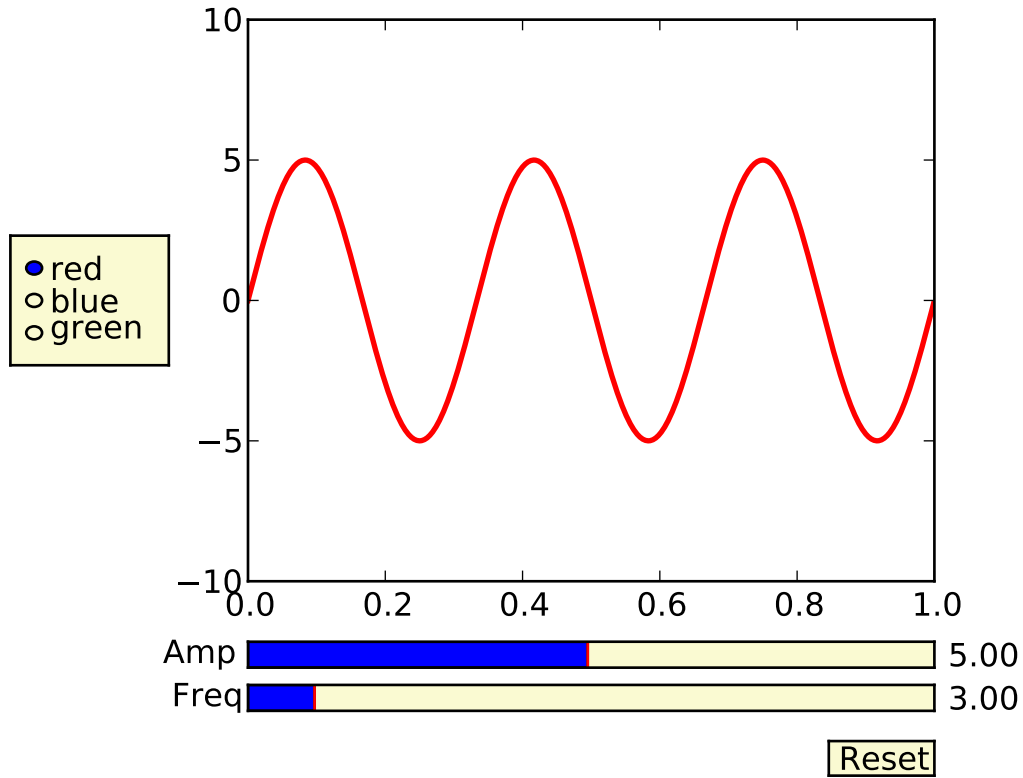
## 18.10 Scatter demo

The `scatter()` command makes a scatter plot with (optional) size and color arguments. This example plots changes in Google stock price from one day to the next with the sizes coding trading volume and the colors coding price change in day  $i$ . Here the alpha attribute is used to make semitransparent circle markers with the Agg backend (see *What is a backend?*)



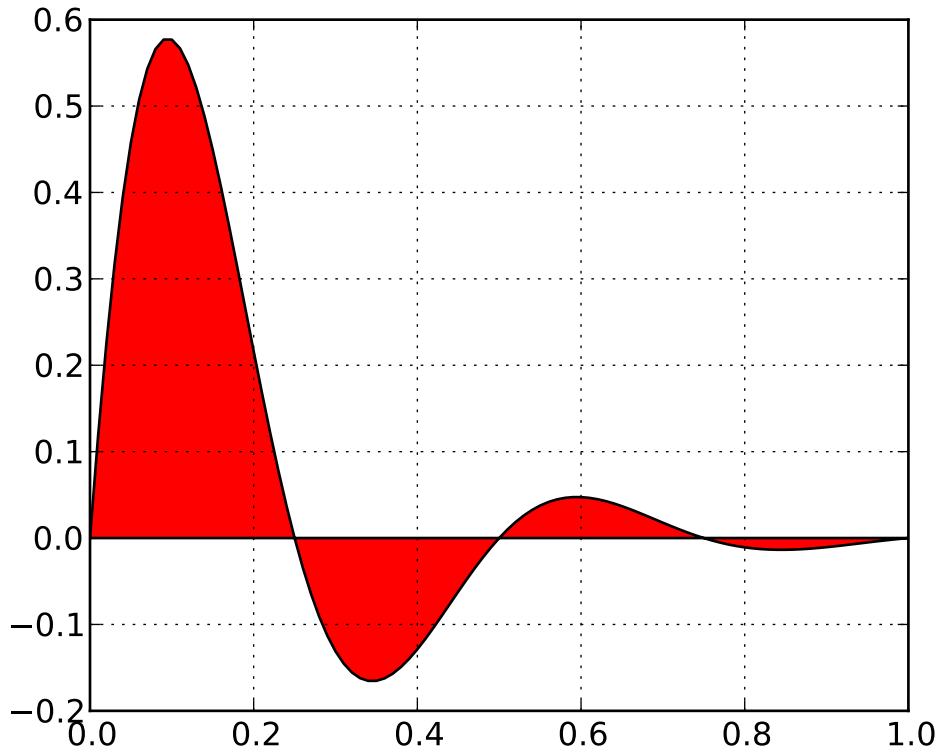
## 18.11 Slider demo

Matplotlib has basic GUI widgets that are independent of the graphical user interface you are using, allowing you to write cross GUI figures and widgets. See `matplotlib.widgets` and the widget *examples* `<examples/widgets>`



## 18.12 Fill demo

The `fill()` command lets you plot filled polygons. Thanks to Andrew Straw for providing this function



### 18.13 Date demo

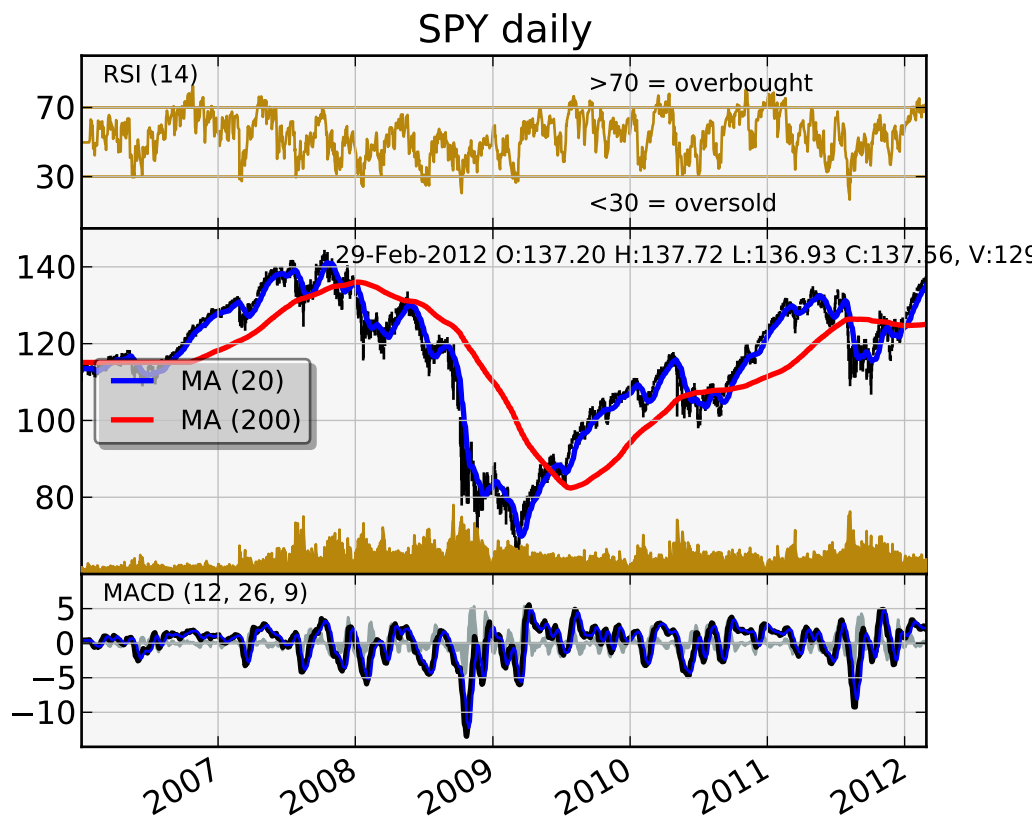
You can plot date data with major and minor ticks and custom tick formatters for both the major and minor ticks; see `matplotlib.ticker` and `matplotlib.dates` for details and usage.





## 18.14 Financial charts

You can make much more sophisticated financial plots. This example emulates one of the [ChartDirector](#) financial plots. Some of the data in the plot, are real financial data, some are random traces that I used since the goal was to illustrate plotting techniques, not market analysis!



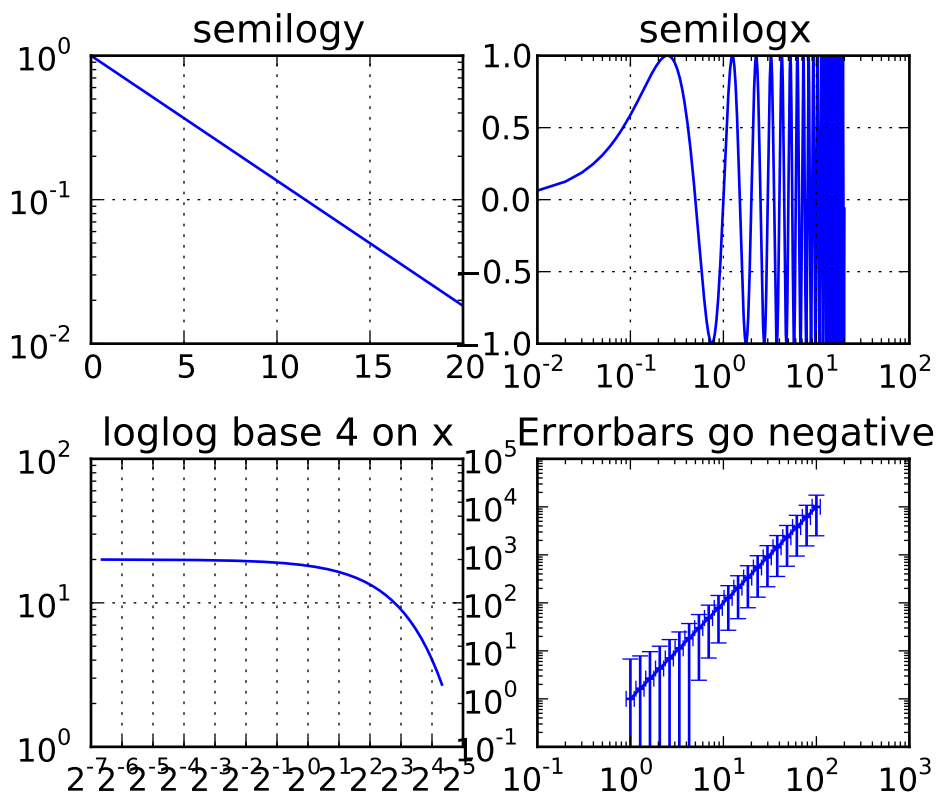
## 18.15 Basemap demo

Jeff Whitaker's *Basemap* add-on toolkit makes it possible to plot data on many different map projections. This example shows how to plot contours, markers and text on an orthographic projection, with NASA's "blue marble" satellite image as a background.

Sorry, could not import Basemap

## 18.16 Log plots

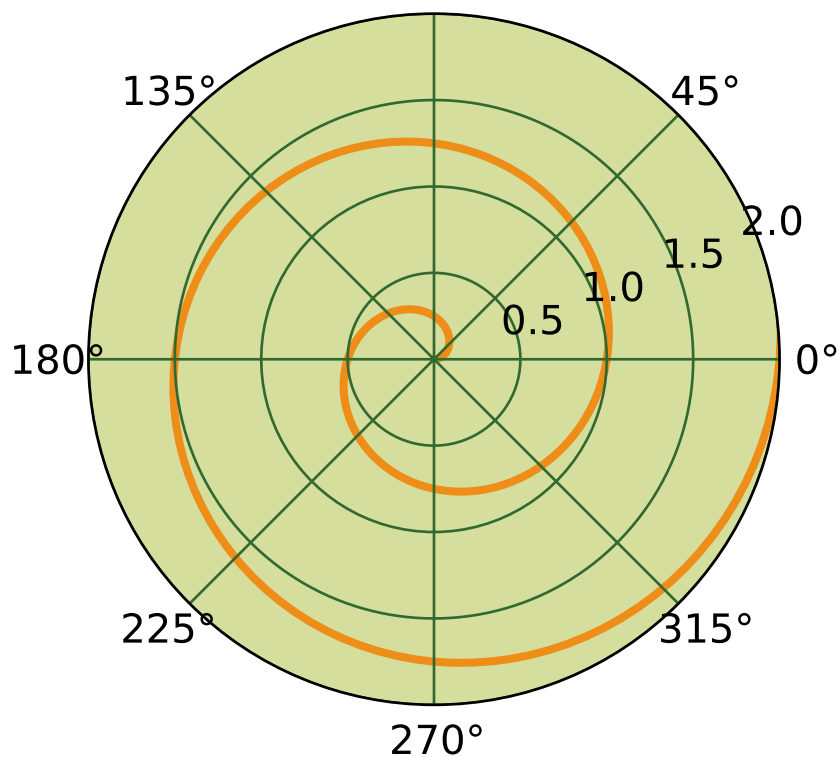
The `semilogx()`, `semilogy()` and `loglog()` functions generate log scaling on the respective axes. The lower subplot uses a base10 log on the xaxis and a base 4 log on the yaxis. Thanks to Andrew Straw, Darren Dale and Gregory Lielens for contributions to the log scaling infrastructure.



## 18.17 Polar plots

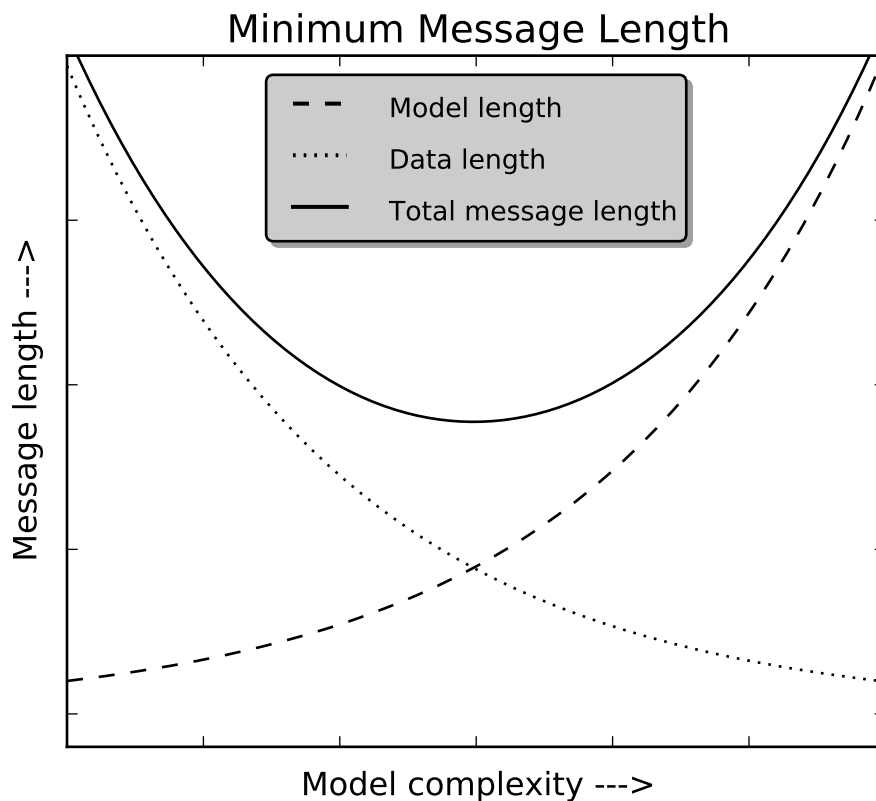
The `polar()` command generates polar plots.

And there was much rejoicing!



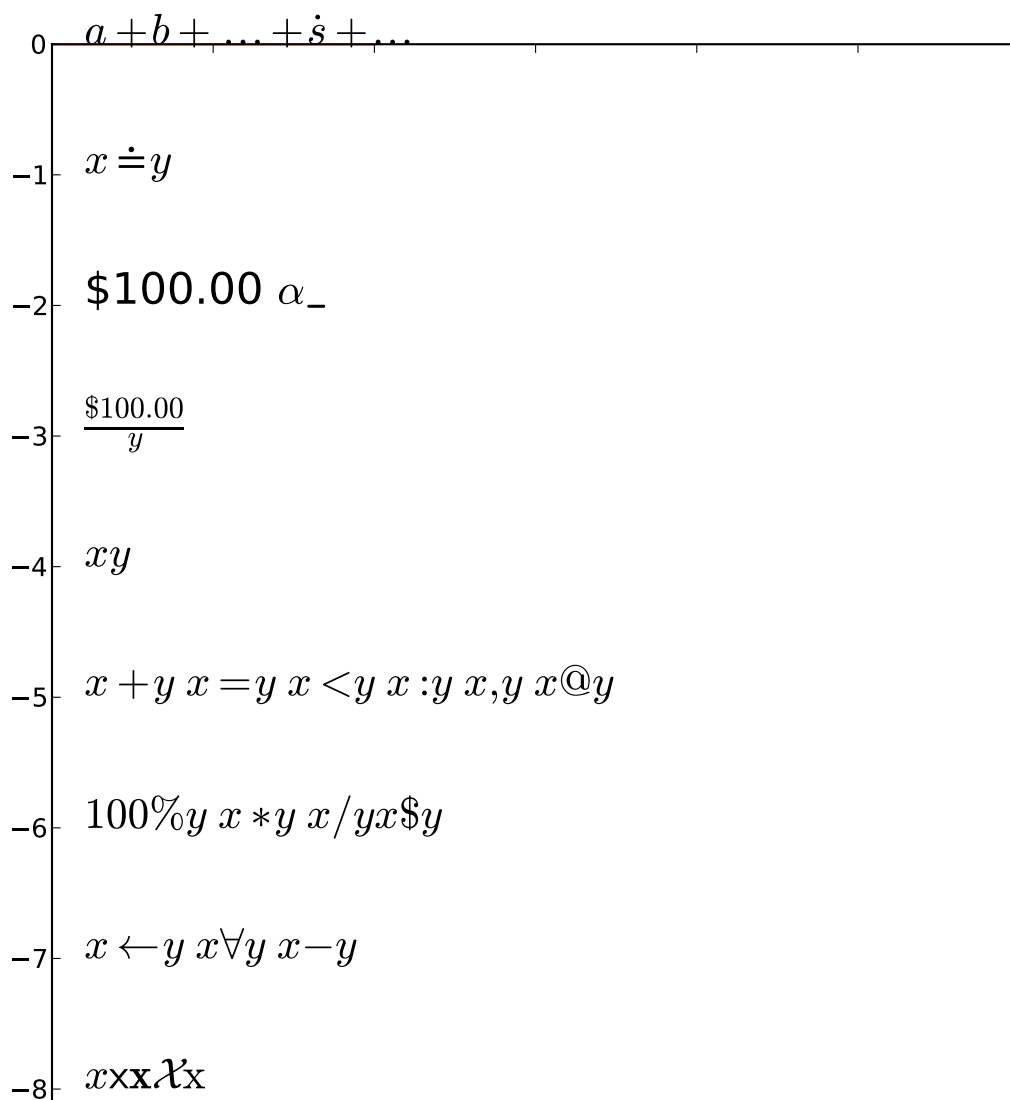
## 18.18 Legends

The `legend()` command automatically generates figure legends, with MATLAB compatible legend placement commands. Thanks to Charles Twardy for input on the legend command



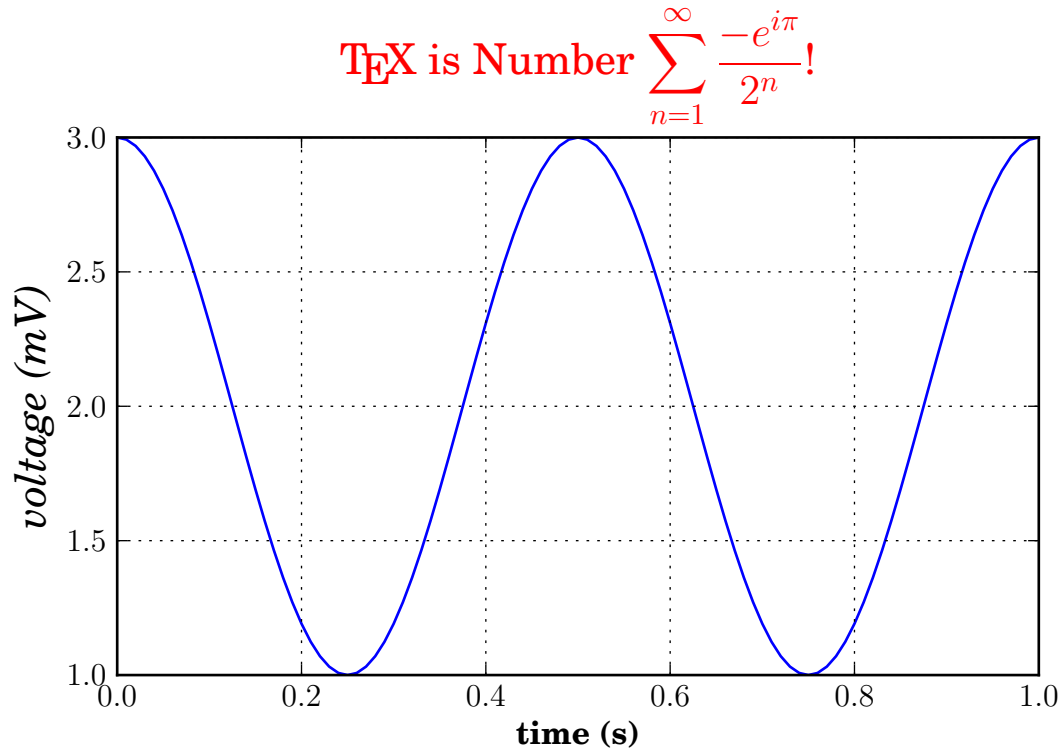
## 18.19 Mathtext\_examples

A sampling of the many TeX expressions now supported by matplotlib's internal mathtext engine. The mathtext module provides TeX style mathematical expressions using [freetype2](#) and the BaKoMa computer modern or [STIX](#) fonts. See the [matplotlib.mathtext](#) module for additional. matplotlib mathtext is an independent implementation, and does not required TeX or any external packages installed on your computer. See the tutorial at [Writing mathematical expressions](#).



## 18.20 Native TeX rendering

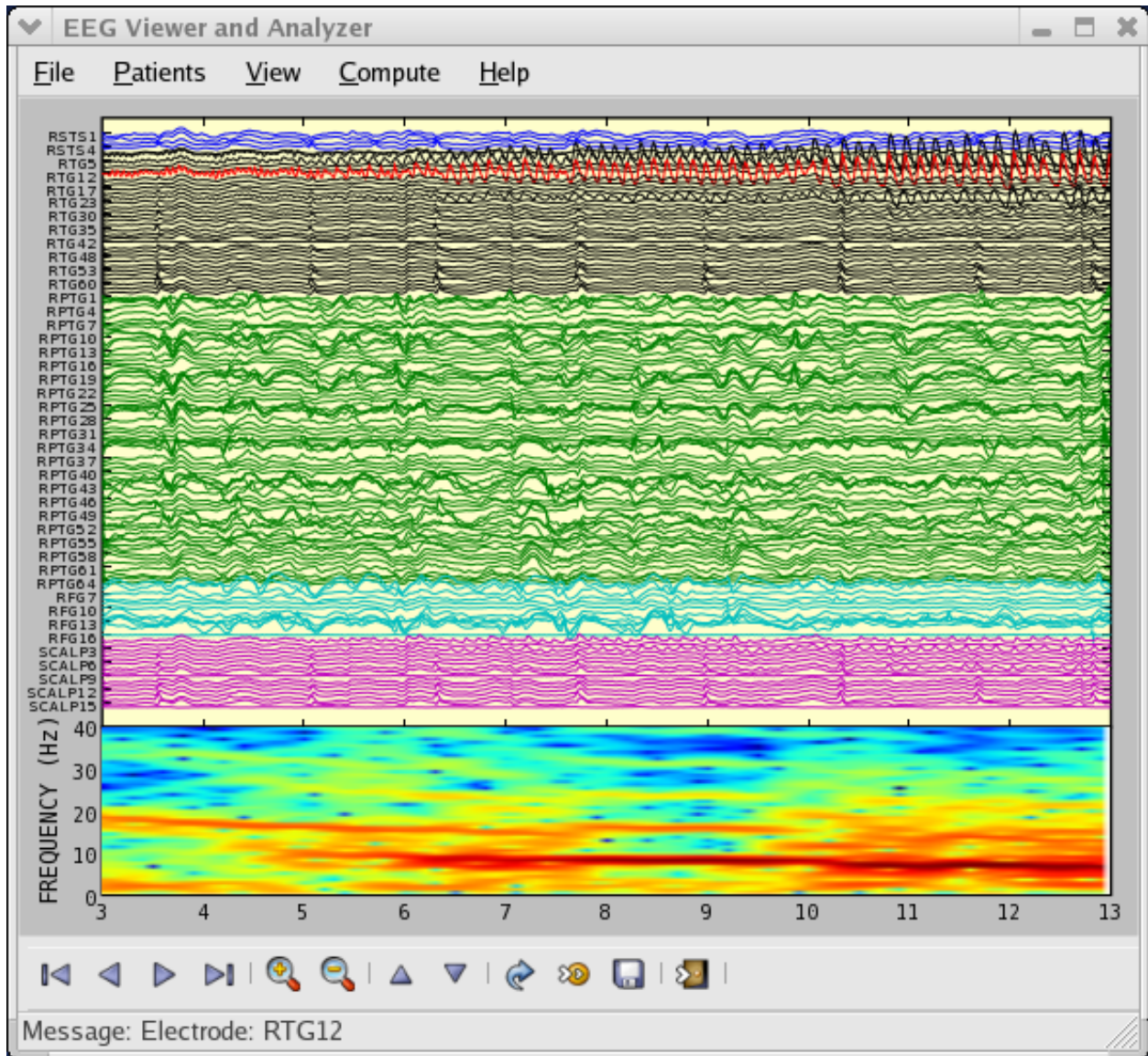
Although matplotlib's internal math rendering engine is quite powerful, sometimes you need TeX, and matplotlib supports external TeX rendering of strings with the *usetex* option.



## 18.21 EEG demo

You can embed matplotlib into pygtk, wxpython, Tk, FLTK or Qt applications. Here is a screenshot of an eeg viewer called pbrain which is part of the NeuroImaging in Python suite [NIPY](#). Pbrain is written in pygtk using matplotlib. The lower axes uses `specgram()` to plot the spectrogram of one of the EEG channels. For an example of how to use the navigation toolbar in your applications, see *user\_interfaces example code: embedding\_in\_gtk2.py*. If you want to use matplotlib in a wx application, see *user\_interfaces example code: embedding\_in\_wx2.py*. If you want to work with [glade](#), see *user\_interfaces example code: mpl\_with\_glade.py*.







# WHAT'S NEW IN MATPLOTLIB

This page just covers the highlights – for the full story, see the [CHANGELOG](#)

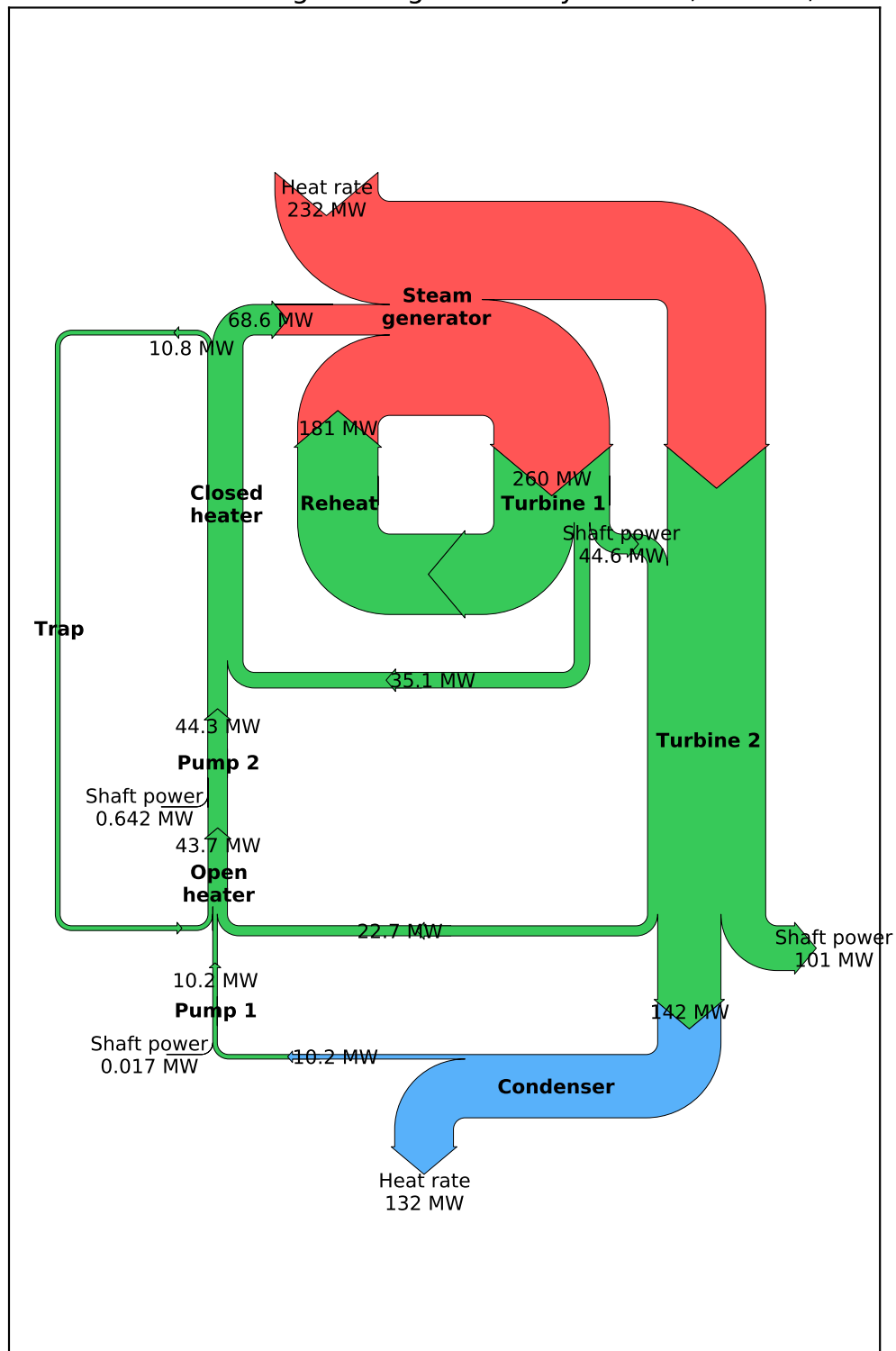
**Note:** Matplotlib version 1.1 is the last major release compatible with Python versions 2.4 to 2.7. The next major release will support versions 2.6, 2.7, and 3.1 and higher.

## 19.1 new in matplotlib-1.1

### 19.1.1 Sankey Diagrams

Kevin Davies has extended Yannick Copin's original Sankey example into a module (`sankey`) and provided new examples (*api example code: `sankey_demo_basics.py`, api example code: `sankey_demo_links.py`, api example code: `sankey_demo_rankine.py`*).

Rankine Power Cycle: Example 8.6 from Moran and Shapiro  
"Fundamentals of Engineering Thermodynamics", 6th ed., 2008



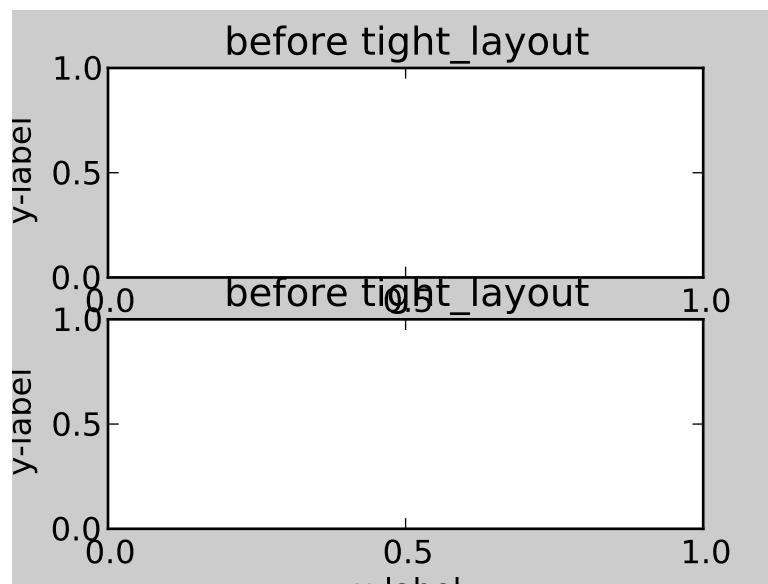
### 19.1.2 Animation

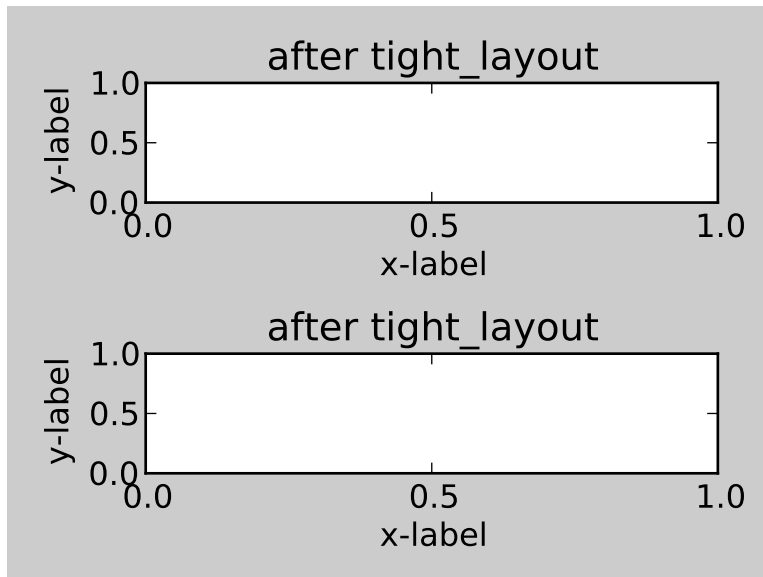
Ryan May has written a backend-independent framework for creating animated figures. The `animation` module is intended to replace the backend-specific examples formerly in the *Matplotlib Examples* listings. Examples using the new framework are in *animation Examples*; see the entrancing *double pendulum* which uses `matplotlib.animation.Animation.save()` to create the movie below.

This should be considered as a beta release of the framework; please try it and provide feedback.

### 19.1.3 Tight Layout

A frequent issue raised by users of matplotlib is the lack of a layout engine to nicely space out elements of the plots. While matplotlib still adheres to the philosophy of giving users complete control over the placement of plot elements, Jae-Joon Lee created the `tight_layout` module and introduced a new command `tight_layout()` to address the most common layout issues.





The usage of this functionality can be as simple as

```
plt.tight_layout()
```

and it will adjust the spacing between subplots so that the axis labels do not overlap with neighboring subplots. A [Tight Layout guide](#) has been created to show how to use this new tool.

### 19.1.4 PyQT4, PySide, and IPython

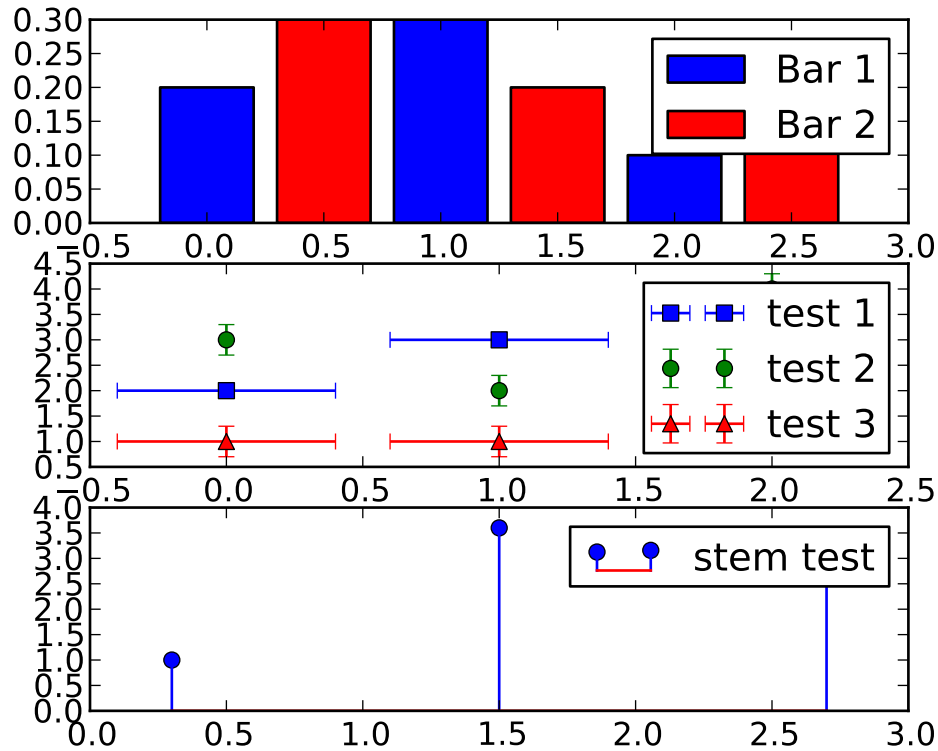
Gerald Storer made the Qt4 backend compatible with PySide as well as PyQT4. At present, however, PySide does not support the `PyOS_InputHook` mechanism for handling gui events while waiting for text input, so it cannot be used with the new version 0.11 of [IPython](#). Until this feature appears in PySide, IPython users should use the PyQT4 wrapper for QT4, which remains the matplotlib default.

An rcParam entry, “backend.qt4”, has been added to allow users to select PyQT4, PyQt4v2, or PySide. The latter two use the Version 2 Qt API. In most cases, users can ignore this rcParam variable; it is available to aid in testing, and to provide control for users who are embedding matplotlib in a PyQT4 or PySide app.

### 19.1.5 Legend

Jae-Joon Lee has improved plot legends. First, legends for complex plots such as `stem()` plots will now display correctly. Second, the ‘best’ placement of a legend has been improved in the presence of NaNs.

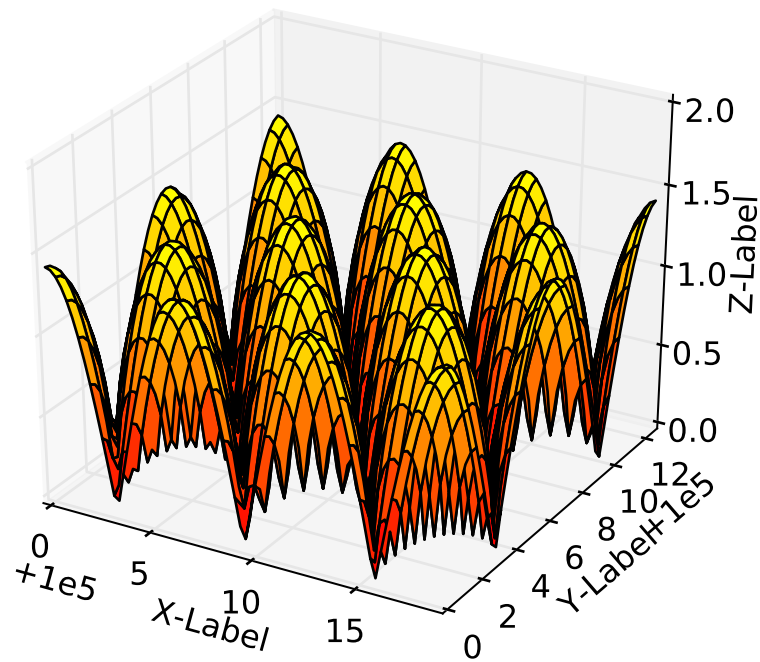
See [Legend of Complex Plots](#) for more detailed explanation and examples.



### 19.1.6 mplot3d

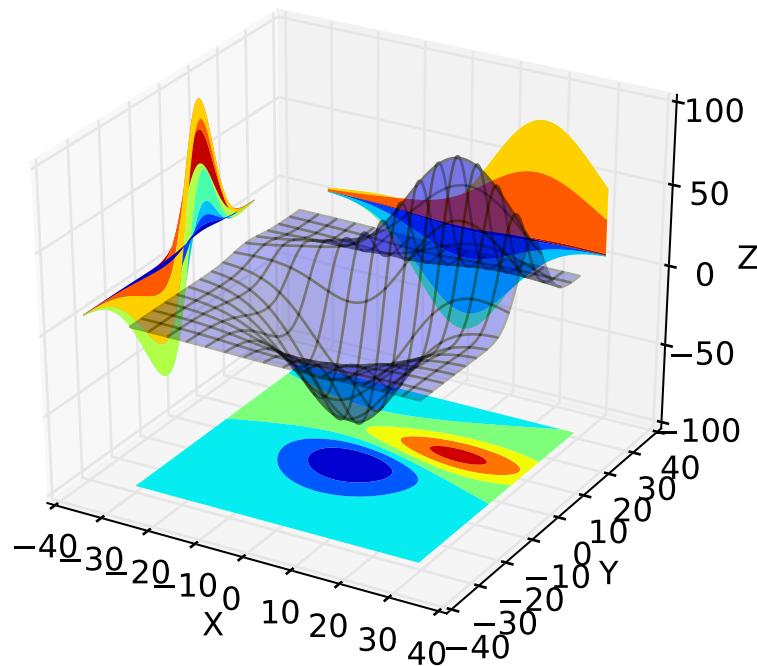
In continuing the efforts to make 3D plotting in matplotlib just as easy as 2D plotting, Ben Root has made several improvements to the `mplot3d` module.

- `Axes3D` has been improved to bring the class towards feature-parity with regular `Axes` objects
- Documentation for *mplot3d* was significantly expanded
- Axis labels and orientation improved
- Most 3D plotting functions now support empty inputs
- Ticker offset display added:



- `contourf()` gains `zdir` and `offset` kwargs. You can now do this:





### 19.1.7 Numerix support removed

After more than two years of deprecation warnings, Numerix support has now been completely removed from matplotlib.

### 19.1.8 Markers

The list of available markers for `plot()` and `scatter()` has now been merged. While they were mostly similar, some markers existed for one function, but not the other. This merge did result in a conflict for the ‘d’ diamond marker. Now, ‘d’ will be interpreted to always mean “thin” diamond while ‘D’ will mean “regular” diamond.

Thanks to Michael Droettboom for this effort.

### 19.1.9 Other improvements

- Unit support for polar axes and `arrow()`
- `PolarAxes` gains getters and setters for “theta\_direction”, and “theta\_offset” to allow for theta to go in either the clock-wise or counter-clockwise direction and to specify where zero degrees should be placed. `set_theta_zero_location()` is an added convenience function.

- Fixed error in argument handling for tri-functions such as `tripcolor()`
- `axes.labelweight` parameter added to `rcParams`.
- For `imshow()`, `interpolation='nearest'` will now always perform an interpolation. A “none” option has been added to indicate no interpolation at all.
- An error in the Hammer projection has been fixed.
- `clabel` for `contour()` now accepts a callable. Thanks to Daniel Hyams for the original patch.
- Jae-Joon Lee added the `HBox` and `VBox` classes.
- Christoph Gohlke reduced memory usage in `imshow()`.
- `scatter()` now accepts empty inputs.
- The behavior for ‘symlog’ scale has been fixed, but this may result in some minor changes to existing plots. This work was refined by ssyr.
- Peter Butterworth added named figure support to `figure()`.
- Michiel de Hoon has modified the MacOSX backend to make its interactive behavior consistent with the other backends.
- Pim Schellart added a new colormap called “cubehelix”. Sameer Grover also added a colormap called “coolwarm”. See it and all other colormaps *here*.
- Many bug fixes and documentation improvements.

## 19.2 new in matplotlib-1.0

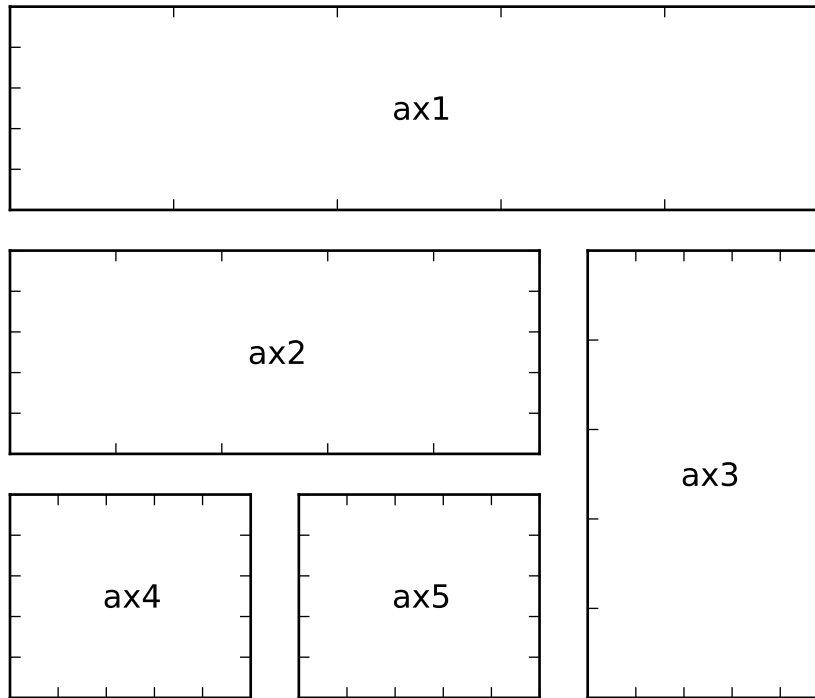
### 19.2.1 HTML5/Canvas backend

Simon Ratcliffe and Ludwig Schwardt have released an [HTML5/Canvas](#) backend for matplotlib. The backend is almost feature complete, and they have done a lot of work comparing their html5 rendered images with our core renderer Agg. The backend features client/server interactive navigation of matplotlib figures in an html5 compliant browser.

### 19.2.2 Sophisticated subplot grid layout

Jae-Joon Lee has written [gridspec](#), a new module for doing complex subplot layouts, featuring row and column spans and more. See *Customizing Location of Subplot Using GridSpec* for a tutorial overview.

subplot2grid



### 19.2.3 Easy pythonic subplots

Fernando Perez got tired of all the boilerplate code needed to create a figure and multiple subplots when using the matplotlib API, and wrote a `subplots()` helper function. Basic usage allows you to create the figure and an array of subplots with numpy indexing (starts with 0). Eg:

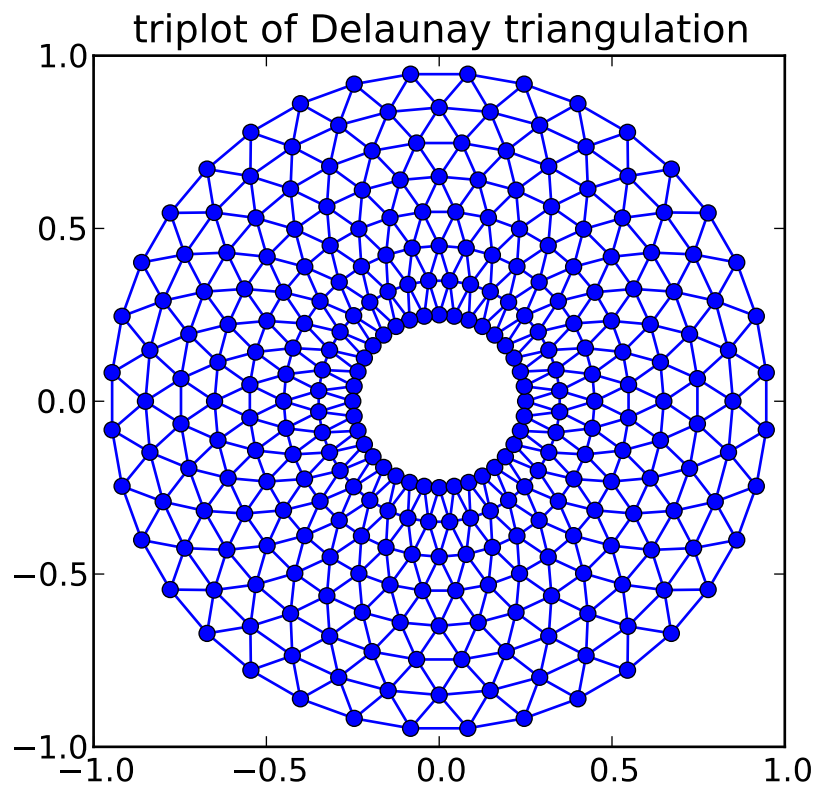
```
fig, axarr = plt.subplots(2, 2)
axarr[0,0].plot([1,2,3]) # upper, left
```

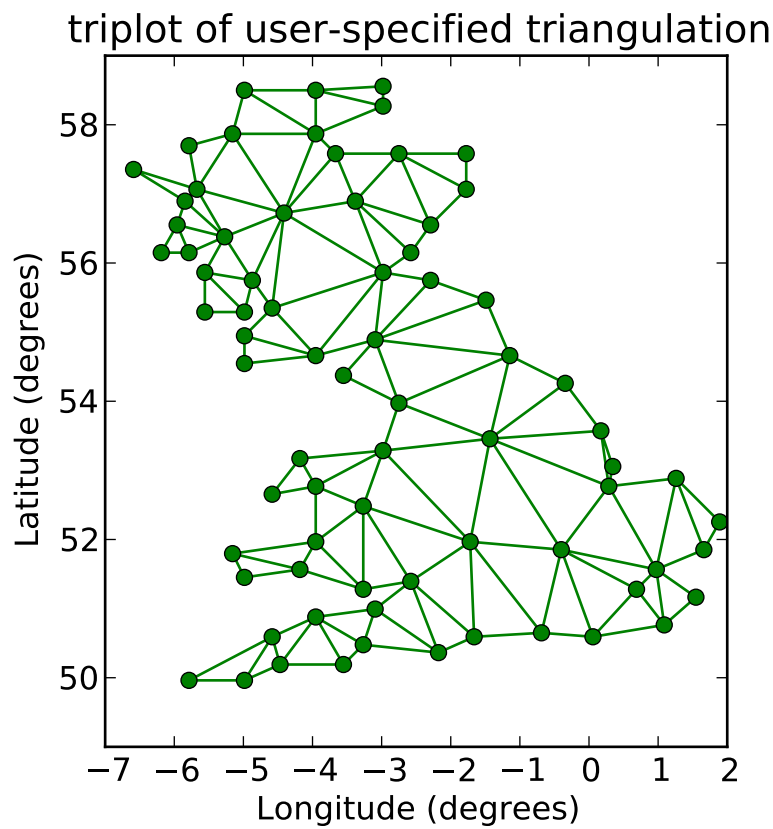
See *pylab\_examples* example code: `subplots_demo.py` for several code examples.

### 19.2.4 Contour fixes and and triplot

Ian Thomas has fixed a long-standing bug that has vexed our most talented developers for years. `contourf()` now handles interior masked regions, and the boundaries of line and filled contours coincide.

Additionally, he has contributed a new module `tri` and helper function `triplot()` for creating and plotting unstructured triangular grids.



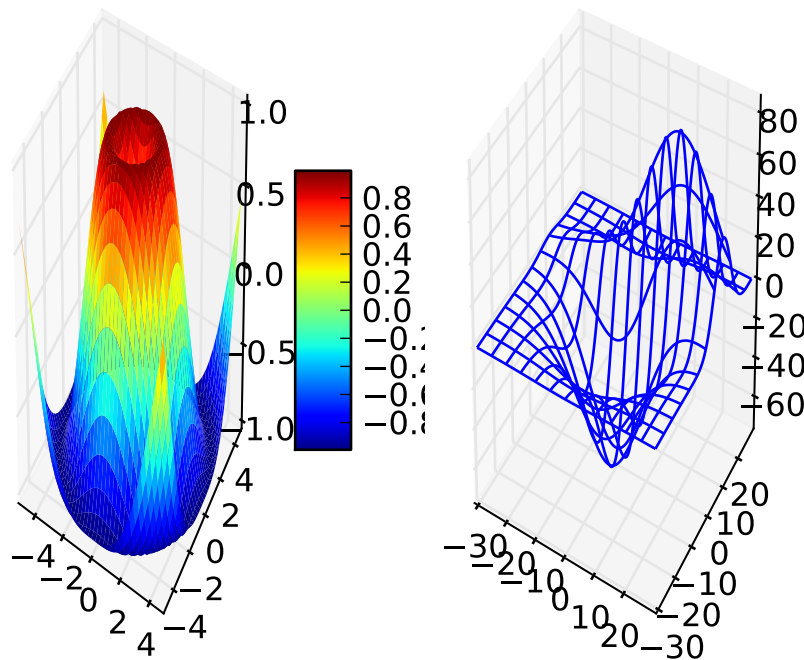


### 19.2.5 multiple calls to show supported

A long standing request is to support multiple calls to `show()`. This has been difficult because it is hard to get consistent behavior across operating systems, user interface toolkits and versions. Eric Firing has done a lot of work on rationalizing show across backends, with the desired behavior to make show raise all newly created figures and block execution until they are closed. Repeated calls to show should raise newly created figures since the last call. Eric has done a lot of testing on the user interface toolkits and versions and platforms he has access to, but it is not possible to test them all, so please report problems to the [mailing list](#) and [bug tracker](#).

### 19.2.6 mplot3d graphs can be embedded in arbitrary axes

You can now place an `mplot3d` graph into an arbitrary axes location, supporting mixing of 2D and 3D graphs in the same figure, and/or multiple 3D graphs in a single figure, using the “projection” keyword argument to `add_axes` or `add_subplot`. Thanks Ben Root.



### 19.2.7 `tick_params`

Eric Firing wrote `tick_params`, a convenience method for changing the appearance of ticks and tick labels. See pyplot function `tick_params()` and associated Axes method `tick_params()`.

### 19.2.8 Lots of performance and feature enhancements

- Faster magnification of large images, and the ability to zoom in to a single pixel
- Local installs of documentation work better
- Improved “widgets” – mouse grabbing is supported
- More accurate snapping of lines to pixel boundaries
- More consistent handling of color, particularly the alpha channel, throughout the API

### 19.2.9 Much improved software carpentry

The matplotlib trunk is probably in as good a shape as it has ever been, thanks to improved [software carpentry](#). We now have a [buildbot](#) which runs a suite of [nose](#) regression tests on every svn commit, auto-generating a set of images and comparing them against a set of known-goods, sending emails to developers on failures

with a pixel-by-pixel [image comparison](#). Releases and release bugfixes happen in branches, allowing active new feature development to happen in the trunk while keeping the release branches stable. Thanks to Andrew Straw, Michael Droettboom and other matplotlib developers for the heavy lifting.

### 19.2.10 Bugfix marathon

Eric Firing went on a bug fixing and closing marathon, closing over 100 bugs on the [bug tracker](#) with help from Jae-Joon Lee, Michael Droettboom, Christoph Gohlke and Michiel de Hoon.

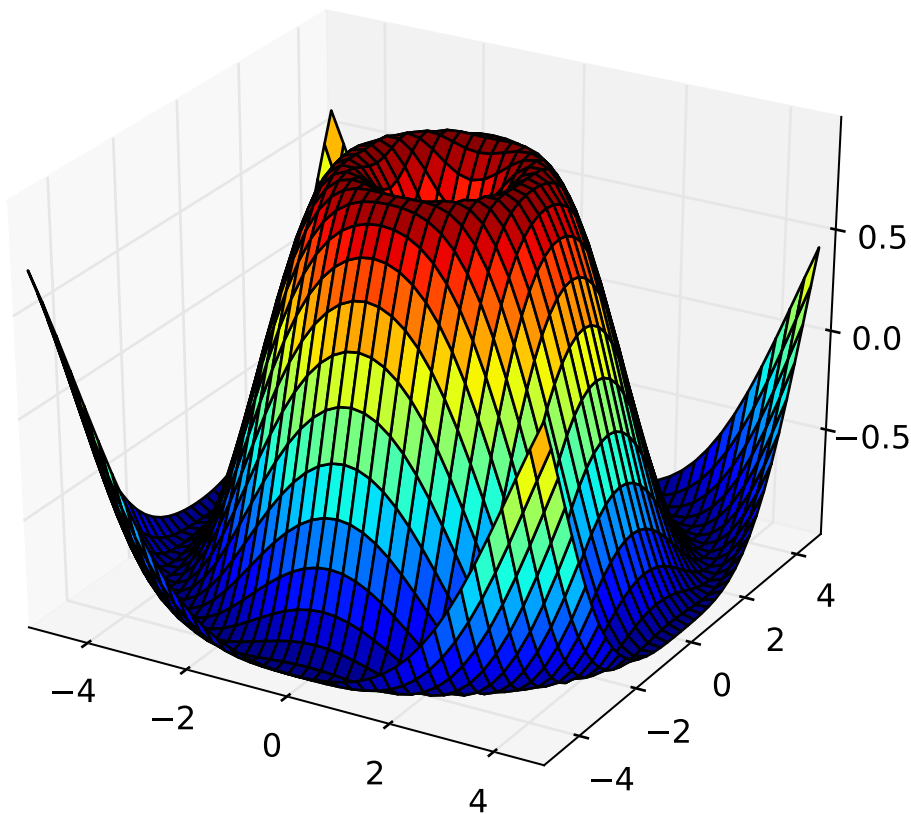
## 19.3 new in matplotlib-0.99

### 19.3.1 New documentation

Jae-Joon Lee has written two new guides [Legend guide](#) and [Annotating Axes](#). Michael Sarahan has written [Image tutorial](#). John Hunter has written two new tutorials on working with paths and transformations: [Path Tutorial](#) and [Transformations Tutorial](#).

### 19.3.2 mplot3d

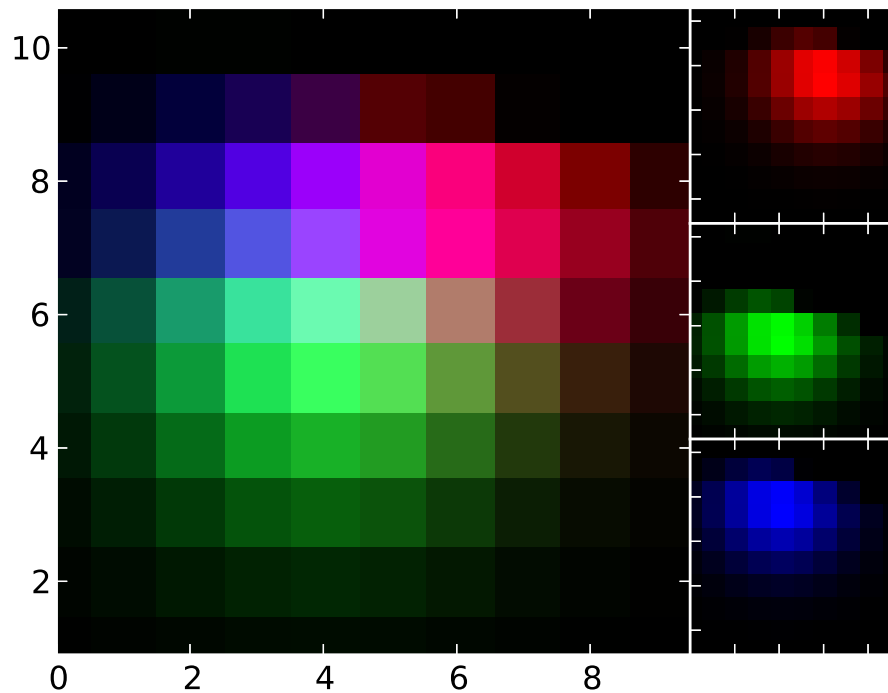
Reinier Heeres has ported John Porter's mplot3d over to the new matplotlib transformations framework, and it is now available as a toolkit `mpl_toolkits.mplot3d` (which now comes standard with all mpl installs). See [mplot3d Examples](#) and [mplot3d tutorial](#)



### 19.3.3 axes grid toolkit

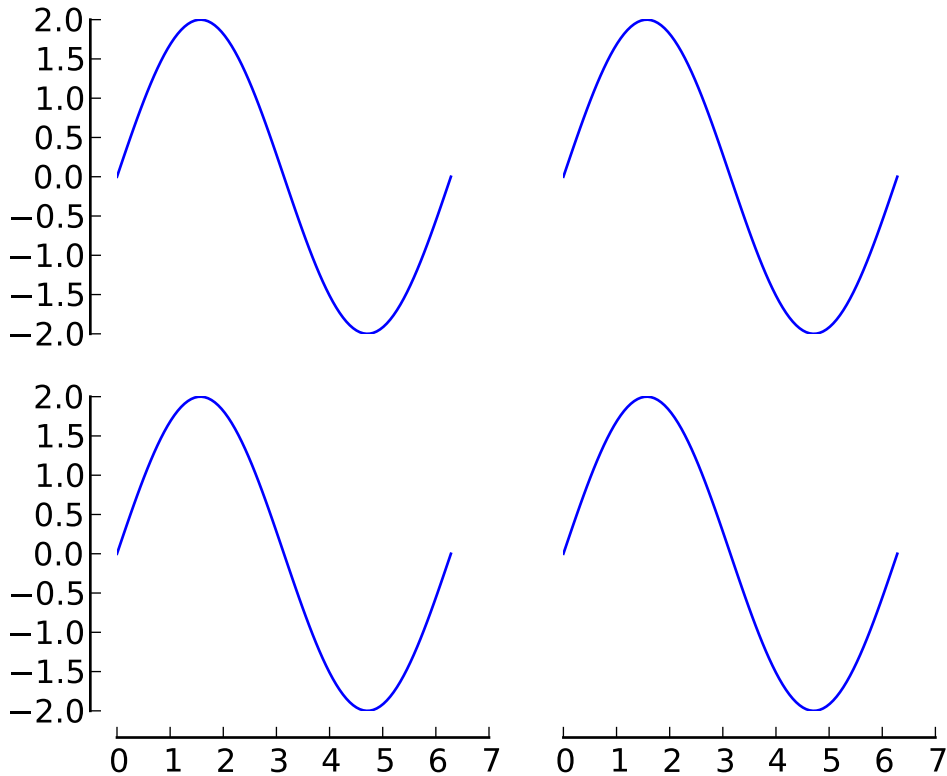
Jae-Joon Lee has added a new toolkit to ease displaying multiple images in matplotlib, as well as some support for curvilinear grids to support the world coordinate system. The toolkit is included standard with all new mpl installs. See *axes\_grid Examples* and *The Matplotlib AxesGrid Toolkit User's Guide*.





### 19.3.4 Axis spine placement

Andrew Straw has added the ability to place “axis spines” – the lines that denote the data limits – in various arbitrary locations. No longer are your axis lines constrained to be a simple rectangle around the figure – you can turn on or off left, bottom, right and top, as well as “detach” the spine to offset it away from the data. See *pylab\_examples example code: spine\_placement\_demo.py* and `matplotlib.spines.Spine`.



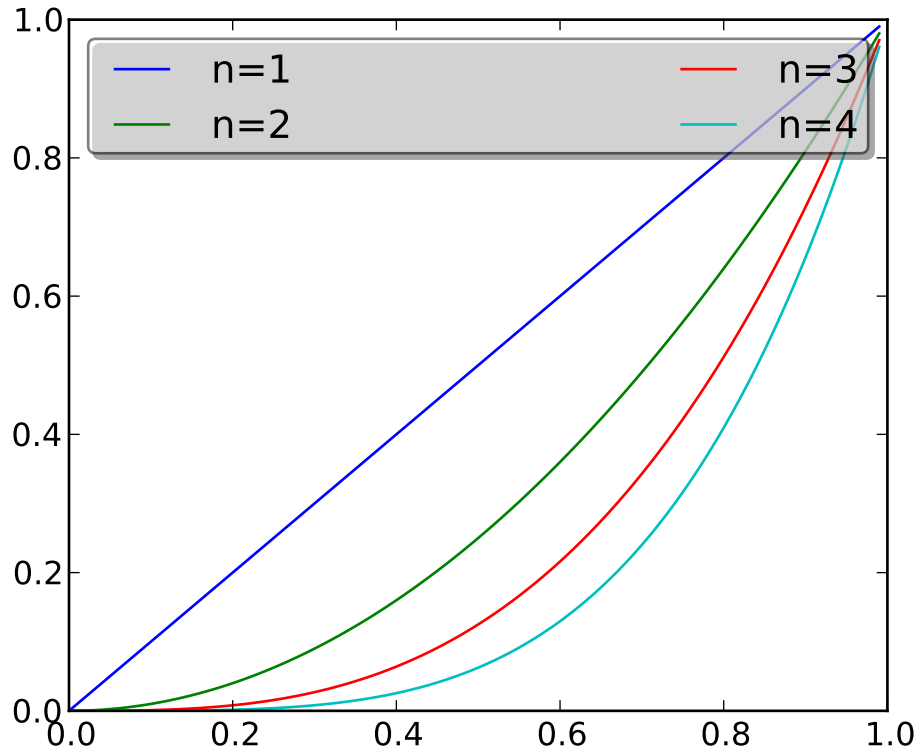
## 19.4 new in 0.98.4

It's been four months since the last matplotlib release, and there are a lot of new features and bug-fixes.

Thanks to Charlie Moad for testing and preparing the source release, including binaries for OS X and Windows for python 2.4 and 2.5 (2.6 and 3.0 will not be available until numpy is available on those releases). Thanks to the many developers who contributed to this release, with contributions from Jae-Joon Lee, Michael Droettboom, Ryan May, Eric Firing, Manuel Metz, Jouni K. Seppänen, Jeff Whitaker, Darren Dale, David Kaplan, Michiel de Hoon and many others who submitted patches

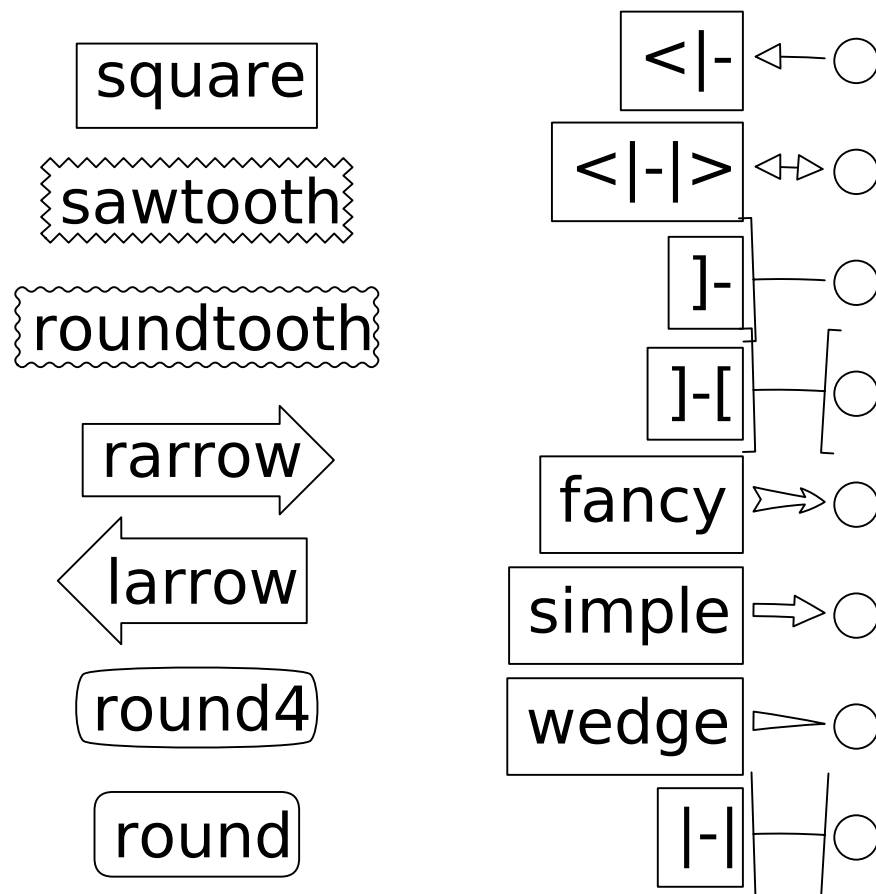
### 19.4.1 Legend enhancements

Jae-Joon has rewritten the legend class, and added support for multiple columns and rows, as well as fancy box drawing. See `legend()` and `matplotlib.legend.Legend`.



### 19.4.2 Fancy annotations and arrows

Jae-Joon has added lot's of support to annotations for drawing fancy boxes and connectors in annotations. See `annotate()` and `BoxStyle`, `ArrowStyle`, and `ConnectionStyle`.



### 19.4.3 Native OS X backend

Michiel de Hoon has provided a native Mac OSX backend that is almost completely implemented in C. The backend can therefore use Quartz directly and, depending on the application, can be orders of magnitude faster than the existing backends. In addition, no third-party libraries are needed other than Python and NumPy. The backend is interactive from the usual terminal application on Mac using regular Python. It hasn't been tested with ipython yet, but in principle it should to work there as well. Set 'backend : macosx' in your matplotlibrc file, or run your script with:

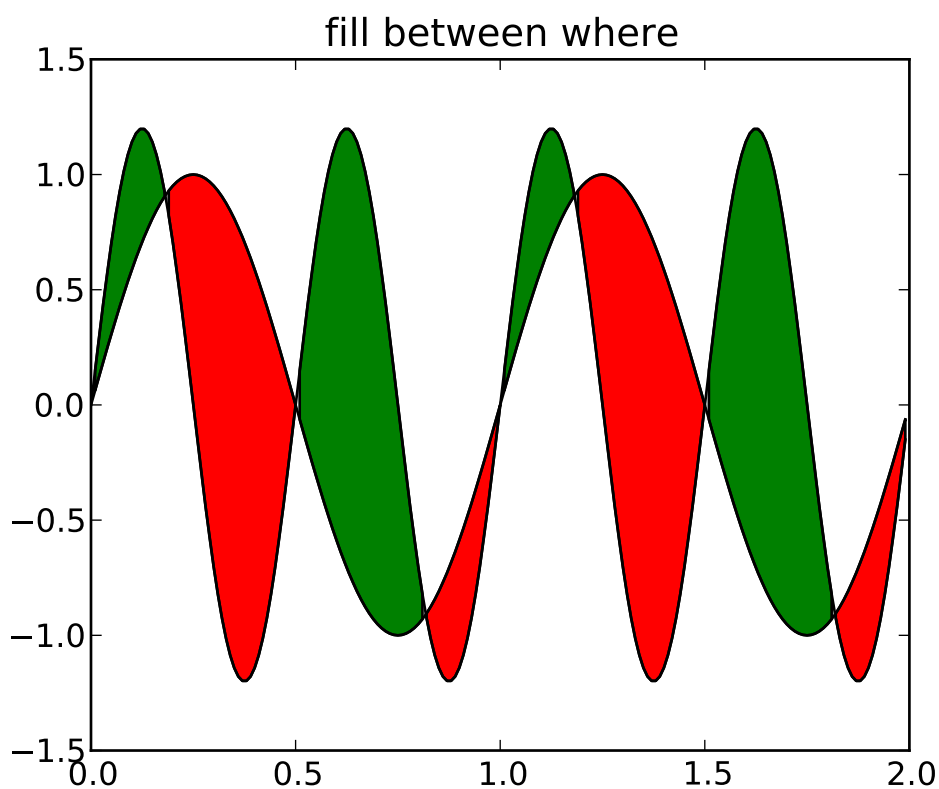
```
> python myfile.py -dmacosx
```

### 19.4.4 psd amplitude scaling

Ryan May did a lot of work to rationalize the amplitude scaling of `psd()` and friends. See *pylab\_examples example code: psd\_demo2.py*. and *pylab\_examples example code: psd\_demo3.py*. The changes should increase MATLAB compatability and increase scaling options.

### 19.4.5 Fill between

Added a `fill_between()` function to make it easier to do shaded region plots in the presence of masked data. You can pass an *x* array and a *ylower* and *yupper* array to fill between, and an optional *where* argument which is a logical mask where you want to do the filling.



### 19.4.6 Lots more

Here are the 0.98.4 notes from the CHANGELOG:

Added mdehoon's native macosx backend from sf patch 2179017 - JDH

Removed the prints in the `set_*style` commands. Return the list of pprinted strings instead - JDH

Some of the changes Michael made to improve the output of the

property tables in the rest docs broke of made difficult to use some of the interactive doc helpers, eg setp and getp. Having all the rest markup in the ipython shell also confused the docstrings. I added a new rc param docstring.harcopy, to format the docstrings differently for hardcopy and other use. Ther ArtistInspector could use a little refactoring now since there is duplication of effort between the rest out put and the non-rest output - JDH

Updated spectral methods (psd, csd, etc.) to scale one-sided densities by a factor of 2 and, optionally, scale all densities by the sampling frequency. This gives better MATLAB compatibility. -RM

Fixed alignment of ticks in colorbars. -MGD

drop the deprecated "new" keyword of np.histogram() for numpy 1.2 or later. -JJL

Fixed a bug in svg backend that new\_figure\_manager() ignores keywords arguments such as figsize, etc. -JJL

Fixed a bug that the handlelength of the new legend class set too short when numpoints=1 -JJL

Added support for data with units (e.g. dates) to Axes.fill\_between. -RM

Added fancybox keyword to legend. Also applied some changes for better look, including baseline adjustment of the multiline texts so that it is center aligned. -JJL

The transmuter classes in the patches.py are reorganized as subclasses of the Style classes. A few more box and arrow styles are added. -JJL

Fixed a bug in the new legend class that didn't allowed a tuple of coordinate vlaues as loc. -JJL

Improve checks for external dependencies, using subprocess (instead of deprecated popen\*) and distutils (for version checking) - DSD

Reimplementaion of the legend which supports baseline alignment, multi-column, and expand mode. - JJL

Fixed histogram autoscaling bug when bins or range are given explicitly (fixes Debian bug 503148) - MM

Added rcParam axes.unicode\_minus which allows plain hypen for minus when False - JDH

Added scatterpoints support in Legend. patch by Erik Tollerud - JJL

Fix crash in log ticking. - MGD

Added static helper method `BrokenHBarCollection.span_where` and `Axes/pyplot` method `fill_between`. See `examples/pylab/fill_between.py` - JDH

Add `x_isdata` and `y_isdata` attributes to `Artist` instances, and use them to determine whether either or both coordinates are used when updating `dataLim`. This is used to fix autoscaling problems that had been triggered by `axhline`, `axhspan`, `axvline`, `axvspan`. - EF

Update the `psd()`, `csd()`, `cohere()`, and `specgram()` methods of `Axes` and the `csd()`, `cohere()`, and `specgram()` functions in `mlab` to be in sync with the changes to `psd()`. In fact, under the hood, these all call the same core to do computations. - RM

Add `'pad_to'` and `'sides'` parameters to `mlab.psd()` to allow controlling of zero padding and returning of negative frequency components, respectively. These are added in a way that does not change the API. - RM

Fix handling of `c` kwarg by `scatter`; generalize `is_string_like` to accept `numpy` and `numpy.ma` string array scalars. - RM and EF

Fix a possible EINTR problem in `dviread`, which might help when saving pdf files from the qt backend. - JKS

Fix bug with zoom to rectangle and twin axes - MGD

Added Jae Joon's fancy arrow, box and annotation enhancements -- see `examples/pylab_examples/annotation_demo2.py`

Autoscaling is now supported with shared axes - EF

Fixed exception in `dviread` that happened with `Minion` - JKS

`set_xlim`, `ylim` now return a copy of the `viewlim` array to avoid modify inplace surprises

Added image thumbnail generating function `matplotlib.image.thumbnail`. See `examples/misc/image_thumbnail.py` - JDH

Applied `scatleg` patch based on ideas and work by Erik Tollerud and Jae-Joon Lee. - MM

Fixed bug in pdf backend: if you pass a file object for output instead of a filename, e.g. in a web app, we now flush the object at the end. - JKS

Add path simplification support to paths with gaps. - EF

Fix problem with AFM files that don't specify the font's full name or family name. - JKS

Added 'scilimits' kwarg to Axes.ticklabel\_format() method, for easy access to the set\_powerlimits method of the major ScalarFormatter. - EF

Experimental new kwarg borderpad to replace pad in legend, based on suggestion by Jae-Joon Lee. - EF

Allow spy to ignore zero values in sparse arrays, based on patch by Tony Yu. Also fixed plot to handle empty data arrays, and fixed handling of markers in figlegend. - EF

Introduce drawstyles for lines. Transparently split linestyles like 'steps--' into drawstyle 'steps' and linestyle '--'. Legends always use drawstyle 'default'. - MM

Fixed quiver and quiverkey bugs (failure to scale properly when resizing) and added additional methods for determining the arrow angles - EF

Fix polar interpolation to handle negative values of theta - MGD

Reorganized cbook and mlab methods related to numerical calculations that have little to do with the goals of those two modules into a separate module numerical\_methods.py Also, added ability to select points and stop point selection with keyboard in ginput and manual contour labeling code. Finally, fixed contour labeling bug. - DMK

Fix backtick in Postscript output. - MGD

[ 2089958 ] Path simplification for vector output backends  
Leverage the simplification code exposed through path\_to\_polygons to simplify certain well-behaved paths in the vector backends (PDF, PS and SVG). "path.simplify" must be set to True in matplotlibrc for this to work. - MGD

Add "filled" kwarg to Path.intersects\_path and Path.intersects\_bbox. - MGD

Changed full arrows slightly to avoid an xpdf rendering problem reported by Friedrich Hagedorn. - JKS

Fix conversion of quadratic to cubic Bezier curves in PDF and PS backends. Patch by Jae-Joon Lee. - JKS

Added 5-point star marker to plot command q- EF

Fix hatching in PS backend - MGD

Fix log with base 2 - MGD



Added support for bilinear interpolation in  
NonUniformImage; patch by Gregory Lielens. - EF

Added support for multiple histograms with data of  
different length - MM

Fix step plots with log scale - MGD

Fix masked arrays with markers in non-Agg backends - MGD

Fix clip\_on kwarg so it actually works correctly - MGD

Fix locale problems in SVG backend - MGD

fix quiver so masked values are not plotted - JSW

improve interactive pan/zoom in qt4 backend on windows - DSD

Fix more bugs in NaN/inf handling. In particular, path  
simplification (which does not handle NaNs or infs) will be turned  
off automatically when infs or NaNs are present. Also masked  
arrays are now converted to arrays with NaNs for consistent  
handling of masks and NaNs - MGD and EF



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## CREDITS

matplotlib was written by John Hunter and is now developed and maintained by a number of [active](#) developers.

Special thanks to those who have made valuable contributions (roughly in order of first contribution by date)

**Jeremy O'Donoghue** wrote the wx backend

**Andrew Straw** provided much of the log scaling architecture, the `fill` command, PIL support for `imshow`, and provided many examples. He also wrote the support for dropped axis spines and the [buildbot](#) unit testing infrastructure which triggers the JPL/James Evans platform specific builds and regression test image comparisons from svn matplotlib across platforms on svn commits.

**Charles Twardy** provided the impetus code for the legend class and has made countless bug reports and suggestions for improvement.

**Gary Ruben** made many enhancements to `errorbar` to support x and y errorbar plots, and added a number of new marker types to plot.

**John Gill** wrote the table class and examples, helped with support for auto-legend placement, and added support for legending scatter plots.

**David Moore** wrote the paint backend (no longer used)

**Todd Miller** supported by [STSCI](#) contributed the TkAgg backend and the `numerix` module, which allows matplotlib to work with either numeric or `numarray`. He also ported image support to the postscript backend, with much pain and suffering.

**Paul Barrett** supported by [STSCI](#) overhauled font management to provide an improved, free-standing, platform independent font manager with a WC3 compliant font finder and cache mechanism and ported truetype and `mathtext` to PS.

**Perry Greenfield** supported by [STSCI](#) overhauled and modernized the goals and priorities page, implemented an improved colormap framework, and has provided many suggestions and a lot of insight to the overall design and organization of matplotlib.

**Jared Wahlstrand** wrote the initial SVG backend.

**Steve Chaplin** served as the GTK maintainer and wrote the Cairo and `GTKCairo` backends.

**Jim Benson** provided the patch to handle vertical `mathttext`.

**Gregory Lielens** provided the FltkAgg backend and several patches for the frontend, including contributions to toolbar2, and support for log ticking with alternate bases and major and minor log ticking.

Darren Dale

did the work to do mathtext exponential labeling for log plots, added improved support for scalar formatting, and did the lions share of the [psfrag](#) LaTeX support for postscript. He has made substantial contributions to extending and maintaining the PS and Qt backends, and wrote the site.cfg and matplotlib.conf build and runtime configuration support. He setup the infrastructure for the sphinx documentation that powers the mpl docs.

**Paul McGuire** provided the pyparsing module on which mathtext relies, and made a number of optimizations to the matplotlib mathtext grammar.

**Fernando Perez** has provided numerous bug reports and patches for cleaning up backend imports and expanding pylab functionality, and provided matplotlib support in the pylab mode for [ipython](#). He also provided the [matshow\(\)](#) command, and wrote TConfig, which is the basis for the experimental traitled mpl configuration.

**Andrew Dalke** of [Dalke Scientific Software](#) contributed the strftime formatting code to handle years earlier than 1900.

**Jochen Voss** served as PS backend maintainer and has contributed several bugfixes.

Nadia Dencheva

supported by [STSCI](#) provided the contouring and contour labeling code.

**Baptiste Carvello** provided the key ideas in a patch for proper shared axes support that underlies ganged plots and multiscale plots.

**Jeffrey Whitaker** at [NOAA](#) wrote the [Basemap](#) toolkit

**Sigve Tjoraand, Ted Drain, James Evans** and colleagues at the [JPL](#) collaborated on the QtAgg backend and sponsored development of a number of features including custom unit types, datetime support, scale free ellipses, broken bar plots and more. The JPL team wrote the unit testing image comparison [infrastructure](#) for regression test image comparisons.

**James Amundson** did the initial work porting the qt backend to qt4

**Eric Firing** has contributed significantly to contouring, masked array, pcolor, image and quiver support, in addition to ongoing support and enhancements in performance, design and code quality in most aspects of matplotlib.

**Daishi Harada** added support for “Dashed Text”. See dashpointlabel.py and [TextWithDash](#).

**Nicolas Young** added support for byte images to imshow, which are more efficient in CPU and memory, and added support for irregularly sampled images.

The [brainvisa](#) Orsay team and **Fernando Perez** added Qt support to [ipython](#) in pylab mode.

**Charlie Moad** contributed work to matplotlib’s Cocoa support and has done a lot of work on the OSX and win32 binary releases.

**Jouni K. Seppänen** wrote the PDF backend and contributed numerous fixes to the code, to tex support and to the get\_sample\_data handler

**Paul Kienzle** improved the picking infrastructure for interactive plots, and with Alex Mont contributed fast rendering code for quadrilateral meshes.

**Michael Droettboom** supported by [STSCI](#) wrote the enhanced mathtext support, implementing Knuth's box layout algorithms, saving to file-like objects across backends, and is responsible for numerous bug-fixes, much better font and unicode support, and feature and performance enhancements across the matplotlib code base. He also rewrote the transformation infrastructure to support custom projections and scales.

**John Porter, Jonathon Taylor and Reinier Heeres** John Porter wrote the mplot3d module for basic 3D plotting in matplotlib, and Jonathon Taylor and Reinier Heeres ported it to the refactored transform trunk.

**Jae-Joon Lee implemented fancy arrows and boxes, rewrote the legend** support to handle multiple columns and fancy text boxes, wrote the axes grid toolkit, and has made numerous contributions to the code and documentation





## **Part II**

# **The Matplotlib FAQ**



# INSTALLATION

## Contents

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## 22.1 Report a compilation problem

See *Report a problem*.

## 22.2 matplotlib compiled fine, but nothing shows up when I use it

The first thing to try is a *clean install* and see if that helps. If not, the best way to test your install is by running a script, rather than working interactively from a python shell or an integrated development environment such as **IDLE** which add additional complexities. Open up a UNIX shell or a DOS command

prompt and cd into a directory containing a minimal example in a file. Something like `simple_plot.py` for example:

```
from pylab import *
plot([1,2,3])
show()
```

and run it with:

```
python simple_plot.py --verbose-helpful
```

This will give you additional information about which backends matplotlib is loading, version information, and more. At this point you might want to make sure you understand matplotlib's [configuration](#) process, governed by the `matplotlibrc` configuration file which contains instructions within and the concept of the matplotlib backend.

If you are still having trouble, see [Report a problem](#).

## 22.3 How to completely remove matplotlib

Occasionally, problems with matplotlib can be solved with a clean installation of the package.

The process for removing an installation of matplotlib depends on how matplotlib was originally installed on your system. Follow the steps below that goes with your original installation method to cleanly remove matplotlib from your system.

### 22.3.1 Easy Install

1. Delete the caches from your *.matplotlib configuration directory*.
2. Run:

```
easy_install -m matplotlib
```

3. Delete any `.egg` files or directories from your *installation directory*.

### 22.3.2 Windows installer

1. Delete the caches from your *.matplotlib configuration directory*.
2. Use *Start* → *Control Panel* to start the **Add and Remove Software** utility.

### 22.3.3 Source install

Unfortunately:

```
python setup.py clean
```

does not properly clean the build directory, and does nothing to the install directory. To cleanly rebuild:

1. Delete the caches from your *.matplotlib configuration directory*.
2. Delete the build directory in the source tree.
3. Delete any matplotlib directories or eggs from your *installation directory*.

## 22.4 How to Install

### 22.4.1 Source install from git

Clone the main source using one of:

```
git clone git@github.com:matplotlib/matplotlib.git
```

or:

```
git clone git://github.com/matplotlib/matplotlib.git
```

and build and install as usual with:

```
> cd matplotlib
> python setup.py install
```

**Note:** If you are on debian/ubuntu, you can get all the dependencies required to build matplotlib with:

```
sudo apt-get build-dep python-matplotlib
```

If you are on Fedora/RedHat, you can get all the dependencies required to build matplotlib by first installing `yum-builddep` and then running:

```
su -c "yum-builddep python-matplotlib"
```

This does not build matplotlib, but it does get all of the build dependencies, which will make building from source easier.

If you want to be able to follow the development branch as it changes just replace the last step with (make sure you have **setuptools** installed):

```
> python setupegg.py develop
```

This creates links in the right places and installs the command line script to the appropriate places.

**Note:** Mac OSX users please see the *Building on OSX* guide.

Then, if you want to update your matplotlib at any time, just do:

```
> git pull
```

When you run *git pull*, if the output shows that only Python files have been updated, you are all set. If C files have changed, you need to run the *python setup.py develop* command again to compile them.

There is more information on *using git* in the developer docs.

## 22.5 Linux Notes

Because most Linux distributions use some sort of package manager, we do not provide a pre-built binary for the Linux platform. Instead, we recommend that you use the “Add Software” method for your system to install matplotlib. This will guarantee that everything that is needed for matplotlib will be installed as well.

If, for some reason, you can not use the package manager, Linux usually comes with at least a basic build system. Follow the *instructions* found above for how to build and install matplotlib.

## 22.6 OS-X Notes

### 22.6.1 Which python for OS X?

Apple ships with its own python, and many users have had trouble with it. There are several alternative versions of python that can be used. If it is feasible, we recommend that you use the *enthought* python distribution *EPD* for OS X (which comes with matplotlib and much more). Also available is *MacPython* or the official OS X version from [python.org](http://python.org).

**Note:** Before installing any of the binary packages, be sure that all of the packages were compiled for the same version of python. Often, the download site for NumPy and matplotlib will display a supposed ‘current’ version of the package, but you may need to choose a different package from the full list that was built for your combination of python and OSX.

### 22.6.2 Installing OSX binaries

If you want to install matplotlib from one of the binary installers we build, you have two choices: a *mpkg* installer, which is a typical *Installer.app*, or a binary OSX egg, which you can install via *setuptools*’ *easy\_install*.

The *mpkg* installer will have a “zip” extension, and will have a name like *matplotlib-0.99.0.rc1-py2.5-macosx10.5\_mpkg.zip*. The name of the installer depends on which versions of python, matplotlib, and OSX it was built for. You need to unzip this file using either the “unzip” command, or simply double clicking on it. Then when you double-click on the resulting *mpkg*, which will have a name like *matplotlib-0.99.0.rc1-py2.5-macosx10.5.mpkg*, it will run the *Installer.app*, prompt you for a password if you need system-wide installation privileges, and install to a directory like */Library/Python/2.5/site-packages/* (exact path depends on your python version). This directory may not be in your python ‘path’ variable, so you should test your installation with:

```
> python -c 'import matplotlib; print matplotlib.__version__, matplotlib.__file__'
```

If you get an error like:

```
Traceback (most recent call last):
  File "<string>", line 1, in <module>
ImportError: No module named matplotlib
```

then you will need to set your PYTHONPATH, eg:

```
export PYTHONPATH=/Library/Python/2.5/site-packages:$PYTHONPATH
```

See also ref:*environment-variables*.

### 22.6.3 easy\_install from egg

You can also use the eggs we build for OSX (see the [installation instructions](#) for easy\_install if you do not have it on your system already). You can try:

```
> easy_install matplotlib
```

which should grab the latest egg from the sourceforge site, but sometimes the naming conventions for OSX eggs can be broken (see below). Therefore, there is no guarantee the right egg will be found. We recommend you download the latest egg from our [download site](#) directly to your harddrive, and manually install it, eg:

```
> easy_install --install-dir=~/.dev/lib/python2.5/site-packages/ matplotlib-0.99.0.rc1-py2.5-macosx-10.
```

### Naming convention issues

**Note:** This should no longer be an issue. If it is, please report it to the mailing list.

Some users have reported problems with the egg for 0.98 from the matplotlib download site, with easy\_install, getting an error:

```
> easy_install ./matplotlib-0.98.0-py2.5-macosx-10.3-fat.egg
Processing matplotlib-0.98.0-py2.5-macosx-10.3-fat.egg
removing '/Library/Python/2.5/site-packages/matplotlib-0.98.0-py2.5-
...snip...
Reading http://matplotlib.sourceforge.net
Reading http://cheeseshop.python.org/pypi/matplotlib/0.91.3
No local packages or download links found for matplotlib==0.98.0
error: Could not find suitable distribution for
Requirement.parse('matplotlib==0.98.0')
```

If you rename `matplotlib-0.98.0-py2.5-macosx-10.3-fat.egg` to `matplotlib-0.98.0-py2.5.egg`, `easy_install` will install it from the disk. Many Mac OS X eggs have cruft at the end of the filename, which prevents their installation through `easy_install`. Renaming is all it takes to install them; still, it's annoying.

## 22.6.4 Building and installing from source on OSX with EPD

If you have the EPD installed (*Which python for OS X?*), it might turn out to be rather tricky to install a new version of matplotlib from source on the Mac OS 10.5. Here's a procedure that seems to work, at least sometimes:

0. Remove the `~/matplotlib` folder (`rm -rf ~/matplotlib`).
1. Edit the file (make a backup before you start, just in case):  
`/Library/Frameworks/Python.framework/Versions/Current/lib/python2.5/config/Makefile`, removing all occurrences of the string `-arch ppc`, changing the line `MACOSX_DEPLOYMENT_TARGET=10.3` to `MACOSX_DEPLOYMENT_TARGET=10.5` and changing the occurrences of `MacOSX10.4u.sdk` into `MacOSX10.5.sdk`
2. In `/Library/Frameworks/Python.framework/Versions/Current/lib/pythonX.Y/site-packages/easy-inst` (where X.Y is the version of Python you are building against) Comment out the line containing the name of the directory in which the previous version of MPL was installed (Looks something like `./matplotlib-0.98.5.2n2-py2.5-macosx-10.3-fat.egg`).
3. Save the following as a shell script, for example `./install-matplotlib-epd-osx.sh`:

```
NAME=matplotlib
VERSION=v1.1.x
PREFIX=$HOME
#branch="release"
branch="master"
git clone git://github.com/matplotlib/matplotlib.git
cd matplotlib
if [ $branch = "release" ]
then
    echo getting the maintenance branch
    git checkout -b $VERSION origin/$VERSION
fi
export CFLAGS="-Os -arch i386"
export LDFLAGS="-Os -arch i386"
export PKG_CONFIG_PATH="/usr/x11/lib/pkgconfig"
export ARCHFLAGS="-arch i386"
python setup.py build
# use --prefix if you don't want it installed in the default location:
python setup.py install --prefix=$PREFIX
cd ..
```

Run this script (for example `sh ./install-matplotlib-epd-osx.sh`) in the directory in which you want the source code to be placed, or simply type the commands in the terminal command line. This script sets some local variable (`CFLAGS`, `LDFLAGS`, `PKG_CONFIG_PATH`, `ARCHFLAGS`), removes previous



installations, checks out the source from github, builds and installs it. The backend should to be set to MacOSX.

## 22.7 Windows Notes

### 22.7.1 Binary installers for Windows

If you have already installed python, you can use one of the matplotlib binary installers for windows – you can get these from the [sourceforge download](#) site. Choose the files that match your version of python (eg py2.5 if you installed Python 2.5) which have the exe extension. If you haven't already installed python, you can get the official version from the [python web site](#).

There are also two packaged distributions of python that come preloaded with matplotlib and many other tools like ipython, numpy, scipy, vtk and user interface toolkits. These packages are quite large because they come with so much, but you get everything with a single click installer.

- The Enthought Python Distribution [EPD](#)
- [python \(x, y\)](#)



# USAGE

## Contents

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  - General Concepts
  - Matplotlib, pylab, and pyplot: how are they related?
  - Coding Styles
  - What is a backend?
  - What is interactive mode?
    - \* Interactive example
    - \* Non-interactive example
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## 23.1 General Concepts

`matplotlib` has an extensive codebase that can be daunting to many new users. However, most of `matplotlib` can be understood with a fairly simple conceptual framework and knowledge of a few important points.

Plotting requires action on a range of levels, from the most general (e.g., ‘contour this 2-D array’) to the most specific (e.g., ‘color this screen pixel red’). The purpose of a plotting package is to assist you in visualizing your data as easily as possible, with all the necessary control – that is, by using relatively high-level commands most of the time, and still have the ability to use the low-level commands when needed.

Therefore, everything in `matplotlib` is organized in a hierarchy. At the top of the hierarchy is the `matplotlib` “state-machine environment” which is provided by the `matplotlib.pyplot` module. At this level, simple functions are used to add plot elements (lines, images, text, etc.) to the current axes in the current figure.

**Note:** Pyplot’s state-machine environment behaves similarly to MATLAB and should be most familiar to users with MATLAB experience.

The next level down in the hierarchy is the first level of the object-oriented interface, in which `pyplot` is used only for a few functions such as figure creation, and the user explicitly creates and keeps track of the figure and axes objects. At this level, the user uses `pyplot` to create figures, and through those figures, one or more axes objects can be created. These axes objects are then used for most plotting actions.

For even more control – which is essential for things like embedding matplotlib plots in GUI applications – the pyplot level may be dropped completely, leaving a purely object-oriented approach.

## 23.2 Matplotlib, pylab, and pyplot: how are they related?

Matplotlib is the whole package; pylab is a module in matplotlib that gets installed alongside `matplotlib`; and `matplotlib.pyplot` is a module in matplotlib.

Pyplot provides the state-machine interface to the underlying plotting library in matplotlib. This means that figures and axes are implicitly and automatically created to achieve the desired plot. For example, calling `plot` from pyplot will automatically create the necessary figure and axes to achieve the desired plot. Setting a title will then automatically set that title to the current axes object:

```
import matplotlib.pyplot as plt

plt.plot(range(10), range(10))
plt.title("Simple Plot")
plt.show()
```

Pylab combines the pyplot functionality (for plotting) with the numpy functionality (for mathematics and for working with arrays) in a single namespace, making that namespace (or environment) even more MATLAB-like. For example, one can call the *sin* and *cos* functions just like you could in MATLAB, as well as having all the features of pyplot.

The pyplot interface is generally preferred for non-interactive plotting (i.e., scripting). The pylab interface is convenient for interactive calculations and plotting, as it minimizes typing. Note that this is what you get if you use the *ipython* shell with the *-pylab* option, which imports everything from pylab and makes plotting fully interactive.

## 23.3 Coding Styles

When viewing this documentation and examples, you will find different coding styles and usage patterns. These styles are perfectly valid and have their pros and cons. Just about all of the examples can be converted into another style and achieve the same results. The only caveat is to avoid mixing the coding styles for your own code.

**Note:** Developers for matplotlib have to follow a specific style and guidelines. See *The Matplotlib Developers' Guide*.

Of the different styles, there are two that are officially supported. Therefore, these are the preferred ways to use matplotlib.

For the preferred pyplot style, the imports at the top of your scripts will typically be:

```
import matplotlib.pyplot as plt
import numpy as np
```

Then one calls, for example, `np.arange`, `np.zeros`, `np.pi`, `plt.figure`, `plt.plot`, `plt.show`, etc. So, a simple example in this style would be:

```
import matplotlib.pyplot as plt
import numpy as np
x = np.arange(0, 10, 0.2)
y = np.sin(x)
plt.plot(x, y)
plt.show()
```

Note that this example used pyplot's state-machine to automatically and implicitly create a figure and an axes. For full control of your plots and more advanced usage, use the pyplot interface for creating figures, and then use the object methods for the rest:

```
import matplotlib.pyplot as plt
import numpy as np
x = np.arange(0, 10, 0.2)
y = np.sin(x)
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(x, y)
plt.show()
```

Next, the same example using a pure MATLAB-style:

```
from pylab import *
x = arange(0, 10, 0.2)
y = sin(x)
plot(x, y)
show()
```

So, why all the extra typing as one moves away from the pure MATLAB-style? For very simple things like this example, the only advantage is academic: the wordier styles are more explicit, more clear as to where things come from and what is going on. For more complicated applications, this explicitness and clarity becomes increasingly valuable, and the richer and more complete object-oriented interface will likely make the program easier to write and maintain.

## 23.4 What is a backend?

A lot of documentation on the website and in the mailing lists refers to the “backend” and many new users are confused by this term. matplotlib targets many different use cases and output formats. Some people use matplotlib interactively from the python shell and have plotting windows pop up when they type commands. Some people embed matplotlib into graphical user interfaces like wxpython or pygtk to build rich applications. Others use matplotlib in batch scripts to generate postscript images from some numerical simulations, and still others in web application servers to dynamically serve up graphs.

To support all of these use cases, matplotlib can target different outputs, and each of these capabilities is called a backend; the “frontend” is the user facing code, ie the plotting code, whereas the “backend” does all the hard work behind-the-scenes to make the figure. There are two types of backends: user interface

backends (for use in pygtk, wxpython, tkinter, qt, macosx, or fltk; also referred to as “interactive backends”) and hardcopy backends to make image files (PNG, SVG, PDF, PS; also referred to as “non-interactive backends”).

There are two primary ways to configure your backend. One is to set the backend parameter in your matplotlibrc file (see [Customizing matplotlib](#)):

```
backend : WXAgg    # use wxpython with antigrain (agg) rendering
```

The other is to use the matplotlib `use()` directive:

```
import matplotlib
matplotlib.use('PS')    # generate postscript output by default
```

If you use the `use` directive, this must be done before importing `matplotlib.pyplot` or `matplotlib.pylab`.

**Note:** Backend name specifications are not case-sensitive; e.g., ‘GTKAgg’ and ‘gtkagg’ are equivalent.

With a typical installation of matplotlib, such as from a binary installer or a linux distribution package, a good default backend will already be set, allowing both interactive work and plotting from scripts, with output to the screen and/or to a file, so at least initially you will not need to use either of the two methods given above.

If, however, you want to write graphical user interfaces, or a web application server ([Matplotlib in a web application server](#)), or need a better understanding of what is going on, read on. To make things a little more customizable for graphical user interfaces, matplotlib separates the concept of the renderer (the thing that actually does the drawing) from the canvas (the place where the drawing goes). The canonical renderer for user interfaces is Agg which uses the [Anti-Grain Geometry](#) C++ library to make a raster (pixel) image of the figure. All of the user interfaces except macosx can be used with agg rendering, eg WXAgg, GTKAgg, QT4Agg, TkAgg. In addition, some of the user interfaces support other rendering engines. For example, with GTK, you can also select GDK rendering (backend GTK) or Cairo rendering (backend GTKCairo).

For the rendering engines, one can also distinguish between [vector](#) or [raster](#) renderers. Vector graphics languages issue drawing commands like “draw a line from this point to this point” and hence are scale free, and raster backends generate a pixel representation of the line whose accuracy depends on a DPI setting.

Here is a summary of the matplotlib renderers (there is an eponymous backed for each; these are *non-interactive backends*, capable of writing to a file):

| Renderer     | Filetypes                 | Description   |
|--------------|---------------------------|---|
| <i>AGG</i>   | <i>png</i>                | <i>raster graphics</i> – high quality images using the <a href="#">Anti-Grain Geometry</a> engine |
| PS           | <i>ps eps</i>             | <i>vector graphics</i> – Postscript output  |
| PDF          | <i>pdf</i>                | <i>vector graphics</i> – Portable Document Format   |
| SVG          | <i>svg</i>                | <i>vector graphics</i> – Scalable Vector Graphics   |
| <i>Cairo</i> | <i>png ps pdf svg ...</i> | <i>vector graphics</i> – Cairo graphics   |
| <i>GDK</i>   | <i>png jpg tiff ...</i>   | <i>raster graphics</i> – the <a href="#">Gimp Drawing Kit</a>                                     |

And here are the user interfaces and renderer combinations supported; these are *interactive backends*, capable of displaying to the screen and of using appropriate renderers from the table above to write to a file:

| Back-end  | Description  |
|-----------|--|
| GTK-Agg   | Agg rendering to a <i>GTK</i> canvas (requires <a href="#">PyGTK</a> )   |
| GTK       | GDK rendering to a <i>GTK</i> canvas (not recommended) (requires <a href="#">PyGTK</a> )   |
| GTK-Cairo | Cairo rendering to a <i>GTK</i> Canvas (requires <a href="#">PyGTK</a> )   |
| WX-Agg    | Agg rendering to a <i>wxWidgets</i> canvas (requires <a href="#">wxPython</a> )  |
| WX        | Native <i>wxWidgets</i> drawing to a <i>wxWidgets</i> Canvas (not recommended) (requires <a href="#">wxPython</a> )                          |
| TkAgg     | Agg rendering to a <i>Tk</i> canvas (requires <a href="#">TkInter</a> )  |
| QtAgg     | Agg rendering to a <i>Qt</i> canvas (requires <a href="#">PyQt</a> ) (not recommended; use Qt4Agg)   |
| Qt4Agg    | Agg rendering to a <i>Qt4</i> canvas (requires <a href="#">PyQt4</a> )   |
| FLTK-Agg  | Agg rendering to a <i>FLTK</i> canvas (requires <a href="#">pyFLTK</a> ) (not widely used; consider TKAgg, GTKAgg, WXAgg, or QT4Agg instead) |
| macosx    | Cocoa rendering in OSX windows (presently lacks blocking <code>show()</code> behavior when matplotlib is in non-interactive mode)            |

## 23.5 What is interactive mode?

Use of an interactive backend (see *What is a backend?*) permits—but does not by itself require or ensure—plotting to the screen. Whether and when plotting to the screen occurs, and whether a script or shell session continues after a plot is drawn on the screen, depends on the functions and methods that are called, and on a state variable that determines whether matplotlib is in “interactive mode”. The default Boolean value is set by the `matplotlibrc` file, and may be customized like any other configuration parameter (see *Customizing matplotlib*). It may also be set via `matplotlib.interactive()`, and its value may be queried via `matplotlib.is_interactive()`. Turning interactive mode on and off in the middle of a stream of plotting commands, whether in a script or in a shell, is rarely needed and potentially confusing, so in the following we will assume all plotting is done with interactive mode either on or off.

**Note:** Major changes related to interactivity, and in particular the role and behavior of `show()`, were made in the transition to matplotlib version 1.0, and bugs were fixed in 1.0.1. Here we describe the version 1.0.1 behavior for the primary interactive backends, with the partial exception of *macosx*.

Interactive mode may also be turned on via `matplotlib.pyplot.ion()`, and turned off via `matplotlib.pyplot.ioff()`.

### 23.5.1 Interactive example

From an ordinary python prompt, or after invoking `ipython` with no options, try this:

```
import matplotlib.pyplot as plt
plt.ion()
plt.plot([1.6, 2.7])
```

Assuming you are running version 1.0.1 or higher, and you have an interactive backend installed and selected by default, you should see a plot, and your terminal prompt should also be active; you can type additional

commands such as:

```
plt.title("interactive test")
plt.xlabel("index")
```

and you will see the plot being updated after each line. This is because you are in interactive mode *and* you are using pyplot functions. Now try an alternative method of modifying the plot. Get a reference to the [Axes](#) instance, and call a method of that instance:

```
ax = plt.gca()
ax.plot([3.1, 2.2])
```

Nothing changed, because the Axes methods do not include an automatic call to `draw_if_interactive()`; that call is added by the pyplot functions. If you are using methods, then when you want to update the plot on the screen, you need to call `draw()`:

```
plt.draw()
```

Now you should see the new line added to the plot.

### 23.5.2 Non-interactive example

Start a fresh session as in the previous example, but now turn interactive mode off:

```
import matplotlib.pyplot as plt
plt.ioff()
plt.plot([1.6, 2.7])
```

Nothing happened—or at least nothing has shown up on the screen (unless you are using *macosx* backend, which is anomalous). To make the plot appear, you need to do this:

```
plt.show()
```

Now you see the plot, but your terminal command line is unresponsive; the `show()` command *blocks* the input of additional commands until you manually kill the plot window.

What good is this—being forced to use a blocking function? Suppose you need a script that plots the contents of a file to the screen. You want to look at that plot, and then end the script. Without some blocking command such as `show()`, the script would flash up the plot and then end immediately, leaving nothing on the screen.

In addition, non-interactive mode delays all drawing until `show()` is called; this is more efficient than re-drawing the plot each time a line in the script adds a new feature.

Prior to version 1.0, `show()` generally could not be called more than once in a single script (although sometimes one could get away with it); for version 1.0.1 and above, this restriction is lifted, so one can write a script like this:



```
import numpy as np
import matplotlib.pyplot as plt
plt.ioff()
for i in range(3):
    plt.plot(np.random.rand(10))
    plt.show()
```

which makes three plots, one at a time.

### 23.5.3 Summary

In interactive mode, pyplot functions automatically draw to the screen.

When plotting interactively, if using object method calls in addition to pyplot functions, then call `draw()` whenever you want to refresh the plot.

Use non-interactive mode in scripts in which you want to generate one or more figures and display them before ending or generating a new set of figures. In that case, use `show()` to display the figure(s) and to block execution until you have manually destroyed them.



# HOW-TO

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## 24.1 Plotting: howto

### 24.1.1 Find all objects in a figure of a certain type

Every matplotlib artist (see [Artist tutorial](#)) has a method called `findobj()` that can be used to recursively search the artist for any artists it may contain that meet some criteria (eg match all `Line2D` instances or match some arbitrary filter function). For example, the following snippet finds every object in the figure which has a `set_color` property and makes the object blue:

```
def myfunc(x):
    return hasattr(x, 'set_color')

for o in fig.findobj(myfunc):
    o.set_color('blue')
```

You can also filter on class instances:

```
import matplotlib.text as text
for o in fig.findobj(text.Text):
    o.set_fontstyle('italic')
```

### 24.1.2 Save transparent figures

The `savefig()` command has a keyword argument *transparent* which, if ‘True’, will make the figure and axes backgrounds transparent when saving, but will not affect the displayed image on the screen.

If you need finer grained control, eg you do not want full transparency or you want to affect the screen displayed version as well, you can set the alpha properties directly. The figure has a `Rectangle` instance called *patch* and the axes has a `Rectangle` instance called *patch*. You can set any property on them directly (*facecolor*, *edgecolor*, *linewidth*, *linestyle*, *alpha*). Eg:

```
fig = plt.figure()
fig.patch.set_alpha(0.5)
ax = fig.add_subplot(111)
ax.patch.set_alpha(0.5)
```

If you need *all* the figure elements to be transparent, there is currently no global alpha setting, but you can set the alpha channel on individual elements, eg:

```
ax.plot(x, y, alpha=0.5)
ax.set_xlabel('volts', alpha=0.5)
```

### 24.1.3 Save multiple plots to one pdf file

Many image file formats can only have one image per file, but some formats support multi-page files. Currently only the pdf backend has support for this. To make a multi-page pdf file, first initialize the file:

```
from matplotlib.backends.backend_pdf import PdfPages
pp = PdfPages('multipage.pdf')
```

You can give the `PdfPages` object to `savefig()`, but you have to specify the format:

```
plt.savefig(pp, format='pdf')
```

An easier way is to call `PdfPages.savefig()`:

```
pp.savefig()
```

Finally, the multipage pdf object has to be closed:

```
pp.close()
```

#### 24.1.4 Move the edge of an axes to make room for tick labels

For subplots, you can control the default spacing on the left, right, bottom, and top as well as the horizontal and vertical spacing between multiple rows and columns using the `matplotlib.figure.Figure.subplots_adjust()` method (in pyplot it is `subplots_adjust()`). For example, to move the bottom of the subplots up to make room for some rotated x tick labels:

```
fig = plt.figure()
fig.subplots_adjust(bottom=0.2)
ax = fig.add_subplot(111)
```

You can control the defaults for these parameters in your `matplotlibrc` file; see [Customizing matplotlib](#). For example, to make the above setting permanent, you would set:

```
figure.subplot.bottom : 0.2    # the bottom of the subplots of the figure
```

The other parameters you can configure are, with their defaults

***left* = 0.125** the left side of the subplots of the figure

***right* = 0.9** the right side of the subplots of the figure

***bottom* = 0.1** the bottom of the subplots of the figure

***top* = 0.9** the top of the subplots of the figure

***wspace* = 0.2** the amount of width reserved for blank space between subplots

***hspace* = 0.2** the amount of height reserved for white space between subplots

If you want additional control, you can create an `Axes` using the `axes()` command (or equivalently the figure `add_axes()` method), which allows you to specify the location explicitly:

```
ax = fig.add_axes([left, bottom, width, height])
```

where all values are in fractional (0 to 1) coordinates. See *pylab\_examples example code: axes\_demo.py* for an example of placing axes manually.

### 24.1.5 Automatically make room for tick labels

**Note:** This is now easier to handle than ever before. Calling `tight_layout()` can fix many common layout issues. See the *Tight Layout guide*.

The information below is kept here in case it is useful for other purposes.

In most use cases, it is enough to simply change the subplots adjust parameters as described in *Move the edge of an axes to make room for tick labels*. But in some cases, you don't know ahead of time what your tick labels will be, or how large they will be (data and labels outside your control may be being fed into your graphing application), and you may need to automatically adjust your subplot parameters based on the size of the tick labels. Any `Text` instance can report its extent in window coordinates (a negative x coordinate is outside the window), but there is a rub.

The `RendererBase` instance, which is used to calculate the text size, is not known until the figure is drawn (`draw()`). After the window is drawn and the text instance knows its renderer, you can call `get_window_extent()`. One way to solve this chicken and egg problem is to wait until the figure is draw by connecting (`mpl_connect()`) to the “on\_draw” signal (`DrawEvent`) and get the window extent there, and then do something with it, eg move the left of the canvas over; see *Event handling and picking*.

Here is an example that gets a bounding box in relative figure coordinates (0..1) of each of the labels and uses it to move the left of the subplots over so that the tick labels fit in the figure

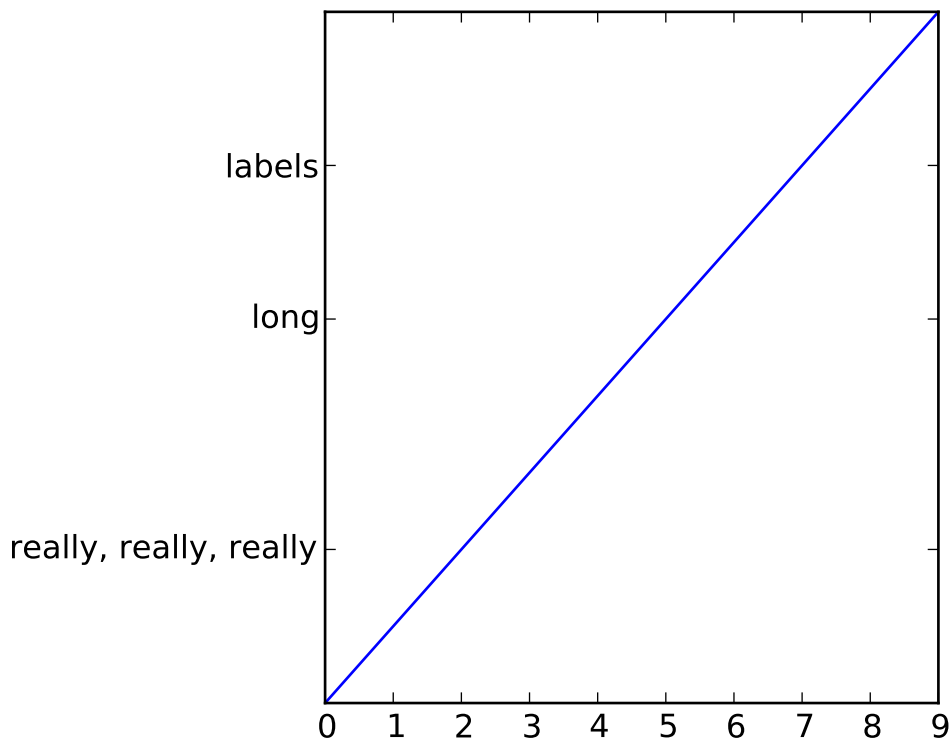
```
import matplotlib.pyplot as plt
import matplotlib.transforms as mtransforms
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(range(10))
ax.set_yticks((2,5,7))
labels = ax.set_yticklabels(('really, really, really', 'long', 'labels'))

def on_draw(event):
    bboxes = []
    for label in labels:
        bbox = label.get_window_extent()
        # the figure transform goes from relative coords->pixels and we
        # want the inverse of that
        bboxi = bbox.inverse_transformed(fig.transFigure)
        bboxes.append(bboxi)

    # this is the bbox that bounds all the bboxes, again in relative
    # figure coords
    bbox = mtransforms.Bbox.union(bboxes)
    if fig.subplotpars.left < bbox.width:
        # we need to move it over
        fig.subplots_adjust(left=1.1*bbox.width) # pad a little
        fig.canvas.draw()
    return False
```

```
fig.canvas.mpl_connect('draw_event', on_draw)

plt.show()
```



### 24.1.6 Configure the tick linewidths

In matplotlib, the ticks are *markers*. All `Line2D` objects support a line (solid, dashed, etc) and a marker (circle, square, tick). The tick linewidth is controlled by the “`markeredgewidth`” property:

```
import matplotlib.pyplot as plt
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(range(10))

for line in ax.get_xticklines() + ax.get_yticklines():
    line.set_markersize(10)

plt.show()
```

The other properties that control the tick marker, and all markers, are `markerfacecolor`, `markeredgewidth`, `markeredgewidth`, `markersize`. For more information on configuring ticks, see [Axis containers](#) and [Tick containers](#).

### 24.1.7 Align my ylabels across multiple subplots

If you have multiple subplots over one another, and the y data have different scales, you can often get ylabels that do not align vertically across the multiple subplots, which can be unattractive. By default, matplotlib positions the x location of the ylabel so that it does not overlap any of the y ticks. You can override this default behavior by specifying the coordinates of the label. The example below shows the default behavior in the left subplots, and the manual setting in the right subplots.

```
import numpy as np
import matplotlib.pyplot as plt

box = dict(facecolor='yellow', pad=5, alpha=0.2)

fig = plt.figure()
fig.subplots_adjust(left=0.2, wspace=0.6)

ax1 = fig.add_subplot(221)
ax1.plot(2000*np.random.rand(10))
ax1.set_title('ylabels not aligned')
ax1.set_ylabel('misaligned 1', bbox=box)
ax1.set_ylim(0, 2000)
ax3 = fig.add_subplot(223)
ax3.set_ylabel('misaligned 2', bbox=box)
ax3.plot(np.random.rand(10))

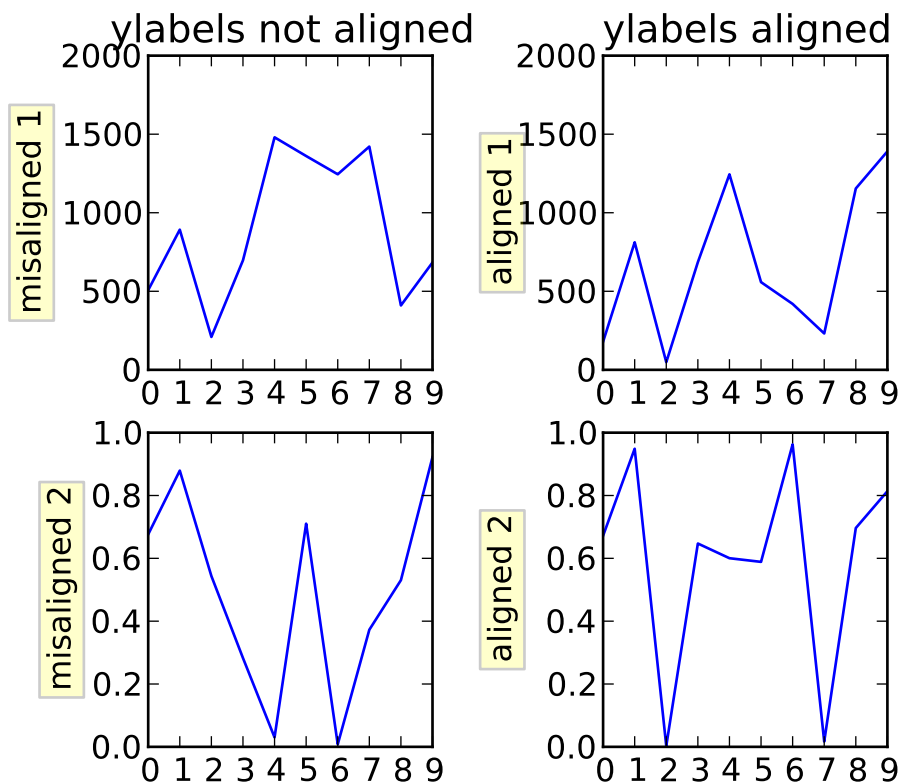
labelx = -0.3 # axes coords

ax2 = fig.add_subplot(222)
ax2.set_title('ylabels aligned')
ax2.plot(2000*np.random.rand(10))
ax2.set_ylabel('aligned 1', bbox=box)
ax2.yaxis.set_label_coords(labelx, 0.5)
ax2.set_ylim(0, 2000)

ax4 = fig.add_subplot(224)
ax4.plot(np.random.rand(10))
ax4.set_ylabel('aligned 2', bbox=box)
ax4.yaxis.set_label_coords(labelx, 0.5)

plt.show()
```





### 24.1.8 Skip dates where there is no data

When plotting time series, eg financial time series, one often wants to leave out days on which there is no data, eg weekends. By passing in dates on the x-axis, you get large horizontal gaps on periods when there is not data. The solution is to pass in some proxy x-data, eg evenly sampled indices, and then use a custom formatter to format these as dates. The example below shows how to use an ‘index formatter’ to achieve the desired plot:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.mlab as mlab
import matplotlib.ticker as ticker

r = mlab.csv2rec('../data/aapl.csv')
r.sort()
r = r[-30:] # get the last 30 days

N = len(r)
ind = np.arange(N) # the evenly spaced plot indices

def format_date(x, pos=None):
    thisind = np.clip(int(x+0.5), 0, N-1)
    return r.date[thisind].strftime('%Y-%m-%d')
```

```
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(ind, r.adj_close, 'o-')
ax.xaxis.set_major_formatter(ticker.FuncFormatter(format_date))
fig.autofmt_xdate()

plt.show()
```

### 24.1.9 Test whether a point is inside a polygon

The `nxutils` provides two high-performance methods: for a single point use `pnpoly()` and for an array of points use `points_inside_poly()`. For a discussion of the implementation see `pnpoly`.

```
In [25]: import numpy as np
```

```
In [26]: import matplotlib.nxutils as nx
```

```
In [27]: verts = np.array([ [0,0], [0, 1], [1, 1], [1,0]], float)
```

```
In [28]: nx.pnpoly( 0.5, 0.5, verts)
```

```
Out[28]: 1
```

```
In [29]: nx.pnpoly( 0.5, 1.5, verts)
```

```
Out[29]: 0
```

```
In [30]: points = np.random.rand(10,2)*2
```

```
In [31]: points
```

```
Out[31]:
```

```
array([[ 1.03597426,  0.61029911],
       [ 1.94061056,  0.65233947],
       [ 1.08593748,  1.16010789],
       [ 0.9255139 ,  1.79098751],
       [ 1.54564936,  1.15604046],
       [ 1.71514397,  1.26147554],
       [ 1.19133536,  0.56787764],
       [ 0.40939549,  0.35190339],
       [ 1.8944715 ,  0.61785408],
       [ 0.03128518,  0.48144145]])
```

```
In [32]: nx.points_inside_poly(points, verts)
```

```
Out[32]: array([False, False, False, False, False, False,  True, False,  True], dtype=bool)
```

### 24.1.10 Control the depth of plot elements

Within an axes, the order that the various lines, markers, text, collections, etc appear is determined by the `set_zorder()` property. The default order is patches, lines, text, with collections of lines and collections of patches appearing at the same level as regular lines and patches, respectively:

```
line, = ax.plot(x, y, zorder=10)
```

You can also use the Axes property `set_axisbelow()` to control whether the grid lines are placed above or below your other plot elements.

### 24.1.11 Make the aspect ratio for plots equal

The Axes property `set_aspect()` controls the aspect ratio of the axes. You can set it to be ‘auto’, ‘equal’, or some ratio which controls the ratio:

```
ax = fig.add_subplot(111, aspect='equal')
```

### 24.1.12 Make a movie

If you want to take an animated plot and turn it into a movie, the best approach is to save a series of image files (eg PNG) and use an external tool to convert them to a movie. You can use `mencoder`, which is part of the `mplayer` suite for this:

```
#fps (frames per second) controls the play speed
mencoder 'mf://*.png' -mf type=png:fps=10 -ovc \\\
    lavc -lavcopts vcodec=wmv2 -oac copy -o animation.avi
```

The swiss army knife of image tools, ImageMagick’s `convert` works for this as well.

Here is a simple example script that saves some PNGs, makes them into a movie, and then cleans up:

```
import os, sys
import matplotlib.pyplot as plt

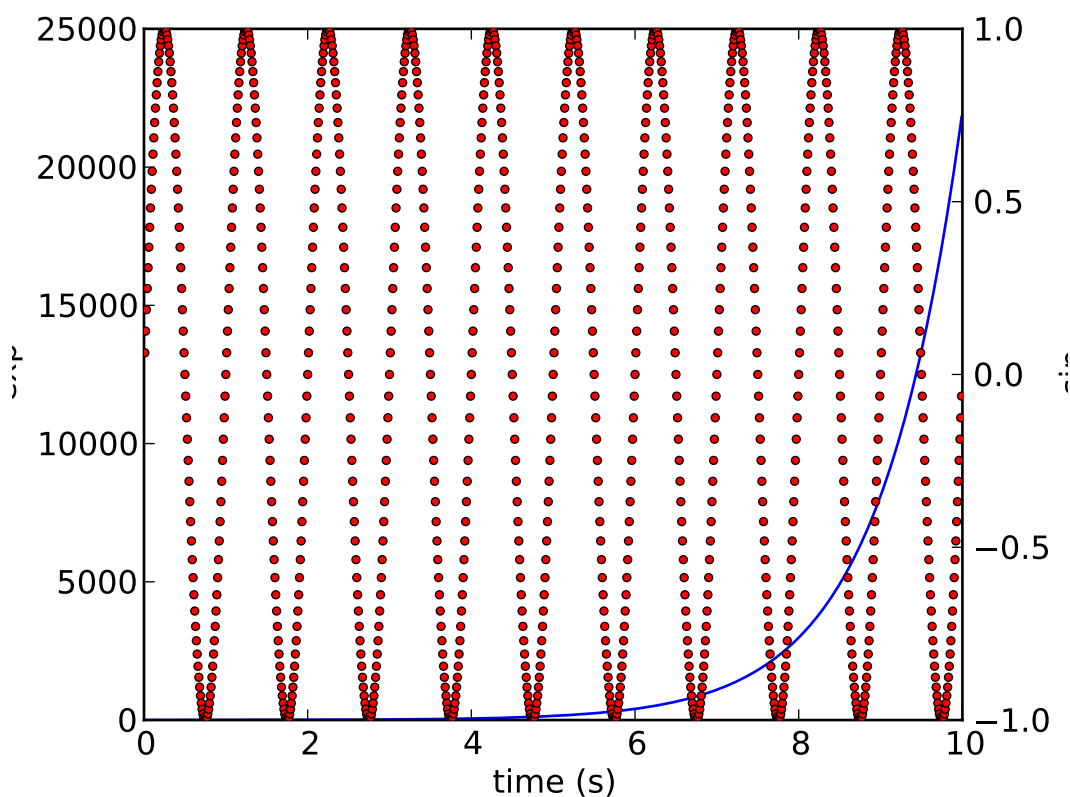
files = []
fig = plt.figure(figsize=(5,5))
ax = fig.add_subplot(111)
for i in range(50): # 50 frames
    ax.cla()
    ax.imshow(rand(5,5), interpolation='nearest')
    fname = '_tmp%03d.png'%i
    print 'Saving frame', fname
    fig.savefig(fname)
    files.append(fname)

print 'Making movie animation.mpg - this make take a while'
os.system("mencoder 'mf://_tmp*.png' -mf type=png:fps=10 \\\
    -ovc lavc -lavcopts vcodec=wmv2 -oac copy -o animation.mpg")
```

### 24.1.13 Multiple y-axis scales

A frequent request is to have two scales for the left and right y-axis, which is possible using `twinx()` (more than two scales are not currently supported, though it is on the wish list). This works pretty well, though there are some quirks when you are trying to interactively pan and zoom, because both scales do not get the signals.

The approach uses `twinx()` (and its sister `twinx()`) to use 2 *different axes*, turning the axes rectangular frame off on the 2nd axes to keep it from obscuring the first, and manually setting the tick locs and labels as desired. You can use separate `matplotlib.ticker` formatters and locators as desired because the two axes are independent.



### 24.1.14 Generate images without having a window appear

The easiest way to do this is use a non-interactive backend (see *What is a backend?*) such as Agg (for PNGs), PDF, SVG or PS. In your figure-generating script, just call the `matplotlib.use()` directive before importing pylab or pyplot:

```
import matplotlib
matplotlib.use('Agg')
import matplotlib.pyplot as plt
plt.plot([1,2,3])
plt.savefig('myfig')
```

**See Also:**

*Matplotlib in a web application server* for information about running matplotlib inside of a web application.

**24.1.15 Use `show()`**

When you want to view your plots on your display, the user interface backend will need to start the GUI mainloop. This is what `show()` does. It tells matplotlib to raise all of the figure windows created so far and start the mainloop. Because this mainloop is blocking by default (i.e., script execution is paused), you should only call this once per script, at the end. Script execution is resumed after the last window is closed. Therefore, if you are using matplotlib to generate only images and do not want a user interface window, you do not need to call `show` (see *Generate images without having a window appear* and *What is a backend?*).

**Note:** Because closing a figure window invokes the destruction of its plotting elements, you should call `savefig()` before calling `show` if you wish to save the figure as well as view it. New in version v1.0.0: `show` now starts the GUI mainloop only if it isn't already running. Therefore, multiple calls to `show` are now allowed. Having `show` block further execution of the script or the python interpreter depends on whether matplotlib is set for interactive mode or not. In non-interactive mode (the default setting), execution is paused until the last figure window is closed. In interactive mode, the execution is not paused, which allows you to create additional figures (but the script won't finish until the last figure window is closed).

**Note:** Support for interactive/non-interactive mode depends upon the backend. Until version 1.0.0 (and subsequent fixes for 1.0.1), the behavior of the interactive mode was not consistent across backends. As of v1.0.1, only the macosx backend differs from other backends because it does not support non-interactive mode.

Because it is expensive to draw, you typically will not want matplotlib to redraw a figure many times in a script such as the following:

```
plot([1,2,3])           # draw here ?
xlabel('time')          # and here ?
ylabel('volts')         # and here ?
title('a simple plot')  # and here ?
show()
```

However, it is *possible* to force matplotlib to draw after every command, which might be what you want when working interactively at the python console (see *Using matplotlib in a python shell*), but in a script you want to defer all drawing until the call to `show`. This is especially important for complex figures that take some time to draw. `show()` is designed to tell matplotlib that you're all done issuing commands and you want to draw the figure now.

**Note:** `show()` should typically only be called at most once per script and it should be the last line of your script. At that point, the GUI takes control of the interpreter. If you want to force a figure draw, use `draw()` instead.

Many users are frustrated by `show` because they want it to be a blocking call that raises the figure, pauses the script until they close the figure, and then allow the script to continue running until the next figure is created and the next `show` is made. Something like this:

```
# WARNING : illustrating how NOT to use show
for i in range(10):
    # make figure i
    show()
```

This is not what `show` does and unfortunately, because doing blocking calls across user interfaces can be tricky, is currently unsupported, though we have made significant progress towards supporting blocking events. New in version v1.0.0: As noted earlier, this restriction has been relaxed to allow multiple calls to `show`. In *most* backends, you can now expect to be able to create new figures and raise them in a subsequent call to `show` after closing the figures from a previous call to `show`.

## 24.2 Contributing: howto

### 24.2.1 Submit a patch

See *Making patches* for information on how to make a patch with git.

If you are posting a patch to fix a code bug, please explain your patch in words – what was broken before and how you fixed it. Also, even if your patch is particularly simple, just a few lines or a single function replacement, we encourage people to submit git diffs against HEAD of the branch they are patching. It just makes life easier for us, since we (fortunately) get a lot of contributions, and want to receive them in a standard format. If possible, for any non-trivial change, please include a complete, free-standing example that the developers can run unmodified which shows the undesired behavior pre-patch and the desired behavior post-patch, with a clear verbal description of what to look for. A developer may have written the function you are working on years ago, and may no longer be with the project, so it is quite possible you are the world expert on the code you are patching and we want to hear as much detail as you can offer.

When emailing your patch and examples, feel free to paste any code into the text of the message, indeed we encourage it, but also attach the patches and examples since many email clients screw up the formatting of plain text, and we spend lots of needless time trying to reformat the code to make it usable.

You should check out the guide to developing matplotlib to make sure your patch abides by our coding conventions *The Matplotlib Developers' Guide*.

### 24.2.2 Contribute to matplotlib documentation

matplotlib is a big library, which is used in many ways, and the documentation has only scratched the surface of everything it can do. So far, the place most people have learned all these features are through studying the examples (*Search examples*), which is a recommended and great way to learn, but it would be nice to have more official narrative documentation guiding people through all the dark corners. This is where you come in.

There is a good chance you know more about matplotlib usage in some areas, the stuff you do every day, than many of the core developers who wrote most of the documentation. Just pulled your hair out compiling matplotlib for windows? Write a FAQ or a section for the *Installation* page. Are you a digital signal processing wizard? Write a tutorial on the signal analysis plotting functions like `xcorr()`, `psd()` and `specgram()`. Do you use matplotlib with *django* or other popular web application servers? Write a FAQ or

tutorial and we'll find a place for it in the *User's Guide*. Bundle matplotlib in a `py2exe` app? ... I think you get the idea.

matplotlib is documented using the `sphinx` extensions to restructured text (`ReST`). `sphinx` is an extensible python framework for documentation projects which generates HTML and PDF, and is pretty easy to write; you can see the source for this document or any page on this site by clicking on the *Show Source* link at the end of the page in the sidebar (or here for this document).

The `sphinx` website is a good resource for learning `sphinx`, but we have put together a cheat-sheet at *Documenting matplotlib* which shows you how to get started, and outlines the matplotlib conventions and extensions, eg for including plots directly from external code in your documents.

Once your documentation contributions are working (and hopefully tested by actually *building* the docs) you can submit them as a patch against git. See *Install git* and *Submit a patch*. Looking for something to do? Search for TODO.

## 24.3 Matplotlib in a web application server

Many users report initial problems trying to use matplotlib in web application servers, because by default matplotlib ships configured to work with a graphical user interface which may require an X11 connection. Since many barebones application servers do not have X11 enabled, you may get errors if you don't configure matplotlib for use in these environments. Most importantly, you need to decide what kinds of images you want to generate (PNG, PDF, SVG) and configure the appropriate default backend. For 99% of users, this will be the Agg backend, which uses the C++ `antigrain` rendering engine to make nice PNGs. The Agg backend is also configured to recognize requests to generate other output formats (PDF, PS, EPS, SVG). The easiest way to configure matplotlib to use Agg is to call:

```
# do this before importing pylab or pyplot
import matplotlib
matplotlib.use('Agg')
import matplotlib.pyplot as plt
```

For more on configuring your backend, see *What is a backend?*.

Alternatively, you can avoid `pylab`/`pyplot` altogether, which will give you a little more control, by calling the API directly as shown in *api example code: agg\_oo.py*.

You can either generate hardcopy on the filesystem by calling `savefig`:

```
# do this before importing pylab or pyplot
import matplotlib
matplotlib.use('Agg')
import matplotlib.pyplot as plt
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot([1,2,3])
fig.savefig('test.png')
```

or by saving to a file handle:

```
import sys
fig.savefig(sys.stdout)
```

Here is an example using the Python Imaging Library (PIL). First, the figure is saved to a StringIO object which is then fed to PIL for further processing:

```
import StringIO, Image
imgdata = StringIO.StringIO()
fig.savefig(imgdata, format='png')
imgdata.seek(0) # rewind the data
im = Image.open(imgdata)
```

### 24.3.1 matplotlib with apache

TODO; see *Contribute to matplotlib documentation*.

### 24.3.2 matplotlib with django

TODO; see *Contribute to matplotlib documentation*.

### 24.3.3 matplotlib with zope

TODO; see *Contribute to matplotlib documentation*.

### 24.3.4 Clickable images for HTML

Andrew Dalke of [Dalke Scientific](#) has written a nice [article](#) on how to make html click maps with matplotlib agg PNGs. We would also like to add this functionality to SVG and add a SWF backend to support these kind of images. If you are interested in contributing to these efforts that would be great.

## 24.4 Search examples

The nearly 300 code *Matplotlib Examples* included with the matplotlib source distribution are full-text searchable from the *Search Page* page, but sometimes when you search, you get a lot of results from the *The Matplotlib API* or other documentation that you may not be interested in if you just want to find a complete, free-standing, working piece of example code. To facilitate example searches, we have tagged every code example page with the keyword *codex* for *code example* which shouldn't appear anywhere else on this site except in the FAQ. So if you want to search for an example that uses an ellipse, *Search Page* for *codex ellipse*.



## 24.5 Cite Matplotlib

If you want to refer to matplotlib in a publication, you can use “Matplotlib: A 2D Graphics Environment” by J. D. Hunter In Computing in Science & Engineering, Vol. 9, No. 3. (2007), pp. 90-95 (see [citeulike](#)):

```
@article{Hunter:2007,
  Address = {10662 LOS VAQUEROS CIRCLE, PO BOX 3014, LOS ALAMITOS, CA 90720-1314 USA},
  Author = {Hunter, John D.},
  Date-Added = {2010-09-23 12:22:10 -0700},
  Date-Modified = {2010-09-23 12:22:10 -0700},
  Isi = {000245668100019},
  Isi-Recid = {155389429},
  Journal = {Computing In Science \& Engineering},
  Month = {May-Jun},
  Number = {3},
  Pages = {90--95},
  Publisher = {IEEE COMPUTER SOC},
  Times-Cited = {21},
  Title = {Matplotlib: A 2D graphics environment},
  Type = {Editorial Material},
  Volume = {9},
  Year = {2007},
  Abstract = {Matplotlib is a 2D graphics package used for Python for application
              development, interactive scripting, and publication-quality image
              generation across user interfaces and operating systems.},
  BdsK-Url-1 = {http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&
```



# TROUBLESHOOTING

## Contents

- Troubleshooting
  - Obtaining matplotlib version
  - matplotlib install location
  - .matplotlib directory location
  - Report a problem
  - Problems with recent git versions

## 25.1 Obtaining matplotlib version

To find out your matplotlib version number, import it and print the `__version__` attribute:

```
>>> import matplotlib
>>> matplotlib.__version__
'0.98.0'
```

## 25.2 matplotlib install location

You can find what directory matplotlib is installed in by importing it and printing the `__file__` attribute:

```
>>> import matplotlib
>>> matplotlib.__file__
'/home/jdhunter/dev/lib64/python2.5/site-packages/matplotlib/__init__.pyc'
```

## 25.3 .matplotlib directory location

Each user has a `.matplotlib/` directory which may contain a `matplotlibrc` file and various caches to improve matplotlib's performance. To locate your `.matplotlib/` directory, use `matplotlib.get_configdir()`:

```
>>> import matplotlib as mpl
>>> mpl.get_configdir()
'/home/darren/.matplotlib'
```

On unix-like systems, this directory is generally located in your **HOME** directory. On windows, it is in your documents and settings directory by default:

```
>>> import matplotlib
>>> mpl.get_configdir()
'C:\\Documents and Settings\\jdhunter\\.matplotlib'
```

If you would like to use a different configuration directory, you can do so by specifying the location in your **MPLCONFIGDIR** environment variable – see *Setting environment variables in Linux and OS-X*.

## 25.4 Report a problem

If you are having a problem with matplotlib, search the mailing lists first: there's a good chance someone else has already run into your problem.

If not, please provide the following information in your e-mail to the [mailing list](#):

- your operating system; (Linux/UNIX users: post the output of `uname -a`)
- matplotlib version:

```
python -c 'import matplotlib; print matplotlib.__version__'
```

- where you obtained matplotlib (e.g. your Linux distribution's packages or the matplotlib Sourceforge site, or the enthought python distribution [EPD](#)).
- any customizations to your `matplotlibrc` file (see *Customizing matplotlib*).
- if the problem is reproducible, please try to provide a *minimal*, standalone Python script that demonstrates the problem. This is *the* critical step. If you can't post a piece of code that we can run and reproduce your error, the chances of getting help are significantly diminished. Very often, the mere act of trying to minimize your code to the smallest bit that produces the error will help you find a bug in *your* code that is causing the problem.
- you can get very helpful debugging output from matplotlib by running your script with a `verbose-helpful` or `--verbose-debug` flags and posting the verbose output the lists:

```
> python simple_plot.py --verbose-helpful > output.txt
```

If you compiled matplotlib yourself, please also provide

- any changes you have made to `setup.py` or `setuptools.py`
- the output of:

```
rm -rf build
python setup.py build
```

The beginning of the build output contains lots of details about your platform that are useful for the matplotlib developers to diagnose your problem.

- your compiler version – eg, `gcc --version`

Including this information in your first e-mail to the mailing list will save a lot of time.

You will likely get a faster response writing to the mailing list than filing a bug in the bug tracker. Most developers check the bug tracker only periodically. If your problem has been determined to be a bug and can not be quickly solved, you may be asked to file a bug in the tracker so the issue doesn't get lost.

## 25.5 Problems with recent git versions

First make sure you have a clean build and install (see [How to completely remove matplotlib](#)), get the latest git update, install it and run a simple test script in debug mode:

```
rm -rf build
rm -rf /path/to/site-packages/matplotlib*
git pull
python setup.py install > build.out
python examples/pylab_examples/simple_plot.py --verbose-debug > run.out
```

and post `build.out` and `run.out` to the [matplotlib-devel](#) mailing list (please do not post git problems to the [users list](#)).

Of course, you will want to clearly describe your problem, what you are expecting and what you are getting, but often a clean build and install will help. See also [Report a problem](#).



# ENVIRONMENT VARIABLES

## Contents

- Environment Variables
  - Setting environment variables in Linux and OS-X
    - \* BASH/KSH
    - \* CSH/TCSH
  - Setting environment variables in windows

## HOME

The user's home directory. On linux, `~` is shorthand for **HOME**.

## PATH

The list of directories searched to find executable programs

## PYTHONPATH

The list of directories that is added to Python's standard search list when importing packages and modules

## MPLCONFIGDIR

This is the directory used to store user customizations to matplotlib, as well as some caches to improve performance. If **MPLCONFIGDIR** is not defined, `HOME/.matplotlib` is used by default.

## 26.1 Setting environment variables in Linux and OS-X

To list the current value of **PYTHONPATH**, which may be empty, try:

```
echo $PYTHONPATH
```

The procedure for setting environment variables in depends on what your default shell is. **BASH** seems to be the most common, but **CSH** is also common. You should be able to determine which by running at the command prompt:

```
echo $SHELL
```

### 26.1.1 BASH/KSH

To create a new environment variable:

```
export PYTHONPATH=~/.Python
```

To prepend to an existing environment variable:

```
export PATH=~/.bin:${PATH}
```

The search order may be important to you, do you want `~/bin` to be searched first or last? To append to an existing environment variable:

```
export PATH=${PATH}:~/bin
```

To make your changes available in the future, add the commands to your `~/ .bashrc` file.

### 26.1.2 CSH/TCSH

To create a new environment variable:

```
setenv PYTHONPATH ~/.Python
```

To prepend to an existing environment variable:

```
setenv PATH ~/.bin:${PATH}
```

The search order may be important to you, do you want `~/bin` to be searched first or last? To append to an existing environment variable:

```
setenv PATH ${PATH}:~/bin
```

To make your changes available in the future, add the commands to your `~/ .cshrc` file.

## 26.2 Setting environment variables in windows

Open the **Control Panel** (*Start → Control Panel*), start the **System** program. Click the **Advanced** tab and select the **Environment Variables** button. You can edit or add to the **User Variables**.



## **Part III**

# **The Matplotlib Developers' Guide**



# CODING GUIDE

## 27.1 Committing changes

When committing changes to matplotlib, there are a few things to bear in mind.

- if your changes are non-trivial, please make an entry in the `CHANGELOG`
- if you change the API, please document it in `doc/api/api_changes.rst`, and consider posting to [matplotlib-devel](#)
- Are your changes python2.4 compatible? We still support 2.4, so avoid features new to 2.5
- Can you pass `examples/tests/backend_driver.py`? This is our poor man's unit test.
- Can you add a test to `lib/matplotlib/tests` to test your changes?
- If you have altered extension code, do you pass `unit/memleak_hawaii3.py`?
- if you have added new files or directories, or reorganized existing ones, are the new files included in the match patterns in `MANIFEST.in`. This file determines what goes into the source distribution of the mpl build.
- Keep the maintenance branches and master in sync where it makes sense.

## 27.2 Style guide

### 27.2.1 Importing and name spaces

For `numpy`, use:

```
import numpy as np
a = np.array([1,2,3])
```

For masked arrays, use:

```
import numpy.ma as ma
```

For matplotlib main module, use:

```
import matplotlib as mpl
mpl.rcParams['xtick.major.pad'] = 6
```

For matplotlib modules (or any other modules), use:

```
import matplotlib.cbook as cbook

if cbook.iterable(z):
    pass
```

We prefer this over the equivalent `from matplotlib import cbook` because the latter is ambiguous as to whether `cbook` is a module or a function. The former makes it explicit that you are importing a module or package. There are some modules with names that match commonly used local variable names, eg `matplotlib.lines` or `matplotlib.colors`. To avoid the clash, use the prefix ‘m’ with the `import` `some.thing` as `mthing` syntax, eg:

```
import matplotlib.lines as mlines
import matplotlib.transforms as transforms # OK
import matplotlib.transforms as mtransforms # OK, if you want to disambiguate
import matplotlib.transforms as mtrans    # OK, if you want to abbreviate
```

## 27.2.2 Naming, spacing, and formatting conventions

In general, we want to hew as closely as possible to the standard coding guidelines for python written by Guido in [PEP 0008](#), though we do not do this throughout.

- functions and class methods: lower or lower\_underscore\_separated
- attributes and variables: lower or lowerUpper
- classes: Upper or MixedCase

Prefer the shortest names that are still readable.

Configure your editor to use spaces, not hard tabs. The standard indentation unit is always four spaces; if there is a file with tabs or a different number of spaces it is a bug – please fix it. To detect and fix these and other whitespace errors (see below), use [reindent.py](#) as a command-line script. Unless you are sure your editor always does the right thing, please use `reindent.py` before committing your changes in git.

Keep docstrings uniformly indented as in the example below, with nothing to the left of the triple quotes. The `matplotlib.cbook.dedent()` function is needed to remove excess indentation only if something will be interpolated into the docstring, again as in the example below.

Limit line length to 80 characters. If a logical line needs to be longer, use parentheses to break it; do not use an escaped newline. It may be preferable to use a temporary variable to replace a single long line with two shorter and more readable lines.

Please do not commit lines with trailing white space, as it causes noise in git diffs. Tell your editor to strip whitespace from line ends when saving a file. If you are an emacs user, the following in your `.emacs` will cause emacs to strip trailing white space upon saving for python, C and C++:

```
; and similarly for c++-mode-hook and c-mode-hook
(add-hook 'python-mode-hook
  (lambda ()
    (add-hook 'write-file-functions 'delete-trailing-whitespace)))
```

for older versions of emacs (emacs<22) you need to do:

```
(add-hook 'python-mode-hook
  (lambda ()
    (add-hook 'local-write-file-hooks 'delete-trailing-whitespace)))
```

### 27.2.3 Keyword argument processing

Matplotlib makes extensive use of `**kwargs` for pass-through customizations from one function to another. A typical example is in `matplotlib.pyplot.text()`. The definition of the `pylab` `text` function is a simple pass-through to `matplotlib.axes.Axes.text()`:

```
# in pylab.py
def text(*args, **kwargs):
    ret = gca().text(*args, **kwargs)
    draw_if_interactive()
    return ret
```

`text()` in simplified form looks like this, i.e., it just passes all `args` and `kwargs` on to `matplotlib.text.Text.__init__()`:

```
# in axes.py
def text(self, x, y, s, fontdict=None, withdash=False, **kwargs):
    t = Text(x=x, y=y, text=s, **kwargs)
```

and `__init__()` (again with liberties for illustration) just passes them on to the `matplotlib.artist.Artist.update()` method:

```
# in text.py
def __init__(self, x=0, y=0, text='', **kwargs):
    Artist.__init__(self)
    self.update(kwargs)
```

`update` does the work looking for methods named like `set_property` if `property` is a keyword argument. I.e., no one looks at the keywords, they just get passed through the API to the artist constructor which looks for suitably named methods and calls them with the value.

As a general rule, the use of `**kwargs` should be reserved for pass-through keyword arguments, as in the example above. If all the keyword args are to be used in the function, and not passed on, use the key/value keyword args in the function definition rather than the `**kwargs` idiom.

In some cases, you may want to consume some keys in the local function, and let others pass through. You can `pop` the ones to be used locally and pass on the rest. For example, in `plot()`, `scalex` and `scaley` are local arguments and the rest are passed on as `Line2D()` keyword arguments:

```
# in axes.py
def plot(self, *args, **kwargs):
    scalex = kwargs.pop('scalex', True)
    scaley = kwargs.pop('scaley', True)
    if not self._hold: self.cla()
    lines = []
    for line in self._get_lines(*args, **kwargs):
        self.add_line(line)
        lines.append(line)
```

Note: there is a use case when `kwargs` are meant to be used locally in the function (not passed on), but you still need the `**kwargs` idiom. That is when you want to use `*args` to allow variable numbers of non-keyword args. In this case, python will not allow you to use named keyword args after the `*args` usage, so you will be forced to use `**kwargs`. An example is `matplotlib.contour.ContourLabeler.clabel()`:

```
# in contour.py
def clabel(self, *args, **kwargs):
    fontsize = kwargs.get('fontsize', None)
    inline = kwargs.get('inline', 1)
    self.fmt = kwargs.get('fmt', '%1.3f')
    colors = kwargs.get('colors', None)
    if len(args) == 0:
        levels = self.levels
        indices = range(len(self.levels))
    elif len(args) == 1:
        ...etc...
```

## 27.3 Documentation and docstrings

Matplotlib uses artist introspection of docstrings to support properties. All properties that you want to support through `setp` and `getp` should have a `set_property` and `get_property` method in the `Artist` class. Yes, this is not ideal given python properties or enthought traits, but it is a historical legacy for now. The setter methods use the docstring with the `ACCEPTS` token to indicate the type of argument the method accepts. Eg. in `matplotlib.lines.Line2D`:

```
# in lines.py
def set_linestyle(self, linestyle):
    """
    Set the linestyle of the line

    ACCEPTS: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' | ' ' | '' ]
    """
```

Since matplotlib uses a lot of pass-through `kwargs`, eg. in every function that creates a line (`plot()`, `semilogx()`, `semilogy()`, etc...), it can be difficult for the new user to know which `kwargs` are supported. Matplotlib uses a docstring interpolation scheme to support documentation of every function that takes a `**kwargs`. The requirements are:

1. single point of configuration so changes to the properties don't require multiple docstring edits.

2. as automated as possible so that as properties change, the docs are updated automatically.

The functions `matplotlib.artist.kwdocd` and `matplotlib.artist.kwdoc()` to facilitate this. They combine python string interpolation in the docstring with the matplotlib artist introspection facility that underlies `setp` and `getp`. The `kwdocd` is a single dictionary that maps class name to a docstring of kwargs. Here is an example from `matplotlib.lines`:

```
# in lines.py
artist.kwdocd['Line2D'] = artist.kwdoc(Line2D)
```

Then in any function accepting `Line2D` pass-through kwargs, eg. `matplotlib.axes.Axes.plot()`:

```
# in axes.py
def plot(self, *args, **kwargs):
    """
    Some stuff omitted

    The kwargs are Line2D properties:
    %(Line2D)s

    kwargs scalex and scaley, if defined, are passed on
    to autoscale_view to determine whether the x and y axes are
    autoscaled; default True. See Axes.autoscale_view for more
    information
    """
    pass
plot.__doc__ = cbook.dedent(plot.__doc__) % artist.kwdocd
```

Note there is a problem for `Artist __init__` methods, eg. `matplotlib.patches.Patch.__init__()`, which supports `Patch` kwargs, since the artist inspector cannot work until the class is fully defined and we can't modify the `Patch.__init__.__doc__` docstring outside the class definition. There are some manual hacks in this case, violating the “single entry point” requirement above – see the `artist.kwdocd['Patch']` setting in `matplotlib.patches`.

## 27.4 Developing a new backend

If you are working on a custom backend, the `backend` setting in `matplotlibrc` (*Customizing matplotlib*) supports an external backend via the module directive. if `my_backend.py` is a matplotlib backend in your `PYTHONPATH`, you can set use it on one of several ways

- in `matplotlibrc`:

```
backend : module://my_backend
```

- with the use directive in your script:

```
import matplotlib
matplotlib.use('module://my_backend')
```

- from the command shell with the `-d` flag:

```
> python simple_plot.py -d module://my_backend
```

## 27.5 Writing examples

We have hundreds of examples in subdirectories of file:*matplotlib/examples*, and these are automatically generated when the website is built to show up both in the [examples](#) and [gallery](#) sections of the website. Many people find these examples from the website, and do not have ready access to the file:*examples* directory in which they reside. Thus any example data that is required for the example should be added to the [sample\\_data](#) git repository. Then in your example code you can load it into a file handle with:

```
import matplotlib.cbook as cbook
fh = cbook.get_sample_data('mydata.dat')
```

The file will be fetched from the git repo using `urllib` and updated when the revision number changes.

If you prefer just to get the full path to the file instead of a file object:

```
import matplotlib.cbook as cbook
datafile = cbook.get_sample_data('mydata.dat', asfileobj=False)
print 'datafile', datafile
```

## 27.6 Testing

Matplotlib has a testing infrastructure based on [nose](#), making it easy to write new tests. The tests are in `matplotlib.tests`, and customizations to the nose testing infrastructure are in `matplotlib.testing`. (There is other old testing cruft around, please ignore it while we consolidate our testing to these locations.)

### 27.6.1 Requirements

The following software is required to run the tests:

- [nose](#), version 0.11.1 or later
- [Python Imaging Library](#) (to compare image results)
- [Ghostscript](#) (to render PDF files)
- [Inkscape](#) (to render SVG files)

### 27.6.2 Running the tests

Running the tests is simple. Make sure you have nose installed and run the script `tests.py` in the root directory of the distribution. The script can take any of the usual [nosetest arguments](#), such as



|                              |  |
|------------------------------|--|
| <code>-v</code>              | increase verbosity                     |
| <code>-d</code>              | detailed error messages                |
| <code>--with-coverage</code> | enable collecting coverage information |

To run a single test from the command line, you can provide a dot-separated path to the module followed by the function separated by a colon, eg. (this is assuming the test is installed):

```
python tests.py matplotlib.tests.test_simplification:test_clipping
```

An alternative implementation that does not look at command line arguments works from within Python:

```
import matplotlib
matplotlib.test()
```

### 27.6.3 Writing a simple test

Many elements of Matplotlib can be tested using standard tests. For example, here is a test from `matplotlib.tests.test_basic`:

```
from nose.tools import assert_equal

def test_simple():
    '''very simple example test'''
    assert_equal(1+1,2)
```

Nose determines which functions are tests by searching for functions beginning with “test” in their name.

### 27.6.4 Writing an image comparison test

Writing an image based test is only slightly more difficult than a simple test. The main consideration is that you must specify the “baseline”, or expected, images in the `image_comparison()` decorator. For example, this test generates a single image and automatically tests it:

```
import numpy as np
import matplotlib
from matplotlib.testing.decorators import image_comparison
import matplotlib.pyplot as plt

@image_comparison(baseline_images=['spines_axes_positions.png'])
def test_spines_axes_positions():
    # SF bug 2852168
    fig = plt.figure()
    x = np.linspace(0,2*np.pi,100)
    y = 2*np.sin(x)
    ax = fig.add_subplot(1,1,1)
    ax.set_title('centered spines')
    ax.plot(x,y)
    ax.spines['right'].set_position(('axes',0.1))
    ax.yaxis.set_ticks_position('right')
```

```
ax.spines['top'].set_position(('axes',0.25))
ax.xaxis.set_ticks_position('top')
ax.spines['left'].set_color('none')
ax.spines['bottom'].set_color('none')
fig.savefig('spines_axes_positions.png')
```

The mechanism for comparing images is extremely simple – it compares an image saved in the current directory with one from the Matplotlib sample\_data repository. The correspondence is done by matching filenames, so ensure that:

- The filename given to `savefig()` is exactly the same as the filename given to `image_comparison()` in the `baseline_images` argument.
- The correct image gets added to the sample\_data repository with the name `test_baseline_<IMAGE_FILENAME.png>`. (See *Writing examples* above for a description of how to add files to the sample\_data repository.)

### 27.6.5 Known failing tests

If you're writing a test, you may mark it as a known failing test with the `knownfailureif()` decorator. This allows the test to be added to the test suite and run on the buildbots without causing undue alarm. For example, although the following test will fail, it is an expected failure:

```
from nose.tools import assert_equal
from matplotlib.testing.decorators import knownfailureif

@knownfailureif(True)
def test_simple_fail():
    '''very simple example test that should fail'''
    assert_equal(1+1,3)
```

Note that the first argument to the `knownfailureif()` decorator is a fail condition, which can be a value such as `True`, `False`, or `'indeterminate'`, or may be a dynamically evaluated expression.

### 27.6.6 Creating a new module in `matplotlib.tests`

Let's say you've added a new module named `matplotlib.tests.test_whizbang_features`. To add this module to the list of default tests, append its name to `default_test_modules` in `lib/matplotlib/__init__.py`.

## 27.7 Licenses

Matplotlib only uses BSD compatible code. If you bring in code from another project make sure it has a PSF, BSD, MIT or compatible license (see the Open Source Initiative [licenses page](#) for details on individual licenses). If it doesn't, you may consider contacting the author and asking them to relicense it. GPL and LGPL code are not acceptable in the main code base, though we are considering an alternative way of distributing L/GPL code through an separate channel, possibly a toolkit. If you include code, make sure you

include a copy of that code's license in the license directory if the code's license requires you to distribute the license with it. Non-BSD compatible licenses are acceptable in matplotlib toolkits (eg basemap), but make sure you clearly state the licenses you are using.

### 27.7.1 Why BSD compatible?

The two dominant license variants in the wild are GPL-style and BSD-style. There are countless other licenses that place specific restrictions on code reuse, but there is an important difference to be considered in the GPL and BSD variants. The best known and perhaps most widely used license is the GPL, which in addition to granting you full rights to the source code including redistribution, carries with it an extra obligation. If you use GPL code in your own code, or link with it, your product must be released under a GPL compatible license. I.e., you are required to give the source code to other people and give them the right to redistribute it as well. Many of the most famous and widely used open source projects are released under the GPL, including linux, gcc, emacs and sage.

The second major class are the BSD-style licenses (which includes MIT and the python PSF license). These basically allow you to do whatever you want with the code: ignore it, include it in your own open source project, include it in your proprietary product, sell it, whatever. python itself is released under a BSD compatible license, in the sense that, quoting from the PSF license page:

There is no GPL-like "copyleft" restriction. Distributing binary-only versions of Python, modified or not, is allowed. There is no requirement to release any of your source code. You can also write extension modules for Python and provide them only in binary form.

Famous projects released under a BSD-style license in the permissive sense of the last paragraph are the BSD operating system, python and TeX.

There are several reasons why early matplotlib developers selected a BSD compatible license. matplotlib is a python extension, and we choose a license that was based on the python license (BSD compatible). Also, we wanted to attract as many users and developers as possible, and many software companies will not use GPL code in software they plan to distribute, even those that are highly committed to open source development, such as [enthought](#), out of legitimate concern that use of the GPL will "infect" their code base by its viral nature. In effect, they want to retain the right to release some proprietary code. Companies and institutions who use matplotlib often make significant contributions, because they have the resources to get a job done, even a boring one. Two of the matplotlib backends (FLTK and WX) were contributed by private companies. The final reason behind the licensing choice is compatibility with the other python extensions for scientific computing: ipython, numpy, scipy, the enthought tool suite and python itself are all distributed under BSD compatible licenses. The other reason is licensing compatibility with the other python extensions for scientific computing: ipython, numpy, scipy, the enthought tool suite and python itself are all distributed under BSD compatible licenses.



# WORKING WITH *MATPLOTLIB* SOURCE CODE

Contents:

## 28.1 Introduction

These pages describe a [git](#) and [github](#) workflow for the [matplotlib](#) project.

There are several different workflows here, for different ways of working with *matplotlib*.

This is not a comprehensive [git](#) reference, it's just a workflow for our own project. It's tailored to the [github](#) hosting service. You may well find better or quicker ways of getting stuff done with [git](#), but these should get you started.

For general resources for learning [git](#) see [git resources](#).

## 28.2 Install git

### 28.2.1 Overview

|                 |  |
|-----------------|--|
| Debian / Ubuntu | <code>sudo apt-get install git-core</code>   |
| Fedora          | <code>sudo yum install git-core</code>       |
| Windows         | Download and install <a href="#">msysGit</a> |
| OS X            | Use the <a href="#">git-osx-installer</a>    |

### 28.2.2 In detail

See the [git](#) page for the most recent information.

Have a look at the [github](#) install help pages available from [github help](#)

There are good instructions here: [http://book.git-scm.com/2\\_installing\\_git.html](http://book.git-scm.com/2_installing_git.html)

## 28.3 Following the latest source

These are the instructions if you just want to follow the latest *matplotlib* source, but you don't need to do any development for now.

The steps are:

- *Install git*
- get local copy of the git repository from [github](#)
- update local copy from time to time

### 28.3.1 Get the local copy of the code

From the command line:

```
git clone git://github.com/matplotlib/matplotlib.git
```

You now have a copy of the code tree in the new `matplotlib` directory.

### 28.3.2 Updating the code

From time to time you may want to pull down the latest code. Do this with:

```
cd matplotlib
git pull
```

The tree in `matplotlib` will now have the latest changes from the initial repository.

## 28.4 Making a patch

You've discovered a bug or something else you want to change in `matplotlib` .. — excellent!

You've worked out a way to fix it — even better!

You want to tell us about it — best of all!

The easiest way is to make a *patch* or set of patches. Here we explain how. Making a patch is the simplest and quickest, but if you're going to be doing anything more than simple quick things, please consider following the *Git for development* model instead.

## 28.4.1 Making patches

### Overview

```
# tell git who you are
git config --global user.email you@yourdomain.example.com
git config --global user.name "Your Name Comes Here"
# get the repository if you don't have it
git clone git://github.com/matplotlib/matplotlib.git
# make a branch for your patching
cd matplotlib
git branch the-fix-im-thinking-of
git checkout the-fix-im-thinking-of
# hack, hack, hack
# Tell git about any new files you've made
git add somewhere/tests/test_my_bug.py
# commit work in progress as you go
git commit -am 'BF - added tests for Funny bug'
# hack hack, hack
git commit -am 'BF - added fix for Funny bug'
# make the patch files
git format-patch -M -C master
```

Then, send the generated patch files to the [matplotlib mailing list](#) — where we will thank you warmly.

### In detail

1. Tell [git](#) who you are so it can label the commits you've made:

```
git config --global user.email you@yourdomain.example.com
git config --global user.name "Your Name Comes Here"
```

2. If you don't already have one, clone a copy of the [matplotlib](#) repository:

```
git clone git://github.com/matplotlib/matplotlib.git
cd matplotlib
```

3. Make a 'feature branch'. This will be where you work on your bug fix. It's nice and safe and leaves you with access to an unmodified copy of the code in the main branch:

```
git branch the-fix-im-thinking-of
git checkout the-fix-im-thinking-of
```

4. Do some edits, and commit them as you go:

```
# hack, hack, hack
# Tell git about any new files you've made
git add somewhere/tests/test_my_bug.py
# commit work in progress as you go
```

```
git commit -am 'BF - added tests for Funny bug'
# hack hack, hack
git commit -am 'BF - added fix for Funny bug'
```

Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see [why the -a flag?](#).

5. When you have finished, check you have committed all your changes:

```
git status
```

6. Finally, make your commits into patches. You want all the commits since you branched from the master branch:

```
git format-patch -M -C master
```

You will now have several files named for the commits:

```
0001-BF-added-tests-for-Funny-bug.patch
0002-BF-added-fix-for-Funny-bug.patch
```

Send these files to the [matplotlib mailing list](#).

When you are done, to switch back to the main copy of the code, just return to the master branch:

```
git checkout master
```

## 28.4.2 Moving from patching to development

If you find you have done some patches, and you have one or more feature branches, you will probably want to switch to development mode. You can do this with the repository you have.

Fork the [matplotlib](#) repository on [github](#) — *Making your own copy (fork) of matplotlib*. Then:

```
# checkout and refresh master branch from main repo
git checkout master
git pull origin master
# rename pointer to main repository to 'upstream'
git remote rename origin upstream
# point your repo to default read / write to your fork on github
git remote add origin git@github.com:your-user-name/matplotlib.git
# push up any branches you've made and want to keep
git push origin the-fix-im-thinking-of
```

Then you can, if you want, follow the [Development workflow](#).



## 28.5 Git for development

Contents:

### 28.5.1 Making your own copy (fork) of matplotlib

You need to do this only once. The instructions here are very similar to the instructions at <http://help.github.com/forking/> — please see that page for more detail. We’re repeating some of it here just to give the specifics for the `matplotlib` project, and to suggest some default names.

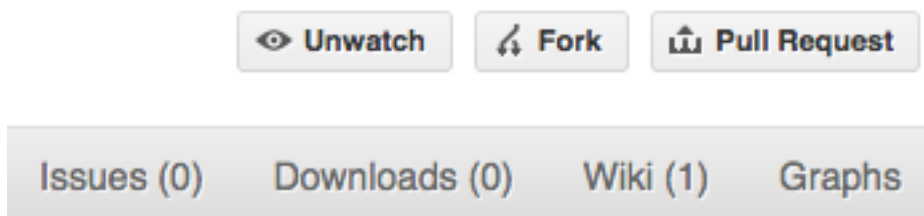
#### Set up and configure a github account

If you don’t have a `github` account, go to the `github` page, and make one.

You then need to configure your account to allow write access — see the `Generating SSH keys` help on `github help`.

#### Create your own forked copy of matplotlib

1. Log into your `github` account.
2. Go to the `matplotlib` github home at `matplotlib github`.
3. Click on the *fork* button:



Now, after a short pause and some ‘Hardcore forking action’, you should find yourself at the home page for your own forked copy of `matplotlib`.

### 28.5.2 Set up your fork

First you follow the instructions for *Making your own copy (fork) of matplotlib*.

#### Overview

```
git clone git@github.com:your-user-name/matplotlib.git
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

## In detail

### Clone your fork

1. Clone your fork to the local computer with `git clone git@github.com:your-user-name/matplotlib.git`
2. Investigate. Change directory to your new repo: `cd matplotlib`. Then `git branch -a` to show you all branches. You'll get something like:

```
* master
remotes/origin/master
```

This tells you that you are currently on the `master` branch, and that you also have a `remote` connection to `origin/master`. What remote repository is `remote/origin`? Try `git remote -v` to see the URLs for the remote. They will point to your [github](#) fork.

Now you want to connect to the upstream [matplotlib github](#) repository, so you can merge in changes from trunk.

### Linking your repository to the upstream repo

```
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

`upstream` here is just the arbitrary name we're using to refer to the main [matplotlib](#) repository at [matplotlib github](#).

Note that we've used `git://` for the URL rather than `git@`. The `git://` URL is read only. This means we that we can't accidentally (or deliberately) write to the upstream repo, and we are only going to use it to merge into our own code.

Note this command needs to be run on every clone of the repository that you make. It is not tracked in your personal repository on [github](#).

Just for your own satisfaction, show yourself that you now have a new 'remote', with `git remote -v` show, giving you something like:

```
upstream    git://github.com/matplotlib/matplotlib.git (fetch)
upstream    git://github.com/matplotlib/matplotlib.git (push)
origin      git@github.com:your-user-name/matplotlib.git (fetch)
origin      git@github.com:your-user-name/matplotlib.git (push)
```

## 28.5.3 Configure git

### Overview

Your personal [git](#) configurations are saved in the `.gitconfig` file in your home directory. Here is an example `.gitconfig` file:

```
[user]
    name = Your Name
    email = you@yourdomain.example.com

[alias]
    ci = commit -a
    co = checkout
    st = status -a
    stat = status -a
    br = branch
    wdiff = diff --color-words

[core]
    editor = vim

[merge]
    summary = true

[apply]
    whitespace = fix

[core]
    autocrlf = input
```

You can edit this file directly or you can use the `git config --global` command:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
git config --global core.editor vim
git config --global merge.summary true
```

To set up on another computer, you can copy your `~/.gitconfig` file, or run the commands above.

## In detail

### user.name and user.email

It is good practice to tell `git` who you are, for labeling any changes you make to the code. The simplest way to do this is from the command line:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
```

This will write the settings into your git configuration file, which should now contain a user section with your name and email:

```
[user]
  name = Your Name
  email = you@yourdomain.example.com
```

Of course you'll need to replace `Your Name` and `you@yourdomain.example.com` with your actual name and email address.

## Aliases

You might well benefit from some aliases to common commands.

For example, you might well want to be able to shorten `git checkout` to `git co`. Or you may want to alias `git diff --color-words` (which gives a nicely formatted output of the diff) to `git wdiff`

The following `git config --global` commands:

```
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
```

will create an alias section in your `.gitconfig` file with contents like this:

```
[alias]
  ci = commit -a
  co = checkout
  st = status -a
  stat = status -a
  br = branch
  wdiff = diff --color-words
```

## Editor

You may also want to make sure that your editor of choice is used

```
git config --global core.editor vim
```

## Merging

To enforce summaries when doing merges (`~/ .gitconfig` file again):

```
[merge]
  log = true
```

Or from the command line:

```
git config --global merge.log true
```

## 28.5.4 Development workflow

You already have your own forked copy of the [matplotlib](#) repository, by following *Making your own copy (fork) of matplotlib*, *Set up your fork*, and you have configured [git](#) by following *Configure git*.

### Workflow summary

- Keep your master branch clean of edits that have not been merged to the main [matplotlib](#) development repo. Your master then will follow the main [matplotlib](#) repository.
- Start a new *feature branch* for each set of edits that you do.
- If you can avoid it, try not to merge other branches into your feature branch while you are working.
- Ask for review!

This way of working really helps to keep work well organized, and in keeping history as clear as possible.

See — for example — [linux git workflow](#).

### Making a new feature branch

```
git checkout -b my-new-feature master
```

This will create and immediately check out a feature branch based on master. To create a feature branch based on a maintenance branch, use:

```
git fetch origin
git checkout -b my-new-feature origin/v1.0.x
```

Generally, you will want to keep this also on your public [github](#) fork of [matplotlib](#). To do this, you [git push](#) this new branch up to your [github](#) repo. Generally (if you followed the instructions in these pages, and by default), git will have a link to your [github](#) repo, called origin. You push up to your own repo on [github](#) with:

```
git push origin my-new-feature
```

You will need to use this exact command, rather than simply `git push` every time you want to push changes on your feature branch to your [github](#) repo. However, in `git >1.7` you can set up a link by using the `--set-upstream` option:

```
git push --set-upstream origin my-new-feature
```

and then next time you need to push changes to your branch a simple `git push` will suffice. Note that `git push` pushes out all branches that are linked to a remote branch.

## The editing workflow

### Overview

```
# hack hack
git add my_new_file
git commit -am 'NF - some message'
git push
```

### In more detail

1. Make some changes
2. See which files have changed with `git status` (see [git status](#)). You'll see a listing like this one:

```
# On branch ny-new-feature
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#   modified:   README
#
# Untracked files:
#   (use "git add <file>..." to include in what will be committed)
#
#   INSTALL
no changes added to commit (use "git add" and/or "git commit -a")
```

3. Check what the actual changes are with `git diff` ([git diff](#)).
4. Add any new files to version control `git add new_file_name` (see [git add](#)).
5. To commit all modified files into the local copy of your repo., do `git commit -am 'A commit message'`. Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see [why the -a flag?](#) — and the helpful use-case description in the [tangled working copy problem](#). The `git commit` manual page might also be useful.
6. To push the changes up to your forked repo on [github](#), do a `git push` (see [git push](#)).

## Asking for code review

1. Go to your repo URL — e.g. <http://github.com/your-user-name/matplotlib>.
2. Click on the *Branch list* button:



3. Click on the *Compare* button for your feature branch — here my-new-feature:



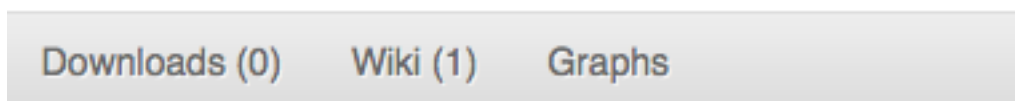
4. If asked, select the *base* and *comparison* branch names you want to compare. Usually these will be *master* and *my-new-feature* (where that is your feature branch name).
5. At this point you should get a nice summary of the changes. Copy the URL for this, and post it to the [matplotlib mailing list](#), asking for review. The URL will look something like: <http://github.com/your-user-name/matplotlib/compare/master...my-new-feature>. There's an example at <http://github.com/matthew-brett/nipy/compare/master...find-install-data> See: <http://github.com/blog/612-introducing-github-compare-view> for more detail.

The generated comparison, is between your feature branch *my-new-feature*, and the place in *master* from which you branched *my-new-feature*. In other words, you can keep updating *master* without interfering with the output from the comparison. More detail? Note the three dots in the URL above (*master...my-new-feature*) and see *Two and three dots in difference specs*.

## Asking for your changes to be merged into the main repo

When you are ready to ask for the merge of your code:

1. Go to the URL of your forked repo, say <http://github.com/your-user-name/matplotlib.git>.
2. Click on the 'Pull request' button:



Enter a message; we suggest you select only *matplotlib* as the recipient. The message will go to the [matplotlib mailing list](#). Please feel free to add others from the list as you like.

3. If the branch is to be merged into a maintenance branch on the main repo, make sure the “base branch” indicates the maintenance branch and not master. Github can not automatically determine the branch to merge into.

### Staying up to date with changes in the central repository

This updates your working copy from the upstream `matplotlib` `github` repo.

### Overview

```
# go to your master branch
git checkout master
# pull changes from github
git fetch upstream
# merge from upstream
git merge --ff-only upstream/master
```

### In detail

We suggest that you do this only for your `master` branch, and leave your ‘feature’ branches unmerged, to keep their history as clean as possible. This makes code review easier:

```
git checkout master
```

Make sure you have done *Linking your repository to the upstream repo*.

Merge the upstream code into your current development by first pulling the upstream repo to a copy on your local machine:

```
git fetch upstream
```

then merging into your current branch:

```
git merge --ff-only upstream/master
```

The `--ff-only` option guarantees that if you have mistakenly committed code on your `master` branch, the merge fails at this point. If you were to merge `upstream/master` to your `master`, you would start to diverge from the upstream. If this command fails, see the section on accidents.

The letters ‘ff’ in `--ff-only` mean ‘fast forward’, which is a special case of merge where git can simply update your branch to point to the other branch and not do any actual merging of files. For `master` and other integration branches this is exactly what you want.



## Other integration branches

Some people like to keep separate local branches corresponding to the maintenance branches on github. At the time of this writing, `v1.0.x` is the active maintenance branch. If you have such a local branch, treat it just as `master`: don't commit on it, and before starting new branches off of it, update it from upstream:

```
git checkout v1.0.x
git fetch upstream
git merge --ff-only upstream/v1.0.x
```

But you don't necessarily have to have such a branch. Instead, if you are preparing a bugfix that applies to the maintenance branch, fetch from upstream and base your bugfix on the remote branch:

```
git fetch upstream
git checkout -b my-bug-fix upstream/v1.0.x
```

## Recovering from accidental commits on master

If you have accidentally committed changes on `master` and `git merge --ff-only` fails, don't panic! First find out how much you have diverged:

```
git diff upstream/master...master
```

If you find that you want simply to get rid of the changes, reset your `master` branch to the upstream version:

```
git reset --hard upstream/master
```

As you might surmise from the words 'reset' and 'hard', this command actually causes your changes to the current branch to be lost, so think twice.

If, on the other hand, you find that you want to preserve the changes, create a feature branch for them:

```
git checkout -b my-important-changes
```

Now `my-important-changes` points to the branch that has your changes, and you can safely reset `master` as above — but make sure to reset the correct branch:

```
git checkout master
git reset --hard upstream/master
```

## Deleting a branch on github

```
git checkout master
# delete branch locally
git branch -D my-unwanted-branch
```

```
# delete branch on github
git push origin :my-unwanted-branch
```

(Note the colon : before test-branch. See also: <http://github.com/guides/remove-a-remote-branch>)

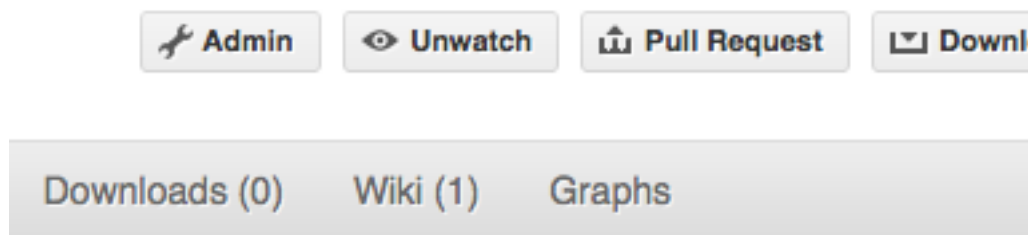
### Several people sharing a single repository

If you want to work on some stuff with other people, where you are all committing into the same repository, or even the same branch, then just share it via [github](#).

First fork matplotlib into your account, as from *Making your own copy (fork) of matplotlib*.

Then, go to your forked repository github page, say <http://github.com/your-user-name/matplotlib>

Click on the ‘Admin’ button, and add anyone else to the repo as a collaborator:



Now all those people can do:

```
git clone git@github.com:your-user-name/matplotlib.git
```

Remember that links starting with `git@` use the ssh protocol and are read-write; links starting with `git://` are read-only.

Your collaborators can then commit directly into that repo with the usual:

```
git commit -am 'ENH - much better code'
git push origin master # pushes directly into your repo
```

### Exploring your repository

To see a graphical representation of the repository branches and commits:

```
gitk --all
```

To see a linear list of commits for this branch:

```
git log
```

You can also look at the [network graph visualizer](#) for your [github](#) repo.

## 28.6 git resources

### 28.6.1 Tutorials and summaries

- [github help](#) has an excellent series of how-to guides.
- [learn.github](#) has an excellent series of tutorials
- The [pro git book](#) is a good in-depth book on git.
- A [git cheat sheet](#) is a page giving summaries of common commands.
- The [git user manual](#)
- The [git tutorial](#)
- The [git community book](#)
- [git ready](#) — a nice series of tutorials
- [git casts](#) — video snippets giving git how-tos.
- [git magic](#) — extended introduction with intermediate detail
- The [git parable](#) is an easy read explaining the concepts behind git.
- Our own [git foundation](#) expands on the [git parable](#).
- Fernando Perez' [git page](#) — [Fernando's git page](#) — many links and tips
- A good but technical page on [git concepts](#)
- [git svn crash course](#): [git](#) for those of us used to [subversion](#)

### 28.6.2 Advanced git workflow

There are many ways of working with [git](#); here are some posts on the rules of thumb that other projects have come up with:

- Linus Torvalds on [git management](#)
- Linus Torvalds on [linux git workflow](#) . Summary; use the git tools to make the history of your edits as clean as possible; merge from upstream edits as little as possible in branches where you are doing active development.

### 28.6.3 Manual pages online

You can get these on your own machine with (e.g) `git help push` or (same thing) `git push --help`, but, for convenience, here are the online manual pages for some common commands:

- [git add](#)
- [git branch](#)
- [git checkout](#)

- `git clone`
- `git commit`
- `git config`
- `git diff`
- `git log`
- `git pull`
- `git push`
- `git remote`
- `git status`

# DOCUMENTING MATPLOTLIB

## 29.1 Getting started

The documentation for matplotlib is generated from ReStructured Text using the [Sphinx](#) documentation generation tool. Sphinx-1.0 or later is required.

The documentation sources are found in the `doc/` directory in the trunk. To build the users guide in html format, cd into `doc/` and do:

```
python make.py html
```

or:

```
./make.py html
```

you can also pass a `latex` flag to `make.py` to build a pdf, or pass no arguments to build everything.

The output produced by Sphinx can be configured by editing the `conf.py` file located in the `doc/`.

## 29.2 Organization of matplotlib's documentation

The actual ReStructured Text files are kept in `doc/users`, `doc/devel`, `doc/api` and `doc/faq`. The main entry point is `doc/index.rst`, which pulls in the `index.rst` file for the users guide, developers guide, api reference, and faqs. The documentation suite is built as a single document in order to make the most effective use of cross referencing, we want to make navigating the Matplotlib documentation as easy as possible.

Additional files can be added to the various guides by including their base file name (the `.rst` extension is not necessary) in the table of contents. It is also possible to include other documents through the use of an `include` statement, such as:

```
.. include:: ../../TODO
```

## 29.3 Formatting

The Sphinx website contains plenty of [documentation](#) concerning ReST markup and working with Sphinx in general. Here are a few additional things to keep in mind:

- Please familiarize yourself with the Sphinx directives for [inline markup](#). Matplotlib’s documentation makes heavy use of cross-referencing and other semantic markup. For example, when referring to external files, use the `:file:` directive.
- Function arguments and keywords should be referred to using the *emphasis* role. This will keep matplotlib’s documentation consistent with Python’s documentation:

Here is a description of *\*argument\**

Please do not use the *default role*:

Please do not describe ‘argument’ like this.

nor the `literal` role:

Please do not describe ‘‘argument’’ like this.

- Sphinx does not support tables with column- or row-spanning cells for latex output. Such tables can not be used when documenting matplotlib.
- Mathematical expressions can be rendered as png images in html, and in the usual way by latex. For example:

`:math: ‘\sin(x_n^2)’` yields:  $\sin(x_n^2)$ , and:

`.. math::`

`\int_{-\infty}^{\infty} \frac{e^{i\phi}}{1+x^2} \frac{e^{i\phi}}{1+x^2}`

yields:

$$\int_{-\infty}^{\infty} \frac{e^{i\phi}}{1+x^2} \frac{e^{i\phi}}{1+x^2} \quad (29.1)$$

- Interactive IPython sessions can be illustrated in the documentation using the following directive:

`.. sourcecode:: ipython`

`In [69]: lines = plot([1,2,3])`

which would yield:

**In [69]:** `lines = plot([1,2,3])`

- Footnotes <sup>1</sup> can be added using `[#]_`, followed later by:

---

<sup>1</sup> For example.

```
.. rubric:: Footnotes
```

```
.. [#]
```

- Use the *note* and *warning* directives, sparingly, to draw attention to important comments:

```
.. note::
    Here is a note
```

yields:

**Note:** here is a note

also:

**Warning:** here is a warning

- Use the *deprecated* directive when appropriate:

```
.. deprecated:: 0.98
    This feature is obsolete, use something else.
```

yields: Deprecated since version 0.98: This feature is obsolete, use something else.

- Use the *versionadded* and *versionchanged* directives, which have similar syntax to the *deprecated* role:

```
.. versionadded:: 0.98
    The transforms have been completely revamped.
```

New in version 0.98: The transforms have been completely revamped.

- Use the *seealso* directive, for example:

```
.. seealso::

    Using ReST :ref:'emacs-helpers':
        One example

    A bit about :ref:'referring-to-mpl-docs':
        One more
```

yields:

**See Also:**

Using ReST *Emacs helpers*: One example

A bit about *Referring to mpl documents*: One more

- Please keep the *Glossary* in mind when writing documentation. You can create a references to a term in the glossary with the `:term:` role.

- The autodoc extension will handle index entries for the API, but additional entries in the [index](#) need to be explicitly added.

### 29.3.1 Docstrings

In addition to the aforementioned formatting suggestions:

- Please limit the text width of docstrings to 70 characters.
- Keyword arguments should be described using a definition list.

**Note:** matplotlib makes extensive use of keyword arguments as pass-through arguments, there are a many cases where a table is used in place of a definition list for autogenerated sections of docstrings.

## 29.4 Figures

### 29.4.1 Dynamically generated figures

Figures can be automatically generated from scripts and included in the docs. It is not necessary to explicitly save the figure in the script, this will be done automatically at build time to ensure that the code that is included runs and produces the advertised figure.

The path should be relative to the doc directory. Any plots specific to the documentation should be added to the `doc/pyplots` directory and committed to git. Plots from the `examples` directory may be referenced through the symlink `mpl_examples` in the doc directory. e.g.:

```
.. plot:: mpl_examples/pylab_examples/simple_plot.py
```

The `:scale:` directive rescales the image to some percentage of the original size, though we don't recommend using this in most cases since it is probably better to choose the correct figure size and dpi in mpl and let it handle the scaling.

### Plot directive documentation

A directive for including a matplotlib plot in a Sphinx document.

By default, in HTML output, `plot` will include a .png file with a link to a high-res .png and .pdf. In LaTeX output, it will include a .pdf.

The source code for the plot may be included in one of three ways:

1. **A path to a source file** as the argument to the directive:

```
.. plot:: path/to/plot.py
```

When a path to a source file is given, the content of the directive may optionally contain a caption for the plot:



```
.. plot:: path/to/plot.py
```

This is the caption for the plot

Additionally, one may specify the name of a function to call (with no arguments) immediately after importing the module:

```
.. plot:: path/to/plot.py plot_function1
```

2. Included as **inline content** to the directive:

```
.. plot::

    import matplotlib.pyplot as plt
    import matplotlib.image as mpimg
    import numpy as np
    img = mpimg.imread('_static/stinkbug.png')
    imgplot = plt.imshow(img)
```

3. Using **doctest** syntax:

```
.. plot::
    A plotting example:
    >>> import matplotlib.pyplot as plt
    >>> plt.plot([1,2,3], [4,5,6])
```

## Options

The `plot` directive supports the following options:

**format** [{ 'python', 'doctest' }] Specify the format of the input

**include-source** [bool] Whether to display the source code. The default can be changed using the `plot_include_source` variable in `conf.py`

**encoding** [str] If this source file is in a non-UTF8 or non-ASCII encoding, the encoding must be specified using the `:encoding:` option. The encoding will not be inferred using the `-*-coding: *-` metacomment.

**context** [bool] If provided, the code will be run in the context of all previous plot directives for which the `:context:` option was specified. This only applies to inline code plot directives, not those run from files.

**nofigs** [bool] If specified, the code block will be run, but no figures will be inserted. This is usually useful with the `:context:` option.

Additionally, this directive supports all of the options of the `image` directive, except for `target` (since plot will add its own target). These include `alt`, `height`, `width`, `scale`, `align` and `class`.

## Configuration options

The plot directive has the following configuration options:

**plot\_include\_source** Default value for the include-source option

**plot\_pre\_code** Code that should be executed before each plot.

**plot\_basedir** Base directory, to which `plot::` file names are relative to. (If None or empty, file names are relative to the directory where the file containing the directive is.)

**plot\_formats** File formats to generate. List of tuples or strings:

```
[(suffix, dpi), suffix, ...]
```

that determine the file format and the DPI. For entries whose DPI was omitted, sensible defaults are chosen.

**plot\_html\_show\_formats** Whether to show links to the files in HTML.

**plot\_rcparams** A dictionary containing any non-standard rcParams that should be applied before each plot.

### 29.4.2 Static figures

Any figures that rely on optional system configurations need to be handled a little differently. These figures are not to be generated during the documentation build, in order to keep the prerequisites to the documentation effort as low as possible. Please run the `doc/pyplots/make.py` script when adding such figures, and commit the script **and** the images to git. Please also add a line to the README in `doc/pyplots` for any additional requirements necessary to generate a new figure. Once these steps have been taken, these figures can be included in the usual way:

```
.. plot:: pyplots/tex_unicode_demo.py
   :include-source:
```

### 29.4.3 Examples

The source of the files in the `examples` directory are automatically included in the HTML docs. An image is generated and included for all examples in the `api` and `pylab_examples` directories. To exclude the example from having an image rendered, insert the following special comment anywhere in the script:

```
# -*- noplot -*-
```

### 29.4.4 Animations

We have a matplotlib google/gmail account with username `mplgithub` which we used to setup the github account but can be used for other purposes, like hosting google docs or youtube videos. You can embed a matplotlib animation in the docs by first saving the animation as a movie using

`matplotlib.animation.Animation.save()`, and then uploading to [matplotlib's youtube channel](#) and inserting the embedding string youtube provides like:

```
.. raw:: html

    <iframe width="420" height="315"
      src="http://www.youtube.com/embed/32cjc6V00ZY"
      frameborder="0" allowfullscreen>
    </iframe>
```

An example save command to generate a movie looks like this

```
ani = animation.FuncAnimation(fig, animate, np.arange(1, len(y)),
    interval=25, blit=True, init_func=init)

ani.save('double_pendulum.mp4', fps=15)
```

Contact John Hunter for the login password to upload youtube videos of google docs to the mplgithub account.

## 29.5 Referring to mpl documents

In the documentation, you may want to include to a document in the matplotlib src, e.g. a license file or an image file from *mpl-data*, refer to it via a relative path from the document where the rst file resides, eg, in *users/navigation\_toolbar.rst*, we refer to the image icons with:

```
.. image:: ../../lib/matplotlib/mpl-data/images/subplots.png
```

In the *users* subdirectory, if I want to refer to a file in the *mpl-data* directory, I use the symlink directory. For example, from *customizing.rst*:

```
.. literalinclude:: ../../lib/matplotlib/mpl-data/matplotlibrc
```

One exception to this is when referring to the examples dir. Relative paths are extremely confusing in the sphinx plot extensions, so without getting into the dirty details, it is easier to simply include a symlink to the files at the top doc level directory. This way, API documents like `matplotlib.pyplot.plot()` can refer to the examples in a known location.

In the top level doc directory we have symlinks pointing to the *mpl examples*:

```
home:~/mpl/doc> ls -l mpl_*
mpl_examples -> ../examples
```

So we can include plots from the examples dir using the symlink:

```
.. plot:: mpl_examples/pylab_examples/simple_plot.py
```

We used to use a symlink for `mpl-data` too, but the distro becomes very large on platforms that do not support links (eg the font files are duplicated and large)

## 29.6 Internal section references

To maximize internal consistency in section labeling and references, use hyphen separated, descriptive labels for section references, eg:

```
.. _howto-webapp:
```

and refer to it using the standard reference syntax:

```
See :ref:'howto-webapp'
```

Keep in mind that we may want to reorganize the contents later, so let's avoid top level names in references like `user` or `devel` or `faq` unless necessary, because for example the FAQ “what is a backend?” could later become part of the users guide, so the label:

```
.. _what-is-a-backend
```

is better than:

```
.. _faq-backend
```

In addition, since underscores are widely used by Sphinx itself, let's prefer hyphens to separate words.

## 29.7 Section names, etc

For everything but top level chapters, please use Upper lower for section titles, eg Possible hangups rather than Possible Hangups

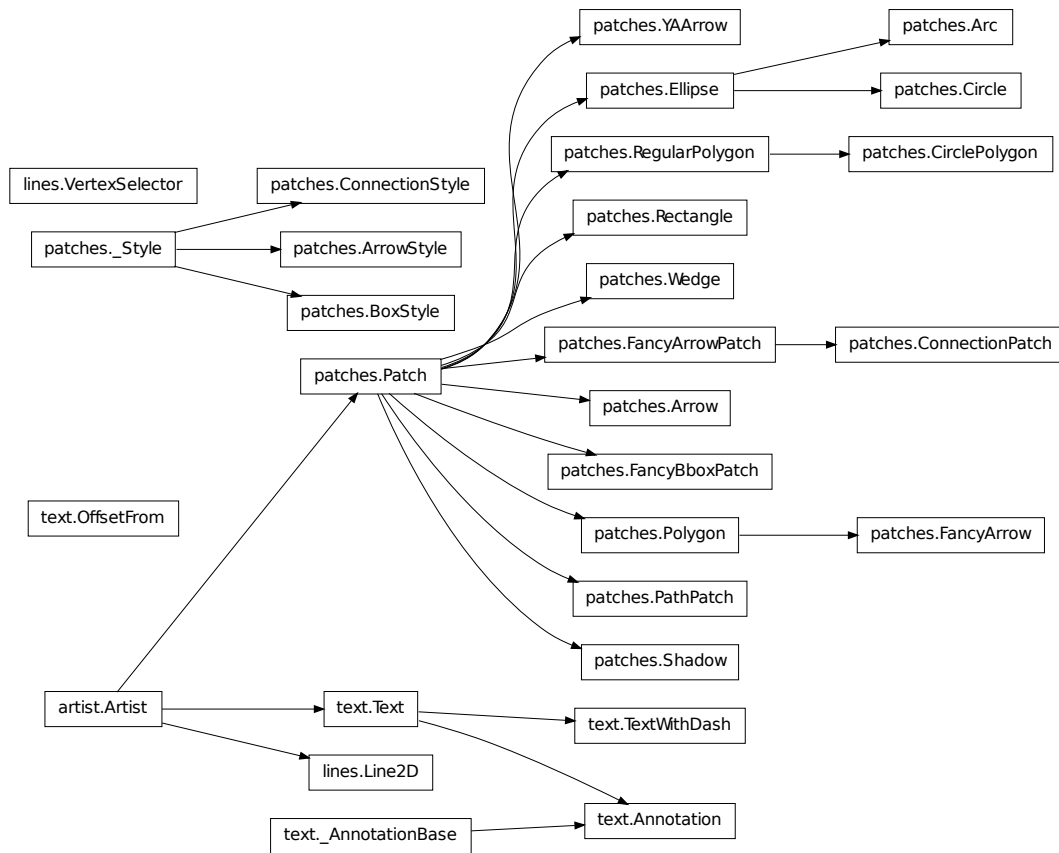
## 29.8 Inheritance diagrams

Class inheritance diagrams can be generated with the `inheritance-diagram` directive. To use it, you provide the directive with a number of class or module names (separated by whitespace). If a module name is provided, all classes in that module will be used. All of the ancestors of these classes will be included in the inheritance diagram.

A single option is available: *parts* controls how many of parts in the path to the class are shown. For example, if *parts* == 1, the class `matplotlib.patches.Patch` is shown as `Patch`. If *parts* == 2, it is shown as `patches.Patch`. If *parts* == 0, the full path is shown.

Example:

```
.. inheritance-diagram:: matplotlib.patches matplotlib.lines matplotlib.text
:parts: 2
```



## 29.9 Emacs helpers

There is an emacs mode `rst.el` which automates many important ReST tasks like building and updating table-of-contents, and promoting or demoting section headings. Here is the basic `.emacs` configuration:

```
(require 'rst)
(setq auto-mode-alist
  (append '(("\\.txt$" . rst-mode)
            ("\\.rst$" . rst-mode)
            ("\\.rest$" . rst-mode)) auto-mode-alist))
```

Some helpful functions:

C-c TAB - rst-toc-insert

Insert table of contents at point

C-c C-u - rst-toc-update

Update the table of contents at point

C-c C-l rst-shift-region-left

Shift region to the left

C-c C-r rst-shift-region-right

Shift region to the right

# DOING A MATPLOLIB RELEASE

A guide for developers who are doing a matplotlib release

- Edit `__init__.py` and bump the version number

When doing a release

## 30.1 Testing

- Run all of the regression tests by running the *tests.py* script at the root of the source tree.
- Run `unit/memleak_hawaii3.py` and make sure there are no memory leaks
- try some GUI examples, eg `simple_plot.py` with `GTKAgg`, `TkAgg`, etc...
- remove font cache and tex cache from `.matplotlib` and test with and without cache on some example script
- Optionally, make sure `examples/tests/backend_driver.py` runs without errors and check the output of the PNG, PDF, PS and SVG backends

## 30.2 Branching

Once all the tests are passing and you are ready to do a release, you need to create a release branch:

```
git checkout -b v1.1.x
git push git@github.com:matplotlib/matplotlib.git v1.1.x
```

On the branch, do any additional testing you want to do, and then build binaries and source distributions for testing as release candidates.

## 30.3 Packaging

- Make sure the `MANIFEST.in` is up to date and remove `MANIFEST` so it will be rebuilt by `MANIFEST.in`

- run *git clean* in the mpl git directory before building the sdist
- unpack the sdist and make sure you can build from that directory
- Use *setup.cfg* to set the default backends. For windows and OSX, the default backend should be TkAgg. You should also turn on or off any platform specific build options you need. Importantly, you also need to make sure that you delete the build dir after any changes to file:*setup.cfg* before rebuilding since cruft in the build dir can get carried along.
- on windows, unix2dos the rc file
- We have a Makefile for the OS X builds in the mpl source dir *release/osx*, so use this to prepare the OS X releases.
- We have a Makefile for the win32 mingw builds in the mpl source dir *release/win32* which you can use this to prepare the windows releases, but this is currently broken for python2.6 as described at <http://www.nabble.com/binary-installers-for-python2.6-libpng-segfault%2C-MSVCR90.DLL-and-%09mingw-td23971661.html>

## 30.4 Release candidate testing:

Post the release candidates to <http://matplotlib.sf.net/release-candidates> and post a message to matplotlib-users and devel requesting testing. To post to the server, you can do:

```
> scp somefile.tgz jdh2358,matplotlib@shell.sf.net:/home/groups/m/ma/matplotlib/htdocs/release-candidates
```

replacing ‘jdh2358’ with your sourceforge login.

Any changes to fix bugs in the release candidate should be fixed in the release branch and merged into the trunk.

## 30.5 Uploading

- Post the win32 and OS-X binaries for testing and make a request on matplotlib-devel for testing. Pester us if we don’t respond
- ftp the source and binaries to the anonymous FTP site:

```
mpl> git clean
mpl> python setup.py sdist
mpl> cd dist/
dist> sftp jdh2358@frs.sourceforge.net
Connecting to frs.sourceforge.net...
sftp> cd uploads
sftp> ls
sftp> lls
matplotlib-0.98.2.tar.gz
sftp> put matplotlib-0.98.2.tar.gz
Uploading matplotlib-0.98.2.tar.gz to /incoming/j/jd/jdh2358/uploads/matplotlib-0.98.2.tar.gz
```



- go [https://sourceforge.net/project/admin/explorer.php?group\\_id=80706](https://sourceforge.net/project/admin/explorer.php?group_id=80706) and do a file release. Click on the “Admin” tab to log in as an admin, and then the “File Releases” tab. Go to the bottom and click “add release” and enter the package name but not the version number in the “Package Name” box. You will then be prompted for the “New release name” at which point you can add the version number, eg somepackage-0.1 and click “Create this release”.

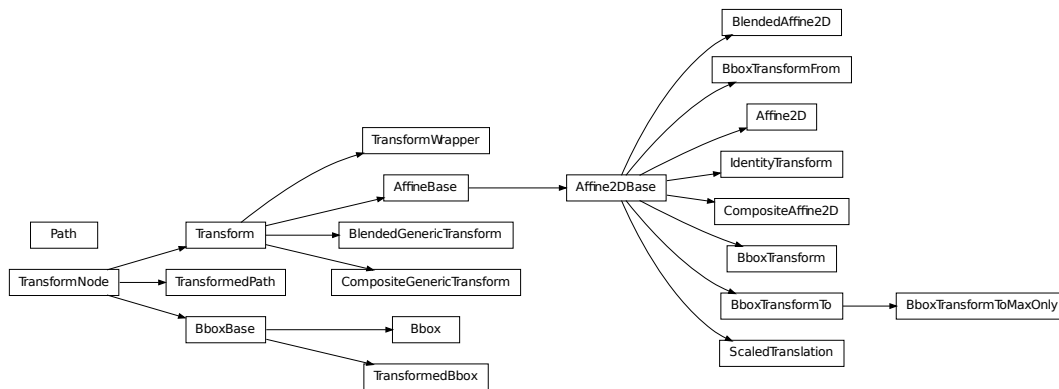
You will then be taken to a fairly self explanatory page where you can enter the Change notes, the release notes, and select which packages from the incoming ftp archive you want to include in this release. For each binary, you will need to select the platform and file type, and when you are done you click on the “notify users who are monitoring this package link”

## 30.6 Announcing

Announce the release on matplotlib-announce, matplotlib-users and matplotlib-devel. Include a summary of highlights from the CHANGELOG and/or post the whole CHANGELOG since the last release.



# WORKING WITH TRANSFORMATIONS

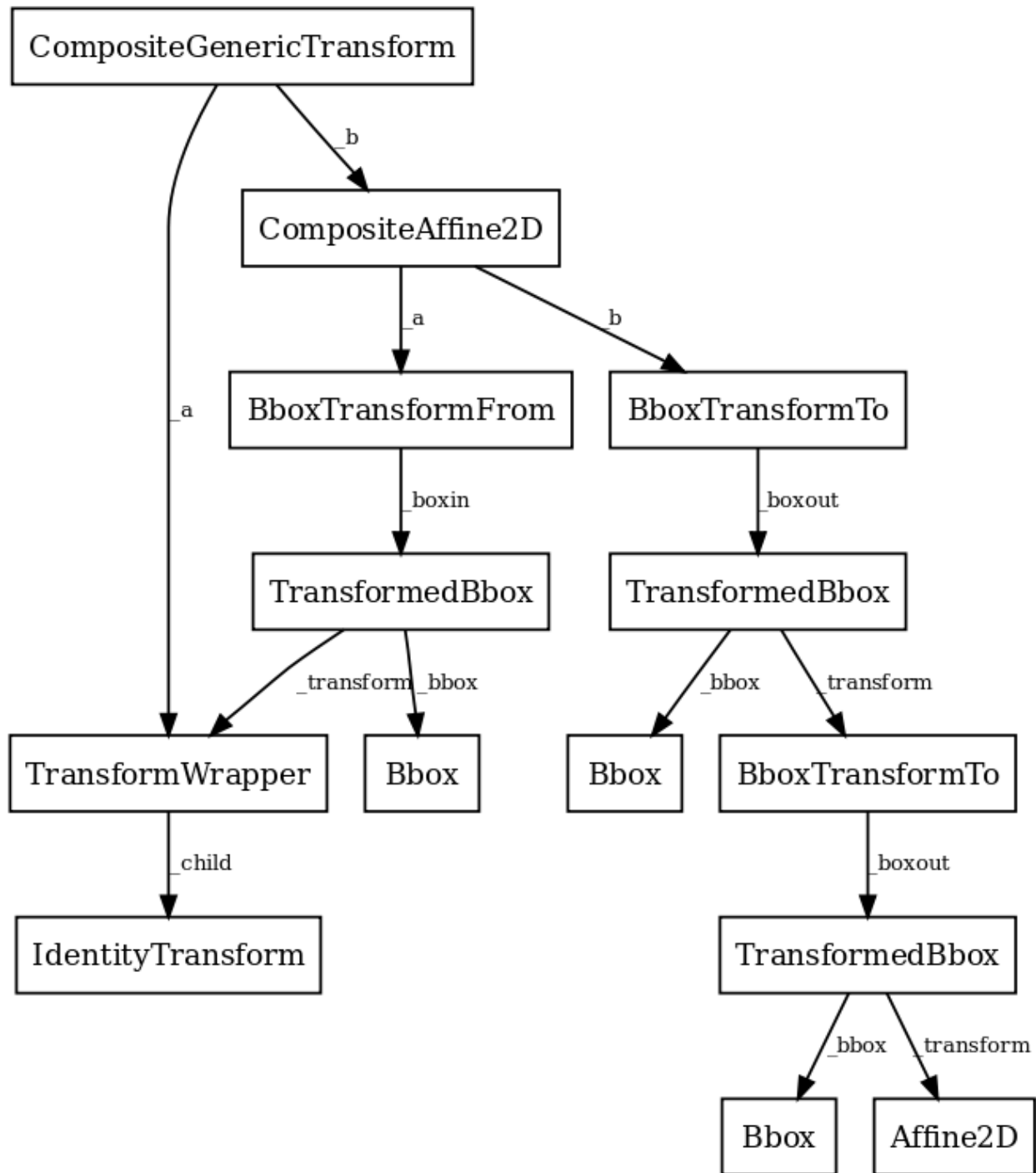


## 31.1 matplotlib.transforms

matplotlib includes a framework for arbitrary geometric transformations that is used to determine the final position of all elements drawn on the canvas.

Transforms are composed into trees of `TransformNode` objects whose actual value depends on their children. When the contents of children change, their parents are automatically invalidated. The next time an invalidated transform is accessed, it is recomputed to reflect those changes. This invalidation/caching approach prevents unnecessary recomputations of transforms, and contributes to better interactive performance.

For example, here is a graph of the transform tree used to plot data to the graph:



The framework can be used for both affine and non-affine transformations. However, for speed, we want use the backend renderers to perform affine transformations whenever possible. Therefore, it is possible to perform just the affine or non-affine part of a transformation on a set of data. The affine is always assumed to occur after the non-affine. For any transform:

```
full transform == non-affine part + affine part
```

The backends are not expected to handle non-affine transformations themselves.

**class TransformNode()**

Bases: `object`

`TransformNode` is the base class for anything that participates in the transform tree and needs to invalidate its parents or be invalidated. This includes classes that are not really transforms, such as bounding boxes, since some transforms depend on bounding boxes to compute their values.

Creates a new `TransformNode`.

**frozen()**

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**invalidate()**

Invalidate this `TransformNode` and all of its ancestors. Should be called any time the transform changes.

**set\_children(\*children)**

Set the children of the transform, to let the invalidation system know which transforms can invalidate this transform. Should be called from the constructor of any transforms that depend on other transforms.

**class BboxBase()**

Bases: `matplotlib.transforms.TransformNode`

This is the base class of all bounding boxes, and provides read-only access to its data. A mutable bounding box is provided by the `Bbox` class.

The canonical representation is as two points, with no restrictions on their ordering. Convenience properties are provided to get the left, bottom, right and top edges and width and height, but these are not stored explicitly.

Creates a new `TransformNode`.

**anchored(c, container=None)**

Return a copy of the `Bbox`, shifted to position `c` within a container.

`c`: may be either:

- a sequence (`cx`, `cy`) where `cx` and `cy` range from 0 to 1, where 0 is left or bottom and 1 is right or top
- a string: - 'C' for centered - 'S' for bottom-center - 'SE' for bottom-left - 'E' for left - etc.

Optional argument `container` is the box within which the `Bbox` is positioned; it defaults to the initial `Bbox`.

**bounds**

(property) Returns (`x0`, `y0`, `width`, `height`).

**contains(x, y)**

Returns `True` if (`x`, `y`) is a coordinate inside the bounding box or on its edge.

**containsx(x)**

Returns `True` if `x` is between or equal to `x0` and `x1`.

**containsy(y)**

Returns True if *y* is between or equal to *y0* and *y1*.

**corners()**

Return an array of points which are the four corners of this rectangle. For example, if this **Bbox** is defined by the points (*a*, *b*) and (*c*, *d*), **corners()** returns (*a*, *b*), (*a*, *d*), (*c*, *b*) and (*c*, *d*).

**count\_contains(vertices)**

Count the number of vertices contained in the **Bbox**.

*vertices* is a Nx2 Numpy array.

**count\_overlaps(bboxes)**

Count the number of bounding boxes that overlap this one.

*bboxes* is a sequence of **BboxBase** objects

**expanded(sw, sh)**

Return a new **Bbox** which is this **Bbox** expanded around its center by the given factors *sw* and *sh*.

**extents**

(property) Returns (*x0*, *y0*, *x1*, *y1*).

**frozen()**

**TransformNode** is the base class for anything that participates in the transform tree and needs to invalidate its parents or be invalidated. This includes classes that are not really transforms, such as bounding boxes, since some transforms depend on bounding boxes to compute their values.

**fully\_contains(x, y)**

Returns True if (*x*, *y*) is a coordinate inside the bounding box, but not on its edge.

**fully\_containsx(x)**

Returns True if *x* is between but not equal to *x0* and *x1*.

**fully\_containsy(y)**

Returns True if *y* is between but not equal to *y0* and *y1*.

**fully\_overlaps(other)**

Returns True if this bounding box overlaps with the given bounding box *other*, but not on its edge alone.

**height**

(property) The height of the bounding box. It may be negative if *y1* < *y0*.

**intervalx**

(property) **intervalx** is the pair of *x* coordinates that define the bounding box. It is not guaranteed to be sorted from left to right.

**intervaly**

(property) **intervaly** is the pair of *y* coordinates that define the bounding box. It is not guaranteed to be sorted from bottom to top.

**inverse\_transformed(transform)**

Return a new **Bbox** object, statically transformed by the inverse of the given transform.

**is\_unit()**

Returns True if the **Bbox** is the unit bounding box from (0, 0) to (1, 1).

**max**

(property) **max** is the top-right corner of the bounding box.

**min**

(property) **min** is the bottom-left corner of the bounding box.

**overlaps(*other*)**

Returns True if this bounding box overlaps with the given bounding box *other*.

**p0**

(property) **p0** is the first pair of (x, y) coordinates that define the bounding box. It is not guaranteed to be the bottom-left corner. For that, use **min**.

**p1**

(property) **p1** is the second pair of (x, y) coordinates that define the bounding box. It is not guaranteed to be the top-right corner. For that, use **max**.

**padded(*p*)**

Return a new **Bbox** that is padded on all four sides by the given value.

**rotated(*radians*)**

Return a new bounding box that bounds a rotated version of this bounding box by the given radians. The new bounding box is still aligned with the axes, of course.

**shrunk(*mx*, *my*)**

Return a copy of the **Bbox**, shrunk by the factor *mx* in the *x* direction and the factor *my* in the *y* direction. The lower left corner of the box remains unchanged. Normally *mx* and *my* will be less than 1, but this is not enforced.

**shrunk\_to\_aspect(*box\_aspect*, *container=None*, *fig\_aspect=1.0*)**

Return a copy of the **Bbox**, shrunk so that it is as large as it can be while having the desired aspect ratio, *box\_aspect*. If the box coordinates are relative—that is, fractions of a larger box such as a figure—then the physical aspect ratio of that figure is specified with *fig\_aspect*, so that *box\_aspect* can also be given as a ratio of the absolute dimensions, not the relative dimensions.

**size**

(property) The width and height of the bounding box. May be negative, in the same way as **width** and **height**.

**splitx(\**args*)**

e.g., `bbox.splitx(f1, f2, ...)`

Returns a list of new **Bbox** objects formed by splitting the original one with vertical lines at fractional positions *f1*, *f2*, ...

**splity(\**args*)**

e.g., `bbox.splity(f1, f2, ...)`

Returns a list of new **Bbox** objects formed by splitting the original one with horizontal lines at fractional positions *f1*, *f2*, ...

**transformed**(*transform*)

Return a new [Bbox](#) object, statically transformed by the given transform.

**translated**(*tx*, *ty*)

Return a copy of the [Bbox](#), statically translated by *tx* and *ty*.

static **union**(*bboxes*)

Return a [Bbox](#) that contains all of the given bboxes.

**width**

(property) The width of the bounding box. It may be negative if [x1](#) < [x0](#).

**x0**

(property) [x0](#) is the first of the pair of *x* coordinates that define the bounding box. [x0](#) is not guaranteed to be less than [x1](#). If you require that, use [xmin](#).

**x1**

(property) [x1](#) is the second of the pair of *x* coordinates that define the bounding box. [x1](#) is not guaranteed to be greater than [x0](#). If you require that, use [xmax](#).

**xmax**

(property) [xmax](#) is the right edge of the bounding box.

**xmin**

(property) [xmin](#) is the left edge of the bounding box.

**y0**

(property) [y0](#) is the first of the pair of *y* coordinates that define the bounding box. [y0](#) is not guaranteed to be less than [y1](#). If you require that, use [ymin](#).

**y1**

(property) [y1](#) is the second of the pair of *y* coordinates that define the bounding box. [y1](#) is not guaranteed to be greater than [y0](#). If you require that, use [ymax](#).

**ymax**

(property) [ymax](#) is the top edge of the bounding box.

**ymin**

(property) [ymin](#) is the bottom edge of the bounding box.

**class Bbox**(*points*)

Bases: [matplotlib.transforms.BboxBase](#)

A mutable bounding box.

*points*: a 2x2 numpy array of the form `[[x0, y0], [x1, y1]]`

If you need to create a [Bbox](#) object from another form of data, consider the static methods [unit\(\)](#), [from\\_bounds\(\)](#) and [from\\_extents\(\)](#).

static **from\_bounds**(*x0*, *y0*, *width*, *height*)

(staticmethod) Create a new [Bbox](#) from *x0*, *y0*, *width* and *height*.

*width* and *height* may be negative.

static **from\_extents**(\**args*)

(staticmethod) Create a new [Bbox](#) from *left*, *bottom*, *right* and *top*.



The y-axis increases upwards.

### **get\_points()**

Get the points of the bounding box directly as a numpy array of the form: `[[x0, y0], [x1, y1]]`.

### **ignore(value)**

Set whether the existing bounds of the box should be ignored by subsequent calls to `update_from_data()` or `update_from_data_xy()`.

*value:*

- When True, subsequent calls to `update_from_data()` will ignore the existing bounds of the `Bbox`.
- When False, subsequent calls to `update_from_data()` will include the existing bounds of the `Bbox`.

### **mutated()**

return whether the bbox has changed since init

### **mutatedx()**

return whether the x-limits have changed since init

### **mutatedy()**

return whether the y-limits have changed since init

### **set(other)**

Set this bounding box from the “frozen” bounds of another `Bbox`.

### **set\_points(points)**

Set the points of the bounding box directly from a numpy array of the form: `[[x0, y0], [x1, y1]]`. No error checking is performed, as this method is mainly for internal use.

### static **unit()**

(staticmethod) Create a new unit `Bbox` from (0, 0) to (1, 1).

### **update\_from\_data(x, y, ignore=None)**

Update the bounds of the `Bbox` based on the passed in data. After updating, the bounds will have positive *width* and *height*; *x0* and *y0* will be the minimal values.

*x*: a numpy array of *x*-values

*y*: a numpy array of *y*-values

*ignore:*

- when True, ignore the existing bounds of the `Bbox`.
- when False, include the existing bounds of the `Bbox`.
- when None, use the last value passed to `ignore()`.

### **update\_from\_data\_xy(xy, ignore=None, updatex=True, updatey=True)**

Update the bounds of the `Bbox` based on the passed in data. After updating, the bounds will have positive *width* and *height*; *x0* and *y0* will be the minimal values.

*xy*: a numpy array of 2D points

*ignore:*

- when True, ignore the existing bounds of the [Bbox](#).
- when False, include the existing bounds of the [Bbox](#).
- when None, use the last value passed to [ignore\(\)](#).

*updatex:* when True, update the x values

*updatey:* when True, update the y values

**update\_from\_path**(*path*, *ignore=None*, *updatex=True*, *updatey=True*)

Update the bounds of the [Bbox](#) based on the passed in data. After updating, the bounds will have positive *width* and *height*; *x0* and *y0* will be the minimal values.

*path:* a [Path](#) instance

*ignore:*

- when True, ignore the existing bounds of the [Bbox](#).
- when False, include the existing bounds of the [Bbox](#).
- when None, use the last value passed to [ignore\(\)](#).

*updatex:* when True, update the x values

*updatey:* when True, update the y values

**class TransformedBbox**(*bbox*, *transform*)

Bases: [matplotlib.transforms.BboxBase](#)

A [Bbox](#) that is automatically transformed by a given transform. When either the child bounding box or transform changes, the bounds of this bbox will update accordingly.

*bbox:* a child [Bbox](#)

*transform:* a 2D [Transform](#)

**get\_points**()

Get the points of the bounding box directly as a numpy array of the form: `[[x0, y0], [x1, y1]]`.

**class Transform**()

Bases: [matplotlib.transforms.TransformNode](#)

The base class of all [TransformNode](#) instances that actually perform a transformation.

All non-affine transformations should be subclasses of this class. New affine transformations should be subclasses of [Affine2D](#).

Subclasses of this class should override the following members (at minimum):

- `input_dims`
- `output_dims`
- `transform()`
- `is_separable`

- `has_inverse`
- `inverted()` (if `has_inverse()` can return True)

If the transform needs to do something non-standard with `matplotlib.path.Path` objects, such as adding curves where there were once line segments, it should override:

- `transform_path()`

Creates a new `TransformNode`.

### `get_affine()`

Get the affine part of this transform.

### `inverted()`

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

### `transform(values)`

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

### `transform_affine(values)`

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

### `transform_angles(angles, pts, radians=False, pushoff=1.0000000000000001e-05)`

Performs transformation on a set of angles anchored at specific locations.

The *angles* must be a column vector (i.e., numpy array).

The *pts* must be a two-column numpy array of x,y positions (angle transforms currently only work in 2D). This array must have the same number of rows as *angles*.

***radians* indicates whether or not input angles are given in** radians (True) or degrees (False; the default).

***pushoff* is the distance to move away from *pts* for** determining transformed angles (see discussion of method below).

The transformed angles are returned in an array with the same size as *angles*.

The generic version of this method uses a very generic algorithm that transforms *pts*, as well as locations very close to *pts*, to find the angle in the transformed system.

**transform\_non\_affine(values)**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_path(path)**

Returns a transformed copy of path.

*path*: a [Path](#) instance.

In some cases, this transform may insert curves into the path that began as line segments.

**transform\_path\_affine(path)**

Returns a copy of path, transformed only by the affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**transform\_path\_non\_affine(path)**

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**transform\_point(point)**

A convenience function that returns the transformed copy of a single point.

The point is given as a sequence of length input\_dims. The transformed point is returned as a sequence of length output\_dims.

**class TransformWrapper(child)**

Bases: [matplotlib.transforms.Transform](#)

A helper class that holds a single child transform and acts equivalently to it.

This is useful if a node of the transform tree must be replaced at run time with a transform of a different type. This class allows that replacement to correctly trigger invalidation.

Note that [TransformWrapper](#) instances must have the same input and output dimensions during their entire lifetime, so the child transform may only be replaced with another child transform of the same dimensions.

*child*: A class:[Transform](#) instance. This child may later be replaced with [set\(\)](#).

**frozen()**

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**set(*child*)**

Replace the current child of this transform with another one.

The new child must have the same number of input and output dimensions as the current child.

**class AffineBase()**

Bases: `matplotlib.transforms.Transform`

The base class of all affine transformations of any number of dimensions.

**get\_affine()**

Get the affine part of this transform.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**transform\_non\_affine(*points*)**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_path\_affine(*path*)**

Returns a copy of path, transformed only by the affine part of this transform.

*path*: a `Path` instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**transform\_path\_non\_affine(*path*)**

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a `Path` instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**class Affine2DBase()**

Bases: `matplotlib.transforms.AffineBase`

The base class of all 2D affine transformations.

2D affine transformations are performed using a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

This class provides the read-only interface. For a mutable 2D affine transformation, use `Affine2D`.

Subclasses of this class will generally only need to override a constructor and `get_matrix()` that generates a custom 3x3 matrix.

**frozen()**

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**inverted()**

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

**static matrix\_from\_values(a, b, c, d, e, f)**

(staticmethod) Create a new transformation matrix as a 3x3 numpy array of the form:

```
a c e
b d f
0 0 1
```

**to\_values()**

Return the values of the matrix as a sequence (a,b,c,d,e,f)

**transform(points)**

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_affine(points)**

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_point(point)**

A convenience function that returns the transformed copy of a single point.

The point is given as a sequence of length input\_dims. The transformed point is returned as a sequence of length output\_dims.

**class Affine2D(matrix=None)**

Bases: `matplotlib.transforms.Affine2DBase`

A mutable 2D affine transformation.

Initialize an Affine transform from a 3x3 numpy float array:

```
a c e
b d f
0 0 1
```

If *matrix* is None, initialize with the identity transform.

**clear()**

Reset the underlying matrix to the identity transform.

static **from\_values**(*a, b, c, d, e, f*)

(staticmethod) Create a new `Affine2D` instance from the given values:

```
a c e
b d f
0 0 1
```

**get\_matrix()**

Get the underlying transformation matrix as a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

static **identity()**

(staticmethod) Return a new `Affine2D` object that is the identity transform.

Unless this transform will be mutated later on, consider using the faster `IdentityTransform` class instead.

**rotate**(*theta*)

Add a rotation (in radians) to this transform in place.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**rotate\_around**(*x, y, theta*)

Add a rotation (in radians) around the point (*x, y*) in place.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**rotate\_deg**(*degrees*)

Add a rotation (in degrees) to this transform in place.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**rotate\_deg\_around**(*x, y, degrees*)

Add a rotation (in degrees) around the point (*x, y*) in place.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**scale**(*sx*, *sy=None*)

Adds a scale in place.

If *sy* is *None*, the same scale is applied in both the *x*- and *y*-directions.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**set**(*other*)

Set this transformation from the frozen copy of another `Affine2DBase` object.

**set\_matrix**(*mtx*)

Set the underlying transformation matrix from a 3x3 numpy array:

```
a c e
b d f
0 0 1
```

**translate**(*tx*, *ty*)

Adds a translation in place.

Returns *self*, so this method can easily be chained with more calls to `rotate()`, `rotate_deg()`, `translate()` and `scale()`.

**class IdentityTransform()**

Bases: `matplotlib.transforms.Affine2DBase`

A special class that does on thing, the identity transform, in a fast way.

**frozen**()

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**get\_affine**()

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

**get\_matrix**()

Get the underlying transformation matrix as a numpy array.

**inverted**()

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

**transform**(*points*)

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.



In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

#### **`transform_affine(points)`**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

#### **`transform_non_affine(points)`**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x `input_dims`) and returns a numpy array of shape (N x `output_dims`).

#### **`transform_path(path)`**

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

#### **`transform_path_affine(path)`**

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

#### **`transform_path_non_affine(path)`**

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

### **`class BlendedGenericTransform(x_transform, y_transform)`**

Bases: [matplotlib.transforms.Transform](#)

A “blended” transform uses one transform for the *x*-direction, and another transform for the *y*-direction.

This “generic” version can handle any given child transform in the *x*- and *y*-directions.

Create a new “blended” transform using *x\_transform* to transform the *x*-axis and *y\_transform* to transform the *y*-axis.

You will generally not call this constructor directly but use the `blended_transform_factory()` function instead, which can determine automatically which kind of blended transform to create.

**frozen()**

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**get\_affine()**

Get the affine part of this transform.

**inverted()**

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

**transform(*points*)**

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_affine(*points*)**

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_non\_affine(*points*)**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**class BlendedAffine2D(*x\_transform*, *y\_transform*)**

Bases: `matplotlib.transforms.Affine2DBase`

A “blended” transform uses one transform for the *x*-direction, and another transform for the *y*-direction.

This version is an optimization for the case where both child transforms are of type `Affine2DBase`.

Create a new “blended” transform using *x\_transform* to transform the *x*-axis and *y\_transform* to transform the *y*-axis.

Both *x\_transform* and *y\_transform* must be 2D affine transforms.

You will generally not call this constructor directly but use the `blended_transform_factory()` function instead, which can determine automatically which kind of blended transform to create.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**blended\_transform\_factory**(*x\_transform*, *y\_transform*)

Create a new “blended” transform using *x\_transform* to transform the *x*-axis and *y\_transform* to transform the *y*-axis.

A faster version of the blended transform is returned for the case where both child transforms are affine.

**class CompositeGenericTransform**(*a*, *b*)

Bases: `matplotlib.transforms.Transform`

A composite transform formed by applying transform *a* then transform *b*.

This “generic” version can handle any two arbitrary transformations.

Create a new composite transform that is the result of applying transform *a* then transform *b*.

You will generally not call this constructor directly but use the `composite_transform_factory()` function instead, which can automatically choose the best kind of composite transform instance to create.

**frozen()**

Returns a frozen copy of this transform node. The frozen copy will not update when its children change. Useful for storing a previously known state of a transform where `copy.deepcopy()` might normally be used.

**get\_affine()**

Get the affine part of this transform.

**inverted()**

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

```
x === self.inverted().transform(self.transform(x))
```

**transform**(*points*)

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_affine**(*points*)

Performs only the affine part of this transformation on the given array of values.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally a no-op. In affine transformations, this is equivalent to `transform(values)`.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_non\_affine**(*points*)

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**transform\_path**(*path*)

Returns a transformed copy of path.

*path*: a [Path](#) instance.

In some cases, this transform may insert curves into the path that began as line segments.

**transform\_path\_affine**(*path*)

Returns a copy of path, transformed only by the affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**transform\_path\_non\_affine**(*path*)

Returns a copy of path, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(values))`.

**class CompositeAffine2D**(*a*, *b*)

Bases: [matplotlib.transforms.Affine2DBase](#)

A composite transform formed by applying transform *a* then transform *b*.

This version is an optimization that handles the case where both *a* and *b* are 2D affines.

Create a new composite transform that is the result of applying transform *a* then transform *b*.

Both *a* and *b* must be instances of [Affine2DBase](#).

You will generally not call this constructor directly but use the [composite\\_transform\\_factory\(\)](#) function instead, which can automatically choose the best kind of composite transform instance to create.

**get\_matrix**()

Get the underlying transformation matrix as a numpy array.

**composite\_transform\_factory**(*a*, *b*)

Create a new composite transform that is the result of applying transform *a* then transform *b*.

Shortcut versions of the blended transform are provided for the case where both child transforms are affine, or one or the other is the identity transform.

Composite transforms may also be created using the ‘+’ operator, e.g.:

```
c = a + b
```

**class BboxTransform**(*boxin, boxout*)

Bases: `matplotlib.transforms.Affine2DBase`

**BboxTransform** linearly transforms points from one **Bbox** to another **Bbox**.

Create a new **BboxTransform** that linearly transforms points from *boxin* to *boxout*.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**class BboxTransformTo**(*boxout*)

Bases: `matplotlib.transforms.Affine2DBase`

**BboxTransformTo** is a transformation that linearly transforms points from the unit bounding box to a given **Bbox**.

Create a new **BboxTransformTo** that linearly transforms points from the unit bounding box to *boxout*.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**class BboxTransformFrom**(*boxin*)

Bases: `matplotlib.transforms.Affine2DBase`

**BboxTransformFrom** linearly transforms points from a given **Bbox** to the unit bounding box.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**class ScaledTranslation**(*xt, yt, scale\_trans*)

Bases: `matplotlib.transforms.Affine2DBase`

A transformation that translates by *xt* and *yt*, after *xt* and *yt* have been transformed by the given transform *scale\_trans*.

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**class TransformedPath**(*path, transform*)

Bases: `matplotlib.transforms.TransformNode`

A **TransformedPath** caches a non-affine transformed copy of the **Path**. This cached copy is automatically updated when the non-affine part of the transform changes.

Create a new **TransformedPath** from the given **Path** and **Transform**.

**get\_fully\_transformed\_path()**

Return a fully-transformed copy of the child path.

**get\_transformed\_path\_and\_affine()**

Return a copy of the child path, with the non-affine part of the transform already applied, along with the affine part of the path necessary to complete the transformation.

**get\_transformed\_points\_and\_affine()**

Return a copy of the child path, with the non-affine part of the transform already applied, along with the affine part of the path necessary to complete the transformation. Unlike [get\\_transformed\\_path\\_and\\_affine\(\)](#), no interpolation will be performed.

**nonsingular**(*vmin*, *vmax*, *expander*=0.001, *tiny*=1.0000000000000001e-15, *increasing*=True)

Ensure the endpoints of a range are finite and not too close together.

“too close” means the interval is smaller than ‘tiny’ times the maximum absolute value.

If they are too close, each will be moved by the ‘expander’. If ‘increasing’ is True and  $vmin > vmax$ , they will be swapped, regardless of whether they are too close.

If either is inf or -inf or nan, return - expander, expander.

# ADDING NEW SCALES AND PROJECTIONS TO MATPLOTLIB

Matplotlib supports the addition of custom procedures that transform the data before it is displayed.

There is an important distinction between two kinds of transformations. Separable transformations, working on a single dimension, are called “scales”, and non-separable transformations, that handle data in two or more dimensions at a time, are called “projections”.

From the user’s perspective, the scale of a plot can be set with `set_xscale()` and `set_yscale()`. Projections can be chosen using the `projection` keyword argument to the `plot()` or `subplot()` functions, e.g.:

```
plot(x, y, projection="custom")
```

This document is intended for developers and advanced users who need to create new scales and projections for matplotlib. The necessary code for scales and projections can be included anywhere: directly within a plot script, in third-party code, or in the matplotlib source tree itself.

## 32.1 Creating a new scale

Adding a new scale consists of defining a subclass of `matplotlib.scale.ScaleBase`, that includes the following elements:

- A transformation from data coordinates into display coordinates.
- An inverse of that transformation. This is used, for example, to convert mouse positions from screen space back into data space.
- A function to limit the range of the axis to acceptable values (`limit_range_for_scale()`). A log scale, for instance, would prevent the range from including values less than or equal to zero.
- Locators (major and minor) that determine where to place ticks in the plot, and optionally, how to adjust the limits of the plot to some “good” values. Unlike `limit_range_for_scale()`, which is always enforced, the range setting here is only used when automatically setting the range of the plot.
- Formatters (major and minor) that specify how the tick labels should be drawn.

Once the class is defined, it must be registered with matplotlib so that the user can select it.

A full-fledged and heavily annotated example is in `examples/api/custom_scale_example.py`. There are also some classes in `matplotlib.scale` that may be used as starting points.

## 32.2 Creating a new projection

Adding a new projection consists of defining a subclass of `matplotlib.axes.Axes`, that includes the following elements:

- A transformation from data coordinates into display coordinates.
- An inverse of that transformation. This is used, for example, to convert mouse positions from screen space back into data space.
- Transformations for the gridlines, ticks and ticklabels. Custom projections will often need to place these elements in special locations, and matplotlib has a facility to help with doing so.
- Setting up default values (overriding `cla()`), since the defaults for a rectilinear axes may not be appropriate.
- Defining the shape of the axes, for example, an elliptical axes, that will be used to draw the background of the plot and for clipping any data elements.
- Defining custom locators and formatters for the projection. For example, in a geographic projection, it may be more convenient to display the grid in degrees, even if the data is in radians.
- Set up interactive panning and zooming. This is left as an “advanced” feature left to the reader, but there is an example of this for polar plots in `matplotlib.projections.polar`.
- Any additional methods for additional convenience or features.

Once the class is defined, it must be registered with matplotlib so that the user can select it.

A full-fledged and heavily annotated example is in `examples/api/custom_projection_example.py`. The polar plot functionality in `matplotlib.projections.polar` may also be of interest.

## 32.3 API documentation

### 32.3.1 `matplotlib.scale`

**class** `LinearScale`(*axis*, *\*\*kwargs*)

Bases: `matplotlib.scale.ScaleBase`

The default linear scale.

**get\_transform**()

The transform for linear scaling is just the `IdentityTransform`.

**set\_default\_locators\_and\_formatters**(*axis*)

Set the locators and formatters to reasonable defaults for linear scaling.



**class LogScale**(*axis*, *\*\*kwargs*)

Bases: `matplotlib.scale.ScaleBase`

A standard logarithmic scale. Care is taken so non-positive values are not plotted.

For computational efficiency (to push as much as possible to Numpy C code in the common cases), this scale provides different transforms depending on the base of the logarithm:

- base 10 (`Log10Transform`)
- base 2 (`Log2Transform`)
- base e (`NaturalLogTransform`)
- arbitrary base (`LogTransform`)

**basex/basey**: The base of the logarithm

**nonposx/nonposy**: [`'mask'` | `'clip'`] non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

**subsx/subsy**: Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**get\_transform()**

Return a `Transform` instance appropriate for the given logarithm base.

**limit\_range\_for\_scale**(*vmin*, *vmax*, *minpos*)

Limit the domain to positive values.

**set\_default\_locators\_and\_formatters**(*axis*)

Set the locators and formatters to specialized versions for log scaling.

**class ScaleBase**()

Bases: `object`

The base class for all scales.

Scales are separable transformations, working on a single dimension.

Any subclasses will want to override:

- `name`
- `get_transform()`

And optionally:

- `set_default_locators_and_formatters()`
- `limit_range_for_scale()`

**get\_transform()**

Return the `Transform` object associated with this scale.

**limit\_range\_for\_scale**(*vmin*, *vmax*, *minpos*)

Returns the range *vmin*, *vmax*, possibly limited to the domain supported by this scale.

***minpos* should be the minimum positive value in the data.** This is used by log scales to determine a minimum value.

**set\_default\_locators\_and\_formatters**(*axis*)

Set the [Locator](#) and [Formatter](#) objects on the given axis to match this scale.

**class SymmetricalLogScale**(*axis*, *\*\*kwargs*)

Bases: [matplotlib.scale.ScaleBase](#)

The symmetrical logarithmic scale is logarithmic in both the positive and negative directions from the origin.

Since the values close to zero tend toward infinity, there is a need to have a range around zero that is linear. The parameter *linthresh* allows the user to specify the size of this range (*-linthresh*, *linthresh*).

***base*/*base*:** The base of the logarithm

***linthreshx*/*linthreshy*:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

***subsx*/*subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**get\_transform**()

Return a [SymmetricalLogTransform](#) instance.

**set\_default\_locators\_and\_formatters**(*axis*)

Set the locators and formatters to specialized versions for symmetrical log scaling.

**get\_scale\_docs**()

Helper function for generating docstrings related to scales.

**register\_scale**(*scale\_class*)

Register a new kind of scale.

*scale\_class* must be a subclass of [ScaleBase](#).

**scale\_factory**(*scale*, *axis*, *\*\*kwargs*)

Return a scale class by name.

ACCEPTS: [ linear | log | symlog ]

### 32.3.2 matplotlib.projections

**class ProjectionRegistry**()

Bases: `object`

Manages the set of projections available to the system.

**get\_projection\_class**(*name*)

Get a projection class from its *name*.

**get\_projection\_names()**

Get a list of the names of all projections currently registered.

**register(\*projections)**

Register a new set of projection(s).

**get\_projection\_class(projection=None)**

Get a projection class from its name.

If *projection* is None, a standard rectilinear projection is returned.

**get\_projection\_names()**

Get a list of acceptable projection names.

**projection\_factory(projection, figure, rect, \*\*kwargs)**

Get a new projection instance.

*projection* is a projection name.

*figure* is a figure to add the axes to.

*rect* is a [Bbox](#) object specifying the location of the axes within the figure.

Any other kwargs are passed along to the specific projection constructor being used.

## matplotlib.projections.polar

**class PolarAxes(\*args, \*\*kwargs)**

Bases: [matplotlib.axes.Axes](#)

A polar graph projection, where the input dimensions are *theta*, *r*.

Theta starts pointing east and goes anti-clockwise.

**class InvertedPolarTransform(axis=None, use\_rmin=True)**

Bases: [matplotlib.transforms.Transform](#)

The inverse of the polar transform, mapping Cartesian coordinate space *x* and *y* back to *theta* and *r*.

**inverted()**

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

**transform(xy)**

Performs the transformation on the given array of values.

Accepts a numpy array of shape (N x input\_dims) and returns a numpy array of shape (N x output\_dims).

**class PolarAffine(scale\_transform, limits)**

Bases: [matplotlib.transforms.Affine2DBase](#)

The affine part of the polar projection. Scales the output so that maximum radius rests on the edge of the axes circle.

*limits* is the view limit of the data. The only part of its bounds that is used is *y*max (for the radius maximum). The theta range is always fixed to (0, 2pi).

**get\_matrix()**

Get the underlying transformation matrix as a numpy array.

**class PolarTransform**(*axis=None, use\_rmin=True*)

Bases: [matplotlib.transforms.Transform](#)

The base polar transform. This handles projection *theta* and *r* into Cartesian coordinate space *x* and *y*, but does not perform the ultimate affine transformation into the correct position.

**inverted()**

Return the corresponding inverse transformation.

The return value of this method should be treated as temporary. An update to *self* does not cause a corresponding update to its inverted copy.

`x == self.inverted().transform(self.transform(x))`

**transform(*tr*)**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

**transform\_non\_affine(*tr*)**

Performs only the non-affine part of the transformation.

`transform(values)` is always equivalent to `transform_affine(transform_non_affine(values))`.

In non-affine transformations, this is generally equivalent to `transform(values)`. In affine transformations, this is always a no-op.

Accepts a numpy array of shape (N x *input\_dims*) and returns a numpy array of shape (N x *output\_dims*).

**transform\_path(*path*)**

Returns a copy of *path*, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(va`

**transform\_path\_non\_affine(*path*)**

Returns a copy of *path*, transformed only by the non-affine part of this transform.

*path*: a [Path](#) instance.

`transform_path(path)` is equivalent to `transform_path_affine(transform_path_non_affine(va`

**class RadialLocator**(*base*)

Bases: `matplotlib.ticker.Locator`

Used to locate radius ticks.

Ensures that all ticks are strictly positive. For all other tasks, it delegates to the base `Locator` (which may be different depending on the scale of the *r*-axis).

**class ThetaFormatter**()

Bases: `matplotlib.ticker.Formatter`

Used to format the *theta* tick labels. Converts the native unit of radians into degrees and adds a degree symbol.

**can\_pan**()

Return *True* if this axes supports the pan/zoom button functionality.

For polar axes, this is slightly misleading. Both panning and zooming are performed by the same button. Panning is performed in azimuth while zooming is done along the radial.

**can\_zoom**()

Return *True* if this axes supports the zoom box button functionality.

Polar axes do not support zoom boxes.

**format\_coord**(*theta*, *r*)

Return a format string formatting the coordinate using Unicode characters.

**get\_data\_ratio**()

Return the aspect ratio of the data itself. For a polar plot, this should always be 1.0

**get\_theta\_direction**()

Get the direction in which theta increases.

**-1:** Theta increases in the clockwise direction

**1:** Theta increases in the counterclockwise direction

**get\_theta\_offset**()

Get the offset for the location of 0 in radians.

**set\_rgrids**(*radii*, *labels=None*, *angle=None*, *rpadd=None*, *fmt=None*, *\*\*kwargs*)

Set the radial locations and labels of the *r* grids.

The labels will appear at radial distances *radii* at the given *angle* in degrees.

*labels*, if not *None*, is a `len(radii)` list of strings of the labels to use at each radius.

If *labels* is *None*, the built-in formatter will be used.

*rpadd* is a fraction of the max of *radii* which will pad each of the radial labels in the radial direction.

Return value is a list of tuples (*line*, *label*), where *line* is `Line2D` instances and the *label* is `Text` instances.

*kwargs* are optional text properties for the labels:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]   |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]  |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance   |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'ultra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>   | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code>                         | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>   | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

ACCEPTS: sequence of floats

**set\_rscale**(*value*, *\*\*kwargs*)

call signature:

`set_yscale(value)`

Set the scaling of the y-axis: 'linear' | 'log' | 'symlog'

ACCEPTS: ['linear' | 'log' | 'symlog']

Different kwargs are accepted, depending on the scale: 'linear'

'log'

**basex/basey:** The base of the logarithm

**nonposx/nonposy:** ['mask' | 'clip' ] non-positive values in  $x$  or  $y$  can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

'symlog'

**basex/basey:** The base of the logarithm

**linthreshx/linthreshy:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**set\_rticks**(*ticks*, *minor=False*)

Set the y ticks with list of *ticks*

ACCEPTS: sequence of floats

Keyword arguments:

**minor:** [ False | True ] Sets the minor ticks if True

**set\_theta\_direction**(*direction*)

Set the direction in which theta increases.

**clockwise, -1:** Theta increases in the clockwise direction

**counterclockwise, anticlockwise, 1:** Theta increases in the counterclockwise direction

**set\_theta\_offset**(*offset*)

Set the offset for the location of 0 in radians.

**set\_theta\_zero\_location**(*loc*)

Sets the location of theta's zero. (Calls `set_theta_offset` with the correct value in radians under the hood.)

May be one of “N”, “NW”, “W”, “SW”, “S”, “SE”, “E”, or “NE”.

**set\_thetagrids**(*angles*, *labels=None*, *frac=None*, *fmt=None*, *\*\*kwargs*)

Set the angles at which to place the theta grids (these gridlines are equal along the theta dimension). *angles* is in degrees.

*labels*, if not None, is a `len(angles)` list of strings of the labels to use at each angle.

If *labels* is None, the labels will be `fmt % angle`

*frac* is the fraction of the polar axes radius at which to place the label (1 is the edge). Eg. 1.05 is outside the axes and 0.95 is inside the axes.

Return value is a list of tuples (*line*, *label*), where *line* is `Line2D` instances and the *label* is `Text` instances.

*kwargs* are optional text properties for the labels:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]                       |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ <code>FONTNAME</code>   ‘serif’   ‘sans-serif’   ‘cursive’   ‘fantasy’   ‘monospace’ ]             |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                                       |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ ‘center’   ‘right’   ‘left’ ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [‘left’   ‘right’   ‘center’ ]   |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   ‘vertical’   ‘horizontal’ ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   ‘xx-small’   ‘x-small’   ‘small’   ‘medium’   ‘large’   ‘x-large’ ]               |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   ‘ultra-condensed’   ‘extra-condensed’   ‘condensed’   ‘normal’ ] |
| <code>style</code> or <code>fontstyle</code>   | [ ‘normal’   ‘italic’   ‘oblique’ ]  |
| <code>text</code>  | string or anything printable with ‘%s’ conversion.   |



Table 32.2 – continued from

|  |   |
|--|---|
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]   |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]  |
| <code>visible</code>   | [True   False]  |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular' ] |
| <code>x</code>   | float   |
| <code>y</code>   | float   |
| <code>zorder</code>  | any number  |

ACCEPTS: sequence of floats



## DOCS OUTLINE

Proposed chapters for the docs, who has responsibility for them, and who reviews them. The “unit” doesn’t have to be a full chapter (though in some cases it will be), it may be a chapter or a section in a chapter.

| User’s guide unit   | Author    | Status     | Reviewer        |
|---------------------|-----------|------------|-----------------|
| plotting 2-D arrays | Eric      | has author | Perry ? Darren  |
| colormapping        | Eric      | has author | ?               |
| quiver plots        | Eric      | has author | ?               |
| histograms          | Manuel ?  | no author  | Erik Tollerud ? |
| bar / errorbar      | ?         | no author  | ?               |
| x-y plots           | ?         | no author  | Darren          |
| time series plots   | ?         | no author  | ?               |
| date plots          | John      | has author | ?               |
| working with data   | John      | has author | Darren          |
| custom ticking      | ?         | no author  | ?               |
| masked data         | Eric      | has author | ?               |
| patches             | ?         | no author  | ?               |
| legends             | ?         | no author  | ?               |
| animation           | John      | has author | ?               |
| collections         | ?         | no author  | ?               |
| text - mathtext     | Michael   | accepted   | John            |
| text - usetex       | Darren    | accepted   | John            |
| text - annotations  | John      | submitted  | ?               |
| fonts et al         | Michael ? | no author  | Darren          |
| pyplot tut          | John      | submitted  | Eric            |
| configuration       | Darren    | submitted  | ?               |
| win32 install       | Charlie ? | no author  | Darren          |
| os x install        | Charlie ? | no author  | ?               |
| linux install       | Darren    | has author | ?               |
| artist api          | John      | submitted  | ?               |
| event handling      | John      | submitted  | ?               |
| navigation          | John      | submitted  | ?               |
| interactive usage   | ?         | no author  | ?               |
| widgets             | ?         | no author  | ?               |
| ui - gtk            | ?         | no author  | ?               |

Continued on next page

Table 33.1 – continued from previous page

|                 |         |            |   |
|-----------------|---------|------------|---|
| ui - wx         | ?       | no author  | ? |
| ui - tk         | ?       | no author  | ? |
| ui - qt         | Darren  | has author | ? |
| backend - pdf   | Jouni ? | no author  | ? |
| backend - ps    | Darren  | has author | ? |
| backend - svg   | ?       | no author  | ? |
| backend - agg   | ?       | no author  | ? |
| backend - cairo | ?       | no author  | ? |

Here is the outline for the dev guide, much less fleshed out

| Developer’s guide unit | Author  | Status     | Reviewer          |
|------------------------|---------|------------|-------------------|
| the renderer           | John    | has author | Michael ?         |
| the canvas             | John    | has author | ?                 |
| the artist             | John    | has author | ?                 |
| transforms             | Michael | submitted  | John              |
| documenting mpl        | Darren  | submitted  | John, Eric, Mike? |
| coding guide           | John    | complete   | Eric              |
| and_much_more          | ?       | ?          | ?                 |

We also have some work to do converting docstrings to ReST for the API Reference. Please be sure to follow the few guidelines described in [Formatting](#). Once it is converted, please include the module in the API documentation and update the status in the table to “converted”. Once docstring conversion is complete and all the modules are available in the docs, we can figure out how best to organize the API Reference and continue from there.

| Module           | Author | Status           |
|------------------|--------|------------------|
| backend_agg      |        | needs conversion |
| backend_cairo    |        | needs conversion |
| backend_cocoa    |        | needs conversion |
| backend_emf      |        | needs conversion |
| backend_fltkagg  |        | needs conversion |
| backend_gdk      |        | needs conversion |
| backend_gtk      |        | needs conversion |
| backend_gtkagg   |        | needs conversion |
| backend_gtkcairo |        | needs conversion |
| backend_mixed    |        | needs conversion |
| backend_pdf      |        | needs conversion |
| backend_ps       | Darren | needs conversion |
| backend_qt       | Darren | needs conversion |
| backend_qtagg    | Darren | needs conversion |
| backend_qt4      | Darren | needs conversion |
| backend_qt4agg   | Darren | needs conversion |
| backend_svg      |        | needs conversion |
| backend_template |        | needs conversion |
| backend_tkagg    |        | needs conversion |
| backend_wx       |        | needs conversion |

Continued on next page

Table 33.2 – continued from previous page

|                        |            |                                       |
|------------------------|------------|---------------------------------------|
| backend_wxagg          |            | needs conversion                      |
| backends/tkagg         |            | needs conversion                      |
| config/checkdep        | Darren     | needs conversion                      |
| config/cutlils         | Darren     | needs conversion                      |
| config/mplconfig       | Darren     | needs conversion                      |
| config/mpltraits       | Darren     | needs conversion                      |
| config/rcparams        | Darren     | needs conversion                      |
| config/rcsetup         | Darren     | needs conversion                      |
| config/tconfig         | Darren     | needs conversion                      |
| config/verbose         | Darren     | needs conversion                      |
| projections/__init__   | Mike       | converted                             |
| projections/geo        | Mike       | converted (not included–experimental) |
| projections/polar      | Mike       | converted                             |
| afm                    |            | converted                             |
| artist                 |            | converted                             |
| axes                   |            | converted                             |
| axis                   |            | converted                             |
| backend_bases          |            | converted                             |
| cbook                  |            | converted                             |
| cm                     |            | converted                             |
| collections            |            | converted                             |
| colorbar               |            | converted                             |
| colors                 |            | converted                             |
| contour                |            | needs conversion                      |
| dates                  | Darren     | needs conversion                      |
| dviread                | Darren     | needs conversion                      |
| figure                 | Darren     | needs conversion                      |
| finance                | Darren     | needs conversion                      |
| font_manager           | Mike       | converted                             |
| fontconfig_pattern     | Mike       | converted                             |
| image                  |            | needs conversion                      |
| legend                 |            | needs conversion                      |
| lines                  | Mike & ??? | converted                             |
| mathtext               | Mike       | converted                             |
| mlab                   | John/Mike  | converted                             |
| mpl                    |            | N/A                                   |
| patches                | Mike       | converted                             |
| path                   | Mike       | converted                             |
| pylab                  |            | N/A                                   |
| pyplot                 |            | converted                             |
| quiver                 |            | needs conversion                      |
| rcsetup                |            | needs conversion                      |
| scale                  | Mike       | converted                             |
| table                  |            | needs conversion                      |
| texmanager             | Darren     | needs conversion                      |
| text                   | Mike       | converted                             |
| Continued on next page |            |                                       |

Table 33.2 – continued from previous page

|            |      |                  |
|------------|------|------------------|
| ticker     | John | converted        |
| transforms | Mike | converted        |
| type1font  |      | needs conversion |
| units      |      | needs conversion |
| widgets    |      | needs conversion |

And we might want to do a similar table for the FAQ, but that may also be overkill...

If you agree to author a unit, remove the question mark by your name (or add your name if there is no candidate), and change the status to “has author”. Once you have completed draft and checked it in, you can change the status to “submitted” and try to find a reviewer if you don’t have one. The reviewer should read your chapter, test it for correctness (eg try your examples) and change the status to “complete” when done.

You are free to lift and convert as much material from the web site or the existing latex user’s guide as you see fit. The more the better.

The UI chapters should give an example or two of using mpl with your GUI and any relevant info, such as version, installation, config, etc... The backend chapters should cover backend specific configuration (eg PS only options), what features are missing, etc...

Please feel free to add units, volunteer to review or author a chapter, etc...

It is probably easiest to be an editor. Once you have signed up to be an editor, if you have an author pester the author for a submission every so often. If you don’t have an author, find one, and then pester them! Your only two responsibilities are getting your author to produce and checking their work, so don’t be shy. You *do not* need to be an expert in the subject you are editing – you should know something about it and be willing to read, test, give feedback and pester!

## 33.1 Reviewer notes

If you want to make notes for the author when you have reviewed a submission, you can put them here. As the author cleans them up or addresses them, they should be removed.

### 33.1.1 mathtext user’s guide– reviewed by JDH

This looks good (see *Writing mathematical expressions*) – there are a few minor things to close the book on this chapter:

1. **The main thing to wrap this up is getting the mathtext module** ported over to rest and included in the API so the links from the user’s guide tutorial work.
  - There’s nothing in the mathtext module that I really consider a “public” API (i.e. that would be useful to people just doing plots). If mathtext.py were to be documented, I would put it in the developer’s docs. Maybe I should just take the link in the user’s guide out. - MGD
2. This section might also benefit from a little more detail on the customizations that are possible (eg an example fleshing out the rc options a little bit). Admittedly, this is pretty clear from reading the rc file, but it might be helpful to a newbie.

- The only rcParam that is currently useful is `mathtext.fontset`, which is documented here. The others only apply when `mathtext.fontset == 'custom'`, which I'd like to declare "unsupported". It's really hard to get a good set of math fonts working that way, though it might be useful in a bind when someone has to use a specific wacky font for `mathtext` and only needs basics, like sub/superscripts. - MGD
3. There is still a TODO in the file to include a complete list of symbols
    - Done. It's pretty extensive, thanks to STIX... - MGD





# **Part IV**

## **Toolkits**



Toolkits are collections of application-specific functions that extend matplotlib.



# BASEMAP

Plots data on map projections, with continental and political boundaries, see [basemap](#) docs.



## GTK TOOLS

`mpl_toolkits.gtktools` provides some utilities for working with GTK. This toolkit ships with `matplotlib`, but requires `pygtk`.





# EXCEL TOOLS

`mpl_toolkits.exceltools` provides some utilities for working with Excel. This toolkit ships with `matplotlib`, but requires `xlwt`



## NATGRID

`mpl_toolkits.natgrid` is an interface to `natgrid` C library for gridding irregularly spaced data. This requires a separate installation of the `natgrid` toolkit from the sourceforge [download](#) page.



## MPLLOT3D

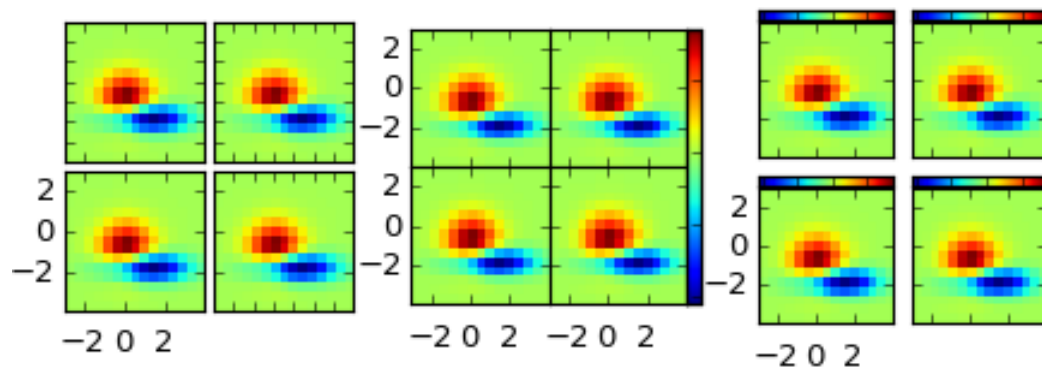
`mpl_toolkits.mplot3d` provides some basic 3D plotting (scatter, surf, line, mesh) tools. Not the fastest or feature complete 3D library out there, but ships with `matplotlib` and thus may be a lighter weight solution for some use cases.

See *mplot3d* for more documentation and examples.



## AXESGRID

The matplotlib AxesGrid toolkit is a collection of helper classes to ease displaying multiple images in matplotlib. The AxesGrid toolkit is distributed with matplotlib source.



See *Matplotlib AxesGrid Toolkit* for documentations.





# **Part V**

## **The Matplotlib API**



---

# API CHANGES

This chapter is a log of changes to matplotlib that affect the outward-facing API. If updating matplotlib breaks your scripts, this list may help describe what changes may be necessary in your code or help figure out possible sources of the changes you are experiencing.

For new features that were added to matplotlib, please see [What's new in matplotlib](#).

## 40.1 Changes in 1.1.x

- Added new `matplotlib.sankey.Sankey` for generating Sankey diagrams.
- In `imshow()`, setting *interpolation* to 'nearest' will now always mean that the nearest-neighbor interpolation is performed. If you want the no-op interpolation to be performed, choose 'none'.
- There were errors in how the tri-functions were handling input parameters that had to be fixed. If your tri-plots are not working correctly anymore, or you were working around apparent mistakes, please see issue #203 in the github tracker. When in doubt, use kwargs.
- The 'symlog' scale had some bad behavior in previous versions. This has now been fixed and users should now be able to use it without frustrations. The fixes did result in some minor changes in appearance for some users who may have been depending on the bad behavior.
- There is now a common set of markers for all plotting functions. Previously, some markers existed only for `scatter()` or just for `plot()`. This is now no longer the case. This merge did result in a conflict. The string 'd' now means "thin diamond" while 'D' will mean "regular diamond".

## 40.2 Changes beyond 0.99.x

- The default behavior of `matplotlib.axes.Axes.set_xlim()`, `matplotlib.axes.Axes.set_ylim()`, and `matplotlib.axes.Axes.axis()`, and their corresponding pyplot functions, has been changed: when view limits are set explicitly with one of these methods, autoscaling is turned off for the matching axis. A new *auto* kwarg is available to control this behavior. The limit kwargs have been renamed to *left* and *right* instead of *xmin* and *xmax*, and *bottom* and *top* instead of *ymin* and *ymax*. The old names may still be used, however.

- There are five new Axes methods with corresponding pyplot functions to facilitate autoscaling, tick location, and tick label formatting, and the general appearance of ticks and tick labels:
  - `matplotlib.axes.Axes.autoscale()` turns autoscaling on or off, and applies it.
  - `matplotlib.axes.Axes.margins()` sets margins used to autoscale the `matplotlib.axes.Axes.viewLim` based on the `matplotlib.axes.Axes.dataLim`.
  - `matplotlib.axes.Axes.locator_params()` allows one to adjust axes locator parameters such as `nbins`.
  - `matplotlib.axes.Axes.ticklabel_format()` is a convenience method for controlling the `matplotlib.ticker.ScalarFormatter` that is used by default with linear axes.
  - `matplotlib.axes.Axes.tick_params()` controls direction, size, visibility, and color of ticks and their labels.
- The `matplotlib.axes.Axes.bar()` method accepts a `error_kw` kwarg; it is a dictionary of kwargs to be passed to the errorbar function.
- The `matplotlib.axes.Axes.hist()` `color` kwarg now accepts a sequence of color specs to match a sequence of datasets.
- The `EllipseCollection` has been changed in two ways:
  - There is a new `units` option, 'xy', that scales the ellipse with the data units. This matches the `:class:'~matplotlib.patches.Ellipse'` scaling.
  - The `height` and `width` kwargs have been changed to specify the height and width, again for consistency with `Ellipse`, and to better match their names; previously they specified the half-height and half-width.
- There is a new rc parameter `axes.color_cycle`, and the color cycle is now independent of the rc parameter `lines.color`. `matplotlib.Axes.set_default_color_cycle()` is deprecated.
- You can now print several figures to one pdf file and modify the document information dictionary of a pdf file. See the docstrings of the class `matplotlib.backends.backend_pdf.PdfPages` for more information.
- Removed `configobj` and `enthought.traits` packages, which are only required by the experimental traited config and are somewhat out of date. If needed, install them independently.
- The new rc parameter `savefig.extension` sets the filename extension that is used by `matplotlib.figure.Figure.savefig()` if its `fname` argument lacks an extension.
- In an effort to simplify the backend API, all clipping rectangles and paths are now passed in using `GraphicsContext` objects, even on collections and images. Therefore:

```
draw_path_collection(self, master_transform, cliprect, clippath,
                    clippath_trans, paths, all_transforms, offsets,
                    offsetTrans, facecolors, edgecolors, linewidths,
                    linestyle, antialiaseds, urls)
```

```
# is now
```

```
draw_path_collection(self, gc, master_transform, paths, all_transforms,
```

```
offsets, offsetTrans, facecolors, edgecolors,
linewidths, linestyle, antialiaseds, urls)
```

```
draw_quad_mesh(self, master_transform, cliprect, clippath,
               clippath_trans, meshWidth, meshHeight, coordinates,
               offsets, offsetTrans, facecolors, antialiased,
               showedges)
```

```
# is now
```

```
draw_quad_mesh(self, gc, master_transform, meshWidth, meshHeight,
               coordinates, offsets, offsetTrans, facecolors,
               antialiased, showedges)
```

```
draw_image(self, x, y, im, bbox, clippath=None, clippath_trans=None)
```

```
# is now
```

```
draw_image(self, gc, x, y, im)
```

- There are four new Axes methods with corresponding pyplot functions that deal with unstructured triangular grids:
  - `matplotlib.axes.Axes.tricontour()` draws contour lines on a triangular grid.
  - `matplotlib.axes.Axes.tricontourf()` draws filled contours on a triangular grid.
  - `matplotlib.axes.Axes.tripcolor()` draws a pseudocolor plot on a triangular grid.
  - `matplotlib.axes.Axes.triplot()` draws a triangular grid as lines and/or markers.

## 40.3 Changes in 0.99

- pylab no longer provides a load and save function. These are available in `matplotlib.mlab`, or you can use `numpy.loadtxt` and `numpy.savetxt` for text files, or `np.save` and `np.load` for binary numpy arrays.
- User-generated colormaps can now be added to the set recognized by `matplotlib.cm.get_cmap()`. Colormaps can be made the default and applied to the current image using `matplotlib.pyplot.set_cmap()`.
- changed `use_mrecords` default to `False` in `mlab.csv2rec` since this is partially broken
- Axes instances no longer have a “frame” attribute. Instead, use the new “spines” attribute. Spines is a dictionary where the keys are the names of the spines (e.g. ‘left’, ‘right’ and so on) and the values are the artists that draw the spines. For normal (rectilinear) axes, these artists are `Line2D` instances. For other axes (such as polar axes), these artists may be `Patch` instances.
- Polar plots no longer accept a resolution kwarg. Instead, each Path must specify its own number of interpolation steps. This is unlikely to be a user-visible change – if interpolation of data is required, that should be done before passing it to matplotlib.

## 40.4 Changes for 0.98.x

- `psd()`, `csd()`, and `cohere()` will now automatically wrap negative frequency components to the beginning of the returned arrays. This is much more sensible behavior and makes them consistent with `specgram()`. The previous behavior was more of an oversight than a design decision.
- Added new keyword parameters `nonposx`, `nonposy` to `matplotlib.axes.Axes` methods that set log scale parameters. The default is still to mask out non-positive values, but the kwargs accept ‘clip’, which causes non-positive values to be replaced with a very small positive value.
- Added new `matplotlib.pyplot.figure_exists()` and `matplotlib.pyplot.get_fignums()`; they merely expose information that had been hidden in `matplotlib._pylab_helpers`.
- Deprecated `numerix` package.
- Added new `matplotlib.image.imsave()` and exposed it to the `matplotlib.pyplot` interface.
- Remove support for `pyExcelerator` in `exceltools` – use `xlwt` instead
- Changed the defaults of `acorr` and `xcorr` to use `usevlines=True`, `maxlags=10` and `normed=True` since these are the best defaults
- Following keyword parameters for `matplotlib.label.Label` are now deprecated and new set of parameters are introduced. The new parameters are given as a fraction of the font-size. Also, `scat-teroffsets`, `fancybox` and `columnspacing` are added as keyword parameters.

| Deprecated                 | New                        |
|----------------------------|----------------------------|
| <code>pad</code>           | <code>borderpad</code>     |
| <code>labelsep</code>      | <code>labelspacing</code>  |
| <code>handlelen</code>     | <code>handlelength</code>  |
| <code>handletextsep</code> | <code>handletextpad</code> |
| <code>axespad</code>       | <code>borderaxespad</code> |

- Removed the `configobj` and experimental `traits rc` support
- Modified `matplotlib.mlab.psd()`, `matplotlib.mlab.csd()`, `matplotlib.mlab.cohere()`, and `matplotlib.mlab.specgram()` to scale one-sided densities by a factor of 2. Also, optionally scale the densities by the sampling frequency, which gives true values of densities that can be integrated by the returned frequency values. This also gives better MATLAB compatibility. The corresponding `matplotlib.axes.Axes` methods and `matplotlib.pyplot` functions were updated as well.
- Font lookup now uses a nearest-neighbor approach rather than an exact match. Some fonts may be different in plots, but should be closer to what was requested.
- `matplotlib.axes.Axes.set_xlim()`, `matplotlib.axes.Axes.set_ylim()` now return a copy of the `viewlim` array to avoid modify-in-place surprises.
- `matplotlib.afm.AFM.get_fullname()` and `matplotlib.afm.AFM.get_familyname()` no longer raise an exception if the AFM file does not specify these optional attributes, but returns a guess based on the required `FontName` attribute.
- Changed precision kwarg in `matplotlib.pyplot.spy()`; default is 0, and the string value ‘present’ is used for sparse arrays only to show filled locations.

- `matplotlib.collections.EllipseCollection` added.
- Added `angles` kwarg to `matplotlib.pyplot.quiver()` for more flexible specification of the arrow angles.
- Deprecated (raise `NotImplementedError`) all the `mlab2` functions from `matplotlib.mlab` out of concern that some of them were not clean room implementations.
- Methods `matplotlib.collections.Collection.get_offsets()` and `matplotlib.collections.Collection.set_offsets()` added to `Collection` base class.
- `matplotlib.figure.Figure.figurePatch` renamed `matplotlib.figure.Figure.patch`; `matplotlib.axes.Axes.axesPatch` renamed `matplotlib.axes.Axes.patch`; `matplotlib.axes.Axes.axesFrame` renamed `matplotlib.axes.Axes.frame`. `matplotlib.axes.Axes.get_frame()`, which returns `matplotlib.axes.Axes.patch`, is deprecated.
- Changes in the `matplotlib.contour.ContourLabeler` attributes (`matplotlib.pyplot.clabel()` function) so that they all have a form like `.labelAttribute`. The three attributes that are most likely to be used by end users, `.cl`, `.cl_xy` and `.cl_cvalues` have been maintained for the moment (in addition to their renamed versions), but they are deprecated and will eventually be removed.
- Moved several functions in `matplotlib.mlab` and `matplotlib.cbook` into a separate module `matplotlib.numerical_methods` because they were unrelated to the initial purpose of `mlab` or `cbook` and appeared more coherent elsewhere.

## 40.5 Changes for 0.98.1

- Removed broken `matplotlib.axes3d` support and replaced it with a non-implemented error pointing to 0.91.x

## 40.6 Changes for 0.98.0

- `matplotlib.image.imread()` now no longer always returns RGBA data—if the image is luminance or RGB, it will return a `MxN` or `MxNx3` array if possible. Also `uint8` is no longer always forced to float.
- Rewrote the `matplotlib.cm.ScalarMappable` callback infrastructure to use `matplotlib.cbook.CallbackRegistry` rather than custom callback handling. Any users of `matplotlib.cm.ScalarMappable.add_observer()` of the `ScalarMappable` should use the `matplotlib.cm.ScalarMappable.callbacks` `CallbackRegistry` instead.
- New axes function and Axes method provide control over the plot color cycle: `matplotlib.axes.set_default_color_cycle()` and `matplotlib.axes.Axes.set_color_cycle()`.
- `matplotlib` now requires Python 2.4, so `matplotlib.cbook` will no longer provide `set`, `enumerate()`, `reversed()` or `izip()` compatibility functions.

- In Numpy 1.0, bins are specified by the left edges only. The axes method `matplotlib.axes.Axes.hist()` now uses future Numpy 1.3 semantics for histograms. Providing `binedges`, the last value gives the upper-right edge now, which was implicitly set to +infinity in Numpy 1.0. This also means that the last bin doesn't contain upper outliers any more by default.
- New axes method and pyplot function, `hexbin()`, is an alternative to `scatter()` for large datasets. It makes something like a `pcolor()` of a 2-D histogram, but uses hexagonal bins.
- New kwarg, `symmetric`, in `matplotlib.ticker.MaxNLocator` allows one require an axis to be centered around zero.
- Toolkits must now be imported from `mpl_toolkits` (not `matplotlib.toolkits`)

#### 40.6.1 Notes about the transforms refactoring

A major new feature of the 0.98 series is a more flexible and extensible transformation infrastructure, written in Python/Numpy rather than a custom C extension.

The primary goal of this refactoring was to make it easier to extend matplotlib to support new kinds of projections. This is mostly an internal improvement, and the possible user-visible changes it allows are yet to come.

See `matplotlib.transforms` for a description of the design of the new transformation framework.

For efficiency, many of these functions return views into Numpy arrays. This means that if you hold on to a reference to them, their contents may change. If you want to store a snapshot of their current values, use the Numpy array method `copy()`.

The view intervals are now stored only in one place – in the `matplotlib.axes.Axes` instance, not in the locator instances as well. This means locators must get their limits from their `matplotlib.axis.Axis`, which in turn looks up its limits from the `Axes`. If a locator is used temporarily and not assigned to an `Axis` or `Axes`, (e.g. in `matplotlib.contour`), a dummy axis must be created to store its bounds. Call `matplotlib.ticker.Locator.create_dummy_axis()` to do so.

The functionality of `Pbox` has been merged with `Bbox`. Its methods now all return copies rather than modifying in place.

The following lists many of the simple changes necessary to update code from the old transformation framework to the new one. In particular, methods that return a copy are named with a verb in the past tense, whereas methods that alter an object in place are named with a verb in the present tense.



**matplotlib.transforms**

| Old method  | New method   |
|---|--|
| <code>Bbox.get_bounds()</code>                      | <code>transforms.Bbox.bounds</code>  |
| <code>Bbox.width()</code>                           | <code>transforms.Bbox.width</code>   |
| <code>Bbox.height()</code>                          | <code>transforms.Bbox.height</code>  |
| <code>Bbox.intervalx().get_bounds()</code>          | <code>transforms.Bbox.intervalx</code>   |
| <code>Bbox.intervalx().set_bounds()</code>          | <code>Bbox.intervalx</code> is now a property.]  |
| <code>Bbox.intervaly().get_bounds()</code>          | <code>transforms.Bbox.intervaly</code>   |
| <code>Bbox.intervaly().set_bounds()</code>          | <code>Bbox.intervaly</code> is now a property.]  |
| <code>Bbox.xmin()</code>                            | <code>transforms.Bbox.x0</code> or <code>transforms.Bbox.xmin</code> <sup>1</sup>  |
| <code>Bbox.ymin()</code>                            | <code>transforms.Bbox.y0</code> or <code>transforms.Bbox.ymin</code> <sup>1</sup>  |
| <code>Bbox.xmax()</code>                            | <code>transforms.Bbox.x1</code> or <code>transforms.Bbox.xmax</code> <sup>1</sup>  |
| <code>Bbox.ymax()</code>                            | <code>transforms.Bbox.y1</code> or <code>transforms.Bbox.ymax</code> <sup>1</sup>  |
| <code>Bbox.overlaps(bboxes)</code>                  | <code>Bbox.count_overlaps(bboxes)</code>   |
| <code>bbox_all(bboxes)</code>                       | <code>Bbox.union(bboxes)</code> [ <code>transforms.Bbox.union()</code> is a static method.]                                |
| <code>lbwh_to_bbox(l, b, w, h)</code>               | <code>Bbox.from_bounds(x0, y0, w, h)</code> [ <code>transforms.Bbox.from_bounds()</code> is a static method.]              |
| <code>inverse_transform_bbox(trans, bbox)</code>    | <code>Bbox.inverse_transformed(trans)</code>   |
| <code>Interval.contains_open(v)</code>              | <code>interval_contains_open(tuple, v)</code>  |
| <code>Interval.contains(v)</code>                   | <code>interval_contains(tuple, v)</code>   |
| <code>identity_transform()</code>                   | <code>matplotlib.transforms.IdentityTransform</code>   |
| <code>blend_xy_sep_transform(xtrans, ytrans)</code> | <code>matplotlib.transforms.transform_factory(xtrans, ytrans)</code>   |
| <code>scale_transform(xs, ys)</code>                | <code>Affine2D().scale(xs[, ys])</code>  |
| <code>get_bbox_transform(boxin, boxout)</code>      | <code>BboxTransform(boxin, boxout)</code> or <code>BboxTransformFrom(boxin)</code> or <code>BboxTransformTo(boxout)</code> |
| <code>Transform.seq_xy_tup(points)</code>           | <code>Transform.transform(points)</code>   |
| <code>Transform.inverse_xy_tup(points)</code>       | <code>Transform.inverted().transform(points)</code>  |

<sup>1</sup>The `Bbox` is bound by the points (x0, y0) to (x1, y1) and there is no defined order to these points, that is, x0 is not necessarily the left edge of the box. To get the left edge of the `Bbox`, use the read-only property `xmin`.

**matplotlib.axes**

| Old method                      | New method  |
|---------------------------------|---|
| <i>Axes.get_position()</i>      | <code>matplotlib.axes.Axes.get_position()</code> <sup>2</sup> |
| <i>Axes.set_position()</i>      | <code>matplotlib.axes.Axes.set_position()</code> <sup>3</sup> |
| <i>Axes.toggle_log_linear()</i> | <code>matplotlib.axes.Axes.set_yscale()</code> <sup>4</sup>   |
| <i>Subplot</i> class            | removed.  |

The Polar class has moved to `matplotlib.projections.polar`.

**matplotlib.artist**

| Old method                    | New method  |
|-------------------------------|---|
| <i>Artist.set_clip_path()</i> | <code>matplotlib.artist.Artist.set_clip_path(path, transform)</code> <sup>5</sup> |

**matplotlib.collections**

| Old method       | New method                     |
|------------------|--------------------------------|
| <i>linestyle</i> | <i>linestyles</i> <sup>6</sup> |

**matplotlib.colors**

| Old method                            | New method  |
|---------------------------------------|---|
| <i>ColorConverter.to_rgba_list(c)</i> | <code>ColorConverter.to_rgba_array(c)</code><br>[ <code>matplotlib.colors.ColorConverter.to_rgba_array()</code> returns an Nx4 Numpy array of RGBA color quadruples.] |

**matplotlib.contour**

| Old method               | New method   |
|--------------------------|--|
| <i>Contour._segments</i> | <code>matplotlib.contour.Contour.get_paths()</code> [Returns a list of <code>matplotlib.path.Path</code> instances.] |

---

<sup>2</sup>`matplotlib.axes.Axes.get_position()` used to return a list of points, now it returns a `matplotlib.transforms.Bbox` instance.

<sup>3</sup>`matplotlib.axes.Axes.set_position()` now accepts either four scalars or a `matplotlib.transforms.Bbox` instance.

<sup>4</sup>Since the refactoring allows for more than two scale types ('log' or 'linear'), it no longer makes sense to have a toggle. `Axes.toggle_log_linear()` has been removed.

<sup>5</sup>`matplotlib.artist.Artist.set_clip_path()` now accepts a `matplotlib.path.Path` instance and a `matplotlib.transforms.Transform` that will be applied to the path immediately before clipping.

<sup>6</sup>Linestyles are now treated like all other collection attributes, i.e. a single value or multiple values may be provided.

**matplotlib.figure**

| Old method  | New method   |
|---|--|
| <code>Figure.dpi.get()</code> / <code>Figure.dpi.set()</code> | <code>matplotlib.figure.Figure.dpi</code> (a property) |

**matplotlib.patches**

| Old method                     | New method  |
|--------------------------------|---|
| <code>Patch.get_verts()</code> | <code>matplotlib.patches.Patch.get_path()</code> [Returns a <code>matplotlib.path.Path</code> instance] |

**matplotlib.backend\_bases**

| Old method   | New method  |
|--|---|
| <code>GraphicsContext.set_clip_rectangle(tuple)</code> | <code>GraphicsContext.set_clip_rectangle(bbox)</code>     |
| <code>GraphicsContext.get_clip_path()</code>           | <code>GraphicsContext.get_clip_path()</code> <sup>7</sup> |
| <code>GraphicsContext.set_clip_path()</code>           | <code>GraphicsContext.set_clip_path()</code> <sup>8</sup> |

**RendererBase**

New methods:

- `draw_path(self, gc, path, transform, rgbFace)`
- `draw_markers(self, gc, marker_path, marker_trans, path, trans, rgbFace)`
- `draw_path_collection(self, master_transform, cliprect, clippath, clippath_trans, paths, all_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyles, antialiaseds)` [optional]

Changed methods:

- `draw_image(self, x, y, im, bbox)` is now `draw_image(self, x, y, im, bbox, clippath, clippath_trans)`

Removed methods:

- `draw_arc`
- `draw_line_collection`
- `draw_line`

<sup>7</sup>`matplotlib.backend_bases.GraphicsContext.get_clip_path()` returns a tuple of the form `(path, affine_transform)`, where `path` is a `matplotlib.path.Path` instance and `affine_transform` is a `matplotlib.transforms.Affine2D` instance.

<sup>8</sup>`matplotlib.backend_bases.GraphicsContext.set_clip_path()` now only accepts a `matplotlib.transforms.TransformPath` instance.

- *draw\_lines*
- *draw\_point*
- *draw\_quad\_mesh*
- *draw\_poly\_collection*
- *draw\_polygon*
- *draw\_rectangle*
- *draw\_regpoly\_collection*

## 40.7 Changes for 0.91.2

- For `csv2rec()`, `checkrows=0` is the new default indicating all rows will be checked for type inference
- A warning is issued when an image is drawn on log-scaled axes, since it will not log-scale the image data.
- Moved `rec2gtk()` to `matplotlib.toolkits.gtktools`
- Moved `rec2excel()` to `matplotlib.toolkits.exceltools`
- Removed, dead/experimental `ExampleInfo`, `Namespace` and `Importer` code from `matplotlib.__init__`

## 40.8 Changes for 0.91.1

## 40.9 Changes for 0.91.0

- Changed `cbook.is_file_like()` to `cbook.is_writable_file_like()` and corrected behavior.
- Added `ax` kwarg to `pyplot.colorbar()` and `Figure.colorbar()` so that one can specify the axes object from which space for the colorbar is to be taken, if one does not want to make the colorbar axes manually.
- Changed `cbook.reversed()` so it yields a tuple rather than a (index, tuple). This agrees with the python `reversed` builtin, and `cbook` only defines `reversed` if python doesn't provide the builtin.
- Made `skiprows=1` the default on `csv2rec()`
- The `gd` and `paint` backends have been deleted.
- The `errorbar` method and function now accept additional kwargs so that upper and lower limits can be indicated by capping the bar with a caret instead of a straight line segment.
- The `matplotlib.dviread` file now has a parser for files like `psfonts.map` and `pdftex.map`, to map TeX font names to external files.

- The file `matplotlib.type1font` contains a new class for Type 1 fonts. Currently it simply reads pfa and pfb format files and stores the data in a way that is suitable for embedding in pdf files. In the future the class might actually parse the font to allow e.g. subsetting.
- `matplotlib.FT2Font` now supports `FT_Attach_File()`. In practice this can be used to read an afm file in addition to a pfa/pfb file, to get metrics and kerning information for a Type 1 font.
- The AFM class now supports querying CapHeight and stem widths. The `get_name_char` method now has an `isord` kwarg like `get_width_char`.
- Changed `pcolor()` default to `shading='flat'`; but as noted now in the docstring, it is preferable to simply use the `edgcolor` kwarg.
- The `mathtext` font commands (`\cal`, `\rm`, `\it`, `\tt`) now behave as TeX does: they are in effect until the next font change command or the end of the grouping. Therefore uses of `$_cal{R}$` should be changed to `$_{cal} R$`. Alternatively, you may use the new LaTeX-style font commands (`\mathcal`, `\mathrm`, `\mathit`, `\mathtt`) which do affect the following group, eg. `$_mathcal{R}$`.
- Text creation commands have a new default `linespacing` and a new `linespacing` kwarg, which is a multiple of the maximum vertical extent of a line of ordinary text. The default is 1.2; `linespacing=2` would be like ordinary double spacing, for example.
- Changed default kwarg in `matplotlib.colors.Normalize.__init__()` to `clip=False`; clipping silently defeats the purpose of the special over, under, and bad values in the colormap, thereby leading to unexpected behavior. The new default should reduce such surprises.
- Made the `emit` property of `set_xlim()` and `set_ylim()` True by default; removed the Axes custom callback handling into a 'callbacks' attribute which is a `CallbackRegistry` instance. This now supports the 'xlim\_changed' and 'ylim\_changed' Axes events.

## 40.10 Changes for 0.90.1

The file `dviread.py` has a (very limited and fragile) dvi reader for usetex support. The API might change in the future so don't depend on it yet.

Removed deprecated support for a float value as a gray-scale; now it must be a string, like `'0.5'`. Added `alpha` kwarg to `ColorConverter.to_rgba_list`.

New method `set_bounds(vmin, vmax)` for formatters, locators sets the `viewInterval` and `dataInterval` from floats.

Removed deprecated `colorbar_classic`.

`Line2D.get_xdata` and `get_ydata` `valid_only=False` kwarg is replaced by `orig=True`. When True, it returns the original data, otherwise the processed data (masked, converted)

Some modifications to the units interface.

`units.ConversionInterface.tickers` renamed to `units.ConversionInterface.axisinfo` and it now returns a `units.AxisInfo` object rather than a tuple. This will make it easier to add axis info functionality (eg I added a default label on this iteration) w/o having to change the tuple length and hence the API of the client code everytime new functionality is added. Also, `units.ConversionInterface.convert_to_value` is now simply named `units.ConversionInterface.convert`.

`Axes.errorbar` uses `Axes.vlines` and `Axes.hlines` to draw its error limits in the vertical and horizontal direction. As you'll see in the changes below, these funcs now return a `LineCollection` rather than a list of lines. The new return signature for `errorbar` is `ylins, caplines, errorcollections` where `errorcollections` is a `xerrcollection`, `yerrcollection`

`Axes.vlines` and `Axes.hlines` now create and return a `LineCollection`, not a list of lines. This is much faster. The kwarg signature has changed, so consult the docs

`MaxNLocator` accepts a new Boolean kwarg (`'integer'`) to force ticks to integer locations.

Commands that pass an argument to the `Text` constructor or to `Text.set_text()` now accept any object that can be converted with `'%s'`. This affects `xlabel()`, `title()`, etc.

`Barh` now takes a `**kwargs` dict instead of most of the old arguments. This helps ensure that `bar` and `barh` are kept in sync, but as a side effect you can no longer pass e.g. `color` as a positional argument.

`ft2font.get_charmap()` now returns a dict that maps character codes to glyph indices (until now it was reversed)

Moved data files into `lib/matplotlib` so that `setuptools'` develop mode works. Re-organized the `mpl-data` layout so that this source structure is maintained in the installation. (I.e. the `'fonts'` and `'images'` sub-directories are maintained in site-packages.). Suggest removing `site-packages/matplotlib/mpl-data` and `~/.matplotlib/ttfont.cache` before installing

## 40.11 Changes for 0.90.0

All artists now implement a `"pick"` method which users should not call. Rather, set the `"picker"` property of any artist you want to pick on (the epsilon distance in points for a hit test) and register with the `"pick_event"` callback. See `examples/pick_event_demo.py` for details

Bar, barh, and hist have "log" binary kwarg: log=True sets the ordinate to a log scale.

Boxplot can handle a list of vectors instead of just an array, so vectors can have different lengths.

Plot can handle 2-D x and/or y; it plots the columns.

Added linewidth kwarg to bar and barh.

Made the default Artist.\_transform None (rather than invoking identity\_transform for each artist only to have it overridden later). Use artist.get\_transform() rather than artist.\_transform, even in derived classes, so that the default transform will be created lazily as needed

New LogNorm subclass of Normalize added to colors.py. All Normalize subclasses have new inverse() method, and the \_\_call\_\_() method has a new clip kwarg.

Changed class names in colors.py to match convention: normalize -> Normalize, no\_norm -> NoNorm. Old names are still available for now.

Removed obsolete pcolor\_classic command and method.

Removed lineprops and markerprops from the Annotation code and replaced them with an arrow configurable with kwarg arrowprops. See examples/annotation\_demo.py - JDH

## 40.12 Changes for 0.87.7

Completely reworked the annotations API because I found the old API cumbersome. The new design is much more legible and easy to read. See matplotlib.text.Annotation and examples/annotation\_demo.py

markeredgecolor and markerfacecolor cannot be configured in matplotlibrc any more. Instead, markers are generally colored automatically based on the color of the line, unless marker colors are explicitly set as kwargs - NN

Changed default comment character for load to '#' - JDH

math\_parse\_s\_ft2font\_svg from mathtext.py & mathtext2.py now returns width, height, svg\_elements. svg\_elements is an instance of Bunch (cmbook.py) and has the attributes svg\_glyphs and svg\_lines, which are both lists.

Renderer.draw\_arc now takes an additional parameter, rotation.

It specifies to draw the artist rotated in degrees anti-clockwise. It was added for rotated ellipses.

Renamed `Figure.set_figsize_inches` to `Figure.set_size_inches` to better match the get method, `Figure.get_size_inches`.

Removed the `copy_bbox_transform` from `transforms.py`; added shallowcopy methods to all transforms. All transforms already had deepcopy methods.

`FigureManager.resize(width, height)`: resize the window specified in pixels

`barh`: `x` and `y` args have been renamed to `width` and `bottom` respectively, and their order has been swapped to maintain a (position, value) order.

`bar` and `barh`: now accept kwarg `'edgecolor'`.

`bar` and `barh`: The `left`, `height`, `width` and `bottom` args can now all be scalars or sequences; see docstring.

`barh`: now defaults to edge aligned instead of center aligned bars

`bar`, `barh` and `hist`: Added a keyword arg `'align'` that controls between edge or center bar alignment.

Collections: `PolyCollection` and `LineCollection` now accept vertices or segments either in the original form `[(x,y), (x,y), ...]` or as a 2D numerix array, with `X` as the first column and `Y` as the second. Contour and quiver output the numerix form. The transforms methods `Bbox.update()` and `Transformation.seq_xy_tups()` now accept either form.

Collections: `LineCollection` is now a `ScalarMappable` like `PolyCollection`, etc.

Specifying a grayscale color as a float is deprecated; use a string instead, e.g., `0.75` -> `'0.75'`.

Collections: initializers now accept any `mpl` color arg, or sequence of such args; previously only a sequence of `rgba` tuples was accepted.

`Colorbar`: completely new version and api; see docstring. The original version is still accessible as `colorbar_classic`, but is deprecated.

`Contourf`: `"extend"` kwarg replaces `"clip_ends"`; see docstring. Masked array support added to `pcolormesh`.

Modified aspect-ratio handling:



Removed aspect kwarg from imshow  
 Axes methods:  
     set\_aspect(self, aspect, adjustable=None, anchor=None)  
     set\_adjustable(self, adjustable)  
     set\_anchor(self, anchor)  
 Pylab interface:  
     axis('image')

Backend developers: ft2font's load\_char now takes a flags argument, which you can OR together from the LOAD\_XXX constants.

## 40.13 Changes for 0.86

Matplotlib data is installed into the matplotlib module. This is similar to package\_data. This should get rid of having to check for many possibilities in \_get\_data\_path(). The MATPLOTLIBDATA env key is still checked first to allow for flexibility.

- 1) Separated the color table data from cm.py out into a new file, \_cm.py, to make it easier to find the actual code in cm.py and to add new colormaps. Everything from \_cm.py is imported by cm.py, so the split should be transparent.
- 2) Enabled automatic generation of a colormap from a list of colors in contour; see modified examples/contour\_demo.py.
- 3) Support for imshow of a masked array, with the ability to specify colors (or no color at all) for masked regions, and for regions that are above or below the normally mapped region. See examples/image\_masked.py.
- 4) In support of the above, added two new classes, ListedColormap, and no\_norm, to colors.py, and modified the Colormap class to include common functionality. Added a clip kwarg to the normalize class.

## 40.14 Changes for 0.85

Made xtick and ytick separate props in rc

made pos=None the default for tick formatters rather than 0 to indicate "not supplied"

Removed "feature" of minor ticks which prevents them from overlapping major ticks. Often you want major and minor ticks at

the same place, and can offset the major ticks with the pad. This could be made configurable

Changed the internal structure of contour.py to a more OO style. Calls to contour or contourf in axes.py or pylab.py now return a ContourSet object which contains references to the LineCollections or PolyCollections created by the call, as well as the configuration variables that were used. The ContourSet object is a "mappable" if a colormap was used.

Added a clip\_ends kwarg to contourf. From the docstring:

```
* clip_ends = True
    If False, the limits for color scaling are set to the
    minimum and maximum contour levels.
    True (default) clips the scaling limits. Example:
    if the contour boundaries are V = [-100, 2, 1, 0, 1, 2, 100],
    then the scaling limits will be [-100, 100] if clip_ends
    is False, and [-3, 3] if clip_ends is True.
```

Added kwargs linewidths, antialiased, and nchunk to contourf. These are experimental; see the docstring.

Changed Figure.colorbar():

- kw argument order changed;
- if mappable arg is a non-filled ContourSet, colorbar() shows lines instead of polygons.
- if mappable arg is a filled ContourSet with clip\_ends=True, the endpoints are not labelled, so as to give the correct impression of open-endedness.

Changed LineCollection.get\_linewidths to get\_linewidth, for consistency.

## 40.15 Changes for 0.84

Unified argument handling between hlines and vlines. Both now take optionally a fmt argument (as in plot) and a keyword args that can be passed onto Line2D.

Removed all references to "data clipping" in rc and lines.py since these were not used and not optimized. I'm sure they'll be resurrected later with a better implementation when needed.

'set' removed - no more deprecation warnings. Use 'setp' instead.

Backend developers: Added flipud method to image and removed it from to\_str. Removed origin kwarg from backend.draw\_image. origin is handled entirely by the frontend now.

## 40.16 Changes for 0.83

- Made HOME/.matplotlib the new config dir where the matplotlibrc file, the ttf.cache, and the tex.cache live. The new default filenames in .matplotlib have no leading dot and are not hidden. Eg, the new names are matplotlibrc, tex.cache, and ttffont.cache. This is how ipython does it so it must be right.

If old files are found, a warning is issued and they are moved to the new location.

- backends/\_\_init\_\_.py no longer imports new\_figure\_manager, draw\_if\_interactive and show from the default backend, but puts these imports into a call to pylab\_setup. Also, the Toolbar is no longer imported from WX/WXAgg. New usage:

```
from backends import pylab_setup
new_figure_manager, draw_if_interactive, show = pylab_setup()
```

- Moved Figure.get\_width\_height() to FigureCanvasBase. It now returns int instead of float.

## 40.17 Changes for 0.82

- toolbar import change in GTKAgg, GTKCairo and WXAgg
- Added subplot config tool to GTK\* backends -- note you must now import the NavigationToolbar2 from your backend of choice rather than from backend\_gtk because it needs to know about the backend specific canvas -- see examples/embedding\_in\_gtk2.py. Ditto for wx backend -- see examples/embedding\_in\_wxagg.py
- hist bin change

Sean Richards notes there was a problem in the way we created the binning for histogram, which made the last bin underrepresented. From his post:

I see that hist uses the linspace function to create the bins and then uses searchsorted to put the values in their correct bin. Thats all good but I am confused over the use of linspace for the bin creation. I wouldn't have thought that it does what is needed, to quote the docstring it creates a "Linear spaced array from min to max". For it to work correctly shouldn't the values in the bins array be the same bound for each bin? (i.e. each value should be the lower bound of a bin). To provide the correct bins for hist would it not be something like

```
def bins(xmin, xmax, N):
    if N==1: return xmax
    dx = (xmax-xmin)/N # instead of N-1
    return xmin + dx*arange(N)
```

This suggestion is implemented in 0.81. My test script with these changes does not reveal any bias in the binning

```
from matplotlib.numerix.mlab import randn, rand, zeros, Float
from matplotlib.mlab import hist, mean
```

```
Nbins = 50
Ntests = 200
results = zeros((Ntests,Nbins), typecode=Float)
for i in range(Ntests):
    print 'computing', i
    x = rand(10000)
    n, bins = hist(x, Nbins)
    results[i] = n
print mean(results)
```

## 40.18 Changes for 0.81

- pylab and artist "set" functions renamed to setp to avoid clash with python2.4 built-in set. Current version will issue a deprecation warning which will be removed in future versions
- imshow interpolation arguments changes for advanced interpolation schemes. See help imshow, particularly the interpolation, filternorm and filterrad kwargs
- Support for masked arrays has been added to the plot command and to the Line2D object. Only the valid points are plotted. A "valid\_only" kwarg was added to the get\_xdata() and get\_ydata() methods of Line2D; by default it is False, so that the original data arrays are returned. Setting it to True returns the plottable points.
- contour changes:

Masked arrays: contour and contourf now accept masked arrays as the variable to be contoured. Masking works correctly for contour, but a bug remains to be fixed before it will work for contourf. The "badmask" kwarg has been removed from both functions.

Level argument changes:

Old version: a list of levels as one of the positional arguments specified the lower bound of each filled region; the upper bound of the last region was taken as a very large number. Hence, it was not possible to specify that  $z$  values between 0 and 1, for example, be filled, and that values outside that range remain unfilled.

New version: a list of  $N$  levels is taken as specifying the boundaries of  $N-1$   $z$  ranges. Now the user has more control over what is colored and what is not. Repeated calls to `contourf` (with different colormaps or color specifications, for example) can be used to color different ranges of  $z$ . Values of  $z$  outside an expected range are left uncolored.

Example:

Old: `contourf(z, [0, 1, 2])` would yield 3 regions: 0-1, 1-2, and  $>2$ .

New: it would yield 2 regions: 0-1, 1-2. If the same 3 regions were desired, the equivalent list of levels would be `[0, 1, 2, 1e38]`.

## 40.19 Changes for 0.80

- `xlim/ylim/axis` always return the new limits regardless of arguments. They now take kwargs which allow you to selectively change the upper or lower limits while leaving unnamed limits unchanged. See `help(xlim)` for example

## 40.20 Changes for 0.73

- Removed deprecated `ColormapJet` and friends
- Removed all error handling from the verbose object
- figure num of zero is now allowed

## 40.21 Changes for 0.72

- `Line2D`, `Text`, and `Patch` `copy_properties` renamed `update_from` and moved into artist base class
- `LineCollecitons.color` renamed to `LineCollections.set_color` for consistency with set/get introspection mechanism,
- `pylab` figure now defaults to `num=None`, which creates a new figure

with a guaranteed unique number

- contour method syntax changed - now it is MATLAB compatible

```
unchanged: contour(Z)
old: contour(Z, x=Y, y=Y)
new: contour(X, Y, Z)
```

see <http://matplotlib.sf.net/matplotlib.pylab.html#-contour>

- Increased the default resolution for save command.
- Renamed the base attribute of the ticker classes to `_base` to avoid conflict with the base method. Sitt for subs
- `subs=None` now does autosubbing in the tick locator.
- New subplots that overlap old will delete the old axes. If you do not want this behavior, use `fig.add_subplot` or the axes command

## 40.22 Changes for 0.71

Significant numerix namespace changes, introduced to resolve namespace clashes between python built-ins and mlab names. Refactored numerix to maintain separate modules, rather than folding all these names into a single namespace. See the following mailing list threads for more information and background

```
http://sourceforge.net/mailarchive/forum.php?thread\_id=6398890&forum\_id=36187
http://sourceforge.net/mailarchive/forum.php?thread\_id=6323208&forum\_id=36187
```

OLD usage

```
from matplotlib.numerix import array, mean, fft
```

NEW usage

```
from matplotlib.numerix import array
from matplotlib.numerix.mlab import mean
from matplotlib.numerix.fft import fft
```

numerix dir structure mirrors numarray (though it is an incomplete implementation)

```
numerix
numerix/mlab
numerix/linear_algebra
```

```
numerix/fft
numerix/random_array
```

but of course you can use 'numerix : Numeric' and still get the symbols.

pylab still imports most of the symbols from Numerix, MLab, fft, etc, but is more cautious. For names that clash with python names (min, max, sum), pylab keeps the builtins and provides the numeric versions with an a\* prefix, eg (amin, amax, asum)

## 40.23 Changes for 0.70

MplEvent factored into a base class Event and derived classes MouseEvent and KeyEvent

Removed defunct set\_measurement in wx toolbar

## 40.24 Changes for 0.65.1

removed add\_axes and add\_subplot from backend\_bases. Use figure.add\_axes and add\_subplot instead. The figure now manages the current axes with gca and sca for get and set current axe. If you have code you are porting which called, eg, figmanager.add\_axes, you can now simply do figmanager.canvas.figure.add\_axes.

## 40.25 Changes for 0.65

mpl\_connect and mpl\_disconnect in the MATLAB interface renamed to connect and disconnect

Did away with the text methods for angle since they were ambiguous. fontangle could mean fontstyle (oblique, etc) or the rotation of the text. Use style and rotation instead.

## 40.26 Changes for 0.63

Dates are now represented internally as float days since 0001-01-01, UTC.

All date tickers and formatters are now in matplotlib.dates, rather

than `matplotlib.tickers`

converters have been abolished from all functions and classes. `num2date` and `date2num` are now the converter functions for all date plots

Most of the date tick locators have a different meaning in their constructors. In the prior implementation, the first argument was a base and multiples of the base were ticked. Eg

```
HourLocator(5) # old: tick every 5 minutes
```

In the new implementation, the explicit points you want to tick are provided as a number or sequence

```
HourLocator(range(0,5,61)) # new: tick every 5 minutes
```

This gives much greater flexibility. I have tried to make the default constructors (no args) behave similarly, where possible.

Note that `YearLocator` still works under the base/multiple scheme. The difference between the `YearLocator` and the other locators is that years are not recurrent.

Financial functions:

```
matplotlib.finance.quotes_historical_yahoo(ticker, date1, date2)
```

`date1`, `date2` are now `datetime` instances. Return value is a list of quotes where the quote time is a float - days since gregorian start, as returned by `date2num`

See `examples/finance_demo.py` for example usage of new API

## 40.27 Changes for 0.61

`canvas.connect` is now deprecated for event handling. use `mpl_connect` and `mpl_disconnect` instead. The callback signature is `func(event)` rather than `func(widget, event)`

## 40.28 Changes for 0.60

`ColormapJet` and `Grayscale` are deprecated. For backwards compatibility, they can be obtained either by doing

```
from matplotlib.cm import ColormapJet
```



or

```
from matplotlib.matlab import *
```

They are replaced by `cm.jet` and `cm.grey`

## 40.29 Changes for 0.54.3

removed the `set_default_font / get_default_font` scheme from the `font_manager` to unify customization of font defaults with the rest of the `rc` scheme. See `examples/font_properties_demo.py` and `help(rc)` in `matplotlib.matlab`.

## 40.30 Changes for 0.54

### 40.30.1 MATLAB interface

#### **dpi**

Several of the backends used a `PIXELS_PER_INCH` hack that I added to try and make images render consistently across backends. This just complicated matters. So you may find that some font sizes and line widths appear different than before. Apologies for the inconvenience. You should set the `dpi` to an accurate value for your screen to get true sizes.

#### **pcolor and scatter**

There are two changes to the MATLAB interface API, both involving the patch drawing commands. For efficiency, `pcolor` and `scatter` have been rewritten to use polygon collections, which are a new set of objects from `matplotlib.collections` designed to enable efficient handling of large collections of objects. These new collections make it possible to build large scatter plots or `pcolor` plots with no loops at the python level, and are significantly faster than their predecessors. The original `pcolor` and `scatter` functions are retained as `pcolor_classic` and `scatter_classic`.

The return value from `pcolor` is a `PolyCollection`. Most of the properties that are available on rectangles or other patches are also available on `PolyCollections`, eg you can say:

```
c = scatter(blah, blah)
c.set_linewidth(1.0)
c.set_facecolor('r')
c.set_alpha(0.5)
```

or:

```
c = scatter(blah, blah)
set(c, 'linewidth', 1.0, 'facecolor', 'r', 'alpha', 0.5)
```

Because the collection is a single object, you no longer need to loop over the return value of `scatter` or `pcolor` to set properties for the entire list.

If you want the different elements of a collection to vary on a property, eg to have different line widths, see `matplotlib.collections` for a discussion on how to set the properties as a sequence.

For `scatter`, the `size` argument is now in `points^2` (the area of the symbol in points) as in MATLAB and is not in data coords as before. Using sizes in data coords caused several problems. So you will need to adjust your size arguments accordingly or use `scatter_classic`.

### mathtext spacing

For reasons not clear to me (and which I'll eventually fix) spacing no longer works in font groups. However, I added three new spacing commands which compensate for this “ (regular space), ‘/’ (small space) and ‘`hspace{frac}`’ where `frac` is a fraction of fontsize in points. You will need to quote spaces in font strings, is:

```
title(r'$\rm{Histogram\ of\ IQ:}\ \mu=100,\ \sigma=15$')
```

## 40.30.2 Object interface - Application programmers

### Autoscaling

The `x` and `y` axis instances no longer have `autoscale` view. These are handled by `axes.autoscale_view`

### Axes creation

You should not instantiate your own `Axes` any more using the OO API. Rather, create a `Figure` as before and in place of:

```
f = Figure(figsize=(5,4), dpi=100)
a = Subplot(f, 111)
f.add_axis(a)
```

use:

```
f = Figure(figsize=(5,4), dpi=100)
a = f.add_subplot(111)
```

That is, `add_axis` no longer exists and is replaced by:

```
add_axes(rect, axisbg=defaultcolor, frameon=True)
add_subplot(num, axisbg=defaultcolor, frameon=True)
```

## Artist methods

If you define your own Artists, you need to rename the `_draw` method to `draw`

## Bounding boxes

`matplotlib.transforms.Bound2D` is replaced by `matplotlib.transforms.Bbox`. If you want to construct a `bbox` from left, bottom, width, height (the signature for `Bound2D`), use `matplotlib.transforms.lbwh_to_bbox`, as in

```
bbox = clickBBox = lbwh_to_bbox(left, bottom, width, height)
```

The `Bbox` has a different API than the `Bound2D`. Eg, if you want to get the width and height of the `bbox`

**OLD::** `width = fig.bbox.x.interval()` `height = fig.bbox.y.interval()`

**New::** `width = fig.bbox.width()` `height = fig.bbox.height()`

## Object constructors

You no longer pass the `bbox`, `dpi`, or `transforms` to the various Artist constructors. The old way of creating lines and rectangles was cumbersome because you had to pass so many attributes to the `Line2D` and `Rectangle` classes not related directly to the geometry and properties of the object. Now default values are added to the object when you call `axes.add_line` or `axes.add_patch`, so they are hidden from the user.

If you want to define a custom transformation on these objects, call `o.set_transform(trans)` where `trans` is a `Transformation` instance.

In prior versions of you wanted to add a custom line in data coords, you would have to do

```
l = Line2D(dpi, bbox, x, y, color = color, transx = transx, transy = transy, )
```

now all you need is

```
l = Line2D(x, y, color=color)
```

and the axes will set the transformation for you (unless you have set your own already, in which case it will leave it unchanged)

## Transformations

The entire transformation architecture has been rewritten. Previously the `x` and `y` transformations were stored in the `xaxis` and `yaxis` instances. The problem with this approach is it only

allows for separable transforms (where the x and y transformations don't depend on one another). But for cases like polar, they do. Now transformations operate on x,y together. There is a new base class `matplotlib.transforms.Transformation` and two concrete implementations, `matplotlib.transforms.SeparableTransformation` and `matplotlib.transforms.Affine`. The `SeparableTransformation` is constructed with the bounding box of the input (this determines the rectangular coordinate system of the input, ie the x and y view limits), the bounding box of the display, and possibly nonlinear transformations of x and y. The 2 most frequently used transformations, data coordinates -> display and axes coordinates -> display are available as `ax.transData` and `ax.transAxes`. See `alignment_demo.py` which uses axes coords.

Also, the transformations should be much faster now, for two reasons

- they are written entirely in extension code
- because they operate on x and y together, they can do the entire transformation in one loop. Earlier I did something along the lines of:

```
xt = sx*func(x) + tx
yt = sy*func(y) + ty
```

Although this was done in `numerix`, it still involves 6 `length(x)` for-loops (the multiply, add, and function evaluation each for x and y). Now all of that is done in a single pass.

If you are using transformations and bounding boxes to get the cursor position in data coordinates, the method calls are a little different now. See the updated `examples/coords_demo.py` which shows you how to do this.

Likewise, if you are using the artist bounding boxes to pick items on the canvas with the GUI, the `bbox` methods are somewhat different. You will need to see the updated `examples/object_picker.py`.

See `unit/transforms_unit.py` for many examples using the new transformations.

## 40.31 Changes for 0.50

- \* refactored `Figure` class so it is no longer backend dependent. `FigureCanvasBackend` takes over the backend specific duties of the `Figure`. `matplotlib.backend_bases.FigureBase` moved to `matplotlib.figure.Figure`.
- \* backends must implement `FigureCanvasBackend` (the thing that controls the figure and handles the events if any) and `FigureManagerBackend` (wraps the canvas and the window for MATLAB interface). `FigureCanvasBase` implements a backend switching mechanism
- \* `Figure` is now an `Artist` (like everything else in the figure) and is totally backend independent
- \* `GDFONTPATH` renamed to `TTFPATH`

- \* backend faceColor argument changed to rgbFace
- \* colormap stuff moved to colors.py
- \* arg\_to\_rgb in backend\_bases moved to class ColorConverter in colors.py
- \* GD users must upgrade to gd-2.0.22 and gdmodule-0.52 since new gd features (clipping, antialiased lines) are now used.
- \* Renderer must implement points\_to\_pixels

Migrating code:

MATLAB interface:

The only API change for those using the MATLAB interface is in how you call figure redraws for dynamically updating figures. In the old API, you did

```
fig.draw()
```

In the new API, you do

```
manager = get_current_fig_manager()
manager.canvas.draw()
```

See the examples system\_monitor.py, dynamic\_demo.py, and anim.py

API

There is one important API change for application developers. Figure instances used subclass GUI widgets that enabled them to be placed directly into figures. Eg, FigureGTK subclassed gtk.DrawingArea. Now the Figure class is independent of the backend, and FigureCanvas takes over the functionality formerly handled by Figure. In order to include figures into your apps, you now need to do, for example

```
# gtk example
fig = Figure(figsize=(5,4), dpi=100)
canvas = FigureCanvasGTK(fig) # a gtk.DrawingArea
canvas.show()
vbox.pack_start(canvas)
```

If you use the NavigationToolbar, this is now initialized with a FigureCanvas, not a Figure. The examples embedding\_in\_gtk.py, embedding\_in\_gtk2.py, and mpl\_with\_glade.py all reflect the new API so use these as a guide.

All prior calls to

```
figure.draw() and  
figure.print_figure(args)
```

should now be

```
canvas.draw() and  
canvas.print_figure(args)
```

Apologies for the inconvenience. This refactorization brings significant more freedom in developing matplotlib and should bring better plotting capabilities, so I hope the inconvenience is worth it.

## 40.32 Changes for 0.42

- \* Refactoring AxisText to be backend independent. Text drawing and get\_window\_extent functionality will be moved to the Renderer.
- \* backend\_bases.AxisTextBase is now text.Text module
- \* All the erase and reset functionality removed from AxisText - not needed with double buffered drawing. Ditto with state change. Text instances have a get\_prop\_tup method that returns a hashable tuple of text properties which you can use to see if text props have changed, eg by caching a font or layout instance in a dict with the prop tup as a key -- see RendererGTK.get\_pango\_layout in backend\_gtk for an example.
- \* Text.\_get\_xy\_display renamed Text.get\_xy\_display
- \* Artist set\_renderer and wash\_brushes methods removed
- \* Moved Legend class from matplotlib.axes into matplotlib.legend
- \* Moved Tick, XTick, YTick, Axis, XAxis, YAxis from matplotlib.axes to matplotlib.axis
- \* moved process\_text\_args to matplotlib.text
- \* After getting Text handled in a backend independent fashion, the import process is much cleaner since there are no longer cyclic dependencies
- \* matplotlib.matlab.\_get\_current\_fig\_manager renamed to matplotlib.matlab.get\_current\_fig\_manager to allow user access to the GUI window attribute, eg figManager.window for GTK and figManager.frame for wx

## 40.33 Changes for 0.40

- Artist
  - \* `__init__` takes a DPI instance and a Bound2D instance which is the bounding box of the artist in display coords
  - \* `get_window_extent` returns a Bound2D instance
  - \* `set_size` is removed; replaced by `bbox` and `dpi`
  - \* the `clip_gc` method is removed. Artists now clip themselves with their box
  - \* added `_clipOn` boolean attribute. If True, gc clip to bbox.
- AxisTextBase
  - \* Initialized with a `transx`, `transy` which are Transform instances
  - \* `set_drawing_area` removed
  - \* `get_left_right` and `get_top_bottom` are replaced by `get_window_extent`
- Line2D Patches now take `transx`, `transy`
  - \* Initialized with a `transx`, `transy` which are Transform instances
- Patches
  - \* Initialized with a `transx`, `transy` which are Transform instances
- FigureBase attributes `dpi` is a DPI instance rather than scalar and new attribute `bbox` is a Bound2D in display coords, and I got rid of the `left`, `width`, `height`, etc... attributes. These are now accessible as, for example, `bbox.x.min` is `left`, `bbox.x.interval()` is `width`, `bbox.y.max` is `top`, etc...
- GcfBase attribute `pagesize` renamed to `figsize`
- Axes
  - \* removed `figbg` attribute
  - \* added `fig` instance to `__init__`
  - \* resizing is handled by figure call to `resize`.
- Subplot
  - \* added `fig` instance to `__init__`
- Renderer methods for patches now take `gcEdge` and `gcFace` instances. `gcFace=None` takes the place of `filled=False`
- True and False symbols provided by `cbook` in a python2.3 compatible way
- new module `transforms` supplies Bound1D, Bound2D and Transform instances and more
- Changes to the MATLAB helpers API
  - \* `_matplotlib_helpers.GcfBase` is renamed by `Gcf`. Backends no longer need to derive from this class. Instead, they provide a factory function `new_figure_manager(num, figsize, dpi)`. The `destroy`

method of the GcfDerived from the backends is moved to the derived FigureManager.

- \* FigureManagerBase moved to backend\_bases

- \* Gcf.get\_all\_figwins renamed to Gcf.get\_all\_fig\_managers

Jeremy:

Make sure to `self._reset = False` in `AxisTextWX._set_font`. This was something missing in my backend code.



# CONFIGURATION

## 41.1 matplotlib

This is an object-orient plotting library.

A procedural interface is provided by the companion pyplot module, which may be imported directly, e.g:

```
from matplotlib.pyplot import *
```

To include numpy functions too, use:

```
from pylab import *
```

or using ipython:

```
ipython -pylab
```

For the most part, direct use of the object-oriented library is encouraged when programming; pyplot is primarily for working interactively. The exceptions are the pyplot commands `figure()`, `subplot()`, `subplots()`, `show()`, and `savefig()`, which can greatly simplify scripting.

Modules include:

`matplotlib.axes` defines the `Axes` class. Most pylab commands are wrappers for `Axes` methods. The axes module is the highest level of OO access to the library.

`matplotlib.figure` defines the `Figure` class.

`matplotlib.artist` defines the `Artist` base class for all classes that draw things.

`matplotlib.lines` defines the `Line2D` class for drawing lines and markers

`matplotlib.patches` defines classes for drawing polygons

`matplotlib.text` defines the `Text`, `TextWithDash`, and `Annotate` classes

`matplotlib.image` defines the `AxesImage` and `FigureImage` classes

`matplotlib.collections` classes for efficient drawing of groups of lines or polygons

`matplotlib.colors` classes for interpreting color specifications and for making colormaps

**matplotlib.cm** colormaps and the `ScalarMappable` mixin class for providing color mapping functionality to other classes

**matplotlib.ticker** classes for calculating tick mark locations and for formatting tick labels

**matplotlib.backends** a subpackage with modules for various gui libraries and output formats

The base matplotlib namespace includes:

**rcParams** a global dictionary of default configuration settings. It is initialized by code which may be overridden by a `matplotlibrc` file.

**rc()** a function for setting groups of rcParams values

**use()** a function for setting the matplotlib backend. If used, this function must be called immediately after importing matplotlib for the first time. In particular, it must be called **before** importing pylab (if pylab is imported).

matplotlib was initially written by John D. Hunter (jdh2358 at gmail.com) and is now developed and maintained by a host of others.

Occasionally the internal documentation (python docstrings) will refer to MATLAB<sup>®</sup>, a registered trademark of The MathWorks, Inc.

**rc(group, \*\*kwargs)**

Set the current rc params. Group is the grouping for the rc, eg. for `lines.linewidth` the group is `lines`, for `axes.facecolor`, the group is `axes`, and so on. Group may also be a list or tuple of group names, eg. (`xtick`, `ytick`). *kwargs* is a dictionary attribute name/value pairs, eg:

```
rc('lines', linewidth=2, color='r')
```

sets the current rc params and is equivalent to:

```
rcParams['lines.linewidth'] = 2
rcParams['lines.color'] = 'r'
```

The following aliases are available to save typing for interactive users:

| Alias | Property          |
|-------|-------------------|
| 'lw'  | 'linewidth'       |
| 'ls'  | 'linestyle'       |
| 'c'   | 'color'           |
| 'fc'  | 'facecolor'       |
| 'ec'  | 'edgecolor'       |
| 'mew' | 'markeredgewidth' |
| 'aa'  | 'antialiased'     |

Thus you could abbreviate the above rc command as:

```
rc('lines', lw=2, c='r')
```

Note you can use python's kwargs dictionary facility to store dictionaries of default parameters. Eg, you can customize the font rc as follows:

```
font = {'family' : 'monospace',
        'weight' : 'bold',
        'size'   : 'larger'}

rc('font', **font)  # pass in the font dict as kwargs
```

This enables you to easily switch between several configurations. Use `rcdefaults()` to restore the default rc params after changes.

### **rcdefaults()**

Restore the default rc params - these are not the params loaded by the rc file, but mpl's internal params. See `rc_file_defaults` for reloading the default params from the rc file

### **use(arg, warn=True)**

Set the matplotlib backend to one of the known backends.

The argument is case-insensitive. For the Cairo backend, the argument can have an extension to indicate the type of output. Example:

```
use('cairo.pdf')
```

will specify a default of pdf output generated by Cairo.

Note: this function must be called *before* importing pylab for the first time; or, if you are not using pylab, it must be called before importing `matplotlib.backends`. If `warn` is `True`, a warning is issued if you try and call this after pylab or pyplot have been loaded. In certain black magic use cases, eg `pyplot.switch_backends`, we are doing the reloading necessary to make the backend switch work (in some cases, eg pure image backends) so one can set `warn=False` to suppress the warnings



# AFM (ADOBE FONT METRICS INTERFACE)

## 42.1 matplotlib.afm

This is a python interface to Adobe Font Metrics Files. Although a number of other python implementations exist (and may be more complete than mine) I decided not to go with them because either they were either

1. copyrighted or used a non-BSD compatible license
2. had too many dependencies and I wanted a free standing lib
3. Did more than I needed and it was easier to write my own than figure out how to just get what I needed from theirs

It is pretty easy to use, and requires only built-in python libs:

```
>>> from afm import AFM
>>> fh = file('ptmr8a.afm')
>>> afm = AFM(fh)
>>> afm.string_width_height('What the heck?')
(6220.0, 683)
>>> afm.get_fontname()
'Times-Roman'
>>> afm.get_kern_dist('A', 'f')
0
>>> afm.get_kern_dist('A', 'y')
-92.0
>>> afm.get_bbox_char('!')
[130, -9, 238, 676]
>>> afm.get_bbox_font()
[-168, -218, 1000, 898]
```

**AUTHOR:** John D. Hunter <jdh2358@gmail.com>

```
class AFM(fh)
    Parse the AFM file in file object fh

    get_angle()
        Return the fontangle as float
```

**get\_bbox\_char**(*c*, *isord=False*)

**get\_capheight**()  
Return the cap height as float

**get\_familyname**()  
Return the font family name, eg, 'Times'

**get\_fontname**()  
Return the font name, eg, 'Times-Roman'

**get\_fullname**()  
Return the font full name, eg, 'Times-Roman'

**get\_height\_char**(*c*, *isord=False*)  
Get the height of character *c* from the bounding box. This is the ink height (space is 0)

**get\_horizontal\_stem\_width**()  
Return the standard horizontal stem width as float, or *None* if not specified in AFM file.

**get\_kern\_dist**(*c1*, *c2*)  
Return the kerning pair distance (possibly 0) for chars *c1* and *c2*

**get\_kern\_dist\_from\_name**(*name1*, *name2*)  
Return the kerning pair distance (possibly 0) for chars *name1* and *name2*

**get\_name\_char**(*c*, *isord=False*)  
Get the name of the character, ie, ';' is 'semicolon'

**get\_str\_bbox**(*s*)  
Return the string bounding box

**get\_str\_bbox\_and\_descent**(*s*)  
Return the string bounding box

**get\_underline\_thickness**()  
Return the underline thickness as float

**get\_vertical\_stem\_width**()  
Return the standard vertical stem width as float, or *None* if not specified in AFM file.

**get\_weight**()  
Return the font weight, eg, 'Bold' or 'Roman'

**get\_width\_char**(*c*, *isord=False*)  
Get the width of the character from the character metric WX field

**get\_width\_from\_char\_name**(*name*)  
Get the width of the character from a type1 character name

**get\_xheight**()  
Return the xheight as float

**string\_width\_height**(*s*)  
Return the string width (including kerning) and string height as a (*w*, *h*) tuple.

**parse\_afm(fh)**

Parse the Adobe Font Metrics file in file handle *fh*. Return value is a (*dhead*, *dcmetrics*, *dkernpairs*, *dcomposite*) tuple where *dhead* is a `_parse_header()` dict, *dcmetrics* is a `_parse_composites()` dict, *dkernpairs* is a `_parse_kern_pairs()` dict (possibly {}), and *dcomposite* is a `_parse_composites()` dict (possibly {})





# ANIMATION

## 43.1 matplotlib.animation

**class Animation**(*fig, event\_source=None, blit=False*)

Bases: object

This class wraps the creation of an animation using matplotlib. It is only a base class which should be subclassed to provide needed behavior.

*fig* is the figure object that is used to get draw, resize, and any other needed events.

*event\_source* is a class that can run a callback when desired events are generated, as well as be stopped and started. Examples include timers (see [TimedAnimation](#)) and file system notifications.

*blit* is a boolean that controls whether blitting is used to optimize drawing.

**ffmpeg\_cmd**(*fname, fps, codec, frame\_prefix*)

**mencoder\_cmd**(*fname, fps, codec, frame\_prefix*)

**new\_frame\_seq**()

Creates a new sequence of frame information.

**new\_saved\_frame\_seq**()

Creates a new sequence of saved/cached frame information.

**save**(*filename, fps=5, codec='mpeg4', clear\_temp=True, frame\_prefix='\_tmp'*)

Saves a movie file by drawing every frame.

*filename* is the output filename, eg `mymovie.mp4`

*fps* is the frames per second in the movie

*codec* is the codec to be used, if it is supported by the output method.

*clear\_temp* specifies whether the temporary image files should be deleted.

*frame\_prefix* gives the prefix that should be used for individual image files. This prefix will have a frame number (i.e. 0001) appended when saving individual frames.

**class ArtistAnimation**(*fig, artists, \*args, \*\*kwargs*)

Bases: [matplotlib.animation.TimedAnimation](#)

Before calling this function, all plotting should have taken place and the relevant artists saved.

`frame_info` is a list, with each list entry a collection of artists that represent what needs to be enabled on each frame. These will be disabled for other frames.

**class FuncAnimation**(*fig, func, frames=None, init\_func=None, fargs=None, save\_count=None, \*\*kwargs*)

Bases: [matplotlib.animation.TimedAnimation](#)

Makes an animation by repeatedly calling a function *func*, passing in (optional) arguments in *fargs*.

*frames* can be a generator, an iterable, or a number of frames.

*init\_func* is a function used to draw a clear frame. If not given, the results of drawing from the first item in the frames sequence will be used.

**new\_frame\_seq()**

**new\_saved\_frame\_seq()**

**class TimedAnimation**(*fig, interval=200, repeat\_delay=None, repeat=True, event\_source=None, \*args, \*\*kwargs*)

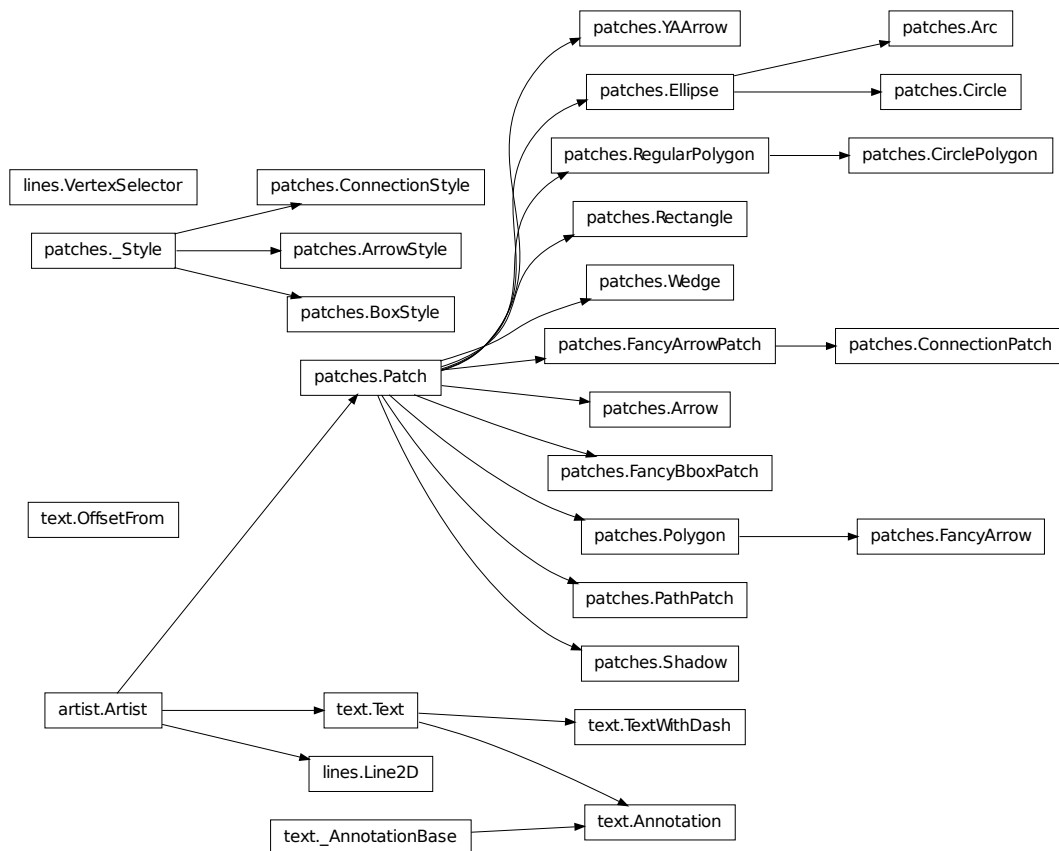
Bases: [matplotlib.animation.Animation](#)

[Animation](#) subclass that supports time-based animation, drawing a new frame every *interval* milliseconds.

*repeat* controls whether the animation should repeat when the sequence of frames is completed.

*repeat\_delay* optionally adds a delay in milliseconds before repeating the animation.

# ARTISTS



## 44.1 matplotlib.artist

**class Artist()**

Bases: object

Abstract base class for someone who renders into a FigureCanvas.

**add\_callback**(*func*)

Adds a callback function that will be called whenever one of the [Artist](#)'s properties changes.

Returns an *id* that is useful for removing the callback with [remove\\_callback\(\)](#) later.

**contains**(*mouseevent*)

Test whether the artist contains the mouse event.

Returns the truth value and a dictionary of artist specific details of selection, such as which points are contained in the pick radius. See individual artists for details.

**convert\_xunits**(*x*)

For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

**convert\_yunits**(*y*)

For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

**draw**(*renderer, \*args, \*\*kwargs*)

Derived classes drawing method

**findobj**(*match=None, include\_self=True*)

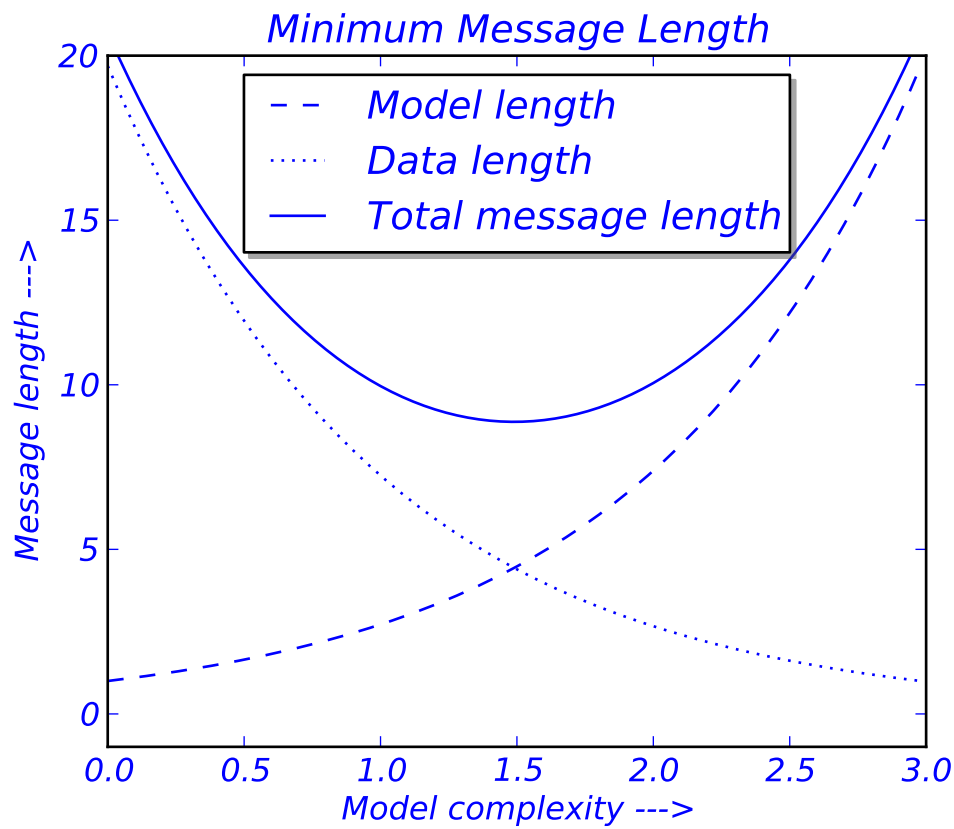
**pyplot signature:** `findobj(o=gcf(), match=None, include_self=True)`

Recursively find all `:class:matplotlib.artist.Artist` instances contained in self.

*match* can be

- None: return all objects contained in artist.
- function with signature `boolean = match(artist)` used to filter matches
- class instance: eg `Line2D`. Only return artists of class type.

If *include\_self* is True (default), include self in the list to be checked for a match.



**get\_agg\_filter()**

return filter function to be used for agg filter

**get\_alpha()**

Return the alpha value used for blending - not supported on all backends

**get\_animated()**

Return the artist's animated state

**get\_axes()**

Return the [Axes](#) instance the artist resides in, or *None*

**get\_children()**

Return a list of the child Artist's `this :class:'Artist'` contains.

**get\_clip\_box()**

Return artist clipbox

**get\_clip\_on()**

Return whether artist uses clipping

**get\_clip\_path()**

Return artist clip path

**get\_contains()**

Return the `_contains` test used by the artist, or *None* for default.

**get\_figure()**

Return the [Figure](#) instance the artist belongs to.

**get\_gid()**

Returns the group id

**get\_label()**

Get the label used for this artist in the legend.

**get\_picker()**

Return the picker object used by this artist

**get\_rasterized()**

return True if the artist is to be rasterized

**get\_snap()**

Returns the snap setting which may be:

- True: snap vertices to the nearest pixel center
- False: leave vertices as-is
- None: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

Only supported by the Agg and MacOSX backends.

**get\_transform()**

Return the [Transform](#) instance used by this artist.

**get\_transformed\_clip\_path\_and\_affine()**

Return the clip path with the non-affine part of its transformation applied, and the remaining affine part of its transformation.

**get\_url()**

Returns the url

**get\_visible()**

Return the artist's visibility

**get\_zorder()**

Return the [Artist](#)'s zorder.

**have\_units()**

Return *True* if units are set on the *x* or *y* axes

**hitlist(event)**

List the children of the artist which contain the mouse event *event*.

**is\_figure\_set()**

Returns True if the artist is assigned to a [Figure](#).

**is\_transform\_set()**

Returns *True* if [Artist](#) has a transform explicitly set.

**pchanged()**

Fire an event when property changed, calling all of the registered callbacks.

**pick**(*mouseevent*)

call signature:

`pick(mouseevent)`

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

**pickable**()

Return *True* if *Artist* is pickable.

**properties**()

return a dictionary mapping property name -> value for all Artist props

**remove**()

Remove the artist from the figure if possible. The effect will not be visible until the figure is redrawn, e.g., with `matplotlib.axes.Axes.draw_idle()`. Call `matplotlib.axes.Axes.relim()` to update the axes limits if desired.

Note: `relim()` will not see collections even if the collection was added to axes with *autolim* = *True*.

Note: there is no support for removing the artist's legend entry.

**remove\_callback**(*oid*)

Remove a callback based on its *id*.

**See Also:**

`add_callback()` For adding callbacks

**set**(\*\**kwargs*)

A tkstyle set command, pass *kwargs* to set properties

**set\_agg\_filter**(*filter\_func*)

set *agg\_filter* fuction.

**set\_alpha**(*alpha*)

Set the alpha value used for blending - not supported on all backends.

ACCEPTS: float (0.0 transparent through 1.0 opaque)

**set\_animated**(*b*)

Set the artist's animation state.

ACCEPTS: [True | False]

**set\_axes**(*axes*)

Set the *Axes* instance in which the artist resides, if any.

ACCEPTS: an *Axes* instance

**set\_clip\_box**(*clipbox*)

Set the artist's clip *Bbox*.

ACCEPTS: a `matplotlib.transforms.Bbox` instance

**set\_clip\_on(*b*)**

Set whether artist uses clipping.

ACCEPTS: [True | False]

**set\_clip\_path(*path*, *transform=None*)**

Set the artist's clip path, which may be:

- a [Patch](#) (or subclass) instance
- a **Path** instance, in which case an optional [Transform](#) instance may be provided, which will be applied to the path before using it for clipping.
- *None*, to remove the clipping path

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to *None*.

ACCEPTS: [ ([Path](#), [Transform](#)) | [Patch](#) | None ]

**set\_contains(*picker*)**

Replace the contains test used by this artist. The new picker should be a callable function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

If the mouse event is over the artist, return *hit = True* and *props* is a dictionary of properties you want returned with the contains test.

ACCEPTS: a callable function

**set\_figure(*fig*)**

Set the [Figure](#) instance the artist belongs to.

ACCEPTS: a `matplotlib.figure.Figure` instance

**set\_gid(*gid*)**

Sets the (group) id for the artist

ACCEPTS: an id string

**set\_label(*s*)**

Set the label to *s* for auto legend.

ACCEPTS: any string

**set\_lod(*on*)**

Set Level of Detail on or off. If on, the artists may examine things like the pixel width of the axes and draw a subset of their contents accordingly

ACCEPTS: [True | False]

**set\_picker(*picker*)**

Set the epsilon for picking used by this artist

*picker* can be one of the following:

- *None*: picking is disabled for this artist (default)



- A boolean: if *True* then picking will be enabled and the artist will fire a pick event if the mouse event is over the artist
- A float: if picker is a number it is interpreted as an epsilon tolerance in points and the artist will fire off an event if it's data is within epsilon of the mouse event. For some artists like lines and patch collections, the artist may provide additional data to the pick event that is generated, e.g. the indices of the data within epsilon of the pick event
- A function: if picker is callable, it is a user supplied function which determines whether the artist is hit by the mouse event:

```
hit, props = picker(artist, mouseevent)
```

to determine the hit test. if the mouse event is over the artist, return *hit=True* and props is a dictionary of properties you want added to the PickEvent attributes.

ACCEPTS: [None|float|boolean|callable]

#### **set\_rasterized(*rasterized*)**

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior

ACCEPTS: [True | False | None]

#### **set\_snap(*snap*)**

Sets the snap setting which may be:

- True: snap vertices to the nearest pixel center
- False: leave vertices as-is
- None: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

Only supported by the Agg and MacOSX backends.

#### **set\_transform(*t*)**

Set the [Transform](#) instance used by this artist.

ACCEPTS: [Transform](#) instance

#### **set\_url(*url*)**

Sets the url for the artist

ACCEPTS: a url string

#### **set\_visible(*b*)**

Set the artist's visibility.

ACCEPTS: [True | False]

#### **set\_zorder(*level*)**

Set the zorder for the artist. Artists with lower zorder values are drawn first.

ACCEPTS: any number

**update**(*props*)

Update the properties of this [Artist](#) from the dictionary *prop*.

**update\_from**(*other*)

Copy properties from *other* to *self*.

**class ArtistInspector**(*o*)

A helper class to inspect an [Artist](#) and return information about its settable properties and their current values.

Initialize the artist inspector with an [Artist](#) or sequence of [Artists](#). If a sequence is used, we assume it is a homogeneous sequence (all [Artists](#) are of the same type) and it is your responsibility to make sure this is so.

**aliased\_name**(*s*)

return 'PROPNAME or alias' if *s* has an alias, else return PROPNAME.

E.g. for the line `markerfacecolor` property, which has an alias, return 'markerfacecolor or mfc' and for the transform property, which does not, return 'transform'

**aliased\_name\_rest**(*s, target*)

return 'PROPNAME or alias' if *s* has an alias, else return PROPNAME formatted for ReST

E.g. for the line `markerfacecolor` property, which has an alias, return 'markerfacecolor or mfc' and for the transform property, which does not, return 'transform'

**findobj**(*match=None*)

Recursively find all `matplotlib.artist.Artist` instances contained in *self*.

If *match* is not None, it can be

- function with signature `boolean = match(artist)`
- class instance: eg [Line2D](#)

used to filter matches.

**get\_aliases**()

Get a dict mapping *fullname* -> *alias* for each *alias* in the [ArtistInspector](#).

Eg., for lines:

```
{'markerfacecolor': 'mfc',  
 'linewidth'      : 'lw',  
}
```

**get\_setters**()

Get the attribute strings with setters for object. Eg., for a line, return ['markerfacecolor', 'linewidth', ....].

**get\_valid\_values**(*attr*)

Get the legal arguments for the setter associated with *attr*.

This is done by querying the docstring of the function *set\_attr* for a line that begins with ACCEPTS:

Eg., for a line linestyle, return “[ ‘-’ | ‘--’ | ‘-.’ | ‘:’ | ‘steps’ | ‘None’ ]”

**is\_alias(o)**

Return *True* if method object *o* is an alias for another function.

**pprint\_getters()**

Return the getters and actual values as list of strings.

**pprint\_setters(prop=None, leadingspace=2)**

If *prop* is *None*, return a list of strings of all settable properties and their valid values.

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

**pprint\_setters\_rest(prop=None, leadingspace=2)**

If *prop* is *None*, return a list of strings of all settable properties and their valid values. Format the output for ReST

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

**properties()**

return a dictionary mapping property name -> value

**allow\_rasterization(draw)**

Decorator for Artist.draw method. Provides routines that run before and after the draw call. The before and after functions are useful for changing artist-dependant renderer attributes or making other setup function calls, such as starting and flushing a mixed-mode renderer.

**get(obj, property=None)**

Return the value of object’s property. *property* is an optional string for the property you want to return

Example usage:

```
getp(obj) # get all the object properties
getp(obj, 'linestyle') # get the linestyle property
```

*obj* is a [Artist](#) instance, eg [Line2D](#) or an instance of a [Axes](#) or [matplotlib.text.Text](#). If the *property* is ‘somename’, this function returns

obj.get\_somename()

[getp\(\)](#) can be used to query all the gettable properties with [getp\(obj\)](#). Many properties have aliases for shorter typing, e.g. ‘lw’ is an alias for ‘linewidth’. In the output, aliases and full property names will be listed as:

property or alias = value

e.g.:

linewidth or lw = 2

**getp(obj, property=None)**

Return the value of object’s property. *property* is an optional string for the property you want to return

Example usage:

```
getp(obj)  # get all the object properties
getp(obj, 'linestyle') # get the linestyle property
```

*obj* is a `Artist` instance, eg `Line2D` or an instance of a `Axes` or `matplotlib.text.Text`. If the *property* is 'somename', this function returns

```
obj.get_somename()
```

`getp()` can be used to query all the gettable properties with `getp(obj)`. Many properties have aliases for shorter typing, e.g. 'lw' is an alias for 'linewidth'. In the output, aliases and full property names will be listed as:

```
property or alias = value
```

e.g.:

```
linewidth or lw = 2
```

**kwdoc(*a*)**

**setp(*obj*, \**args*, \*\**kwargs*)**

matplotlib supports the use of `setp()` ("set property") and `getp()` to set and get object properties, as well as to do introspection on the object. For example, to set the `linestyle` of a line to be dashed, you can do:

```
>>> line, = plot([1,2,3])
>>> setp(line, linestyle='--')
```

If you want to know the valid types of arguments, you can provide the name of the property you want to set without a value:

```
>>> setp(line, 'linestyle')
linestyle: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' ]
```

If you want to see all the properties that can be set, and their possible values, you can do:

```
>>> setp(line)
... long output listing omitted
```

`setp()` operates on a single instance or a list of instances. If you are in query mode introspecting the possible values, only the first instance in the sequence is used. When actually setting values, all the instances will be set. E.g., suppose you have a list of two lines, the following will make both lines thicker and red:

```
>>> x = arange(0,1.0,0.01)
>>> y1 = sin(2*pi*x)
>>> y2 = sin(4*pi*x)
>>> lines = plot(x, y1, x, y2)
>>> setp(lines, linewidth=2, color='r')
```

`setp()` works with the MATLAB style string/value pairs or with python kwargs. For example, the following are equivalent:

```
>>> setp(lines, 'linewidth', 2, 'color', 'r') # MATLAB style
>>> setp(lines, linewidth=2, color='r')      # python style
```

## 44.2 matplotlib.lines

This module contains all the 2D line class which can draw with a variety of line styles, markers and colors.

**class Line2D**(*xdata*, *ydata*, *linewidth=None*, *linestyle=None*, *color=None*, *marker=None*, *marker-size=None*, *markeredgewidth=None*, *markeredgecolor=None*, *markerfacecolor=None*, *markerfacecoloralt='none'*, *fillstyle='full'*, *antialiased=None*, *dash\_capstyle=None*, *solid\_capstyle=None*, *dash\_joinstyle=None*, *solid\_joinstyle=None*, *pickradius=5*, *drawstyle=None*, *markevery=None*, *\*\*kwargs*)

Bases: `matplotlib.artist.Artist`

A line - the line can have both a solid linestyle connecting all the vertices, and a marker at each vertex. Additionally, the drawing of the solid line is influenced by the drawstyle, eg one can create “stepped” lines in various styles.

Create a `Line2D` instance with *x* and *y* data in sequences *xdata*, *ydata*.

The kwargs are `Line2D` properties:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False]   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                                     |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]         |
| <code>color</code> or <code>c</code>        | any matplotlib color   |
| <code>contains</code>                       | a callable function  |
| <code>dash_capstyle</code>                  | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                 | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                         | sequence of on/off ink in points   |
| <code>data</code>                           | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                      | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                     |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                                       |
| <code>fillstyle</code>                      | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                            | an id string   |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | [ '-'   '--'   '-.'   ':'   'None'   ''   '' ] and any drawstyle in combination with a |
| <code>linewidth</code> or <code>lw</code>   | float value in points  |

Table 44.1 – continu

|  |   |
|--|---|
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   "   'None'   None   ' '   '8'   'p'   ', '   '] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>               |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance   |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

See `set_linestyle()` for a decription of the line styles, `set_marker()` for a description of the markers, and `set_drawstyle()` for a description of the draw styles.

#### **contains**(*mouseevent*)

Test whether the mouse event occurred on the line. The pick radius determines the precision of the location test (usually within five points of the value). Use `get_pickradius()` or `set_pickradius()` to view or modify it.

Returns *True* if any values are within the radius along with {'ind': *pointlist*}, where *pointlist* is the set of points within the radius.

TODO: sort returned indices by distance

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

**get\_aa()**

alias for `get_antialiased`

**get\_antialiased()**

**get\_c()**

alias for `get_color`

**get\_color()**

**get\_dash\_capstyle()**

Get the cap style for dashed linestyles

**get\_dash\_joinstyle()**  
Get the join style for dashed linestyles

**get\_data(*orig=True*)**  
Return the xdata, ydata.  
If *orig* is *True*, return the original data

**get\_drawstyle()**

**get\_fillstyle()**  
return the marker fillstyle

**get\_linestyle()**

**get\_linewidth()**

**get\_ls()**  
alias for get\_linestyle

**get\_lw()**  
alias for get\_linewidth

**get\_marker()**

**get\_markedgedcolor()**

**get\_markedgedwidth()**

**get\_markerfacecolor()**

**get\_markerfacecoloralt()**

**get\_markersize()**

**get\_markevery()**  
return the markevery setting

**get\_mec()**  
alias for get\_markedgedcolor

**get\_mew()**  
alias for get\_markedgedwidth

**get\_mfc()**  
alias for get\_markerfacecolor

**get\_mfcalt(*alt=False*)**  
alias for get\_markerfacecoloralt

**get\_ms()**  
alias for get\_markersize

**get\_path()**  
Return the [Path](#) object associated with this line.

**get\_pickradius()**  
return the pick radius used for containment tests

**get\_solid\_capstyle()**

Get the cap style for solid linestyles

**get\_solid\_joinstyle()**

Get the join style for solid linestyles

**get\_window\_extent(renderer)**

**get\_xdata(orig=True)**

Return the xdata.

If *orig* is *True*, return the original data, else the processed data.

**get\_xydata()**

Return the xy data as a Nx2 numpy array.

**get\_ydata(orig=True)**

Return the ydata.

If *orig* is *True*, return the original data, else the processed data.

**is\_dashed()**

return True if line is dashstyle

**recache(always=False)**

**recache\_always()**

**set\_aa(val)**

alias for `set_antialiased`

**set\_antialiased(b)**

True if line should be drawn with antialiased rendering

ACCEPTS: [True | False]

**set\_axes(ax)**

Set the [Axes](#) instance in which the artist resides, if any.

ACCEPTS: an [Axes](#) instance

**set\_c(val)**

alias for `set_color`

**set\_color(color)**

Set the color of the line

ACCEPTS: any matplotlib color

**set\_dash\_capstyle(s)**

Set the cap style for dashed linestyles

ACCEPTS: ['butt' | 'round' | 'projecting']

**set\_dash\_joinstyle(s)**

Set the join style for dashed linestyles ACCEPTS: ['miter' | 'round' | 'bevel']



### **set\_dashes(*seq*)**

Set the dash sequence, sequence of dashes with on off ink in points. If *seq* is empty or if *seq* = (None, None), the linestyle will be set to solid.

ACCEPTS: sequence of on/off ink in points

### **set\_data(\**args*)**

Set the x and y data

ACCEPTS: 2D array (rows are x, y) or two 1D arrays

### **set\_drawstyle(*drawstyle*)**

Set the drawstyle of the plot

‘default’ connects the points with lines. The steps variants produce step-plots. ‘steps’ is equivalent to ‘steps-pre’ and is maintained for backward-compatibility.

ACCEPTS: [ ‘default’ | ‘steps’ | ‘steps-pre’ | ‘steps-mid’ | ‘steps-post’ ]

### **set\_fillstyle(*fs*)**

Set the marker fill style; ‘full’ means fill the whole marker. The other options are for half filled markers

ACCEPTS: [ ‘full’ | ‘left’ | ‘right’ | ‘bottom’ | ‘top’ ]

### **set\_linestyle(*linestyle*)**

Set the linestyle of the line (also accepts drawstyles)

| linestyle | description  |
|-----------|--------------|
| '-'       | solid        |
| '--'      | dashed       |
| '-.'      | dash_dot     |
| ':'       | dotted       |
| 'None'    | draw nothing |
| ' '       | draw nothing |
| ''        | draw nothing |

‘steps’ is equivalent to ‘steps-pre’ and is maintained for backward-compatibility.

### **See Also:**

**set\_drawstyle()** To set the drawing style (stepping) of the plot.

ACCEPTS: [ ‘-’ | ‘--’ | ‘-.’ | ‘:’ | ‘None’ | ‘ ’ | ‘’ ] and any drawstyle in combination with a linestyle, e.g. ‘steps--’.

### **set\_linewidth(*w*)**

Set the line width in points

ACCEPTS: float value in points

### **set\_ls(*val*)**

alias for set\_linestyle

### **set\_lw(*val*)**

alias for set\_linewidth

**set\_marker**(*marker*)

Set the line marker

| marker                          | description                            |
|---------------------------------|--|
| 7                               | caretdown                              |
| 4                               | caretleft                              |
| 5                               | caretright                             |
| 6                               | caretup                                |
| 'o'                             | circle                                 |
| 'D'                             | diamond                                |
| 'h'                             | hexagon1                               |
| 'H'                             | hexagon2                               |
| '_'                             | hline                                  |
| "                               | nothing                                |
| 'None'                          | nothing                                |
| None                            | nothing                                |
| ' '                             | nothing                                |
| '8'                             | octagon                                |
| 'p'                             | pentagon                               |
| ' '                             | pixel                                  |
| '+'                             | plus                                   |
| '.'                             | point                                  |
| 's'                             | square                                 |
| '*'                             | star                                   |
| 'd'                             | thin_diamond                           |
| 3                               | tickdown                               |
| 0                               | tickleft                               |
| 1                               | tickright                              |
| 2                               | tickup                                 |
| '1'                             | tri_down                               |
| '3'                             | tri_left                               |
| '4'                             | tri_right                              |
| '2'                             | tri_up                                 |
| 'v'                             | triangle_down                          |
| '<'                             | triangle_left                          |
| '>'                             | triangle_right                         |
| '^'                             | triangle_up                            |
| ' '                             | vline                                  |
| 'x'                             | x                                      |
| '\$...\$'                       | render the string using mathtext       |
| <i>verts</i>                    | a list of (x, y) pairs in range (0, 1) |
| <i>(numsides, style, angle)</i> | see below                              |

The marker can also be a tuple (*numsides*, *style*, *angle*), which will create a custom, regular symbol.

***numsides***: the number of sides

**style:** the style of the regular symbol:

| Value | Description   |
|-------|---|
| 0     | a regular polygon                                       |
| 1     | a star-like symbol                                      |
| 2     | an asterisk   |
| 3     | a circle ( <i>numsides</i> and <i>angle</i> is ignored) |

**angle:** the angle of rotation of the symbol

For backward compatibility, the form (*verts*, 0) is also accepted, but it is equivalent to just *verts* for giving a raw set of vertices that define the shape.

ACCEPTS: [ 7 | 4 | 5 | 6 | 'o' | 'D' | 'h' | 'H' | '\_' | " | 'None' | None | ' ' | '8' | 'p' | ', ' | '+' | '.' | 's' | '\*' | 'd' | 3 | 0 | 1 | 2 | '1' | '3' | '4' | '2' | 'v' | '<' | '>' | '^' | '|' | 'x' | '\$...\$' | tuple | Nx2 array ]

**set\_markeredgecolor**(*ec*)

Set the marker edge color

ACCEPTS: any matplotlib color

**set\_markeredgewidth**(*ew*)

Set the marker edge width in points

ACCEPTS: float value in points

**set\_markerfacecolor**(*fc*)

Set the marker face color.

ACCEPTS: any matplotlib color

**set\_markerfacecoloralt**(*fc*)

Set the alternate marker face color.

ACCEPTS: any matplotlib color

**set\_markersize**(*sz*)

Set the marker size in points

ACCEPTS: float

**set\_markevery**(*every*)

Set the markevery property to subsample the plot when using markers. Eg if markevery=5, every 5-th marker will be plotted. *every* can be

**None** Every point will be plotted

**an integer N** Every N-th marker will be plotted starting with marker 0

**A length-2 tuple of integers** every=(start, N) will start at point start and plot every N-th marker

ACCEPTS: None | integer | (startind, stride)

**set\_mec**(*val*)

alias for set\_markeredgecolor

**set\_mew**(*val*)  
alias for `set_markeredgewidth`

**set\_mfc**(*val*)  
alias for `set_markerfacecolor`

**set\_mfcalt**(*val*)  
alias for `set_markerfacecoloralt`

**set\_ms**(*val*)  
alias for `set_markersize`

**set\_picker**(*p*)  
Sets the event picker details for the line.  
  
ACCEPTS: float distance in points or callable pick function `fn(artist, event)`

**set\_pickradius**(*d*)  
Sets the pick radius used for containment tests  
  
ACCEPTS: float distance in points

**set\_solid\_capstyle**(*s*)  
Set the cap style for solid linestyles  
  
ACCEPTS: ['butt' | 'round' | 'projecting']

**set\_solid\_joinstyle**(*s*)  
Set the join style for solid linestyles ACCEPTS: ['miter' | 'round' | 'bevel']

**set\_transform**(*t*)  
set the Transformation instance used by this artist  
  
ACCEPTS: a `matplotlib.transforms.Transform` instance

**set\_xdata**(*x*)  
Set the data `np.array` for x  
  
ACCEPTS: 1D array

**set\_ydata**(*y*)  
Set the data `np.array` for y  
  
ACCEPTS: 1D array

**update\_from**(*other*)  
copy properties from other to self

**class VertexSelector**(*line*)

Manage the callbacks to maintain a list of selected vertices for `matplotlib.lines.Line2D`. Derived classes should override `process_selected()` to do something with the picks.

Here is an example which highlights the selected verts with red circles:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.lines as lines
```

```

class HighlightSelected(lines.VertexSelector):
    def __init__(self, line, fmt='ro', **kwargs):
        lines.VertexSelector.__init__(self, line)
        self.markers, = self.axes.plot([], [], fmt, **kwargs)

    def process_selected(self, ind, xs, ys):
        self.markers.set_data(xs, ys)
        self.canvas.draw()

fig = plt.figure()
ax = fig.add_subplot(111)
x, y = np.random.rand(2, 30)
line, = ax.plot(x, y, 'bs-', picker=5)

selector = HighlightSelected(line)
plt.show()

```

Initialize the class with a `matplotlib.lines.Line2D` instance. The line should already be added to some `matplotlib.axes.Axes` instance and should have the `picker` property set.

**onpick**(*event*)

When the line is picked, update the set of selected indices.

**process\_selected**(*ind, xs, ys*)

Default “do nothing” implementation of the `process_selected()` method.

*ind* are the indices of the selected vertices. *xs* and *ys* are the coordinates of the selected vertices.

**segment\_hits**(*cx, cy, x, y, radius*)

Determine if any line segments are within radius of a point. Returns the list of line segments that are within that radius.

## 44.3 matplotlib.patches

**class Arc**(*xy, width, height, angle=0.0, theta1=0.0, theta2=360.0, \*\*kwargs*)

Bases: `matplotlib.patches.Ellipse`

An elliptical arc. Because it performs various optimizations, it can not be filled.

The arc must be used in an `Axes` instance—it can not be added directly to a `Figure`—because it is optimized to only render the segments that are inside the axes bounding box with high resolution.

The following args are supported:

**xy** center of ellipse

**width** length of horizontal axis

**height** length of vertical axis

**angle** rotation in degrees (anti-clockwise)

**theta1** starting angle of the arc in degrees

*theta2* ending angle of the arc in degrees

If *theta1* and *theta2* are not provided, the arc will form a complete ellipse.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

Ellipses are normally drawn using an approximation that uses eight cubic bezier splines. The error of this approximation is 1.89818e-6, according to this unverified source:

Lancaster, Don. Approximating a Circle or an Ellipse Using Four Bezier Cubic Splines.

<http://www.tinaja.com/glib/ellipse4.pdf>

There is a use case where very large ellipses must be drawn with very high accuracy, and it is too expensive to render the entire ellipse with enough segments (either splines or line segments). Therefore, in the case where either radius of the ellipse is large enough that the error of the spline approximation will be visible (greater than one pixel offset from the ideal), a different technique is used.

In that case, only the visible parts of the ellipse are drawn, with each visible arc using a fixed

number of spline segments (8). The algorithm proceeds as follows:

1. The points where the ellipse intersects the axes bounding box are located. (This is done by performing an inverse transformation on the axes bbox such that it is relative to the unit circle – this makes the intersection calculation much easier than doing rotated ellipse intersection directly).

This uses the “line intersecting a circle” algorithm from:

Vince, John. Geometry for Computer Graphics: Formulae, Examples & Proofs.  
London: Springer-Verlag, 2005.

2. The angles of each of the intersection points are calculated.
3. Proceeding counterclockwise starting in the positive x-direction, each of the visible arc-segments between the pairs of vertices are drawn using the bezier arc approximation technique implemented in `matplotlib.path.Path.arc()`.

**class Arrow**(*x, y, dx, dy, width=1.0, \*\*kwargs*)

Bases: `matplotlib.patches.Patch`

An arrow patch.

Draws an arrow, starting at (*x, y*), direction and length given by (*dx, dy*) the width of the arrow is scaled by *width*.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

`get_patch_transform()`

`get_path()`

**class** `ArrowStyle()`

Bases: `matplotlib.patches._Style`

`ArrowStyle` is a container class which defines several arrowstyle classes, which is used to create an arrow path along a given path. These are mainly used with `FancyArrowPatch`.

A arrowstyle object can be either created as:

```
ArrowStyle.Fancy(head_length=.4, head_width=.4, tail_width=.4)
```

or:

```
ArrowStyle("Fancy", head_length=.4, head_width=.4, tail_width=.4)
```

or:



```
ArrowStyle("Fancy", head_length=.4, head_width=.4, tail_width=.4")
```

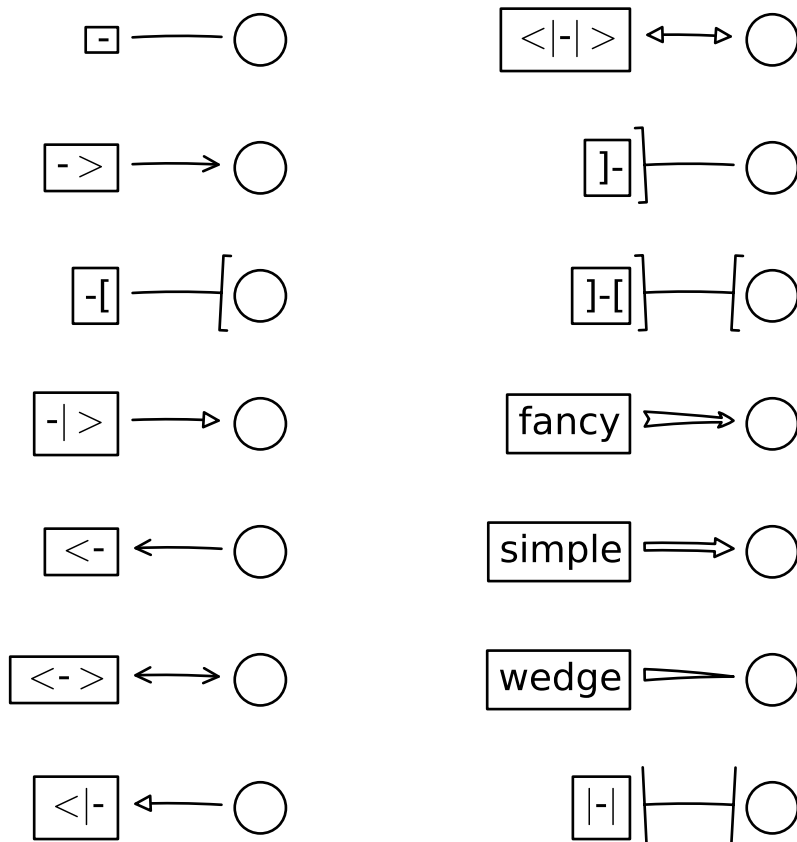
The following classes are defined

| Class          | Name   | Attrs   |
|----------------|--------|---|
| Curve          | -      | None  |
| CurveB         | ->     | head_length=0.4,head_width=0.2  |
| BracketB       | -[     | widthB=1.0,lengthB=0.2,angleB=None                                    |
| CurveFilledB   | - >    | head_length=0.4,head_width=0.2  |
| CurveA         | <-     | head_length=0.4,head_width=0.2  |
| CurveAB        | <->    | head_length=0.4,head_width=0.2  |
| CurveFilledA   | < -    | head_length=0.4,head_width=0.2  |
| Curve-FilledAB | < - >  | head_length=0.4,head_width=0.2  |
| BracketA       | ] -    | widthA=1.0,lengthA=0.2,angleA=None                                    |
| BracketAB      | ] - [  | widthA=1.0,lengthA=0.2,angleA=None,widthB=1.0,lengthB=0.2,angleB=None |
| Fancy          | fancy  | head_length=0.4,head_width=0.4,tail_width=0.4                         |
| Simple         | simple | head_length=0.5,head_width=0.5,tail_width=0.2                         |
| Wedge          | wedge  | tail_width=0.3,shrink_factor=0.5                                      |
| BarAB          | -      | widthA=1.0,angleA=None,widthB=1.0,angleB=None                         |

An instance of any arrow style class is a callable object, whose call signature is:

```
__call__(self, path, mutation_size, linewidth, aspect_ratio=1.)
```

and it returns a tuple of a `Path` instance and a boolean value. *path* is a `Path` instance along which the arrow will be drawn. *mutation\_size* and *aspect\_ratio* has a same meaning as in `BoxStyle`. *linewidth* is a line width to be stroked. This is meant to be used to correct the location of the head so that it does not overshoot the destination point, but not all classes support it.



```
class BarAB(widthA=1.0, angleA=None, widthB=1.0, angleB=None)
```

Bases: `matplotlib.patches._Bracket`

An arrow with a bar(|) at both ends.

***widthA*** width of the bracket

*lengthA* length of the bracket

*angleA* angle between the bracket and the line

***widthB*** width of the bracket

*lengthB* length of the bracket

*angleB* angle between the bracket and the line

```
class BracketA(widthA=1.0, lengthA=0.20000000000000001, angleA=None)
```

Bases: matplotlib.patches.\_Bracket

An arrow with a bracket(`[]`) at its end.

***widthA*** width of the bracket

*lengthA* length of the bracket

*angleA* angle between the bracket and the line

**class BracketAB**(*widthA=1.0*, *lengthA=0.20000000000000001*, *angleA=None*, *widthB=1.0*,  
*lengthB=0.20000000000000001*, *angleB=None*)

Bases: `matplotlib.patches._Bracket`

An arrow with a bracket() at both ends.

*widthA* width of the bracket

*lengthA* length of the bracket

*angleA* angle between the bracket and the line

*widthB* width of the bracket

*lengthB* length of the bracket

*angleB* angle between the bracket and the line

**class BracketB**(*widthB=1.0*, *lengthB=0.20000000000000001*, *angleB=None*)

Bases: `matplotlib.patches._Bracket`

An arrow with a bracket() at its end.

*widthB* width of the bracket

*lengthB* length of the bracket

*angleB* angle between the bracket and the line

**class Curve**()

Bases: `matplotlib.patches._Curve`

A simple curve without any arrow head.

**class CurveA**(*head\_length=0.40000000000000002*, *head\_width=0.20000000000000001*)

Bases: `matplotlib.patches._Curve`

An arrow with a head at its begin point.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class CurveAB**(*head\_length=0.40000000000000002*, *head\_width=0.20000000000000001*)

Bases: `matplotlib.patches._Curve`

An arrow with heads both at the begin and the end point.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class CurveB**(*head\_length=0.40000000000000002*, *head\_width=0.20000000000000001*)

Bases: `matplotlib.patches._Curve`

An arrow with a head at its end point.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class CurveFilledA**(*head\_length*=0.40000000000000002, *head\_width*=0.20000000000000001)

Bases: matplotlib.patches.\_Curve

An arrow with filled triangle head at the begin.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class CurveFilledAB**(*head\_length*=0.40000000000000002, *head\_width*=0.20000000000000001)

Bases: matplotlib.patches.\_Curve

An arrow with filled triangle heads both at the begin and the end point.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class CurveFilledB**(*head\_length*=0.40000000000000002, *head\_width*=0.20000000000000001)

Bases: matplotlib.patches.\_Curve

An arrow with filled triangle head at the end.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

**class Fancy**(*head\_length*=0.40000000000000002, *head\_width*=0.40000000000000002,  
*tail\_width*=0.40000000000000002)

Bases: matplotlib.patches.\_Base

A fancy arrow. Only works with a quadratic bezier curve.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

*tail\_width* width of the arrow tail

**transmute**(*path*, *mutation\_size*, *linewidth*)

**class Simple**(*head\_length*=0.5, *head\_width*=0.5, *tail\_width*=0.20000000000000001)

Bases: matplotlib.patches.\_Base

A simple arrow. Only works with a quadratic bezier curve.

*head\_length* length of the arrow head

*head\_width* width of the arrow head

*tail\_width* width of the arrow tail

**transmute**(*path*, *mutation\_size*, *linewidth*)

**class Wedge**(*tail\_width*=0.29999999999999999, *shrink\_factor*=0.5)

Bases: matplotlib.patches.\_Base

Wedge(?) shape. Only works with a quadratic bezier curve. The begin point has a width of the `tail_width` and the end point has a width of 0. At the middle, the width is `shrink_factor*tail_width`.

**`tail_width`** width of the tail

**`shrink_factor`** fraction of the arrow width at the middle point

**`transmute`**(*path, mutation\_size, linewidth*)

**class `BoxStyle()`**

Bases: `matplotlib.patches._Style`

**`BoxStyle`** is a container class which defines several boxstyle classes, which are used for `FancyBoxPatch`.

A style object can be created as:

```
BoxStyle.Round(pad=0.2)
```

or:

```
BoxStyle("Round", pad=0.2)
```

or:

```
BoxStyle("Round", pad=0.2)
```

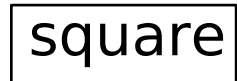
Following boxstyle classes are defined.

| Class      | Name       | Attrs                      |
|------------|------------|----------------------------|
| LArrow     | larrow     | pad=0.3                    |
| RArrow     | rarrow     | pad=0.3                    |
| Round      | round      | pad=0.3,rounding_size=None |
| Round4     | round4     | pad=0.3,rounding_size=None |
| Roundtooth | roundtooth | pad=0.3,tooth_size=None    |
| Sawtooth   | sawtooth   | pad=0.3,tooth_size=None    |
| Square     | square     | pad=0.3                    |

An instance of any boxstyle class is an callable object, whose call signature is:

```
__call__(self, x0, y0, width, height, mutation_size, aspect_ratio=1.)
```

and returns a `Path` instance. *x0*, *y0*, *width* and *height* specify the location and size of the box to be drawn. *mutation\_scale* determines the overall size of the mutation (by which I mean the transformation of the rectangle to the fancy box). *mutation\_aspect* determines the aspect-ratio of the mutation.



square



sawtooth



roundtooth



rarrow



larrow



round4



round

```
class LArrow(pad=0.29999999999999999)
```

```
    Bases: matplotlib.patches._Base
```

```
    (left) Arrow Box
```

```
    transmute(x0, y0, width, height, mutation_size)
```

```
class RArrow(pad=0.29999999999999999)
```

```
    Bases: matplotlib.patches.LArrow
```

```
    (right) Arrow Box
```

```
    transmute(x0, y0, width, height, mutation_size)
```

```
class Round(pad=0.29999999999999999, rounding_size=None)
```

```
    Bases: matplotlib.patches._Base
```

```
    A box with round corners.
```

```
    pad amount of padding
```

```
    rounding_size rounding radius of corners. pad if None
```

```
    transmute(x0, y0, width, height, mutation_size)
```

```
class Round4(pad=0.29999999999999999, rounding_size=None)
```

Bases: `matplotlib.patches._Base`

Another box with round edges.

*pad* amount of padding

*rounding\_size* rounding size of edges. *pad* if None

**transmute**(*x0, y0, width, height, mutation\_size*)

```
class Roundtooth(pad=0.29999999999999999, tooth_size=None)
```

Bases: `matplotlib.patches.Sawtooth`

A roundtooth(?) box.

*pad* amount of padding

*tooth\_size* size of the sawtooth. *pad*\* if None

**transmute**(*x0, y0, width, height, mutation\_size*)

```
class Sawtooth(pad=0.29999999999999999, tooth_size=None)
```

Bases: `matplotlib.patches._Base`

A sawtooth box.

*pad* amount of padding

*tooth\_size* size of the sawtooth. *pad*\* if None

**transmute**(*x0, y0, width, height, mutation\_size*)

```
class Square(pad=0.29999999999999999)
```

Bases: `matplotlib.patches._Base`

A simple square box.

*pad* amount of padding

**transmute**(*x0, y0, width, height, mutation\_size*)

```
class Circle(xy, radius=5, **kwargs)
```

Bases: `matplotlib.patches.Ellipse`

A circle patch.

Create true circle at center  $xy = (x, y)$  with given *radius*. Unlike `CirclePolygon` which is a polygonal approximation, this uses Bézier splines and is much closer to a scale-free circle.

Valid kwargs are:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**get\_radius()**

return the radius of the circle

**radius**

return the radius of the circle

**set\_radius(*radius*)**

Set the radius of the circle

ACCEPTS: float

**class CirclePolygon(*xy*, *radius*=5, *resolution*=20, *\*\*kwargs*)**

Bases: [matplotlib.patches.RegularPolygon](#)

A polygon-approximation of a circle patch.

Create a circle at  $xy = (x, y)$  with given *radius*. This circle is approximated by a regular polygon with *resolution* sides. For a smoother circle drawn with splines, see [Circle](#).

Valid kwargs are:



| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**class [ConnectionPatch](#)**(*xyA*, *xyB*, *coordsA*, *coordsB=None*, *axesA=None*, *axesB=None*, *arrowstyle='-'*,  
*arrow\_transmuter=None*, *connectionstyle='arc3'*, *connector=None*,  
*patchA=None*, *patchB=None*, *shrinkA=0.0*, *shrinkB=0.0*, *mutation\_scale=10.0*,  
*mutation\_aspect=None*, *clip\_on=False*, *dpi\_cor=1.0*, *\*\*kwargs*)

Bases: [matplotlib.patches.FancyArrowPatch](#)

A [ConnectionPatch](#) class is to make connecting lines between two points (possibly in different axes).

Connect point *xyA* in *coordsA* with point *xyB* in *coordsB*

Valid keys are

| Key             | Description   |
|-----------------|---|
| arrowstyle      | the arrow style                                       |
| connectionstyle | the connection style                                  |
| relpos          | default is (0.5, 0.5)                                 |
| patchA          | default is bounding box of the text                   |
| patchB          | default is None                                       |
| shrinkA         | default is 2 points                                   |
| shrinkB         | default is 2 points                                   |
| mutation_scale  | default is text size (in points)                      |
| mutation_aspect | default is 1.   |
| ?               | any key for <code>matplotlib.patches.PathPatch</code> |

*coordsA* and *coordsB* are strings that indicate the coordinates of *xyA* and *xyB*.

| Property          | Description   |
|-------------------|---|
| 'figure points'   | points from the lower left corner of the figure   |
| 'figure pixels'   | pixels from the lower left corner of the figure   |
| 'figure fraction' | 0,0 is lower left of figure and 1,1 is upper, right   |
| 'axes points'     | points from lower left corner of axes   |
| 'axes pixels'     | pixels from lower left corner of axes   |
| 'axes fraction'   | 0,1 is lower left of axes and 1,1 is upper right  |
| 'data'            | use the coordinate system of the object being annotated (default)   |
| 'offset points'   | Specify an offset (in points) from the <i>xy</i> value  |
| 'polar'           | you can specify <i>theta</i> , <i>r</i> for the annotation, even in cartesian plots. Note that if you are using a polar axes, you do not need to specify polar for the coordinate system since that is the native "data" coordinate system. |

**draw**(*renderer*)

Draw.

**get\_annotation\_clip**()

Return *annotation\_clip* attribute. See `set_annotation_clip()` for the meaning of return values.

**get\_path\_in\_displaycoord**()

Return the mutated path of the arrow in the display coord

**set\_annotation\_clip**(*b*)

set *annotation\_clip* attribute.

- True : the annotation will only be drawn when *self.xy* is inside the axes.
- False : the annotation will always be drawn regardless of its position.

- None : the self.xy will be checked only if *xycoords* is “data”

### class `ConnectionStyle()`

Bases: `matplotlib.patches._Style`

`ConnectionStyle` is a container class which defines several connectionstyle classes, which is used to create a path between two points. These are mainly used with `FancyArrowPatch`.

A connectionstyle object can be either created as:

```
ConnectionStyle.Arc3(rad=0.2)
```

or:

```
ConnectionStyle("Arc3", rad=0.2)
```

or:

```
ConnectionStyle("Arc3", rad=0.2)
```

The following classes are defined

| Class  | Name   | Attrs   |
|--------|--------|---|
| Angle  | angle  | angleA=90,angleB=0,rad=0.0                    |
| Angle3 | angle3 | angleA=90,angleB=0                            |
| Arc    | arc    | angleA=0,angleB=0,armA=None,armB=None,rad=0.0 |
| Arc3   | arc3   | rad=0.0                                       |
| Bar    | bar    | armA=0.0,armB=0.0,fraction=0.3,angle=None     |

An instance of any connection style class is an callable object, whose call signature is:

```
__call__(self, posA, posB, patchA=None, patchB=None, shrinkA=2., shrinkB=2.)
```

and it returns a `Path` instance. *posA* and *posB* are tuples of x,y coordinates of the two points to be connected. *patchA* (or *patchB*) is given, the returned path is clipped so that it start (or end) from the boundary of the patch. The path is further shrunk by *shrinkA* (or *shrinkB*) which is given in points.

### class `Angle(angleA=90, angleB=0, rad=0.0)`

Bases: `matplotlib.patches._Base`

Creates a piecewise continuous quadratic bezier path between two points. The path has a one passing-through point placed at the intersecting point of two lines which crosses the start (or end) point and has a angle of *angleA* (or *angleB*). The connecting edges are rounded with *rad*.

***angleA*** starting angle of the path

***angleB*** ending angle of the path

***rad*** rounding radius of the edge

***connect***(*posA*, *posB*)

**class** **Angle3**(*angleA=90, angleB=0*)

Bases: `matplotlib.patches._Base`

Creates a simple quadratic bezier curve between two points. The middle control points is placed at the intersecting point of two lines which crosses the start (or end) point and has a angle of *angleA* (or *angleB*).

*angleA* starting angle of the path

*angleB* ending angle of the path

**connect**(*posA, posB*)

**class** **Arc**(*angleA=0, angleB=0, armA=None, armB=None, rad=0.0*)

Bases: `matplotlib.patches._Base`

Creates a picewise continuous quadratic bezier path between two points. The path can have two passing-through points, a point placed at the distance of *armA* and angle of *angleA* from point A, another point with respect to point B. The edges are rounded with *rad*.

*angleA* : starting angle of the path

*angleB* : ending angle of the path

*armA* : length of the starting arm

*armB* : length of the ending arm

*rad* : rounding radius of the edges

**connect**(*posA, posB*)

**class** **Arc3**(*rad=0.0*)

Bases: `matplotlib.patches._Base`

Creates a simple quadratic bezier curve between two points. The curve is created so that the middle control points (C1) is located at the same distance from the start (C0) and end points(C2) and the distance of the C1 to the line connecting C0-C2 is *rad* times the distance of C0-C2.

*rad* curvature of the curve.

**connect**(*posA, posB*)

**class** **Bar**(*armA=0.0, armB=0.0, fraction=0.29999999999999999, angle=None*)

Bases: `matplotlib.patches._Base`

A line with *angle* between A and B with *armA* and *armB*. One of the arm is extend so that they are connected in a right angle. The length of *armA* is determined by (*armA* + *fraction* x AB distance). Same for *armB*.

*armA* : minimum length of *armA* *armB* : minimum length of *armB* *fraction* : a fraction of the distance between two points that will be added to *armA* and *armB*. *angle* : angle of the connecting line (if None, parallel to A and B)

**connect**(*posA, posB*)

**class** **Ellipse**(*xy, width, height, angle=0.0, \*\*kwargs*)

Bases: `matplotlib.patches.Patch`

A scale-free ellipse.

**xy** center of ellipse

**width** total length (diameter) of horizontal axis

**height** total length (diameter) of vertical axis

**angle** rotation in degrees (anti-clockwise)

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

`contains(ev)`

`get_patch_transform()`

`get_path()`

Return the vertices of the rectangle

**class FancyArrow**(*x, y, dx, dy, width=0.001, length\_includes\_head=False, head\_width=None, head\_length=None, shape='full', overhang=0, head\_starts\_at\_zero=False, \*\*kwargs*)

Bases: `matplotlib.patches.Polygon`

Like Arrow, but lets you set head width and head height independently.

Constructor arguments

***length\_includes\_head***: *True* if head is counted in calculating the length.

***shape***: ['full', 'left', 'right']

***overhang***: distance that the arrow is swept back (0 overhang means triangular shape).

***head\_starts\_at\_zero***: If *True*, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Valid kwargs are:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

```
class FancyArrowPatch(posA=None, posB=None, path=None, arrowstyle='simple',
                      row_transmuter=None, connectionstyle='arc3', connector=None,
                      patchA=None, patchB=None, shrinkA=2.0, shrinkB=2.0, mutation_scale=1.0,
                      mutation_aspect=None, dpi_cor=1.0, **kwargs)
```

Bases: [matplotlib.patches.Patch](#)

A fancy arrow patch. It draws an arrow using the :class:ArrowStyle.

If *posA* and *posB* is given, a path connecting two point are created according to the *connectionstyle*. The path will be clipped with *patchA* and *patchB* and further shirnked by *shrinkA* and *shrinkB*. An arrow is drawn along this resulting path using the *arrowstyle* parameter. If *path* provided, an arrow is drawn along this path and *patchA*, *patchB*, *shrinkA*, and *shrinkB* are ignored.

The *connectionstyle* describes how *posA* and *posB* are connected. It can be an instance of the *ConnectionStyle* class (`matplotlib.patches.ConnectionStlye`) or a string of the connectionstyle name, with optional comma-separated attributes. The following connection styles are available.

| Class  | Name   | Attrs   |
|--------|--------|---|
| Angle  | angle  | angleA=90,angleB=0,rad=0.0                    |
| Angle3 | angle3 | angleA=90,angleB=0                            |
| Arc    | arc    | angleA=0,angleB=0,armA=None,armB=None,rad=0.0 |
| Arc3   | arc3   | rad=0.0                                       |
| Bar    | bar    | armA=0.0,armB=0.0,fraction=0.3,angle=None     |

The *arrowstyle* describes how the fancy arrow will be drawn. It can be string of the available arrowstyle names, with optional comma-separated attributes, or one of the *ArrowStyle* instance. The optional attributes are meant to be scaled with the *mutation\_scale*. The following arrow styles are available.

| Class          | Name   | Attrs   |
|----------------|--------|---|
| Curve          | -      | None  |
| CurveB         | ->     | head_length=0.4,head_width=0.2  |
| BracketB       | -[     | widthB=1.0,lengthB=0.2,angleB=None                                    |
| CurveFilledB   | - >    | head_length=0.4,head_width=0.2  |
| CurveA         | <-     | head_length=0.4,head_width=0.2  |
| CurveAB        | <->    | head_length=0.4,head_width=0.2  |
| CurveFilledA   | < -    | head_length=0.4,head_width=0.2  |
| Curve-FilledAB | < - >  | head_length=0.4,head_width=0.2  |
| BracketA       | ] -    | widthA=1.0,lengthA=0.2,angleA=None                                    |
| BracketAB      | ] - [  | widthA=1.0,lengthA=0.2,angleA=None,widthB=1.0,lengthB=0.2,angleB=None |
| Fancy          | fancy  | head_length=0.4,head_width=0.4,tail_width=0.4                         |
| Simple         | simple | head_length=0.5,head_width=0.5,tail_width=0.2                         |
| Wedge          | wedge  | tail_width=0.3,shrink_factor=0.5                                      |
| BarAB          | -      | widthA=1.0,angleA=None,widthB=1.0,angleB=None                         |

***mutation\_scale*** [a value with which attributes of arrowstyle] (e.g., *head\_length*) will be scaled. default=1.

***mutation\_aspect*** [The height of the rectangle will be] squeezed by this value before the mutation and the mutated box will be stretched by the inverse of it. default=None.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**draw**(*renderer*)

**get\_arrowstyle**()

Return the arrowstyle object

**get\_connectionstyle**()

Return the ConnectionStyle instance

**get\_dpi\_cor**()

`dpi_cor` is currently used for linewidth-related things and shrink factor. Mutation scale is not affected by this.

**get\_mutation\_aspect**()

Return the aspect ratio of the bbox mutation.

**get\_mutation\_scale**()

Return the mutation scale.

**get\_path**()

return the path of the arrow in the data coordinate. Use `get_path_in_displaycoord()` method to retrieve the arrow path in the display coord.



**get\_path\_in\_displaycoord()**

Return the mutated path of the arrow in the display coord

**set\_arrowstyle**(*arrowstyle=None, \*\*kw*)

Set the arrow style.

***arrowstyle* can be a string with arrowstyle name with optional** comma-separated attributes. Alternatively, the attrs can be provided as keywords.

```
set_arrowstyle("Fancy,head_length=0.2") set_arrowstyle("fancy", head_length=0.2)
```

Old attrs simply are forgotten.

Without argument (or with *arrowstyle=None*), return available box styles as a list of strings.

**set\_connectionstyle**(*connectionstyle, \*\*kw*)

Set the connection style.

***connectionstyle* can be a string with connectionstyle name with optional** comma-separated attributes. Alternatively, the attrs can be provided as keywords.

```
set_connectionstyle("arc,angleA=0,armA=30,rad=10") set_connectionstyle("arc", angleA=0,armA=30,rad=10)
```

Old attrs simply are forgotten.

Without argument (or with *connectionstyle=None*), return available styles as a list of strings.

**set\_dpi\_cor**(*dpi\_cor*)

*dpi\_cor* is currently used for linewidth-related things and shrink factor. Mutation scale is not affected by this.

**set\_mutation\_aspect**(*aspect*)

Set the aspect ratio of the bbox mutation.

ACCEPTS: float

**set\_mutation\_scale**(*scale*)

Set the mutation scale.

ACCEPTS: float

**set\_patchA**(*patchA*)

set the begin patch.

**set\_patchB**(*patchB*)

set the begin patch

**set\_positions**(*posA, posB*)

set the begin end end positions of the connecting path. Use current vlaue if None.

**class FancyBboxPatch**(*xy, width, height, boxstyle='round', bbox\_transmuter=None, mutation\_scale=1.0, mutation\_aspect=None, \*\*kwargs*)

Bases: [matplotlib.patches.Patch](#)

Draw a fancy box around a rectangle with lower left at *xy\*=(\*x, y)* with specified width and height.

**FancyBboxPatch** class is similar to **Rectangle** class, but it draws a fancy box around the rectangle. The transformation of the rectangle box to the fancy box is delegated to the **BoxTransmuterBase** and its derived classes.

*xy* = lower left corner

*width, height*

*boxstyle* determines what kind of fancy box will be drawn. It can be a string of the style name with a comma separated attribute, or an instance of **BoxStyle**. Following box styles are available.

| Class      | Name       | Attrs                      |
|------------|------------|----------------------------|
| LArrow     | larrow     | pad=0.3                    |
| RArrow     | rarrow     | pad=0.3                    |
| Round      | round      | pad=0.3,rounding_size=None |
| Round4     | round4     | pad=0.3,rounding_size=None |
| Roundtooth | roundtooth | pad=0.3,tooth_size=None    |
| Sawtooth   | sawtooth   | pad=0.3,tooth_size=None    |
| Square     | square     | pad=0.3                    |

*mutation\_scale* : a value with which attributes of boxstyle (e.g., pad) will be scaled. default=1.

*mutation\_aspect* : The height of the rectangle will be squeezed by this value before the mutation and the mutated box will be stretched by the inverse of it. default=None.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**get\_bbox()**

**get\_boxstyle()**

Return the boxstyle object

**get\_height()**

Return the height of the rectangle

**get\_mutation\_aspect()**

Return the aspect ratio of the bbox mutation.

**get\_mutation\_scale()**

Return the mutation scale.

**get\_path()**

Return the mutated path of the rectangle

**get\_width()**

Return the width of the rectangle

**get\_x()**

Return the left coord of the rectangle

**get\_y()**

Return the bottom coord of the rectangle

**set\_bounds(\*args)**

Set the bounds of the rectangle: l,b,w,h

ACCEPTS: (left, bottom, width, height)

**set\_boxstyle(boxstyle=None, \*\*kw)**

Set the box style.

*boxstyle* can be a string with boxstyle name with optional comma-separated attributes. Alternatively, the attrs can be provided as keywords:

```
set_boxstyle("round,pad=0.2")
set_boxstyle("round", pad=0.2)
```

Old attrs simply are forgotten.

Without argument (or with *boxstyle* = None), it returns available box styles.

| ACCEPTS: | Class      | Name       | Attrs                      |
|----------|------------|------------|----------------------------|
|          | LArrow     | larrow     | pad=0.3                    |
|          | RArrow     | rarrow     | pad=0.3                    |
|          | Round      | round      | pad=0.3,rounding_size=None |
|          | Round4     | round4     | pad=0.3,rounding_size=None |
|          | Roundtooth | roundtooth | pad=0.3,tooth_size=None    |
|          | Sawtooth   | sawtooth   | pad=0.3,tooth_size=None    |
|          | Square     | square     | pad=0.3                    |

**set\_height(h)**

Set the width rectangle

ACCEPTS: float

**set\_mutation\_aspect(aspect)**

Set the aspect ratio of the bbox mutation.

ACCEPTS: float

**set\_mutation\_scale(scale)**

Set the mutation scale.

ACCEPTS: float

**set\_width(w)**

Set the width rectangle

ACCEPTS: float

**set\_x(x)**

Set the left coord of the rectangle

ACCEPTS: float

**set\_y**(y)

Set the bottom coord of the rectangle

ACCEPTS: float

**class Patch**(*edgecolor=None, facecolor=None, color=None, linewidth=None, linestyle=None, antialiased=None, hatch=None, fill=True, path\_effects=None, \*\*kwargs*)

Bases: [matplotlib.artist.Artist](#)

A patch is a 2D thingy with a face color and an edge color.

If any of *edgecolor*, *facecolor*, *linewidth*, or *antialiased* are *None*, they default to their rc params setting.

The following kwarg properties are supported

| Property  | Description   |
|---|---|
| <a href="#">agg_filter</a>                        | unknown   |
| <a href="#">alpha</a>                             | float or None   |
| <a href="#">animated</a>                          | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">aa</a> | [True   False] or None for default  |
| <a href="#">axes</a>                              | an <a href="#">Axes</a> instance  |
| <a href="#">clip_box</a>                          | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <a href="#">clip_on</a>                           | [True   False]  |
| <a href="#">clip_path</a>                         | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <a href="#">color</a>                             | matplotlib color spec   |
| <a href="#">contains</a>                          | a callable function   |
| <a href="#">edgecolor</a> or <a href="#">ec</a>   | mpl color spec, or None for default, or 'none' for no color                             |
| <a href="#">facecolor</a> or <a href="#">fc</a>   | mpl color spec, or None for default, or 'none' for no color                             |
| <a href="#">figure</a>                            | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <a href="#">fill</a>                              | [True   False]  |
| <a href="#">gid</a>                               | an id string  |
| <a href="#">hatch</a>                             | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <a href="#">label</a>                             | any string  |
| <a href="#">linestyle</a> or <a href="#">ls</a>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <a href="#">linewidth</a> or <a href="#">lw</a>   | float or None for default   |
| <a href="#">lod</a>                               | [True   False]  |
| <a href="#">path_effects</a>                      | unknown   |
| <a href="#">picker</a>                            | [None float boolean callable]   |
| <a href="#">rasterized</a>                        | [True   False   None]   |
| <a href="#">snap</a>                              | unknown   |
| <a href="#">transform</a>                         | <a href="#">Transform</a> instance  |
| <a href="#">url</a>                               | a url string  |
| <a href="#">visible</a>                           | [True   False]  |
| <a href="#">zorder</a>                            | any number  |

**contains**(*mouseevent, radius=None*)

Test whether the mouse event occurred in the patch.

Returns T/F, {}

**contains\_point**(*point, radius=None*)

Returns *True* if the given point is inside the path (transformed with its transform attribute).

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

Draw the [Patch](#) to the given *renderer*.

**fill**

return whether fill is set

**get\_aa()**

Returns True if the [Patch](#) is to be drawn with antialiasing.

**get\_antialiased()**

Returns True if the [Patch](#) is to be drawn with antialiasing.

**get\_data\_transform()**

**get\_ec()**

Return the edge color of the [Patch](#).

**get\_edgecolor()**

Return the edge color of the [Patch](#).

**get\_extents()**

Return a [Bbox](#) object defining the axis-aligned extents of the [Patch](#).

**get\_facecolor()**

Return the face color of the [Patch](#).

**get\_fc()**

Return the face color of the [Patch](#).

**get\_fill()**

return whether fill is set

**get\_hatch()**

Return the current hatching pattern

**get\_linestyle()**

Return the linestyle. Will be one of ['solid' | 'dashed' | 'dashdot' | 'dotted']

**get\_linewidth()**

Return the line width in points.

**get\_ls()**

Return the linestyle. Will be one of ['solid' | 'dashed' | 'dashdot' | 'dotted']

**get\_lw()**

Return the line width in points.

**get\_patch\_transform()**

**get\_path()**

Return the path of this patch

**get\_path\_effects()**

**get\_transform()**

Return the [Transform](#) applied to the [Patch](#).

**get\_verts()**

Return a copy of the vertices used in this patch

If the patch contains Bezier curves, the curves will be interpolated by line segments. To access the curves as curves, use [get\\_path\(\)](#).

**get\_window\_extent(renderer=None)****set\_aa(aa)**

alias for `set_antialiased`

**set\_alpha(alpha)**

Set the alpha transparency of the patch.

ACCEPTS: float or None

**set\_antialiased(aa)**

Set whether to use antialiased rendering

ACCEPTS: [True | False] or None for default

**set\_color(c)**

Set both the edgecolor and the facecolor.

ACCEPTS: matplotlib color spec

**See Also:**

[set\\_facecolor\(\)](#), [set\\_edgecolor\(\)](#) For setting the edge or face color individually.

**set\_ec(color)**

alias for `set_edgecolor`

**set\_edgecolor(color)**

Set the patch edge color

ACCEPTS: mpl color spec, or None for default, or 'none' for no color

**set\_facecolor(color)**

Set the patch face color

ACCEPTS: mpl color spec, or None for default, or 'none' for no color

**set\_fc(color)**

alias for `set_facecolor`

**set\_fill(b)**

Set whether to fill the patch

ACCEPTS: [True | False]

**set\_hatch(hatch)**

Set the hatching pattern

*hatch* can be one of:

```
/ - diagonal hatching
\ - back diagonal
| - vertical
- - horizontal
+ - crossed
x - crossed diagonal
o - small circle
O - large circle
. - dots
* - stars
```

Letters can be combined, in which case all the specified hatchings are done. If same letter repeats, it increases the density of hatching of that pattern.

Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

ACCEPTS: [ '/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '\*' ]

**set\_linestyle(*ls*)**

Set the patch linestyle

ACCEPTS: ['solid' | 'dashed' | 'dashdot' | 'dotted']

**set\_linewidth(*w*)**

Set the patch linewidth in points

ACCEPTS: float or None for default

**set\_ls(*ls*)**

alias for set\_linestyle

**set\_lw(*lw*)**

alias for set\_linewidth

**set\_path\_effects(*path\_effects*)**

set path\_effects, which should be a list of instances of matplotlib.patheffect.\_Base class or its derivatives.

**update\_from(*other*)**

Updates this [Patch](#) from the properties of *other*.

**class PathPatch(*path*, *\*\*kwargs*)**

Bases: [matplotlib.patches.Patch](#)

A general polycurve path patch.

*path* is a [matplotlib.path.Path](#) object.

Valid kwargs are:



| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**See Also:**

[Patch](#) For additional kwargs

**get\_path()**

**class Polygon**(*xy*, *closed=True*, *\*\*kwargs*)

Bases: [matplotlib.patches.Patch](#)

A general polygon patch.

*xy* is a numpy array with shape Nx2.

If *closed* is *True*, the polygon will be closed so the starting and ending points are the same.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**See Also:**

`Patch` For additional kwargs

`get_closed()`

`get_path()`

`get_xy()`

`set_closed(closed)`

`set_xy(vertices)`

**xy**

Set/get the vertices of the polygon. This property is provided for backward compatibility with matplotlib 0.91.x only. New code should use `get_xy()` and `set_xy()` instead.

**class `Rectangle`**(*xy*, *width*, *height*, *\*\*kwargs*)

Bases: `matplotlib.patches.Patch`

Draw a rectangle with lower left at *xy* = (*x*, *y*) with specified *width* and *height*.

*fill* is a boolean indicating whether to fill the rectangle

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**contains**(*mouseevent*)

**get\_bbox**()

**get\_height**()

Return the height of the rectangle

**get\_patch\_transform**()

**get\_path**()

Return the vertices of the rectangle

**get\_width**()

Return the width of the rectangle

**get\_x**()

Return the left coord of the rectangle

**get\_xy()**  
Return the left and bottom coords of the rectangle

**get\_y()**  
Return the bottom coord of the rectangle

**set\_bounds(\*args)**  
Set the bounds of the rectangle: l,b,w,h  
ACCEPTS: (left, bottom, width, height)

**set\_height(h)**  
Set the width rectangle  
ACCEPTS: float

**set\_width(w)**  
Set the width rectangle  
ACCEPTS: float

**set\_x(x)**  
Set the left coord of the rectangle  
ACCEPTS: float

**set\_xy(xy)**  
Set the left and bottom coords of the rectangle  
ACCEPTS: 2-item sequence

**set\_y(y)**  
Set the bottom coord of the rectangle  
ACCEPTS: float

**xy**  
Return the left and bottom coords of the rectangle

**class RegularPolygon(xy, numVertices, radius=5, orientation=0, \*\*kwargs)**  
Bases: [matplotlib.patches.Patch](#)

A regular polygon patch.

Constructor arguments:

**xy** A length 2 tuple (x, y) of the center.

**numVertices** the number of vertices.

**radius** The distance from the center to each of the vertices.

**orientation** rotates the polygon (in radians).

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

`get_patch_transform()`

`get_path()`

`numvertices`

`orientation`

`radius`

`xy`

**class** `Shadow(patch, ox, oy, props=None, **kwargs)`

Bases: `matplotlib.patches.Patch`

Create a shadow of the given *patch* offset by *ox*, *oy*. *props*, if not *None*, is a patch property update dictionary. If *None*, the shadow will have the same color as the face, but darkened.

kwargs are

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**draw**(*renderer*)

**get\_patch\_transform**()

**get\_path**()

**class Wedge**(*center, r, theta1, theta2, width=None, \*\*kwargs*)

Bases: `matplotlib.patches.Patch`

Wedge shaped patch.

Draw a wedge centered at *x, y* center with radius *r* that sweeps *theta1* to *theta2* (in degrees). If *width* is given, then a partial wedge is drawn from inner radius *r - width* to outer radius *r*.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**get\_path()**

**class YAArrow**(*figure*, *xytip*, *xybase*, *width*=4, *frac*=0.10000000000000001, *headwidth*=12, *\*\*kwargs*)  
 Bases: `matplotlib.patches.Patch`

Yet another arrow class.

This is an arrow that is defined in display space and has a tip at *x1*, *y1* and a base at *x2*, *y2*.

Constructor arguments:

***xytip*** (*x*, *y*) location of arrow tip

***xybase*** (*x*, *y*) location the arrow base mid point

***figure*** The `Figure` instance (fig.dpi)

***width*** The width of the arrow in points

***frac*** The fraction of the arrow length occupied by the head

***headwidth*** The width of the base of the arrow head in points

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**get\_patch\_transform()**

**get\_path()**

**getpoints**(*x1*, *y1*, *x2*, *y2*, *k*)

For line segment defined by (*x1*, *y1*) and (*x2*, *y2*) return the points on the line that is perpendicular to the line and intersects (*x2*, *y2*) and the distance from (*x2*, *y2*) of the returned points is *k*.

**bbox\_artist**(*artist*, *renderer*, *props=None*, *fill=True*)

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.

*props* is a dict of rectangle props with the additional property 'pad' that sets the padding around the bbox in points.

**draw\_bbox**(*bbox*, *renderer*, *color='k'*, *trans=None*)

This is a debug function to draw a rectangle around the bounding box returned by `get_window_extent()` of an artist, to test whether the artist is returning the correct bbox.



## 44.4 matplotlib.text

Classes for including text in a figure.

**class Annotation**(*s, xy, xytext=None, xycoords='data', textcoords=None, arrowprops=None, annotation\_clip=None, \*\*kwargs*)

Bases: `matplotlib.text.Text`, `matplotlib.text._AnnotationBase`

A `Text` class to make annotating things in the figure, such as `Figure`, `Axes`, `Rectangle`, etc., easier.

Annotate the *x, y* point *xy* with text *s* at *x, y* location *xytext*. (If *xytext* = *None*, defaults to *xy*, and if *textcoords* = *None*, defaults to *xycoords*).

*arrowprops*, if not *None*, is a dictionary of line properties (see `matplotlib.lines.Line2D`) for the arrow that connects annotation to the point.

If the dictionary has a key *arrowstyle*, a `FancyArrowPatch` instance is created with the given dictionary and is drawn. Otherwise, a `YAArow` patch instance is created and drawn. Valid keys for `YAArow` are

| Key        | Description   |
|------------|---|
| width      | the width of the arrow in points  |
| frac       | the fraction of the arrow length occupied by the head   |
| head-width | the width of the base of the arrow head in points   |
| shrink     | oftentimes it is convenient to have the arrowtip and base a bit away from the text and point being annotated. If <i>d</i> is the distance between the text and annotated point, shrink will shorten the arrow so the tip and base are shrink percent of the distance <i>d</i> away from the endpoints. ie, <code>shrink=0.05</code> is 5% |
| ?          | any key for <code>matplotlib.patches.polygon</code>   |

Valid keys for `FancyArrowPatch` are

| Key             | Description   |
|-----------------|---|
| arrowstyle      | the arrow style                                       |
| connectionstyle | the connection style                                  |
| relpos          | default is (0.5, 0.5)                                 |
| patchA          | default is bounding box of the text                   |
| patchB          | default is <i>None</i>                                |
| shrinkA         | default is 2 points                                   |
| shrinkB         | default is 2 points                                   |
| mutation_scale  | default is text size (in points)                      |
| mutation_aspect | default is 1.   |
| ?               | any key for <code>matplotlib.patches.PathPatch</code> |

*xycoords* and *textcoords* are strings that indicate the coordinates of *xy* and *xytext*.

| Property          | Description   |
|-------------------|---|
| 'figure points'   | points from the lower left corner of the figure   |
| 'figure pixels'   | pixels from the lower left corner of the figure   |
| 'figure fraction' | 0,0 is lower left of figure and 1,1 is upper, right   |
| 'axes points'     | points from lower left corner of axes   |
| 'axes pixels'     | pixels from lower left corner of axes   |
| 'axes fraction'   | 0,1 is lower left of axes and 1,1 is upper right  |
| 'data'            | use the coordinate system of the object being annotated (default)   |
| 'offset points'   | Specify an offset (in points) from the <i>xy</i> value  |
| 'polar'           | you can specify <i>theta</i> , <i>r</i> for the annotation, even in cartesian plots. Note that if you are using a polar axes, you do not need to specify polar for the coordinate system since that is the native “data” coordinate system. |

If a ‘points’ or ‘pixels’ option is specified, values will be added to the bottom-left and if negative, values will be subtracted from the top-right. Eg:

```
# 10 points to the right of the left border of the axes and
# 5 points below the top border
xy=(10,-5), xycoords='axes points'
```

You may use an instance of [Transform](#) or [Artist](#). See [Annotating Axes](#) for more details.

The `annotation_clip` attribute controls the visibility of the annotation when it goes outside the axes area. If True, the annotation will only be drawn when the *xy* is inside the axes. If False, the annotation will always be drawn regardless of its position. The default is *None*, which behave as True only if *xycoords* is “data”.

Additional kwargs are Text properties:

| Property                     | Description   |
|------------------------------|---|
| <code>agg_filter</code>      | unknown   |
| <code>alpha</code>           | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>        | [True   False]  |
| <code>axes</code>            | an <a href="#">Axes</a> instance  |
| <code>backgroundcolor</code> | any matplotlib color  |
| <code>bbox</code>            | rectangle prop dict   |
| <code>clip_box</code>        | a <code>matplotlib.transforms.Bbox</code> instance                                      |
| <code>clip_on</code>         | [True   False]  |
| <code>clip_path</code>       | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>           | any matplotlib color  |
| <code>contains</code>        | a callable function   |

Table 44.3 – continued from

|  |  |
|--|--|
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   ‘serif’   ‘sans-serif’   ‘cursive’   ‘fantasy’   ‘monospace’ ]  |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance   |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ ‘center’   ‘right’   ‘left’ ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ ‘left’   ‘right’   ‘center’ ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   ‘vertical’   ‘horizontal’ ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   ‘xx-small’   ‘x-small’   ‘small’   ‘medium’   ‘large’   ‘x-large’ ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   ‘ultra-condensed’   ‘extra-condensed’   ‘condensed’   ‘normal’   ‘expanded’   ‘ultra-expanded’ ] |
| <code>style</code> or <code>fontstyle</code>   | [ ‘normal’   ‘italic’   ‘oblique’ ]  |
| <code>text</code>  | string or anything printable with ‘%s’ conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>   | [ ‘normal’   ‘small-caps’ ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code>                         | [ ‘center’   ‘top’   ‘bottom’   ‘baseline’ ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>   | [ a numeric value in range 0-1000   ‘ultralight’   ‘light’   ‘normal’   ‘regular’   ‘bold’   ‘extra-bold’   ‘black’ ]                |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

**contains**(*event*)

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

Draw the `Annotation` object to the given *renderer*.

**set\_figure**(*fig*)

**update\_bbox\_position\_size**(*renderer*)

Update the location and the size of the bbox. This method should be used when the position and size of the bbox needs to be updated before actually drawing the bbox.

**update\_positions**(*renderer*)

Update the pixel positions of the annotated point and the text.

**FT2Font**()

FT2Font

```
class OffsetFrom(artist, ref_coord, unit='points')
```

Bases: object

```
get_unit()
```

```
set_unit(unit)
```

```
class Text(x=0, y=0, text="", color=None, verticalalignment='baseline', horizontalalignment='left',
           multialignment=None, fontproperties=None, rotation=None, linespacing=None, rotation_mode=None, path_effects=None, **kwargs)
```

Bases: `matplotlib.artist.Artist`

Handle storing and drawing of text in window or data coordinates.

Create a `Text` instance at  $x, y$  with string `text`.

Valid kwargs are

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]                       |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]                          |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                                       |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]               |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |

Table 44.4 – continued from

|  |   |
|--|---|
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]   |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]  |
| <code>visible</code>   | [True   False]  |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular' ] |
| <code>x</code>   | float   |
| <code>y</code>   | float   |
| <code>zorder</code>  | any number  |

- contains**(*mouseevent*)  
Test whether the mouse event occurred in the patch.
- In the case of text, a hit is true anywhere in the axis-aligned bounding-box containing the text.
- Returns True or False.
- draw**(*artist, renderer, \*args, \*\*kwargs*)  
Draws the `Text` object to the given *renderer*.
- get\_bbox\_patch**()  
Return the bbox Patch object. Returns None if the the FancyBboxPatch is not made.
- get\_color**()  
Return the color of the text
- get\_family**()  
Return the list of font families used for font lookup
- get\_font\_properties**()  
alias for `get_fontproperties`
- get\_fontfamily**()  
alias for `get_family`
- get\_fontname**()  
alias for `get_name`
- get\_fontproperties**()  
Return the `FontProperties` object
- get\_fontsize**()  
alias for `get_size`
- get\_fontstretch**()  
alias for `get_stretch`
- get\_fontstyle**()  
alias for `get_style`
- get\_fontvariant**()  
alias for `get_variant`

**get\_fontweight()**

alias for `get_weight`

**get\_ha()**

alias for `get_horizontalalignment`

**get\_horizontalalignment()**

Return the horizontal alignment as string. Will be one of 'left', 'center' or 'right'.

**get\_name()**

Return the font name as string

**get\_path\_effects()**

**get\_position()**

Return the position of the text as a tuple (x, y)

**get\_prop\_tup()**

Return a hashable tuple of properties.

Not intended to be human readable, but useful for backends who want to cache derived information about text (eg layouts) and need to know if the text has changed.

**get\_rotation()**

return the text angle as float in degrees

**get\_rotation\_mode()**

get text rotation mode

**get\_size()**

Return the font size as integer

**get\_stretch()**

Get the font stretch as a string or number

**get\_style()**

Return the font style as string

**get\_text()**

Get the text as string

**get\_va()**

alias for `getverticalalignment()`

**get\_variant()**

Return the font variant as a string

**get\_verticalalignment()**

Return the vertical alignment as string. Will be one of 'top', 'center', 'bottom' or 'baseline'.

**get\_weight()**

Get the font weight as string or number

**get\_window\_extent(*renderer=None, dpi=None*)**

Return a [Bbox](#) object bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

*renderer* defaults to the `_renderer` attribute of the text object. This is not assigned until the first execution of `draw()`, so you must use this kwarg if you want to call `get_window_extent()` prior to the first `draw()`. For getting web page regions, it is simpler to call the method after saving the figure.

*dpi* defaults to `self.figure.dpi`; the *renderer* *dpi* is irrelevant. For the web application, if `figure.dpi` is not the value used when saving the figure, then the value that was used must be specified as the *dpi* argument.

static **is\_math\_text**(*s*)

Returns a cleaned string and a boolean flag. The flag indicates if the given string *s* contains any mathtext, determined by counting unescaped dollar signs. If no mathtext is present, the cleaned string has its dollar signs unescaped. If `usetex` is on, the flag always has the value “TeX”.

**set\_backgroundcolor**(*color*)

Set the background color of the text by updating the `bbox`.

**See Also:**

**set\_bbox()** To change the position of the bounding box.

ACCEPTS: any matplotlib color

**set\_bbox**(*rectprops*)

Draw a bounding box around `self`. *rectprops* are any settable properties for a rectangle, eg `facecolor='red', alpha=0.5`.

```
t.set_bbox(dict(facecolor='red', alpha=0.5))
```

If *rectprops* has “`boxstyle`” key. A `FancyBboxPatch` is initialized with *rectprops* and will be drawn. The mutation scale of the `FancyBboxPath` is set to the `fontsize`.

ACCEPTS: rectangle prop dict

**set\_color**(*color*)

Set the foreground color of the text

ACCEPTS: any matplotlib color

**set\_family**(*fontname*)

Set the font family. May be either a single string, or a list of strings in decreasing priority. Each string may be either a real font name or a generic font class name. If the latter, the specific font names will be looked up in the `matplotlibrc` file.

ACCEPTS: [ FONTNAME | ‘serif’ | ‘sans-serif’ | ‘cursive’ | ‘fantasy’ | ‘monospace’ ]

**set\_font\_properties**(*fp*)

alias for `set_fontproperties`

**set\_fontname**(*fontname*)

alias for `set_family`

**set\_fontproperties(*fp*)**

Set the font properties that control the text. *fp* must be a `matplotlib.font_manager.FontProperties` object.

ACCEPTS: a `matplotlib.font_manager.FontProperties` instance

**set\_fontsize(*fontsize*)**

alias for `set_size`

**set\_fontstretch(*stretch*)**

alias for `set_stretch`

**set\_fontstyle(*fontstyle*)**

alias for `set_style`

**set\_fontvariant(*variant*)**

alias for `set_variant`

**set\_fontweight(*weight*)**

alias for `set_weight`

**set\_ha(*align*)**

alias for `set_horizontalalignment`

**set\_horizontalalignment(*align*)**

Set the horizontal alignment to one of

ACCEPTS: [ 'center' | 'right' | 'left' ]

**set\_linespacing(*spacing*)**

Set the line spacing as a multiple of the font size. Default is 1.2.

ACCEPTS: float (multiple of font size)

**set\_ma(*align*)**

alias for `set_verticalalignment`

**set\_multialignment(*align*)**

Set the alignment for multiple lines layout. The layout of the bounding box of all the lines is determined by the `horizontalalignment` and `verticalalignment` properties, but the multiline text within that box can be

ACCEPTS: [ 'left' | 'right' | 'center' ]

**set\_name(*fontname*)**

alias for `set_family`

**set\_path\_effects(*path\_effects*)****set\_position(*xy*)**

Set the (x, y) position of the text

ACCEPTS: (x,y)

**set\_rotation(*s*)**

Set the rotation of the text

ACCEPTS: [ angle in degrees | 'vertical' | 'horizontal' ]



**set\_rotation\_mode(*m*)**

set text rotation mode. If “anchor”, the un-rotated text will first aligned according to their *ha* and *va*, and then will be rotated with the alignment reference point as a origin. If None (default), the text will be rotated first then will be aligned.

**set\_size(*fontsize*)**

Set the font size. May be either a size string, relative to the default font size, or an absolute font size in points.

ACCEPTS: [ size in points | ‘xx-small’ | ‘x-small’ | ‘small’ | ‘medium’ | ‘large’ | ‘x-large’ | ‘xx-large’ ]

**set\_stretch(*stretch*)**

Set the font stretch (horizontal condensation or expansion).

ACCEPTS: [ a numeric value in range 0-1000 | ‘ultra-condensed’ | ‘extra-condensed’ | ‘condensed’ | ‘semi-condensed’ | ‘normal’ | ‘semi-expanded’ | ‘expanded’ | ‘extra-expanded’ | ‘ultra-expanded’ ]

**set\_style(*fontstyle*)**

Set the font style.

ACCEPTS: [ ‘normal’ | ‘italic’ | ‘oblique’ ]

**set\_text(*s*)**

Set the text string *s*

It may contain newlines (\n) or math in LaTeX syntax.

ACCEPTS: string or anything printable with ‘%s’ conversion.

**set\_va(*align*)**

alias for set\_verticalalignment

**set\_variant(*variant*)**

Set the font variant, either ‘normal’ or ‘small-caps’.

ACCEPTS: [ ‘normal’ | ‘small-caps’ ]

**set\_verticalalignment(*align*)**

Set the vertical alignment

ACCEPTS: [ ‘center’ | ‘top’ | ‘bottom’ | ‘baseline’ ]

**set\_weight(*weight*)**

Set the font weight.

ACCEPTS: [ a numeric value in range 0-1000 | ‘ultralight’ | ‘light’ | ‘normal’ | ‘regular’ | ‘book’ | ‘medium’ | ‘roman’ | ‘semibold’ | ‘demibold’ | ‘demi’ | ‘bold’ | ‘heavy’ | ‘extra bold’ | ‘black’ ]

**set\_x(*x*)**

Set the *x* position of the text

ACCEPTS: float

**set\_y(*y*)**

Set the *y* position of the text

ACCEPTS: float

**update\_bbox\_position\_size**(*renderer*)

Update the location and the size of the bbox. This method should be used when the position and size of the bbox needs to be updated before actually drawing the bbox.

**update\_from**(*other*)

Copy properties from other to self

**class TextWithDash**(*x=0, y=0, text="", color=None, verticalalignment='center', horizontalalignment='center', multialignment=None, fontproperties=None, rotation=None, linespacing=None, dashlength=0.0, dashdirection=0, dashrotation=None, dashpad=3, dashpush=0*)

Bases: `matplotlib.text.Text`

This is basically a `Text` with a dash (drawn with a `Line2D`) before/after it. It is intended to be a drop-in replacement for `Text`, and should behave identically to it when *dashlength* = 0.0.

The dash always comes between the point specified by `set_position()` and the text. When a dash exists, the text alignment arguments (*horizontalalignment*, *verticalalignment*) are ignored.

*dashlength* is the length of the dash in canvas units. (default = 0.0).

*dashdirection* is one of 0 or 1, where 0 draws the dash after the text and 1 before. (default = 0).

*dashrotation* specifies the rotation of the dash, and should generally stay *None*. In this case `get_dashrotation()` returns `get_rotation()`. (I.e., the dash takes its rotation from the text's rotation). Because the text center is projected onto the dash, major deviations in the rotation cause what may be considered visually unappealing results. (default = *None*)

*dashpad* is a padding length to add (or subtract) space between the text and the dash, in canvas units. (default = 3)

*dashpush* “pushes” the dash and text away from the point specified by `set_position()` by the amount in canvas units. (default = 0)

**Note:** The alignment of the two objects is based on the bounding box of the `Text`, as obtained by `get_window_extent()`. This, in turn, appears to depend on the font metrics as given by the rendering backend. Hence the quality of the “centering” of the label text with respect to the dash varies depending on the backend used.

**Note:** I’m not sure that I got the `get_window_extent()` right, or whether that’s sufficient for providing the object bounding box.

**draw**(*renderer*)

Draw the `TextWithDash` object to the given *renderer*.

**get\_dashdirection**()

Get the direction dash. 1 is before the text and 0 is after.

**get\_dashlength**()

Get the length of the dash.

**get\_dashpad**()

Get the extra spacing between the dash and the text, in canvas units.

**get\_dashpush()**

Get the extra spacing between the dash and the specified text position, in canvas units.

**get\_dashrotation()**

Get the rotation of the dash in degrees.

**get\_figure()**

return the figure instance the artist belongs to

**get\_position()**

Return the position of the text as a tuple (x, y)

**get\_prop\_tup()**

Return a hashable tuple of properties.

Not intended to be human readable, but useful for backends who want to cache derived information about text (eg layouts) and need to know if the text has changed.

**get\_window\_extent(renderer=None)**

Return a [Bbox](#) object bounding the text, in display units.

In addition to being used internally, this is useful for specifying clickable regions in a png file on a web page.

*renderer* defaults to the *\_renderer* attribute of the text object. This is not assigned until the first execution of [draw\(\)](#), so you must use this kwarg if you want to call [get\\_window\\_extent\(\)](#) prior to the first [draw\(\)](#). For getting web page regions, it is simpler to call the method after saving the figure.

**set\_dashdirection(dd)**

Set the direction of the dash following the text. 1 is before the text and 0 is after. The default is 0, which is what you'd want for the typical case of ticks below and on the left of the figure.

ACCEPTS: int (1 is before, 0 is after)

**set\_dashlength(dl)**

Set the length of the dash.

ACCEPTS: float (canvas units)

**set\_dashpad(dp)**

Set the “pad” of the TextWithDash, which is the extra spacing between the dash and the text, in canvas units.

ACCEPTS: float (canvas units)

**set\_dashpush(dp)**

Set the “push” of the TextWithDash, which is the extra spacing between the beginning of the dash and the specified position.

ACCEPTS: float (canvas units)

**set\_dashrotation(dr)**

Set the rotation of the dash, in degrees

ACCEPTS: float (degrees)

**set\_figure(*fig*)**

Set the figure instance the artist belong to.

ACCEPTS: a `matplotlib.figure.Figure` instance

**set\_position(*xy*)**

Set the (*x*, *y*) position of the `TextWithDash`.

ACCEPTS: (*x*, *y*)

**set\_transform(*t*)**

Set the `matplotlib.transforms.Transform` instance used by this artist.

ACCEPTS: a `matplotlib.transforms.Transform` instance

**set\_x(*x*)**

Set the *x* position of the `TextWithDash`.

ACCEPTS: float

**set\_y(*y*)**

Set the *y* position of the `TextWithDash`.

ACCEPTS: float

**update\_coords(*renderer*)**

Computes the actual *x*, *y* coordinates for text based on the input *x*, *y* and the *dashlength*. Since the rotation is with respect to the actual canvas's coordinates we need to map back and forth.

**get\_rotation(*rotation*)**

Return the text angle as float.

*rotation* may be 'horizontal', 'vertical', or a numeric value in degrees.

# AXES

## 45.1 matplotlib.axes

**class Axes**(fig, rect, axisbg=None, frameon=True, sharex=None, sharey=None, label="", xscale=None, yscale=None, \*\*kwargs)  
Bases: `matplotlib.artist.Artist`

The **Axes** contains most of the figure elements: **Axis**, **Tick**, **Line2D**, **Text**, **Polygon**, etc., and sets the coordinate system.

The **Axes** instance supports callbacks through a `callbacks` attribute which is a **CallbackRegistry** instance. The events you can connect to are 'xlim\_changed' and 'ylim\_changed' and the callback will be called with `func(ax)` where *ax* is the **Axes** instance.

**acorr**(x, \*\*kwargs)  
call signature:

```
acorr(x, normed=True, detrend=mlab.detrend_none, usevlines=True,
      maxlags=10, **kwargs)
```

Plot the autocorrelation of *x*. If *normed* = *True*, normalize the data by the autocorrelation at 0-th lag. *x* is detrended by the *detrend* callable (default no normalization).

Data are plotted as `plot(lags, c, **kwargs)`

Return value is a tuple (*lags*, *c*, *line*) where:

- *lags* are a length  $2 \cdot \text{maxlags} + 1$  lag vector
- *c* is the  $2 \cdot \text{maxlags} + 1$  auto correlation vector
- *line* is a **Line2D** instance returned by `plot()`

The default *linestyle* is *None* and the default *marker* is 'o', though these can be overridden with keyword args. The cross correlation is performed with `numpy.correlate()` with *mode* = 2.

If *usevlines* is *True*, `vlines()` rather than `plot()` is used to draw vertical lines from the origin to the *acorr*. Otherwise, the plot style is determined by the *kwargs*, which are **Line2D** properties.

*maxlags* is a positive integer detailing the number of lags to show. The default value of *None* will return all  $2 \cdot \text{timeslen}(x) - 1$  lags.

The return value is a tuple (*lags*, *c*, *linecol*, *b*) where

- *linecol* is the [LineCollection](#)
- *b* is the *x*-axis.

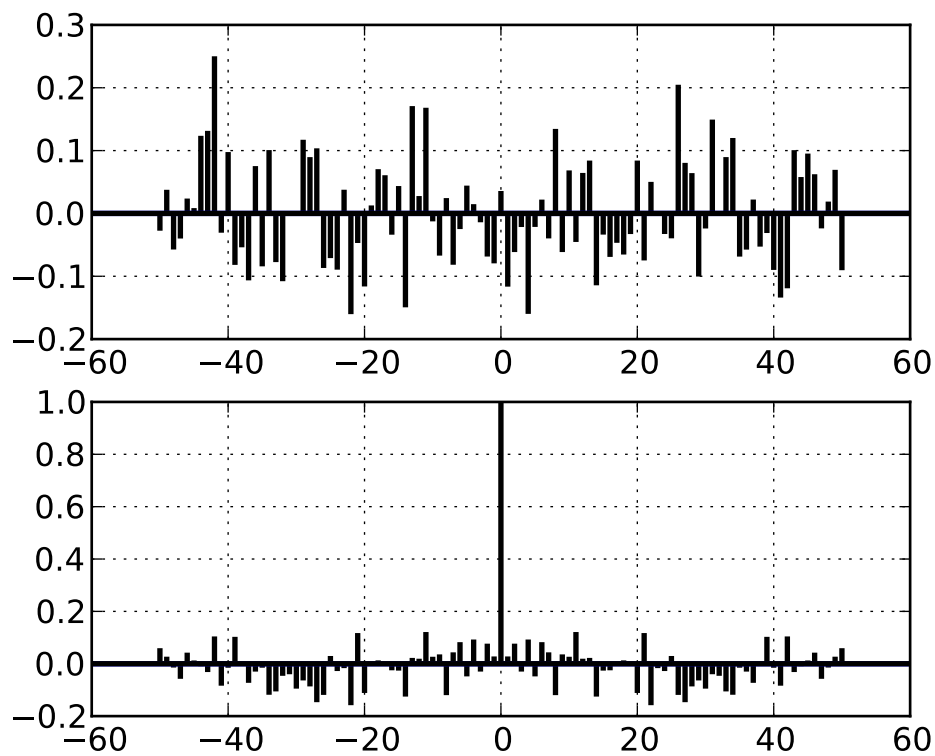
**See Also:**

[plot\(\)](#) or [vlines\(\)](#) For documentation on valid kwargs.

**Example:**

[xcorr\(\)](#) above, and [acorr\(\)](#) below.

**Example:**



**add\_artist(*a*)**

Add any [Artist](#) to the axes.

Returns the artist.

**add\_collection(*collection*, *autolim=True*)**

Add a [Collection](#) instance to the axes.

Returns the collection.

**add\_container(*container*)**

Add a [Container](#) instance to the axes.

Returns the collection.

#### **add\_line**(*line*)

Add a [Line2D](#) to the list of plot lines

Returns the line.

#### **add\_patch**(*p*)

Add a [Patch](#) *p* to the list of axes patches; the clipbox will be set to the Axes clipping box. If the transform is not set, it will be set to `transData`.

Returns the patch.

#### **add\_table**(*tab*)

Add a `Table` instance to the list of axes tables

Returns the table.

#### **annotate**(*\*args, \*\*kwargs*)

call signature:

```
annotate(s, xy, xytext=None, xycoords='data',
         textcoords='data', arrowprops=None, **kwargs)
```

Keyword arguments:

Annotate the *x, y* point *xy* with text *s* at *x, y* location *xytext*. (If *xytext* = *None*, defaults to *xy*, and if *textcoords* = *None*, defaults to *xycoords*).

*arrowprops*, if not *None*, is a dictionary of line properties (see [matplotlib.lines.Line2D](#)) for the arrow that connects annotation to the point.

If the dictionary has a key *arrowstyle*, a `FancyArrowPatch` instance is created with the given dictionary and is drawn. Otherwise, a `YAArow` patch instance is created and drawn. Valid keys for `YAArow` are

| Key        | Description  |
|------------|--|
| width      | the width of the arrow in points   |
| frac       | the fraction of the arrow length occupied by the head  |
| head-width | the width of the base of the arrow head in points  |
| shrink     | oftentimes it is convenient to have the arrowtip and base a bit away from the text and point being annotated. If <i>d</i> is the distance between the text and annotated point, shrink will shorten the arrow so the tip and base are shrink percent of the distance <i>d</i> away from the endpoints. ie, shrink=0.05 is 5% |
| ?          | any key for <code>matplotlib.patches.polygon</code>  |

Valid keys for `FancyArrowPatch` are

| Key             | Description   |
|-----------------|---|
| arrowstyle      | the arrow style                                       |
| connectionstyle | the connection style                                  |
| relpos          | default is (0.5, 0.5)                                 |
| patchA          | default is bounding box of the text                   |
| patchB          | default is None                                       |
| shrinkA         | default is 2 points                                   |
| shrinkB         | default is 2 points                                   |
| mutation_scale  | default is text size (in points)                      |
| mutation_aspect | default is 1.   |
| ?               | any key for <code>matplotlib.patches.PathPatch</code> |

*xycoords* and *textcoords* are strings that indicate the coordinates of *xy* and *xytext*.

| Property          | Description   |
|-------------------|---|
| 'figure points'   | points from the lower left corner of the figure   |
| 'figure pixels'   | pixels from the lower left corner of the figure   |
| 'figure fraction' | 0,0 is lower left of figure and 1,1 is upper, right   |
| 'axes points'     | points from lower left corner of axes   |
| 'axes pixels'     | pixels from lower left corner of axes   |
| 'axes fraction'   | 0,1 is lower left of axes and 1,1 is upper right  |
| 'data'            | use the coordinate system of the object being annotated (default)   |
| 'offset points'   | Specify an offset (in points) from the <i>xy</i> value  |
| 'polar'           | you can specify <i>theta</i> , <i>r</i> for the annotation, even in cartesian plots. Note that if you are using a polar axes, you do not need to specify polar for the coordinate system since that is the native "data" coordinate system. |

If a 'points' or 'pixels' option is specified, values will be added to the bottom-left and if negative, values will be subtracted from the top-right. Eg:

```
# 10 points to the right of the left border of the axes and
# 5 points below the top border
xy=(10,-5), xycoords='axes points'
```

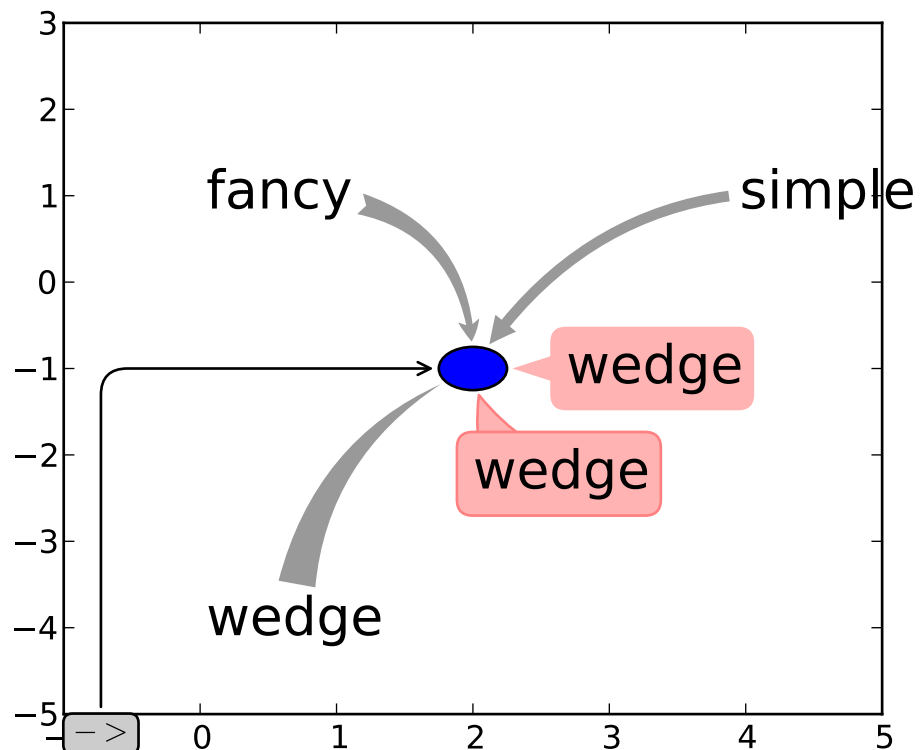
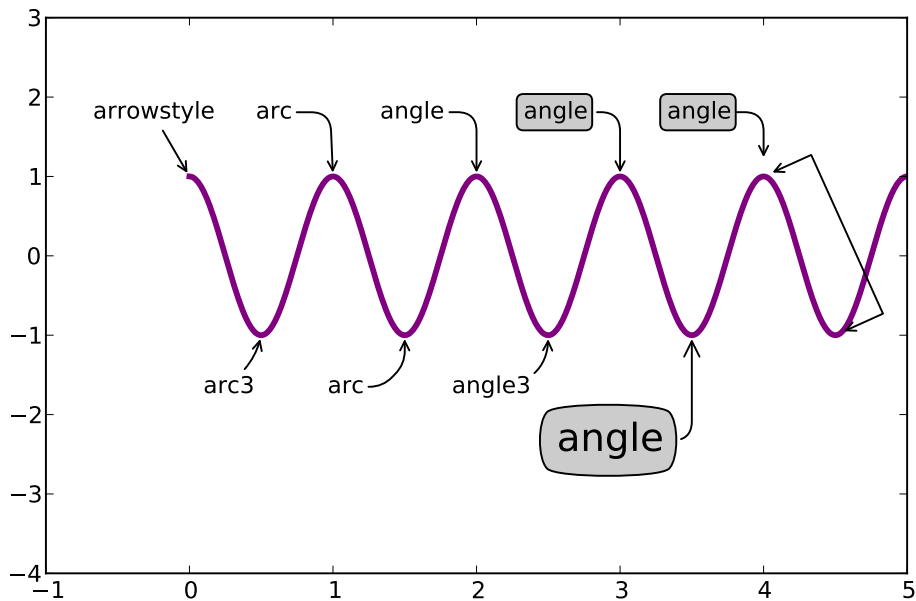
You may use an instance of `Transform` or `Artist`. See *Annotating Axes* for more details.

The *annotation\_clip* attribute controls the visibility of the annotation when it goes outside the axes area. If True, the annotation will only be drawn when the *xy* is inside the axes. If False, the annotation will always be drawn regardless of its position. The default is *None*, which behave as True only if *xycoords* is "data".

Additional kwargs are Text properties:



| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <a href="#">Axes</a> instance   |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]  |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]  |
| <code>figure</code>  | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <a href="#">matplotlib.font_manager.FontProperties</a> instance  |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'ultra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <a href="#">Transform</a> instance   |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>   | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code>                         | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>   | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |



**apply\_aspect**(*position=None*)

Use `_aspect()` and `_adjustable()` to modify the axes box or the view limits.

**arrow**(*x, y, dx, dy, \*\*kwargs*)

call signature:

```
arrow(x, y, dx, dy, **kwargs)
```

Draws arrow on specified axis from  $(x, y)$  to  $(x + dx, y + dy)$ .

Optional kwargs control the arrow properties:

Constructor arguments

***length\_includes\_head***: *True* if head is counted in calculating the length.

***shape***: ['full', 'left', 'right']

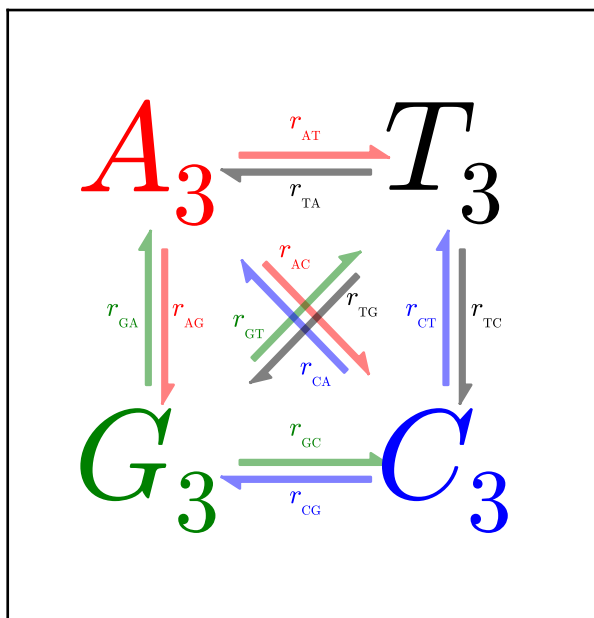
***overhang***: distance that the arrow is swept back (0 overhang means triangular shape).

***head\_starts\_at\_zero***: If *True*, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Valid kwargs are:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:**



**autoscale**(*enable=True*, *axis='both'*, *tight=None*)

Convenience method for simple axis view autoscaling. It turns autoscaling on or off, and then, if autoscaling for either axis is on, it performs the autoscaling on the specified axis or axes.

**enable:** [**True** | **False** | **None**] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

**axis:** ['x' | 'y' | 'both'] which axis to operate on; default is 'both'

**tight:** [**True** | **False** | **None**] If True, set view limits to data limits; if False, let the locator and margins expand the view limits; if None, use tight scaling if the only artist is an image, otherwise treat *tight* as False. The *tight* setting is retained for future autoscaling until it is explicitly changed.

Returns None.

**autoscale\_view**(*tight=None*, *scalex=True*, *scaley=True*)

Autoscale the view limits using the data limits. You can selectively autoscale only a single axis, eg, the xaxis by setting *scaley* to *False*. The autoscaling preserves any axis direction reversal that has already been done.

The data limits are not updated automatically when artist data are changed after the artist has been added to an Axes instance. In that case, use `matplotlib.axes.Axes.relim()` prior to calling `autoscale_view`.

**axhline**(*y=0*, *xmin=0*, *xmax=1*, *\*\*kwargs*)

call signature:

```
axhline(y=0, xmin=0, xmax=1, **kwargs)
```

### Axis Horizontal Line

Draw a horizontal line at  $y$  from  $xmin$  to  $xmax$ . With the default values of  $xmin = 0$  and  $xmax = 1$ , this line will always span the horizontal extent of the axes, regardless of the `xlim` settings, even if you change them, eg. with the `set_xlim()` command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the  $y$  location is in data coordinates.

Return value is the [Line2D](#) instance. `kwargs` are the same as `kwargs` to `plot`, and can be used to control the line properties. Eg.,

- draw a thick red hline at  $y = 0$  that spans the xrange

```
>>> axhline(linewidth=4, color='r')
```

- draw a default hline at  $y = 1$  that spans the xrange

```
>>> axhline(y=1)
```

- draw a default hline at  $y = .5$  that spans the the middle half of the xrange

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

Valid `kwargs` are [Line2D](#) properties, with the exception of ‘transform’:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False]  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                                      |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ (Path, Transform)   Patch   None ]  |
| <code>color</code> or <code>c</code>        | any matplotlib color  |
| <code>contains</code>                       | a callable function   |
| <code>dash_capstyle</code>                  | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                 | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                         | sequence of on/off ink in points  |
| <code>data</code>                           | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                      | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                      |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance  |
| <code>fillstyle</code>                      | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                            | an id string  |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a |
| <code>linewidth</code> or <code>lw</code>   | float value in points   |

Table 45.2 – continu

|  |   |
|--|---|
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   "   'None'   None   ' '   '8'   'p'   ', '   '] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>               |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance   |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

**See Also:**

`axhspan()` for example plot and source code

**`axhspan(ymin, ymax, xmin=0, xmax=1, **kwargs)`**

call signature:

```
axhspan(ymin, ymax, xmin=0, xmax=1, **kwargs)
```

Axis Horizontal Span.

$y$  coords are in data units and  $x$  coords are in axes (relative 0-1) units.

Draw a horizontal span (rectangle) from  $ymin$  to  $ymax$ . With the default values of  $xmin = 0$  and  $xmax = 1$ , this always spans the xrange, regardless of the xlim settings, even if you change them, eg. with the `set_xlim()` command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the  $y$  location is in data coordinates.

Return value is a `matplotlib.patches.Polygon` instance.

Examples:

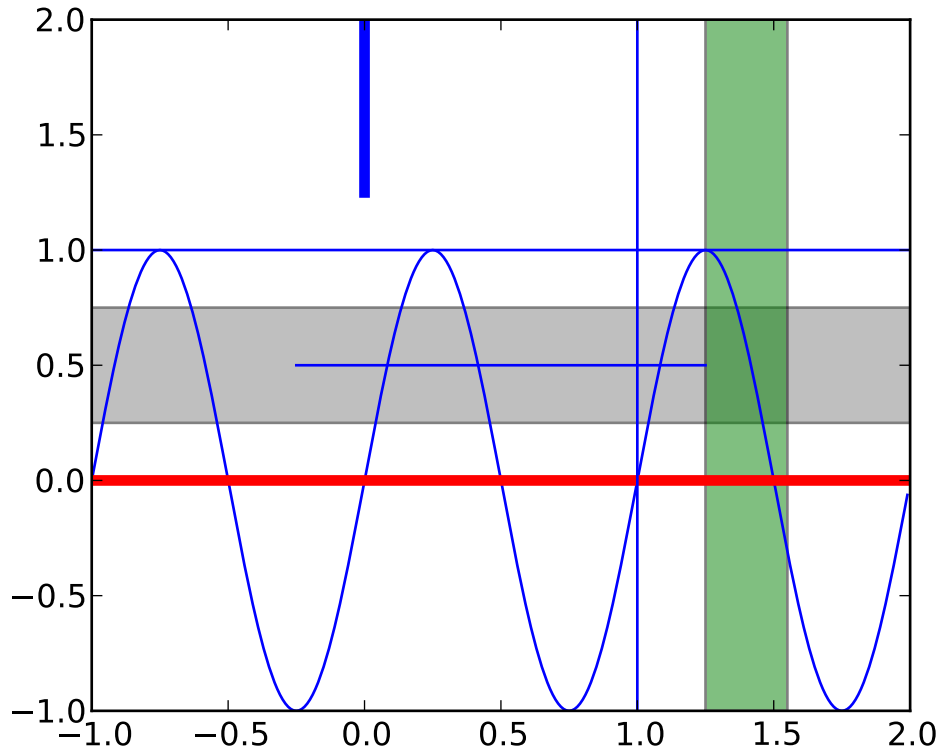
- draw a gray rectangle from  $y = 0.25-0.75$  that spans the horizontal extent of the axes

```
>>> axhspan(0.25, 0.75, facecolor='0.5', alpha=0.5)
```

Valid kwargs are [Polygon](#) properties:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**Example:**



**axis**(\*v, \*\*kwargs)

Convenience method for manipulating the x and y view limits and the aspect ratio of the plot. For details, see [axis\(\)](#).

kwargs are passed on to [set\\_xlim\(\)](#) and [set\\_ylim\(\)](#)

**axvline**(x=0, ymin=0, ymax=1, \*\*kwargs)

call signature:

`axvline(x=0, ymin=0, ymax=1, **kwargs)`

Axis Vertical Line

Draw a vertical line at  $x$  from  $ymin$  to  $ymax$ . With the default values of  $ymin = 0$  and  $ymax = 1$ , this line will always span the vertical extent of the axes, regardless of the ylim settings, even if you change them, eg. with the [set\\_ylim\(\)](#) command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the  $x$  location is in data coordinates.

Return value is the [Line2D](#) instance. kwargs are the same as kwargs to plot, and can be used to control the line properties. Eg.,

- draw a thick red vline at  $x = 0$  that spans the yrange

```
>>> axvline(linewidth=4, color='r')
```

- draw a default vline at  $x = 1$  that spans the yrange



```
>>> axvline(x=1)
```

- draw a default vline at  $x = .5$  that spans the the middle half of the yrange

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

Valid kwargs are [Line2D](#) properties, with the exception of ‘transform’:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance   |
| <code>url</code>                                       | a url string   |

Table 45.3 – continu

|                      |                |
|----------------------|----------------|
| <code>visible</code> | [True   False] |
| <code>xdata</code>   | 1D array       |
| <code>ydata</code>   | 1D array       |
| <code>zorder</code>  | any number     |

**See Also:**

[`axhspan\(\)`](#) for example plot and source code

**`axvspan(xmin, xmax, ymin=0, ymax=1, **kwargs)`**

call signature:

```
axvspan(xmin, xmax, ymin=0, ymax=1, **kwargs)
```

Axis Vertical Span.

$x$  coords are in data units and  $y$  coords are in axes (relative 0-1) units.

Draw a vertical span (rectangle) from  $xmin$  to  $xmax$ . With the default values of  $ymin = 0$  and  $ymax = 1$ , this always spans the yrange, regardless of the ylim settings, even if you change them, eg. with the [`set\_ylim\(\)`](#) command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the  $y$  location is in data coordinates.

Return value is the [`matplotlib.patches.Polygon`](#) instance.

Examples:

- draw a vertical green translucent rectangle from  $x=1.25$  to  $1.55$  that spans the yrange of the axes

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

Valid kwargs are [`Polygon`](#) properties:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default                               |
| <code>axes</code>                           | an <code>Axes</code> instance                                    |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance               |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ (Path, Transform)   Patch   None ]                             |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color      |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color      |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                 |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\ '   ' '   '- '   '+ '   'x'   'o'   'O'   '.'   '*' ] |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                      |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]                                    |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance                                  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**See Also:**

`axhspan()` for example plot and source code

**bar**(*left, height, width=0.80000000000000004, bottom=None, \*\*kwargs*)  
call signature:

`bar(left, height, width=0.8, bottom=0, **kwargs)`

Make a bar plot with rectangles bounded by:

*left, left + width, bottom, bottom + height* (left, right, bottom and top edges)

*left, height, width, and bottom* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

| Argument      | Description                                     |
|---------------|---|
| <i>left</i>   | the x coordinates of the left sides of the bars |
| <i>height</i> | the heights of the bars                         |

Optional keyword arguments:

| Key-word           | Description   |
|--------------------|---|
| <i>width</i>       | the widths of the bars  |
| <i>bottom</i>      | the y coordinates of the bottom edges of the bars   |
| <i>color</i>       | the colors of the bars  |
| <i>edge-color</i>  | the colors of the bar edges   |
| <i>linewidth</i>   | width of bar edges; None means use default linewidth; 0 means don't draw edges.   |
| <i>xerr</i>        | if not None, will be used to generate errorbars on the bar chart  |
| <i>yerr</i>        | if not None, will be used to generate errorbars on the bar chart  |
| <i>ecolor</i>      | specifies the color of any errorbar   |
| <i>capsize</i>     | (default 3) determines the length in points of the error bar caps   |
| <i>eror_kw</i>     | dictionary of kwargs to be passed to errorbar method. <i>ecolor</i> and <i>capsize</i> may be specified here rather than as independent kwargs. |
| <i>align</i>       | 'edge' (default)   'center'   |
| <i>orientation</i> | 'vertical'   'horizontal'   |
| <i>log</i>         | [False True] False (default) leaves the orientation axis as-is; True sets it to log scale   |

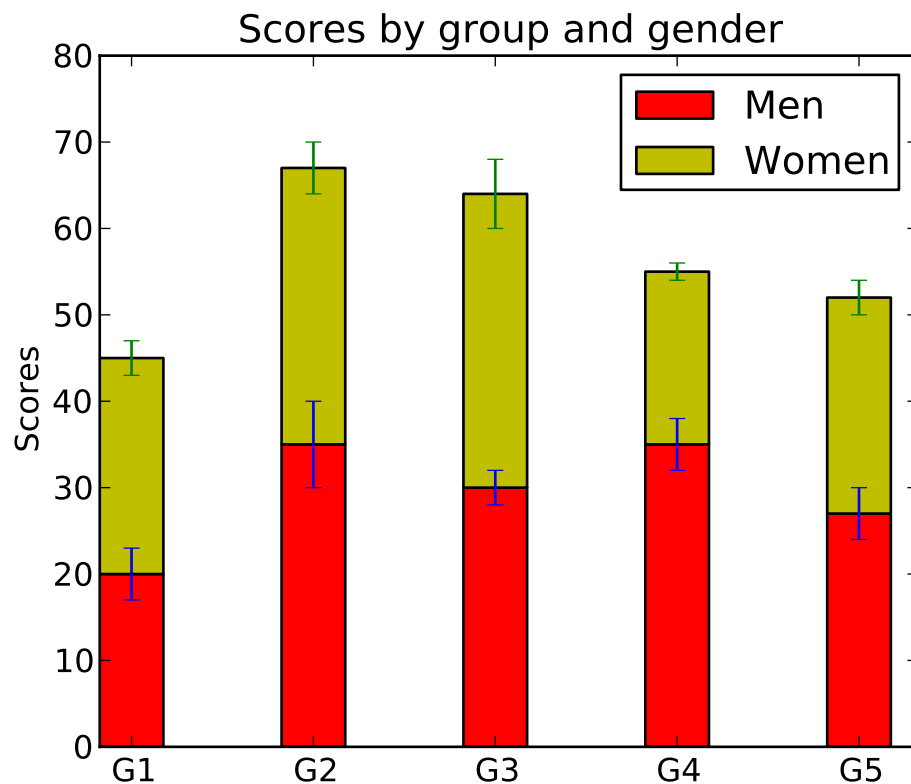
For vertical bars, *align* = 'edge' aligns bars by their left edges in left, while *align* = 'center' interprets these values as the *x* coordinates of the bar centers. For horizontal bars, *align* = 'edge' aligns bars by their bottom edges in bottom, while *align* = 'center' interprets these values as the *y* coordinates of the bar centers.

The optional arguments *color*, *edgecolor*, *linewidth*, *xerr*, and *yerr* can be either scalars or sequences of length equal to the number of bars. This enables you to use bar as the basis for stacked bar charts, or candlestick plots. Detail: *xerr* and *yerr* are passed directly to [errorbar\(\)](#), so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:** A stacked bar chart.



**barbs**(\*args, \*\*kw)

Plot a 2-D field of barbs.

call signatures:

```
barb(U, V, **kw)
barb(U, V, C, **kw)
barb(X, Y, U, V, **kw)
barb(X, Y, U, V, C, **kw)
```

Arguments:

**X, Y:** The x and y coordinates of the barb locations (default is head of barb; see *pivot* kwarg)

**U, V:** give the *x* and *y* components of the barb shaft

**C:** an optional array used to map colors to the barbs

All arguments may be 1-D or 2-D arrays or sequences. If *X* and *Y* are absent, they will be generated as a uniform grid. If *U* and *V* are 2-D arrays but *X* and *Y* are 1-D, and if `len(X)` and `len(Y)` match the column and row dimensions of *U*, then *X* and *Y* will be expanded with `numpy.meshgrid()`.

*U*, *V*, *C* may be masked arrays, but masked *X*, *Y* are not supported at present.

Keyword arguments:

**length:** Length of the barb in points; the other parts of the barb are scaled against this. Default is 9

**pivot:** [ **'tip'** | **'middle'** ] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tip'

**barbcolor:** [ **color** | **color sequence** ] Specifies the color all parts of the barb except any flags. This parameter is analagous to the *edgecolor* parameter for polygons, which can be used instead. However this parameter will override facecolor.

**flagcolor:** [ **color** | **color sequence** ] Specifies the color of any flags on the barb. This parameter is analagous to the *facecolor* parameter for polygons, which can be used instead. However this parameter will override facecolor. If this is not set (and *C* has not either) then *flagcolor* will be set to match *barbcolor* so that the barb has a uniform color. If *C* has been set, *flagcolor* has no effect.

**sizes:** A dictionary of coefficients specifying the ratio of a given feature to the length of the barb. Only those values one wishes to override need to be included. These features include:

- 'spacing' - space between features (flags, full/half barbs)
- 'height' - height (distance from shaft to top) of a flag or full barb
- 'width' - width of a flag, twice the width of a full barb
- 'emptybarb' - radius of the circle used for low magnitudes

**fill\_empty:** A flag on whether the empty barbs (circles) that are drawn should be filled with the flag color. If they are not filled, they will be drawn such that no color is applied to the center. Default is False

**rounding:** A flag to indicate whether the vector magnitude should be rounded when allocating barb components. If True, the magnitude is rounded to the nearest multiple of the half-barb increment. If False, the magnitude is simply truncated to the next lowest multiple. Default is True

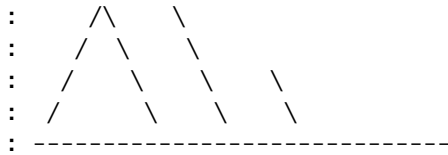
**barb\_increments:** A dictionary of increments specifying values to associate with different parts of the barb. Only those values one wishes to override need to be included.

- 'half' - half barbs (Default is 5)
- 'full' - full barbs (Default is 10)
- 'flag' - flags (default is 50)

**flip\_barb:** Either a single boolean flag or an array of booleans. Single boolean indicates whether the lines and flags should point opposite to normal for all barbs. An array (which should be the same size as the other data arrays) indicates whether to flip for each individual barb. Normal behavior is for the barbs and lines to point right (comes from wind barbs having these features point towards low pressure in the Northern Hemisphere.) Default is False

Barbs are traditionally used in meteorology as a way to plot the speed and direction of wind observations, but can technically be used to plot any two dimensional vector quantity. As opposed

to arrows, which give vector magnitude by the length of the arrow, the barbs give more quantitative information about the vector magnitude by putting slanted lines or a triangle for various increments in magnitude, as show schematically below:



The largest increment is given by a triangle (or “flag”). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset from the end of the barb so that it can be easily distinguished from barbs with a single full line. The magnitude for the barb shown above would nominally be 65, using the standard increments of 50, 10, and 5.

linewidths and edgecolors can be used to customize the barb. Additional `PolyCollection` keyword arguments:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |
| <code>pickradius</code>  | unknown   |

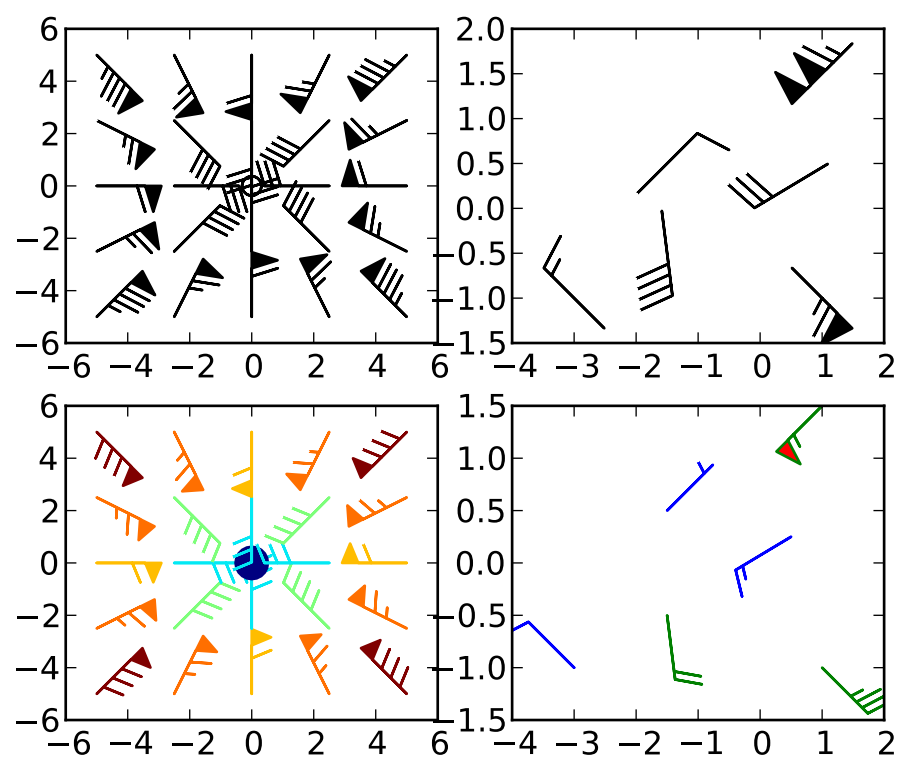
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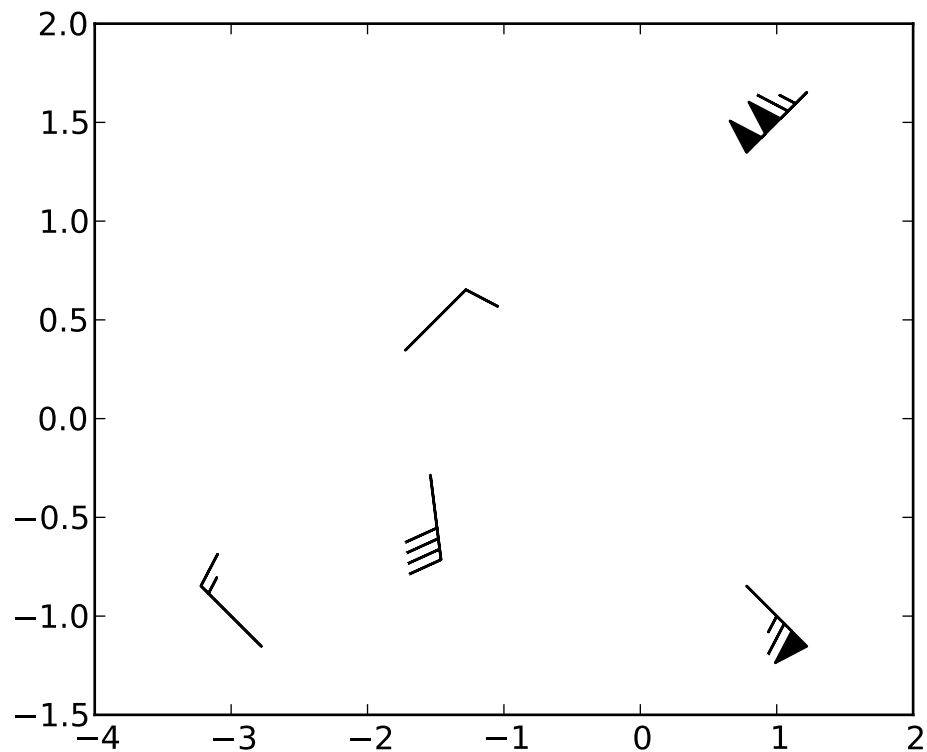


Table 45.4 – continued from previous page

|                         |                                 |
|-------------------------|---------------------------------|
| <code>rasterized</code> | [True   False   None]           |
| <code>snap</code>       | unknown                         |
| <code>transform</code>  | <code>Transform</code> instance |
| <code>url</code>        | a url string                    |
| <code>urls</code>       | unknown                         |
| <code>visible</code>    | [True   False]                  |
| <code>zorder</code>     | any number                      |

Example:





**barh**(*bottom*, *width*, *height*=0.8000000000000004, *left*=None, *\*\*kwargs*)  
call signature:

`barh(bottom, width, height=0.8, left=0, **kwargs)`

Make a horizontal bar plot with rectangles bounded by:

*left*, *left + width*, *bottom*, *bottom + height* (left, right, bottom and top edges)

*bottom*, *width*, *height*, and *left* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

| Argument      | Description  |
|---------------|--|
| <i>bottom</i> | the vertical positions of the bottom edges of the bars |
| <i>width</i>  | the lengths of the bars                                |

Optional keyword arguments:

| Keyword          | Description  |
|------------------|--|
| <i>height</i>    | the heights (thicknesses) of the bars  |
| <i>left</i>      | the x coordinates of the left edges of the bars  |
| <i>color</i>     | the colors of the bars   |
| <i>edgecolor</i> | the colors of the bar edges  |
| <i>linewidth</i> | width of bar edges; None means use default linewidth; 0 means don't draw edges.          |
| <i>xerr</i>      | if not None, will be used to generate errorbars on the bar chart                         |
| <i>yerr</i>      | if not None, will be used to generate errorbars on the bar chart                         |
| <i>ecolor</i>    | specifies the color of any errorbar  |
| <i>capsize</i>   | (default 3) determines the length in points of the error bar caps                        |
| <i>align</i>     | 'edge' (default)   'center'  |
| <i>log</i>       | [False True] False (default) leaves the horizontal axis as-is; True sets it to log scale |

Setting *align* = 'edge' aligns bars by their bottom edges in bottom, while *align* = 'center' interprets these values as the y coordinates of the bar centers.

The optional arguments *color*, *edgecolor*, *linewidth*, *xerr*, and *yerr* can be either scalars or sequences of length equal to the number of bars. This enables you to use `barh` as the basis for stacked bar charts, or candlestick plots.

other optional kwargs:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default                             |
| <code>axes</code>                           | an <code>Axes</code> instance                                  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ (Path, Transform)   Patch   None ]                           |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-.'   '+'   'x'   'o'   'O'   '.'   '*' ] |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default                                      |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]                                  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance                                |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**boxplot**(*x*, *notch*=0, *sym*='b+', *vert*=1, *whis*=1.5, *positions*=None, *widths*=None, *patch\_artist*=False, *bootstrap*=None)  
call signature:

```
boxplot(x, notch=0, sym='+', vert=1, whis=1.5,
        positions=None, widths=None, patch_artist=False)
```

Make a box and whisker plot for each column of *x* or each vector in sequence *x*. The box extends from the lower to upper quartile values of the data, with a line at the median. The whiskers extend from the box to show the range of the data. Flier points are those past the end of the whiskers.

*x* is an array or a sequence of vectors.

- *notch* = 0 (default) produces a rectangular box plot.
- *notch* = 1 will produce a notched box plot

*sym* (default 'b+') is the default symbol for flier points. Enter an empty string ('') if you don't want to show fliers.

- `vert = 1` (default) makes the boxes vertical.

- `vert = 0` makes horizontal boxes. This seems goofy, but that's how MATLAB did it.

`whis` (default 1.5) defines the length of the whiskers as a function of the inner quartile range. They extend to the most extreme data point within ( `whis*(75%-25%)` ) data range.

`bootstrap` (default None) specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If `bootstrap=None`, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall and Stuart, 1967). Otherwise, `bootstrap` specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

`positions` (default 1,2,...,n) sets the horizontal positions of the boxes. The ticks and limits are automatically set to match the positions.

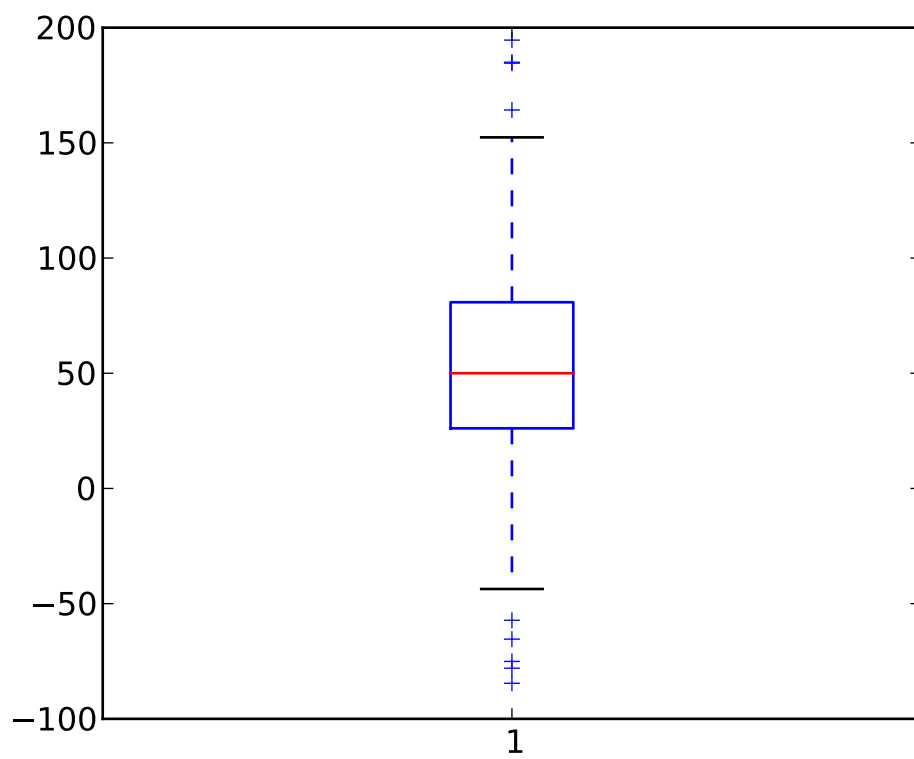
`widths` is either a scalar or a vector and sets the width of each box. The default is 0.5, or `0.15*(distance between extreme positions)` if that is smaller.

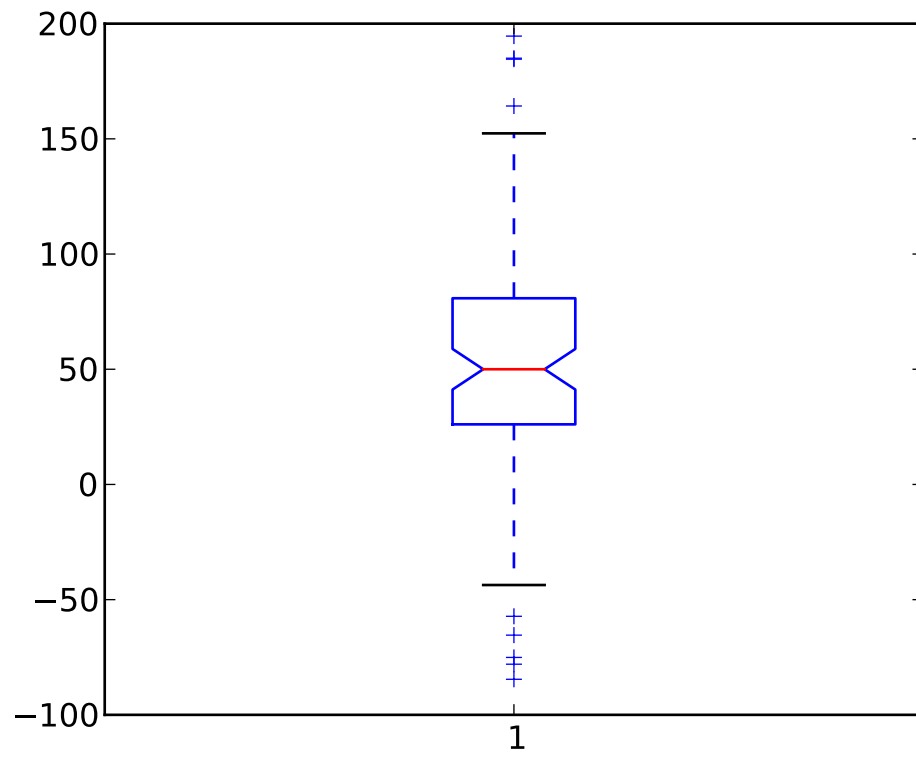
- `patch_artist = False` (default) produces boxes with the Line2D artist

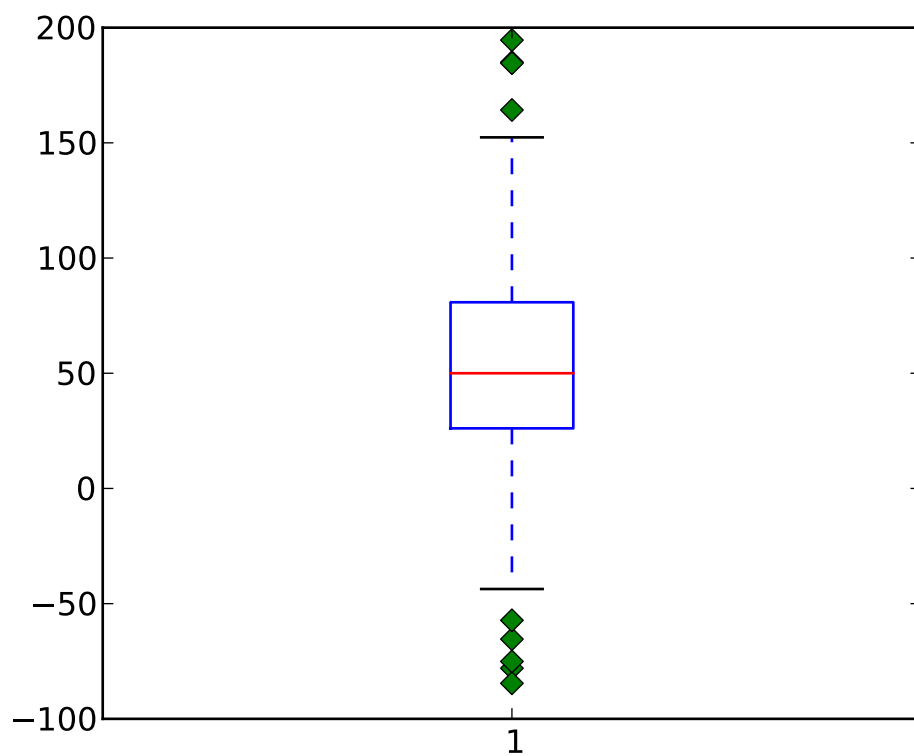
- `patch_artist = True` produces boxes with the Patch artist

Returns a dictionary mapping each component of the boxplot to a list of the `matplotlib.lines.Line2D` instances created.

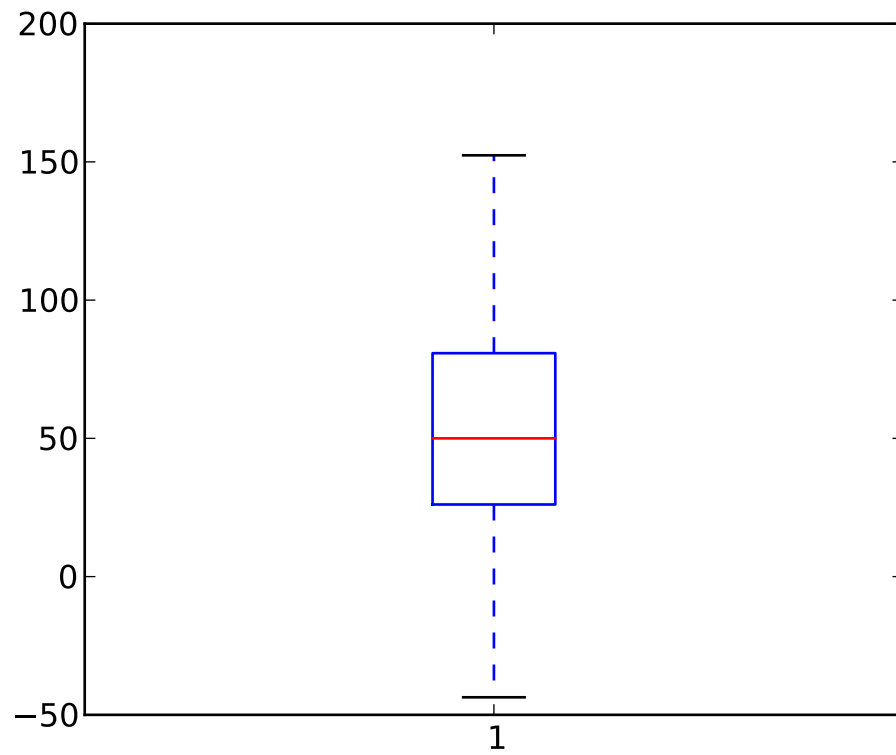
**Example:**

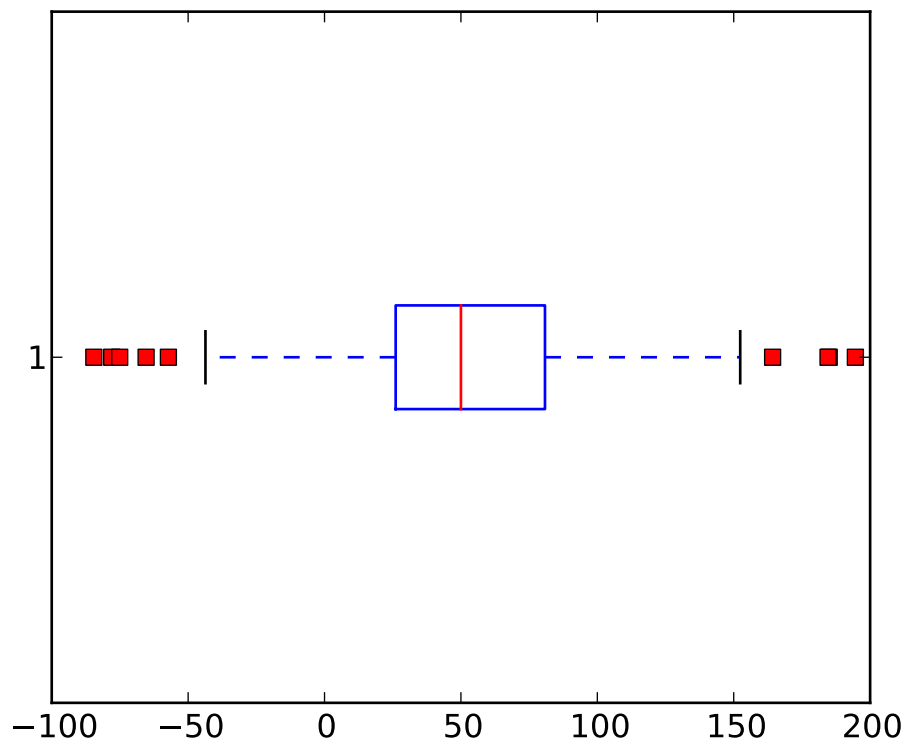


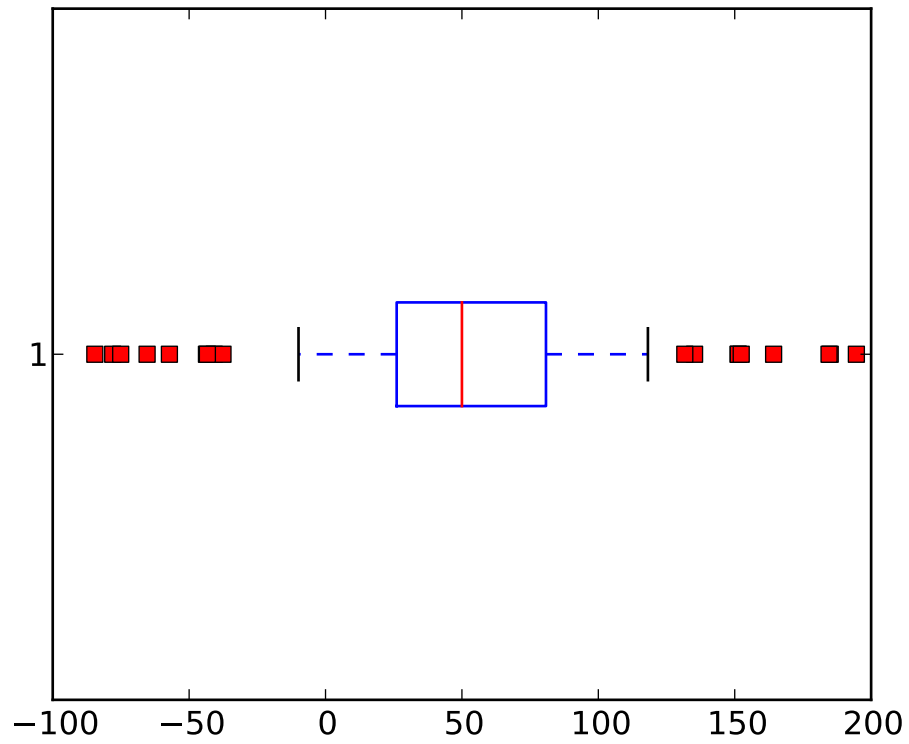


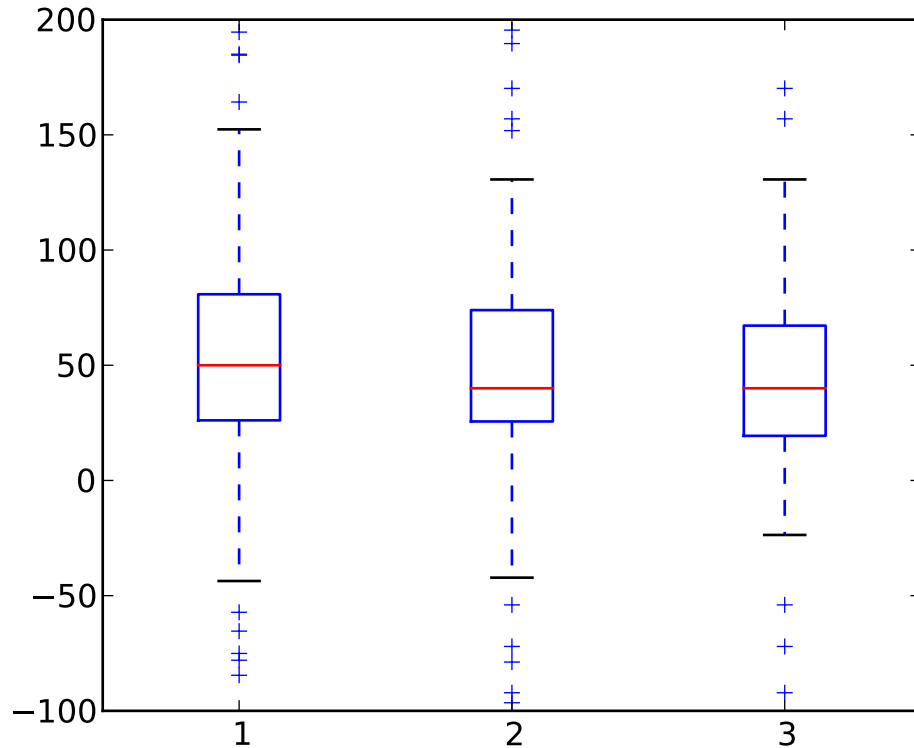












**broken\_barh**(*xranges*, *yrange*, **\*\*kwargs**)

call signature:

`broken_barh(self, xranges, yrange, **kwargs)`

A collection of horizontal bars spanning *yrange* with a sequence of *xranges*.

Required arguments:

| Argument       | Description                                 |
|----------------|---|
| <i>xranges</i> | sequence of ( <i>xmin</i> , <i>xwidth</i> ) |
| <i>yrange</i>  | sequence of ( <i>ymin</i> , <i>ywidth</i> ) |

kwargs are `matplotlib.collections.BrokenBarHCollection` properties:

| Property  | Description  |
|---|--|
| <code>agg_filter</code>                               | unknown  |
| <code>alpha</code>                                    | float or None                                      |
| <code>animated</code>                                 | [True   False]                                     |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans                    |
| <code>array</code>                                    | unknown  |
| <code>axes</code>                                     | an <code>Axes</code> instance                      |
| <code>clim</code>                                     | a length 2 sequence of floats                      |
| <code>clip_box</code>                                 | a <code>matplotlib.transforms.Bbox</code> instance |
| Continued on next page                                |  |

Table 45.5 – continued from previous page

|  |  |
|--|--|
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                   |
| <code>cmap</code>  | a colormap or registered colormap name                                 |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                        |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                       |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | ['solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>snap</code>  | unknown  |
| <code>transform</code>   | Transform instance   |
| <code>url</code>   | a url string   |
| <code>urls</code>  | unknown  |
| <code>visible</code>   | [True   False]   |
| <code>zorder</code>  | any number   |

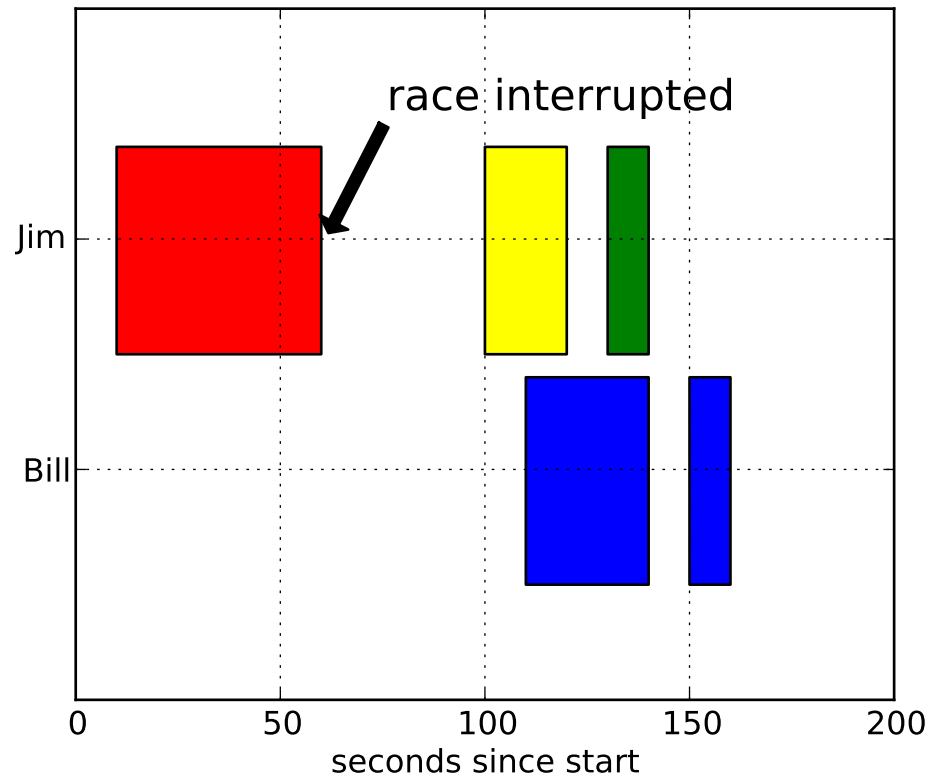
these can either be a single argument, ie:

```
facecolors = 'black'
```

or a sequence of arguments for the various bars, ie:

```
facecolors = ('black', 'red', 'green')
```

**Example:**

**can\_pan()**

Return *True* if this axes supports any pan/zoom button functionality.

**can\_zoom()**

Return *True* if this axes supports the zoom box button functionality.

**cla()**

Clear the current axes

**clabel(*CS*, \**args*, \*\**kwargs*)**

call signature:

```
clabel(cs, **kwargs)
```

adds labels to line contours in *cs*, where *cs* is a *ContourSet* object returned by *contour*.

```
clabel(cs, v, **kwargs)
```

only labels contours listed in *v*.

Optional keyword arguments:

**fontsize:** See <http://matplotlib.sf.net/fonts.html>

**colors:**

- if *None*, the color of each label matches the color of the corresponding contour

- if one string color, e.g. `colors = 'r'` or `colors = 'red'`, all labels will be plotted in this color
- if a tuple of matplotlib color args (string, float, rgb, etc), different labels will be plotted in different colors in the order specified

***inline***: controls whether the underlying contour is removed or not. Default is *True*.

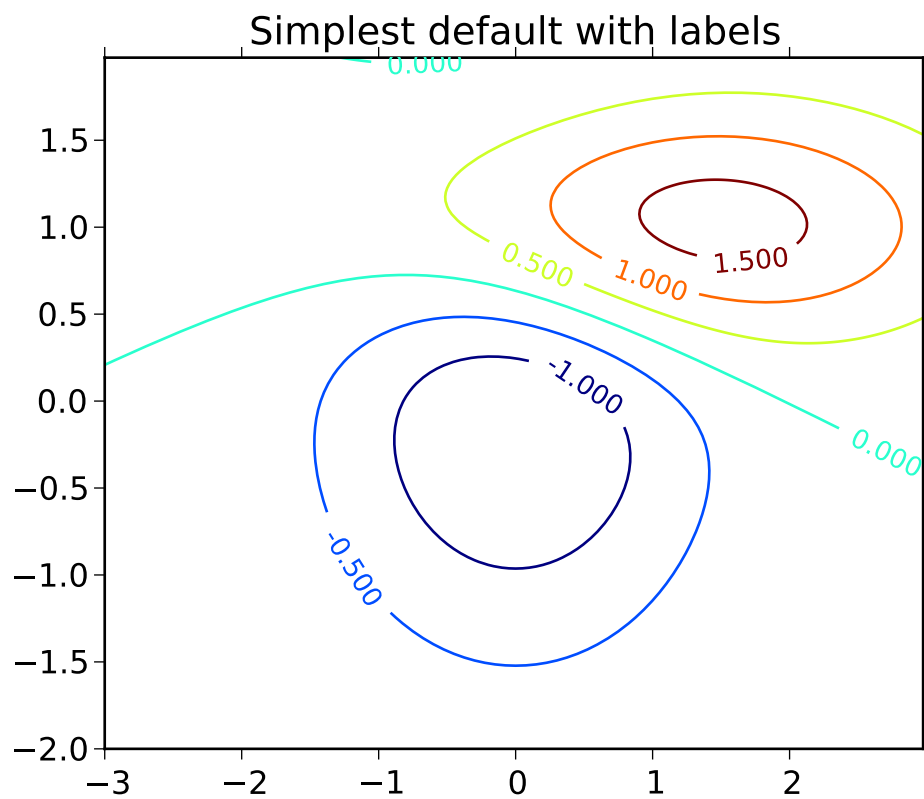
***inline\_spacing***: space in pixels to leave on each side of label when placing inline. Defaults to 5. This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

***fmt***: a format string for the label. Default is `'%1.3f'` Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., `fmt[level]=string`), or it can be any callable, such as a [Formatter](#) instance, that returns a string when called with a numeric contour level.

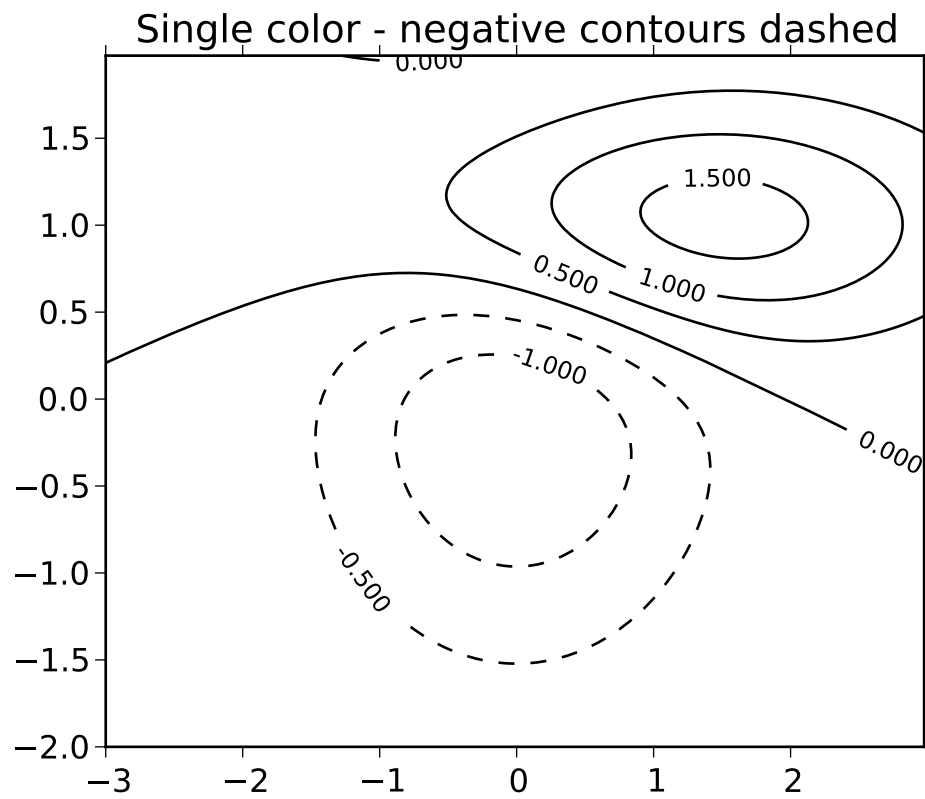
***manual***: if *True*, contour labels will be placed manually using mouse clicks. Click the first button near a contour to add a label, click the second button (or potentially both mouse buttons at once) to finish adding labels. The third button can be used to remove the last label added, but only if labels are not inline. Alternatively, the keyboard can be used to select label locations (enter to end label placement, delete or backspace act like the third mouse button, and any other key will select a label location).

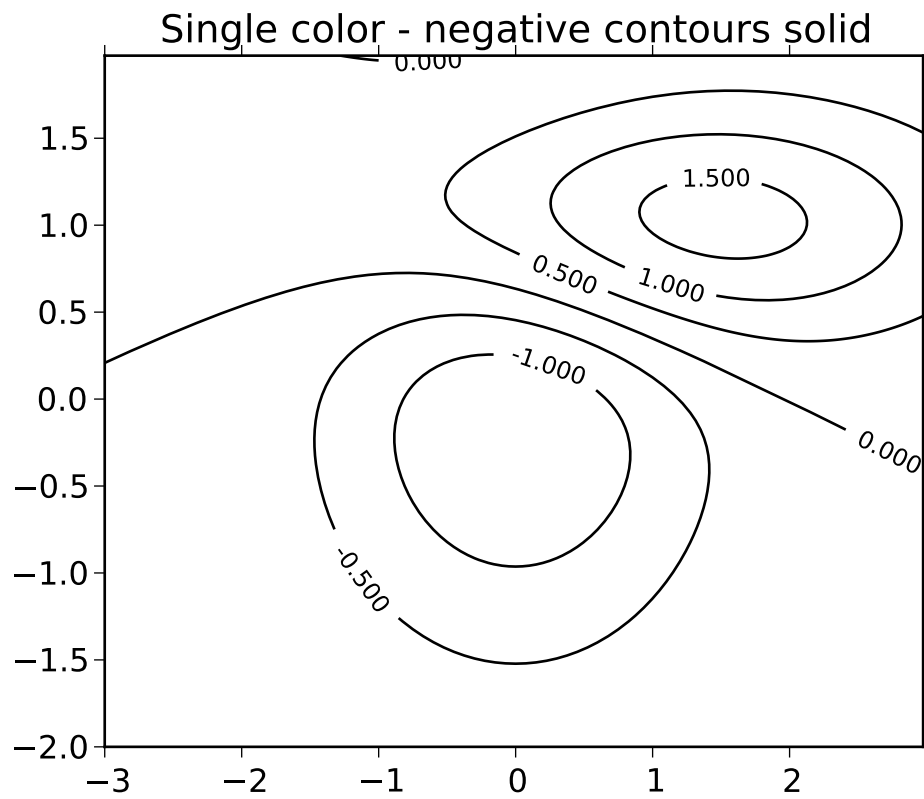
***rightside\_up***: if *True* (default), label rotations will always be plus or minus 90 degrees from level.

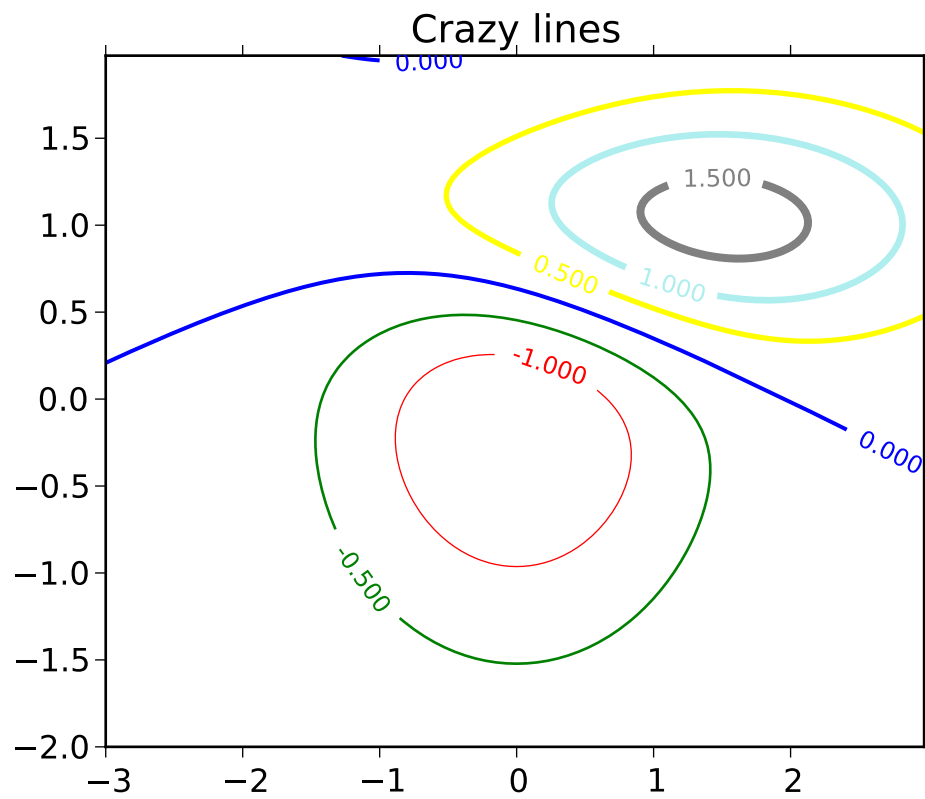
***use\_clabeltext***: if *True* (default is *False*), `ClabelText` class (instead of `matplotlib.Text`) is used to create labels. `ClabelText` recalculates rotation angles of texts during the drawing time, therefore this can be used if aspect of the axes changes.

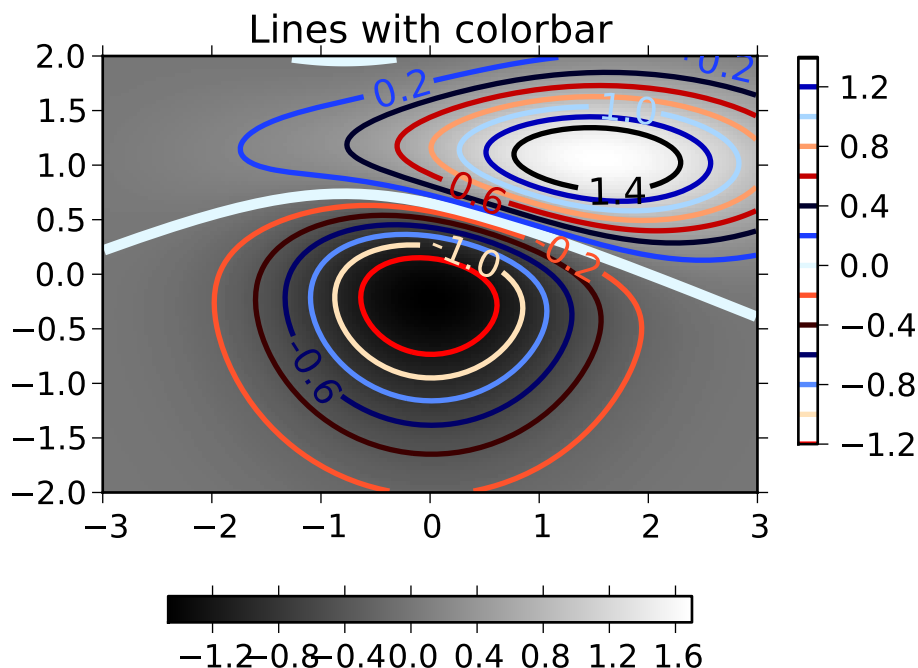












**clear()**

clear the axes

**cohere**(*x*, *y*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, **\*\*kwargs**)

call signature:

```
cohere(x, y, NFFT=256, Fs=2, Fc=0, detrend = mlab.detrend_none,
       window = mlab.window_hanning, noverlap=0, pad_to=None,
       sides='default', scale_by_freq=None, **kwargs)
```

**cohere()** the coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \quad (45.1)$$

Keyword arguments:

**NFFT: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**Fs: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**detrend: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The `pylab` module defines `detrend_none()`, `detrend_mean()`, and `detrend_linear()`, but you can use a custom function as well.

**window: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see `window_hanning()`, `window_none()`, `numpy.blackman()`, `numpy.hamming()`, `numpy.bartlett()`, `scipy.signal()`, `scipy.signal.get_window()`, etc. The default is `window_hanning()`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**noverlap: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

**pad\_to: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to *NFFT*.

**sides: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

**scale\_by\_freq: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.

**Fc: integer** The center frequency of *x* (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

The return value is a tuple (*Cxy*, *f*), where *f* are the frequencies of the coherence vector.

kwargs are applied to the lines.

References:

- Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

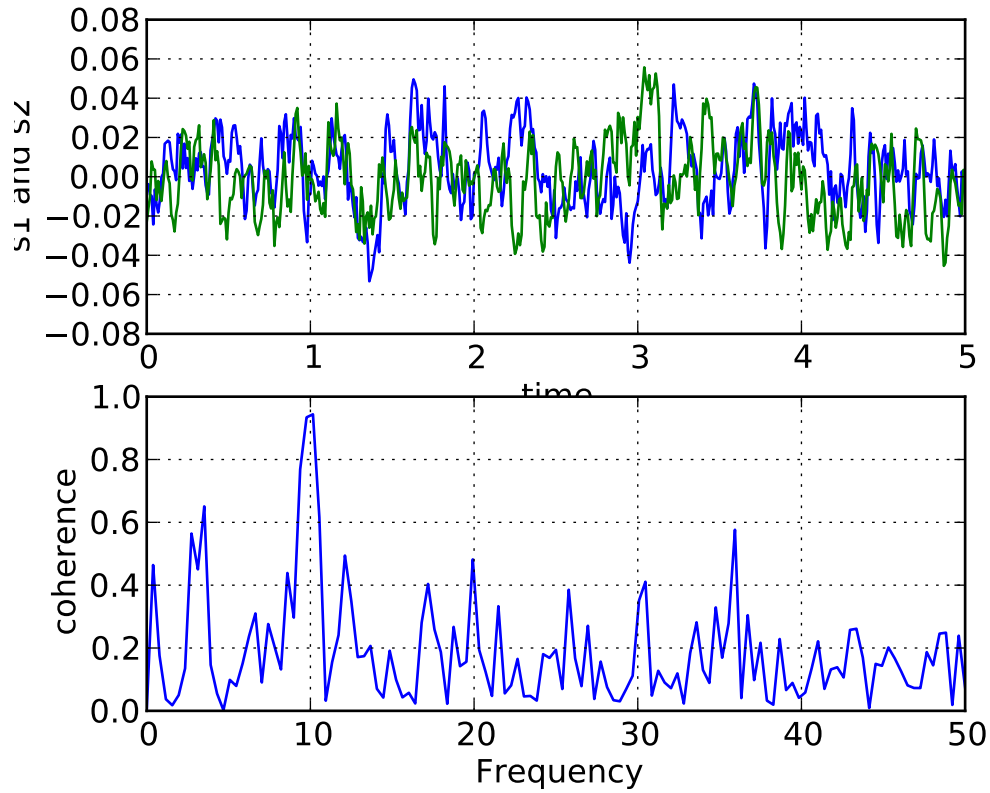
kwargs control the [Line2D](#) properties of the coherence plot:

| Property                | Description                                |
|-------------------------|--|
| <code>agg_filter</code> | unknown                                    |
| <code>alpha</code>      | float (0.0 transparent through 1.0 opaque) |
| <code>animated</code>   | [True   False]                             |

Table 45.6 – continu

|  |  |
|--|--|
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <code>Axes</code> instance  |
| <code>clip_box</code>                                  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]                     |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance  |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |
| <code>xdata</code>                                     | 1D array   |
| <code>ydata</code>                                     | 1D array   |
| <code>zorder</code>                                    | any number   |

**Example:**

**connect**(*s*, *func*)

Register observers to be notified when certain events occur. Register with callback functions with the following signatures. The function has the following signature:

```
func(ax) # where ax is the instance making the callback.
```

The following events can be connected to:

```
'xlim_changed', 'ylim_changed'
```

The connection id is returned - you can use this with `disconnect` to disconnect from the axes event

**contains**(*mouseevent*)

Test whether the mouse event occurred in the axes.

Returns T/F, {}

**contains\_point**(*point*)

Returns True if the point (tuple of x,y) is inside the axes (the area defined by the its patch). A pixel coordinate is required.

**contour**(\*args, \*\*kwargs)

`contour()` and `contourf()` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

`contourf()` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour()`.

call signatures:

`contour(Z)`

make a contour plot of an array *Z*. The level values are chosen automatically.

`contour(X,Y,Z)`

*X*, *Y* specify the (*x*, *y*) coordinates of the surface

`contour(Z,N)`

`contour(X,Y,Z,N)`

contour *N* automatically-chosen levels.

`contour(Z,V)`

`contour(X,Y,Z,V)`

draw contour lines at the values specified in sequence *V*

`contourf(..., V)`

fill the ( $\text{len}(V)-1$ ) regions between the values in *V*

`contour(Z, **kwargs)`

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

*X* and *Y* must both be 2-D with the same shape as *Z*, or they must both be 1-D such that  $\text{len}(X)$  is the number of columns in *Z* and  $\text{len}(Y)$  is the number of rows in *Z*.

`C = contour(...)` returns a `QuadContourSet` object.

Optional keyword arguments:

**colors:** [ **None** | **string** | (**mpl\_colors**) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** **float** The alpha blending value

**cmap:** [ **None** | **Colormap** ] A `cm Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.



**norm:** [ **None** | **Normalize** ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [**level0**, **level1**, ..., **leveln**] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ **None** | **'upper'** | **'lower'** | **'image'** ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If **'image'**, the `rc` value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**extent:** [ **None** | (*x0*,*x1*,*y0*,*y1*) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ **None** | **ticker.Locator subclass** ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ **'neither'** | **'both'** | **'min'** | **'max'** ] Unless this is **'neither'**, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ **None** | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased:** [ **True** | **False** ] enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams['lines.antialiased']`.

contour-only keyword arguments:

**linewidths:** [ **None** | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ **None** | **'solid'** | **'dashed'** | **'dashdot'** | **'dotted'** ] If *linestyles* is *None*, the **'solid'** is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

contourf-only keyword arguments:

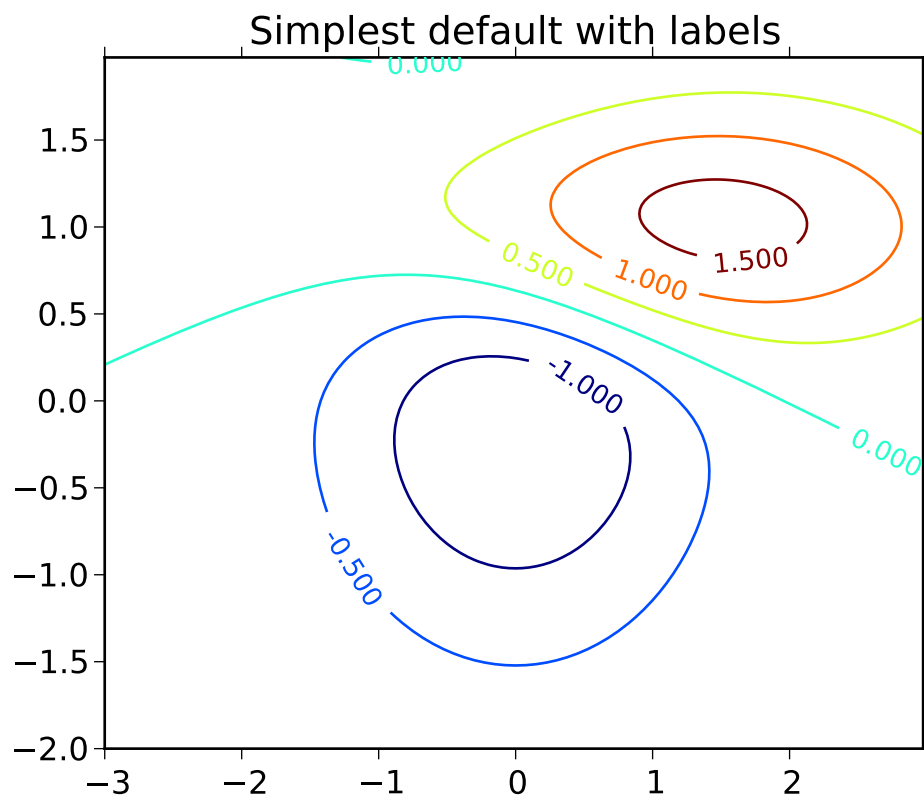
***nchunk***: [ 0 | integer ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

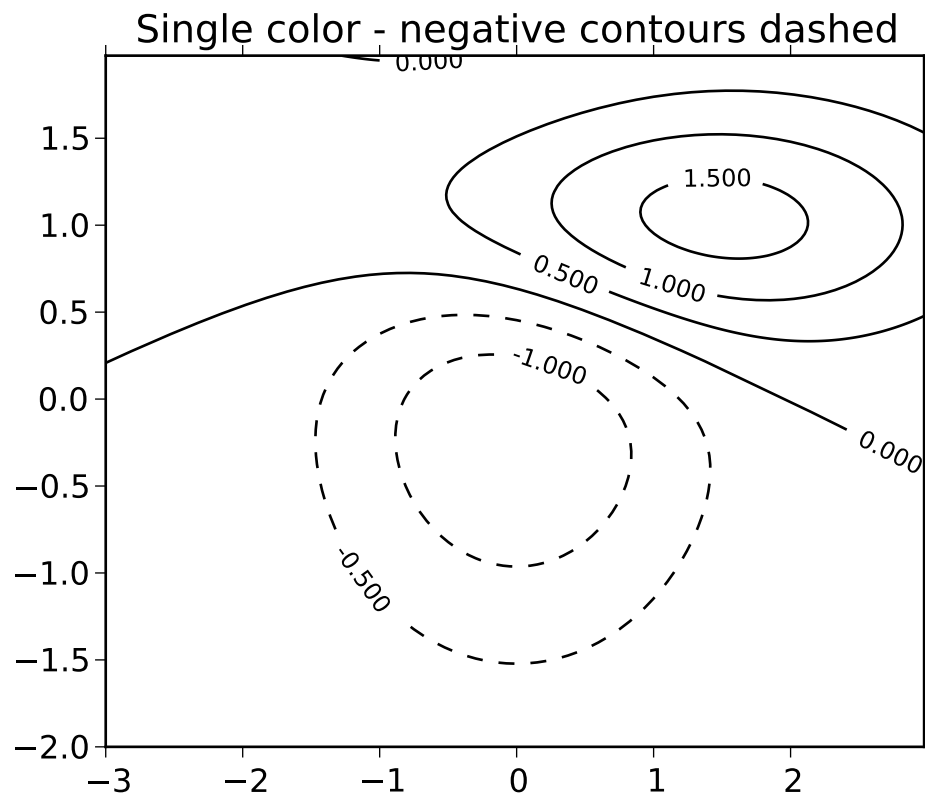
Note: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

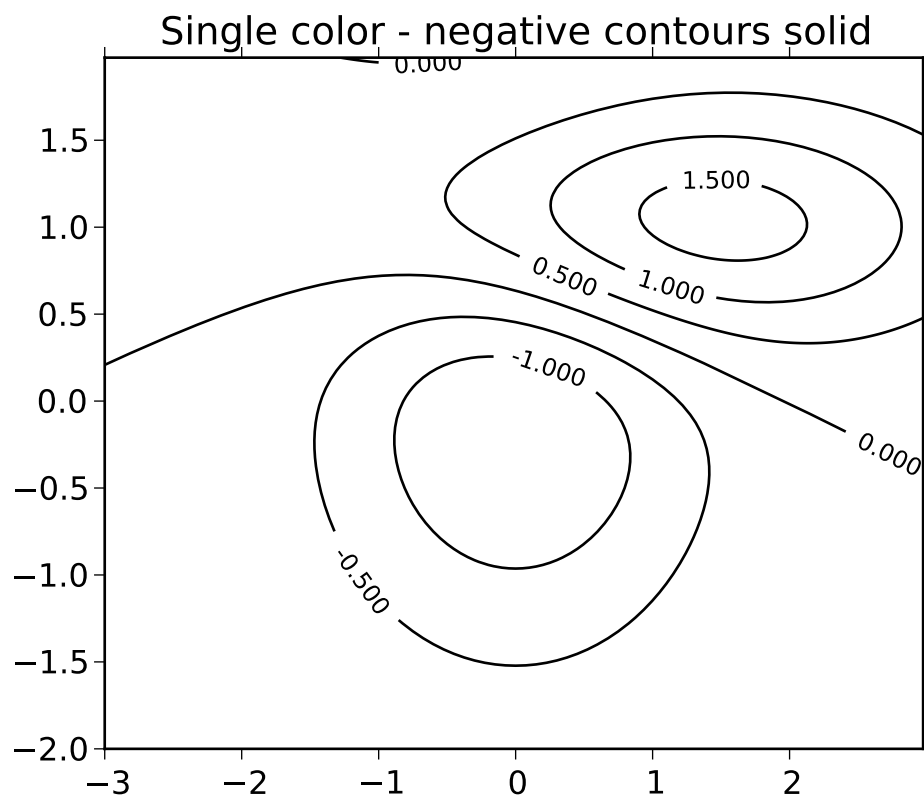
$$z1 < z \leq z2$$

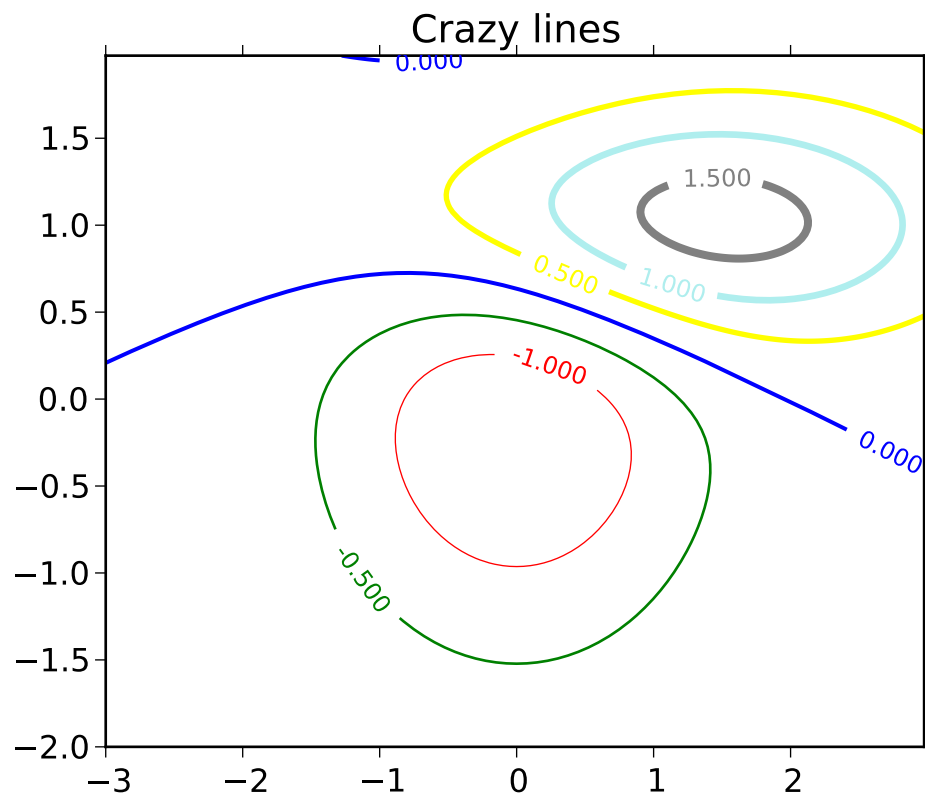
There is one exception: if the lowest boundary coincides with the minimum value of the *z* array, then that minimum value will be included in the lowest interval.

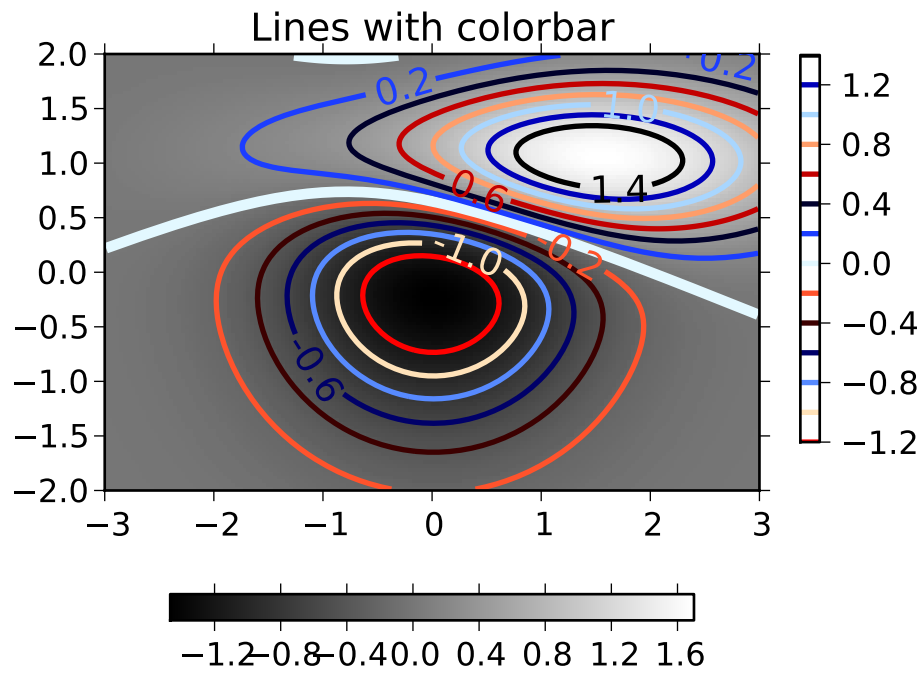
**Examples:**

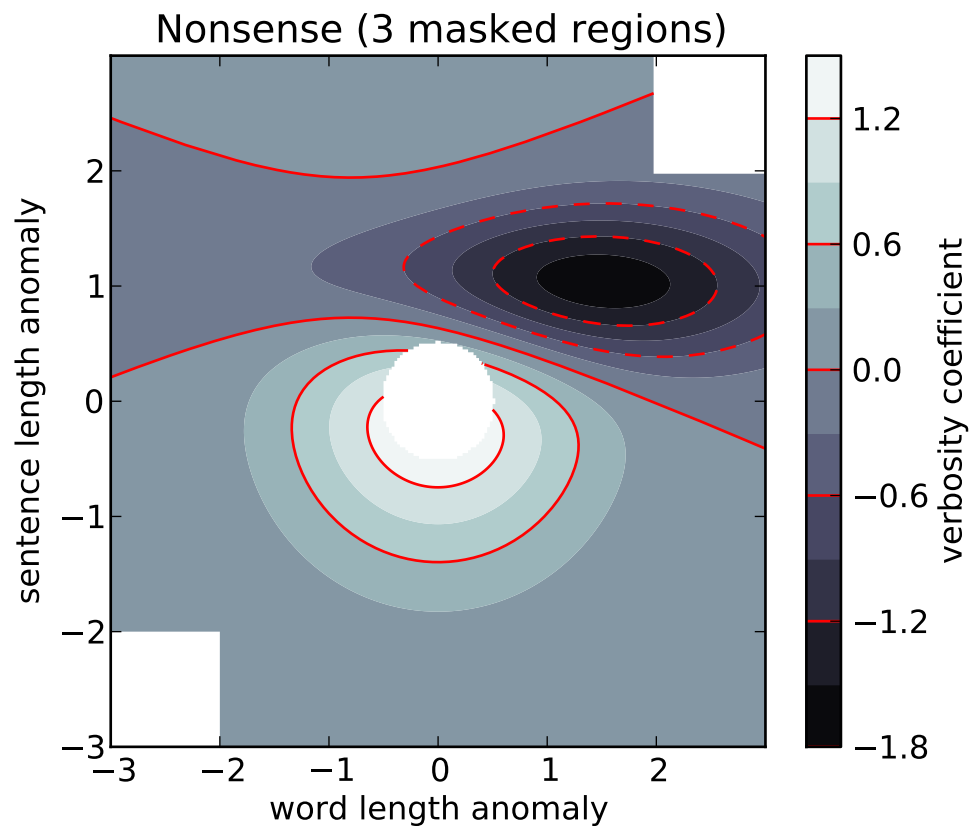


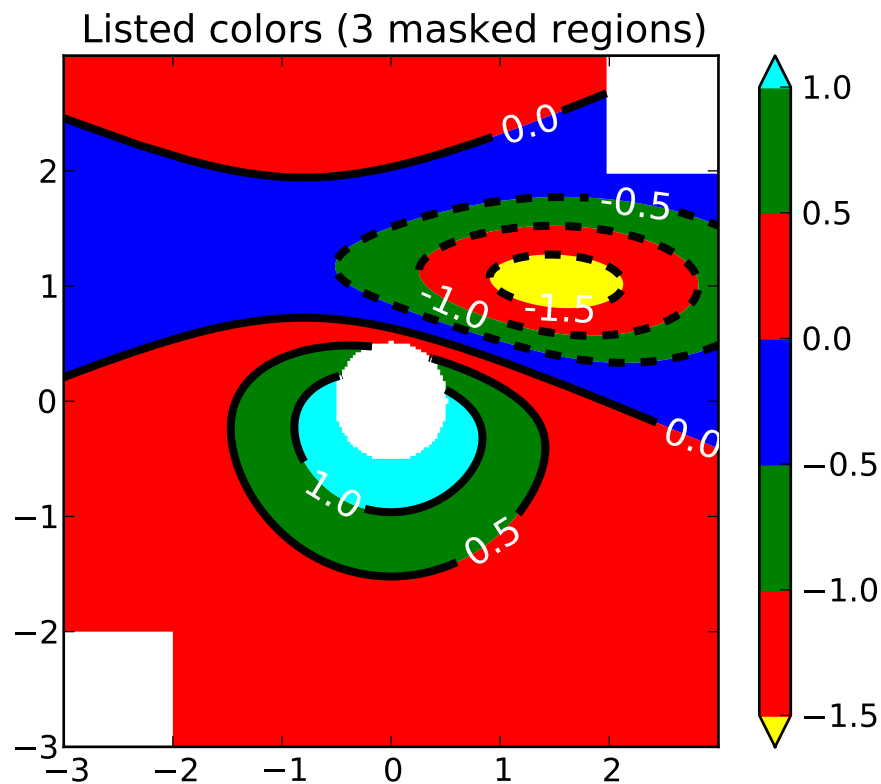












**contourf**(\*args, \*\*kwargs)

`contour()` and `contourf()` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

`contourf()` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour()`.

call signatures:

`contour(Z)`

make a contour plot of an array *Z*. The level values are chosen automatically.

`contour(X,Y,Z)`

*X*, *Y* specify the (*x*, *y*) coordinates of the surface

`contour(Z,N)`

`contour(X,Y,Z,N)`

contour *N* automatically-chosen levels.

`contour(Z,V)`

`contour(X,Y,Z,V)`



draw contour lines at the values specified in sequence *V*

```
contourf(..., V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in *V*

```
contour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

*X* and *Y* must both be 2-D with the same shape as *Z*, or they must both be 1-D such that  $\text{len}(X)$  is the number of columns in *Z* and  $\text{len}(Y)$  is the number of rows in *Z*.

*C* = `contour(...)` returns a `QuadContourSet` object.

Optional keyword arguments:

**colors:** [ *None* | **string** | (**mpl\_colors**) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** **float** The alpha blending value

**cmap:** [ *None* | **Colormap** ] A cm `Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.

**norm:** [ *None* | **Normalize** ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [**level0**, **level1**, ..., **leveln**] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**extent:** [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (x0, y0) is the position of *Z*[0,0], and (x1, y1) is the position of *Z*[-1,-1].

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ **None** | **ticker.Locator subclass** ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ **'neither'** | **'both'** | **'min'** | **'max'** ] Unless this is **'neither'**, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ **None** | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased:** [ **True** | **False** ] enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams['lines.antialiased']`.

contour-only keyword arguments:

**linewidths:** [ **None** | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ **None** | **'solid'** | **'dashed'** | **'dashdot'** | **'dotted'** ] If *linestyles* is *None*, the **'solid'** is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

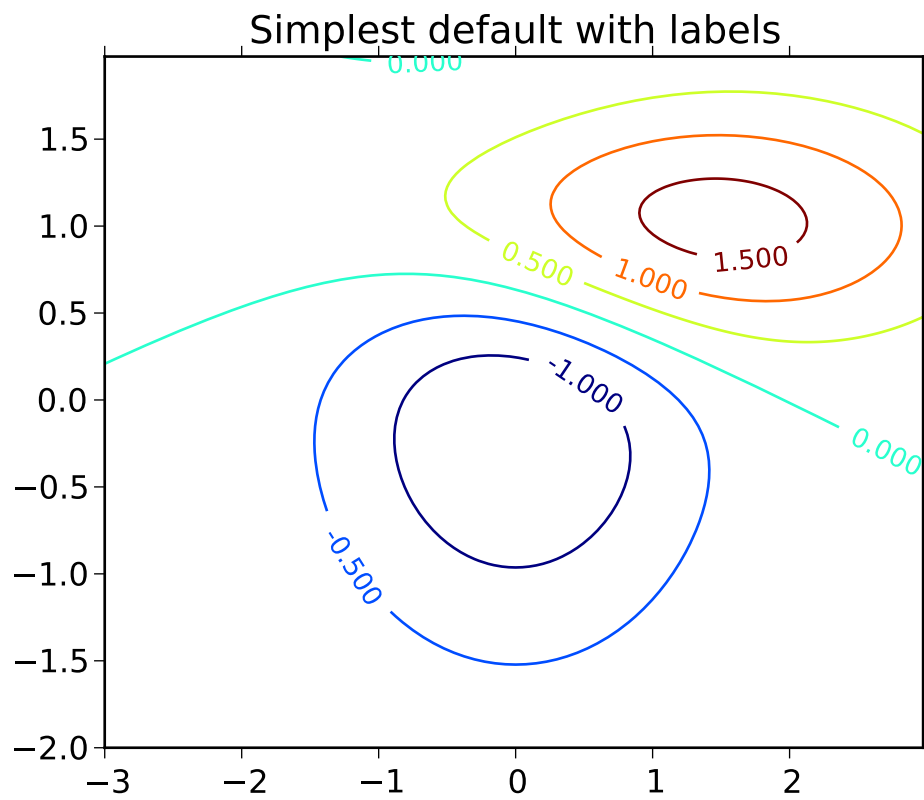
contourf-only keyword arguments:

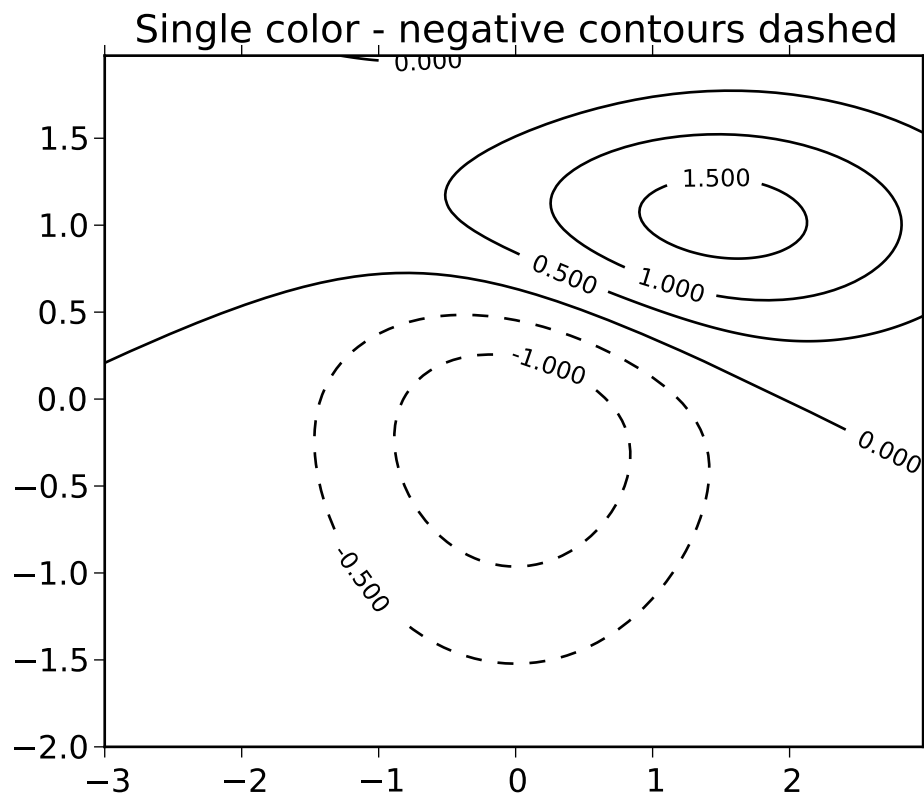
**nchunk:** [ **0** | **integer** ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

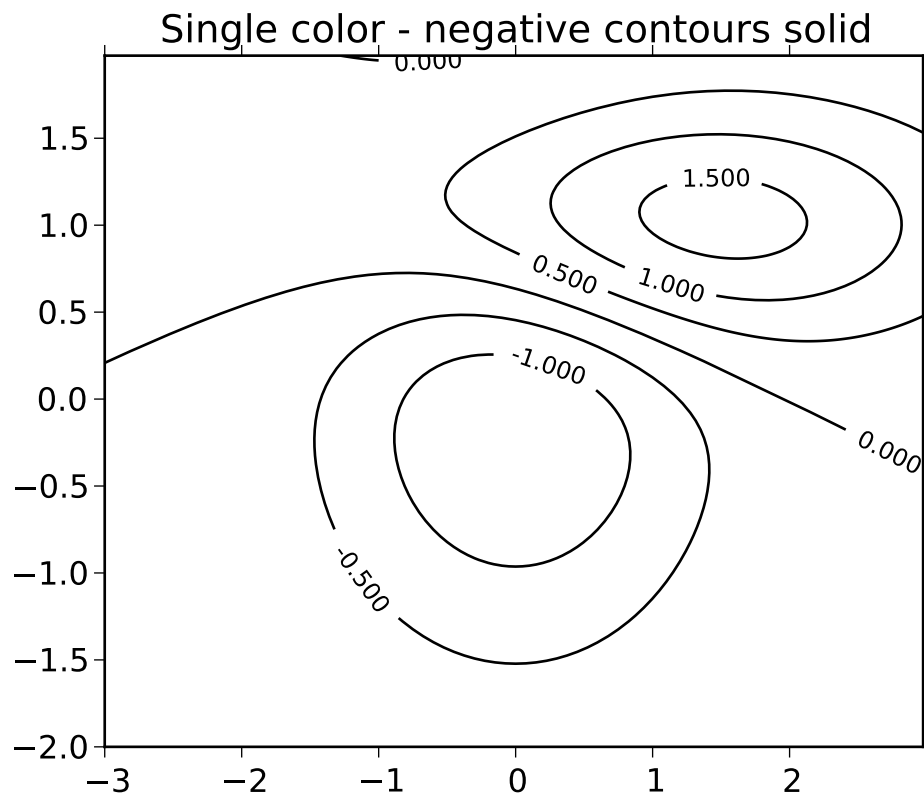
Note: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

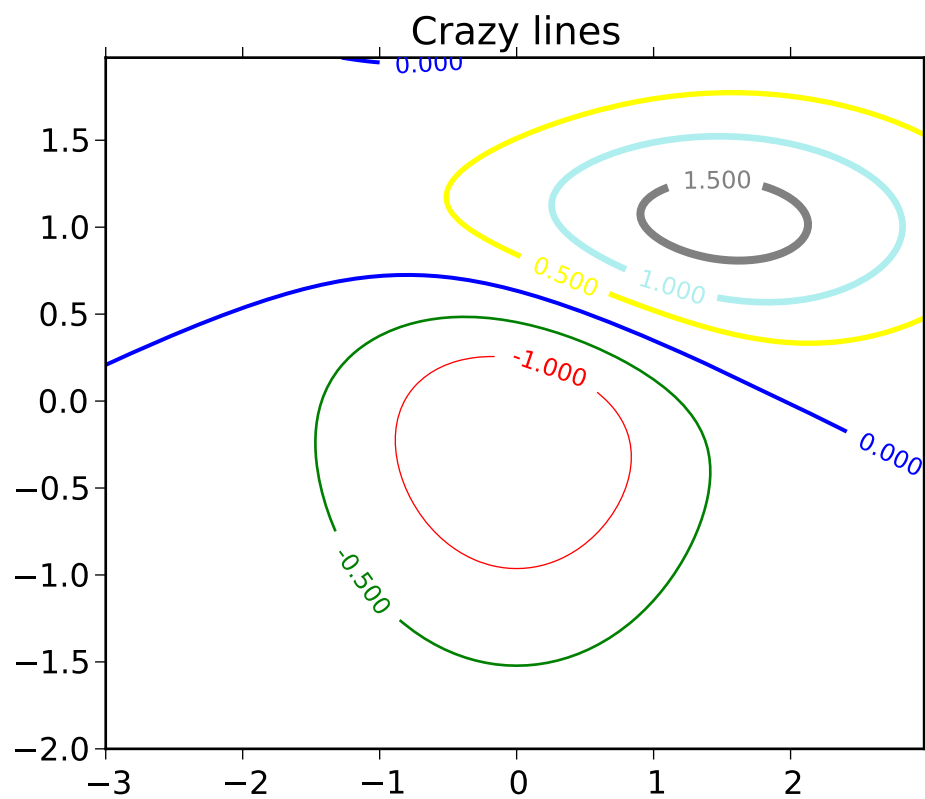
$$z1 < z \leq z2$$

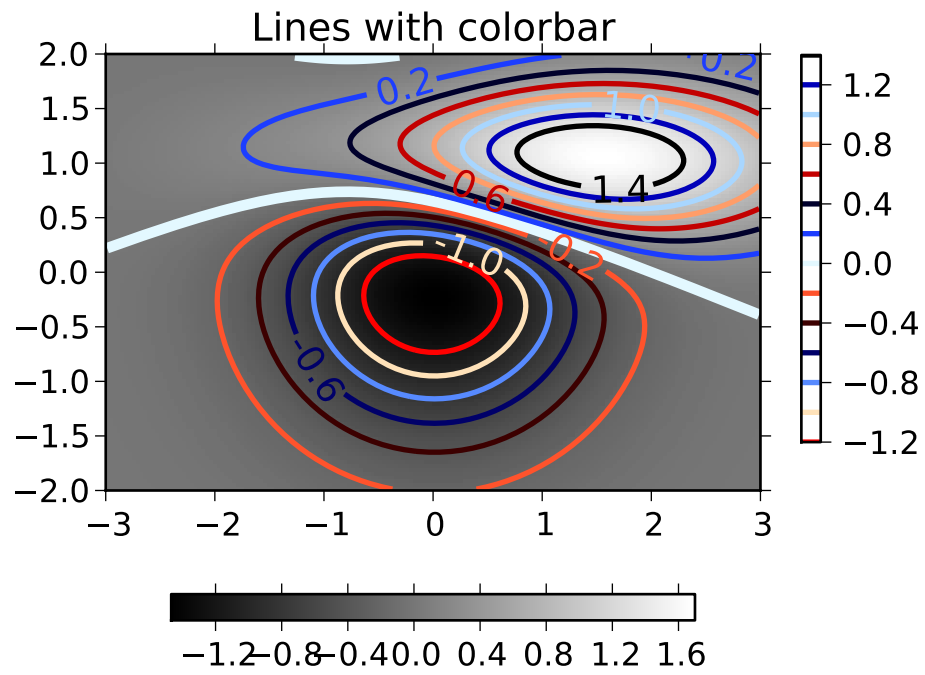
There is one exception: if the lowest boundary coincides with the minimum value of the *z* array, then that minimum value will be included in the lowest interval.

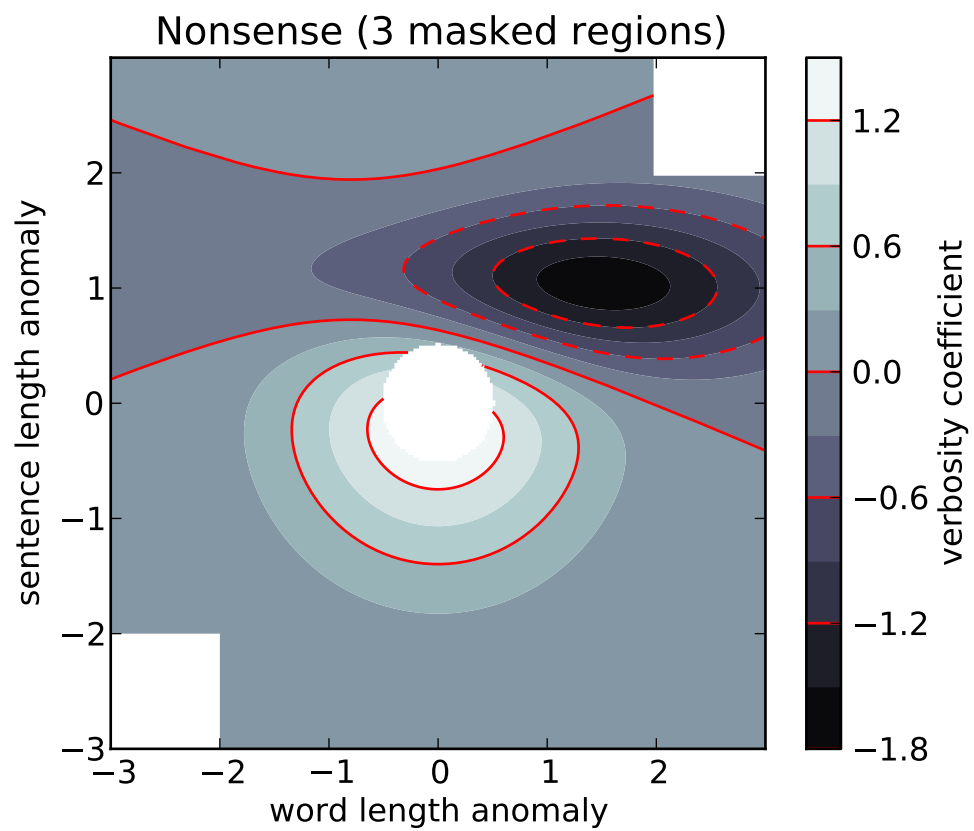
**Examples:**



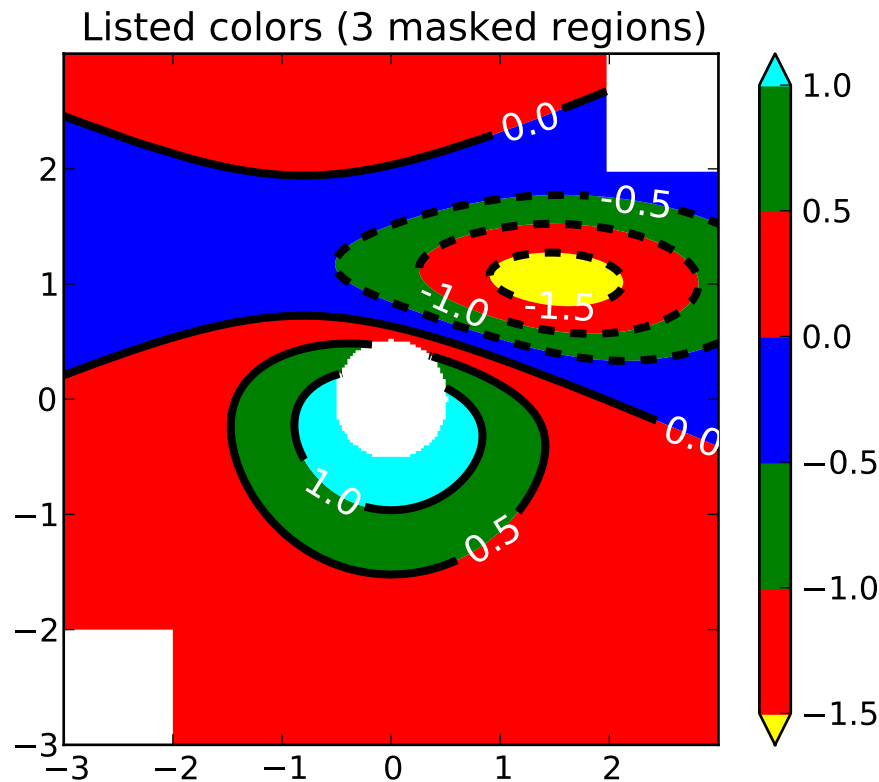












**csd**(*x*, *y*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, **\*\*kwargs**)  
 call signature:

```
csd(x, y, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
    window=mlab.window_hanning, noverlap=0, pad_to=None,
    sides='default', scale_by_freq=None, **kwargs)
```

The cross spectral density  $P_{xy}$  by Welch's average periodogram method. The vectors *x* and *y* are divided into *NFFT* length segments. Each segment is detrended by function *detrend* and windowed by function *window*. The product of the direct FFTs of *x* and *y* are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

Returns the tuple (*Pxy*, *freqs*). *P* is the cross spectrum (complex valued), and  $10 \log_{10} |P_{xy}|$  is plotted.

Keyword arguments:

**NFFT: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**Fs: scalar** The sampling frequency (samples per time unit). It is used to calculate the

Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before *fft*-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the *psd* (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*.

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

***Fc*: integer** The center frequency of *x* (defaults to 0), which offsets the *x* extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**References:** Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

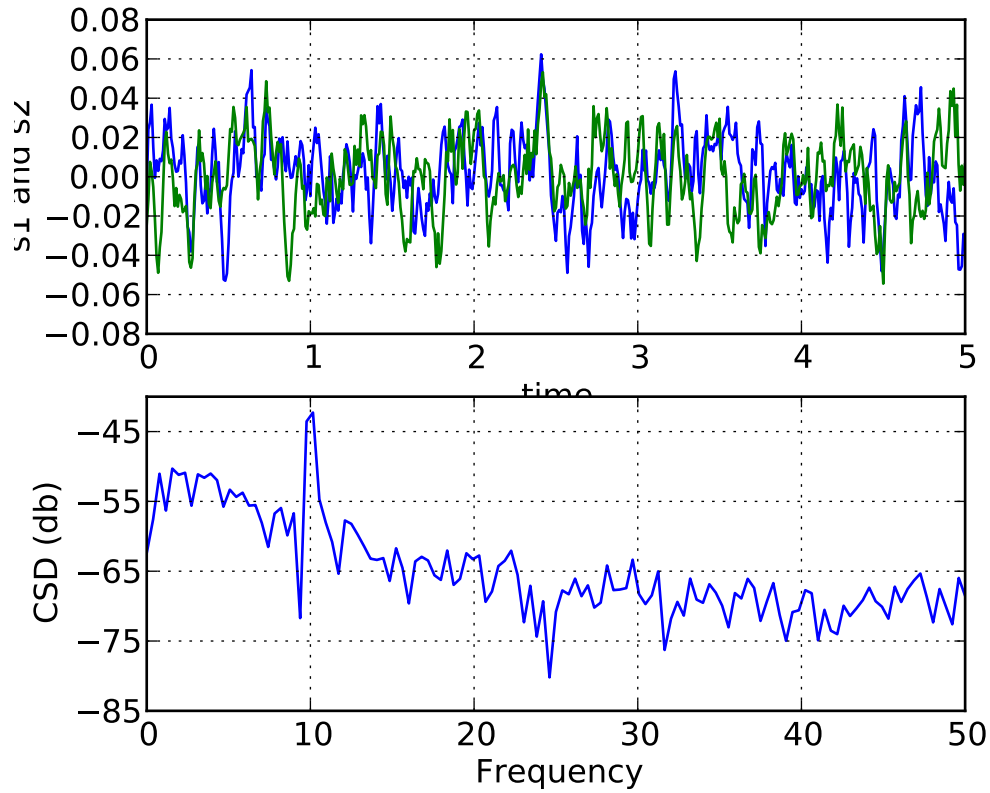
kwargs control the *Line2D* properties:

| Property                                    | Description                                |
|---|--|
| <code>agg_filter</code>                     | unknown                                    |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque) |
| <code>animated</code>                       | [True   False]                             |
| <code>antialiased</code> or <code>aa</code> | [True   False]                             |
| <code>axes</code>                           | an <i>Axes</i> instance                    |

Table 45.7 – continu

|  |  |
|--|--|
| <code>clip_box</code>                                  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]                     |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance  |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |
| <code>xdata</code>                                     | 1D array   |
| <code>ydata</code>                                     | 1D array   |
| <code>zorder</code>                                    | any number   |

**Example:**



**disconnect**(*cid*)

disconnect from the Axes event.

**drag\_pan**(*button*, *key*, *x*, *y*)

Called when the mouse moves during a pan operation.

*button* is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

*key* is a “shift” key

*x*, *y* are the mouse coordinates in display coords.

**Note:** Intended to be overridden by new projection types.

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

Draw everything (plot lines, axes, labels)

**draw\_artist**(*a*)

This method can only be used after an initial draw which caches the renderer. It is used to efficiently update Axes data (axis ticks, labels, etc are not updated)

**end\_pan()**

Called when a pan operation completes (when the mouse button is up.)

**Note:** Intended to be overridden by new projection types.

**errorbar**(*x*, *y*, *yerr*=None, *xerr*=None, *fmt*='-', *ecolor*=None, *elinewidth*=None, *capsize*=3, *barsabove*=False, *lolims*=False, *uplims*=False, *xlolims*=False, *xuplims*=False, **\*\*kwargs**)  
call signature:

```
errorbar(x, y, yerr=None, xerr=None,
         fmt='-', ecolor=None, elinewidth=None, capsize=3,
         barsabove=False, lolims=False, uplims=False,
         xlolims=False, xuplims=False)
```

Plot *x* versus *y* with error deltas in *yerr* and *xerr*. Vertical errorbars are plotted if *yerr* is not None. Horizontal errorbars are plotted if *xerr* is not None.

*x*, *y*, *xerr*, and *yerr* can all be scalars, which plots a single error bar at *x*, *y*.

Optional keyword arguments:

***xerr/yerr***: [ scalar | N, Nx1, or 2xN array-like ] If a scalar number, len(N) array-like object, or an Nx1 array-like object, errorbars are drawn +/- value.

If a sequence of shape 2xN, errorbars are drawn at -row1 and +row2

***fmt***: '-' The plot format symbol. If *fmt* is None, only the errorbars are plotted. This is used for adding errorbars to a bar plot, for example.

***ecolor***: [ None | mpl color ] a matplotlib color arg which gives the color the errorbar lines; if None, use the marker color.

***elinewidth***: scalar the linewidth of the errorbar lines. If None, use the linewidth.

***capsize***: scalar the size of the error bar caps in points

***barsabove***: [ True | False ] if True, will plot the errorbars above the plot symbols. Default is below.

***lolims/uplims/xlolims/xuplims***: [ False | True ] These arguments can be used to indicate that a value gives only upper/lower limits. In that case a caret symbol is used to indicate this. lims-arguments may be of the same type as *xerr* and *yerr*.

All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)
errorbar(x, y, yerr, marker='s',
         mfc='red', mec='green', ms=20, mew=4)
```

where *mfc*, *mec*, *ms* and *mew* are aliases for the longer property names, *markerfacecolor*, *markeredgecolor*, *markersize* and *markeredgewidth*.

valid kwargs for the marker properties are

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance  |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

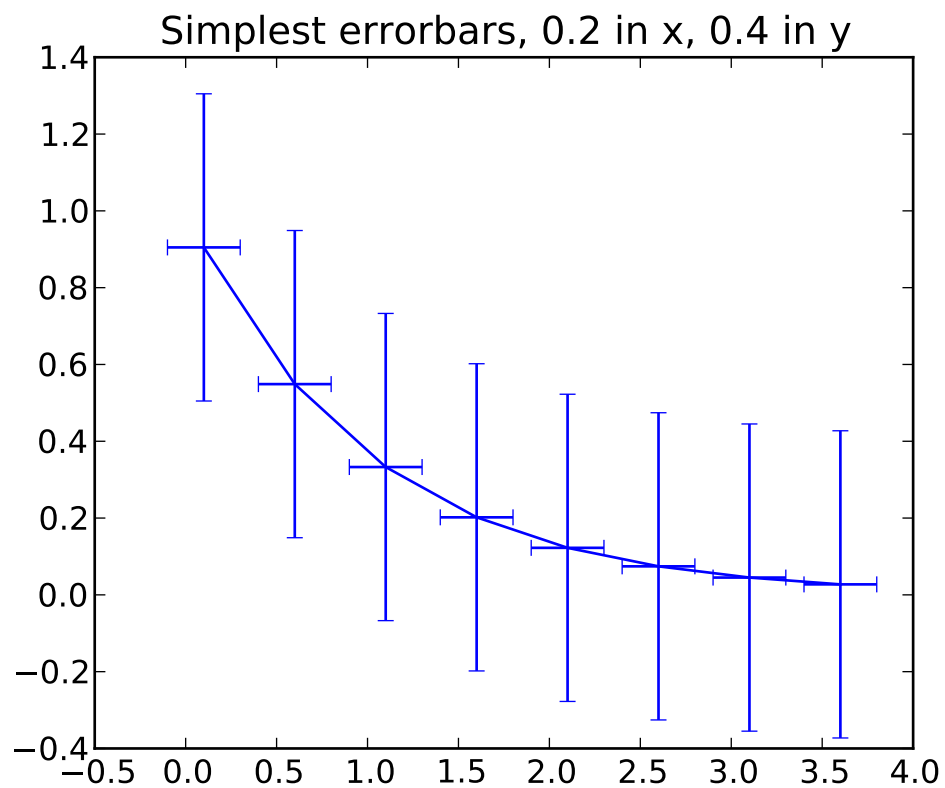
Returns (*plotline*, *caplines*, *barlinecols*):

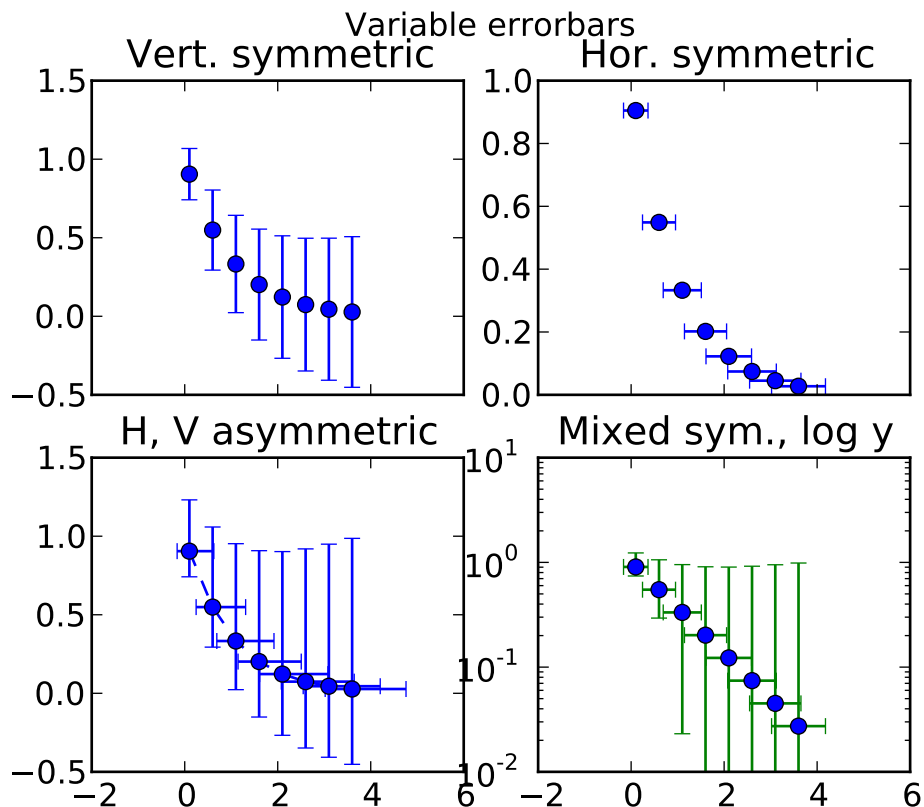
*plotline*: [Line2D](#) instance  $x$ ,  $y$  plot markers and/or line

*caplines*: list of error bar cap [Line2D](#) instances

*barlinecols*: list of [LineCollection](#) instances for the horizontal and vertical error ranges.

**Example:**





**fill**(\*args, \*\*kwargs)

call signature:

`fill(*args, **kwargs)`

Plot filled polygons. *args* is a variable length argument, allowing for multiple *x*, *y* pairs with an optional color format string; see `plot()` for details on the argument parsing. For example, to plot a polygon with vertices at *x*, *y* in blue.:

```
ax.fill(x,y, 'b' )
```

An arbitrary number of *x*, *y*, *color* groups can be specified:

```
ax.fill(x1, y1, 'g', x2, y2, 'r')
```

Return value is a list of `Patch` instances that were added.

The same color strings that `plot()` supports are supported by the fill format string.

If you would like to fill below a curve, eg. shade a region between 0 and *y* along *x*, use `fill_between()`

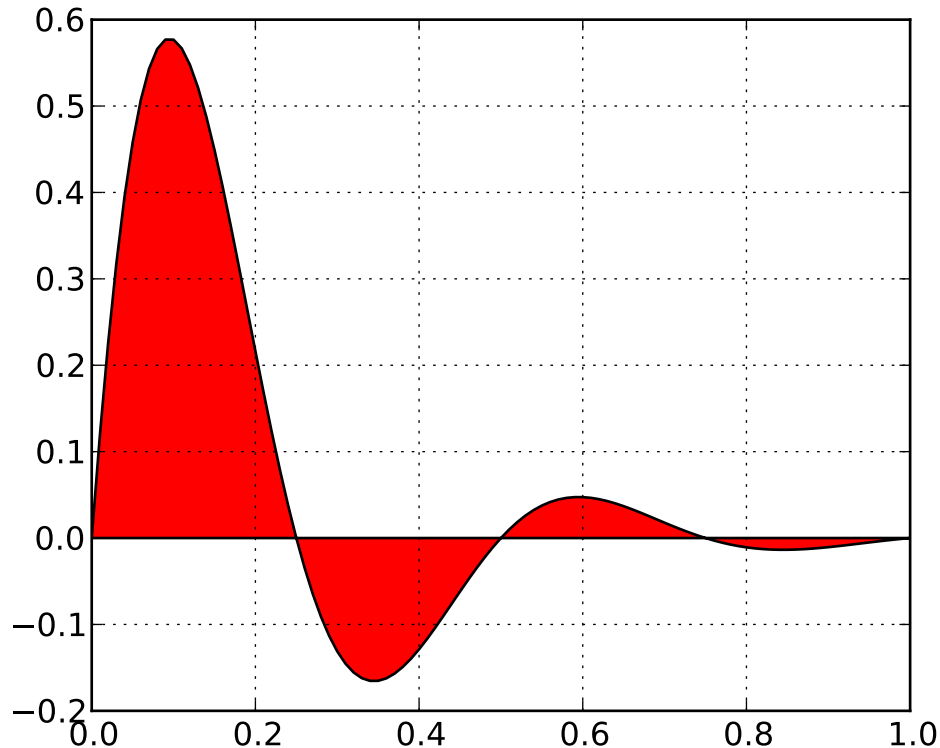
The *closed* kwarg will close the polygon when *True* (default).

kwargs control the Polygon properties:



| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:**



**fill\_between**(*x*, *y1*, *y2*=0, *where*=None, *interpolate*=False, *\*\*kwargs*)

call signature:

`fill_between(x, y1, y2=0, where=None, **kwargs)`

Create a [PolyCollection](#) filling the regions between *y1* and *y2* where *where*==True

*x* an N length np array of the x data

*y1* an N length scalar or np array of the y data

*y2* an N length scalar or np array of the y data

**where** if None, default to fill between everywhere. If not None, it is a N length numpy boolean array and the fill will only happen over the regions where *where*==True

**interpolate** If True, interpolate between the two lines to find the precise point of intersection. Otherwise, the start and end points of the filled region will only occur on explicit values in the *x* array.

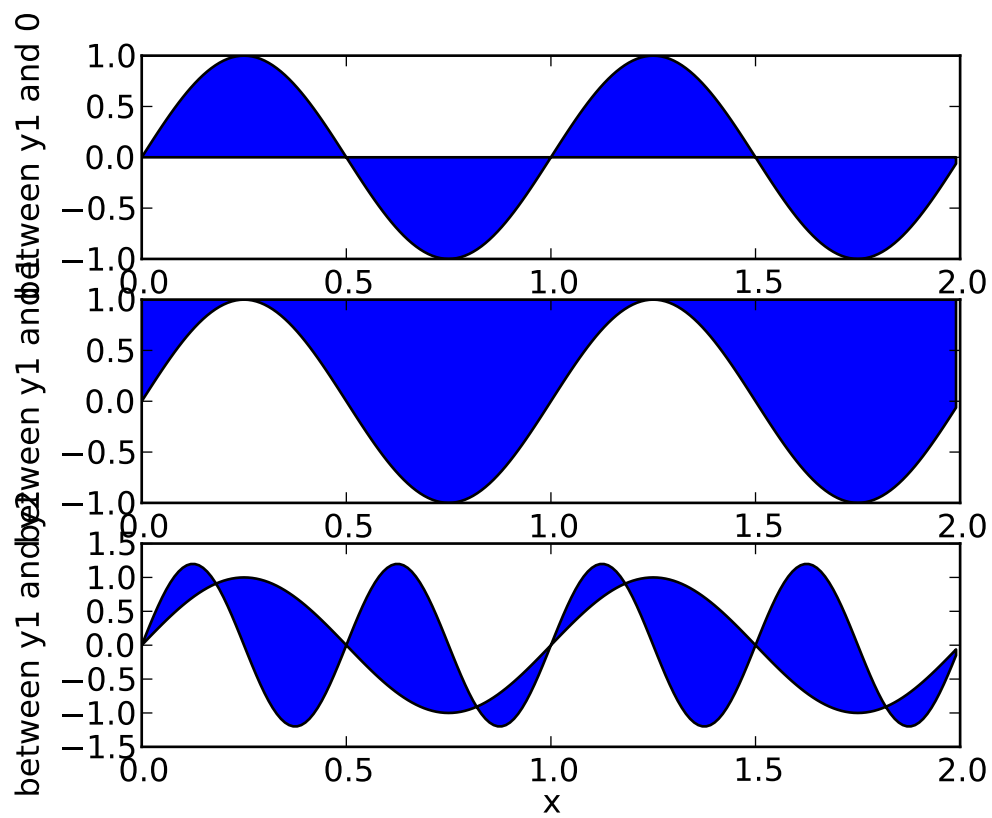
**kwargs** keyword args passed on to the PolyCollection

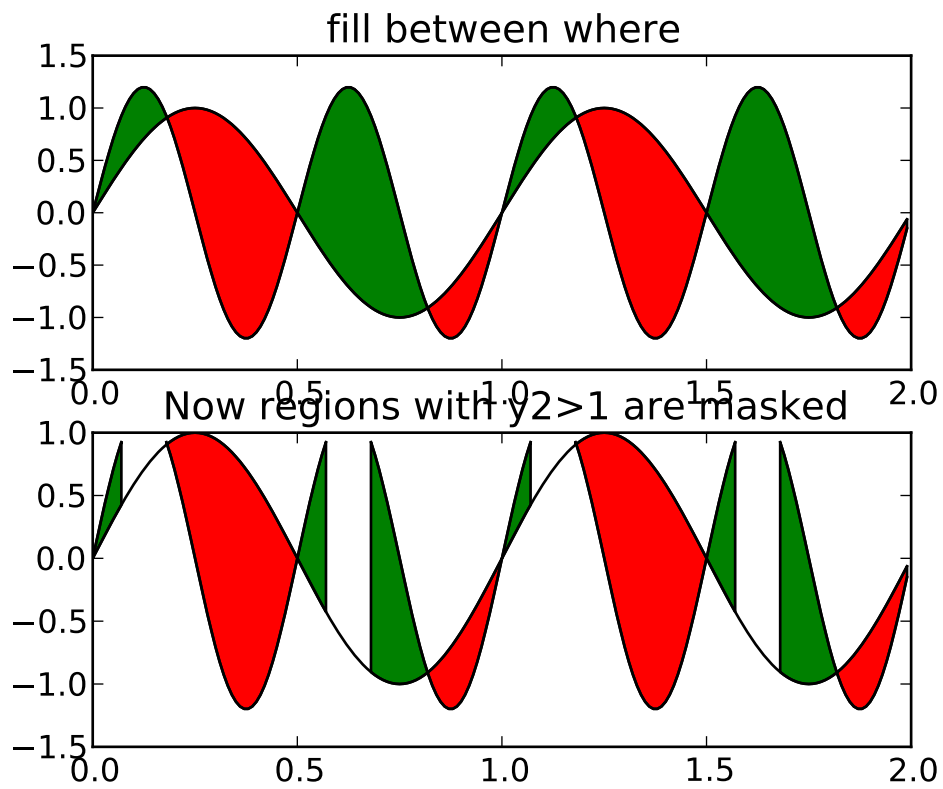
kwargs control the Polygon properties:

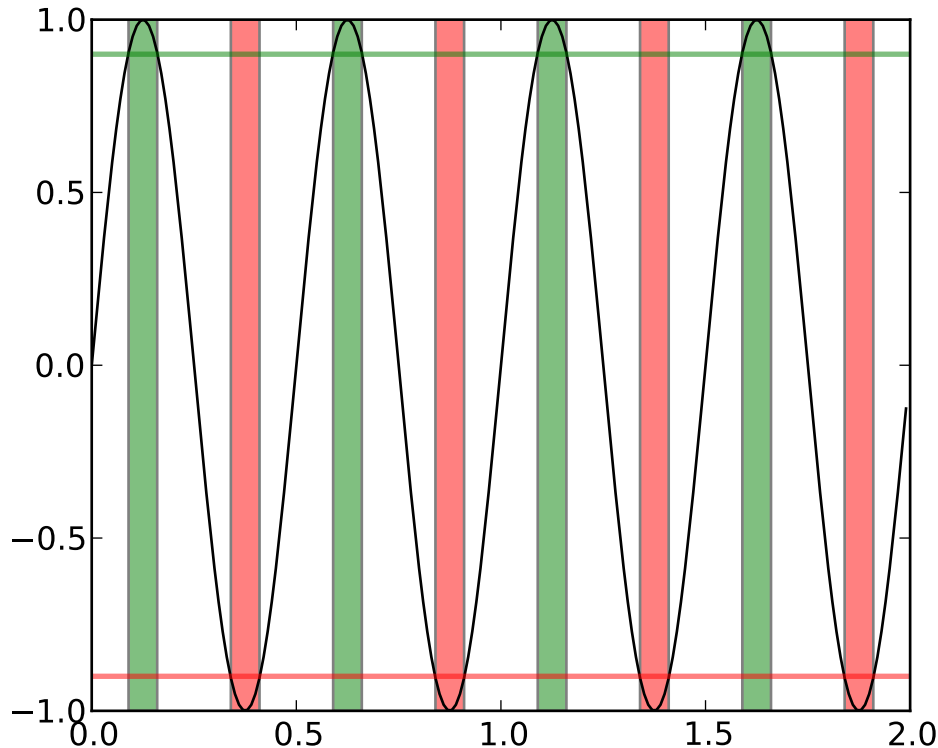
| Property               | Description |
|------------------------|-------------|
| Continued on next page |             |

Table 45.9 – continued from previous page

|  |  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float or None  |
| <code>animated</code>  | [True   False]   |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans  |
| <code>array</code>   | unknown  |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>clim</code>  | a length 2 sequence of floats  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>cmap</code>  | a colormap or registered colormap name   |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                                |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]        |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>snap</code>  | unknown  |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>urls</code>  | unknown  |
| <code>visible</code>   | [True   False]   |
| <code>zorder</code>  | any number   |







See Also:

[fill\\_betweenx\(\)](#) for filling between two sets of x-values

**fill\_betweenx**(y, x1, x2=0, where=None, \*\*kwargs)  
call signature:

fill\_between(y, x1, x2=0, where=None, \*\*kwargs)

Create a [PolyCollection](#) filling the regions between *x1* and *x2* where *where*==True

*y* an N length np array of the y data

*x1* an N length scalar or np array of the x data

*x2* an N length scalar or np array of the x data

**where** if None, default to fill between everywhere. If not None, it is a N length numpy boolean array and the fill will only happen over the regions where *where*==True

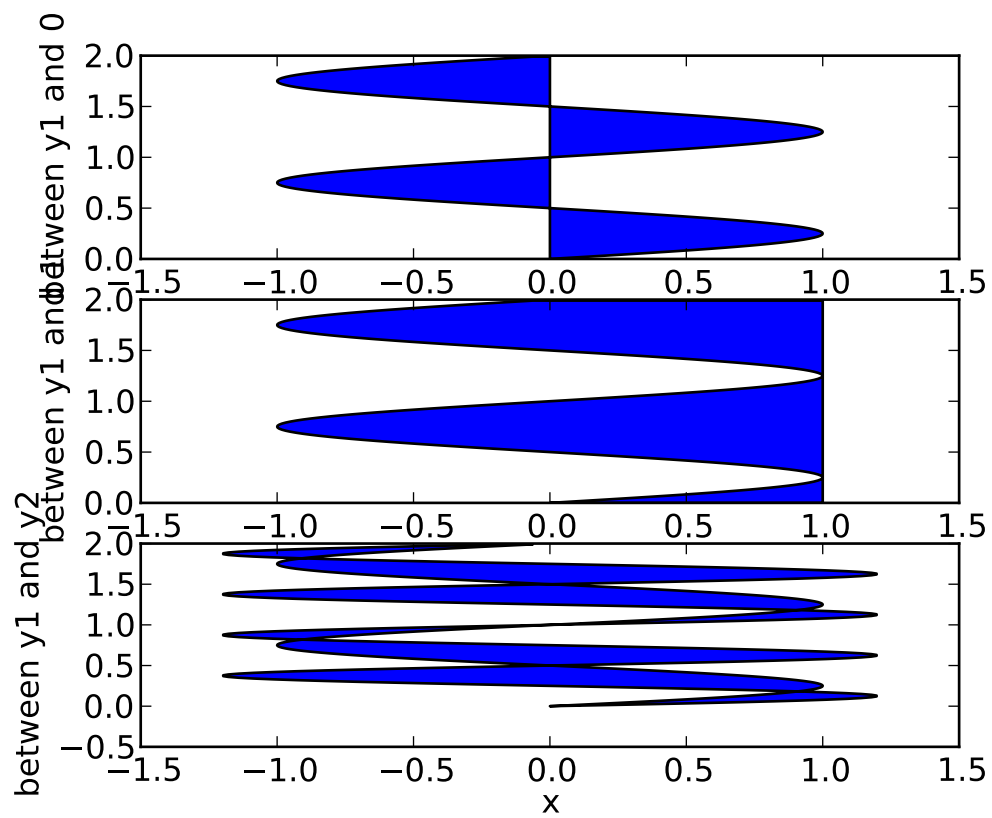
**kwargs** keyword args passed on to the PolyCollection

kwargs control the Polygon properties:

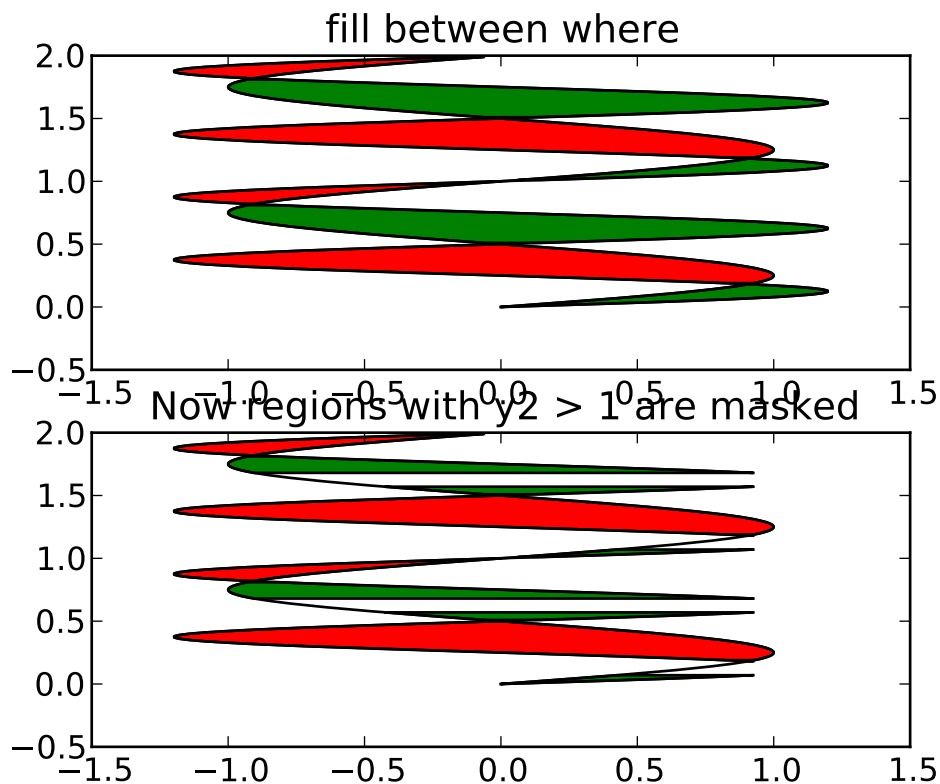
| Property               | Description |
|------------------------|-------------|
| Continued on next page |             |

Table 45.10 – continued from previous page

|  |  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float or None  |
| <code>animated</code>  | [True   False]   |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans  |
| <code>array</code>   | unknown  |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>clim</code>  | a length 2 sequence of floats  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>cmap</code>  | a colormap or registered colormap name   |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                                |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]        |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>snap</code>  | unknown  |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>urls</code>  | unknown  |
| <code>visible</code>   | [True   False]   |
| <code>zorder</code>  | any number   |







See Also:

[`fill\_between\(\)`](#) for filling between two sets of y-values

**`format_coord(x, y)`**

return a format string formatting the  $x$ ,  $y$  coord

**`format_xdata(x)`**

Return  $x$  string formatted. This function will use the attribute `self.fmt_xdata` if it is callable, else will fall back on the xaxis major formatter

**`format_ydata(y)`**

Return  $y$  string formatted. This function will use the `fmt_ydata` attribute if it is callable, else will fall back on the yaxis major formatter

**`frame`**

**`get_adjustable()`**

**`get_anchor()`**

**`get_aspect()`**

**`get_autoscale_on()`**

Get whether autoscaling is applied for both axes on plot commands

**get\_autoscalex\_on()**

Get whether autoscaling for the x-axis is applied on plot commands

**get\_autoscaley\_on()**

Get whether autoscaling for the y-axis is applied on plot commands

**get\_axes\_locator()**

return axes\_locator

**get\_axis\_bgcolor()**

Return the axis background color

**get\_axisbelow()**

Get whether axis below is true or not

**get\_child\_artists()**

Return a list of artists the axes contains. Deprecated since version 0.98.

**get\_children()**

return a list of child artists

**get\_cursor\_props()**

return the cursor properties as a (*linewidth*, *color*) tuple, where *linewidth* is a float and *color* is an RGBA tuple

**get\_data\_ratio()**

Returns the aspect ratio of the raw data.

This method is intended to be overridden by new projection types.

**get\_data\_ratio\_log()**

Returns the aspect ratio of the raw data in log scale. Will be used when both axis scales are in log.

**get\_frame()**

Return the axes Rectangle frame

**get\_frame\_on()**

Get whether the axes rectangle patch is drawn

**get\_images()**

return a list of Axes images contained by the Axes

**get\_legend()**

Return the legend. Legend instance, or None if no legend is defined

**get\_legend\_handles\_labels(*legend\_handler\_map=None*)**

return handles and labels for legend

ax.legend() is equivalent to

```
h, l = ax.get_legend_handles_labels()
ax.legend(h, l)
```

**get\_lines()**

Return a list of lines contained by the Axes

**get\_navigate()**

Get whether the axes responds to navigation commands

**get\_navigate\_mode()**

Get the navigation toolbar button status: 'PAN', 'ZOOM', or None

**get\_position(*original=False*)**

Return the a copy of the axes rectangle as a Bbox

**get\_rasterization\_zorder()**

Get zorder value below which artists will be rasterized

**get\_renderer\_cache()****get\_shared\_x\_axes()**

Return a copy of the shared axes Grouper object for x axes

**get\_shared\_y\_axes()**

Return a copy of the shared axes Grouper object for y axes

**get\_tightbbox(*renderer, call\_axes\_locator=True*)**

return the tight bounding box of the axes. The dimension of the Bbox in canvas coordinate.

If *call\_axes\_locator* is False, it does not call the *\_axes\_locator* attribute, which is necessary to get the correct bounding box. *call\_axes\_locator==False* can be used if the caller is only interested in the relative size of the tightbbox compared to the axes bbox.

**get\_title()**

Get the title text string.

**get\_window\_extent(\**args*, \*\**kwargs*)**

get the axes bounding box in display space; *args* and *kwargs* are empty

**get\_xaxis()**

Return the XAxis instance

**get\_xaxis\_text1\_transform(*pad\_points*)**

Get the transformation used for drawing x-axis labels, which will add the given amount of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates. Returns a 3-tuple of the form:

(transform, valign, halign)

where *valign* and *halign* are requested alignments for the text.

**Note:** This transformation is primarily used by the [Axis](#) class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_xaxis\_text2\_transform(*pad\_points*)**

Get the transformation used for drawing the secondary x-axis labels, which will add the given amount of padding (in points) between the axes and the label. The x-direction is in data coordinates and the y-direction is in axis coordinates. Returns a 3-tuple of the form:

(transform, valign, halign)

where *valign* and *halign* are requested alignments for the text.

**Note:** This transformation is primarily used by the `Axis` class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_xaxis\_transform**(*which='grid'*)

Get the transformation used for drawing x-axis labels, ticks and gridlines. The x-direction is in data coordinates and the y-direction is in axis coordinates.

**Note:** This transformation is primarily used by the `Axis` class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_xbound**()

Returns the x-axis numerical bounds where:

`lowerBound < upperBound`

**get\_xgridlines**()

Get the x grid lines as a list of `Line2D` instances

**get\_xlabel**()

Get the xlabel text string.

**get\_xlim**()

Get the x-axis range [*left*, *right*]

**get\_xmajorticklabels**()

Get the xtick labels as a list of `Text` instances

**get\_xminorticklabels**()

Get the xtick labels as a list of `Text` instances

**get\_xscale**()

**get\_xticklabels**(*minor=False*)

Get the xtick labels as a list of `Text` instances

**get\_xticklines**()

Get the xtick lines as a list of `Line2D` instances

**get\_xticks**(*minor=False*)

Return the x ticks as a list of locations

**get\_yaxis**()

Return the `YAxis` instance

**get\_yaxis\_text1\_transform**(*pad\_points*)

Get the transformation used for drawing y-axis labels, which will add the given amount of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates. Returns a 3-tuple of the form:

(*transform*, *valign*, *halign*)

where *valign* and *halign* are requested alignments for the text.

**Note:** This transformation is primarily used by the [Axis](#) class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_yaxis\_text2\_transform**(*pad\_points*)

Get the transformation used for drawing the secondary y-axis labels, which will add the given amount of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates. Returns a 3-tuple of the form:

(transform, valign, halign)

where *valign* and *halign* are requested alignments for the text.

**Note:** This transformation is primarily used by the [Axis](#) class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_yaxis\_transform**(*which='grid'*)

Get the transformation used for drawing y-axis labels, ticks and gridlines. The x-direction is in axis coordinates and the y-direction is in data coordinates.

**Note:** This transformation is primarily used by the [Axis](#) class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

**get\_ybound**()

Return y-axis numerical bounds in the form of lowerBound < upperBound

**get\_ygridlines**()

Get the y grid lines as a list of Line2D instances

**get\_ylabel**()

Get the ylabel text string.

**get\_ylim**()

Get the y-axis range [*bottom*, *top*]

**get\_ymajorticklabels**()

Get the xtick labels as a list of Text instances

**get\_yminorticklabels**()

Get the xtick labels as a list of Text instances

**get\_yscale**()

**get\_yticklabels**(*minor=False*)

Get the xtick labels as a list of Text instances

**get\_yticklines**()

Get the ytick lines as a list of Line2D instances

**get\_yticks**(*minor=False*)

Return the y ticks as a list of locations

**grid**(*b=None*, *which='major'*, *axis='both'*, *\*\*kwargs*)

call signature:

```
grid(self, b=None, which='major', axis='both', **kwargs)
```

Set the axes grids on or off; *b* is a boolean. (For MATLAB compatibility, *b* may also be a string, 'on' or 'off'.)

If *b* is *None* and `len(kwargs)==0`, toggle the grid state. If *kwargs* are supplied, it is assumed that you want a grid and *b* is thus set to *True*.

*which* can be 'major' (default), 'minor', or 'both' to control whether major tick grids, minor tick grids, or both are affected.

*axis* can be 'both' (default), 'x', or 'y' to control which set of gridlines are drawn.

*kwargs* are used to set the grid line properties, eg:

```
ax.grid(color='r', linestyle='-', linewidth=2)
```

Valid [Line2D](#) kwargs are

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ''   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |

Table 45.11 – continu

|                              |   |
|------------------------------|---|
| <code>markevery</code>       | None   integer   (startind, stride)   |
| <code>picker</code>          | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>      | float distance in points  |
| <code>rasterized</code>      | [True   False   None]   |
| <code>snap</code>            | unknown   |
| <code>solid_capstyle</code>  | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code> | ['miter'   'round'   'bevel']   |
| <code>transform</code>       | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>             | a url string  |
| <code>visible</code>         | [True   False]  |
| <code>xdata</code>           | 1D array  |
| <code>ydata</code>           | 1D array  |
| <code>zorder</code>          | any number  |

**has\_data()**

Return *True* if any artists have been added to axes.

This should not be used to determine whether the *dataLim* need to be updated, and may not actually be useful for anything.

**hexbin**(*x*, *y*, *C*=None, *gridsize*=100, *bins*=None, *xscale*='linear', *yscale*='linear', *extent*=None, *cmap*=None, *norm*=None, *vmin*=None, *vmax*=None, *alpha*=None, *linewidths*=None, *edgecolors*='none', *reduce\_C\_function*=<function mean at 0x23ea758>, *mincnt*=None, *marginals*=False, *\*\*kwargs*)  
call signature:

```
hexbin(x, y, C = None, gridsize = 100, bins = None,
       xscale = 'linear', yscale = 'linear',
       cmap=None, norm=None, vmin=None, vmax=None,
       alpha=None, linewidths=None, edgecolors='none'
       reduce_C_function = np.mean, mincnt=None, marginals=True
       **kwargs)
```

Make a hexagonal binning plot of *x* versus *y*, where *x*, *y* are 1-D sequences of the same length, *N*. If *C* is None (the default), this is a histogram of the number of occurrences of the observations at (*x*[*i*],*y*[*i*]).

If *C* is specified, it specifies values at the coordinate (*x*[*i*],*y*[*i*]). These values are accumulated for each hexagonal bin and then reduced according to *reduce\_C\_function*, which defaults to numpy's mean function (`np.mean`). (If *C* is specified, it must also be a 1-D sequence of the same length as *x* and *y*.)

*x*, *y* and/or *C* may be masked arrays, in which case only unmasked points will be plotted.

Optional keyword arguments:

**gridsize:** [ 100 | integer ] The number of hexagons in the *x*-direction, default is 100. The corresponding number of hexagons in the *y*-direction is chosen such that the hexagons are

approximately regular. Alternatively, `gridsize` can be a tuple with two elements specifying the number of hexagons in the  $x$ -direction and the  $y$ -direction.

**`bins`:** [ **None** | **'log'** | **integer** | **sequence** ] If *None*, no binning is applied; the color of each hexagon directly corresponds to its count value.

If **'log'**, use a logarithmic scale for the color map. Internally,  $\log_{10}(i+1)$  is used to determine the hexagon color.

If an integer, divide the counts in the specified number of bins, and color the hexagons accordingly.

If a sequence of values, the values of the lower bound of the bins to be used.

**`xscale`:** [ **'linear'** | **'log'** ] Use a linear or log10 scale on the horizontal axis.

**`yscale`:** [ **'linear'** | **'log'** ] Use a linear or log10 scale on the vertical axis.

**`mincnt`:** **None** | **a positive integer** If not *None*, only display cells with more than *mincnt* number of points in the cell

**`marginals`:** **True|False** if `marginals` is *True*, plot the marginal density as colormapped rectangles along the bottom of the  $x$ -axis and left of the  $y$ -axis

**`extent`:** [ **None** | **scalars (left, right, bottom, top)** ] The limits of the bins. The default assigns the limits based on `gridsize`,  $x$ ,  $y$ , `xscale` and `yscale`.

Other keyword arguments controlling color mapping and normalization arguments:

**`cmap`:** [ **None** | **Colormap** ] a `matplotlib.cm.Colormap` instance. If *None*, defaults to `rc.image.cmap`.

**`norm`:** [ **None** | **Normalize** ] `matplotlib.colors.Normalize` instance is used to scale luminance data to 0,1.

**`vmin/vmax`:** **scalar** *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. Note if you pass a *norm* instance, your settings for *vmin* and *vmax* will be ignored.

**`alpha`:** **scalar between 0 and 1, or None** the alpha value for the patches

**`linewidths`:** [ **None** | **scalar** ] If *None*, defaults to `rc.lines.linewidth`. Note that this is a tuple, and if you set the `linewidths` argument you must set it as a sequence of floats, as required by `RegularPolyCollection`.

Other keyword arguments controlling the `Collection` properties:

**`edgecolors`:** [ **None** | **mpl color** | **color sequence** ] If *'none'*, draws the edges in the same color as the fill color. This is the default, as it avoids unsightly unpainted pixels between the hexagons.

If *None*, draws the outlines in the default color.

If a matplotlib color arg or sequence of rgba tuples, draws the outlines in the specified color.

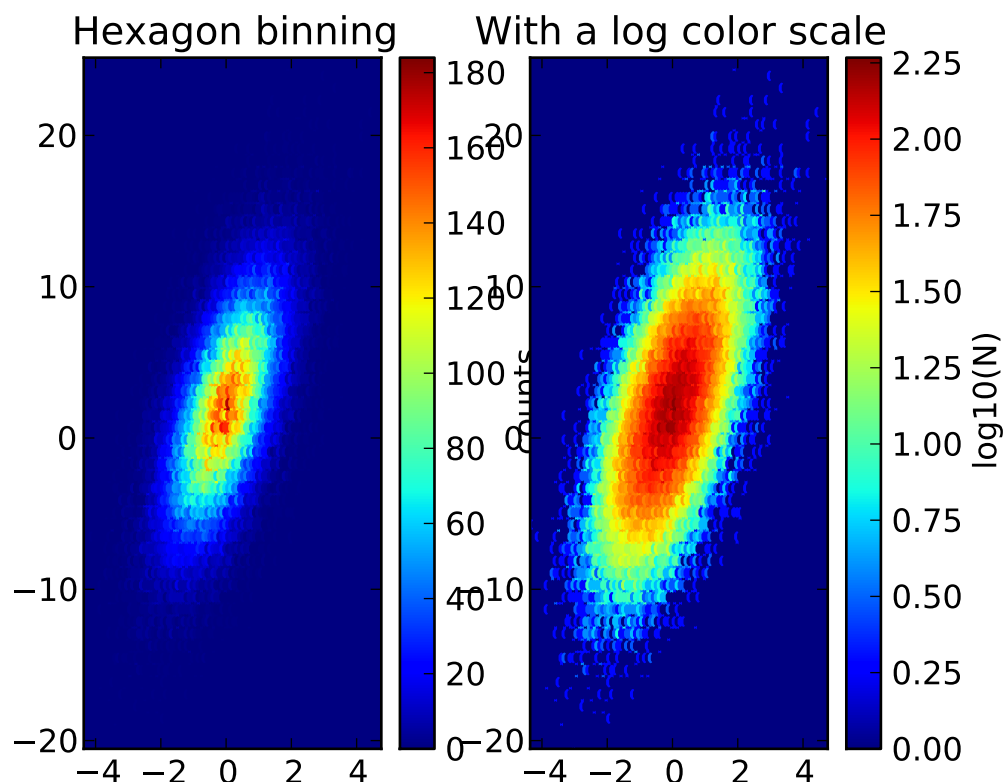
Here are the standard descriptions of all the `Collection` kwargs:



| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [True   False   None]   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [True   False]  |
| <code>zorder</code>  | any number  |

The return value is a `PolyCollection` instance; use `get_array()` on this `PolyCollection` to get the counts in each hexagon. If `marginals` is True, horizontal bar and vertical bar (both `PolyCollections`) will be attached to the return collection as attributes `hbar` and `vbar`

**Example:**



**hist**(*x*, *bins*=10, *range*=None, *normed*=False, *weights*=None, *cumulative*=False, *bottom*=None, *histtype*='bar', *align*='mid', *orientation*='vertical', *rwidth*=None, *log*=False, *color*=None, *label*=None, *\*\*kwargs*)  
 call signature:

```
def hist(x, bins=10, range=None, normed=False, weights=None,
        cumulative=False, bottom=None, histtype='bar', align='mid',
        orientation='vertical', rwidth=None, log=False,
        color=None, label=None,
        **kwargs):
```

Compute and draw the histogram of *x*. The return value is a tuple (*n*, *bins*, *patches*) or (*[n0, n1, ...]*, *bins*, *[patches0, patches1, ...]*) if the input contains multiple data.

Multiple data can be provided via *x* as a list of datasets of potentially different length (*[x0, x1, ...]*), or as a 2-D ndarray in which each column is a dataset. Note that the ndarray form is transposed relative to the list form.

Masked arrays are not supported at present.

Keyword arguments:

***bins***: Either an integer number of bins or a sequence giving the bins. If *bins* is an integer, *bins* + 1 bin edges will be returned, consistent with `numpy.histogram()` for numpy version  $\geq 1.3$ , and with the *new* = True argument in earlier versions. Unequally spaced bins are supported if *bins* is a sequence.

**range:** The lower and upper range of the bins. Lower and upper outliers are ignored. If not provided, *range* is (x.min(), x.max()). Range has no effect if *bins* is a sequence.

If *bins* is a sequence or *range* is specified, autoscaling is based on the specified bin range instead of the range of *x*.

**normed:** If *True*, the first element of the return tuple will be the counts normalized to form a probability density, i.e.,  $n/(\text{len}(x)*\text{dbin})$ . In a probability density, the integral of the histogram should be 1; you can verify that with a trapezoidal integration of the probability density function:

```
pdf, bins, patches = ax.hist(...)
print np.sum(pdf * np.diff(bins))
```

**Note:** Until numpy release 1.5, the underlying numpy histogram function was incorrect with *normed\*=True* if bin sizes were unequal. MPL inherited that error. It is now corrected within MPL when using earlier numpy versions

**weights** An array of weights, of the same shape as *x*. Each value in *x* only contributes its associated weight towards the bin count (instead of 1). If *normed* is *True*, the weights are normalized, so that the integral of the density over the range remains 1.

**cumulative:** If *True*, then a histogram is computed where each bin gives the counts in that bin plus all bins for smaller values. The last bin gives the total number of datapoints. If *normed* is also *True* then the histogram is normalized such that the last bin equals 1. If *cumulative* evaluates to less than 0 (e.g. -1), the direction of accumulation is reversed. In this case, if *normed* is also *True*, then the histogram is normalized such that the first bin equals 1.

**histtype:** [ 'bar' | 'barstacked' | 'step' | 'stepfilled' ] The type of histogram to draw.

- 'bar' is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- 'barstacked' is a bar-type histogram where multiple data are stacked on top of each other.
- 'step' generates a lineplot that is by default unfilled.
- 'stepfilled' generates a lineplot that is by default filled.

**align:** [ 'left' | 'mid' | 'right' ] Controls how the histogram is plotted.

- 'left': bars are centered on the left bin edges.
- 'mid': bars are centered between the bin edges.
- 'right': bars are centered on the right bin edges.

**orientation:** [ 'horizontal' | 'vertical' ] If 'horizontal', `barh()` will be used for bar-type histograms and the *bottom* kwarg will be the left edges.

**rwidth:** The relative width of the bars as a fraction of the bin width. If *None*, automatically compute the width. Ignored if *histtype* = 'step' or 'stepfilled'.

**log:** If *True*, the histogram axis will be set to a log scale. If *log* is *True* and *x* is a 1D array, empty bins will be filtered out and only the non-empty (*n*, *bins*, *patches*) will be returned.

**color:** Color spec or sequence of color specs, one per dataset. Default (*None*) uses the standard line color sequence.

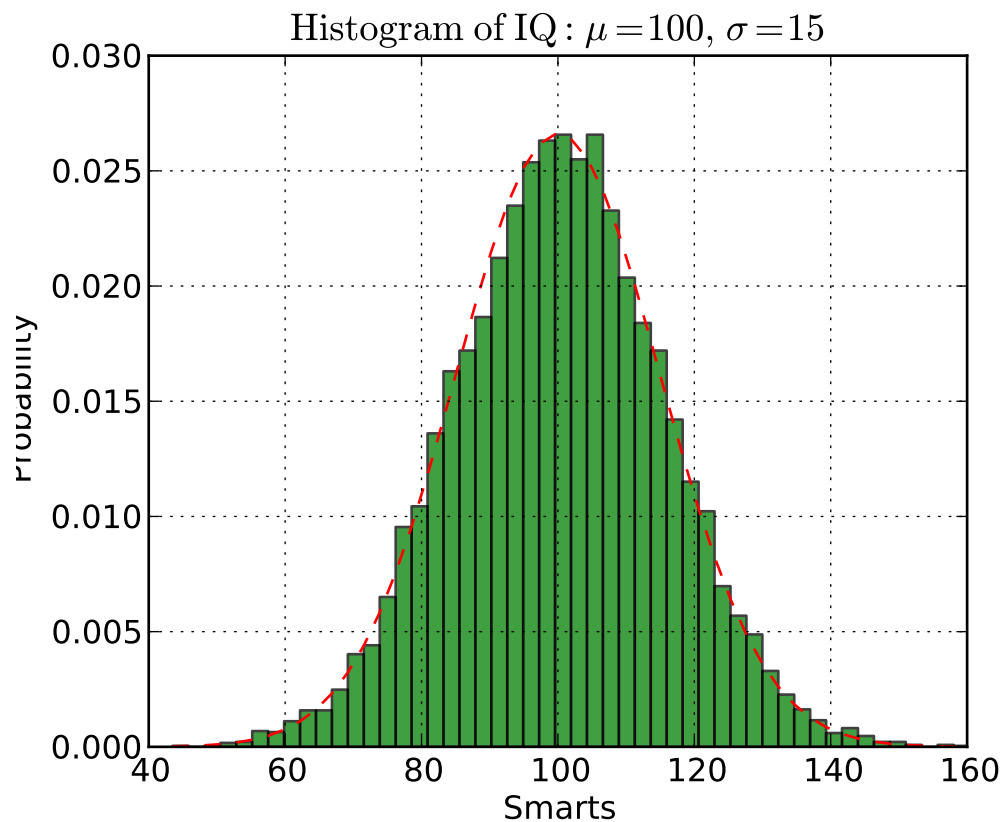
**label:** String, or sequence of strings to match multiple datasets. Bar charts yield multiple patches per dataset, but only the first gets the label, so that the legend command will work as expected:

```
ax.hist(10+2*np.random.randn(1000), label='men')
ax.hist(12+3*np.random.randn(1000), label='women', alpha=0.5)
ax.legend()
```

kwargs are used to update the properties of the [Patch](#) instances returned by *hist*:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**Example:**



**hlines**(*y*, *xmin*, *xmax*, *colors*='k', *linestyles*='solid', *label*='', \*\**kwargs*)  
 call signature:

`hlines(y, xmin, xmax, colors='k', linestyles='solid', **kwargs)`

Plot horizontal lines at each *y* from *xmin* to *xmax*.

Returns the [LineCollection](#) that was added.

Required arguments:

**y:** a 1-D numpy array or iterable.

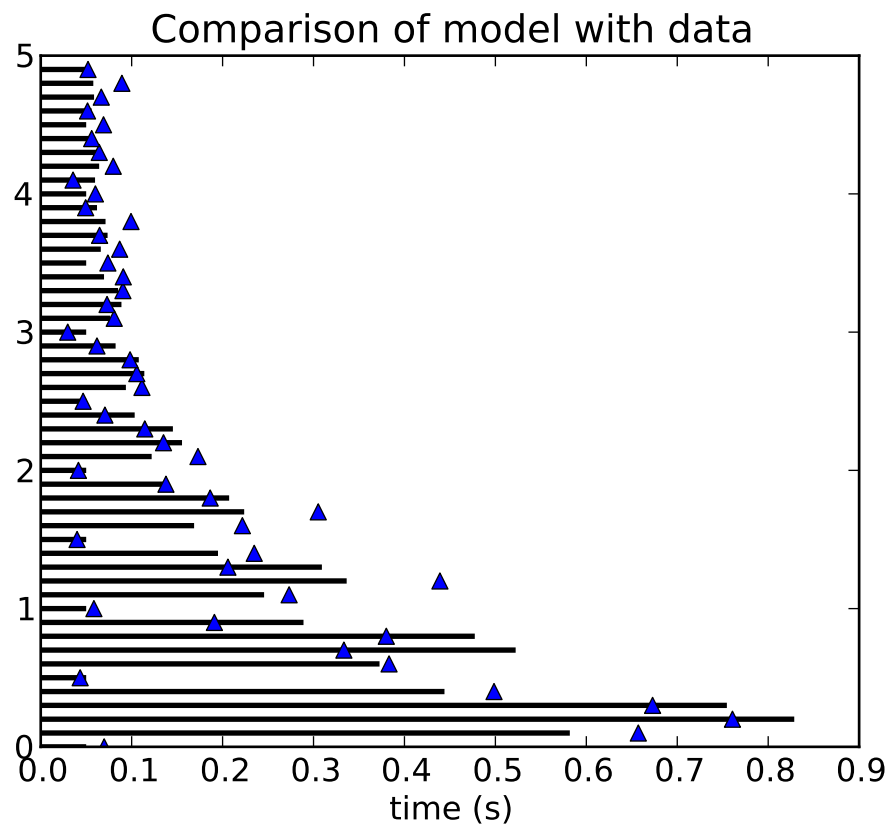
**xmin and xmax:** can be scalars or `len(x)` numpy arrays. If they are scalars, then the respective values are constant, else the widths of the lines are determined by *xmin* and *xmax*.

Optional keyword arguments:

**colors:** a line collections color argument, either a single color or a `len(y)` list of colors

**linestyles:** [ 'solid' | 'dashed' | 'dashdot' | 'dotted' ]

**Example:**



**hold**(*b=None*)

call signature:

**hold**(*b=None*)

Set the hold state. If *hold* is *None* (default), toggle the *hold* state. Else set the *hold* state to boolean value *b*.

Examples:

- toggle hold: `>>> hold()`
- turn hold on: `>>> hold(True)`
- turn hold off `>>> hold(False)`

When hold is True, subsequent plot commands will be added to the current axes. When hold is False, the current axes and figure will be cleared on the next plot command

**imshow**(*X*, *cmap=None*, *norm=None*, *aspect=None*, *interpolation=None*, *alpha=None*, *vmin=None*, *vmax=None*, *origin=None*, *extent=None*, *shape=None*, *filtnorm=1*, *filtrrad=4.0*, *imlim=None*, *resample=None*, *url=None*, *\*\*kwargs*)

call signature:

```
imshow(X, cmap=None, norm=None, aspect=None, interpolation=None,
       alpha=None, vmin=None, vmax=None, origin=None, extent=None,
       **kwargs)
```

Display the image in *X* to current axes. *X* may be a float array, a uint8 array or a PIL image. If *X* is an array, *X* can have the following shapes:

- *M*×*N* – luminance (grayscale, float array only)
- *M*×*N*×3 – RGB (float or uint8 array)
- *M*×*N*×4 – RGBA (float or uint8 array)

The value for each component of *M*×*N*×3 and *M*×*N*×4 float arrays should be in the range 0.0 to 1.0; *M*×*N* float arrays may be normalised.

An `matplotlib.image.AxesImage` instance is returned.

Keyword arguments:

***cmap***: [ **None** | **Colormap** ] A `matplotlib.cm.Colormap` instance, eg. `cm.jet`. If *None*, default to `rc image.cmap` value.

*cmap* is ignored when *X* has RGB(A) information

***aspect***: [ **None** | **'auto'** | **'equal'** | **scalar** ] If **'auto'**, changes the image aspect ratio to match that of the axes

If **'equal'**, and *extent* is *None*, changes the axes aspect ratio to match that of the image. If *extent* is not *None*, the axes aspect ratio is changed to match that of the extent.

If *None*, default to `rc image.aspect` value.

*interpolation*:

Acceptable values are *None*, **'none'**, **'nearest'**, **'bilinear'**, **'bicubic'**, **'spline16'**, **'spline36'**, **'hanning'**, **'hamming'**, **'hermite'**, **'kaiser'**, **'quadric'**, **'catrom'**, **'gaussian'**, **'bessel'**, **'mitchell'**, **'sinc'**, **'lanczos'**

If *interpolation* is *None*, default to `rc image.interpolation`. See also the *filtnorm* and *filterrad* parameters

If *interpolation* is **'none'**, then no interpolation is performed on the Agg, ps and pdf backends. Other backends will fall back to **'nearest'**.

***norm***: [ **None** | **Normalize** ] An `matplotlib.colors.Normalize` instance; if *None*, default is `normalization()`. This scales luminance -> 0-1

*norm* is only used for an *M*×*N* float array.

***vmin/vmax***: [ **None** | **scalar** ] Used to scale a luminance image to 0-1. If either is *None*, the min and max of the luminance values will be used. Note if *norm* is not *None*, the settings for *vmin* and *vmax* will be ignored.

**alpha:** **scalar** The alpha blending value, between 0 (transparent) and 1 (opaque) or *None*

**origin:** [ **None** | **'upper'** | **'lower'** ] Place the [0,0] index of the array in the upper left or lower left corner of the axes. If *None*, default to `rc image.origin`.

**extent:** [ **None** | **scalars (left, right, bottom, top)** ] Data limits for the axes. The default assigns zero-based row, column indices to the *x*, *y* centers of the pixels.

**shape:** [ **None** | **scalars (columns, rows)** ] For raw buffer images

**filtnorm:** A parameter for the antigrain image resize filter. From the antigrain documentation, if *filtnorm* = 1, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule of 1.0 which means that any sum of pixel weights must be equal to 1.0. So, the filter function must produce a graph of the proper shape.

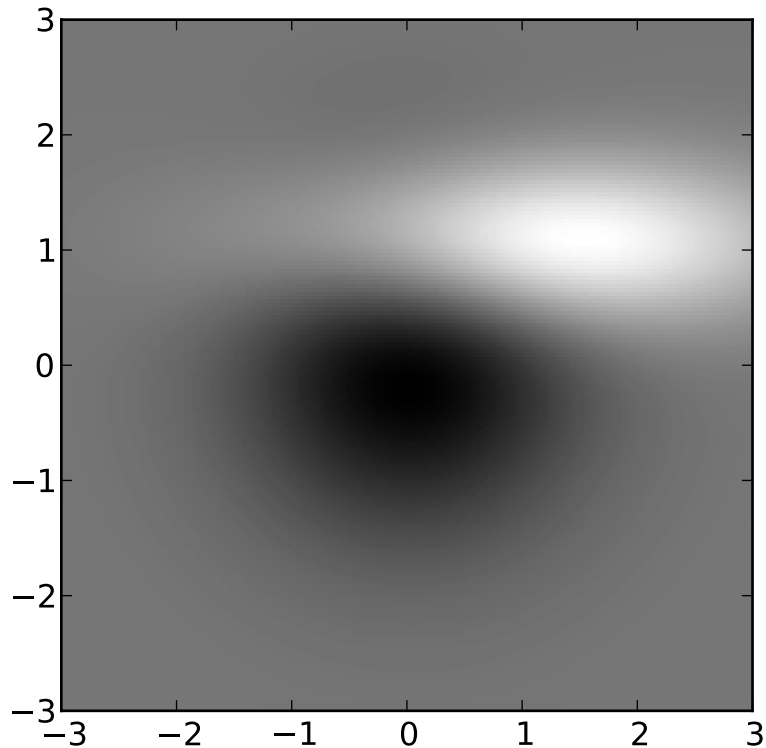
**filterrad:** The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: 'sinc', 'lanczos' or 'blackman'

Additional kwargs are [Artist](#) properties:

| Property                   | Description   |
|----------------------------|---|
| <a href="#">agg_filter</a> | unknown   |
| <a href="#">alpha</a>      | float (0.0 transparent through 1.0 opaque)  |
| <a href="#">animated</a>   | [True   False]  |
| <a href="#">axes</a>       | an <a href="#">Axes</a> instance  |
| <a href="#">clip_box</a>   | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <a href="#">clip_on</a>    | [True   False]  |
| <a href="#">clip_path</a>  | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <a href="#">contains</a>   | a callable function   |
| <a href="#">figure</a>     | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <a href="#">gid</a>        | an id string  |
| <a href="#">label</a>      | any string  |
| <a href="#">lod</a>        | [True   False]  |
| <a href="#">picker</a>     | [None float boolean callable]   |
| <a href="#">rasterized</a> | [True   False   None]   |
| <a href="#">snap</a>       | unknown   |
| <a href="#">transform</a>  | <a href="#">Transform</a> instance  |
| <a href="#">url</a>        | a url string  |
| <a href="#">visible</a>    | [True   False]  |
| <a href="#">zorder</a>     | any number  |

**Example:**





**in\_axes**(*mouseevent*)

return *True* if the given *mouseevent* (in display coords) is in the Axes

**invert\_xaxis**()

Invert the x-axis.

**invert\_yaxis**()

Invert the y-axis.

**ishold**()

return the HOLD status of the axes

**legend**(\*args, \*\*kwargs)

call signature:

`legend(*args, **kwargs)`

Place a legend on the current axes at location *loc*. Labels are a sequence of strings and *loc* can be a string or an integer specifying the legend location.

To make a legend with existing lines:

`legend()`

`legend()` by itself will try and build a legend using the label property of the lines/patches/collections. You can set the label of a line by doing:

```
plot(x, y, label='my data')
```

or:

```
line.set_label('my data').
```

If label is set to `'_nolegend_'`, the item will not be shown in legend.

To automatically generate the legend from labels:

```
legend( ('label1', 'label2', 'label3') )
```

To make a legend for a list of lines and labels:

```
legend( (line1, line2, line3), ('label1', 'label2', 'label3') )
```

To make a legend at a given location, using a location argument:

```
legend( ('label1', 'label2', 'label3'), loc='upper left')
```

or:

```
legend( (line1, line2, line3), ('label1', 'label2', 'label3'), loc=2)
```

The location codes are

| Location String | Location Code |
|-----------------|---------------|
| 'best'          | 0             |
| 'upper right'   | 1             |
| 'upper left'    | 2             |
| 'lower left'    | 3             |
| 'lower right'   | 4             |
| 'right'         | 5             |
| 'center left'   | 6             |
| 'center right'  | 7             |
| 'lower center'  | 8             |
| 'upper center'  | 9             |
| 'center'        | 10            |

Users can specify any arbitrary location for the legend using the *bbox\_to\_anchor* keyword argument. *bbox\_to\_anchor* can be an instance of *BboxBase*(or its derivatives) or a tuple of 2 or 4 floats. For example,

```
loc = 'upper right', bbox_to_anchor = (0.5, 0.5)
```

will place the legend so that the upper right corner of the legend at the center of the axes.

The legend location can be specified in other coordinate, by using the *bbox\_transform* keyword.

The *loc* itself can be a 2-tuple giving x,y of the lower-left corner of the legend in axes coords (*bbox\_to\_anchor* is ignored).

Keyword arguments:

**prop:** [ **None** | **FontProperties** | **dict** ] A `matplotlib.font_manager.FontProperties` instance. If *prop* is a dictionary, a new instance will be created with *prop*. If *None*, use rc settings.

**numpoints:** **integer** The number of points in the legend for line

**scatterpoints:** **integer** The number of points in the legend for scatter plot

**scatteroffsets:** **list of floats** a list of yoffsets for scatter symbols in legend

**markerscale:** [ **None** | **scalar** ] The relative size of legend markers vs. original. If *None*, use rc settings.

**frameon:** [ **True** | **False** ] if *True*, draw a frame around the legend. The default is set by the rcParam ‘legend.frameon’

**fancybox:** [ **None** | **False** | **True** ] if *True*, draw a frame with a round fancybox. If *None*, use rc

**shadow:** [ **None** | **False** | **True** ] If *True*, draw a shadow behind legend. If *None*, use rc settings.

**ncol** [integer] number of columns. default is 1

**mode** [[ “expand” | *None* ]] if mode is “expand”, the legend will be horizontally expanded to fill the axes area (or *bbox\_to\_anchor*)

**bbox\_to\_anchor** [an instance of *BboxBase* or a tuple of 2 or 4 floats] the bbox that the legend will be anchored.

**bbox\_transform** [[ an instance of *Transform* | *None* ]] the transform for the bbox. *transAxes* if *None*.

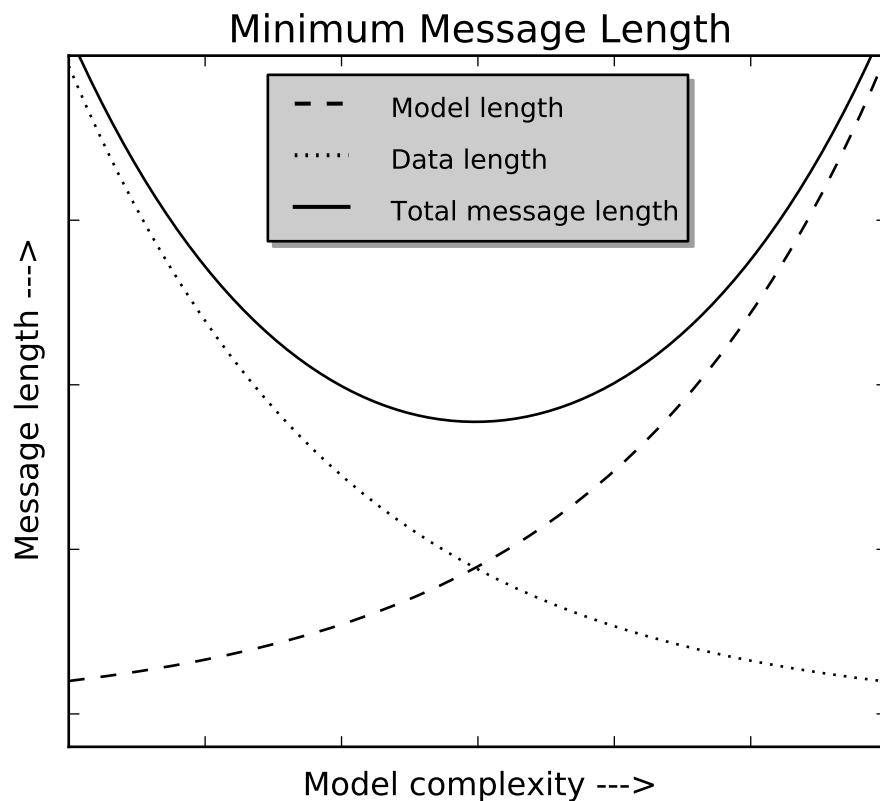
**title** [string] the legend title

Padding and spacing between various elements use following keywords parameters. These values are measure in font-size units. E.g., a fontsize of 10 points and a *handlelength*=5 implies a *handlelength* of 50 points. Values from rcParams will be used if *None*.

| Keyword              | Description  |
|----------------------|--|
| <i>borderpad</i>     | the fractional whitespace inside the legend border |
| <i>labelspacing</i>  | the vertical space between the legend entries      |
| <i>handlelength</i>  | the length of the legend handles                   |
| <i>handletextpad</i> | the pad between the legend handle and text         |
| <i>borderaxespad</i> | the pad between the axes and legend border         |
| <i>columnspacing</i> | the spacing between columns                        |

**Note:** Not all kinds of artist are supported by the legend command. See [LINK](#) (FIXME) for details.

**Example:**



Also see [Legend guide](#).

**locator\_params**(axis='both', tight=None, \*\*kwargs)

Convenience method for controlling tick locators.

Keyword arguments:

**axis** ['x' | 'y' | 'both'] Axis on which to operate; default is 'both'.

**tight** [True | False | None] Parameter passed to [autoscale\\_view\(\)](#). Default is None, for no change.

Remaining keyword arguments are passed to directly to the [set\\_params\(\)](#) method.

Typically one might want to reduce the maximum number of ticks and use tight bounds when plotting small subplots, for example:

```
ax.locator_params(tight=True, nbins=4)
```

Because the locator is involved in autoscaling, [autoscale\\_view\(\)](#) is called automatically after the parameters are changed.

This presently works only for the [MaxNLocator](#) used by default on linear axes, but it may be generalized.

**loglog**(\*args, \*\*kwargs)

call signature:

```
loglog(*args, **kwargs)
```

Make a plot with log scaling on the  $x$  and  $y$  axis.

`loglog()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_xscale()` / `matplotlib.axes.Axes.set_yscale()`.

Notable keyword arguments:

***basex/basey***: **scalar** > 1 base of the  $x/y$  logarithm

***subsx/subsy***: [ **None** | **sequence** ] the location of the minor  $x/y$  ticks; *None* defaults to autosubs, which depend on the number of decades in the plot; see `matplotlib.axes.Axes.set_xscale()` / `matplotlib.axes.Axes.set_yscale()` for details

***nonposx/nonposy***: [ **'mask'** | **'clip'** ] non-positive values in  $x$  or  $y$  can be masked as invalid, or clipped to a very small positive number

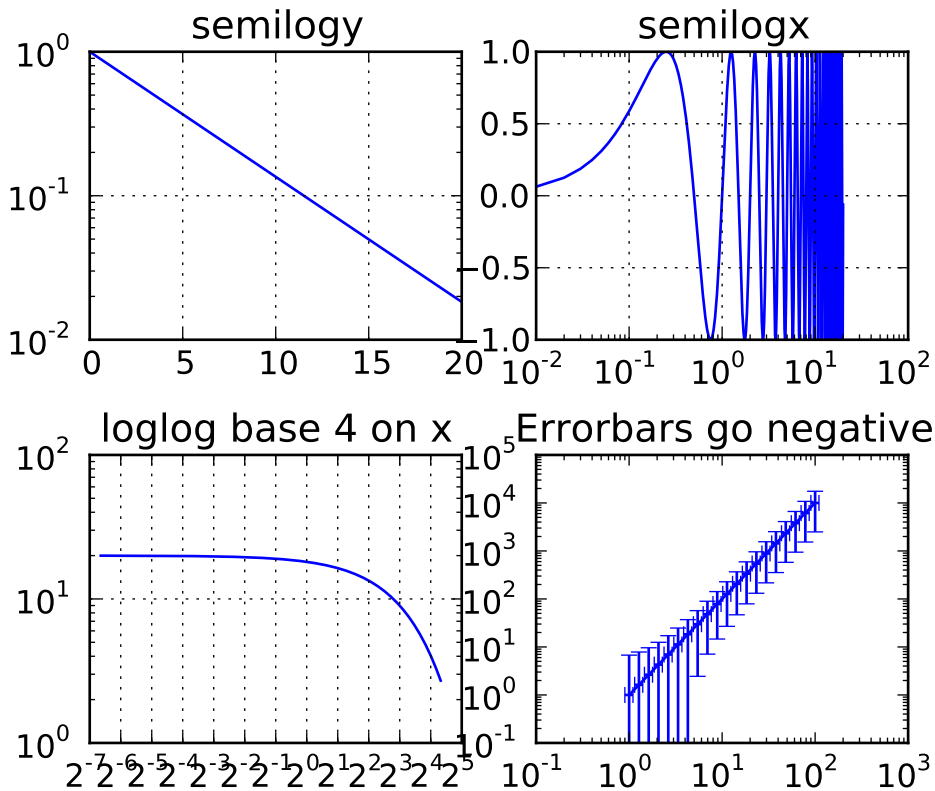
The remaining valid kwargs are [Line2D](#) properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | [ 'butt'   'round'   'projecting' ]  |
| <code>dash_joinstyle</code>                            | [ 'miter'   'round'   'bevel' ]  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are $x$ , $y$ ) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | [ 'full'   'left'   'right'   'bottom'   'top' ]   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |

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|  |   |
|--|---|
| <code>markersize</code> or <code>ms</code> | float   |
| <code>markevery</code>                     | None   integer   (startind, stride)   |
| <code>picker</code>                        | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>                    | float distance in points  |
| <code>rasterized</code>                    | [True   False   None]   |
| <code>snap</code>                          | unknown   |
| <code>solid_capstyle</code>                | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>               | ['miter'   'round'   'bevel']   |
| <code>transform</code>                     | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>                           | a url string  |
| <code>visible</code>                       | [True   False]  |
| <code>xdata</code>                         | 1D array  |
| <code>ydata</code>                         | 1D array  |
| <code>zorder</code>                        | any number  |

Example:



**margins**(\*args, \*\*kw)  
Convenience method to set or retrieve autoscaling margins.  
signatures:

```
margins()
```

returns `xmargin`, `ymargin`

```
margins(margin)
```

```
margins(xmargin, ymargin)
```

```
margins(x=xmargin, y=ymargin)
```

```
margins(..., tight=False)
```

All three forms above set the `xmargin` and `ymargin` parameters. All keyword parameters are optional. A single argument specifies both `xmargin` and `ymargin`. The *tight* parameter is passed to `autoscale_view()`, which is executed after a margin is changed; the default here is *True*, on the assumption that when margins are specified, no additional padding to match tick marks is usually desired. Setting *tight* to *None* will preserve the previous setting.

Specifying any margin changes only the autoscaling; for example, if *xmargin* is not *None*, then *xmargin* times the X data interval will be added to each end of that interval before it is used in autoscaling.

**matshow**(*Z*, *\*\*kwargs*)

Plot a matrix or array as an image.

The matrix will be shown the way it would be printed, with the first row at the top. Row and column numbering is zero-based.

**Argument:** *Z* anything that can be interpreted as a 2-D array

*kwargs* all are passed to `imshow()`. `matshow()` sets defaults for *origin*, *interpolation*, and *aspect*; if you want row zero to be at the bottom instead of the top, you can set the *origin* kwarg to “lower”.

Returns: an `matplotlib.image.AxesImage` instance.

**minorticks\_off()**

Remove minor ticks from the axes.

**minorticks\_on()**

Add autoscaling minor ticks to the axes.

**pcolor**(*\*args*, *\*\*kwargs*)

call signatures:

```
pcolor(C, **kwargs)
```

```
pcolor(X, Y, C, **kwargs)
```

Create a pseudocolor plot of a 2-D array.

*C* is the array of color values.

$X$  and  $Y$ , if given, specify the  $(x, y)$  coordinates of the colored quadrilaterals; the quadrilateral for  $C[i,j]$  has corners at:

```
(X[i, j], Y[i, j]),  
(X[i, j+1], Y[i, j+1]),  
(X[i+1, j], Y[i+1, j]),  
(X[i+1, j+1], Y[i+1, j+1]).
```

Ideally the dimensions of  $X$  and  $Y$  should be one greater than those of  $C$ ; if the dimensions are the same, then the last row and column of  $C$  will be ignored.

Note that the column index corresponds to the  $x$ -coordinate, and the row index corresponds to  $y$ ; for details, see the [Grid Orientation](#) section below.

If either or both of  $X$  and  $Y$  are 1-D arrays or column vectors, they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

$X$ ,  $Y$  and  $C$  may be masked arrays. If either  $C[i, j]$ , or one of the vertices surrounding  $C[i,j]$  ( $X$  or  $Y$  at  $[i, j]$ ,  $[i+1, j]$ ,  $[i, j+1]$ ,  $[i+1, j+1]$ ) is masked, nothing is plotted.

Keyword arguments:

**cmap:** [ **None** | **Colormap** ] A `matplotlib.cm.Colormap` instance. If *None*, use rc settings.

**norm:** [ **None** | **Normalize** ] An `matplotlib.colors.Normalize` instance is used to scale luminance data to 0,1. If *None*, defaults to `normalize()`.

**vmin/vmax:** [ **None** | **scalar** ] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array  $C$  is used. If you pass a *norm* instance, *vmin* and *vmax* will be ignored.

**shading:** [ **'flat'** | **'faceted'** ] If **'faceted'**, a black grid is drawn around each rectangle; if **'flat'**, edges are not drawn. Default is **'flat'**, contrary to MATLAB.

**This kwarg is deprecated; please use 'edgecolors' instead:**

- shading='flat' – edgecolors='none'
- shading='faceted' – edgecolors='k'

**edgecolors:** [ **None** | **'none'** | **color** | **color sequence** ] If *None*, the rc setting is used by default.

If **'none'**, edges will not be visible.

An mpl color or sequence of colors will set the edge color

**alpha:** **0** <= **scalar** <= **1** or **None** the alpha blending value

Return value is a `matplotlib.collection.Collection` instance. The grid orientation follows the MATLAB convention: an array  $C$  with shape  $(nrows, ncolumns)$  is plotted with the column number as  $X$  and the row number as  $Y$ , increasing up; hence it is plotted the way the array would be printed, except that the  $Y$  axis is reversed. That is,  $C$  is taken as  $C^*(y, x)$ .

Similarly for `meshgrid()`:



```
x = np.arange(5)
y = np.arange(3)
X, Y = meshgrid(x,y)
```

is equivalent to:

```
X = array([[0, 1, 2, 3, 4], [0, 1, 2, 3, 4], [0, 1, 2, 3, 4]])
```

```
Y = array([[0, 0, 0, 0, 0], [1, 1, 1, 1, 1], [2, 2, 2, 2, 2]])
```

so if you have:

```
C = rand( len(x), len(y))
```

then you need:

```
pcolor(X, Y, C.T)
```

or:

```
pcolor(C.T)
```

MATLAB `pcolor()` always discards the last row and column of *C*, but matplotlib displays the last row and column if *X* and *Y* are not specified, or if *X* and *Y* have one more row and column than *C*.

kwargs can be used to control the PolyCollection properties:

| Property  | Description  |
|---|--|
| <code>agg_filter</code>                               | unknown  |
| <code>alpha</code>                                    | float or None                                      |
| <code>animated</code>                                 | [True   False]                                     |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans                    |
| <code>array</code>                                    | unknown  |
| <code>axes</code>                                     | an <code>Axes</code> instance                      |
| <code>clim</code>                                     | a length 2 sequence of floats                      |
| <code>clip_box</code>                                 | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>                                  | [True   False]                                     |
| <code>clip_path</code>                                | [ (Path, Transform)   Patch   None ]               |
| <code>cmap</code>                                     | a colormap or registered colormap name             |
| <code>color</code>                                    | matplotlib color arg or sequence of rgba tuples    |
| <code>colorbar</code>                                 | unknown  |
| <code>contains</code>                                 | a callable function                                |
| <code>edgecolor</code> or <code>edgecolors</code>     | matplotlib color arg or sequence of rgba tuples    |
| <code>facecolor</code> or <code>facecolors</code>     | matplotlib color arg or sequence of rgba tuples    |
| <code>figure</code>                                   | a <code>matplotlib.figure.Figure</code> instance   |
| <code>gid</code>                                      | an id string                                       |
| <code>label</code>                                    | any string   |

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|  |   |
|--|---|
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | <code>['solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]</code> |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | <code>[True   False]</code>   |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | <code>[None float boolean callable]</code>  |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | <code>[True   False   None]</code>  |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | <code>[True   False]</code>   |
| <code>zorder</code>  | any number  |

Note: the default *antialiaseds* is *False* if the default *edgecolors*\*=*"none"* is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of *alpha*. If *\*edgecolors* is not *"none"*, then the default *antialiaseds* is taken from `rcParams['patch.antialiased']`, which defaults to *True*. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

### **pcolorfast**(\*args, \*\*kwargs)

pseudocolor plot of a 2-D array

Experimental; this is a version of `pcolor` that does not draw lines, that provides the fastest possible rendering with the Agg backend, and that can handle any quadrilateral grid.

Call signatures:

```
pcolor(C, **kwargs)
pcolor(xr, yr, C, **kwargs)
pcolor(x, y, C, **kwargs)
pcolor(X, Y, C, **kwargs)
```

*C* is the 2D array of color values corresponding to quadrilateral cells. Let (nr, nc) be its shape. *C* may be a masked array.

`pcolor(C, **kwargs)` is equivalent to `pcolor([0,nc], [0,nr], C, **kwargs)`

*xr, yr* specify the ranges of *x* and *y* corresponding to the rectangular region bounding *C*. If:

```
xr = [x0, x1]
```

and:

```
yr = [y0,y1]
```

then  $x$  goes from  $x_0$  to  $x_1$  as the second index of  $C$  goes from 0 to  $nc$ , etc.  $(x_0, y_0)$  is the outermost corner of cell (0,0), and  $(x_1, y_1)$  is the outermost corner of cell  $(nr-1, nc-1)$ . All cells are rectangles of the same size. This is the fastest version.

$x$ ,  $y$  are 1D arrays of length  $nc + 1$  and  $nr + 1$ , respectively, giving the  $x$  and  $y$  boundaries of the cells. Hence the cells are rectangular but the grid may be nonuniform. The speed is intermediate. (The grid is checked, and if found to be uniform the fast version is used.)

$X$  and  $Y$  are 2D arrays with shape  $(nr + 1, nc + 1)$  that specify the  $(x,y)$  coordinates of the corners of the colored quadrilaterals; the quadrilateral for  $C[i,j]$  has corners at  $(X[i,j], Y[i,j])$ ,  $(X[i,j+1], Y[i,j+1])$ ,  $(X[i+1,j], Y[i+1,j])$ ,  $(X[i+1,j+1], Y[i+1,j+1])$ . The cells need not be rectangular. This is the most general, but the slowest to render. It may produce faster and more compact output using ps, pdf, and svg backends, however.

Note that the column index corresponds to the  $x$ -coordinate, and the row index corresponds to  $y$ ; for details, see the “Grid Orientation” section below.

Optional keyword arguments:

**cmap:** [ **None** | **Colormap** ] A cm Colormap instance from cm. If None, use rc settings.

**norm:** [ **None** | **Normalize** ] An mcolors.Normalize instance is used to scale luminance data to 0,1. If None, defaults to `normalize()`

**vmin/vmax:** [ **None** | **scalar** ] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. If you pass a *norm* instance, *vmin* and *vmax* will be *None*.

**alpha:**  $0 \leq \text{scalar} \leq 1$  or *None* the alpha blending value

Return value is an image if a regular or rectangular grid is specified, and a QuadMesh collection in the general quadrilateral case.

**pcolormesh**(\*args, \*\*kwargs)

call signatures:

```
pcolormesh(C)
pcolormesh(X, Y, C)
pcolormesh(C, **kwargs)
```

*C* may be a masked array, but *X* and *Y* may not. Masked array support is implemented via *cmap* and *norm*; in contrast, `pcolor()` simply does not draw quadrilaterals with masked colors or vertices.

Keyword arguments:

**cmap:** [ **None** | **Colormap** ] A matplotlib.cm.Colormap instance. If None, use rc settings.

**norm:** [ **None** | **Normalize** ] A matplotlib.colors.Normalize instance is used to scale luminance data to 0,1. If None, defaults to `normalize()`.

***vmin/vmax***: [ **None** | **scalar** ] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. If you pass a *norm* instance, *vmin* and *vmax* will be ignored.

***shading***: [ **'flat'** | **'faceted'** | **'gouraud'** ] If **'faceted'**, a black grid is drawn around each rectangle; if **'flat'**, edges are not drawn. Default is **'flat'**, contrary to MATLAB.

**This kwarg is deprecated; please use **'edgecolors'** instead:**

- shading=**'flat'** – edgecolors=**'None'**
- shading=**'faceted'** – edgecolors=**'k'**

***edgecolors***: [ **None** | **'None'** | **color** | **color sequence** ] If **None**, the rc setting is used by default.

If **'None'**, edges will not be visible.

An mpl color or sequence of colors will set the edge color

***alpha***: **0** <= **scalar** <= **1** or **None** the alpha blending value

Return value is a `matplotlib.collection.QuadMesh` object.

kwargs can be used to control the `matplotlib.collections.QuadMesh` properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |

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|                         |                                 |
|-------------------------|---------------------------------|
| <code>paths</code>      | unknown                         |
| <code>picker</code>     | [None float boolean callable]   |
| <code>pickradius</code> | unknown                         |
| <code>rasterized</code> | [True   False   None]           |
| <code>snap</code>       | unknown                         |
| <code>transform</code>  | <code>Transform</code> instance |
| <code>url</code>        | a url string                    |
| <code>urls</code>       | unknown                         |
| <code>visible</code>    | [True   False]                  |
| <code>zorder</code>     | any number                      |

**See Also:**

**`pcolor()`** For an explanation of the grid orientation and the expansion of 1-D *X* and/or *Y* to 2-D arrays.

**`pick(*args)`**

call signature:

```
pick(mouseevent)
```

each child artist will fire a pick event if mouseevent is over the artist and the artist has picker set

**`pie(x, explode=None, labels=None, colors=None, autopct=None, pctdistance=0.59999999999999998, shadow=False, labeldistance=1.1000000000000001)`**

call signature:

```
pie(x, explode=None, labels=None,
    colors=('b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'),
    autopct=None, pctdistance=0.6, labeldistance=1.1, shadow=False)
```

Make a pie chart of array *x*. The fractional area of each wedge is given by *x*/sum(*x*). If sum(*x*) ≤ 1, then the values of *x* give the fractional area directly and the array will not be normalized.

Keyword arguments:

**`explode`:** [ **None** | **len(*x*) sequence** ] If not *None*, is a len(*x*) array which specifies the fraction of the radius with which to offset each wedge.

**`colors`:** [ **None** | **color sequence** ] A sequence of matplotlib color args through which the pie chart will cycle.

**`labels`:** [ **None** | **len(*x*) sequence of strings** ] A sequence of strings providing the labels for each wedge

**`autopct`:** [ **None** | **format string** | **format function** ] If not *None*, is a string or function used to label the wedges with their numeric value. The label will be placed

inside the wedge. If it is a format string, the label will be `fmt%pct`. If it is a function, it will be called.

***pctdistance*: scalar** The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*; default is 0.6.

***labeldistance*: scalar** The radial distance at which the pie labels are drawn

***shadow*: [ False | True ]** Draw a shadow beneath the pie.

The pie chart will probably look best if the figure and axes are square. Eg.:

```
figure(figsize=(8,8))
ax = axes([0.1, 0.1, 0.8, 0.8])
```

**Return value:** If *autopct* is *None*, return the tuple (*patches*, *texts*):

- *patches* is a sequence of `matplotlib.patches.Wedge` instances
- *texts* is a list of the label `matplotlib.text.Text` instances.

If *autopct* is not *None*, return the tuple (*patches*, *texts*, *autotexts*), where *patches* and *texts* are as above, and *autotexts* is a list of `Text` instances for the numeric labels.

**plot**(\*args, \*\*kwargs)

Plot lines and/or markers to the `Axes`. *args* is a variable length argument, allowing for multiple *x*, *y* pairs with an optional format string. For example, each of the following is legal:

```
plot(x, y)           # plot x and y using default line style and color
plot(x, y, 'bo')      # plot x and y using blue circle markers
plot(y)              # plot y using x as index array 0..N-1
plot(y, 'r+')         # ditto, but with red plusses
```

If *x* and/or *y* is 2-dimensional, then the corresponding columns will be plotted.

An arbitrary number of *x*, *y*, *fmt* groups can be specified, as in:

```
a.plot(x1, y1, 'g^', x2, y2, 'g-')
```

Return value is a list of lines that were added.

The following format string characters are accepted to control the line style or marker:

| character | description           |
|-----------|-----------------------|
| '—'       | solid line style      |
| '--'      | dashed line style     |
| '-.'      | dash-dot line style   |
| ':'       | dotted line style     |
| '.'       | point marker          |
| ','       | pixel marker          |
| 'o'       | circle marker         |
| 'v'       | triangle_down marker  |
| '^'       | triangle_up marker    |
| '<'       | triangle_left marker  |
| '>'       | triangle_right marker |
| '1'       | tri_down marker       |
| '2'       | tri_up marker         |
| '3'       | tri_left marker       |
| '4'       | tri_right marker      |
| 's'       | square marker         |
| 'p'       | pentagon marker       |
| '*'       | star marker           |
| 'h'       | hexagon1 marker       |
| 'H'       | hexagon2 marker       |
| '+'       | plus marker           |
| 'x'       | x marker              |
| 'D'       | diamond marker        |
| 'd'       | thin_diamond marker   |
| ' '       | vline marker          |
| '_'       | hline marker          |

The following color abbreviations are supported:

| character | color   |
|-----------|---------|
| 'b'       | blue    |
| 'g'       | green   |
| 'r'       | red     |
| 'c'       | cyan    |
| 'm'       | magenta |
| 'y'       | yellow  |
| 'k'       | black   |
| 'w'       | white   |

In addition, you can specify colors in many weird and wonderful ways, including full names ('green'), hex strings ('#008000'), RGB or RGBA tuples ((0, 1, 0, 1)) or grayscale intensities as a string ('0.8'). Of these, the string specifications can be used in place of a `fmt` group, but the tuple forms can be used only as `kwargs`.

Line styles and colors are combined in a single format string, as in 'bo' for blue circles.

The *kwargs* can be used to set line properties (any property that has a `set_*` method). You can use this to set a line label (for auto legends), linewidth, antialiasing, marker face color, etc. Here is an example:

```

plot([1,2,3], [1,2,3], 'go-', label='line 1', linewidth=2)
plot([1,2,3], [1,4,9], 'rs', label='line 2')
axis([0, 4, 0, 10])
legend()

```

If you make multiple lines with one plot command, the kwargs apply to all those lines, e.g.:

```
plot(x1, y1, x2, y2, antialiased=False)
```

Neither line will be antialiased.

You do not need to use format strings, which are just abbreviations. All of the line properties can be controlled by keyword arguments. For example, you can set the color, marker, linestyle, and markercolor with:

```

plot(x, y, color='green', linestyle='dashed', marker='o',
     markerfacecolor='blue', markersize=12). See
     :class:`~matplotlib.lines.Line2D` for details.

```

The kwargs are [Line2D](#) properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                          | unknown  |
| <code>alpha</code>                               | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                            | [True   False]   |
| <code>antialiased</code> or <code>aa</code>      | [True   False]   |
| <code>axes</code>                                | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                            | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                             | [True   False]   |
| <code>clip_path</code>                           | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>             | any matplotlib color   |
| <code>contains</code>                            | a callable function  |
| <code>dash_capstyle</code>                       | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                      | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                              | sequence of on/off ink in points   |
| <code>data</code>                                | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                           | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                              | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                           | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                 | an id string   |
| <code>label</code>                               | any string   |
| <code>linestyle</code> or <code>ls</code>        | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>        | float value in points  |
| <code>lod</code>                                 | [True   False]   |
| <code>marker</code>                              | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' ] |
| <code>markeredgecolor</code> or <code>mec</code> | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code> | float value in points  |



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|  |   |
|--|---|
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

kwargs `scalex` and `scaley`, if defined, are passed on to `autoscale_view()` to determine whether the  $x$  and  $y$  axes are autoscaled; the default is `True`.

**plot\_date**( $x$ ,  $y$ , `fmt='bo'`, `tz=None`, `xdate=True`, `ydate=False`, **\*\*kwargs**)  
call signature:

```
plot_date(x, y, fmt='bo', tz=None, xdate=True, ydate=False, **kwargs)
```

Similar to the `plot()` command, except the  $x$  or  $y$  (or both) data is considered to be dates, and the axis is labeled accordingly.

$x$  and/or  $y$  can be a sequence of dates represented as float days since 0001-01-01 UTC.

Keyword arguments:

**fmt: string** The plot format string.

**tz: [ None | timezone string | tzinfo instance ]** The time zone to use in labeling dates. If `None`, defaults to rc value.

**xdate: [ True | False ]** If `True`, the  $x$ -axis will be labeled with dates.

**ydate: [ False | True ]** If `True`, the  $y$ -axis will be labeled with dates.

Note if you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to `plot_date()` since `plot_date()` will set the default tick locator to `matplotlib.dates.AutoDateLocator` (if the tick locator is not already set to a `matplotlib.dates.DateLocator` instance) and the default tick formatter to `matplotlib.dates.AutoDateFormatter` (if the tick formatter is not already set to a `matplotlib.dates.DateFormatter` instance).

Valid kwargs are `Line2D` properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance  |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

See Also:

`dates` for helper functions

`date2num()`, `num2date()` and `drange()` for help on creating the required floating point dates.

**psd**(*x*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, *\*\*kwargs*)

call signature:

```
psd(x, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
    window=mlab.window_hanning, noverlap=0, pad_to=None,
    sides='default', scale_by_freq=None, **kwargs)
```

The power spectral density by Welch's average periodogram method. The vector *x* is divided into *NFFT* length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The  $|\text{fft}(i)|^2$  of each segment *i* are averaged to compute *Pxx*, with a scaling to correct for power loss due to windowing. *Fs* is the sampling frequency.

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is None, which sets *pad\_to* equal to *NFFT*.

**sides:** [ 'default' | 'onesided' | 'twosided' ] Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

**scale\_by\_freq:** **boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

**Fc:** **integer** The center frequency of  $x$  (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

Returns the tuple ( $P_{xx}$ ,  $f_{\text{reqs}}$ ).

For plotting, the power is plotted as  $10 \log_{10}(P_{xx})$  for decibels, though  $P_{xx}$  itself is returned.

**References:** Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

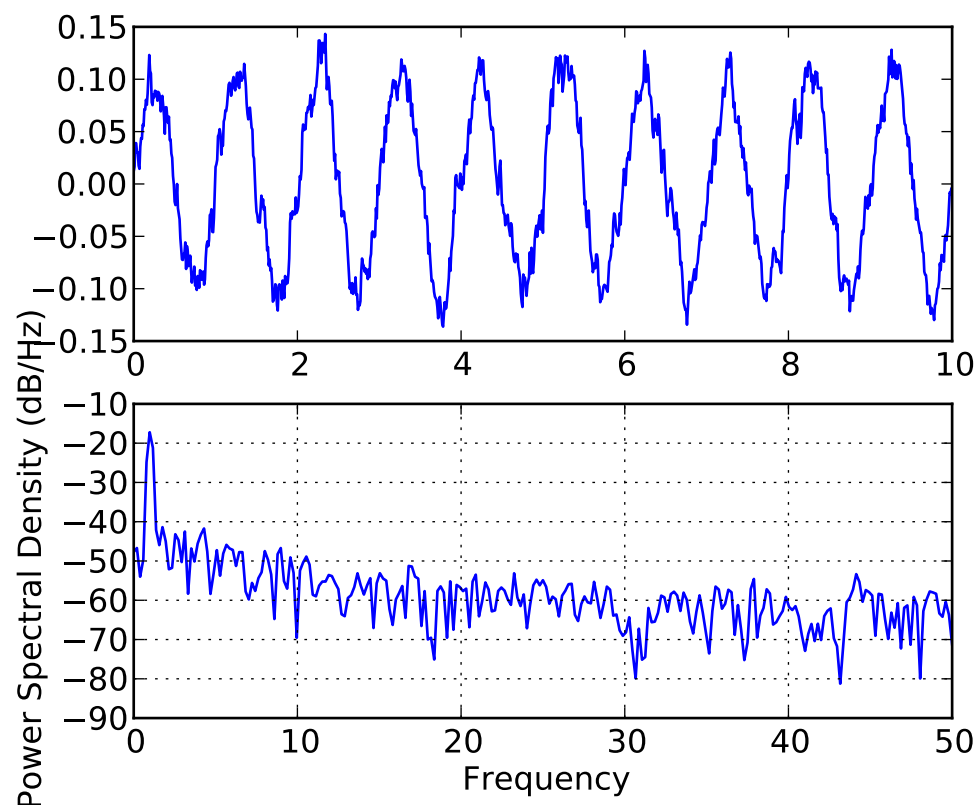
kwargs control the [Line2D](#) properties:

| Property   | Description   |
|--|---|
| <a href="#">agg_filter</a>                             | unknown   |
| <a href="#">alpha</a>                                  | float (0.0 transparent through 1.0 opaque)  |
| <a href="#">animated</a>                               | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">aa</a>      | [True   False]  |
| <a href="#">axes</a>                                   | an <a href="#">Axes</a> instance  |
| <a href="#">clip_box</a>                               | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <a href="#">clip_on</a>                                | [True   False]  |
| <a href="#">clip_path</a>                              | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <a href="#">color</a> or <a href="#">c</a>             | any matplotlib color  |
| <a href="#">contains</a>                               | a callable function   |
| <a href="#">dash_capstyle</a>                          | ['butt'   'round'   'projecting']   |
| <a href="#">dash_joinstyle</a>                         | ['miter'   'round'   'bevel']   |
| <a href="#">dashes</a>                                 | sequence of on/off ink in points  |
| <a href="#">data</a>                                   | 2D array (rows are x, y) or two 1D arrays   |
| <a href="#">drawstyle</a>                              | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <a href="#">figure</a>                                 | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <a href="#">fillstyle</a>                              | ['full'   'left'   'right'   'bottom'   'top']  |
| <a href="#">gid</a>                                    | an id string  |
| <a href="#">label</a>                                  | any string  |
| <a href="#">linestyle</a> or <a href="#">ls</a>        | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <a href="#">linewidth</a> or <a href="#">lw</a>        | float value in points   |
| <a href="#">lod</a>                                    | [True   False]  |
| <a href="#">marker</a>                                 | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <a href="#">markeredgecolor</a> or <a href="#">mec</a> | any matplotlib color  |
| <a href="#">markeredgewidth</a> or <a href="#">mew</a> | float value in points   |
| <a href="#">markerfacecolor</a> or <a href="#">mfc</a> | any matplotlib color  |

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|  |   |
|--|---|
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

Example:



`quiver(*args, **kw)`  
Plot a 2-D field of arrows.

call signatures:

```
quiver(U, V, **kw)
quiver(U, V, C, **kw)
quiver(X, Y, U, V, **kw)
quiver(X, Y, U, V, C, **kw)
```

Arguments:

*X, Y*:

The *x* and *y* coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

*U, V*:

give the *x* and *y* components of the arrow vectors

*C*: an optional array used to map colors to the arrows

All arguments may be 1-D or 2-D arrays or sequences. If *X* and *Y* are absent, they will be generated as a uniform grid. If *U* and *V* are 2-D arrays but *X* and *Y* are 1-D, and if `len(X)` and `len(Y)` match the column and row dimensions of *U*, then *X* and *Y* will be expanded with `numpy.meshgrid()`.

*U, V, C* may be masked arrays, but masked *X, Y* are not supported at present.

Keyword arguments:

***units***: ['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy']

arrow units; the arrow dimensions *except for length* are in multiples of this unit.

- 'width' or 'height': the width or height of the axes
- 'dots' or 'inches': pixels or inches, based on the figure dpi
- 'x', 'y', or 'xy': *X, Y*, or  $\sqrt{X^2+Y^2}$  data units

The arrows scale differently depending on the units. For 'x' or 'y', the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For 'width' or 'height', the arrow size increases with the width and height of the axes, respectively, when the window is resized; for 'dots' or 'inches', resizing does not change the arrows.

***angles***: ['uv' | 'xy' | array] With the default 'uv', the arrow aspect ratio is 1, so that if  $U==V$  the angle of the arrow on the plot is 45 degrees CCW from the *x*-axis. With 'xy', the arrow points from (*x,y*) to (*x+u, y+v*). Alternatively, arbitrary angles may be specified as an array of values in degrees, CCW from the *x*-axis.

***scale***: [ None | float ]

data units per arrow length unit, e.g. m/s per plot width; a smaller scale parameter makes the arrow longer. If *None*, a simple autoscaling algorithm is used, based on the average vector length and the number of vectors. The arrow length unit is given by the *scale\_units* parameter

***scale\_units***: **None**, or any of the *units* options. For example, if *scale\_units* is ‘inches’, *scale* is 2.0, and  $(u,v) = (1,0)$ , then the vector will be 0.5 inches long. If *scale\_units* is ‘width’, then the vector will be half the width of the axes. If *scale\_units* is ‘x’ then the vector will be 0.5 x-axis units. To plot vectors in the x-y plane, with *u* and *v* having the same units as *x* and *y*, use “*angles*=‘xy’, *scale\_units*=‘xy’, *scale*=1”.

***width***: shaft width in arrow units; default depends on choice of units, above, and number of vectors; a typical starting value is about 0.005 times the width of the plot.

***headwidth***: **scalar** head width as multiple of shaft width, default is 3

***headlength***: **scalar** head length as multiple of shaft width, default is 5

***headaxislength***: **scalar** head length at shaft intersection, default is 4.5

***minshaft***: **scalar** length below which arrow scales, in units of head length. Do not set this to less than 1, or small arrows will look terrible! Default is 1

***minlength***: **scalar** minimum length as a multiple of shaft width; if an arrow length is less than this, plot a dot (hexagon) of this diameter instead. Default is 1.

***pivot***: [ ‘tail’ | ‘middle’ | ‘tip’ ] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*.

***color***: [ **color** | **color sequence** ] This is a synonym for the [PolyCollection](#) face-color kwarg. If *C* has been set, *color* has no effect.

The defaults give a slightly swept-back arrow; to make the head a triangle, make *headaxislength* the same as *headlength*. To make the arrow more pointed, reduce *headwidth* or increase *headlength* and *headaxislength*. To make the head smaller relative to the shaft, scale down all the head parameters. You will probably do best to leave *minshaft* alone.

*linewidths* and *edgecolors* can be used to customize the arrow outlines. Additional [PolyCollection](#) keyword arguments:

| Property                                  | Description   |
|---|---|
| <i>agg_filter</i>                         | unknown   |
| <i>alpha</i>                              | float or None   |
| <i>animated</i>                           | [True   False]  |
| <i>antialiased</i> or <i>antialiaseds</i> | Boolean or sequence of booleans                       |
| <i>array</i>                              | unknown   |
| <i>axes</i>                               | an <a href="#">Axes</a> instance                      |
| <i>clim</i>                               | a length 2 sequence of floats                         |
| <i>clip_box</i>                           | a <a href="#">matplotlib.transforms.Bbox</a> instance |
| <i>clip_on</i>                            | [True   False]  |

Continued on next page

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|  |   |
|--|---|
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [ True   False ]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [ None   float   boolean   callable ]                                   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [ True   False   None ]   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | Transform instance  |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [ True   False ]  |
| <code>zorder</code>  | any number  |

**quiverkey(\*args, \*\*kw)**

Add a key to a quiver plot.

call signature:

```
quiverkey(Q, X, Y, U, label, **kw)
```

Arguments:

**Q:** The Quiver instance returned by a call to `quiver`.

**X, Y:** The location of the key; additional explanation follows.

**U:** The length of the key

**label:** a string with the length and units of the key

Keyword arguments:

**coordinates** = [ 'axes' | 'figure' | 'data' | 'inches' ] Coordinate system and units for *X, Y*: 'axes' and 'figure' are normalized coordinate systems with 0,0 in the lower left and 1,1 in the upper right; 'data' are the axes data coordinates (used for the



locations of the vectors in the quiver plot itself); ‘inches’ is position in the figure in inches, with 0,0 at the lower left corner.

**color:** overrides face and edge colors from *Q*.

**labelpos** = [ ‘N’ | ‘S’ | ‘E’ | ‘W’ ] Position the label above, below, to the right, to the left of the arrow, respectively.

**labelsep:** Distance in inches between the arrow and the label. Default is 0.1

**labelcolor:** defaults to default [Text](#) color.

**fontproperties:** A dictionary with keyword arguments accepted by the [FontProperties](#) initializer: *family, style, variant, size, weight*

Any additional keyword arguments are used to override vector properties taken from *Q*.

The positioning of the key depends on *X, Y, coordinates*, and *labelpos*. If *labelpos* is ‘N’ or ‘S’, *X, Y* give the position of the middle of the key arrow. If *labelpos* is ‘E’, *X, Y* positions the head, and if *labelpos* is ‘W’, *X, Y* positions the tail; in either of these two cases, *X, Y* is somewhere in the middle of the arrow+label key object.

### **redraw\_in\_frame()**

This method can only be used after an initial draw which caches the renderer. It is used to efficiently update Axes data (axis ticks, labels, etc are not updated)

### **relim()**

Recompute the data limits based on current artists.

At present, [Collection](#) instances are not supported.

### **reset\_position()**

Make the original position the active position

**scatter**(*x, y, s=20, c='b', marker='o', cmap=None, norm=None, vmin=None, vmax=None, alpha=None, linewidths=None, faceted=True, verts=None, \*\*kwargs*)

call signatures:

```
scatter(x, y, s=20, c='b', marker='o', cmap=None, norm=None,
        vmin=None, vmax=None, alpha=None, linewidths=None,
        verts=None, **kwargs)
```

Make a scatter plot of *x* versus *y*, where *x, y* are converted to 1-D sequences which must be of the same length, *N*.

Keyword arguments:

**s:** size in points<sup>2</sup>. It is a scalar or an array of the same length as *x* and *y*.

**c:** a color. *c* can be a single color format string, or a sequence of color specifications of length *N*, or a sequence of *N* numbers to be mapped to colors using the *cmap* and *norm* specified via *kwargs* (see below). Note that *c* should not be a single numeric RGB or RGBA sequence because that is indistinguishable from an array of values to be colormapped. *c* can be a 2-D array in which the rows are RGB or RGBA, however.

**marker:** can be one of:

| marker                          | description                                   |
|---------------------------------|---|
| 7                               | caret down                                    |
| 4                               | caret left                                    |
| 5                               | caret right                                   |
| 6                               | caret up                                      |
| 'o'                             | circle  |
| 'D'                             | diamond                                       |
| 'h'                             | hexagon1                                      |
| 'H'                             | hexagon2                                      |
| '_'                             | hline   |
| ''                              | nothing                                       |
| 'None'                          | nothing                                       |
| None                            | nothing                                       |
| ' '                             | nothing                                       |
| '8'                             | octagon                                       |
| 'p'                             | pentagon                                      |
| '.'                             | pixel   |
| '+'                             | plus  |
| '.'                             | point   |
| 's'                             | square  |
| '*'                             | star  |
| 'd'                             | thin_diamond                                  |
| 3                               | tick down                                     |
| 0                               | tick left                                     |
| 1                               | tick right                                    |
| 2                               | tick up                                       |
| '1'                             | tri_down                                      |
| '3'                             | tri_left                                      |
| '4'                             | tri_right                                     |
| '2'                             | tri_up  |
| 'v'                             | triangle_down                                 |
| '<'                             | triangle_left                                 |
| '>'                             | triangle_right                                |
| '^'                             | triangle_up                                   |
| ' '                             | vline   |
| 'x'                             | x   |
| '\$...\$'                       | render the string using <code>mathtext</code> |
| <i>verts</i>                    | a list of (x, y) pairs in range (0, 1)        |
| <i>(numsides, style, angle)</i> | see below                                     |

The marker can also be a tuple *(numsides, style, angle)*, which will create a custom, regular symbol.

**numsides:** the number of sides

**style:** the style of the regular symbol:

| Value | Description   |
|-------|---|
| 0     | a regular polygon                                       |
| 1     | a star-like symbol                                      |
| 2     | an asterisk   |
| 3     | a circle ( <i>numsides</i> and <i>angle</i> is ignored) |

**angle:** the angle of rotation of the symbol

For backward compatibility, the form (*verts*, 0) is also accepted, but it is equivalent to just *verts* for giving a raw set of vertices that define the shape.

Any or all of *x*, *y*, *s*, and *c* may be masked arrays, in which case all masks will be combined and only unmasked points will be plotted.

Other keyword arguments: the color mapping and normalization arguments will be used only if *c* is an array of floats.

**cmap:** [ **None** | **Colormap** ] A [matplotlib.colors.Colormap](#) instance or registered name. If *None*, defaults to `rc image.cmap`. *cmap* is only used if *c* is an array of floats.

**norm:** [ **None** | **Normalize** ] A [matplotlib.colors.Normalize](#) instance is used to scale luminance data to 0, 1. If *None*, use the default `normalize()`. *norm* is only used if *c* is an array of floats.

**vmin/vmax:** *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. Note if you pass a *norm* instance, your settings for *vmin* and *vmax* will be ignored.

**alpha:**  $0 \leq \text{scalar} \leq 1$  or **None** The alpha value for the patches

**linewidths:** [ **None** | **scalar** | **sequence** ] If *None*, defaults to `(lines.linewidth,)`. Note that this is a tuple, and if you set the *linewidths* argument you must set it as a sequence of floats, as required by [RegularPolyCollection](#).

Optional kwargs control the [Collection](#) properties; in particular:

**edgecolors:** The string 'none' to plot faces with no outlines

**facecolors:** The string 'none' to plot unfilled outlines

Here are the standard descriptions of all the [Collection](#) kwargs:

| Property  | Description   |
|---|---|
| <a href="#">agg_filter</a>                                  | unknown   |
| <a href="#">alpha</a>                                       | float or None   |
| <a href="#">animated</a>                                    | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">antialiaseds</a> | Boolean or sequence of booleans                       |
| <a href="#">array</a>                                       | unknown   |
| <a href="#">axes</a>  | an <a href="#">Axes</a> instance                      |
| <a href="#">clim</a>  | a length 2 sequence of floats                         |
| <a href="#">clip_box</a>                                    | a <a href="#">matplotlib.transforms.Bbox</a> instance |
| <a href="#">clip_on</a>                                     | [True   False]  |

Continued on next page

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|  |   |
|--|---|
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   <code>None</code> ] |
| <code>cmap</code>  | a colormap or registered colormap name  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples   |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples   |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples   |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance  |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]                     |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [ <code>None</code>   float   boolean   callable ]  |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [ <code>True</code>   <code>False</code>   <code>None</code> ]                              |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>zorder</code>  | any number  |

A `Collection` instance is returned.

**`semilogx(*args, **kwargs)`**

call signature:

`semilogx(*args, **kwargs)`

Make a plot with log scaling on the  $x$  axis.

`semilogx()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_xscale()`.

Notable keyword arguments:

**`basex: scalar > 1`** base of the  $x$  logarithm

**`subsx: [ None | sequence ]`** The location of the minor xticks; `None` defaults to auto-subticks, which depend on the number of decades in the plot; see `set_xscale()` for details.

**`nonposx: ['mask' | 'clip']`** non-positive values in  $x$  can be masked as invalid, or clipped to a very small positive number

The remaining valid kwargs are [Line2D](#) properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance  |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

See Also:

`loglog()` For example code and figure

**semilogy**(\*args, \*\*kwargs)

call signature:

```
semilogy(*args, **kwargs)
```

Make a plot with log scaling on the y axis.

`semilogy()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_yscale()`.

Notable keyword arguments:

**basey:** **scalar** > 1 Base of the y logarithm

**subsy:** [ **None** | **sequence** ] The location of the minor yticks; *None* defaults to auto-sub, which depend on the number of decades in the plot; see `set_yscale()` for details.

**nonposy:** ['mask' | 'clip' ] non-positive values in y can be masked as invalid, or clipped to a very small positive number

The remaining valid kwargs are [Line2D](#) properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                          | unknown  |
| <code>alpha</code>                               | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                            | [True   False]   |
| <code>antialiased</code> or <code>aa</code>      | [True   False]   |
| <code>axes</code>                                | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                            | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>                             | [True   False]   |
| <code>clip_path</code>                           | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>             | any matplotlib color   |
| <code>contains</code>                            | a callable function  |
| <code>dash_capstyle</code>                       | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                      | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                              | sequence of on/off ink in points   |
| <code>data</code>                                | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                           | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                              | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                           | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                 | an id string   |
| <code>label</code>                               | any string   |
| <code>linestyle</code> or <code>ls</code>        | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>        | float value in points  |
| <code>lod</code>                                 | [True   False]   |
| <code>marker</code>                              | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' ] |
| <code>markeredgecolor</code> or <code>mec</code> | any matplotlib color   |

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|  |   |
|--|---|
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

**See Also:****loglog()** For example code and figure**set\_adjustable**(*adjustable*)

ACCEPTS: [ 'box' | 'datalim' | 'box-forced' ]

**set\_anchor**(*anchor*)*anchor*

| value | description  |
|-------|--------------|
| 'C'   | Center       |
| 'SW'  | bottom left  |
| 'S'   | bottom       |
| 'SE'  | bottom right |
| 'E'   | right        |
| 'NE'  | top right    |
| 'N'   | top          |
| 'NW'  | top left     |
| 'W'   | left         |

**set\_aspect**(*aspect*, *adjustable*=None, *anchor*=None)*aspect*

| value    | description   |
|----------|---|
| 'auto'   | automatic; fill position rectangle with data  |
| 'normal' | same as 'auto'; deprecated  |
| 'equal'  | same scaling from data to plot units for x and y  |
| num      | a circle will be stretched such that the height is num times the width. aspect=1 is the same as aspect='equal'. |

*adjustable*

| value        | description                           |
|--------------|---------------------------------------|
| 'box'        | change physical size of axes          |
| 'datalim'    | change xlim or ylim                   |
| 'box-forced' | same as 'box', but axes can be shared |

'box' does not allow axes sharing, as this can cause unintended side effect. For cases when sharing axes is fine, use 'box-forced'.

*anchor*

| value | description           |
|-------|-----------------------|
| 'C'   | centered              |
| 'SW'  | lower left corner     |
| 'S'   | middle of bottom edge |
| 'SE'  | lower right corner    |
| etc.  |                       |

**set\_autoscale\_on(*b*)**

Set whether autoscaling is applied on plot commands

accepts: [ *True* | *False* ]

**set\_autoscalex\_on(*b*)**

Set whether autoscaling for the x-axis is applied on plot commands

accepts: [ *True* | *False* ]

**set\_autoscaley\_on(*b*)**

Set whether autoscaling for the y-axis is applied on plot commands

accepts: [ *True* | *False* ]

**set\_axes\_locator(*locator*)**

set axes\_locator

**ACCEPT** [a callable object which takes an axes instance and renderer and] returns a bbox.

**set\_axis\_bgcolor(*color*)**

set the axes background color

ACCEPTS: any matplotlib color - see [colors\(\)](#)

**set\_axis\_off()**

turn off the axis



**set\_axis\_on()**

turn on the axis

**set\_axisbelow(*b*)**

Set whether the axis ticks and gridlines are above or below most artists

ACCEPTS: [ *True* | *False* ]

**set\_color\_cycle(*clist*)**

Set the color cycle for any future plot commands on this Axes.

*clist* is a list of mpl color specifiers.

**set\_cursor\_props(\**args*)**

Set the cursor property as:

```
ax.set_cursor_props(linewidth, color)
```

or:

```
ax.set_cursor_props((linewidth, color))
```

ACCEPTS: a (*float*, *color*) tuple

**set\_figure(*fig*)**

Set the class:~matplotlib.axes.Axes figure

accepts a class:~matplotlib.figure.Figure instance

**set\_frame\_on(*b*)**

Set whether the axes rectangle patch is drawn

ACCEPTS: [ *True* | *False* ]

**set\_navigate(*b*)**

Set whether the axes responds to navigation toolbar commands

ACCEPTS: [ *True* | *False* ]

**set\_navigate\_mode(*b*)**

Set the navigation toolbar button status;

**Warning:** this is not a user-API function.

**set\_position(*pos*, *which*='both')**

Set the axes position with:

```
pos = [left, bottom, width, height]
```

in relative 0,1 coords, or *pos* can be a [Bbox](#)

There are two position variables: one which is ultimately used, but which may be modified by [apply\\_aspect\(\)](#), and a second which is the starting point for [apply\\_aspect\(\)](#).

**Optional keyword arguments:** *which*

| value      | description          |
|------------|----------------------|
| 'active'   | to change the first  |
| 'original' | to change the second |
| 'both'     | to change both       |

**set\_rasterization\_zorder(z)**

Set zorder value below which artists will be rasterized

**set\_title(label, fontdict=None, \*\*kwargs)**

call signature:

```
set_title(label, fontdict=None, **kwargs):
```

Set the title for the axes.

kwargs are Text properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <a href="#">Axes</a> instance   |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]              |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]                          |
| <code>figure</code>  | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <a href="#">matplotlib.font_manager.FontProperties</a> instance                                    |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]               |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |

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|  |   |
|--|---|
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]   |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]  |
| <code>visible</code>   | [True   False]  |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular' ] |
| <code>x</code>   | float   |
| <code>y</code>   | float   |
| <code>zorder</code>  | any number  |

ACCEPTS: str

**See Also:**

`text()` for information on how override and the optional args work

**set\_xbound**(*lower=None, upper=None*)

Set the lower and upper numerical bounds of the x-axis. This method will honor axes inversion regardless of parameter order. It will not change the `_autoscaleXon` attribute.

**set\_xlabel**(*xlabel, fontdict=None, labelpad=None, \*\*kwargs*)

call signature:

`set_xlabel(xlabel, fontdict=None, labelpad=None, **kwargs)`

Set the label for the axis.

*labelpad* is the spacing in points between the label and the x-axis

Valid kwargs are Text properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)                                     |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]    |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                 |

Table 45.25 – continued from

|  |  |
|--|--|
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>                  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>                           | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'extra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>                         | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

ACCEPTS: str

**See Also:**

`text()` for information on how override and the optional args work

**set\_xlim**(*left=None, right=None, emit=True, auto=False, \*\*kw*)

call signature:

```
set_xlim(self, *args, **kwargs):
```

Set the data limits for the xaxis

Examples:

```
set_xlim((left, right))
set_xlim(left, right)
set_xlim(left=1) # right unchanged
set_xlim(right=1) # left unchanged
```

Keyword arguments:

**left: scalar** the left xlim; *xmin*, the previous name, may still be used

**right: scalar** the right xlim; *xmax*, the previous name, may still be used

**emit: [ True | False ]** notify observers of lim change

**auto: [ True | False | None ]** turn *x* autoscaling on (True), off (False; default), or leave unchanged (None)

Note: the *left* (formerly *xmin*) value may be greater than the *right* (formerly *xmax*). For example, suppose *x* is years before present. Then one might use:

```
set_ylim(5000, 0)
```

so 5000 years ago is on the left of the plot and the present is on the right.

Returns the current xlims as a length 2 tuple

ACCEPTS: len(2) sequence of floats

**set\_xmargin(*m*)**

Set padding of X data limits prior to autoscaling.

*m* times the data interval will be added to each end of that interval before it is used in autoscaling.

accepts: float in range 0 to 1

**set\_xscale(*value*, \*\**kwargs*)**

call signature:

```
set_xscale(value)
```

Set the scaling of the x-axis: 'linear' | 'log' | 'symlog'

ACCEPTS: ['linear' | 'log' | 'symlog']

Different kwargs are accepted, depending on the scale: 'linear'

'log'

**basex/basey:** The base of the logarithm

**nonposx/nonposy: ['mask' | 'clip']** non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

'symlog'

**basex/basey:** The base of the logarithm

**linthreshx/linthreshy:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**set\_xticklabels**(*labels*, *fontdict=None*, *minor=False*, *\*\*kwargs*)

call signature:

```
set_xticklabels(labels, fontdict=None, minor=False, **kwargs)
```

Set the xtick labels with list of strings *labels*. Return a list of axis text instances.

*kwargs* set the [Text](#) properties. Valid properties are

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <a href="#">Axes</a> instance   |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]              |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]                          |
| <code>figure</code>  | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <a href="#">matplotlib.font_manager.FontProperties</a> instance                                    |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]               |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |

Table 45.26 – continued from

|  |   |
|--|---|
| <code>text</code>  | string or anything printable with ‘%s’ conversion.                                  |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>variant</code> or <code>fontvariant</code>                     | [ ‘normal’   ‘small-caps’ ]   |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ ‘center’   ‘top’   ‘bottom’   ‘baseline’ ]  |
| <code>visible</code>   | [True   False]  |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   ‘ultralight’   ‘light’   ‘normal’   ‘regular’ ] |
| <code>x</code>   | float   |
| <code>y</code>   | float   |
| <code>zorder</code>  | any number  |

ACCEPTS: sequence of strings

**set\_xticks**(*ticks*, *minor=False*)

Set the x ticks with list of *ticks*

ACCEPTS: sequence of floats

**set\_ybound**(*lower=None*, *upper=None*)

Set the lower and upper numerical bounds of the y-axis. This method will honor axes inversion regardless of parameter order. It will not change the `_autoscaleOn` attribute.

**set\_ylabel**(*ylabel*, *fontdict=None*, *labelpad=None*, *\*\*kwargs*)

call signature:

`set_ylabel(ylabel, fontdict=None, labelpad=None, **kwargs)`

Set the label for the yaxis

*labelpad* is the spacing in points between the label and the y-axis

Valid kwargs are Text properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)                                     |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   ‘serif’   ‘sans-serif’   ‘cursive’   ‘fantasy’   ‘monospace’ ]    |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |

Table 45.27 – continued from

|  |  |
|--|--|
| <code>fontproperties</code> or <code>font_properties</code>          | a <code>matplotlib.font_manager.FontProperties</code> instance   |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>                  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>                           | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'ultra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>                         | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

ACCEPTS: str

**See Also:**

`text()` for information on how override and the optional args work

**set\_ylim**(*bottom=None, top=None, emit=True, auto=False, \*\*kw*)

call signature:

```
set_ylim(self, *args, **kwargs):
```

Set the data limits for the yaxis

Examples:

```
set_ylim((bottom, top))
set_ylim(bottom, top)
```



```
set_ylim(bottom=1) # top unchanged
set_ylim(top=1) # bottom unchanged
```

Keyword arguments:

**bottom: scalar** the bottom ylim; the previous name, *ymin*, may still be used

**top: scalar** the top ylim; the previous name, *ymax*, may still be used

**emit: [ True | False ]** notify observers of lim change

**auto: [ True | False | None ]** turn y autoscaling on (True), off (False; default), or leave unchanged (None)

Note: the *bottom* (formerly *ymin*) value may be greater than the *top* (formerly *ymax*). For example, suppose *y* is depth in the ocean. Then one might use:

```
set_ylim(5000, 0)
```

so 5000 m depth is at the bottom of the plot and the surface, 0 m, is at the top.

Returns the current ylims as a length 2 tuple

ACCEPTS: len(2) sequence of floats

#### **set\_ymargin(*m*)**

Set padding of Y data limits prior to autoscaling.

*m* times the data interval will be added to each end of that interval before it is used in autoscaling.

accepts: float in range 0 to 1

#### **set\_yscale(*value*, *\*\*kwargs*)**

call signature:

```
set_yscale(value)
```

Set the scaling of the y-axis: 'linear' | 'log' | 'symlog'

ACCEPTS: ['linear' | 'log' | 'symlog']

Different kwargs are accepted, depending on the scale: 'linear'

'log'

**basex/basey:** The base of the logarithm

**nonposx/nonposy:** ['mask' | 'clip'] non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

'symlog'

**basex/basey:** The base of the logarithm

**linthreshx/linthreshy:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**set\_yticklabels**(*labels*, *fontdict=None*, *minor=False*, *\*\*kwargs*)

call signature:

set\_yticklabels(labels, fontdict=None, minor=False, \*\*kwargs)

Set the ytick labels with list of strings *labels*. Return a list of [Text](#) instances.

*kwargs* set [Text](#) properties for the labels. Valid properties are

| Property   | Description   |
|--|---|
| <a href="#">agg_filter</a>   | unknown   |
| <a href="#">alpha</a>  | float (0.0 transparent through 1.0 opaque)  |
| <a href="#">animated</a>   | [True   False]  |
| <a href="#">axes</a>   | an <a href="#">Axes</a> instance  |
| <a href="#">backgroundcolor</a>  | any matplotlib color  |
| <a href="#">bbox</a>   | rectangle prop dict   |
| <a href="#">clip_box</a>   | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <a href="#">clip_on</a>  | [True   False]  |
| <a href="#">clip_path</a>  | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <a href="#">color</a>  | any matplotlib color  |
| <a href="#">contains</a>   | a callable function   |
| <a href="#">family</a> or <a href="#">fontfamily</a> or <a href="#">fontname</a> or <a href="#">name</a> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]             |
| <a href="#">figure</a>   | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <a href="#">fontproperties</a> or <a href="#">font_properties</a>  | a <a href="#">matplotlib.font_manager.FontProperties</a> instance                       |
| <a href="#">gid</a>  | an id string  |
| <a href="#">horizontalalignment</a> or <a href="#">ha</a>  | [ 'center'   'right'   'left' ]   |
| <a href="#">label</a>  | any string  |
| <a href="#">linespacing</a>  | float (multiple of font size)   |
| <a href="#">lod</a>  | [True   False]  |
| <a href="#">multialignment</a>   | [ 'left'   'right'   'center' ]   |
| <a href="#">path_effects</a>   | unknown   |
| <a href="#">picker</a>   | [None float boolean callable]   |
| <a href="#">position</a>   | (x,y)   |
| <a href="#">rasterized</a>   | [True   False   None]   |
| <a href="#">rotation</a>   | [ angle in degrees   'vertical'   'horizontal' ]  |
| <a href="#">rotation_mode</a>  | unknown   |
| <a href="#">size</a> or <a href="#">fontsize</a>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]  |
| <a href="#">snap</a>   | unknown   |

Table 45.28 – continued from

|  |   |
|--|---|
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   ‘ultra-condensed’   ‘extra-condensed’   ‘condensed’   ‘normal’   ‘italic’   ‘oblique’ ] |
| <code>style</code> or <code>fontstyle</code>                         | [ ‘normal’   ‘italic’   ‘oblique’ ]   |
| <code>text</code>  | string or anything printable with ‘%s’ conversion.  |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>variant</code> or <code>fontvariant</code>                     | [ ‘normal’   ‘small-caps’ ]   |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ ‘center’   ‘top’   ‘bottom’   ‘baseline’ ]  |
| <code>visible</code>   | [True   False]  |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   ‘ultralight’   ‘light’   ‘normal’   ‘regular’   ‘bold’ ]                                |
| <code>x</code>   | float   |
| <code>y</code>   | float   |
| <code>zorder</code>  | any number  |

ACCEPTS: sequence of strings

**set\_yticks**(*ticks*, *minor=False*)

Set the y ticks with list of *ticks*

ACCEPTS: sequence of floats

Keyword arguments:

**minor**: [ **False** | **True** ] Sets the minor ticks if True

**specgram**(*x*, *NFFT=256*, *Fs=2*, *Fc=0*, *detrend=<function detrend\_none at 0x3110050>*, *window=<function window\_hanning at 0x310a2a8>*, *noverlap=128*, *cmap=None*, *xextent=None*, *pad\_to=None*, *sides='default'*, *scale\_by\_freq=None*, *\*\*kwargs*)  
call signature:

```
specgram(x, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
         window=mlab.window_hanning, noverlap=128,
         cmap=None, xextent=None, pad_to=None, sides='default',
         scale_by_freq=None, **kwargs)
```

Compute a spectrogram of data in *x*. Data are split into *NFFT* length segments and the PSD of each section is computed. The windowing function *window* is applied to each segment, and the amount of overlap of each segment is specified with *noverlap*.

Keyword arguments:

**NFFT: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**Fs: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**detrend:** **callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The `pylab` module defines `detrend_none()`, `detrend_mean()`, and `detrend_linear()`, but you can use a custom function as well.

**window:** **callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see `window_hanning()`, `window_none()`, `numpy.blackman()`, `numpy.hamming()`, `numpy.bartlett()`, `scipy.signal()`, `scipy.signal.get_window()`, etc. The default is `window_hanning()`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**noverlap:** **integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

**pad\_to:** **integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is `None`, which sets *pad\_to* equal to *NFFT*.

**sides:** [ **'default'** | **'onesided'** | **'twosided'** ] Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. **'onesided'** forces the return of a one-sided PSD, while **'twosided'** forces two-sided.

**scale\_by\_freq:** **boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is `True` for MATLAB compatibility.

**Fc:** **integer** The center frequency of *x* (defaults to 0), which offsets the y extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**cmap:** A `matplotlib.cm.Colormap` instance; if `None` use default determined by `rc`

**xextent:** The image extent along the x-axis. `xextent = (xmin, xmax)` The default is `(0, max(bins))`, where `bins` is the return value from `mlab.specgram()`

*kwargs:*

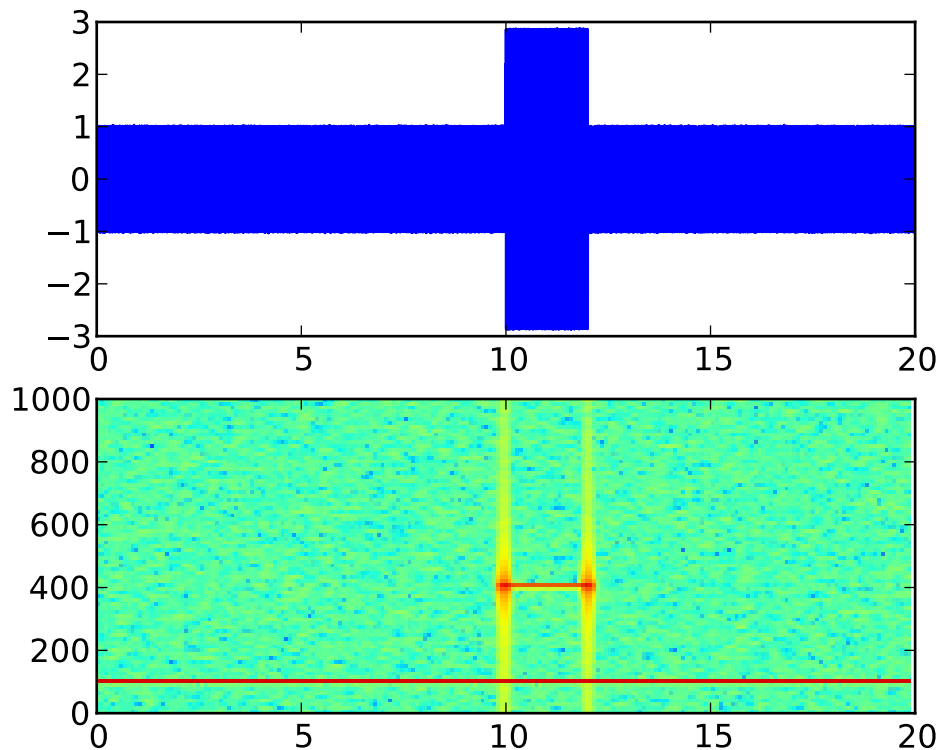
Additional kwargs are passed on to `imshow` which makes the spectrogram image

Return value is (*Pxx*, *freqs*, *bins*, *im*):

- *bins* are the time points the spectrogram is calculated over
- *freqs* is an array of frequencies
- *Pxx* is a `len(times) x len(freqs)` array of power
- *im* is a `matplotlib.image.AxesImage` instance

Note: If  $x$  is real (i.e. non-complex), only the positive spectrum is shown. If  $x$  is complex, both positive and negative parts of the spectrum are shown. This can be overridden using the *sides* keyword argument.

**Example:**



**spy**(*Z*, *precision*=0, *marker*=None, *markersize*=None, *aspect*='equal', *\*\*kwargs*)  
call signature:

```
spy(Z, precision=0, marker=None, markersize=None,  
    aspect='equal', **kwargs)
```

**spy**(*Z*) plots the sparsity pattern of the 2-D array *Z*.

If *precision* is 0, any non-zero value will be plotted; else, values of  $|Z| > precision$  will be plotted.

For `scipy.sparse.spmatrix` instances, there is a special case: if *precision* is 'present', any value present in the array will be plotted, even if it is identically zero.

The array will be plotted as it would be printed, with the first index (row) increasing down and the second index (column) increasing to the right.

By default *aspect* is 'equal', so that each array element occupies a square space; set the *aspect* kwarg to 'auto' to allow the plot to fill the plot box, or to any scalar number to specify the aspect ratio of an array element directly.

Two plotting styles are available: image or marker. Both are available for full arrays, but only the marker style works for `scipy.sparse.spmatrix` instances.

If *marker* and *markersize* are *None*, an image will be returned and any remaining kwargs are passed to `imshow()`; else, a `Line2D` object will be returned with the value of *marker* determining the marker type, and any remaining kwargs passed to the `plot()` method.

If *marker* and *markersize* are *None*, useful kwargs include:

- *cmap*
- *alpha*

**See Also:**

`imshow()` For image options.

For controlling colors, e.g. cyan background and red marks, use:

```
cmap = mcolors.ListedColormap(['c', 'r'])
```

If *marker* or *markersize* is not *None*, useful kwargs include:

- *marker*
- *markersize*
- *color*

Useful values for *marker* include:

- 's' square (default)
- 'o' circle
- '.' point
- ',' pixel

**See Also:**

`plot()` For plotting options

**start\_pan**(*x*, *y*, *button*)

Called when a pan operation has started.

*x*, *y* are the mouse coordinates in display coords. *button* is the mouse button number:

- 1: LEFT
- 2: MIDDLE
- 3: RIGHT

**Note:** Intended to be overridden by new projection types.

**stem**(*x*, *y*, *linefmt*='b-', *markerfmt*='bo', *basefmt*='r-', *bottom*=*None*, *label*=*None*)

call signature:

```
stem(x, y, linefmt='b-', markerfmt='bo', basefmt='r-')
```

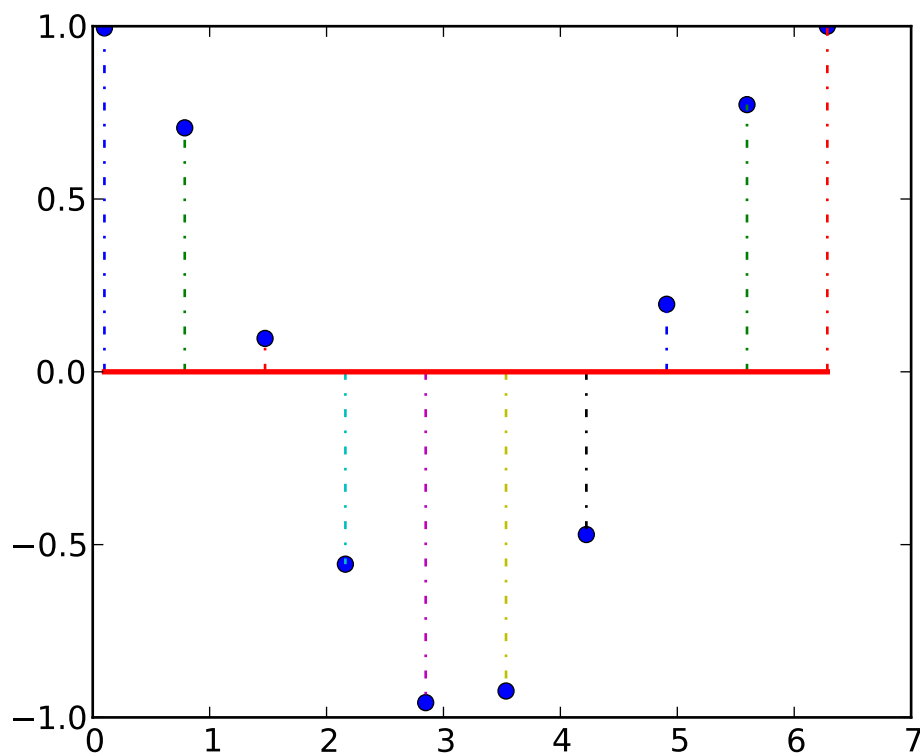
A stem plot plots vertical lines (using *linefmt*) at each *x* location from the baseline to *y*, and places a marker there using *markerfmt*. A horizontal line at 0 is plotted using *basefmt*.

Return value is a tuple (*markerline*, *stemlines*, *baseline*).

#### See Also:

This [document](#) for details.

#### Example:



```
step(x, y, *args, **kwargs)
```

call signature:

```
step(x, y, *args, **kwargs)
```

Make a step plot. Additional keyword args to `step()` are the same as those for `plot()`.

*x* and *y* must be 1-D sequences, and it is assumed, but not checked, that *x* is uniformly increasing.

Keyword arguments:

**where:** [ 'pre' | 'post' | 'mid' ] If 'pre', the interval from *x*[*i*] to *x*[*i*+1] has level *y*[*i*+1]

If 'post', that interval has level *y*[*i*]

If 'mid', the jumps in y occur half-way between the x-values.

**table**(\*\*kwargs)

call signature:

```
table(cellText=None, cellColours=None,
      cellLoc='right', colWidths=None,
      rowLabels=None, rowColours=None, rowLoc='left',
      colLabels=None, colColours=None, colLoc='center',
      loc='bottom', bbox=None):
```

Add a table to the current axes. Returns a `matplotlib.table.Table` instance. For finer grained control over tables, use the `Table` class and add it to the axes with `add_table()`.

Thanks to John Gill for providing the class and table.

kwargs control the `Table` properties:

| Property                | Description  |
|-------------------------|--|
| <code>agg_filter</code> | unknown  |
| <code>alpha</code>      | float (0.0 transparent through 1.0 opaque)         |
| <code>animated</code>   | [True   False]                                     |
| <code>axes</code>       | an <code>Axes</code> instance                      |
| <code>clip_box</code>   | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>    | [True   False]                                     |
| <code>clip_path</code>  | [ (Path, Transform)   Patch   None ]               |
| <code>contains</code>   | a callable function                                |
| <code>figure</code>     | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontsize</code>   | a float in points                                  |
| <code>gid</code>        | an id string                                       |
| <code>label</code>      | any string   |
| <code>lod</code>        | [True   False]                                     |
| <code>picker</code>     | [None float boolean callable]                      |
| <code>rasterized</code> | [True   False   None]                              |
| <code>snap</code>       | unknown  |
| <code>transform</code>  | <code>Transform</code> instance                    |
| <code>url</code>        | a url string                                       |
| <code>visible</code>    | [True   False]                                     |
| <code>zorder</code>     | any number   |

**text**(x, y, s, fontdict=None, withdash=False, \*\*kwargs)

call signature:

```
text(x, y, s, fontdict=None, **kwargs)
```

Add text in string *s* to axis at location *x*, *y*, data coordinates.

Keyword arguments:

**fontdict**: A dictionary to override the default text properties. If *fontdict* is *None*, the defaults are determined by your rc parameters.



***withdash***: [ False | True ] Creates a `TextWithDash` instance instead of a `Text` instance.

Individual keyword arguments can be used to override any given parameter:

```
text(x, y, s, fontsize=12)
```

The default transform specifies that text is in data coords, alternatively, you can specify text in axis coords (0,0 is lower-left and 1,1 is upper-right). The example below places text in the center of the axes:

```
text(0.5, 0.5, 'matplotlib',
     horizontalalignment='center',
     verticalalignment='center',
     transform = ax.transAxes)
```

You can put a rectangular box around the text instance (eg. to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of `matplotlib.patches.Rectangle` properties. For example:

```
text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

Valid kwargs are `matplotlib.text.Text` properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)                                     |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]    |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                 |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |

Table 45.29 – continued from

|  |  |
|--|--|
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>                           | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'ultra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>                         | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

**tick\_params**(*axis*='both', *\*\*kwargs*)

Convenience method for changing the appearance of ticks and tick labels.

Keyword arguments:

**axis** ['x' | 'y' | 'both'] Axis on which to operate; default is 'both'.

**reset** [True | False] If *True*, set all parameters to defaults before processing other keyword arguments. Default is *False*.

**which** ['major' | 'minor' | 'both'] Default is 'major': apply arguments to major ticks only.

**direction** ['in' | 'out'] Puts ticks inside or outside the axes.

**length** Tick length in points.

**width** Tick width in points.

**color** Tick color; accepts any mpl color spec.

**pad** Distance in points between tick and label.

**labelsize** Tick label font size in points or as a string (e.g. 'large').

**labelcolor** Tick label color; mpl color spec.

**colors** Changes the tick color and the label color to the same value: mpl color spec.

**zorder** Tick and label zorder.

**bottom, top, left, right** Boolean or ['on' | 'off'], controls whether to draw the respective ticks.

**labelbottom, labeltop, labelleft, labelright** Boolean or ['on' | 'off'], controls whether to draw the respective tick labels.

Example:

```
ax.tick_params(direction='out', length=6, width=2, colors='r')
```

This will make all major ticks be red, pointing out of the box, and with dimensions 6 points by 2 points. Tick labels will also be red.

**ticklabel\_format(\*\*kwargs)**

Convenience method for manipulating the `ScalarFormatter` used by default for linear axes.

Optional keyword arguments:

| Key-word           | Description   |
|--------------------|---|
| <i>style</i>       | [ 'sci' (or 'scientific')   'plain' ] plain turns off scientific notation   |
| <i>scilimits</i>   | (m, n), pair of integers; if <i>style</i> is 'sci', scientific notation will be used for numbers outside the range $10^{-m}$ to $10^n$ . Use (0,0) to include all numbers.  |
| <i>use-Offset</i>  | [True   False   offset]; if True, the offset will be calculated as needed; if False, no offset will be used; if a numeric offset is specified, it will be used.   |
| <i>axis</i>        | [ 'x'   'y'   'both' ]  |
| <i>use-Lo-cale</i> | If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the <code>axes.formatter.use_locale</code> rparam. |

Only the major ticks are affected. If the method is called when the `ScalarFormatter` is not the `Formatter` being used, an `AttributeError` will be raised.

**tricontour(\*args, \*\*kwargs)**

`tricontour()` and `tricontourf()` draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either:

```
tricontour(triangulation, ...)
```

where `triangulation` is a `Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See `Triangulation` for a explanation of these possibilities.

The remaining arguments may be:

```
tricontour(..., Z)
```

where  $Z$  is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour  $N$  automatically-chosen levels.

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence  $V$

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in  $V$

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

$C = \text{tricontour}(\dots)$  returns a `TriContourSet` object.

Optional keyword arguments:

**colors:** [ **None** | **string** | (**mpl\_colors**) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** **float** The alpha blending value

**cmap:** [ **None** | **Colormap** ] A cm `Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.

**norm:** [ **None** | **Normalize** ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [**level0**, **level1**, ..., **leveln**] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ **None** | **'upper'** | **'lower'** | **'image'** ] If *None*, the first value of  $Z$  will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if  $X$  and  $Y$  are specified in the call to contour.

**extent:** [ **None** | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of  $Z[0,0]$  is the center of the pixel, not a corner.

If *origin* is *None*, then  $(x0, y0)$  is the position of  $Z[0,0]$ , and  $(x1, y1)$  is the position of  $Z[-1,-1]$ .

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ *'neither'* | *'both'* | *'min'* | *'max'* ] Unless this is *'neither'*, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ *None* | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

**linewidths:** [ *None* | number | tuple of numbers ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ *None* | *'solid'* | *'dashed'* | *'dashdot'* | *'dotted'* ] If *linestyles* is *None*, the *'solid'* is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

tricontourf-only keyword arguments:

**antialiased:** [ *True* | *False* ] enable antialiasing

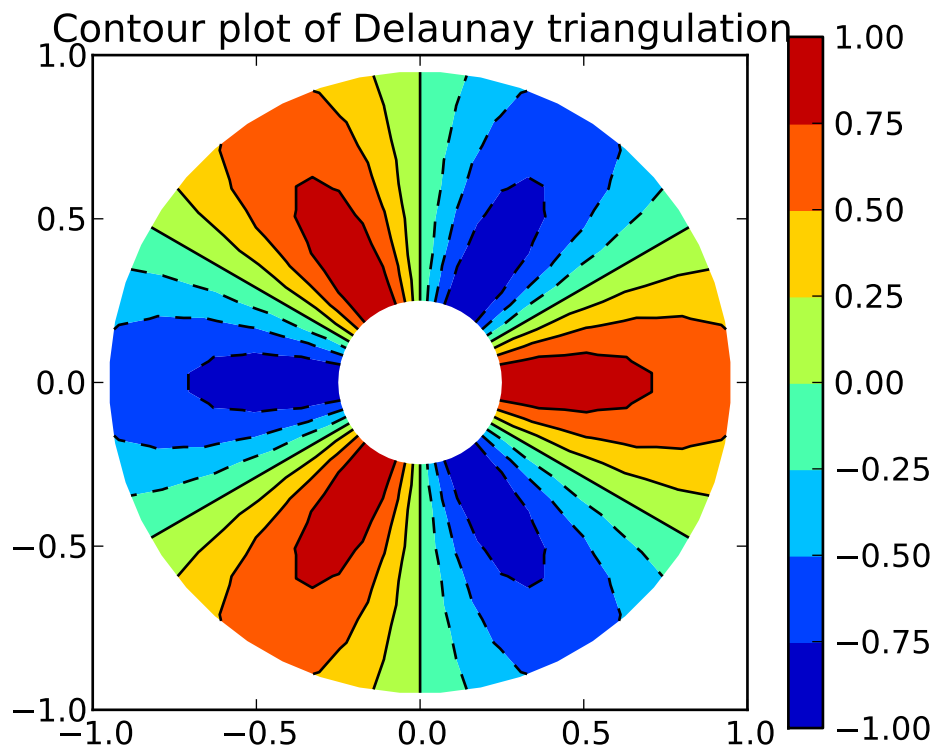
**nchunk:** [ *0* | integer ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

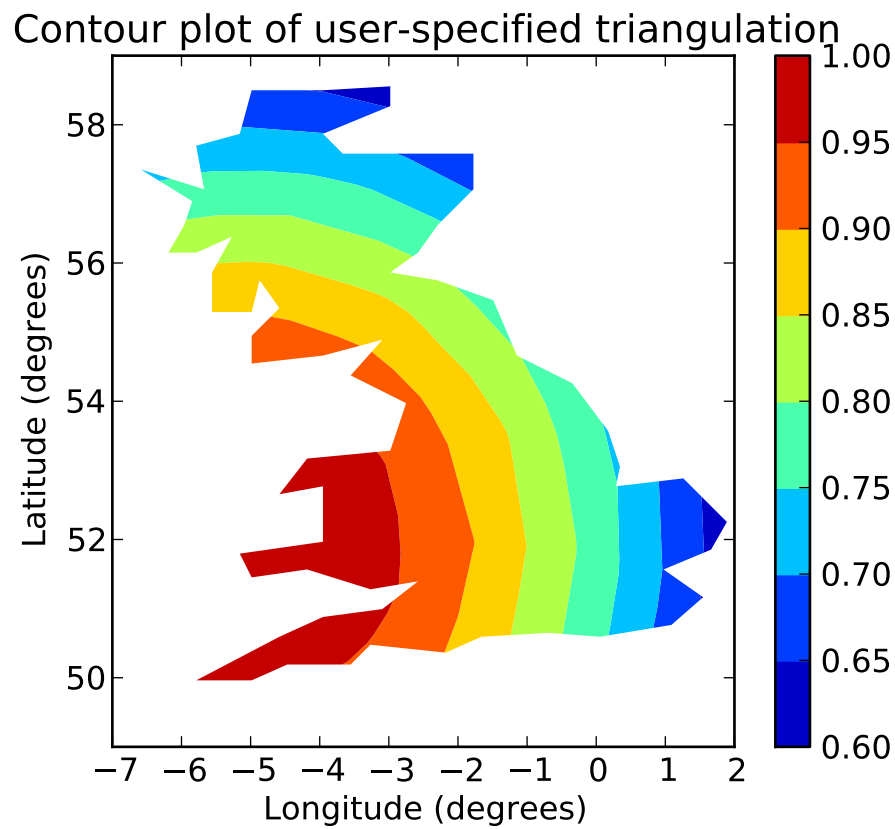
Note: `tricontourf` fills intervals that are closed at the top; that is, for boundaries  $z1$  and  $z2$ , the filled region is:

$$z1 < z \leq z2$$

There is one exception: if the lowest boundary coincides with the minimum value of the  $z$  array, then that minimum value will be included in the lowest interval.

**Examples:**





**tricontourf**(\*args, \*\*kwargs)

`tricontour()` and `tricontourf()` draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either:

```
tricontour(triangulation, ...)
```

where `triangulation` is a `Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See `Triangulation` for a explanation of these possibilities.

The remaining arguments may be:

```
tricontour(..., Z)
```

where  $Z$  is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour  $N$  automatically-chosen levels.

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence  $V$

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in  $V$

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`C = tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

**colors:** [ **None** | **string** | (**mpl\_colors**) ] If *None*, the colormap specified by `cmap` will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** **float** The alpha blending value

**cmap:** [ **None** | **Colormap** ] A cm `Colormap` instance or *None*. If `cmap` is *None* and `colors` is *None*, a default `Colormap` is used.

**norm:** [ **None** | **Normalize** ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If `norm` is *None* and `colors` is *None*, the default linear scaling is used.

**levels** [**level0**, **level1**, ..., **leveln**] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ **None** | **'upper'** | **'lower'** | **'image'** ] If *None*, the first value of  $Z$  will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if  $X$  and  $Y$  are specified in the call to contour.

**extent:** [ **None** | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of  $Z[0,0]$  is the center of the pixel, not a corner.



If *origin* is *None*, then  $(x0, y0)$  is the position of  $Z[0,0]$ , and  $(x1, y1)$  is the position of  $Z[-1,-1]$ .

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ **None** | **ticker.Locator subclass** ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ **'neither'** | **'both'** | **'min'** | **'max'** ] Unless this is **'neither'**, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ **None** | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

**linewidths:** [ **None** | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ **None** | **'solid'** | **'dashed'** | **'dashdot'** | **'dotted'** ] If *linestyles* is *None*, the **'solid'** is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

tricontourf-only keyword arguments:

**antialiased:** [ **True** | **False** ] enable antialiasing

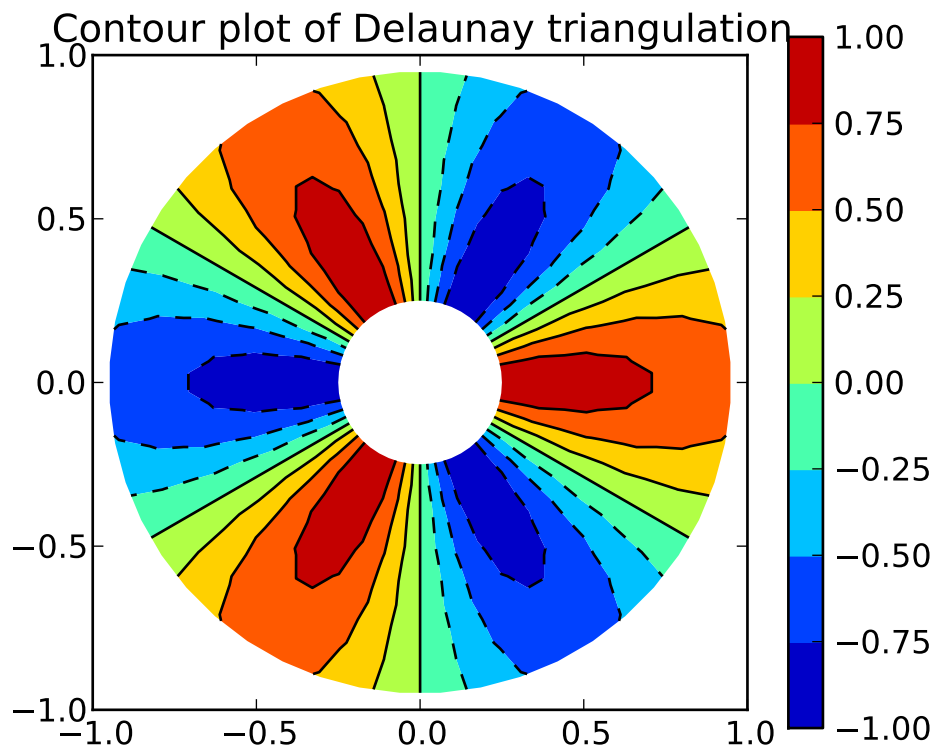
**nchunk:** [ **0** | **integer** ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

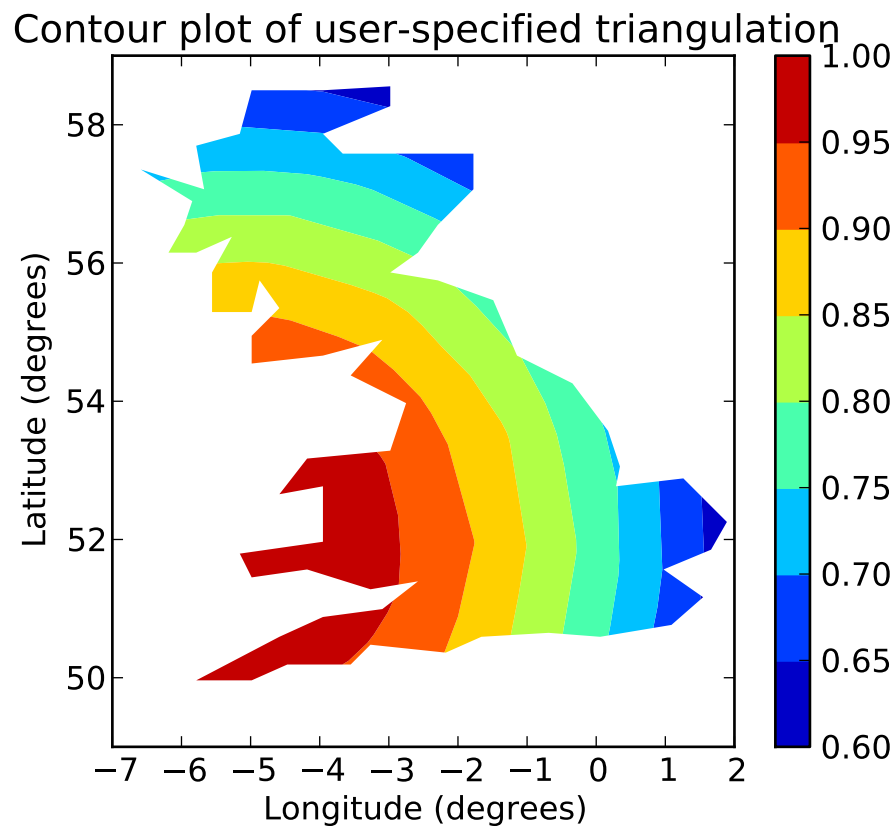
Note: `tricontourf` fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < z \leq z2$$

There is one exception: if the lowest boundary coincides with the minimum value of the  $z$  array, then that minimum value will be included in the lowest interval.

**Examples:**





**tripcolor**(\*args, \*\*kwargs)

Create a pseudocolor plot of an unstructured triangular grid to the [Axes](#).

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where triangulation is a [Triangulation](#) object, or

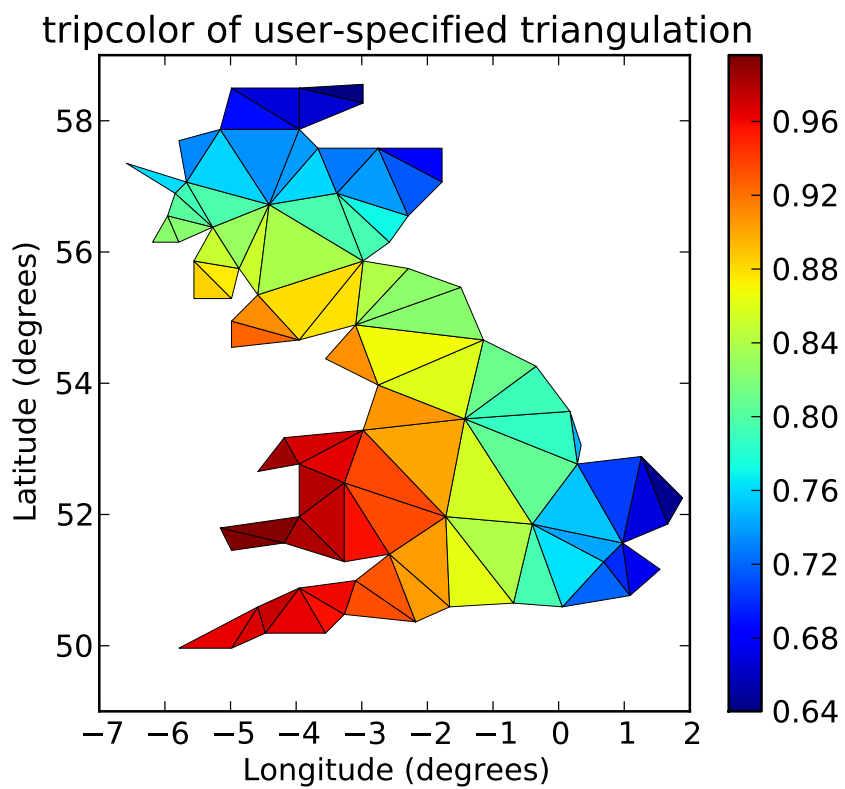
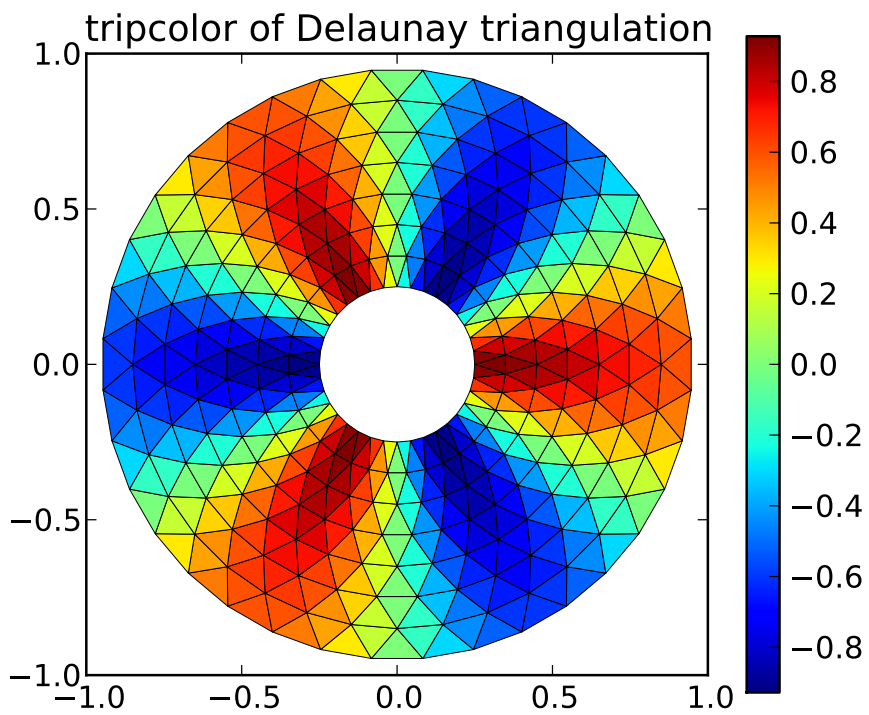
```
tripcolor(x, y, ...)
tripcolor(x, y, triangles, ...)
tripcolor(x, y, triangles=triangles, ...)
tripcolor(x, y, mask=mask, ...)
tripcolor(x, y, triangles, mask=mask, ...)
```

in which case a [Triangulation](#) object will be created. See [Triangulation](#) for a explanation of these possibilities.

The next argument must be *C*, the array of color values, one per point in the triangulation. The colors used for each triangle are from the mean *C* of the triangle's three points.

The remaining kwargs are the same as for [pcolor\(\)](#).

**Example:**



**triplot**(\*args, \*\*kwargs)

Draw a unstructured triangular grid as lines and/or markers to the [Axes](#).

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

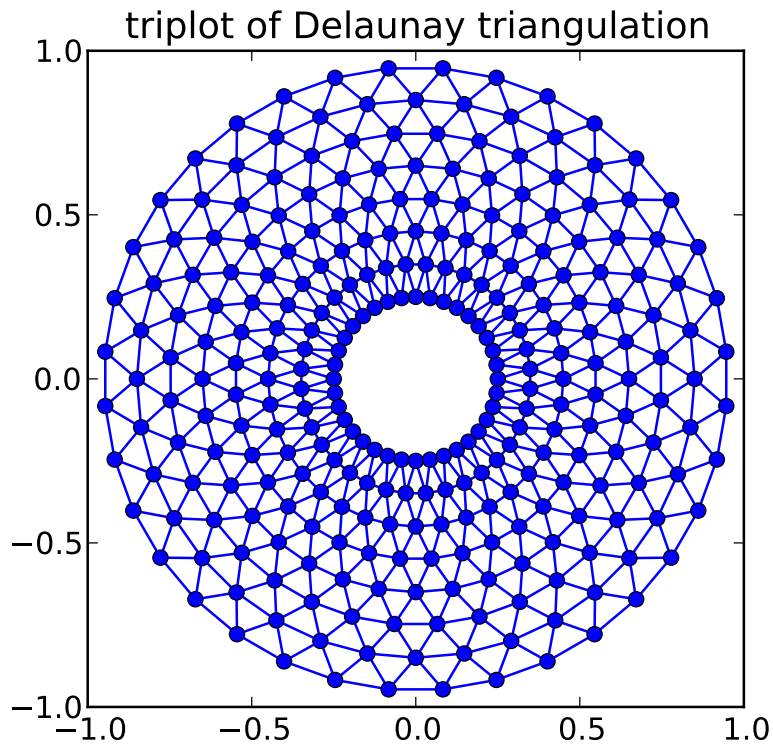
where triangulation is a `Triangulation` object, or

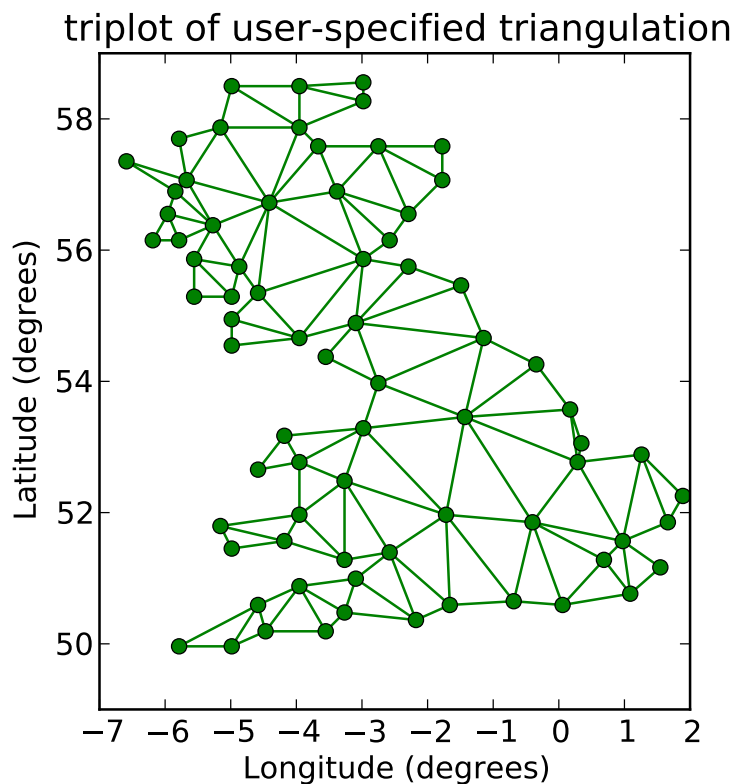
```
triplot(x, y, ...)
triplot(x, y, triangles, ...)
triplot(x, y, triangles=triangles, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See [Triangulation](#) for a explanation of these possibilities.

The remaining args and kwargs are the same as for [plot\(\)](#).

**Example:**



**twinx()**

call signature:

```
ax = twinx()
```

create a twin of Axes for generating a plot with a shared x-axis but independent y axis. The y-axis of self will have ticks on left and the returned axes will have ticks on the right

**twiny()**

call signature:

```
ax = twiny()
```

create a twin of Axes for generating a plot with a shared y-axis but independent x axis. The x-axis of self will have ticks on bottom and the returned axes will have ticks on the top

**update\_datalim**(*xy*, *updatex=True*, *updatey=True*)

Update the data lim bbox with seq of xy tups or equiv. 2-D array

**update\_datalim\_bounds**(*bounds*)

Update the datalim to include the given [Bbox](#) bounds

**update\_datalim\_numerix**(*x*, *y*)

Update the data lim bbox with seq of xy tups

**vlines**(*x*, *ymin*, *ymax*, *colors*='k', *linestyles*='solid', *label*=", \*\**kwargs*)  
 call signature:

```
vlines(x, ymin, ymax, color='k', linestyle='solid')
```

Plot vertical lines at each *x* from *ymin* to *ymax*. *ymin* or *ymax* can be scalars or `len(x)` numpy arrays. If they are scalars, then the respective values are constant, else the heights of the lines are determined by *ymin* and *ymax*.

**colors** a line collections color args, either a single color or a `len(x)` list of colors

**linestyles**

one of [ 'solid' | 'dashed' | 'dashdot' | 'dotted' ]

Returns the `matplotlib.collections.LineCollection` that was added.

*kwargs* are `LineCollection` properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float or None  |
| <code>animated</code>  | [True   False]   |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans  |
| <code>array</code>   | unknown  |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>clim</code>  | a length 2 sequence of floats  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>cmap</code>  | a colormap or registered colormap name   |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                                |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                                |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]        |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>segments</code>  | unknown  |

Continued on next page

Table 45.30 – continued from previous page

|                        |                                 |
|------------------------|---------------------------------|
| <code>snap</code>      | unknown                         |
| <code>transform</code> | <code>Transform</code> instance |
| <code>url</code>       | a url string                    |
| <code>urls</code>      | unknown                         |
| <code>verts</code>     | unknown                         |
| <code>visible</code>   | [True   False]                  |
| <code>zorder</code>    | any number                      |

**`xaxis_date`**(*tz=None*)

Sets up x-axis ticks and labels that treat the x data as dates.

*tz* is a timezone string or `tzinfo` instance. Defaults to rc value.

**`xaxis_inverted`**()

Returns True if the x-axis is inverted.

**`xcorr`**(*x, y, normed=True, detrend=<function detrend\_none at 0x3110050>, usevlines=True, maxlags=10, \*\*kwargs*)  
call signature:

```
def xcorr(self, x, y, normed=True, detrend=mlab.detrend_none,
          usevlines=True, maxlags=10, **kwargs):
```

Plot the cross correlation between *x* and *y*. If *normed = True*, normalize the data by the cross correlation at 0-th lag. *x* and *y* are detrended by the *detrend* callable (default no normalization). *x* and *y* must be equal length.

Data are plotted as `plot(lags, c, **kwargs)`

Return value is a tuple (*lags, c, line*) where:

- *lags* are a length  $2 \cdot \text{maxlags} + 1$  lag vector
- *c* is the  $2 \cdot \text{maxlags} + 1$  auto correlation vector
- *line* is a `Line2D` instance returned by `plot()`.

The default *linestyle* is *None* and the default *marker* is ‘o’, though these can be overridden with keyword args. The cross correlation is performed with `numpy.correlate()` with *mode = 2*.

If *usevlines* is *True*:

`vlines()` rather than `plot()` is used to draw vertical lines from the origin to the `xcorr`. Otherwise the plotstyle is determined by the *kwargs*, which are `Line2D` properties.

The return value is a tuple (*lags, c, linecol, b*) where *linecol* is the `matplotlib.collections.LineCollection` instance and *b* is the *x*-axis.

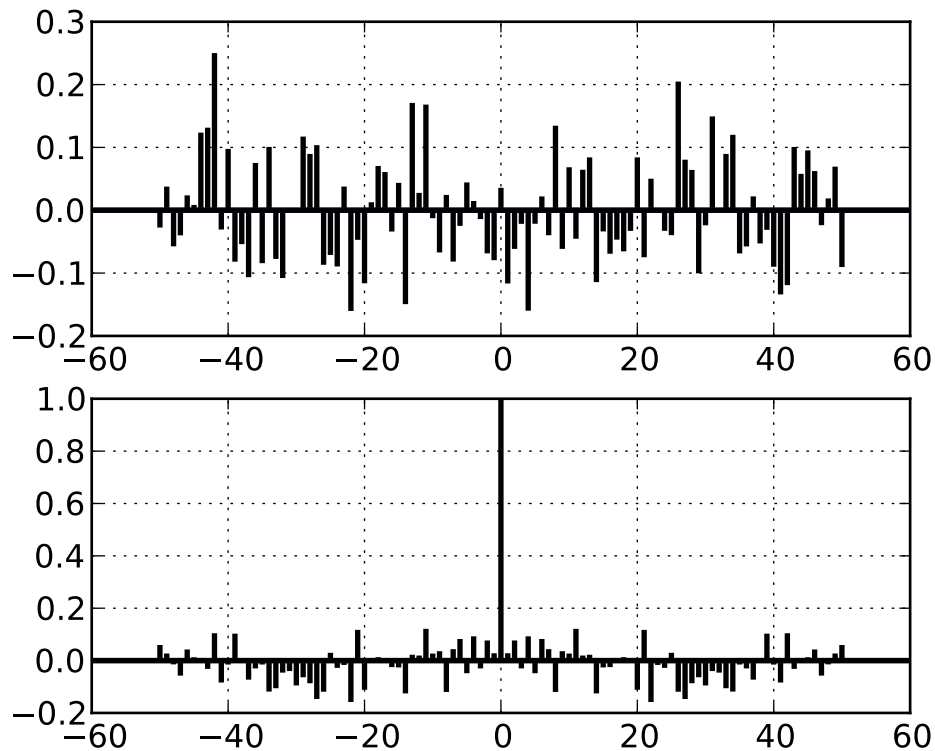
*maxlags* is a positive integer detailing the number of lags to show. The default value of *None* will return all  $(2 \cdot \text{len}(x) - 1)$  lags.

**Example:**



`xcorr()` above, and `acorr()` below.

**Example:**



**`yaxis_date(tz=None)`**

Sets up y-axis ticks and labels that treat the y data as dates.

*tz* is a timezone string or `tzinfo` instance. Defaults to rc value.

**`yaxis_inverted()`**

Returns True if the y-axis is inverted.

## Subplot

alias of `AxesSubplot`

**`class SubplotBase(fig, *args, **kwargs)`**

Base class for subplots, which are `Axes` instances with additional methods to facilitate generating and manipulating a set of `Axes` within a figure.

*fig* is a `matplotlib.figure.Figure` instance.

*args* is the tuple (*numRows*, *numCols*, *plotNum*), where the array of subplots in the figure has dimensions *numRows*, *numCols*, and where *plotNum* is the number of the subplot being created. *plotNum* starts at 1 in the upper left corner and increases to the right.

If *numRows* <= *numCols* <= *plotNum* < 10, *args* can be the decimal integer *numRows* \* 100 + *numCols* \* 10 + *plotNum*.

**change\_geometry**(*numrows, numcols, num*)  
change subplot geometry, eg. from 1,1,1 to 2,2,3

**get\_geometry**()  
get the subplot geometry, eg 2,2,3

**get\_subplotspec**()  
get the SubplotSpec instance associated with the subplot

**is\_first\_col**()

**is\_first\_row**()

**is\_last\_col**()

**is\_last\_row**()

**label\_outer**()  
set the visible property on ticklabels so xticklabels are visible only if the subplot is in the last row and yticklabels are visible only if the subplot is in the first column

**set\_subplotspec**(*subplotspec*)  
set the SubplotSpec instance associated with the subplot

**update\_params**()  
update the subplot position from fig.subplotspars

**set\_default\_color\_cycle**(*clist*)  
Change the default cycle of colors that will be used by the plot command. This must be called before creating the [Axes](#) to which it will apply; it will apply to all future axes.

*clist* is a sequence of mpl color specifiers.

See also: [set\\_color\\_cycle\(\)](#).

**Note:** Deprecated 2010/01/03. Set rcParams['axes.color\_cycle'] directly.

**subplot\_class\_factory**(*axes\_class=None*)

# AXIS

## 46.1 matplotlib.axis

Classes for the ticks and x and y axis

**class** **Axis**(*axes*, *pickradius=15*)

Bases: `matplotlib.artist.Artist`

Public attributes

- `axes.transData` - transform data coords to display coords
- `axes.transAxes` - transform axis coords to display coords
- `labelpad` - number of points between the axis and its label

Init the axis with the parent Axes instance

**axis\_date**(*tz=None*)

Sets up x-axis ticks and labels that treat the x data as dates. *tz* is a `tzinfo` instance or a timezone string. This timezone is used to create date labels.

**cla**()

clear the current axis

**convert\_units**(*x*)

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

Draw the axis lines, grid lines, tick lines and labels

**get\_children**()

**get\_data\_interval**()

return the Interval instance for this axis data limits

**get\_gridlines**()

Return the grid lines as a list of Line2D instance

**get\_label**()

Return the axis label as a Text instance

**get\_label\_text**()

Get the text of the label

**get\_major\_formatter()**  
Get the formatter of the major ticker

**get\_major\_locator()**  
Get the locator of the major ticker

**get\_major\_ticks(*numticks=None*)**  
get the tick instances; grow as necessary

**get\_majorticklabels()**  
Return a list of Text instances for the major ticklabels

**get\_majorticklines()**  
Return the major tick lines as a list of Line2D instances

**get\_majorticklocs()**  
Get the major tick locations in data coordinates as a numpy array

**get\_minor\_formatter()**  
Get the formatter of the minor ticker

**get\_minor\_locator()**  
Get the locator of the minor ticker

**get\_minor\_ticks(*numticks=None*)**  
get the minor tick instances; grow as necessary

**get\_minorticklabels()**  
Return a list of Text instances for the minor ticklabels

**get\_minorticklines()**  
Return the minor tick lines as a list of Line2D instances

**get\_minorticklocs()**  
Get the minor tick locations in data coordinates as a numpy array

**get\_offset\_text()**  
Return the axis offsetText as a Text instance

**get\_pickradius()**  
Return the depth of the axis used by the picker

**get\_scale()**

**get\_smart\_bounds()**  
get whether the axis has smart bounds

**get\_ticklabel\_extents(*renderer*)**  
Get the extents of the tick labels on either side of the axes.

**get\_ticklabels(*minor=False*)**  
Return a list of Text instances for ticklabels

**get\_ticklines(*minor=False*)**  
Return the tick lines as a list of Line2D instances

**get\_ticklocs**(*minor=False*)

Get the tick locations in data coordinates as a numpy array

**get\_tightbbox**(*renderer*)

Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and offset-Text.

**get\_transform**()

**get\_units**()

return the units for axis

**get\_view\_interval**()

return the Interval instance for this axis view limits

**grid**(*b=None, which='major', \*\*kwargs*)

Set the axis grid on or off; *b* is a boolean. Use *which* = 'major' | 'minor' | 'both' to set the grid for major or minor ticks.

If *b* is *None* and `len(kwargs)==0`, toggle the grid state. If *kwargs* are supplied, it is assumed you want the grid on and *b* will be set to *True*.

*kwargs* are used to set the line properties of the grids, eg,

```
xax.grid(color='r', linestyle='-', linewidth=2)
```

**have\_units**()

**iter\_ticks**()

Iterate through all of the major and minor ticks.

**limit\_range\_for\_scale**(*vmin, vmax*)

**pan**(*numsteps*)

Pan *numsteps* (can be positive or negative)

**reset\_ticks**()

**set\_clip\_path**(*clippath, transform=None*)

**set\_data\_interval**()

set the axis data limits

**set\_default\_intervals**()

set the default limits for the axis data and view interval if they are not mutated

**set\_label\_coords**(*x, y, transform=None*)

Set the coordinates of the label. By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If *None*, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

**set\_label\_text**(*label, fontdict=None, \*\*kwargs*)

Sets the text value of the axis label

ACCEPTS: A string value for the label

**set\_major\_formatter**(*formatter*)

Set the formatter of the major ticker

ACCEPTS: A [Formatter](#) instance

**set\_major\_locator**(*locator*)

Set the locator of the major ticker

ACCEPTS: a [Locator](#) instance

**set\_minor\_formatter**(*formatter*)

Set the formatter of the minor ticker

ACCEPTS: A [Formatter](#) instance

**set\_minor\_locator**(*locator*)

Set the locator of the minor ticker

ACCEPTS: a [Locator](#) instance

**set\_pickradius**(*pickradius*)

Set the depth of the axis used by the picker

ACCEPTS: a distance in points

**set\_scale**(*value*, *\*\*kwargs*)

**set\_smart\_bounds**(*value*)

set the axis to have smart bounds

**set\_tick\_params**(*which*='major', *reset*=False, *\*\*kw*)

Set appearance parameters for ticks and ticklabels.

For documentation of keyword arguments, see [matplotlib.axes.Axes.tick\\_params\(\)](#).

**set\_ticklabels**(*ticklabels*, *\*args*, *\*\*kwargs*)

Set the text values of the tick labels. Return a list of Text instances. Use kwarg *minor=True* to select minor ticks. All other kwargs are used to update the text object properties. As for [get\\_ticklabels](#), *label1* (left or bottom) is affected for a given tick only if its *label1On* attribute is True, and similarly for *label2*. The list of returned label text objects consists of all such *label1* objects followed by all such *label2* objects.

The input *ticklabels* is assumed to match the set of tick locations, regardless of the state of *label1On* and *label2On*.

ACCEPTS: sequence of strings

**set\_ticks**(*ticks*, *minor*=False)

Set the locations of the tick marks from sequence ticks

ACCEPTS: sequence of floats

**set\_units**(*u*)

set the units for axis

ACCEPTS: a units tag

**set\_view\_interval**(*vmin, vmax, ignore=False*)

**update\_units**(*data*)

introspect *data* for units converter and update the axis.converter instance if necessary. Return *True* if *data* is registered for unit conversion.

**zoom**(*direction*)

Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

**class Tick**(*axes, loc, label, size=None, width=None, color=None, tickdir=None, pad=None, label-size=None, labelcolor=None, zorder=None, gridOn=None, tick1On=True, tick2On=True, label1On=True, label2On=False, major=True*)

Bases: [matplotlib.artist.Artist](#)

Abstract base class for the axis ticks, grid lines and labels

1 refers to the bottom of the plot for xticks and the left for yticks 2 refers to the top of the plot for xticks and the right for yticks

Publicly accessible attributes:

**tick1line** a Line2D instance

**tick2line** a Line2D instance

**gridline** a Line2D instance

**label1** a Text instance

**label2** a Text instance

**gridOn** a boolean which determines whether to draw the tickline

**tick1On** a boolean which determines whether to draw the 1st tickline

**tick2On** a boolean which determines whether to draw the 2nd tickline

**label1On** a boolean which determines whether to draw tick label

**label2On** a boolean which determines whether to draw tick label

bbox is the Bound2D bounding box in display coords of the Axes loc is the tick location in data coords size is the tick size in points

**apply\_tickdir**(*tickdir*)

Calculate self.\_pad and self.\_tickmarkers

**contains**(*mouseevent*)

Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

**draw**(*artist, renderer, \*args, \*\*kwargs*)

**get\_children**()

**get\_loc**()

Return the tick location (data coords) as a scalar

**get\_pad()**

Get the value of the tick label pad in points

**get\_pad\_pixels()****get\_view\_interval()**

return the view Interval instance for the axis this tick is ticking

**set\_clip\_path(*clippath*, *transform=None*)**

Set the artist's clip path, which may be:

- a [Patch](#) (or subclass) instance
- a **Path** instance, in which case an optional [Transform](#) instance may be provided, which will be applied to the path before using it for clipping.
- *None*, to remove the clipping path

For efficiency, if the path happens to be an axis-aligned rectangle, this method will set the clipping box to the corresponding rectangle and set the clipping path to *None*.

ACCEPTS: [ ([Path](#), [Transform](#)) | [Patch](#) | None ]**set\_label(*s*)**

Set the text of ticklabel

ACCEPTS: str

**set\_label1(*s*)**

Set the text of ticklabel

ACCEPTS: str

**set\_label2(*s*)**

Set the text of ticklabel2

ACCEPTS: str

**set\_pad(*val*)**

Set the tick label pad in points

ACCEPTS: float

**class Ticker()****class XAxis(*axes*, *pickradius=15*)**Bases: [matplotlib.axis.Axis](#)

Init the axis with the parent Axes instance

**contains(*mouseevent*)**

Test whether the mouse event occurred in the x axis.

**get\_data\_interval()**

return the Interval instance for this axis data limits

**get\_label\_position()**

Return the label position (top or bottom)



**get\_minpos()**

**get\_text\_heights**(*renderer*)

Returns the amount of space one should reserve for text above and below the axes. Returns a tuple (above, below)

**get\_ticks\_position()**

Return the ticks position (top, bottom, default or unknown)

**get\_view\_interval()**

return the Interval instance for this axis view limits

**set\_data\_interval**(*vmin, vmax, ignore=False*)

set the axis data limits

**set\_default\_intervals()**

set the default limits for the axis interval if they are not mutated

**set\_label\_position**(*position*)

Set the label position (top or bottom)

ACCEPTS: [ 'top' | 'bottom' ]

**set\_ticks\_position**(*position*)

Set the ticks position (top, bottom, both, default or none) both sets the ticks to appear on both positions, but does not change the tick labels. 'default' resets the tick positions to the default: ticks on both positions, labels at bottom. 'none' can be used if you don't want any ticks. 'none' and 'both' affect only the ticks, not the labels.

ACCEPTS: [ 'top' | 'bottom' | 'both' | 'default' | 'none' ]

**set\_view\_interval**(*vmin, vmax, ignore=False*)

If *ignore* is *False*, the order of *vmin*, *vmax* does not matter; the original axis orientation will be preserved. In addition, the view limits can be expanded, but will not be reduced. This method is for mpl internal use; for normal use, see [set\\_xlim\(\)](#).

**tick\_bottom()**

use ticks only on bottom

**tick\_top()**

use ticks only on top

**class XTick**(*axes, loc, label, size=None, width=None, color=None, tickdir=None, pad=None, labelsize=None, labelcolor=None, zorder=None, gridOn=None, tick1On=True, tick2On=True, label1On=True, label2On=False, major=True*)

Bases: [matplotlib.axis.Tick](#)

Contains all the Artists needed to make an x tick - the tick line, the label text and the grid line

bbox is the Bound2D bounding box in display coords of the Axes loc is the tick location in data coords size is the tick size in points

**apply\_tickdir**(*tickdir*)

**get\_view\_interval()**

return the Interval instance for this axis view limits

**update\_position**(*loc*)

Set the location of tick in data coords with scalar *loc*

**class YAxis**(*axes, pickradius=15*)

Bases: `matplotlib.axis.Axis`

Init the axis with the parent Axes instance

**contains**(*mouseevent*)

Test whether the mouse event occurred in the y axis.

Returns *True* | *False*

**get\_data\_interval**()

return the Interval instance for this axis data limits

**get\_label\_position**()

Return the label position (left or right)

**get\_minpos**()

**get\_text\_widths**(*renderer*)

**get\_ticks\_position**()

Return the ticks position (left, right, both or unknown)

**get\_view\_interval**()

return the Interval instance for this axis view limits

**set\_data\_interval**(*vmin, vmax, ignore=False*)

set the axis data limits

**set\_default\_intervals**()

set the default limits for the axis interval if they are not mutated

**set\_label\_position**(*position*)

Set the label position (left or right)

ACCEPTS: [ 'left' | 'right' ]

**set\_offset\_position**(*position*)

**set\_ticks\_position**(*position*)

Set the ticks position (left, right, both, default or none) 'both' sets the ticks to appear on both positions, but does not change the tick labels. 'default' resets the tick positions to the default: ticks on both positions, labels at left. 'none' can be used if you don't want any ticks. 'none' and 'both' affect only the ticks, not the labels.

ACCEPTS: [ 'left' | 'right' | 'both' | 'default' | 'none' ]

**set\_view\_interval**(*vmin, vmax, ignore=False*)

If *ignore* is *False*, the order of *vmin*, *vmax* does not matter; the original axis orientation will be preserved. In addition, the view limits can be expanded, but will not be reduced. This method is for mpl internal use; for normal use, see `set_ylim()`.

**tick\_left**()

use ticks only on left

**tick\_right()**

use ticks only on right

**class YTick**(*axes, loc, label, size=None, width=None, color=None, tickdir=None, pad=None, labelsize=None, labelcolor=None, zorder=None, gridOn=None, tick1On=True, tick2On=True, label1On=True, label2On=False, major=True*)

Bases: [matplotlib.axis.Tick](#)

Contains all the Artists needed to make a Y tick - the tick line, the label text and the grid line

bbox is the Bound2D bounding box in display coords of the Axes loc is the tick location in data coords

size is the tick size in points

**apply\_tickdir**(*tickdir*)

**get\_view\_interval**()

return the Interval instance for this axis view limits

**update\_position**(*loc*)

Set the location of tick in data coords with scalar loc



# BACKENDS

## 47.1 `matplotlib.backend_bases`

Abstract base classes define the primitives that renderers and graphics contexts must implement to serve as a matplotlib backend

**RendererBase** An abstract base class to handle drawing/rendering operations.

**FigureCanvasBase** The abstraction layer that separates the `matplotlib.figure.Figure` from the back-end specific details like a user interface drawing area

**GraphicsContextBase** An abstract base class that provides color, line styles, etc...

**Event** The base class for all of the matplotlib event handling. Derived classes such as **KeyEvent** and **MouseEvent** store the meta data like keys and buttons pressed, x and y locations in pixel and **Axes** coordinates.

**ShowBase** The base class for the Show class of each interactive backend; the 'show' callable is then set to `Show.__call__`, inherited from ShowBase.

**class CloseEvent**(*name, canvas, guiEvent=None*)  
Bases: `matplotlib.backend_bases.Event`

An event triggered by a figure being closed

In addition to the **Event** attributes, the following event attributes are defined:

**class Cursors**()

**class DrawEvent**(*name, canvas, renderer*)  
Bases: `matplotlib.backend_bases.Event`

An event triggered by a draw operation on the canvas

In addition to the **Event** attributes, the following event attributes are defined:

**renderer** the **RendererBase** instance for the draw event

**class Event**(*name, canvas, guiEvent=None*)  
A matplotlib event. Attach additional attributes as defined in `FigureCanvasBase.mpl_connect()`.  
The following attributes are defined and shown with their default values

**name** the event name

*canvas* the FigureCanvas instance generating the event

*guiEvent* the GUI event that triggered the matplotlib event

**class FigureCanvasBase**(*figure*)

Bases: object

The canvas the figure renders into.

Public attributes

*figure* A `matplotlib.figure.Figure` instance

**blit**(*bbox=None*)

blit the canvas in bbox (default entire canvas)

**button\_press\_event**(*x, y, button, guiEvent=None*)

Backend derived classes should call this function on any mouse button press. *x,y* are the canvas coords: 0,0 is lower, left. *button* and *key* are as defined in `MouseEvent`.

This method will be call all functions connected to the 'button\_press\_event' with a `MouseEvent` instance.

**button\_release\_event**(*x, y, button, guiEvent=None*)

Backend derived classes should call this function on any mouse button release.

*x* the canvas coordinates where 0=left

*y* the canvas coordinates where 0=bottom

*guiEvent* the native UI event that generated the mpl event

This method will be call all functions connected to the 'button\_release\_event' with a `MouseEvent` instance.

**close\_event**(*guiEvent=None*)

This method will be called by all functions connected to the 'close\_event' with a `CloseEvent`

**draw**(*\*args, \*\*kwargs*)

Render the `Figure`

**draw\_cursor**(*event*)

Draw a cursor in the event.axes if inaxes is not None. Use native GUI drawing for efficiency if possible

**draw\_event**(*renderer*)

This method will be call all functions connected to the 'draw\_event' with a `DrawEvent`

**draw\_idle**(*\*args, \*\*kwargs*)

`draw()` only if idle; defaults to draw but backends can override

**enter\_notify\_event**(*guiEvent=None*)

Backend derived classes should call this function when entering canvas

*guiEvent* the native UI event that generated the mpl event

**flush\_events**()

Flush the GUI events for the figure. Implemented only for backends with GUIs.

**get\_default\_filetype()**

**get\_supported\_filetypes()**

**get\_supported\_filetypes\_grouped()**

**get\_width\_height()**

return the figure width and height in points or pixels (depending on the backend), truncated to integers

**grab\_mouse(ax)**

Set the child axes which are currently grabbing the mouse events. Usually called by the widgets themselves. It is an error to call this if the mouse is already grabbed by another axes.

**idle\_event(guiEvent=None)**

call when GUI is idle

**key\_press\_event(key, guiEvent=None)**

This method will be call all functions connected to the 'key\_press\_event' with a [KeyEvent](#)

**key\_release\_event(key, guiEvent=None)**

This method will be call all functions connected to the 'key\_release\_event' with a [KeyEvent](#)

**leave\_notify\_event(guiEvent=None)**

Backend derived classes should call this function when leaving canvas

**guiEvent** the native UI event that generated the mpl event

**motion\_notify\_event(x, y, guiEvent=None)**

Backend derived classes should call this function on any motion-notify-event.

**x** the canvas coordinates where 0=left

**y** the canvas coordinates where 0=bottom

**guiEvent** the native UI event that generated the mpl event

This method will be call all functions connected to the 'motion\_notify\_event' with a [MouseEvent](#) instance.

**mpl\_connect(s, func)**

Connect event with string *s* to *func*. The signature of *func* is:

```
def func(event)
```

where event is a [matplotlib.backend\\_bases.Event](#). The following events are recognized

- 'button\_press\_event'
- 'button\_release\_event'
- 'draw\_event'
- 'key\_press\_event'
- 'key\_release\_event'
- 'motion\_notify\_event'

- 'pick\_event'
- 'resize\_event'
- 'scroll\_event'
- 'figure\_enter\_event',
- 'figure\_leave\_event',
- 'axes\_enter\_event',
- 'axes\_leave\_event'
- 'close\_event'

For the location events (button and key press/release), if the mouse is over the axes, the variable `event.inaxes` will be set to the [Axes](#) the event occurs is over, and additionally, the variables `event.xdata` and `event.ydata` will be defined. This is the mouse location in data coords. See [KeyEvent](#) and [MouseEvent](#) for more info.

Return value is a connection id that can be used with `mpl_disconnect()`.

Example usage:

```
def on_press(event):
    print 'you pressed', event.button, event.xdata, event.ydata

cid = canvas.mpl_connect('button_press_event', on_press)
```

**mpl\_disconnect**(cid)  
disconnect callback id cid

Example usage:

```
cid = canvas.mpl_connect('button_press_event', on_press)
#...later
canvas.mpl_disconnect(cid)
```

**new\_timer**(\*args, \*\*kwargs)

Creates a new backend-specific subclass of `backend_bases.Timer`. This is useful for getting periodic events through the backend's native event loop. Implemented only for backends with GUIs.

optional arguments:

**interval** Timer interval in milliseconds

**callbacks** Sequence of (func, args, kwargs) where `func(args, **kwargs)` will be executed by the timer every *\*interval*.

**onHilite**(ev)

Mouse event processor which highlights the artists under the cursor. Connect this to the 'motion\_notify\_event' using:



```
canvas.mpl_connect('motion_notify_event', canvas.onHilite)
```

### **onRemove(ev)**

Mouse event processor which removes the top artist under the cursor. Connect this to the 'mouse\_press\_event' using:

```
canvas.mpl_connect('mouse_press_event', canvas.onRemove)
```

### **pick(mouseevent)**

### **pick\_event(mouseevent, artist, \*\*kwargs)**

This method will be called by artists who are picked and will fire off `PickEvent` callbacks registered listeners

### **print\_bmp(\*args, \*\*kwargs)**

### **print\_emf(\*args, \*\*kwargs)**

### **print\_eps(\*args, \*\*kwargs)**

### **print\_figure(filename, dpi=None, facecolor='w', edgecolor='w', orientation='portrait', format=None, \*\*kwargs)**

Render the figure to hardcopy. Set the figure patch face and edge colors. This is useful because some of the GUIs have a gray figure face color background and you'll probably want to override this on hardcopy.

Arguments are:

**filename** can also be a file object on image backends

**orientation** only currently applies to PostScript printing.

**dpi** the dots per inch to save the figure in; if None, use savefig.dpi

**facecolor** the facecolor of the figure

**edgecolor** the edgecolor of the figure

**orientation** 'landscape' | 'portrait' (not supported on all backends)

**format** when set, forcibly set the file format to save to

**bbox\_inches** Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure.

**pad\_inches** Amount of padding around the figure when bbox\_inches is 'tight'.

**bbox\_extra\_artists** A list of extra artists that will be considered when the tight bbox is calculated.

### **print\_jpeg(filename\_or\_obj, \*args, \*\*kwargs)**

Supported kwargs:

**quality:** The image quality, on a scale from 1 (worst) to 95 (best). The default is 75. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

**optimize:** If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

**progressive:** If present, indicates that this image should be stored as a progressive JPEG file.

**print\_jpg**(filename\_or\_obj, \*args, \*\*kwargs)

Supported kwargs:

**quality:** The image quality, on a scale from 1 (worst) to 95 (best). The default is 75. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

**optimize:** If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

**progressive:** If present, indicates that this image should be stored as a progressive JPEG file.

**print\_pdf**(\*args, \*\*kwargs)

**print\_png**(\*args, \*\*kwargs)

**print\_ps**(\*args, \*\*kwargs)

**print\_raw**(\*args, \*\*kwargs)

**print\_rgb**(\*args, \*\*kwargs)

**print\_svg**(\*args, \*\*kwargs)

**print\_svgz**(\*args, \*\*kwargs)

**print\_tif**(filename\_or\_obj, \*args, \*\*kwargs)

**print\_tiff**(filename\_or\_obj, \*args, \*\*kwargs)

**release\_mouse**(ax)

Release the mouse grab held by the axes, ax. Usually called by the widgets. It is ok to call this even if you ax doesn't have the mouse grab currently.

**resize**(w, h)

set the canvas size in pixels

**resize\_event**()

This method will be call all functions connected to the 'resize\_event' with a [ResizeEvent](#)

**scroll\_event**(x, y, step, guiEvent=None)

Backend derived classes should call this function on any scroll wheel event. x,y are the canvas coords: 0,0 is lower, left. button and key are as defined in [MouseEvent](#).

This method will be call all functions connected to the 'scroll\_event' with a [MouseEvent](#) instance.

**set\_window\_title**(title)

Set the title text of the window containing the figure. Note that this has no effect if there is no window (eg, a PS backend).

**start\_event\_loop**(timeout)

Start an event loop. This is used to start a blocking event loop so that interactive functions, such

as `ginput` and `waitforbuttonpress`, can wait for events. This should not be confused with the main GUI event loop, which is always running and has nothing to do with this.

This is implemented only for backends with GUIs.

#### **start\_event\_loop\_default**(*timeout=0*)

Start an event loop. This is used to start a blocking event loop so that interactive functions, such as `ginput` and `waitforbuttonpress`, can wait for events. This should not be confused with the main GUI event loop, which is always running and has nothing to do with this.

This function provides default event loop functionality based on `time.sleep` that is meant to be used until event loop functions for each of the GUI backends can be written. As such, it throws a deprecated warning.

Call signature:

```
start_event_loop_default(self, timeout=0)
```

This call blocks until a callback function triggers `stop_event_loop()` or *timeout* is reached. If *timeout* is  $\leq 0$ , never timeout.

#### **stop\_event\_loop**()

Stop an event loop. This is used to stop a blocking event loop so that interactive functions, such as `ginput` and `waitforbuttonpress`, can wait for events.

This is implemented only for backends with GUIs.

#### **stop\_event\_loop\_default**()

Stop an event loop. This is used to stop a blocking event loop so that interactive functions, such as `ginput` and `waitforbuttonpress`, can wait for events.

Call signature:

```
stop_event_loop_default(self)
```

#### **switch\_backends**(*FigureCanvasClass*)

instantiate an instance of `FigureCanvasClass`

This is used for backend switching, eg, to instantiate a `FigureCanvasPS` from a `FigureCanvas-GTK`. Note, deep copying is not done, so any changes to one of the instances (eg, setting figure size or line props), will be reflected in the other

#### **class FigureManagerBase**(*canvas, num*)

Helper class for pyplot mode, wraps everything up into a neat bundle

Public attributes:

*canvas* A `FigureCanvasBase` instance

*num* The figure number

**destroy**()

**full\_screen\_toggle**()

**key\_press**(*event*)

**resize**(*w, h*)

For gui backends: resize window in pixels

**set\_window\_title**(*title*)

Set the title text of the window containing the figure. Note that this has no effect if there is no window (eg, a PS backend).

**show\_popup**(*msg*)

Display message in a popup – GUI only

**class GraphicsContextBase**()

An abstract base class that provides color, line styles, etc...

**copy\_properties**(*gc*)

Copy properties from gc to self

**get\_alpha**()

Return the alpha value used for blending - not supported on all backends

**get\_antialiased**()

Return true if the object should try to do antialiased rendering

**get\_capstyle**()

Return the capstyle as a string in ('butt', 'round', 'projecting')

**get\_clip\_path**()

Return the clip path in the form (path, transform), where path is a [Path](#) instance, and transform is an affine transform to apply to the path before clipping.

**get\_clip\_rectangle**()

Return the clip rectangle as a [Bbox](#) instance

**get\_dashes**()

Return the dash information as an offset dashlist tuple.

The dash list is a even size list that gives the ink on, ink off in pixels.

See p107 of to PostScript [BLUEBOOK](#) for more info.

Default value is None

**get\_hatch**()

Gets the current hatch style

**get\_hatch\_path**(*density=6.0*)

Returns a Path for the current hatch.

**get\_joinstyle**()

Return the line join style as one of ('miter', 'round', 'bevel')

**get\_linestyle**(*style*)

Return the linestyle: one of ('solid', 'dashed', 'dashdot', 'dotted').

**get\_linewidth**()

Return the line width in points as a scalar

**get\_rgb()**

returns a tuple of three or four floats from 0-1.

**get\_snap()**

returns the snap setting which may be:

- True: snap vertices to the nearest pixel center
- False: leave vertices as-is
- None: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

**get\_url()**

returns a url if one is set, None otherwise

**restore()**

Restore the graphics context from the stack - needed only for backends that save graphics contexts on a stack

**set\_alpha(alpha)**

Set the alpha value used for blending - not supported on all backends

**set\_antialiased(b)**

True if object should be drawn with antialiased rendering

**set\_capstyle(cs)**

Set the capstyle as a string in ('butt', 'round', 'projecting')

**set\_clip\_path(path)**

Set the clip path and transformation. Path should be a [TransformedPath](#) instance.

**set\_clip\_rectangle(rectangle)**

Set the clip rectangle with sequence (left, bottom, width, height)

**set\_dashes(dash\_offset, dash\_list)**

Set the dash style for the gc.

*dash\_offset* is the offset (usually 0).

*dash\_list* specifies the on-off sequence as points. (None, None) specifies a solid line

**set\_foreground(fg, isRGB=False)**

Set the foreground color. fg can be a MATLAB format string, a html hex color string, an rgb or rgba unit tuple, or a float between 0 and 1. In the latter case, grayscale is used.

If you know fg is rgb or rgba, set *isRGB*=True for efficiency.

**set\_graylevel(frac)**

Set the foreground color to be a gray level with *frac*

**set\_hatch(hatch)**

Sets the hatch style for filling

**set\_joinstyle(js)**

Set the join style to be one of ('miter', 'round', 'bevel')

**set\_linestyle(*style*)**

Set the linestyle to be one of ('solid', 'dashed', 'dashdot', 'dotted'). One may specify customized dash styles by providing a tuple of (offset, dash pairs). For example, the predefined line styles have following values.:

'dashed' : (0, (6.0, 6.0)), 'dashdot' : (0, (3.0, 5.0, 1.0, 5.0)), 'dotted' : (0, (1.0, 3.0)),

**set\_linewidth(*w*)**

Set the linewidth in points

**set\_snap(*snap*)**

Sets the snap setting which may be:

- True: snap vertices to the nearest pixel center
- False: leave vertices as-is
- None: (auto) If the path contains only rectilinear line segments, round to the nearest pixel center

**set\_url(*url*)**

Sets the url for links in compatible backends

**class IdleEvent(*name, canvas, guiEvent=None*)**

Bases: [matplotlib.backend\\_bases.Event](#)

An event triggered by the GUI backend when it is idle – useful for passive animation

**class KeyEvent(*name, canvas, key, x=0, y=0, guiEvent=None*)**

Bases: [matplotlib.backend\\_bases.LocationEvent](#)

A key event (key press, key release).

Attach additional attributes as defined in [FigureCanvasBase.mpl\\_connect\(\)](#).

In addition to the [Event](#) and [LocationEvent](#) attributes, the following attributes are defined:

**key** the key pressed: None, chr(range(255)), shift, win, or control

This interface may change slightly when better support for modifier keys is included.

Example usage:

```
def on_key(event):  
    print 'you pressed', event.key, event.xdata, event.ydata  
  
cid = fig.canvas.mpl_connect('key_press_event', on_key)
```

**class LocationEvent(*name, canvas, x, y, guiEvent=None*)**

Bases: [matplotlib.backend\\_bases.Event](#)

An event that has a screen location

The following additional attributes are defined and shown with their default values.

In addition to the [Event](#) attributes, the following event attributes are defined:

**x** x position - pixels from left of canvas

**y** y position - pixels from bottom of canvas

**inaxes** the [Axes](#) instance if mouse is over axes

**xdata** x coord of mouse in data coords

**ydata** y coord of mouse in data coords

x, y in figure coords, 0,0 = bottom, left

**class MouseEvent**(*name, canvas, x, y, button=None, key=None, step=0, guiEvent=None*)

Bases: [matplotlib.backend\\_bases.LocationEvent](#)

A mouse event ('button\_press\_event', 'button\_release\_event', 'scroll\_event', 'motion\_notify\_event').

In addition to the [Event](#) and [LocationEvent](#) attributes, the following attributes are defined:

**button** button pressed None, 1, 2, 3, 'up', 'down' (up and down are used for scroll events)

**key** the key pressed: None, chr(range(255)), 'shift', 'win', or 'control'

**step** number of scroll steps (positive for 'up', negative for 'down')

Example usage:

```
def on_press(event):
    print 'you pressed', event.button, event.xdata, event.ydata
```

```
cid = fig.canvas.mpl_connect('button_press_event', on_press)
```

x, y in figure coords, 0,0 = bottom, left button pressed None, 1, 2, 3, 'up', 'down'

**class NavigationToolbar2**(*canvas*)

Bases: object

Base class for the navigation cursor, version 2

backends must implement a canvas that handles connections for 'button\_press\_event' and 'button\_release\_event'. See [FigureCanvasBase.mpl\\_connect\(\)](#) for more information

They must also define

**save\_figure()** save the current figure

**set\_cursor()** if you want the pointer icon to change

**\_init\_toolbar()** create your toolbar widget

**draw\_rubberband()** (optional) draw the zoom to rect "rubberband" rectangle

**press()** (optional) whenever a mouse button is pressed, you'll be notified with the event

**release()** (optional) whenever a mouse button is released, you'll be notified with the event

**dynamic\_update()** (optional) dynamically update the window while navigating

**set\_message()** (optional) display message

**set\_history\_buttons()** (optional) you can change the history back / forward buttons to indicate disabled / enabled state.

That's it, we'll do the rest!

**back(\*args)**

move back up the view lim stack

**drag\_pan(event)**

the drag callback in pan/zoom mode

**drag\_zoom(event)**

the drag callback in zoom mode

**draw()**

redraw the canvases, update the locators

**draw\_rubberband(event, x0, y0, x1, y1)**

draw a rectangle rubberband to indicate zoom limits

**dynamic\_update()**

**forward(\*args)**

move forward in the view lim stack

**home(\*args)**

restore the original view

**mouse\_move(event)**

**pan(\*args)**

Activate the pan/zoom tool. pan with left button, zoom with right

**press(event)**

this will be called whenever a mouse button is pressed

**press\_pan(event)**

the press mouse button in pan/zoom mode callback

**press\_zoom(event)**

the press mouse button in zoom to rect mode callback

**push\_current()**

push the current view limits and position onto the stack

**release(event)**

this will be called whenever mouse button is released

**release\_pan(event)**

the release mouse button callback in pan/zoom mode

**release\_zoom(event)**

the release mouse button callback in zoom to rect mode

**save\_figure(\*args)**

save the current figure



**set\_cursor**(*cursor*)

Set the current cursor to one of the [Cursors](#) enums values

**set\_history\_buttons**()

enable or disable back/forward button

**set\_message**(*s*)

display a message on toolbar or in status bar

**update**()

reset the axes stack

**zoom**(\**args*)

activate zoom to rect mode

**class PickEvent**(*name, canvas, mouseevent, artist, guiEvent=None, \*\*kwargs*)

Bases: [matplotlib.backend\\_bases.Event](#)

a pick event, fired when the user picks a location on the canvas sufficiently close to an artist.

Attrs: all the [Event](#) attributes plus

*mouseevent* the [MouseEvent](#) that generated the pick

*artist* the [Artist](#) picked

**other** extra class dependent attrs – eg a [Line2D](#) pick may define different extra attributes than a [PatchCollection](#) pick event

Example usage:

```
line, = ax.plot(rand(100), 'o', picker=5) # 5 points tolerance
```

```
def on_pick(event):
    thisline = event.artist
    xdata, ydata = thisline.get_data()
    ind = event.ind
    print 'on pick line:', zip(xdata[ind], ydata[ind])
```

```
cid = fig.canvas.mpl_connect('pick_event', on_pick)
```

**class RendererBase**()

An abstract base class to handle drawing/rendering operations.

The following methods *must* be implemented in the backend:

- [draw\\_path\(\)](#)
- [draw\\_image\(\)](#)
- [draw\\_text\(\)](#)
- [get\\_text\\_width\\_height\\_descent\(\)](#)

The following methods *should* be implemented in the backend for optimization reasons:

- [draw\\_markers\(\)](#)

- [draw\\_path\\_collection\(\)](#)

- [draw\\_quad\\_mesh\(\)](#)

**close\_group(*s*)**

Close a grouping element with label *s* Is only currently used by backend\_svg

**draw\_gouraud\_triangle(*gc, points, colors, transform*)**

Draw a Gouraud-shaded triangle.

*points* is a 3x2 array of (x, y) points for the triangle.

*colors* is a 3x4 array of RGBA colors for each point of the triangle.

*transform* is an affine transform to apply to the points.

**draw\_gouraud\_triangles(*gc, triangles\_array, colors\_array, transform*)**

Draws a series of Gouraud triangles.

*points* is a Nx3x2 array of (x, y) points for the triangles.

*colors* is a Nx3x4 array of RGBA colors for each point of the triangles.

*transform* is an affine transform to apply to the points.

**draw\_image(*gc, x, y, im*)**

Draw the image instance into the current axes;

*gc* a GraphicsContext containing clipping information

*x* is the distance in pixels from the left hand side of the canvas.

*y* the distance from the origin. That is, if origin is upper, *y* is the distance from top. If origin is lower, *y* is the distance from bottom

*im* the matplotlib.\_image.Image instance

**draw\_markers(*gc, marker\_path, marker\_trans, path, trans, rgbFace=None*)**

Draws a marker at each of the vertices in path. This includes all vertices, including control points on curves. To avoid that behavior, those vertices should be removed before calling this function.

*gc* the [GraphicsContextBase](#) instance

*marker\_trans* is an affine transform applied to the marker.

*trans* is an affine transform applied to the path.

This provides a fallback implementation of draw\_markers that makes multiple calls to [draw\\_path\(\)](#). Some backends may want to override this method in order to draw the marker only once and reuse it multiple times.

**draw\_path(*gc, path, transform, rgbFace=None*)**

Draws a [Path](#) instance using the given affine transform.

**draw\_path\_collection(*gc, master\_transform, paths, all\_transforms, offsets, offsetTrans, facecolors, edgecolors, linewidths, linestyle, antialiaseds, urls*)**

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyle* and *antialiaseds*. *offsets* is a list of offsets to apply to each of the paths. The offsets in *offsets* are first transformed by *offsetTrans* before being applied.

This provides a fallback implementation of `draw_path_collection()` that makes multiple calls to `draw_path()`. Some backends may want to override this in order to render each set of path data only once, and then reference that path multiple times with the different offsets, colors, styles etc. The generator methods `_iter_collection_raw_paths()` and `_iter_collection()` are provided to help with (and standardize) the implementation across backends. It is highly recommended to use those generators, so that changes to the behavior of `draw_path_collection()` can be made globally.

**draw\_quad\_mesh**(*gc, master\_transform, meshWidth, meshHeight, coordinates, offsets, offsetTrans, face\_colors, antialiased, showedges*)

This provides a fallback implementation of `draw_quad_mesh()` that generates paths and then calls `draw_path_collection()`.

**draw\_tex**(*gc, x, y, s, prop, angle, ismath='TeX!'*)

**draw\_text**(*gc, x, y, s, prop, angle, ismath=False*)

Draw the text instance

*gc* the `GraphicsContextBase` instance

*x* the x location of the text in display coords

*y* the y location of the text in display coords

*s* a `matplotlib.text.Text` instance

*prop* a `matplotlib.font_manager.FontProperties` instance

*angle* the rotation angle in degrees

#### backend implementers note

When you are trying to determine if you have gotten your bounding box right (which is what enables the text layout/alignment to work properly), it helps to change the line in `text.py`:

```
if 0: bbox_artist(self, renderer)
```

to if 1, and then the actual bounding box will be blotted along with your text.

**flipy()**

Return true if y small numbers are top for renderer Is used for drawing text (`matplotlib.text`) and images (`matplotlib.image`) only

**get\_canvas\_width\_height()**

return the canvas width and height in display coords

**get\_image\_magnification()**

Get the factor by which to magnify images passed to `draw_image()`. Allows a backend to have images at a different resolution to other artists.

**get\_texmanager()**

return the `matplotlib.texmanager.TextManager` instance

**get\_text\_width\_height\_descent**(*s, prop, ismath*)

get the width and height, and the offset from the bottom to the baseline (descent), in display coords of the string *s* with `FontProperties` *prop*

**new\_gc()**Return an instance of a [GraphicsContextBase](#)**open\_group**(*s*, *gid=None*)Open a grouping element with label *s*. If *gid* is given, use *gid* as the id of the group. Is only currently used by `backend_svg`.**option\_image\_nocomposite()**

override this method for renderers that do not necessarily want to rescale and composite raster images. (like SVG)

**option\_scale\_image()**

override this method for renderers that support arbitrary scaling of image (most of the vector backend).

**points\_to\_pixels**(*points*)

Convert points to display units

*points* a float or a numpy array of float

return points converted to pixels

You need to override this function (unless your backend doesn't have a dpi, eg, postscript or svg). Some imaging systems assume some value for pixels per inch:

$$\text{points to pixels} = \text{points} * \text{pixels\_per\_inch} / 72.0 * \text{dpi} / 72.0$$
**start\_filter()**

Used in AggRenderer. Switch to a temporary renderer for image filtering effects.

**start\_rasterizing()**

Used in MixedModeRenderer. Switch to the raster renderer.

**stop\_filter**(*filter\_func*)Used in AggRenderer. Switch back to the original renderer. The contents of the temporary renderer is processed with the *filter\_func* and is drawn on the original renderer as an image.**stop\_rasterizing()**

Used in MixedModeRenderer. Switch back to the vector renderer and draw the contents of the raster renderer as an image on the vector renderer.

**strip\_math**(*s*)**class ResizeEvent**(*name*, *canvas*)Bases: [matplotlib.backend\\_bases.Event](#)

An event triggered by a canvas resize

In addition to the [Event](#) attributes, the following event attributes are defined:*width* width of the canvas in pixels*height* height of the canvas in pixels**class ShowBase**()

Bases: object

Simple base class to generate a `show()` callable in backends.

Subclass must override `mainloop()` method.

**mainloop()**

**class TimerBase**(*interval=None, callbacks=None*)

Bases: `object`

A base class for providing timer events, useful for things animations. Backends need to implement a few specific methods in order to use their own timing mechanisms so that the timer events are integrated into their event loops.

Mandatory functions that must be implemented:

- **`_timer_start`**: Contains backend-specific code for starting the timer
- **`_timer_stop`**: Contains backend-specific code for stopping the timer

Optional overrides:

- **`_timer_set_single_shot`**: Code for setting the timer to single shot operating mode, if supported by the timer object. If not, the *Timer* class itself will store the flag and the `_on_timer` method should be overridden to support such behavior.
- **`_timer_set_interval`**: Code for setting the interval on the timer, if there is a method for doing so on the timer object.
- **`_on_timer`**: This is the internal function that any timer object should call, which will handle the task of running all callbacks that have been set.

Attributes:

- **`interval`**: The time between timer events in milliseconds. Default is 1000 ms.
- **`single_shot`**: Boolean flag indicating whether this timer should operate as single shot (run once and then stop). Defaults to *False*.
- **`callbacks`**: Stores list of (func, args) tuples that will be called upon timer events. This list can be manipulated directly, or the functions `add_callback` and `remove_callback` can be used.

**add\_callback**(*func, \*args, \*\*kwargs*)

Register *func* to be called by timer when the event fires. Any additional arguments provided will be passed to *func*.

**interval**

**remove\_callback**(*func, \*args, \*\*kwargs*)

Remove *func* from list of callbacks. *args* and *kwargs* are optional and used to distinguish between copies of the same function registered to be called with different arguments.

**single\_shot**

**start**(*interval=None*)

Start the timer object. *interval* is optional and will be used to reset the timer interval first if provided.

**stop()**

Stop the timer.

**register\_backend**(*format, backend\_class*)

## 47.2 matplotlib.backends.backend\_gtkagg

**TODO** We'll add this later, importing the gtk backends requires an active X-session, which is not compatible with cron jobs.

## 47.3 matplotlib.backends.backend\_qt4agg

Render to qt from agg

**class FigureCanvasQTAgg**(*figure*)

Bases: `matplotlib.backends.backend_qt4.FigureCanvasQT`,  
`matplotlib.backends.backend_agg.FigureCanvasAgg`

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

Public attribute

figure - A Figure instance

**blit**(*bbox=None*)

Blit the region in bbox

**draw**()

Draw the figure when xwindows is ready for the update

**drawRectangle**(*rect*)

**paintEvent**(*e*)

Draw to the Agg backend and then copy the image to the qt.drawable. In Qt, all drawing should be done inside of here when a widget is shown onscreen.

**print\_figure**(*\*args, \*\*kwargs*)

**class FigureManagerQTAgg**(*canvas, num*)

Bases: `matplotlib.backends.backend_qt4.FigureManagerQT`

**class NavigationToolbar2QTAgg**(*canvas, parent, coordinates=True*)

Bases: `matplotlib.backends.backend_qt4.NavigationToolbar2QT`

coordinates: should we show the coordinates on the right?

**new\_figure\_manager**(*num, \*args, \*\*kwargs*)

Create a new figure manager instance

## 47.4 matplotlib.backends.backend\_wxagg

**class FigureCanvasWxAgg**(*parent, id, figure*)

Bases: `matplotlib.backends.backend_agg.FigureCanvasAgg`,  
`matplotlib.backends.backend_wx.FigureCanvasWx`

The FigureCanvas contains the figure and does event handling.

In the wxPython backend, it is derived from wxPanel, and (usually) lives inside a frame instantiated by a FigureManagerWx. The parent window probably implements a wxSizer to control the displayed control size - but we give a hint as to our preferred minimum size.

Initialise a FigureWx instance.

- Initialise the FigureCanvasBase and wxPanel parents.
- Set event handlers for: EVT\_SIZE (Resize event) EVT\_PAINT (Paint event)

**blit**(*bbox=None*)

Transfer the region of the agg buffer defined by bbox to the display. If bbox is None, the entire buffer is transferred.

**draw**(*drawDC=None*)

Render the figure using agg.

**print\_figure**(*filename, \*args, \*\*kwargs*)

**class FigureFrameWxAgg**(*num, fig*)

Bases: `matplotlib.backends.backend_wx.FigureFrameWx`

**get\_canvas**(*fig*)

**class NavigationToolbar2WxAgg**(*canvas*)

Bases: `matplotlib.backends.backend_wx.NavigationToolbar2Wx`

**get\_canvas**(*frame, fig*)

**new\_figure\_manager**(*num, \*args, \*\*kwargs*)

Create a new figure manager instance

## 47.5 matplotlib.backends.backend\_pdf

A PDF matplotlib backend (not yet complete) Author: Jouni K Seppänen <[jks@iki.fi](mailto:jks@iki.fi)>

**FT2Font**()

FT2Font

**class FigureCanvasPdf**(*figure*)

Bases: `matplotlib.backend_bases.FigureCanvasBase`

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

Public attribute

`figure` - A Figure instance

**class Name**(*name*)

Bases: object

PDF name object.

**class Operator**(*op*)

Bases: object

PDF operator object.

**class PdfFile**(*filename*)

Bases: object

PDF file object.

**alphaState**(*alpha*)

Return name of an ExtGState that sets alpha to the given value

**embedTTF**(*filename, characters*)

Embed the TTF font from the named file into the document.

**fontName**(*fontprop*)

Select a font based on fontprop and return a name suitable for Op.selectfont. If fontprop is a string, it will be interpreted as the filename (or dvi name) of the font.

**imageObject**(*image*)

Return name of an image XObject representing the given image.

**markerObject**(*path, trans, fillp, lw*)

Return name of a marker XObject representing the given path.

**reserveObject**(*name=""*)

Reserve an ID for an indirect object. The name is used for debugging in case we forget to print out the object with writeObject.

**writeInfoDict**()

Write out the info dictionary, checking it for good form

**writeTrailer**()

Write out the PDF trailer.

**writeXref**()

Write out the xref table.

**class PdfPages**(*filename*)

Bases: object

A multi-page PDF file.

Use like this:

```
# Initialize:
```

```
pp = PdfPages('foo.pdf')
```

```
# As many times as you like, create a figure fig, then either:
```

```
fig.savefig(pp, format='pdf') # note the format argument!
```



```
# or:
pp.savefig(fig)

# Once you are done, remember to close the object:
pp.close()
```

(In reality PdfPages is a thin wrapper around PdfFile, in order to avoid confusion when using savefig and forgetting the format argument.)

Create a new PdfPages object that will be written to the file named *filename*. The file is opened at once and any older file with the same name is overwritten.

#### **close()**

Finalize this object, making the underlying file a complete PDF file.

#### **infodict()**

Return a modifiable information dictionary object (see PDF reference section 10.2.1 ‘Document Information Dictionary’).

#### **savefig**(figure=None, \*\*kwargs)

Save the Figure instance *figure* to this file as a new page. If *figure* is a number, the figure instance is looked up by number, and if *figure* is None, the active figure is saved. Any other keyword arguments are passed to Figure.savefig.

#### **class Reference**(id)

Bases: object

PDF reference object. Use PdfFile.reserveObject() to create References.

#### **class Stream**(id, len, file, extra=None)

Bases: object

PDF stream object.

This has no pdfRepr method. Instead, call begin(), then output the contents of the stream by calling write(), and finally call end().

id: object id of stream; len: an unused Reference object for the length of the stream, or None (to use a memory buffer); file: a PdfFile; extra: a dictionary of extra key-value pairs to include in the stream header

#### **end()**

Finalize stream.

#### **write**(data)

Write some data on the stream.

#### **fill**(strings, linelen=75)

Make one string from sequence of strings, with whitespace in between. The whitespace is chosen to form lines of at most linelen characters, if possible.

#### **new\_figure\_manager**(num, \*args, \*\*kwargs)

Create a new figure manager instance

**pdfRepr**(*obj*)

Map Python objects to PDF syntax.

## 47.6 matplotlib.dviread

An experimental module for reading dvi files output by TeX. Several limitations make this not (currently) useful as a general-purpose dvi preprocessor, but it is currently used by the pdf backend for processing usetex text.

Interface:

```
dvi = Dvi(filename, 72)
# iterate over pages (but only one page is supported for now):
for page in dvi:
    w, h, d = page.width, page.height, page.descent
    for x,y,font,glyph,width in page.text:
        fontname = font.texname
        pointsize = font.size
        ...
    for x,y,height,width in page.bboxes:
        ...
```

**class Dvi**(*filename, dpi*)

Bases: object

A dvi (“device-independent”) file, as produced by TeX. The current implementation only reads the first page and does not even attempt to verify the postamble.

Initialize the object. This takes the filename as input and opens the file; actually reading the file happens when iterating through the pages of the file.

**close()**

Close the underlying file if it is open.

**class DviFont**(*scale, tfm, texname, vf*)

Bases: object

Object that holds a font’s texname and size, supports comparison, and knows the widths of glyphs in the same units as the AFM file. There are also internal attributes (for use by dviread.py) that are *not* used for comparison.

The size is in Adobe points (converted from TeX points).

**texname**

Name of the font as used internally by TeX and friends. This is usually very different from any external font names, and dviread.PsfontsMap can be used to find the external name of the font.

**size**

Size of the font in Adobe points, converted from the slightly smaller TeX points.

**widths**

Widths of glyphs in glyph-space units, typically 1/1000ths of the point size.

**size****texname****widths****class Encoding**(filename)

Bases: object

Parses a \*.enc file referenced from a psfonts.map style file. The format this class understands is a very limited subset of PostScript.

Usage (subject to change):

```
for name in Encoding(filename):
    whatever(name)
```

**encoding****class PsfontsMap**(filename)

Bases: object

A psfonts.map formatted file, mapping TeX fonts to PS fonts. Usage:

```
>>> map = PsfontsMap(find_tex_file('pdftex.map'))
>>> entry = map['ptmbo8r']
>>> entry.texname
'ptmbo8r'
>>> entry.psname
'Times-Bold'
>>> entry.encoding
'/usr/local/texlive/2008/texmf-dist/fonts/enc/dvips/base/8r.enc'
>>> entry.effects
{'slant': 0.16700000000000001}
>>> entry.filename
```

For historical reasons, TeX knows many Type-1 fonts by different names than the outside world. (For one thing, the names have to fit in eight characters.) Also, TeX's native fonts are not Type-1 but Metafont, which is nontrivial to convert to PostScript except as a bitmap. While high-quality conversions to Type-1 format exist and are shipped with modern TeX distributions, we need to know which Type-1 fonts are the counterparts of which native fonts. For these reasons a mapping is needed from internal font names to font file names.

A texmf tree typically includes mapping files called e.g. psfonts.map, pdftex.map, dvipdfm.map. psfonts.map is used by dvips, pdftex.map by pdfTeX, and dvipdfm.map by dvipdfm. psfonts.map might avoid embedding the 35 PostScript fonts (i.e., have no filename for them, as in the Times-Bold example above), while the pdf-related files perhaps only avoid the "Base 14" pdf fonts. But the user may have configured these files differently.

**class Tfm**(filename)

Bases: object

A TeX Font Metric file. This implementation covers only the bare minimum needed by the Dvi class.

**checksum**

Used for verifying against the dvi file.

**design\_size**

Design size of the font (in what units?)

**width**

Width of each character, needs to be scaled by the factor specified in the dvi file. This is a dict because indexing may not start from 0.

**height**

Height of each character.

**depth**

Depth of each character.

**checksum****depth****design\_size****height****width****class Vf(filename)**

Bases: `matplotlib.dviread.Dvi`

A virtual font (\*.vf file) containing subroutines for dvi files.

Usage:

```
vf = Vf(filename)
glyph = vf[code]
glyph.text, glyph.bboxes, glyph.width
```

**find\_tex\_file(filename, format=None)**

Call **kpsewhich** to find a file in the texmf tree. If *format* is not None, it is used as the value for the *--format* option.

Apparently most existing TeX distributions on Unix-like systems use kpathsea. I hear MikTeX (a popular distribution on Windows) doesn't use kpathsea, so what do we do? (TODO)

**See Also:**

**Kpathsea documentation** The library that **kpsewhich** is part of.

## 47.7 matplotlib.type1font

This module contains a class representing a Type 1 font.

This version reads pfa and pfb files and splits them for embedding in pdf files. It also supports SlantFont and ExtendFont transformations, similarly to pdfTeX and friends. There is no support yet for subsetting.

Usage:

```
>>> font = Type1Font(filename)
>>> clear_part, encrypted_part, finale = font.parts
>>> slanted_font = font.transform({'slant': 0.167})
>>> extended_font = font.transform({'extend': 1.2})
```

Sources:

- Adobe Technical Note #5040, Supporting Downloadable PostScript Language Fonts.
- Adobe Type 1 Font Format, Adobe Systems Incorporated, third printing, v1.1, 1993. ISBN 0-201-57044-0.

**class** **Type1Font**(*input*)

Bases: `object`

A class representing a Type-1 font, for use by backends.

**parts**

A 3-tuple of the cleartext part, the encrypted part, and the finale of zeros.

**prop**

A dictionary of font properties.

Initialize a Type-1 font. *input* can be either the file name of a pfb file or a 3-tuple of already-decoded Type-1 font parts.

**parts**

**prop**

**transform**(*effects*)

Transform the font by slanting or extending. *effects* should be a dict where `effects['slant']` is the tangent of the angle that the font is to be slanted to the right (so negative values slant to the left) and `effects['extend']` is the multiplier by which the font is to be extended (so values less than 1.0 condense). Returns a new `Type1Font` object.



# CBOOK

## 48.1 matplotlib.cbook

A collection of utility functions and classes. Many (but not all) from the Python Cookbook – hence the name cbook

**class Bunch**(\*\**kws*)

Often we want to just collect a bunch of stuff together, naming each item of the bunch; a dictionary's OK for that, but a small do- nothing class is even handier, and prettier to use. Whenever you want to group a few variables:

```
>>> point = Bunch(datum=2, squared=4, coord=12)
>>> point.datum
```

By: Alex Martelli From: <http://aspn.activestate.com/ASPN/Cookbook/Python/Recipe/52308>

**class CallbackRegistry**(*\*args*)

Handle registering and disconnecting for a set of signals and callbacks:

```
def oneat(x):
    print 'eat', x

def ondrink(x):
    print 'drink', x

callbacks = CallbackRegistry()

ideat = callbacks.connect('eat', oneat)
iddrink = callbacks.connect('drink', ondrink)

#tmp = callbacks.connect('drunk', ondrink) # this will raise a ValueError

callbacks.process('drink', 123)    # will call oneat
callbacks.process('eat', 456)     # will call ondrink
callbacks.process('be merry', 456) # nothing will be called
callbacks.disconnect(ideat)       # disconnect oneat
callbacks.process('eat', 456)     # nothing will be called
```

In practice, one should always disconnect all callbacks when they are no longer needed to avoid dangling references (and thus memory leaks). However, real code in matplotlib rarely does so, and due to its design, it is rather difficult to place this kind of code. To get around this, and prevent this class of memory leaks, we instead store weak references to bound methods only, so when the destination object needs to die, the CallbackRegistry won't keep it alive. The Python stdlib weakref module can not create weak references to bound methods directly, so we need to create a proxy object to handle weak references to bound methods (or regular free functions). This technique was shared by Peter Parente on his "[Mindtrove](#)" blog.

**class BoundMethodProxy(*cb*)**

Bases: object

Our own proxy object which enables weak references to bound and unbound methods and arbitrary callables. Pulls information about the function, class, and instance out of a bound method. Stores a weak reference to the instance to support garbage collection.

@organization: IBM Corporation @copyright: Copyright (c) 2005, 2006 IBM Corporation @license: The BSD License

Minor bugfixes by Michael Droettboom

**connect(*s, func*)**

register *func* to be called when a signal *s* is generated *func* will be called

**disconnect(*cid*)**

disconnect the callback registered with callback id *cid*

**process(*s, \*args, \*\*kwargs*)**

process signal *s*. All of the functions registered to receive callbacks on *s* will be called with *\*args* and *\*\*kwargs*

**class GetRealpathAndStat()**

**class Grouper(*init=, []*)**

Bases: object

This class provides a lightweight way to group arbitrary objects together into disjoint sets when a full-blown graph data structure would be overkill.

Objects can be joined using `join()`, tested for connectedness using `joined()`, and all disjoint sets can be retrieved by using the object as an iterator.

The objects being joined must be hashable and weak-referenceable.

For example:

```
>>> class Foo:
...     def __init__(self, s):
...         self.s = s
...     def __repr__(self):
...         return self.s
...
>>> a, b, c, d, e, f = [Foo(x) for x in 'abcdef']
>>> g = Grouper()
>>> g.join(a, b)
```



```

>>> g.join(b, c)
>>> g.join(d, e)
>>> list(g)
[[d, e], [a, b, c]]
>>> g.joined(a, b)
True
>>> g.joined(a, c)
True
>>> g.joined(a, d)
False

```

**clean()**

Clean dead weak references from the dictionary

**get\_siblings(*a*)**

Returns all of the items joined with *a*, including itself.

**join(*a*, \**args*)**

Join given arguments into the same set. Accepts one or more arguments.

**joined(*a*, *b*)**

Returns True if *a* and *b* are members of the same set.

**class Idle(*func*)**

Bases: `matplotlib.cbook.Scheduler`

Schedule callbacks when scheduler is idle

**run()**

**class MemoryMonitor(*nmax*=20000)**

**clear()**

**plot(*i0*=0, *isub*=1, *fig*=None)**

**report(*segments*=4)**

**xy(*i0*=0, *isub*=1)**

**class Null(\**args*, \*\**kwargs*)**

Null objects always and reliably “do nothing.”

**class RingBuffer(*size\_max*)**

class that implements a not-yet-full buffer

**append(*x*)**

append an element at the end of the buffer

**get()**

Return a list of elements from the oldest to the newest.

**class Scheduler()**

Bases: `threading.Thread`

Base class for timeout and idle scheduling

**stop()**

**class Sorter()**

Sort by attribute or item

Example usage:

```
sort = Sorter()
```

```
list = [(1, 2), (4, 8), (0, 3)]
```

```
dict = [{'a': 3, 'b': 4}, {'a': 5, 'b': 2}, {'a': 0, 'b': 0},  
        {'a': 9, 'b': 9}]
```

```
sort(list)      # default sort
```

```
sort(list, 1)   # sort by index 1
```

```
sort(dict, 'a') # sort a list of dicts by key 'a'
```

**byAttribute**(data, attributename, inplace=1)

**byItem**(data, itemindex=None, inplace=1)

**sort**(data, itemindex=None, inplace=1)

**class Stack**(default=None)

Bases: object

Implement a stack where elements can be pushed on and you can move back and forth. But no pop.  
Should mimic home / back / forward in a browser

**back()**

move the position back and return the current element

**bubble**(o)

raise o to the top of the stack and return o. o must be in the stack

**clear()**

empty the stack

**empty()**

**forward()**

move the position forward and return the current element

**home()**

push the first element onto the top of the stack

**push**(o)

push object onto stack at current position - all elements occurring later than the current position  
are discarded

**remove**(o)

remove element o from the stack

**class Timeout**(wait, func)

Bases: [matplotlib.cbook.Scheduler](#)

Schedule recurring events with a wait time in seconds

**run()**

**class Xlator()**

Bases: dict

All-in-one multiple-string-substitution class

Example usage:

```
text = "Larry Wall is the creator of Perl"
adict = {
    "Larry Wall" : "Guido van Rossum",
    "creator" : "Benevolent Dictator for Life",
    "Perl" : "Python",
}
```

```
print multiple_replace(adict, text)
```

```
xlat = Xlator(adict)
print xlat.xlat(text)
```

**xlat(text)**

Translate *text*, returns the modified text.

**align\_iterators(func, \*iterables)**

This generator takes a bunch of iterables that are ordered by func. It sends out ordered tuples:

(func(row), [rows from all iterators matching func(row)])

It is used by `matplotlib.mlab.recs_join()` to join record arrays

**allequal(seq)**

Return *True* if all elements of *seq* compare equal. If *seq* is 0 or 1 length, return *True*

**allpairs(x)**

return all possible pairs in sequence *x*

Condensed by Alex Martelli from this [thread](#) on c.l.python

**alltrue(seq)**

Return *True* if all elements of *seq* evaluate to *True*. If *seq* is empty, return *False*.

**class converter(missing='Null', missingval=None)**

Base class for handling string -> python type with support for missing values

**is\_missing(s)**

**dedent(s)**

Remove excess indentation from docstring *s*.

Discards any leading blank lines, then removes up to *n* whitespace characters from each line, where *n* is the number of leading whitespace characters in the first line. It differs from `textwrap.dedent` in its deletion of leading blank lines and its use of the first non-blank line to determine the indentation.

It is also faster in most cases.

**delete\_masked\_points(\*args)**

Find all masked and/or non-finite points in a set of arguments, and return the arguments with only the unmasked points remaining.

Arguments can be in any of 5 categories:

1. 1-D masked arrays
2. 1-D ndarrays
3. ndarrays with more than one dimension
4. other non-string iterables
5. anything else

The first argument must be in one of the first four categories; any argument with a length differing from that of the first argument (and hence anything in category 5) then will be passed through unchanged.

Masks are obtained from all arguments of the correct length in categories 1, 2, and 4; a point is bad if masked in a masked array or if it is a nan or inf. No attempt is made to extract a mask from categories 2, 3, and 4 if `np.isfinite()` does not yield a Boolean array.

All input arguments that are not passed unchanged are returned as ndarrays after removing the points or rows corresponding to masks in any of the arguments.

A vastly simpler version of this function was originally written as a helper for `Axes.scatter()`.

**dict\_delall(d, keys)**

delete all of the *keys* from the dict *d*

**distances\_along\_curve(X)**

This function has been moved to `matplotlib.mlab` – please import it from there

**exception\_to\_str(s=None)****finddir(o, match, case=False)**

return all attributes of *o* which match string in *match*. if *case* is True require an exact case match.

**flatten(seq, scalarp=<function is\_scalar\_or\_string at 0x27107d0>)**

this generator flattens nested containers such as

```
>>> l=( ('John', 'Hunter'), (1,23), [[[[42,(5,23)]]]])
```

so that

```
>>> for i in flatten(l): print i,  
John Hunter 1 23 42 5 23
```

By: Composite of Holger Krekel and Luther Blissett From:  
<http://aspn.activestate.com/ASPN/Cookbook/Python/Recipe/121294> and Recipe 1.12 in cookbook

**get\_recursive\_filelist(args)**

Recurse all the files and dirs in *args* ignoring symbolic links and return the files as a list of strings

**get\_sample\_data**(*fname*, *asfileobj*=*True*)

Check the cachedirectory `~/matplotlib/sample_data` for a `sample_data` file. If it does not exist, fetch it with `urllib` from the `mpl` git repo

[https://raw.githubusercontent.com/matplotlib/sample\\_data/master](https://raw.githubusercontent.com/matplotlib/sample_data/master)

and store it in the `cachedir`.

If `asfileobj` is `True`, a file object will be returned. Else the path to the file as a string will be returned

To add a datafile to this directory, you need to check out `sample_data` from `matplotlib` git:

```
git clone git@github.com:matplotlib/sample_data
```

and `git add` the data file you want to support. This is primarily intended for use in `mpl` examples that need custom data.

To bypass all downloading, set the `rc` parameter `examples.download` to `False` and `examples.directory` to the directory where we should look.

**get\_split\_ind**(*seq*, *N*)

*seq* is a list of words. Return the index into *seq* such that:

```
len(' '.join(seq[:ind]))<=N
```

**is\_closed\_polygon**(*X*)

This function has been moved to `matplotlib.mlab` – please import it from there

**is\_math\_text**(*s*)**is\_numlike**(*obj*)

return true if *obj* looks like a number

**is\_scalar**(*obj*)

return true if *obj* is not string like and is not iterable

**is\_scalar\_or\_string**(*val*)**is\_sequence\_of\_strings**(*obj*)

Returns true if *obj* is iterable and contains strings

**is\_string\_like**(*obj*)

Return True if *obj* looks like a string

**is\_writable\_file\_like**(*obj*)

return true if *obj* looks like a file object with a *write* method

**issubclass\_safe**(*x*, *klass*)

return `issubclass(x, klass)` and return `False` on a `TypeError`

**isvector**(*X*)

This function has been moved to `matplotlib.mlab` – please import it from there

**iterable**(*obj*)

return true if *obj* is iterable

**less\_simple\_linear\_interpolation**(*x, y, xi, extrap=False*)

This function has been moved to matplotlib.mlab – please import it from there

**listFiles**(*root, patterns='\*', recurse=1, return\_folders=0*)

Recursively list files

from Parmar and Martelli in the Python Cookbook

**class maxdict**(*maxsize*)

Bases: dict

A dictionary with a maximum size; this doesn't override all the relevant methods to constrain size, just setitem, so use with caution

**makedirs**(*newdir, mode=511*)

make directory *newdir* recursively, and set *mode*. Equivalent to

```
> mkdir -p NEWDIR
> chmod MODE NEWDIR
```

**onetrue**(*seq*)

Return *True* if one element of *seq* is *True*. If *seq* is empty, return *False*.

**path\_length**(*X*)

This function has been moved to matplotlib.mlab – please import it from there

**pieces**(*seq, num=2*)

Break up the *seq* into *num* tuples

**popall**(*seq*)

empty a list

**print\_cycles**(*objects, outstream=<open file '<stdout>', mode 'w' at 0x2b9e1b7c1150>, show\_progress=False*)

**objects** A list of objects to find cycles in. It is often useful to pass in gc.garbage to find the cycles that are preventing some objects from being garbage collected.

**outstream** The stream for output.

**show\_progress** If True, print the number of objects reached as they are found.

**quad2cubic**(*q0x, q0y, q1x, q1y, q2x, q2y*)

This function has been moved to matplotlib.mlab – please import it from there

**recursive\_remove**(*path*)

**report\_memory**(*i=0*)

return the memory consumed by process

**restrict\_dict**(*d, keys*)

Return a dictionary that contains those keys that appear in both *d* and *keys*, with values from *d*.

**reverse\_dict**(*d*)

reverse the dictionary – may lose data if values are not unique!

**safe\_masked\_invalid**(*x*)

**safezip**(\*args)

make sure *args* are equal len before zipping

**class silent\_list**(*type, seq=None*)

Bases: list

override repr when returning a list of matplotlib artists to prevent long, meaningless output. This is meant to be used for a homogeneous list of a give type

**simple\_linear\_interpolation**(*a, steps*)

**soundex**(*name, len=4*)

soundex module conforming to Odell-Russell algorithm

**strip\_math**(*s*)

remove latex formatting from mathtext

**to\_filehandle**(*fname, flag='rU', return\_opened=False*)

*fname* can be a filename or a file handle. Support for gzipped files is automatic, if the filename ends in .gz. *flag* is a read/write flag for `file()`

**class todate**(*fmt='%Y-%m-%d', missing='Null', missingval=None*)

Bases: `matplotlib.cbook.converter`

convert to a date or None

use a `time.strptime()` format string for conversion

**class todatetime**(*fmt='%Y-%m-%d', missing='Null', missingval=None*)

Bases: `matplotlib.cbook.converter`

convert to a datetime or None

use a `time.strptime()` format string for conversion

**class tofloat**(*missing='Null', missingval=None*)

Bases: `matplotlib.cbook.converter`

convert to a float or None

**class toint**(*missing='Null', missingval=None*)

Bases: `matplotlib.cbook.converter`

convert to an int or None

**class tostr**(*missing='Null', missingval=''*)

Bases: `matplotlib.cbook.converter`

convert to string or None

**unicode\_safe**(*s*)

**unique**(*x*)

Return a list of unique elements of *x*

**unmasked\_index\_ranges**(*mask, compressed=True*)

Find index ranges where *mask* is *False*.

*mask* will be flattened if it is not already 1-D.

Returns Nx2 `numpy.ndarray` with each row the start and stop indices for slices of the compressed `numpy.ndarray` corresponding to each of *N* uninterrupted runs of unmasked values. If optional argument *compressed* is *False*, it returns the start and stop indices into the original `numpy.ndarray`, not the compressed `numpy.ndarray`. Returns *None* if there are no unmasked values.

Example:

```
y = ma.array(np.arange(5), mask = [0,0,1,0,0])
ii = unmasked_index_ranges(ma.getmaskarray(y))
# returns array [[0,2,] [2,4,]]

y.compressed()[ii[1,0]:ii[1,1]]
# returns array [3,4,]

ii = unmasked_index_ranges(ma.getmaskarray(y), compressed=False)
# returns array [[0, 2], [3, 5]]

y.filled()[ii[1,0]:ii[1,1]]
# returns array [3,4,]
```

Prior to the transforms refactoring, this was used to support masked arrays in Line2D.

**vector\_lengths**(*X*, *P*=2.0, *axis*=None)

This function has been moved to `matplotlib.mlab` – please import it from there

**wrap**(*prefix*, *text*, *cols*)

wrap *text* with *prefix* at length *cols*



## CM (COLORMAP)

### 49.1 matplotlib.cm

This module provides a large set of colormaps, functions for registering new colormaps and for getting a colormap by name, and a mixin class for adding color mapping functionality.

**class `ScalarMappable`**(*norm=None, cmap=None*)

This is a mixin class to support scalar -> RGBA mapping. Handles normalization and colormapping

*norm* is an instance of `colors.Normalize` or one of its subclasses, used to map luminance to 0-1.  
*cmap* is a `cm` colormap instance, for example `cm.jet`

**`add_checker`**(*checker*)

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

**`autoscale`**()

Autoscale the scalar limits on the *norm* instance using the current array

**`autoscale_None`**()

Autoscale the scalar limits on the *norm* instance using the current array, changing only limits that are None

**`changed`**()

Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

**`check_update`**(*checker*)

If mappable has changed since the last check, return True; else return False

**`get_array`**()

Return the array

**`get_clim`**()

return the min, max of the color limits for image scaling

**`get_cmap`**()

return the colormap

**`set_array`**(*A*)

Set the image array from numpy array *A*

**set\_clim**(*vmin=None, vmax=None*)

set the norm limits for image scaling; if *vmin* is a length2 sequence, interpret it as (*vmin*, *vmax*) which is used to support setp

ACCEPTS: a length 2 sequence of floats

**set\_cmap**(*cmap*)

set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

**set\_colorbar**(*im, ax*)

set the colorbar image and axes associated with mappable

**set\_norm**(*norm*)

set the normalization instance

**to\_rgba**(*x, alpha=None, bytes=False*)

Return a normalized rgba array corresponding to *x*. If *x* is already an rgb array, insert *alpha*; if it is already rgba, return it unchanged. If *bytes* is True, return rgba as 4 uint8s instead of 4 floats.

**get\_cmap**(*name=None, lut=None*)

Get a colormap instance, defaulting to rc values if *name* is None.

Colormaps added with [register\\_cmap\(\)](#) take precedence over builtin colormaps.

If *name* is a `colors.Colormap` instance, it will be returned.

If *lut* is not None it must be an integer giving the number of entries desired in the lookup table, and *name* must be a standard mpl colormap name with a corresponding data dictionary in *datad*.

**register\_cmap**(*name=None, cmap=None, data=None, lut=None*)

Add a colormap to the set recognized by [get\\_cmap\(\)](#).

It can be used in two ways:

```
register_cmap(name='swirly', cmap=swirly_cmap)
```

```
register_cmap(name='choppy', data=choppydata, lut=128)
```

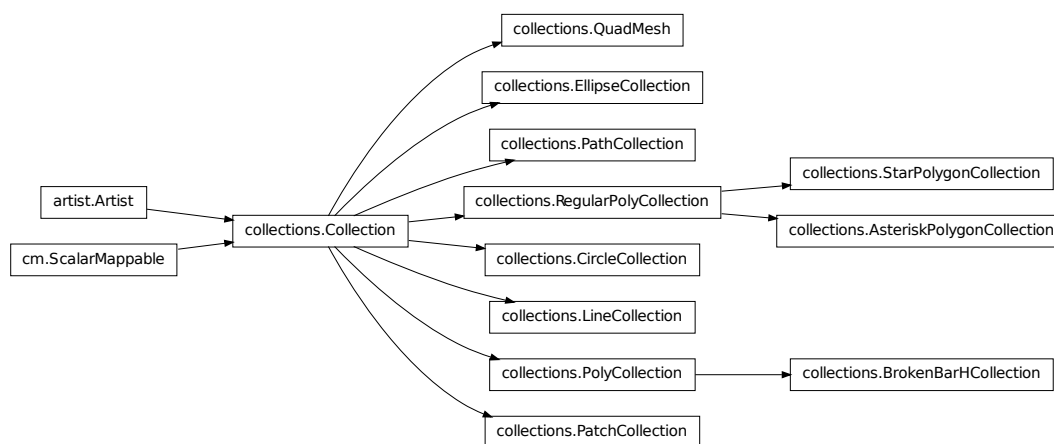
In the first case, *cmap* must be a `colors.Colormap` instance. The *name* is optional; if absent, the name will be the *name* attribute of the *cmap*.

In the second case, the three arguments are passed to the `colors.LinearSegmentedColormap` initializer, and the resulting colormap is registered.

**revcmap**(*data*)

Can only handle specification *data* in dictionary format.

# COLLECTIONS



## 50.1 matplotlib.collections

Classes for the efficient drawing of large collections of objects that share most properties, e.g. a large number of line segments or polygons.

The classes are not meant to be as flexible as their single element counterparts (e.g. you may not be able to select all line styles) but they are meant to be fast for common use cases (e.g. a large set of solid line segments)

**class AsteriskPolygonCollection**(*numsides*, *rotation*=0, *sizes*=(1, ), *\*\*kwargs*)

Bases: `matplotlib.collections.RegularPolygonCollection`

Draw a collection of regular asterisks with *numsides* points.

***numsides*** the number of sides of the polygon

***rotation*** the rotation of the polygon in radians

***sizes*** gives the area of the circle circumscribing the regular polygon in points<sup>2</sup>

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

Example: see `examples/dynamic_collection.py` for complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)
```

```
collection = RegularPolyCollection(
    numsides=5, # a pentagon
    rotation=0, sizes=(50,),
    facecolors = facecolors,
    edgecolors = (black,),
    linewidths = (1,),
    offsets = offsets,
    transOffset = ax.transData,
)
```

**class BrokenBarHCollection**(*xranges*, *yrange*, *\*\*kwargs*)

Bases: `matplotlib.collections.PolyCollection`

A collection of horizontal bars spanning *yrange* with a sequence of *xranges*.

*xranges* sequence of (*xmin*, *xwidth*)

*yrange* *ymin*, *ywidth*

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None

- *transOffset*: transforms.IdentityTransform()
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

static **span\_where**(*x*, *ymin*, *ymax*, *where*, *\*\*kwargs*)

Create a `BrokenBarHCollection` to plot horizontal bars from over the regions in *x* where *where* is True. The bars range on the y-axis from *ymin* to *ymax*

A `BrokenBarHCollection` is returned. *kwargs* are passed on to the collection.

**class CircleCollection**(*sizes*, *\*\*kwargs*)

Bases: `matplotlib.collections.Collection`

A collection of circles, drawn using splines.

*sizes* Gives the area of the circle in points<sup>2</sup>

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: transforms.IdentityTransform()
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

**get\_sizes**()

return sizes of circles

**class Collection**(*edgecolors=None*, *facecolors=None*, *linewidths=None*, *linestyles='solid'*, *antialiaseds=None*, *offsets=None*, *transOffset=None*, *norm=None*, *cmap=None*, *pickradius=5.0*, *urls=None*, *\*\*kwargs*)

Bases: `matplotlib.artist.Artist`, `matplotlib.cm.ScalarMappable`

Base class for Collections. Must be subclassed to be usable.

All properties in a collection must be sequences or scalars; if scalars, they will be converted to sequences. The property of the *i*th element of the collection is:

```
prop[i % len(props)]
```

Keyword arguments and default values:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets).

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

The use of `ScalarMappable` is optional. If the `ScalarMappable` matrix *\_A* is not None (ie a call to `set_array` has been made), at draw time a call to scalar mappable will be made to set the face colors.

Create a Collection

```
%(Collection)s
```

**contains**(*mouseevent*)

Test whether the mouse event occurred in the collection.

Returns True | False, `dict(ind=itemlist)`, where every item in *itemlist* contains the event.

**draw**(*artist, renderer, \*args, \*\*kwargs*)

**get\_dashes**()

**get\_dataLim**(*transData*)

**get\_edgecolor**()

**get\_edgecolors**()

**get\_facecolor**()

**get\_facecolors**()

**get\_linestyle**()

**get\_linestyles**()

**get\_linewidth**()

**get\_linewidths**()

**get\_offsets()**

Return the offsets for the collection.

**get\_paths()****get\_pickradius()****get\_transforms()****get\_urls()****get\_window\_extent(renderer)****set\_alpha(alpha)**

Set the alpha transparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

**set\_antialiased(aa)**

Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

**set\_antialiaseds(aa)**

alias for set\_antialiased

**set\_color(c)**

Set both the edgecolor and the facecolor.

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**See Also:**

[\*\*set\\_facecolor\(\)\*\*](#), [\*\*set\\_edgecolor\(\)\*\*](#) For setting the edge or face color individually.

**set\_dashes(ls)**

alias for set\_linestyle

**set\_edgecolor(c)**

Set the edgecolor(s) of the collection. *c* can be a matplotlib color arg (all patches have same color), or a sequence of rgba tuples; if it is a sequence the patches will cycle through the sequence.

If *c* is 'face', the edge color will always be the same as the face color. If it is 'none', the patch boundary will not be drawn.

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**set\_edgecolors(c)**

alias for set\_edgecolor

**set\_facecolor(c)**

Set the facecolor(s) of the collection. *c* can be a matplotlib color arg (all patches have same color), or a sequence of rgba tuples; if it is a sequence the patches will cycle through the sequence.

If *c* is 'none', the patch will not be filled.

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**set\_facecolors(*c*)**  
alias for set\_facecolor

**set\_linestyle(*ls*)**  
Set the linestyle(s) for the collection.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) ]

**set\_linestyles(*ls*)**  
alias for set\_linestyle

**set\_linewidth(*lw*)**  
Set the linewidth(s) for the collection. *lw* can be a scalar or a sequence; if it is a sequence the patches will cycle through the sequence

ACCEPTS: float or sequence of floats

**set\_linewidths(*lw*)**  
alias for set\_linewidth

**set\_lw(*lw*)**  
alias for set\_linewidth

**set\_offsets(*offsets*)**  
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

**set\_paths()**

**set\_pickradius(*pr*)**

**set\_urls(*urls*)**

**update\_from(*other*)**  
copy properties from other to self

**update\_scalarmappable()**  
If the scalar mappable array is not none, update colors from scalar data

**class EllipseCollection(*widths, heights, angles, units='points', \*\*kwargs*)**

Bases: [matplotlib.collections.Collection](#)

A collection of ellipses, drawn using splines.

**widths: sequence** lengths of first axes (e.g., major axis lengths)

**heights: sequence** lengths of second axes

**angles: sequence** angles of first axes, degrees CCW from the X-axis

**units:** ['points' | 'inches' | 'dots' | 'width' | 'height' | 'x' | 'y' | 'xy']

units in which majors and minors are given; 'width' and 'height' refer to the dimensions of the axes, while 'x' and 'y' refer to the *offsets* data units. 'xy' differs from all others in that the angle as plotted varies with the aspect ratio, and equals the specified angle only when



the aspect ratio is unity. Hence it behaves the same as the [Ellipse](#) with `axes.transData` as its transform.

Additional kwargs inherited from the base [Collection](#):

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for [matplotlib.cm.ScalarMappable](#))
- *cmap*: None (optional for [matplotlib.cm.ScalarMappable](#))

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

**class LineCollection**(*segments*, *linewidths*=None, *colors*=None, *antialiaseds*=None, *linestyles*='solid', *offsets*=None, *transOffset*=None, *norm*=None, *cmap*=None, *pickradius*=5, \*\**kwargs*)

Bases: [matplotlib.collections.Collection](#)

All parameters must be sequences or scalars; if scalars, they will be converted to sequences. The property of the *i*th line segment is:

`prop[i % len(props)]`

i.e., the properties cycle if the `len` of props is less than the number of segments.

*segments* a sequence of (*line0*, *line1*, *line2*), where:

`linen = (x0, y0), (x1, y1), ... (xm, ym)`

or the equivalent numpy array with two columns. Each line can be a different length.

*colors* must be a sequence of RGBA tuples (eg arbitrary color strings, etc, not allowed).

*antialiaseds* must be a sequence of ones or zeros

*linestyles* [ 'solid' | 'dashed' | 'dashdot' | 'dotted' ] a string or dash tuple. The dash tuple is:

`(offset, onoffseq)`,

where *onoffseq* is an even length tuple of on and off ink in points.

If *linewidths*, *colors*, or *antialiaseds* is None, they default to their rcParams setting, in sequence form.

If *offsets* and *transOffset* are not None, then *offsets* are transformed by *transOffset* and applied after the segments have been transformed to display coordinates.

If *offsets* is not None but *transOffset* is None, then the *offsets* are added to the segments before any transformation. In this case, a single offset can be specified as:

```
offsets=(xo,yo)
```

and this value will be added cumulatively to each successive segment, so as to produce a set of successively offset curves.

**norm** None (optional for `matplotlib.cm.ScalarMappable`)

**cmap** None (optional for `matplotlib.cm.ScalarMappable`)

*pickradius* is the tolerance for mouse clicks picking a line. The default is 5 pt.

The use of `ScalarMappable` is optional. If the `ScalarMappable` array `_A` is not None (ie a call to `set_array()` has been made), at draw time a call to scalar mappable will be made to set the colors.

**color(*c*)**

Set the color(s) of the line collection. *c* can be a matplotlib color arg (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**get\_color()**

**get\_colors()**

**set\_color(*c*)**

Set the color(s) of the line collection. *c* can be a matplotlib color arg (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence.

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**set\_paths(*segments*)**

**set\_segments(*segments*)**

**set\_verts(*segments*)**

**class PatchCollection(*patches*, *match\_original=False*, *\*\*kwargs*)**

Bases: `matplotlib.collections.Collection`

A generic collection of patches.

This makes it easier to assign a color map to a heterogeneous collection of patches.

This also may improve plotting speed, since PatchCollection will draw faster than a large number of patches.

***patches*** a sequence of Patch objects. This list may include a heterogeneous assortment of different patch types.

***match\_original*** If True, use the colors and linewidths of the original patches. If False, new colors may be assigned by providing the standard collection arguments, *facecolor*, *edgecolor*, *linewidths*, *norm* or *cmap*.

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

The use of `ScalarMappable` is optional. If the `ScalarMappable` matrix *\_A* is not None (ie a call to `set_array` has been made), at draw time a call to scalar mappable will be made to set the face colors.

**`set_paths`**(*patches*)

**class `PathCollection`**(*paths*, *sizes=None*, *\*\*kwargs*)

Bases: `matplotlib.collections.Collection`

This is the most basic `Collection` subclass.

*paths* is a sequence of `matplotlib.path.Path` instances.

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

**`draw`**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

**`get_paths`**()

**`get_sizes`**()

**`set_paths`**(*paths*)

**class `PolyCollection`**(*verts*, *sizes=None*, *closed=True*, *\*\*kwargs*)

Bases: `matplotlib.collections.Collection`

*verts* is a sequence of (*verts0*, *verts1*, ...) where *verts<sub>i</sub>* is a sequence of *xy* tuples of vertices, or an equivalent `numpy` array of shape (*nv*, 2).

*sizes* is *None* (default) or a sequence of floats that scale the corresponding *verts<sub>i</sub>*. The scaling is applied before the Artist master transform; if the latter is an identity transform, then the overall scaling is such that if *verts<sub>i</sub>* specify a unit square, then *sizes<sub>i</sub>* is the area of that square in points<sup>2</sup>. If `len(sizes) < nv`, the additional values will be taken cyclically from the array.

*closed*, when *True*, will explicitly close the polygon.

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

**set\_paths**(*verts*, *closed*=*True*)

This allows one to delay initialization of the vertices.

**set\_verts**(*verts*, *closed*=*True*)

This allows one to delay initialization of the vertices.

**class QuadMesh**(*meshWidth*, *meshHeight*, *coordinates*, *showedges*, *antialiased*=*True*, *shading*='flat', \*\**kwargs*)

Bases: `matplotlib.collections.Collection`

Class for the efficient drawing of a quadrilateral mesh.

A quadrilateral mesh consists of a grid of vertices. The dimensions of this array are (*meshWidth* + 1, *meshHeight* + 1). Each vertex in the mesh has a different set of “mesh coordinates” representing its position in the topology of the mesh. For any values (*m*, *n*) such that  $0 \leq m \leq \text{meshWidth}$  and  $0 \leq n \leq \text{meshHeight}$ , the vertices at mesh coordinates (*m*, *n*), (*m*, *n* + 1), (*m* + 1, *n* + 1), and (*m* + 1, *n*) form one of the quadrilaterals in the mesh. There are thus (*meshWidth* \* *meshHeight*) quadrilaterals in the mesh. The mesh need not be regular and the polygons need not be convex.

A quadrilateral mesh is represented by a (2 x ((*meshWidth* + 1) \* (*meshHeight* + 1))) numpy array *coordinates*, where each row is the *x* and *y* coordinates of one of the vertices. To define the function that maps from a data point to its corresponding color, use the `set_cmap()` method. Each of these arrays is indexed in row-major order by the mesh coordinates of the vertex (or the mesh coordinates of the lower left vertex, in the case of the colors).

For example, the first entry in *coordinates* is the coordinates of the vertex at mesh coordinates (0, 0), then the one at (0, 1), then at (0, 2) .. (0, *meshWidth*), (1, 0), (1, 1), and so on.

*shading* may be ‘flat’, ‘faceted’ or ‘gouraud’

static **convert\_mesh\_to\_paths**(*meshWidth, meshHeight, coordinates*)

Converts a given mesh into a sequence of `matplotlib.path.Path` objects for easier rendering by backends that do not directly support quadmeshes.

This function is primarily of use to backend implementers.

**convert\_mesh\_to\_triangles**(*meshWidth, meshHeight, coordinates*)

Converts a given mesh into a sequence of triangles, each point with its own color. This is useful for experiments using `draw_qouraud_triangle`.

**draw**(*artist, renderer, \*args, \*\*kwargs*)

**get\_datalim**(*transData*)

**get\_paths**()

**set\_paths**()

**class RegularPolyCollection**(*numsides, rotation=0, sizes=(1, ), \*\*kwargs*)

Bases: `matplotlib.collections.Collection`

Draw a collection of regular polygons with *numsides*.

**numsides** the number of sides of the polygon

**rotation** the rotation of the polygon in radians

**sizes** gives the area of the circle circumscribing the regular polygon in points<sup>2</sup>

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

Example: see `examples/dynamic_collection.py` for complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)
```

```
collection = RegularPolyCollection(
```

```
    numsides=5, # a pentagon
    rotation=0, sizes=(50,),
    facecolors = facecolors,
    edgecolors = (black,),
    linewidths = (1,),
    offsets = offsets,
    transOffset = ax.transData,
)
```

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

**get\_numsides**()

**get\_rotation**()

**get\_sizes**()

**class StarPolygonCollection**(*numsides*, *rotation*=0, *sizes*=(1, ), \*\**kwargs*)

Bases: `matplotlib.collections.RegularPolyCollection`

Draw a collection of regular stars with *numsides* points.

**numsides** the number of sides of the polygon

**rotation** the rotation of the polygon in radians

**sizes** gives the area of the circle circumscribing the regular polygon in points<sup>2</sup>

Valid Collection keyword arguments:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: `transforms.IdentityTransform()`
- *norm*: None (optional for `matplotlib.cm.ScalarMappable`)
- *cmap*: None (optional for `matplotlib.cm.ScalarMappable`)

*offsets* and *transOffset* are used to translate the patch after rendering (default no offsets)

If any of *edgecolors*, *facecolors*, *linewidths*, *antialiaseds* are None, they default to their `matplotlib.rcParams` patch setting, in sequence form.

Example: see `examples/dynamic_collection.py` for complete example:

```
offsets = np.random.rand(20,2)
facecolors = [cm.jet(x) for x in np.random.rand(20)]
black = (0,0,0,1)
```

```
collection = RegularPolyCollection(
```

```
numsides=5, # a pentagon
rotation=0, sizes=(50,),
facecolors = facecolors,
edgecolors = (black,),
linewidths = (1,),
offsets = offsets,
transOffset = ax.transData,
)
```





# COLORBAR

## 51.1 matplotlib.colorbar

Colorbar toolkit with two classes and a function:

**ColorbarBase** the base class with full colorbar drawing functionality. It can be used as-is to make a colorbar for a given colormap; a mappable object (e.g., image) is not needed.

**Colorbar** the derived class for use with images or contour plots.

**make\_axes()** a function for resizing an axes and adding a second axes suitable for a colorbar

The `colorbar()` method uses `make_axes()` and `Colorbar`; the `colorbar()` function is a thin wrapper over `colorbar()`.

**class Colorbar**(*ax, mappable, \*\*kw*)

Bases: `matplotlib.colorbar.ColorbarBase`

This class connects a `ColorbarBase` to a `ScalarMappable` such as a `AxesImage` generated via `imshow()`.

It is not intended to be instantiated directly; instead, use `colorbar()` or `colorbar()` to make your colorbar.

**add\_lines**(*CS*)

Add the lines from a non-filled `ContourSet` to the colorbar.

**update\_bruteforce**(*mappable*)

Destroy and rebuild the colorbar. This is intended to become obsolete, and will probably be deprecated and then removed. It is not called when the `pyplot.colorbar` function or the `Figure.colorbar` method are used to create the colorbar.

**update\_normal**(*mappable*)

update solid, lines, etc. Unlike `update_bruteforce`, it does not clear the axes. This is meant to be called when the image or contour plot to which this colorbar belongs is changed.

**class ColorbarBase**(*ax, cmap=None, norm=None, alpha=None, values=None, boundaries=None, orientation='vertical', extend='neither', spacing='uniform', ticks=None, format=None, drawedges=False, filled=True*)

Bases: `matplotlib.cm.ScalarMappable`

Draw a colorbar in an existing axes.

This is a base class for the `Colorbar` class, which is the basis for the `colorbar()` function and the `colorbar()` method, which are the usual ways of creating a colorbar.

It is also useful by itself for showing a colormap. If the `cmap` kwarg is given but `boundaries` and `values` are left as `None`, then the colormap will be displayed on a 0-1 scale. To show the under- and over-value colors, specify the `norm` as:

```
colors.Normalize(clip=False)
```

To show the colors versus index instead of on the 0-1 scale, use:

```
norm=colors.NoNorm.
```

Useful attributes:

**ax** the Axes instance in which the colorbar is drawn

**lines** a LineCollection if lines were drawn, otherwise `None`

**dividers** a LineCollection if `drawedges` is `True`, otherwise `None`

Useful public methods are `set_label()` and `add_lines()`.

**add\_lines**(*levels, colors, linewidths*)

Draw lines on the colorbar.

**config\_axis**()

**draw\_all**()

Calculate any free parameters based on the current `cmap` and `norm`, and do all the drawing.

**set\_alpha**(*alpha*)

**set\_label**(*label, \*\*kw*)

Label the long axis of the colorbar

**set\_ticklabels**(*ticklabels, update\_ticks=True*)

set tick labels. Tick labels are updated immediately unless `update_ticks` is `False`. To manually update the ticks, call `update_ticks` method explicitly.

**set\_ticks**(*ticks, update\_ticks=True*)

set tick locations. Tick locations are updated immediately unless `update_ticks` is `False`. To manually update the ticks, call `update_ticks` method explicitly.

**update\_ticks**()

Force the update of the ticks and ticklabels. This must be called whenever the tick locator and/or tick formatter changes.

**make\_axes**(*parent, \*\*kw*)

Resize and reposition a parent axes, and return a child axes suitable for a colorbar:

```
cax, kw = make_axes(parent, **kw)
```

Keyword arguments may include the following (with defaults):

**orientation** ‘vertical’ or ‘horizontal’

| Property           | Description   |
|--------------------|---|
| <i>orientation</i> | vertical or horizontal  |
| <i>fraction</i>    | 0.15; fraction of original axes to use for colorbar   |
| <i>pad</i>         | 0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes |
| <i>shrink</i>      | 1.0; fraction by which to shrink the colorbar   |
| <i>aspect</i>      | 20; ratio of long to short dimensions   |
| <i>anchor</i>      | (0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes             |
| <i>panchor</i>     | (1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes      |

All but the first of these are stripped from the input kw set.

Returns (cax, kw), the child axes and the reduced kw dictionary.

**make\_axes\_gridspec**(parent, \*\*kw)

Resize and reposition a parent axes, and return a child axes suitable for a colorbar. This function is similar to `make_axes`. Primary differences are

- **make\_axes\_gridspec** should only be used with a subplot parent.
- **make\_axes** creates an instance of `Axes`. **make\_axes\_gridspec** creates an instance of `Subplot`.
- **make\_axes** updates the position of the parent. **make\_axes\_gridspec** replaces the `grid_spec` attribute of the parent with a new one.

While this function is meant to be compatible with `make_axes`, there could be some minor differences.:

```
cax, kw = make_axes_gridspec(parent, **kw)
```

Keyword arguments may include the following (with defaults):

**orientation** ‘vertical’ or ‘horizontal’

| Property           | Description   |
|--------------------|---|
| <i>orientation</i> | vertical or horizontal  |
| <i>fraction</i>    | 0.15; fraction of original axes to use for colorbar   |
| <i>pad</i>         | 0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes |
| <i>shrink</i>      | 1.0; fraction by which to shrink the colorbar   |
| <i>aspect</i>      | 20; ratio of long to short dimensions   |
| <i>anchor</i>      | (0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes             |
| <i>panchor</i>     | (1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes      |

All but the first of these are stripped from the input kw set.

Returns (cax, kw), the child axes and the reduced kw dictionary.



# COLORS

## 52.1 matplotlib.colors

A module for converting numbers or color arguments to *RGB* or *RGBA*

*RGB* and *RGBA* are sequences of, respectively, 3 or 4 floats in the range 0-1.

This module includes functions and classes for color specification conversions, and for mapping numbers to colors in a 1-D array of colors called a colormap. Colormapping typically involves two steps: a data array is first mapped onto the range 0-1 using an instance of `Normalize` or of a subclass; then this number in the 0-1 range is mapped to a color using an instance of a subclass of `Colormap`. Two are provided here: `LinearSegmentedColormap`, which is used to generate all the built-in colormap instances, but is also useful for making custom colormaps, and `ListedColormap`, which is used for generating a custom colormap from a list of color specifications.

The module also provides a single instance, `colorConverter`, of the `ColorConverter` class providing methods for converting single color specifications or sequences of them to *RGB* or *RGBA*.

Commands which take color arguments can use several formats to specify the colors. For the basic builtin colors, you can use a single letter

- b : blue
- g : green
- r : red
- c : cyan
- m : magenta
- y : yellow
- k : black
- w : white

Gray shades can be given as a string encoding a float in the 0-1 range, e.g.:

```
color = '0.75'
```

For a greater range of colors, you have two options. You can specify the color using an html hex string, as in:

```
color = '#eeffff'
```

or you can pass an  $R$ ,  $G$ ,  $B$  tuple, where each of  $R$ ,  $G$ ,  $B$  are in the range  $[0,1]$ .

Finally, legal html names for colors, like 'red', 'burlywood' and 'chartreuse' are supported.

**class BoundaryNorm**(*boundaries*, *ncolors*, *clip=False*)

Bases: `matplotlib.colors.Normalize`

Generate a colormap index based on discrete intervals.

Unlike `Normalize` or `LogNorm`, `BoundaryNorm` maps values to integers instead of to the interval 0-1.

Mapping to the 0-1 interval could have been done via piece-wise linear interpolation, but using integers seems simpler, and reduces the number of conversions back and forth between integer and floating point.

**boundaries** a monotonically increasing sequence

**ncolors** number of colors in the colormap to be used

If:

```
b[i] <= v < b[i+1]
```

then  $v$  is mapped to color  $j$ ; as  $i$  varies from 0 to  $\text{len}(\text{boundaries})-2$ ,  $j$  goes from 0 to  $\text{ncolors}-1$ .

Out-of-range values are mapped to -1 if low and  $\text{ncolors}$  if high; these are converted to valid indices by `Colormap.__call__()`.

**inverse**(*value*)

**class ColorConverter**()

Provides methods for converting color specifications to *RGB* or *RGBA*

Caching is used for more efficient conversion upon repeated calls with the same argument.

Ordinarily only the single instance instantiated in this module, *colorConverter*, is needed.

**to\_rgb**(*arg*)

Returns an *RGB* tuple of three floats from 0-1.

*arg* can be an *RGB* or *RGBA* sequence or a string in any of several forms:

1.a letter from the set 'rgbcmykw'

2.a hex color string, like '#00FFFF'

3.a standard name, like 'aqua'

4.a float, like '0.4', indicating gray on a 0-1 scale

if *arg* is *RGBA*, the *A* will simply be discarded.

**to\_rgba**(*arg*, *alpha=None*)

Returns an *RGBA* tuple of four floats from 0-1.

For acceptable values of *arg*, see [to\\_rgb\(\)](#). In addition, if *arg* is “none” (case-insensitive), then (0,0,0,0) will be returned. If *arg* is an *RGBA* sequence and *alpha* is not *None*, *alpha* will replace the original *A*.

**to\_rgba\_array**(*c*, *alpha=None*)

Returns a numpy array of *RGBA* tuples.

Accepts a single mpl color spec or a sequence of specs.

Special case to handle “no color”: if *c* is “none” (case-insensitive), then an empty array will be returned. Same for an empty list.

**class Colormap**(*name*, *N=256*)

Base class for all scalar to rgb mappings

Important methods:

- [set\\_bad\(\)](#)
- [set\\_under\(\)](#)
- [set\\_over\(\)](#)

**Public class attributes:** *N* : number of rgb quantization levels *name* : name of colormap

**is\_gray**()

**set\_bad**(*color='k'*, *alpha=None*)

Set color to be used for masked values.

**set\_over**(*color='k'*, *alpha=None*)

Set color to be used for high out-of-range values. Requires *norm.clip* = False

**set\_under**(*color='k'*, *alpha=None*)

Set color to be used for low out-of-range values. Requires *norm.clip* = False

**class LightSource**(*azdeg=315*, *altdeg=45*, *hsv\_min\_val=0*, *hsv\_max\_val=1*, *hsv\_min\_sat=1*,  
*hsv\_max\_sat=0*)

Bases: `object`

Create a light source coming from the specified azimuth and elevation. Angles are in degrees, with the azimuth measured clockwise from north and elevation up from the zero plane of the surface. The [shade\(\)](#) is used to produce rgb values for a shaded relief image given a data array.

Specify the azimuth (measured clockwise from south) and altitude (measured up from the plane of the surface) of the light source in degrees.

The color of the resulting image will be darkened by moving the (s,v) values (in hsv colorspace) toward (hsv\_min\_sat, hsv\_min\_val) in the shaded regions, or lightened by sliding (s,v) toward (hsv\_max\_sat, hsv\_max\_val) in regions that are illuminated. The default extremes are chose so that completely shaded points are nearly black (*s* = 1, *v* = 0) and completely illuminated points are nearly white (*s* = 0, *v* = 1).

**shade**(*data, cmap*)

Take the input data array, convert to HSV values in the given colormap, then adjust those color values to given the impression of a shaded relief map with a specified light source. RGBA values are returned, which can then be used to plot the shaded image with `imshow`.

**shade\_rgb**(*rgb, elevation, fraction=1.0*)

Take the input RGB array ( $ny \times nx \times 3$ ) adjust their color values to given the impression of a shaded relief map with a specified light source using the elevation ( $ny \times nx$ ). A new RGB array ( $(ny \times nx \times 3)$ ) is returned.

**class LinearSegmentedColormap**(*name, segmentdata, N=256, gamma=1.0*)

Bases: `matplotlib.colors.Colormap`

Colormap objects based on lookup tables using linear segments.

The lookup table is generated using linear interpolation for each primary color, with the 0-1 domain divided into any number of segments.

Create color map from linear mapping segments

`segmentdata` argument is a dictionary with a red, green and blue entries. Each entry should be a list of  $x, y0, y1$  tuples, forming rows in a table.

Example: suppose you want red to increase from 0 to 1 over the bottom half, green to do the same over the middle half, and blue over the top half. Then you would use:

```
cdict = {'red': [(0.0, 0.0, 0.0),
                 (0.5, 1.0, 1.0),
                 (1.0, 1.0, 1.0)],
         'green': [(0.0, 0.0, 0.0),
                   (0.25, 0.0, 0.0),
                   (0.75, 1.0, 1.0),
                   (1.0, 1.0, 1.0)],
         'blue': [(0.0, 0.0, 0.0),
                  (0.5, 0.0, 0.0),
                  (1.0, 1.0, 1.0)]}
```

Each row in the table for a given color is a sequence of  $x, y0, y1$  tuples. In each sequence,  $x$  must increase monotonically from 0 to 1. For any input value  $z$  falling between  $x[i]$  and  $x[i+1]$ , the output value of a given color will be linearly interpolated between  $y1[i]$  and  $y0[i+1]$ :

```
row i:   x  y0  y1
          /
         /
row i+1: x  y0  y1
```

Hence  $y0$  in the first row and  $y1$  in the last row are never used.

**See Also:**



**LinearSegmentedColormap.from\_list()** Static method; factory function for generating a smoothly-varying LinearSegmentedColormap.

**makeMappingArray()** For information about making a mapping array.

static **from\_list**(*name*, *colors*, *N*=256, *gamma*=1.0)

Make a linear segmented colormap with *name* from a sequence of *colors* which evenly transitions from colors[0] at val=0 to colors[-1] at val=1. *N* is the number of rgb quantization levels. Alternatively, a list of (value, color) tuples can be given to divide the range unevenly.

**set\_gamma**(*gamma*)

Set a new gamma value and regenerate color map.

**class ListedColormap**(*colors*, *name*='from\_list', *N*=None)

Bases: `matplotlib.colors.Colormap`

Colormap object generated from a list of colors.

This may be most useful when indexing directly into a colormap, but it can also be used to generate special colormaps for ordinary mapping.

Make a colormap from a list of colors.

**colors** a list of matplotlib color specifications, or an equivalent Nx3 floating point array (*N* rgb values)

**name** a string to identify the colormap

**N** the number of entries in the map. The default is *None*, in which case there is one colormap entry for each element in the list of colors. If:

$N < \text{len}(\text{colors})$

the list will be truncated at *N*. If:

$N > \text{len}(\text{colors})$

the list will be extended by repetition.

**class LogNorm**(*vmin*=None, *vmax*=None, *clip*=False)

Bases: `matplotlib.colors.Normalize`

Normalize a given value to the 0-1 range on a log scale

If *vmin* or *vmax* is not given, they are taken from the input's minimum and maximum value respectively. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

$vmin == vmax$

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip* = *False*.

**autoscale**(*A*)

Set *vmin*, *vmax* to min, max of *A*.

**autoscale\_None**(*A*)

autoscale only None-valued *vmin* or *vmax*

**inverse**(*value*)

**class NoNorm**(*vmin=None, vmax=None, clip=False*)

Bases: `matplotlib.colors.Normalize`

Dummy replacement for `Normalize`, for the case where we want to use indices directly in a `ScalarMappable`.

If *vmin* or *vmax* is not given, they are taken from the input's minimum and maximum value respectively. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

*vmin*==*vmax*

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

**inverse**(*value*)

**class Normalize**(*vmin=None, vmax=None, clip=False*)

Normalize a given value to the 0-1 range

If *vmin* or *vmax* is not given, they are taken from the input's minimum and maximum value respectively. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

*vmin*==*vmax*

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

**autoscale**(*A*)

Set *vmin*, *vmax* to min, max of *A*.

**autoscale\_None**(*A*)

autoscale only None-valued *vmin* or *vmax*

**inverse**(*value*)

static **process\_value**(*value*)

Homogenize the input *value* for easy and efficient normalization.

*value* can be a scalar or sequence.

Returns *result*, *is\_scalar*, where *result* is a masked array matching *value*. Float dtypes are preserved; integer types with two bytes or smaller are converted to `np.float32`, and larger types are converted to `np.float`. Preserving `float32` when possible, and using in-place operations, can greatly improve speed for large arrays.

Experimental; we may want to add an option to force the use of `float32`.

**scaled()**

return true if vmin and vmax set

**hex2color(*s*)**

Take a hex string *s* and return the corresponding rgb 3-tuple Example: `#efefef` -> (0.93725, 0.93725, 0.93725)

**hsv\_to\_rgb(*hsv*)**

convert hsv values in a numpy array to rgb values both input and output arrays have shape (M,N,3)

**is\_color\_like(*c*)**

Return *True* if *c* can be converted to *RGB*

**makeMappingArray(*N*, *data*, *gamma*=1.0)**

Create an *N* -element 1-d lookup table

*data* represented by a list of x,y0,y1 mapping correspondences. Each element in this list represents how a value between 0 and 1 (inclusive) represented by *x* is mapped to a corresponding value between 0 and 1 (inclusive). The two values of *y* are to allow for discontinuous mapping functions (say as might be found in a sawtooth) where *y0* represents the value of *y* for values of *x* <= to that given, and *y1* is the value to be used for *x* > than that given). The list must start with *x*=0, end with *x*=1, and all values of *x* must be in increasing order. Values between the given mapping points are determined by simple linear interpolation.

Alternatively, *data* can be a function mapping values between 0 - 1 to 0 - 1.

The function returns an array “result” where `result[x*(N-1)]` gives the closest value for values of *x* between 0 and 1.

**no\_norm**

alias of `NoNorm`

**normalize**

alias of `Normalize`

**rgb2hex(*rgb*)**

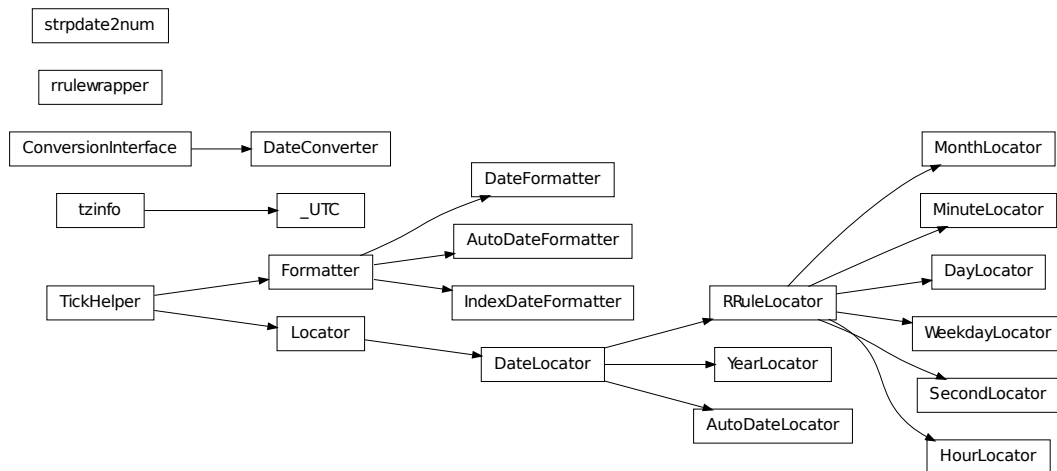
Given an rgb or rgba sequence of 0-1 floats, return the hex string

**rgb\_to\_hsv(*arr*)**

convert rgb values in a numpy array to hsv values input and output arrays should have shape (M,N,3)



# DATES



## 53.1 matplotlib.dates

Matplotlib provides sophisticated date plotting capabilities, standing on the shoulders of python `datetime`, the add-on modules `pytz` and `dateutils`. `datetime` objects are converted to floating point numbers which represent time in days since 0001-01-01 UTC, plus 1. For example, 0001-01-01, 06:00 is 1.25, not 0.25. The helper functions `date2num()`, `num2date()` and `drange()` are used to facilitate easy conversion to and from `datetime` and numeric ranges.

**Note:** Like Python's `datetime`, mpl uses the Gregorian calendar for all conversions between dates and floating point numbers. This practice is not universal, and calendar differences can cause confusing differences between what Python and mpl give as the number of days since 0001-01-01 and what other software and databases yield. For example, the [US Naval Observatory](#) uses a calendar that switches from Julian to Gregorian in October, 1582. Hence, using their calculator, the number of days between 0001-01-01 and 2006-04-01 is 732403, whereas using the Gregorian calendar via the `datetime` module we find:

```
In [31]:date(2006,4,1).toordinal() - date(1,1,1).toordinal()
Out[31]:732401
```

A wide range of specific and general purpose date tick locators and formatters are provided in this module. See `matplotlib.ticker` for general information on tick locators and formatters. These are described below.

All the matplotlib date converters, tickers and formatters are timezone aware, and the default timezone is given by the `timezone` parameter in your `matplotlibrc` file. If you leave out a `tz` timezone instance, the default from your rc file will be assumed. If you want to use a custom time zone, pass a `pytz.timezone` instance with the `tz` keyword argument to `num2date()`, `plot_date()`, and any custom date tickers or locators you create. See `pytz` for information on `pytz` and timezone handling.

The `dateutil` module provides additional code to handle date ticking, making it easy to place ticks on any kinds of dates. See examples below.

### 53.1.1 Date tickers

Most of the date tickers can locate single or multiple values. For example:

```
# tick on mondays every week
loc = WeekdayLocator(byweekday=MO, tz=tz)
```

```
# tick on mondays and saturdays
loc = WeekdayLocator(byweekday=(MO, SA))
```

In addition, most of the constructors take an interval argument:

```
# tick on mondays every second week
loc = WeekdayLocator(byweekday=MO, interval=2)
```

The rule locator allows completely general date ticking:

```
# tick every 5th easter
rule = rrulewrapper(YEARLY, byeaster=1, interval=5)
loc = RRuleLocator(rule)
```

Here are all the date tickers:

- `MinuteLocator`: locate minutes
- `HourLocator`: locate hours
- `DayLocator`: locate specified days of the month
- `WeekdayLocator`: Locate days of the week, eg MO, TU
- `MonthLocator`: locate months, eg 7 for july
- `YearLocator`: locate years that are multiples of base

- **RRuleLocator**: locate using a `matplotlib.dates.rrulewrapper`. The `rrulewrapper` is a simple wrapper around a `dateutils.rrule` (`dateutil`) which allow almost arbitrary date tick specifications. See `rrule` example.
- **AutoDateLocator**: On autoscale, this class picks the best `MultipleDateLocator` to set the view limits and the tick locations.

### 53.1.2 Date formatters

Here all all the date formatters:

- **AutoDateFormatter**: attempts to figure out the best format to use. This is most useful when used with the **AutoDateLocator**.
- **DateFormatter**: use `strftime()` format strings
- **IndexDateFormatter**: date plots with implicit  $x$  indexing.

#### **date2num**(*d*)

*d* is either a `datetime` instance or a sequence of `datetimes`.

Return value is a floating point number (or sequence of floats) which gives the number of days (fraction part represents hours, minutes, seconds) since 0001-01-01 00:00:00 UTC, *plus one*. The addition of one here is a historical artifact. Also, note that the Gregorian calendar is assumed; this is not universal practice. For details, see the module docstring.

#### **num2date**(*x*, *tz=None*)

*x* is a float value which gives the number of days (fraction part represents hours, minutes, seconds) since 0001-01-01 00:00:00 UTC *plus one*. The addition of one here is a historical artifact. Also, note that the Gregorian calendar is assumed; this is not universal practice. For details, see the module docstring.

Return value is a `datetime` instance in timezone *tz* (default to `rcparams` TZ value).

If *x* is a sequence, a sequence of `datetime` objects will be returned.

#### **drange**(*dstart*, *dend*, *delta*)

Return a date range as float Gregorian ordinals. *dstart* and *dend* are `datetime` instances. *delta* is a `datetime.timedelta` instance.

#### **epoch2num**(*e*)

Convert an epoch or sequence of epochs to the new date format, that is days since 0001.

#### **num2epoch**(*d*)

Convert days since 0001 to epoch. *d* can be a number or sequence.

#### **mx2num**(*mxdates*)

Convert *mx* `datetime` instance (or sequence of *mx* instances) to the new date format.

#### **class DateFormatter**(*fmt*, *tz=None*)

Bases: `matplotlib.ticker.Formatter`

Tick location is seconds since the epoch. Use a `strftime()` format string.

Python only supports datetime `strftime()` formatting for years greater than 1900. Thanks to Andrew Dalke, Dalke Scientific Software who contributed the `strftime()` code below to include dates earlier than this year.

*fmt* is an `strftime()` format string; *tz* is the `tzinfo` instance.

```
set_tzinfo(tz)
```

```
strftime(dt, fmt)
```

```
class IndexDateFormatter(t, fmt, tz=None)
```

Bases: `matplotlib.ticker.Formatter`

Use with `IndexLocator` to cycle format strings by index.

*t* is a sequence of dates (floating point days). *fmt* is a `strftime()` format string.

```
class AutoDateFormatter(locator, tz=None, defaultfmt='%Y-%m-%d')
```

Bases: `matplotlib.ticker.Formatter`

This class attempts to figure out the best format to use. This is most useful when used with the `AutoDateLocator`.

The `AutoDateFormatter` has a scale dictionary that maps the scale of the tick (the distance in days between one major tick) and a format string. The default looks like this:

```
self.scaled = {
    365.0 : '%Y',
    30.   : '%b %Y',
    1.0   : '%b %d %Y',
    1./24. : '%H:%M:%D',
}
```

The algorithm picks the key in the dictionary that is  $\geq$  the current scale and uses that format string. You can customize this dictionary by doing:

```
formatter = AutoDateFormatter()
formatter.scaled[1/(24.*60.)] = '%M:%S' # only show min and sec
```

Autofmt the date labels. The default format is the one to use if none of the times in scaled match

```
class DateLocator(tz=None)
```

Bases: `matplotlib.ticker.Locator`

*tz* is a `tzinfo` instance.

```
datalim_to_dt()
```

```
nonsingular(vmin, vmax)
```

```
set_tzinfo(tz)
```

```
viewlim_to_dt()
```

```
class RRuleLocator(o, tz=None)
```

Bases: `matplotlib.dates.DateLocator`



**autoscale()**

Set the view limits to include the data range.

static **get\_unit\_generic**(*freq*)

**class AutoDateLocator**(*tz=None, minticks=5, maxticks=None, interval\_multiples=False*)

Bases: `matplotlib.dates.DateLocator`

On autoscale, this class picks the best `MultipleDateLocator` to set the view limits and the tick locations.

*minticks* is the minimum number of ticks desired, which is used to select the type of ticking (yearly, monthly, etc.).

*maxticks* is the maximum number of ticks desired, which controls any interval between ticks (ticking every other, every 3, etc.). For really fine-grained control, this can be a dictionary mapping individual rrule frequency constants (YEARLY, MONTHLY, etc.) to their own maximum number of ticks. This can be used to keep the number of ticks appropriate to the format chosen in class:`AutoDateFormatter`. Any frequency not specified in this dictionary is given a default value.

*tz* is a `tzinfo` instance.

*interval\_multiples* is a boolean that indicates whether ticks should be chosen to be multiple of the interval. This will lock ticks to ‘nicer’ locations. For example, this will force the ticks to be at hours 0,6,12,18 when hourly ticking is done at 6 hour intervals.

The `AutoDateLocator` has an interval dictionary that maps the frequency of the tick (a constant from `dateutil.rrule`) and a multiple allowed for that ticking. The default looks like this:

```
self.intervald = {
    YEARLY : [1, 2, 4, 5, 10],
    MONTHLY : [1, 2, 3, 4, 6],
    DAILY : [1, 2, 3, 7, 14],
    HOURLY : [1, 2, 3, 4, 6, 12],
    MINUTELY: [1, 5, 10, 15, 30],
    SECONDLY: [1, 5, 10, 15, 30]
}
```

The interval is used to specify multiples that are appropriate for the frequency of ticking. For instance, every 7 days is sensible for daily ticks, but for minutes/seconds, 15 or 30 make sense. You can customize this dictionary by doing:

```
locator = AutoDateLocator()
locator.intervald[HOURLY] = [3] # only show every 3 hours
```

**autoscale()**

Try to choose the view limits intelligently.

**get\_locator**(*dmin, dmax*)

Pick the best locator based on a distance.

**refresh()**

Refresh internal information based on current limits.

**set\_axis**(*axis*)

**class YearLocator**(*base=1, month=1, day=1, tz=None*)

Bases: `matplotlib.dates.DateLocator`

Make ticks on a given day of each year that is a multiple of base.

Examples:

```
# Tick every year on Jan 1st
locator = YearLocator()
```

```
# Tick every 5 years on July 4th
locator = YearLocator(5, month=7, day=4)
```

Mark years that are multiple of base on a given month and day (default jan 1).

**autoscale**()

Set the view limits to include the data range.

**class MonthLocator**(*bymonth=None, bymonthday=1, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each month month, eg 1, 3, 12.

Mark every month in *bymonth*; *bymonth* can be an int or sequence. Default is `range(1,13)`, i.e. every month.

*interval* is the interval between each iteration. For example, if *interval*=2, mark every second occurrence.

**class WeekdayLocator**(*byweekday=1, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each weekday.

Mark every weekday in *byweekday*; *byweekday* can be a number or sequence.

Elements of *byweekday* must be one of MO, TU, WE, TH, FR, SA, SU, the constants from `dateutils.rrule`.

*interval* specifies the number of weeks to skip. For example, *interval*=2 plots every second week.

**class DayLocator**(*bymonthday=None, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each day of the month. For example, 1, 15, 30.

Mark every day in *bymonthday*; *bymonthday* can be an int or sequence.

Default is to tick every day of the month: *bymonthday*=`range(1,32)`

**class HourLocator**(*byhour=None, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each hour.

Mark every hour in *byhour*; *byhour* can be an int or sequence. Default is to tick every hour: `byhour=range(24)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

**class MinuteLocator**(*byminute=None, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each minute.

Mark every minute in *byminute*; *byminute* can be an int or sequence. Default is to tick every minute: `byminute=range(60)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

**class SecondLocator**(*bysecond=None, interval=1, tz=None*)

Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurrences of each second.

Mark every second in *bysecond*; *bysecond* can be an int or sequence. Default is to tick every second: `bysecond = range(60)`

*interval* is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

**class rrule**(*freq, dtstart=None, interval=1, wkst=None, count=None, until=None, bysetpos=None, bymonth=None, bymonthday=None, byyearday=None, byeaster=None, byweekno=None, byweekday=None, byhour=None, byminute=None, bysecond=None, cache=False*)

Bases: `dateutil.rrule.rrulebase`

**class relativedelta**(*dt1=None, dt2=None, years=0, months=0, days=0, leapdays=0, weeks=0, hours=0, minutes=0, seconds=0, microseconds=0, year=None, month=None, day=None, weekday=None, yearday=None, nlyearday=None, hour=None, minute=None, second=None, microsecond=None*)

The `relativedelta` type is based on the specification of the excellent work done by M.-A. Lemburg in his `mx.DateTime` extension. However, notice that this type does *NOT* implement the same algorithm as his work. Do *NOT* expect it to behave like `mx.DateTime`'s counterpart.

There's two different ways to build a `relativedelta` instance. The first one is passing it two date/datetime classes:

```
relativedelta(datetime1, datetime2)
```

And the other way is to use the following keyword arguments:

**year, month, day, hour, minute, second, microsecond:** Absolute information.

**years, months, weeks, days, hours, minutes, seconds, microseconds:** Relative information, may be negative.

**weekday:** One of the weekday instances (MO, TU, etc). These instances may receive a parameter *N*, specifying the *N*th weekday, which could be positive or negative (like MO(+1) or MO(-2)). Not specifying it is the same as specifying +1. You can also use an integer, where 0=MO.

**leapdays:** Will add given days to the date found, if year is a leap year, and the date found is post 28 of february.

**yearday, nlyearday:** Set the yearday or the non-leap year day (jump leap days). These are converted to day/month/leapdays information.

Here is the behavior of operations with relativedelta:

1. Calculate the absolute year, using the 'year' argument, or the original datetime year, if the argument is not present.
2. Add the relative 'years' argument to the absolute year.
3. Do steps 1 and 2 for month/months.
4. Calculate the absolute day, using the 'day' argument, or the original datetime day, if the argument is not present. Then, subtract from the day until it fits in the year and month found after their operations.
5. Add the relative 'days' argument to the absolute day. Notice that the 'weeks' argument is multiplied by 7 and added to 'days'.
6. Do steps 1 and 2 for hour/hours, minute/minutes, second/seconds, microsecond/microseconds.
7. If the 'weekday' argument is present, calculate the weekday, with the given (wday, nth) tuple. wday is the index of the weekday (0-6, 0=Mon), and nth is the number of weeks to add forward or backward, depending on its signal. Notice that if the calculated date is already Monday, for example, using (0, 1) or (0, -1) won't change the day.

**seconds(s)**

Return seconds as days.

**minutes(m)**

Return minutes as days.

**hours(h)**

Return hours as days.

**weeks(w)**

Return weeks as days.

# FIGURE

## 54.1 matplotlib.figure

The figure module provides the top-level `Artist`, the `Figure`, which contains all the plot elements. The following classes are defined

`SubplotParams` control the default spacing of the subplots

`Figure` top level container for all plot elements

**class** `AxesStack()`

Bases: `matplotlib.cbook.Stack`

Specialization of the `Stack` to handle all tracking of `Axes` in a `Figure`. This requires storing key, (ind, axes) pairs. The key is based on the args and kwargs used in generating the `Axes`. ind is a serial number for tracking the order in which axes were added.

**add**(*key*, *a*)

Add `Axes` *a*, with key *key*, to the stack, and return the stack.

If *a* is already on the stack, don't add it again, but return *None*.

**as\_list**()

Return a list of the `Axes` instances that have been added to the figure

**bubble**(*a*)

**get**(*key*)

Return the `Axes` instance that was added with *key*. If it is not present, return *None*.

**remove**(*a*)

**class** `Figure`(*figsize=None*, *dpi=None*, *facecolor=None*, *edgecolor=None*, *linewidth=0.0*, *frameon=True*, *subplotpars=None*)

Bases: `matplotlib.artist.Artist`

The `Figure` instance supports callbacks through a `callbacks` attribute which is a `matplotlib.cbook.CallbackRegistry` instance. The events you can connect to are 'dpi\_changed', and the callback will be called with `func(fig)` where `fig` is the `Figure` instance.

**patch** The figure patch is drawn by a `matplotlib.patches.Rectangle` instance

***suppressComposite*** For multiple figure images, the figure will make composite images depending on the renderer option `image_nocomposite` function. If `suppressComposite` is `True|False`, this will override the renderer

***figsize*** `w,h` tuple in inches

***dpi*** dots per inch

***facecolor*** the figure patch facecolor; defaults to `rc figure.facecolor`

***edgecolor*** the figure patch edge color; defaults to `rc figure.edgecolor`

***linewidth*** the figure patch edge linewidth; the default linewidth of the frame

***frameon*** if `False`, suppress drawing the figure frame

***subplotpars*** a `SubplotParams` instance, defaults to `rc`

***add\_axes(\*args, \*\*kwargs)***

Add an axes at position *rect* [*left*, *bottom*, *width*, *height*] where all quantities are in fractions of figure width and height. *kwargs* are legal `Axes` *kwargs* plus *projection* which sets the projection type of the axes. (For backward compatibility, `polar=True` may also be provided, which is equivalent to `projection='polar'`). Valid values for *projection* are: [`'aitoff'`, `'hammer'`, `'lambert'`, `'mollweide'`, `'polar'`, `'rectilinear'`]. Some of these projections support additional *kwargs*, which may be provided to `add_axes()`. Typical usage:

```
rect = l,b,w,h
fig.add_axes(rect)
fig.add_axes(rect, frameon=False, axisbg='g')
fig.add_axes(rect, polar=True)
fig.add_axes(rect, projection='polar')
fig.add_axes(ax)
```

If the figure already has an axes with the same parameters, then it will simply make that axes current and return it. If you do not want this behavior, e.g. you want to force the creation of a new `Axes`, you must use a unique set of *args* and *kwargs*. The `axes_label` attribute has been exposed for this purpose. Eg., if you want two axes that are otherwise identical to be added to the figure, make sure you give them unique labels:

```
fig.add_axes(rect, label='axes1')
fig.add_axes(rect, label='axes2')
```

In rare circumstances, `add_axes` may be called with a single argument, an `Axes` instance already created in the present figure but not in the figure's list of axes. For example, if an axes has been removed with `delaxes()`, it can be restored with:

```
fig.add_axes(ax)
```

In all cases, the `Axes` instance will be returned.

In addition to *projection*, the following *kwargs* are supported:

| Property                          | Description   |
|-----------------------------------|---|
| <code>adjustable</code>           | [ 'box'   'datalim'   'box-forced' ]  |
| <code>agg_filter</code>           | unknown   |
| <code>alpha</code>                | float (0.0 transparent through 1.0 opaque)  |
| <code>anchor</code>               | unknown   |
| <code>animated</code>             | [ True   False ]  |
| <code>aspect</code>               | unknown   |
| <code>autoscale_on</code>         | unknown   |
| <code>autoscalex_on</code>        | unknown   |
| <code>autoscaley_on</code>        | unknown   |
| <code>axes</code>                 | an <a href="#">Axes</a> instance  |
| <code>axes_locator</code>         | unknown   |
| <code>axis_bgcolor</code>         | any matplotlib color - see <a href="#">colors()</a>                                     |
| <code>axis_off</code>             | unknown   |
| <code>axis_on</code>              | unknown   |
| <code>axisbelow</code>            | [ <i>True</i>   <i>False</i> ]  |
| <code>clip_box</code>             | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>              | [ True   False ]  |
| <code>clip_path</code>            | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color_cycle</code>          | unknown   |
| <code>contains</code>             | a callable function   |
| <code>cursor_props</code>         | a ( <i>float</i> , <i>color</i> ) tuple   |
| <code>figure</code>               | unknown   |
| <code>frame_on</code>             | [ <i>True</i>   <i>False</i> ]  |
| <code>gid</code>                  | an id string  |
| <code>label</code>                | any string  |
| <code>lod</code>                  | [ True   False ]  |
| <code>navigate</code>             | [ <i>True</i>   <i>False</i> ]  |
| <code>navigate_mode</code>        | unknown   |
| <code>picker</code>               | [ None   float   boolean   callable ]   |
| <code>position</code>             | unknown   |
| <code>rasterization_zorder</code> | unknown   |
| <code>rasterized</code>           | [ True   False   None ]   |
| <code>snap</code>                 | unknown   |
| <code>title</code>                | str   |
| <code>transform</code>            | <a href="#">Transform</a> instance  |
| <code>url</code>                  | a url string  |
| <code>visible</code>              | [ True   False ]  |
| <code>xbound</code>               | unknown   |
| <code>xlabel</code>               | str   |
| <code>xlim</code>                 | len(2) sequence of floats   |
| <code>xmargin</code>              | unknown   |
| <code>xscale</code>               | [ 'linear'   'log'   'symlog' ]   |
| <code>xticklabels</code>          | sequence of strings   |
| <code>xticks</code>               | sequence of floats  |

Continued on next page

Table 54.1 – continued from previous page

|             |                               |
|-------------|-------------------------------|
| ybound      | unknown                       |
| ylabel      | str                           |
| ylim        | len(2) sequence of floats     |
| ymargin     | unknown                       |
| yscale      | ['linear'   'log'   'symlog'] |
| yticklabels | sequence of strings           |
| yticks      | sequence of floats            |
| zorder      | any number                    |

**add\_axobserver(func)**

whenever the axes state change, func(self) will be called

**add\_subplot(\*args, \*\*kwargs)**

Add a subplot. Examples:

```
fig.add_subplot(111)  fig.add_subplot(1,1,1)  # equivalent but more gen-
eral  fig.add_subplot(212, axisbg='r')  # add subplot with red background
fig.add_subplot(111, polar=True)  # add a polar subplot  fig.add_subplot(sub)  #
add Subplot instance sub
```

*kwargs* are legal `matplotlib.axes.Axes` *kwargs* plus *projection*, which chooses a projection type for the axes. (For backward compatibility, *polar=True* may also be provided, which is equivalent to *projection='polar'*). Valid values for *projection* are: ['aitoff', 'hammer', 'lambert', 'mollweide', 'polar', 'rectilinear']. Some of these projections support additional *kwargs*, which may be provided to `add_axes()`.

The *Axes* instance will be returned.

If the figure already has a subplot with key (*args*, *kwargs*) then it will simply make that subplot current and return it.

The following *kwargs* are supported:

| Property               | Description                                      |
|------------------------|--|
| adjustable             | ['box'   'datalim'   'box-forced']               |
| agg_filter             | unknown  |
| alpha                  | float (0.0 transparent through 1.0 opaque)       |
| anchor                 | unknown  |
| animated               | [True   False]                                   |
| aspect                 | unknown  |
| autoscale_on           | unknown  |
| autoscalex_on          | unknown  |
| autoscaley_on          | unknown  |
| axes                   | an <i>Axes</i> instance                          |
| axes_locator           | unknown  |
| axis_bgcolor           | any matplotlib color - see <code>colors()</code> |
| axis_off               | unknown  |
| Continued on next page |  |



Table 54.2 – continued from previous page

|                                   |   |
|-----------------------------------|---|
| <code>axis_on</code>              | unknown   |
| <code>axisbelow</code>            | [ <i>True</i>   <i>False</i> ]                                      |
| <code>clip_box</code>             | a <code>matplotlib.transforms.Bbox</code> instance                  |
| <code>clip_on</code>              | [ <i>True</i>   <i>False</i> ]                                      |
| <code>clip_path</code>            | [ ( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ] |
| <code>color_cycle</code>          | unknown   |
| <code>contains</code>             | a callable function   |
| <code>cursor_props</code>         | a ( <i>float</i> , <i>color</i> ) tuple                             |
| <code>figure</code>               | unknown   |
| <code>frame_on</code>             | [ <i>True</i>   <i>False</i> ]                                      |
| <code>gid</code>                  | an id string  |
| <code>label</code>                | any string  |
| <code>lod</code>                  | [ <i>True</i>   <i>False</i> ]                                      |
| <code>navigate</code>             | [ <i>True</i>   <i>False</i> ]                                      |
| <code>navigate_mode</code>        | unknown   |
| <code>picker</code>               | [ <i>None</i>   <i>float</i>   <i>boolean</i>   <i>callable</i> ]   |
| <code>position</code>             | unknown   |
| <code>rasterization_zorder</code> | unknown   |
| <code>rasterized</code>           | [ <i>True</i>   <i>False</i>   <i>None</i> ]                        |
| <code>snap</code>                 | unknown   |
| <code>title</code>                | str   |
| <code>transform</code>            | <code>Transform</code> instance                                     |
| <code>url</code>                  | a url string  |
| <code>visible</code>              | [ <i>True</i>   <i>False</i> ]                                      |
| <code>xbound</code>               | unknown   |
| <code>xlabel</code>               | str   |
| <code>xlim</code>                 | len(2) sequence of floats   |
| <code>xmargin</code>              | unknown   |
| <code>xscale</code>               | [ <i>'linear'</i>   <i>'log'</i>   <i>'symlog'</i> ]                |
| <code>xticklabels</code>          | sequence of strings   |
| <code>xticks</code>               | sequence of floats  |
| <code>ybound</code>               | unknown   |
| <code>ylabel</code>               | str   |
| <code>ylim</code>                 | len(2) sequence of floats   |
| <code>ymargin</code>              | unknown   |
| <code>yscale</code>               | [ <i>'linear'</i>   <i>'log'</i>   <i>'symlog'</i> ]                |
| <code>yticklabels</code>          | sequence of strings   |
| <code>yticks</code>               | sequence of floats  |
| <code>zorder</code>               | any number  |

**autofmt\_xdate**(*bottom=0.20000000000000001*, *rotation=30*, *ha='right'*)

Date ticklabels often overlap, so it is useful to rotate them and right align them. Also, a common use case is a number of subplots with shared xaxes where the x-axis is date data. The ticklabels are often long, and it helps to rotate them on the bottom subplot and turn them off on other subplots, as well as turn off xlabels.

**bottom** the bottom of the subplots for `subplots_adjust()`

**rotation** the rotation of the xtick labels

**ha** the horizontal alignment of the xticklabels

#### **axes**

Read-only: list of axes in Figure

#### **clear()**

Clear the figure – synonym for `fig.clf`

#### **clf(keep\_observers=False)**

Clear the figure.

Set `keep_observers` to True if, for example, a gui widget is tracking the axes in the figure.

#### **colorbar(mappable, cax=None, ax=None, \*\*kw)**

Create a colorbar for a `ScalarMappable` instance.

Documentation for the pylab thin wrapper:

Add a colorbar to a plot.

Function signatures for the `pyplot` interface; all but the first are also method signatures for the `colorbar()` method:

```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

arguments:

**mappable** the `Image`, `ContourSet`, etc. to which the colorbar applies; this argument is mandatory for the `colorbar()` method but optional for the `colorbar()` function, which sets the default to the current image.

keyword arguments:

**cax** None | axes object into which the colorbar will be drawn

**ax** None | parent axes object from which space for a new colorbar axes will be stolen

**use\_gridspec** False | If `cax` is None, a new `cax` is created as an instance of `Axes`. If `ax` is an instance of `Subplot` and `use_gridspec` is True, `cax` is created as an instance of `Subplot` using the `grid_spec` module.

Additional keyword arguments are of two kinds:

axes properties:

| Property           | Description   |
|--------------------|---|
| <i>orientation</i> | vertical or horizontal  |
| <i>fraction</i>    | 0.15; fraction of original axes to use for colorbar   |
| <i>pad</i>         | 0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes |
| <i>shrink</i>      | 1.0; fraction by which to shrink the colorbar   |
| <i>aspect</i>      | 20; ratio of long to short dimensions   |
| <i>anchor</i>      | (0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes             |
| <i>panchor</i>     | (1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes      |

colorbar properties:

| Property         | Description   |
|------------------|---|
| <i>extend</i>    | [ 'neither'   'both'   'min'   'max' ] If not 'neither', make pointed end(s) for out-of-range values. These are set for a given colormap using the colormap <code>set_under</code> and <code>set_over</code> methods.                 |
| <i>spacing</i>   | [ 'uniform'   'proportional' ] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.  |
| <i>ticks</i>     | [ None   list of ticks   Locator object ] If None, ticks are determined automatically from the input.   |
| <i>format</i>    | [ None   format string   Formatter object ] If None, the <code>ScalarFormatter</code> is used. If a format string is given, e.g. <code>%.3f</code> , that is used. An alternative <code>Formatter</code> object may be given instead. |
| <i>drawedges</i> | [ False   True ] If true, draw lines at color boundaries.   |

The following will probably be useful only in the context of indexed colors (that is, when the mappable has `norm=NoNorm()`), or other unusual circumstances.

| Property          | Description  |
|-------------------|--|
| <i>boundaries</i> | None or a sequence   |
| <i>values</i>     | None or a sequence which must be of length 1 less than the sequence of <i>boundaries</i> . For each region delimited by adjacent entries in <i>boundaries</i> , the color mapped to the corresponding value in <i>values</i> will be used. |

If *mappable* is a `ContourSet`, its *extend* kwarg is included automatically.

Note that the *shrink* kwarg provides a simple way to keep a vertical colorbar, for example, from being taller than the axes of the mappable to which the colorbar is attached; but it is a manual method requiring some trial and error. If the colorbar is too tall (or a horizontal colorbar is too wide) use a smaller value of *shrink*.

For more precise control, you can manually specify the positions of the axes objects in which the mappable and the colorbar are drawn. In this case, do not use any of the axes properties kwargs.

**returns:** `Colorbar` instance; see also its base class, `ColorbarBase`. Call the `set_label()` method to label the colorbar.

**contains**(*mouseevent*)

Test whether the mouse event occurred on the figure.

Returns True, { }

**delaxes**(*a*)

remove *a* from the figure and update the current axes

**dpi**

**draw**(*artist*, *renderer*, \**args*, \*\**kwargs*)

Render the figure using `matplotlib.backend_bases.RendererBase` instance *renderer*

**draw\_artist**(*a*)

draw `matplotlib.artist.Artist` instance *a* only – this is available only after the figure is drawn

**figimage**(*X*, *xo*=0, *yo*=0, *alpha*=None, *norm*=None, *cmap*=None, *vmin*=None, *vmax*=None, *origin*=None, \*\**kwargs*)

call signatures:

`figimage(X, **kwargs)`

adds a non-resampled array *X* to the figure.

`figimage(X, xo, yo)`

with pixel offsets *xo*, *yo*,

*X* must be a float array:

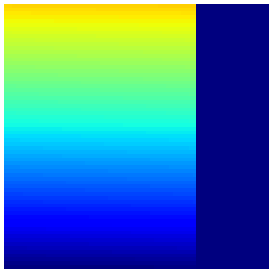
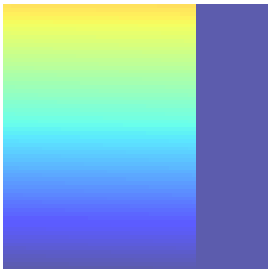
- If *X* is MxN, assume luminance (grayscale)
- If *X* is MxNx3, assume RGB
- If *X* is MxNx4, assume RGBA

Optional keyword arguments:

| Key-word  | Description   |
|-----------|---|
| xo or yo  | An integer, the <i>x</i> and <i>y</i> image offset in pixels  |
| cmap      | a <code>matplotlib.cm.ColorMap</code> instance, eg <code>cm.jet</code> . If None, default to the <code>rc image.cmap</code> value   |
| norm      | a <code>matplotlib.colors.Normalize</code> instance. The default is <code>normalization()</code> . This scales luminance -> 0-1   |
| vmin/vmax | are used to scale a luminance image to 0-1. If either is None, the min and max of the luminance values will be used. Note if you pass a <code>norm</code> instance, the settings for <i>vmin</i> and <i>vmax</i> will be ignored. |
| alpha     | the alpha blending value, default is None   |
| origin    | [ 'upper'   'lower' ] Indicates where the [0,0] index of the array is in the upper left or lower left corner of the axes. Defaults to the <code>rc image.origin</code> value  |

figimage complements the axes image (`imshow()`) which will be resampled to fit the current axes. If you want a resampled image to fill the entire figure, you can define an `Axes` with size `[0,1,0,1]`.

An `matplotlib.image.FigureImage` instance is returned.



Additional kwargs are Artist kwargs passed on to `FigureImage`

`gca(**kwargs)`  
Return the current axes, creating one if necessary

The following kwargs are supported

| Property                   | Description                                |
|----------------------------|--|
| <code>adjustable</code>    | [ 'box'   'datalim'   'box-forced' ]       |
| <code>agg_filter</code>    | unknown                                    |
| <code>alpha</code>         | float (0.0 transparent through 1.0 opaque) |
| <code>anchor</code>        | unknown                                    |
| <code>animated</code>      | [True   False]                             |
| <code>aspect</code>        | unknown                                    |
| <code>autoscale_on</code>  | unknown                                    |
| <code>autoscalex_on</code> | unknown                                    |
| <code>autoscaley_on</code> | unknown                                    |
| <code>axes</code>          | an <code>Axes</code> instance              |
| Continued on next page     |  |

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|                                   |   |
|-----------------------------------|---|
| <code>axes_locator</code>         | unknown   |
| <code>axis_bgcolor</code>         | any matplotlib color - see <code>colors()</code>                    |
| <code>axis_off</code>             | unknown   |
| <code>axis_on</code>              | unknown   |
| <code>axisbelow</code>            | [ <i>True</i>   <i>False</i> ]                                      |
| <code>clip_box</code>             | a <code>matplotlib.transforms.Bbox</code> instance                  |
| <code>clip_on</code>              | [ <i>True</i>   <i>False</i> ]                                      |
| <code>clip_path</code>            | [ ( <i>Path</i> , <i>Transform</i> )   <i>Patch</i>   <i>None</i> ] |
| <code>color_cycle</code>          | unknown   |
| <code>contains</code>             | a callable function   |
| <code>cursor_props</code>         | a ( <i>float</i> , <i>color</i> ) tuple                             |
| <code>figure</code>               | unknown   |
| <code>frame_on</code>             | [ <i>True</i>   <i>False</i> ]                                      |
| <code>gid</code>                  | an id string  |
| <code>label</code>                | any string  |
| <code>lod</code>                  | [ <i>True</i>   <i>False</i> ]                                      |
| <code>navigate</code>             | [ <i>True</i>   <i>False</i> ]                                      |
| <code>navigate_mode</code>        | unknown   |
| <code>picker</code>               | [ <i>None</i>   <i>float</i>   <i>boolean</i>   <i>callable</i> ]   |
| <code>position</code>             | unknown   |
| <code>rasterization_zorder</code> | unknown   |
| <code>rasterized</code>           | [ <i>True</i>   <i>False</i>   <i>None</i> ]                        |
| <code>snap</code>                 | unknown   |
| <code>title</code>                | str   |
| <code>transform</code>            | <code>Transform</code> instance                                     |
| <code>url</code>                  | a url string  |
| <code>visible</code>              | [ <i>True</i>   <i>False</i> ]                                      |
| <code>xbound</code>               | unknown   |
| <code>xlabel</code>               | str   |
| <code>xlim</code>                 | len(2) sequence of floats   |
| <code>xmargin</code>              | unknown   |
| <code>yscale</code>               | [ <i>'linear'</i>   <i>'log'</i>   <i>'symlog'</i> ]                |
| <code>xticklabels</code>          | sequence of strings   |
| <code>xticks</code>               | sequence of floats  |
| <code>ybound</code>               | unknown   |
| <code>ylabel</code>               | str   |
| <code>ylim</code>                 | len(2) sequence of floats   |
| <code>ymargin</code>              | unknown   |
| <code>yscale</code>               | [ <i>'linear'</i>   <i>'log'</i>   <i>'symlog'</i> ]                |
| <code>yticklabels</code>          | sequence of strings   |
| <code>yticks</code>               | sequence of floats  |
| <code>zorder</code>               | any number  |

`get_axes()`

**get\_children()**

get a list of artists contained in the figure

**get\_dpi()**

Return the dpi as a float

**get\_edgecolor()**

Get the edge color of the Figure rectangle

**get\_facecolor()**

Get the face color of the Figure rectangle

**get\_figheight()**

Return the figheight as a float

**get\_figwidth()**

Return the figwidth as a float

**get\_frameon()**

get the boolean indicating frameon

**get\_size\_inches()****get\_tightbbox(*renderer*)**

Return a (tight) bounding box of the figure in inches.

It only accounts axes title, axis labels, and axis ticklabels. Needs improvement.

**get\_window\_extent(\**args*, \*\**kwargs*)**

get the figure bounding box in display space; kwargs are void

**ginput(*n*=1, *timeout*=30, *show\_clicks*=True, *mouse\_add*=1, *mouse\_pop*=3, *mouse\_stop*=2)**

call signature:

```
ginput(self, n=1, timeout=30, show_clicks=True,
        mouse_add=1, mouse_pop=3, mouse_stop=2)
```

Blocking call to interact with the figure.

This will wait for *n* clicks from the user and return a list of the coordinates of each click.

If *timeout* is zero or negative, does not timeout.

If *n* is zero or negative, accumulate clicks until a middle click (or potentially both mouse buttons at once) terminates the input.

Right clicking cancels last input.

The buttons used for the various actions (adding points, removing points, terminating the inputs) can be overridden via the arguments *mouse\_add*, *mouse\_pop* and *mouse\_stop*, that give the associated mouse button: 1 for left, 2 for middle, 3 for right.

The keyboard can also be used to select points in case your mouse does not have one or more of the buttons. The delete and backspace keys act like right clicking (i.e., remove last point), the enter key terminates input and any other key (not already used by the window manager) selects a point.

**hold**(*b=None*)

Set the hold state. If hold is None (default), toggle the hold state. Else set the hold state to boolean value b.

Eg:

```
hold()      # toggle hold
hold(True)  # hold is on
hold(False) # hold is off
```

**legend**(*handles, labels, \*args, \*\*kwargs*)

Place a legend in the figure. Labels are a sequence of strings, handles is a sequence of [Line2D](#) or [Patch](#) instances, and loc can be a string or an integer specifying the legend location

USAGE:

```
legend( (line1, line2, line3),
        ('label1', 'label2', 'label3'),
        'upper right')
```

The *loc* location codes are:

```
'best' : 0,          (currently not supported for figure legends)
'upper right' : 1,
'upper left' : 2,
'lower left' : 3,
'lower right' : 4,
'right' : 5,
'center left' : 6,
'center right' : 7,
'lower center' : 8,
'upper center' : 9,
'center' : 10,
```

*loc* can also be an (x,y) tuple in figure coords, which specifies the lower left of the legend box. figure coords are (0,0) is the left, bottom of the figure and 1,1 is the right, top.

Keyword arguments:

**prop:** [ None | [FontProperties](#) | dict ] A [matplotlib.font\\_manager.FontProperties](#) instance. If *prop* is a dictionary, a new instance will be created with *prop*. If *None*, use rc settings.

**numpoints:** integer The number of points in the legend line, default is 4

**scatterpoints:** integer The number of points in the legend line, default is 4

**scatteroffsets:** list of floats a list of yoffsets for scatter symbols in legend

**markerscale:** [ None | scalar ] The relative size of legend markers vs. original. If *None*, use rc settings.

**fancybox:** [ None | False | True ] if True, draw a frame with a round fancybox. If *None*, use rc



**shadow:** [ **None** | **False** | **True** ] If *True*, draw a shadow behind legend. If *None*, use rc settings.

**ncol** [integer] number of columns. default is 1

**mode** [[ “expand” | *None* ]] if mode is “expand”, the legend will be horizontally expanded to fill the axes area (or *bbox\_to\_anchor*)

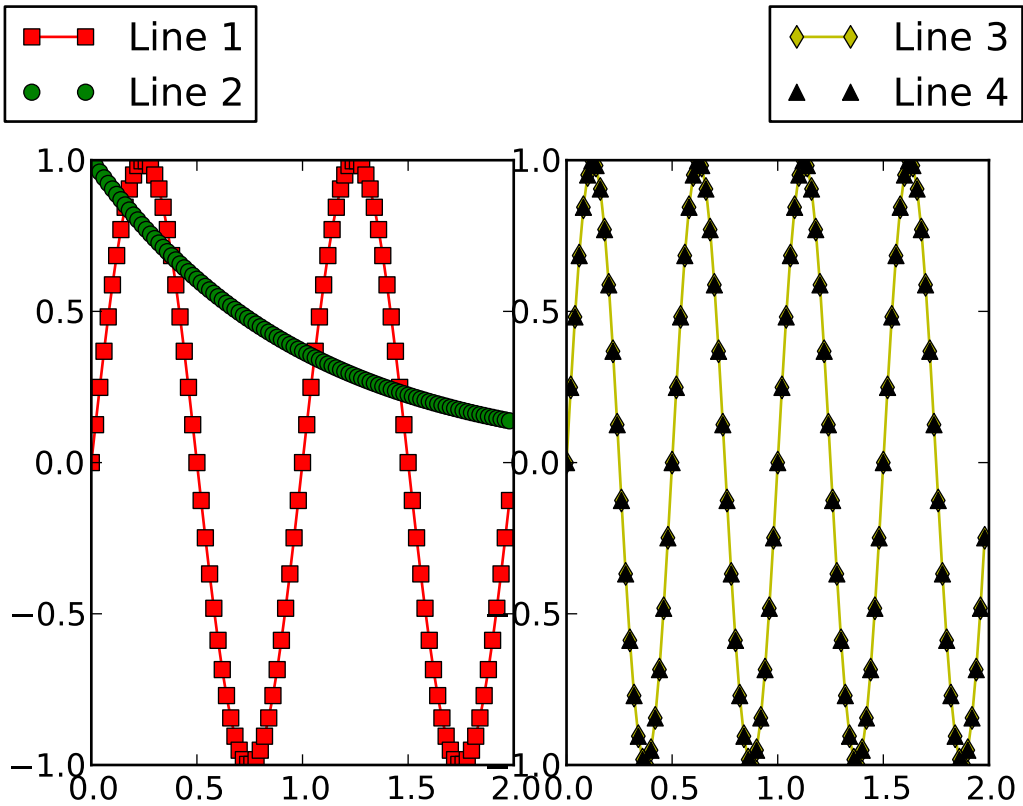
**title** [string] the legend title

Padding and spacing between various elements use following keywords parameters. The dimensions of these values are given as a fraction of the fontsize. Values from rcParams will be used if *None*.

| Keyword       | Description  |
|---------------|--|
| borderpad     | the fractional whitespace inside the legend border |
| labelspacing  | the vertical space between the legend entries      |
| handlelength  | the length of the legend handles                   |
| handletextpad | the pad between the legend handle and text         |
| borderaxespad | the pad between the axes and legend border         |
| columnspacing | the spacing between columns                        |

**Note:** Not all kinds of artist are supported by the legend. See [LINK \(FIXME\)](#) for details.

**Example:**



`savefig(*args, **kwargs)`

call signature:

```
savefig(fname, dpi=None, facecolor='w', edgecolor='w',
        orientation='portrait', papertype=None, format=None,
        transparent=False, bbox_inches=None, pad_inches=0.1):
```

Save the current figure.

The output formats available depend on the backend being used.

Arguments:

***fname***: A string containing a path to a filename, or a Python file-like object, or possibly some backend-dependent object such as [PdfPages](#).

If *format* is *None* and *fname* is a string, the output format is deduced from the extension of the filename. If the filename has no extension, the value of the rc parameter `savefig.extension` is used. If that value is 'auto', the backend determines the extension.

If *fname* is not a string, remember to specify *format* to ensure that the correct backend is used.

Keyword arguments:

***dpi***: [ *None* | *scalar* > 0 ] The resolution in dots per inch. If *None* it will default to the value `savefig.dpi` in the `matplotlibrc` file.

***facecolor, edgecolor***: the colors of the figure rectangle

***orientation***: [ 'landscape' | 'portrait' ] not supported on all backends; currently only on postscript output

***papertype***: One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.

***format***: One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

***transparent***: If *True*, the axes patches will all be transparent; the figure patch will also be transparent unless *facecolor* and/or *edgecolor* are specified via *kwargs*. This is useful, for example, for displaying a plot on top of a colored background on a web page. The transparency of these patches will be restored to their original values upon exit of this function.

***bbox\_inches***: Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure.

***pad\_inches***: Amount of padding around the figure when *bbox\_inches* is 'tight'.

***bbox\_extra\_artists***: A list of extra artists that will be considered when the tight bbox is calculated.

***sca(a)***

Set the current axes to be *a* and return *a*

**set\_canvas(*canvas*)**

Set the canvas the contains the figure

ACCEPTS: a FigureCanvas instance

**set\_dpi(*val*)**

Set the dots-per-inch of the figure

ACCEPTS: float

**set\_edgecolor(*color*)**

Set the edge color of the Figure rectangle

ACCEPTS: any matplotlib color - see help(colors)

**set\_facecolor(*color*)**

Set the face color of the Figure rectangle

ACCEPTS: any matplotlib color - see help(colors)

**set\_figheight(*val*)**

Set the height of the figure in inches

ACCEPTS: float

**set\_figwidth(*val*)**

Set the width of the figure in inches

ACCEPTS: float

**set\_frameon(*b*)**

Set whether the figure frame (background) is displayed or invisible

ACCEPTS: boolean

**set\_size\_inches(*\*args*, *\*\*kwargs*)**

set\_size\_inches(w,h, forward=False)

Set the figure size in inches

Usage:

```
fig.set_size_inches(w,h)  # OR
fig.set_size_inches((w,h) )
```

optional kwarg *forward=True* will cause the canvas size to be automatically updated; eg you can resize the figure window from the shell

ACCEPTS: a w,h tuple with w,h in inches

**subplots\_adjust(*\*args*, *\*\*kwargs*)**

**fig.subplots\_adjust(left=None, bottom=None, right=None, top=None, wspace=None, hspace=None)**

Update the [SubplotParams](#) with *kwargs* (defaulting to rc where None) and update the subplot locations

**suptitle**(*t*, *\*\*kwargs*)

Add a centered title to the figure.

*kwargs* are `matplotlib.text.Text` properties. Using figure coordinates, the defaults are:

- ***x* = 0.5** the x location of text in figure coords
- ***y* = 0.98** the y location of the text in figure coords
- ***horizontalalignment* = 'center'** the horizontal alignment of the text
- ***verticalalignment* = 'top'** the vertical alignment of the text

A `matplotlib.text.Text` instance is returned.

Example:

```
fig.suptitle('this is the figure title', fontsize=12)
```

**text**(*x*, *y*, *s*, *\*args*, *\*\*kwargs*)

Call signature:

```
figtext(x, y, s, fontdict=None, **kwargs)
```

Add text to figure at location *x*, *y* (relative 0-1 coords). See `text()` for the meaning of the other arguments.

*kwargs* control the `Text` properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)                                     |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]    |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                 |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |

Table 54.4 – continued from

|  |  |
|--|--|
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   ‘vertical’   ‘horizontal’ ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>                           | [ size in points   ‘xx-small’   ‘x-small’   ‘small’   ‘medium’   ‘large’   ‘x-large’ ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   ‘ultra-condensed’   ‘extra-condensed’   ‘condensed’   ‘normal’   ‘expanded’   ‘ultra-expanded’ ] |
| <code>style</code> or <code>fontstyle</code>                         | [ ‘normal’   ‘italic’   ‘oblique’ ]  |
| <code>text</code>  | string or anything printable with ‘%s’ conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>                     | [ ‘normal’   ‘small-caps’ ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ ‘center’   ‘top’   ‘bottom’   ‘baseline’ ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   ‘ultralight’   ‘light’   ‘normal’   ‘regular’   ‘bold’   ‘extra-bold’ ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

**tight\_layout**(*renderer=None, pad=1.2, h\_pad=None, w\_pad=None*)

Adjust subplot parameters to give specified padding.

Parameters:

**pad** [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

**h\_pad, w\_pad** [float] padding (height/width) between edges of adjacent subplots. Defaults to *pad\_inches*.

**waitforbuttonpress**(*timeout=-1*)

call signature:

```
waitforbuttonpress(self, timeout=-1)
```

Blocking call to interact with the figure.

This will return True if a key was pressed, False if a mouse button was pressed and None if *timeout* was reached without either being pressed.

If *timeout* is negative, does not timeout.

**class SubplotParams**(*left=None, bottom=None, right=None, top=None, wspace=None, hspace=None*)

A class to hold the parameters for a subplot

All dimensions are fraction of the figure width or height. All values default to their rc params

The following attributes are available

***left*** = 0.125 the left side of the subplots of the figure

***right*** = 0.9 the right side of the subplots of the figure

***bottom*** = 0.1 the bottom of the subplots of the figure

***top*** = 0.9 the top of the subplots of the figure

***wspace*** = 0.2 the amount of width reserved for blank space between subplots

***hspace*** = 0.2 the amount of height reserved for white space between subplots

***validate*** make sure the params are in a legal state (*left*\*<\**right*, etc)

***update***(*left=None, bottom=None, right=None, top=None, wspace=None, hspace=None*)

Update the current values. If any kwarg is None, default to the current value, if set, otherwise to rc

### **figaspect**(*arg*)

Create a figure with specified aspect ratio. If *arg* is a number, use that aspect ratio. If *arg* is an array, figaspect will determine the width and height for a figure that would fit array preserving aspect ratio. The figure width, height in inches are returned. Be sure to create an axes with equal width and height, eg

Example usage:

```
# make a figure twice as tall as it is wide
w, h = figaspect(2.)
fig = Figure(figsize=(w,h))
ax = fig.add_axes([0.1, 0.1, 0.8, 0.8])
ax.imshow(A, **kwargs)
```

```
# make a figure with the proper aspect for an array
A = rand(5,3)
w, h = figaspect(A)
fig = Figure(figsize=(w,h))
ax = fig.add_axes([0.1, 0.1, 0.8, 0.8])
ax.imshow(A, **kwargs)
```

Thanks to Fernando Perez for this function

# FONT\_MANAGER

## 55.1 matplotlib.font\_manager

A module for finding, managing, and using fonts across platforms.

This module provides a single `FontManager` instance that can be shared across backends and platforms. The `findfont()` function returns the best TrueType (TTF) font file in the local or system font path that matches the specified `FontProperties` instance. The `FontManager` also handles Adobe Font Metrics (AFM) font files for use by the PostScript backend.

The design is based on the [W3C Cascading Style Sheet, Level 1 \(CSS1\) font specification](#). Future versions may implement the Level 2 or 2.1 specifications.

Experimental support is included for using *fontconfig* on Unix variant platforms (Linux, OS X, Solaris). To enable it, set the constant `USE_FONTCONFIG` in this file to `True`. Fontconfig has the advantage that it is the standard way to look up fonts on X11 platforms, so if a font is installed, it is much more likely to be found.

**class FontEntry**(*fname=""*, *name=""*, *style='normal'*, *variant='normal'*, *weight='normal'*,  
*stretch='normal'*, *size='medium'*)  
Bases: object

A class for storing Font properties. It is used when populating the font lookup dictionary.

**class FontManager**(*size=None*, *weight='normal'*)

On import, the `FontManager` singleton instance creates a list of TrueType fonts based on the font properties: name, style, variant, weight, stretch, and size. The `findfont()` method does a nearest neighbor search to find the font that most closely matches the specification. If no good enough match is found, a default font is returned.

**findfont**(*prop*, *fontext='ttf'*, *directory=None*, *fallback\_to\_default=True*, *rebuild\_if\_missing=True*)  
Search the font list for the font that most closely matches the `FontProperties` *prop*.

`findfont()` performs a nearest neighbor search. Each font is given a similarity score to the target font properties. The first font with the highest score is returned. If no matches below a certain threshold are found, the default font (usually Vera Sans) is returned.

*directory*, if specified, will only return fonts from the given directory (or subdirectory of that directory).

The result is cached, so subsequent lookups don't have to perform the  $O(n)$  nearest neighbor search.

If *fallback\_to\_default* is True, will fallback to the default font family (usually “Bitstream Vera Sans” or “Helvetica”) if the first lookup hard-fails.

See the [W3C Cascading Style Sheet, Level 1](#) documentation for a description of the font finding algorithm.

**get\_default\_size()**

Return the default font size.

**get\_default\_weight()**

Return the default font weight.

**score\_family(*families*, *family2*)**

Returns a match score between the list of font families in *families* and the font family name *family2*.

An exact match anywhere in the list returns 0.0.

A match by generic font name will return 0.1.

No match will return 1.0.

**score\_size(*size1*, *size2*)**

Returns a match score between *size1* and *size2*.

If *size2* (the size specified in the font file) is ‘scalable’, this function always returns 0.0, since any font size can be generated.

Otherwise, the result is the absolute distance between *size1* and *size2*, normalized so that the usual range of font sizes (6pt - 72pt) will lie between 0.0 and 1.0.

**score\_stretch(*stretch1*, *stretch2*)**

Returns a match score between *stretch1* and *stretch2*.

The result is the absolute value of the difference between the CSS numeric values of *stretch1* and *stretch2*, normalized between 0.0 and 1.0.

**score\_style(*style1*, *style2*)**

Returns a match score between *style1* and *style2*.

An exact match returns 0.0.

A match between ‘italic’ and ‘oblique’ returns 0.1.

No match returns 1.0.

**score\_variant(*variant1*, *variant2*)**

Returns a match score between *variant1* and *variant2*.

An exact match returns 0.0, otherwise 1.0.

**score\_weight(*weight1*, *weight2*)**

Returns a match score between *weight1* and *weight2*.



The result is the absolute value of the difference between the CSS numeric values of *weight1* and *weight2*, normalized between 0.0 and 1.0.

**set\_default\_weight**(*weight*)

Set the default font weight. The initial value is ‘normal’.

**update\_fonts**(*filenames*)

Update the font dictionary with new font files. Currently not implemented.

**class FontProperties**(*family=None, style=None, variant=None, weight=None, stretch=None, size=None, fname=None, \_init=None*)

Bases: object

A class for storing and manipulating font properties.

The font properties are those described in the [W3C Cascading Style Sheet, Level 1](#) font specification. The six properties are:

- **family**: A list of font names in decreasing order of priority. The items may include a generic font family name, either ‘serif’, ‘sans-serif’, ‘cursive’, ‘fantasy’, or ‘monospace’. In that case, the actual font to be used will be looked up from the associated rcParam in `matplotlibrc`.
- **style**: Either ‘normal’, ‘italic’ or ‘oblique’.
- **variant**: Either ‘normal’ or ‘small-caps’.
- **stretch**: A numeric value in the range 0-1000 or one of ‘ultra-condensed’, ‘extra-condensed’, ‘condensed’, ‘semi-condensed’, ‘normal’, ‘semi-expanded’, ‘expanded’, ‘extra-expanded’ or ‘ultra-expanded’
- **weight**: A numeric value in the range 0-1000 or one of ‘ultralight’, ‘light’, ‘normal’, ‘regular’, ‘book’, ‘medium’, ‘roman’, ‘semibold’, ‘demibold’, ‘demi’, ‘bold’, ‘heavy’, ‘extra bold’, ‘black’
- **size**: Either an relative value of ‘xx-small’, ‘x-small’, ‘small’, ‘medium’, ‘large’, ‘x-large’, ‘xx-large’ or an absolute font size, e.g. 12

The default font property for TrueType fonts (as specified in the default `matplotlibrc` file) is:

`sans-serif, normal, normal, normal, normal, scalable.`

Alternatively, a font may be specified using an absolute path to a .ttf file, by using the *fname* kwarg.

The preferred usage of font sizes is to use the relative values, e.g. ‘large’, instead of absolute font sizes, e.g. 12. This approach allows all text sizes to be made larger or smaller based on the font manager’s default font size.

This class will also accept a [fontconfig](#) pattern, if it is the only argument provided. See the documentation on [fontconfig patterns](#). This support does not require fontconfig to be installed. We are merely borrowing its pattern syntax for use here.

Note that matplotlib’s internal font manager and fontconfig use a different algorithm to lookup fonts, so the results of the same pattern may be different in matplotlib than in other applications that use fontconfig.

**copy()**

Return a deep copy of self

**get\_family()**

Return a list of font names that comprise the font family.

**get\_file()**

Return the filename of the associated font.

**get\_fontconfig\_pattern()**

Get a fontconfig pattern suitable for looking up the font as specified with fontconfig's `fc-match` utility.

See the documentation on [fontconfig patterns](#).

This support does not require fontconfig to be installed or support for it to be enabled. We are merely borrowing its pattern syntax for use here.

**get\_name()**

Return the name of the font that best matches the font properties.

**get\_size()**

Return the font size.

**get\_size\_in\_points()****get\_slant()**

Return the font style. Values are: 'normal', 'italic' or 'oblique'.

**get\_stretch()**

Return the font stretch or width. Options are: 'ultra-condensed', 'extra-condensed', 'condensed', 'semi-condensed', 'normal', 'semi-expanded', 'expanded', 'extra-expanded', 'ultra-expanded'.

**get\_style()**

Return the font style. Values are: 'normal', 'italic' or 'oblique'.

**get\_variant()**

Return the font variant. Values are: 'normal' or 'small-caps'.

**get\_weight()**

Set the font weight. Options are: A numeric value in the range 0-1000 or one of 'light', 'normal', 'regular', 'book', 'medium', 'roman', 'semibold', 'demibold', 'demi', 'bold', 'heavy', 'extra bold', 'black'

**set\_family(*family*)**

Change the font family. May be either an alias (generic name is CSS parlance), such as: 'serif', 'sans-serif', 'cursive', 'fantasy', or 'monospace', or a real font name.

**set\_file(*file*)**

Set the filename of the fontfile to use. In this case, all other properties will be ignored.

**set\_fontconfig\_pattern(*pattern*)**

Set the properties by parsing a fontconfig *pattern*.

See the documentation on [fontconfig patterns](#).

This support does not require fontconfig to be installed or support for it to be enabled. We are merely borrowing its pattern syntax for use here.

**set\_name**(*family*)

Change the font family. May be either an alias (generic name is CSS parlance), such as: ‘serif’, ‘sans-serif’, ‘cursive’, ‘fantasy’, or ‘monospace’, or a real font name.

**set\_size**(*size*)

Set the font size. Either an relative value of ‘xx-small’, ‘x-small’, ‘small’, ‘medium’, ‘large’, ‘x-large’, ‘xx-large’ or an absolute font size, e.g. 12.

**set\_slant**(*style*)

Set the font style. Values are: ‘normal’, ‘italic’ or ‘oblique’.

**set\_stretch**(*stretch*)

Set the font stretch or width. Options are: ‘ultra-condensed’, ‘extra-condensed’, ‘condensed’, ‘semi-condensed’, ‘normal’, ‘semi-expanded’, ‘expanded’, ‘extra-expanded’ or ‘ultra-expanded’, or a numeric value in the range 0-1000.

**set\_style**(*style*)

Set the font style. Values are: ‘normal’, ‘italic’ or ‘oblique’.

**set\_variant**(*variant*)

Set the font variant. Values are: ‘normal’ or ‘small-caps’.

**set\_weight**(*weight*)

Set the font weight. May be either a numeric value in the range 0-1000 or one of ‘ultralight’, ‘light’, ‘normal’, ‘regular’, ‘book’, ‘medium’, ‘roman’, ‘semibold’, ‘demibold’, ‘demi’, ‘bold’, ‘heavy’, ‘extra bold’, ‘black’

**OSXInstalledFonts**(*directories=None, fontext='ttf'*)

Get list of font files on OS X - ignores font suffix by default.

**afmFontProperty**(*fontpath, font*)

A function for populating a FontKey instance by extracting information from the AFM font file.

*font* is a class:AFM instance.

**createFontList**(*fontfiles, fontext='ttf'*)

A function to create a font lookup list. The default is to create a list of TrueType fonts. An AFM font list can optionally be created.

**findSystemFonts**(*fontpaths=None, fontext='ttf'*)

Search for fonts in the specified font paths. If no paths are given, will use a standard set of system paths, as well as the list of fonts tracked by fontconfig if fontconfig is installed and available. A list of TrueType fonts are returned by default with AFM fonts as an option.

**findfont**(*prop, \*\*kw*)

**get\_fontconfig\_fonts**(*fontext='ttf'*)

Grab a list of all the fonts that are being tracked by fontconfig by making a system call to fc-list. This is an easy way to grab all of the fonts the user wants to be made available to applications, without needing knowing where all of them reside.

**get\_fonttext\_synonyms**(*fonttext*)

Return a list of file extensions extensions that are synonyms for the given file extension *fileext*.

**is\_opentype\_cff\_font**(*filename*)

Returns True if the given font is a Postscript Compact Font Format Font embedded in an OpenType wrapper. Used by the PostScript and PDF backends that can not subset these fonts.

**list\_fonts**(*directory*, *extensions*)

Return a list of all fonts matching any of the extensions, possibly upper-cased, found recursively under the directory.

**pickle\_dump**(*data*, *filename*)

Equivalent to `pickle.dump(data, open(filename, 'w'))` but closes the file to prevent filehandle leakage.

**pickle\_load**(*filename*)

Equivalent to `pickle.load(open(filename, 'r'))` but closes the file to prevent filehandle leakage.

**ttfFontProperty**(*font*)

A function for populating the `FontKey` by extracting information from the TrueType font file.

*font* is a `FT2Font` instance.

**ttfdict\_to\_fnames**(*d*)

flatten a `ttfdict` to all the filenames it contains

**weight\_as\_number**(*weight*)

Return the weight property as a numeric value. String values are converted to their corresponding numeric value.

**win32FontDirectory**()

Return the user-specified font directory for Win32. This is looked up from the registry key:

`\HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Explorer\Shell Folders\Fonts`

If the key is not found, `$WINDIR/Fonts` will be returned.

**win32InstalledFonts**(*directory=None*, *fonttext='ttf'*)

Search for fonts in the specified font directory, or use the system directories if none given. A list of TrueType font filenames are returned by default, or AFM fonts if *fonttext* == 'afm'.

## 55.2 matplotlib.fontconfig\_pattern

A module for parsing and generating fontconfig patterns.

See the [fontconfig pattern specification](#) for more information.

**class FontconfigPatternParser**()

A simple pyparsing-based parser for fontconfig-style patterns.

See the [fontconfig pattern specification](#) for more information.

**parse(*pattern*)**

Parse the given fontconfig *pattern* and return a dictionary of key/value pairs useful for initializing a `font_manager.FontProperties` object.

**family\_escape()**

`sub(repl, string[, count = 0]) -> newstring` Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

**family\_unescape()**

`sub(repl, string[, count = 0]) -> newstring` Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

**generate\_fontconfig\_pattern(*d*)**

Given a dictionary of key/value pairs, generates a fontconfig pattern string.

**value\_escape()**

`sub(repl, string[, count = 0]) -> newstring` Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

**value\_unescape()**

`sub(repl, string[, count = 0]) -> newstring` Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.



# GRIDSPEC

## 56.1 matplotlib.gridspec

`gridspec` is a module which specifies the location of the subplot in the figure.

**GridSpec** specifies the geometry of the grid that a subplot will be placed. The number of rows and number of columns of the grid need to be set. Optionally, the subplot layout parameters (e.g., left, right, etc.) can be tuned.

**SubplotSpec** specifies the location of the subplot in the given *GridSpec*.

**class GridSpec**(*nrows, ncols, left=None, bottom=None, right=None, top=None, wspace=None, hspace=None, width\_ratios=None, height\_ratios=None*)  
Bases: `matplotlib.gridspec.GridSpecBase`

A class that specifies the geometry of the grid that a subplot will be placed. The location of grid is determined by similar way as the SubplotParams.

The number of rows and number of columns of the grid need to be set. Optionally, the subplot layout parameters (e.g., left, right, etc.) can be tuned.

**get\_subplot\_params**(*fig=None*)  
return a dictionary of subplot layout parameters. The default parameters are from rcParams unless a figure attribute is set.

**locally\_modified\_subplot\_params**()

**tight\_layout**(*fig, renderer=None, pad=1.2, h\_pad=None, w\_pad=None, rect=None*)  
Adjust subplot parameters to give specified padding.

Parameters:

**pad** [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

**h\_pad, w\_pad** [float] padding (height/width) between edges of adjacent subplots. Defaults to *pad\_inches*.

**update**(*\*\*kwargs*)  
Update the current values. If any kwarg is None, default to the current value, if set, otherwise to rc.

**class GridSpecBase**(*nrows, ncols, height\_ratios=None, width\_ratios=None*)

Bases: object

A base class of GridSpec that specifies the geometry of the grid that a subplot will be placed.

The number of rows and number of columns of the grid need to be set. Optionally, the ratio of heights and widths of rows and columns can be specified.

**get\_geometry()**

get the geometry of the grid, eg 2,3

**get\_grid\_positions**(*fig*)

return lists of bottom and top position of rows, left and right positions of columns.

**get\_height\_ratios()**

**get\_subplot\_params**(*fig=None*)

**get\_width\_ratios()**

**new\_subplotspec**(*loc, rowspan=1, colspan=1*)

create and return a SubplotSpec instance.

**set\_height\_ratios**(*height\_ratios*)

**set\_width\_ratios**(*width\_ratios*)

**class GridSpecFromSubplotSpec**(*nrows, ncols, subplot\_spec, wspace=None, hspace=None, height\_ratios=None, width\_ratios=None*)

Bases: [matplotlib.gridspec.GridSpecBase](#)

GridSpec whose subplot layout parameters are inherited from the location specified by a given SubplotSpec.

The number of rows and number of columns of the grid need to be set. An instance of SubplotSpec is also needed to be set from which the layout parameters will be inherited. The wspace and hspace of the layout can be optionally specified or the default values (from the figure or rcParams) will be used.

**get\_subplot\_params**(*fig=None*)

return a dictionary of subplot layout parameters.

**get\_topmost\_subplotspec()**

get the topmost SubplotSpec instance associated with the subplot

**class SubplotSpec**(*gridspec, num1, num2=None*)

Bases: object

specifies the location of the subplot in the given *GridSpec*.

The subplot will occupy the num1-th cell of the given gridspec. If num2 is provided, the subplot will span between num1-th cell and num2-th cell.

The index starts from 0.

**get\_geometry()**

get the subplot geometry, eg 2,2,3. Unlike SubplotParams, index is 0-based



**get\_gridspec()**

**get\_position**(*fig*, *return\_all=False*)

update the subplot position from *fig.subplotpars*

**get\_topmost\_subplotspec()**

get the topmost SubplotSpec instance associated with the subplot



# LEGEND

## 57.1 matplotlib.legend

The legend module defines the Legend class, which is responsible for drawing legends associated with axes and/or figures.

The Legend class can be considered as a container of legend handles and legend texts. Creation of corresponding legend handles from the plot elements in the axes or figures (e.g., lines, patches, etc.) are specified by the handler map, which defines the mapping between the plot elements and the legend handlers to be used (the default legend handlers are defined in the `legend_handler` module). Note that not all kinds of artist are supported by the legend yet (See [Legend guide](#) for more information).

**class DraggableLegend**(*legend, use\_blit=False, update='loc'*)

Bases: `matplotlib.offsetbox.DraggableOffsetBox`

**update** [If “loc”, update *loc* parameter of] legend upon finalizing. If “bbox”, update *bbox\_to\_anchor* parameter.

**artist\_picker**(*legend, evt*)

**finalize\_offset**()

**class Legend**(*parent, handles, labels, loc=None, numpoints=None, markerscale=None, scatterpoints=3, scatteryoffsets=None, prop=None, pad=None, labelsep=None, handlelen=None, handletextsep=None, axespad=None, borderpad=None, labelspacing=None, handlelength=None, handleheight=None, handletextpad=None, borderaxespad=None, columnspacing=None, ncol=1, mode=None, fancybox=None, shadow=None, title=None, bbox\_to\_anchor=None, bbox\_transform=None, frameon=None, handler\_map=None*)

Bases: `matplotlib.artist.Artist`

Place a legend on the axes at location *loc*. Labels are a sequence of strings and *loc* can be a string or an integer specifying the legend location

The location codes are:

```
'best'      : 0, (only implemented for axis legends)
'upper right' : 1,
'upper left'  : 2,
'lower left'  : 3,
```

```
'lower right' : 4,  
'right'       : 5,  
'center left' : 6,  
'center right': 7,  
'lower center': 8,  
'upper center': 9,  
'center'      : 10,
```

`loc` can be a tuple of the normalized coordinate values with respect its parent.

- *parent* : the artist that contains the legend
- *handles* : a list of artists (lines, patches) to be added to the legend
- *labels* : a list of strings to label the legend

Optional keyword arguments:

| Keyword                      | Description  |
|------------------------------|--|
| <code>loc</code>             | a location code  |
| <code>prop</code>            | the font property  |
| <code>markerscale</code>     | the relative size of legend markers vs. original             |
| <code>numpoints</code>       | the number of points in the legend for line                  |
| <code>scatterpoints</code>   | the number of points in the legend for scatter plot          |
| <code>scatteryoffsets</code> | a list of yoffsets for scatter symbols in legend             |
| <code>frameon</code>         | if True, draw a frame around the legend. If None, use rc     |
| <code>fancybox</code>        | if True, draw a frame with a round fancybox. If None, use rc |
| <code>shadow</code>          | if True, draw a shadow behind legend                         |
| <code>ncol</code>            | number of columns  |
| <code>borderpad</code>       | the fractional whitespace inside the legend border           |
| <code>labelspacing</code>    | the vertical space between the legend entries                |
| <code>handlelength</code>    | the length of the legend handles                             |
| <code>handleheight</code>    | the length of the legend handles                             |
| <code>handletextpad</code>   | the pad between the legend handle and text                   |
| <code>borderaxespad</code>   | the pad between the axes and legend border                   |
| <code>columnspacing</code>   | the spacing between columns                                  |
| <code>title</code>           | the legend title   |
| <code>bbox_to_anchor</code>  | the bbox that the legend will be anchored.                   |
| <code>bbox_transform</code>  | the transform for the bbox. <code>transAxes</code> if None.  |

The pad and spacing parameters are measured in font-size units. E.g., a fontsize of 10 points and a `handlelength=5` implies a `handlelength` of 50 points. Values from rcParams will be used if None.

Users can specify any arbitrary location for the legend using the *bbox\_to\_anchor* keyword argument. `bbox_to_anchor` can be an instance of `BboxBase`(or its derivatives) or a tuple of 2 or 4 floats. See [set\\_bbox\\_to\\_anchor\(\)](#) for more detail.

The legend location can be specified by setting *loc* with a tuple of 2 floats, which is interpreted as the lower-left corner of the legend in the normalized axes coordinate.

**draggable**(*state=None, use\_blit=False, update='loc'*)

Set the draggable state – if state is

- None : toggle the current state
- True : turn draggable on
- False : turn draggable off

If draggable is on, you can drag the legend on the canvas with the mouse. The DraggableLegend helper instance is returned if draggable is on.

The update parameter control which parameter of the legend changes when dragged. If update is “loc”, the *loc* paramter of the legend is changed. If “bbox”, the *bbox\_to\_anchor* parameter is changed.

**draw**(*artist, renderer, \*args, \*\*kwargs*)

Draw everything that belongs to the legend

**draw\_frame**(*b*)

*b* is a boolean. Set draw frame to *b*

**get\_bbox\_to\_anchor**()

return the bbox that the legend will be anchored

**get\_children**()

return a list of child artists

class **get\_default\_handler\_map**()

A class method that returns the default handler map.

**get\_frame**()

return the Rectangle instance used to frame the legend

**get\_frame\_on**()

Get whether the legend box patch is drawn

static **get\_legend\_handler**(*legend\_handler\_map, orig\_handle*)

return a legend handler from *legend\_handler\_map* that corresponds to *orig\_handler*.

*legend\_handler\_map* should be a dictionary object (that is returned by the *get\_legend\_handler\_map* method).

It first checks if the *orig\_handle* itself is a key in the *legend\_hanler\_map* and return the associated value. Otherwised, it checks for each of the classes in its method-resolution-order. If no matching key is found, it returns None.

**get\_legend\_handler\_map**()

return the handler map.

**get\_lines**()

return a list of lines.Line2D instances in the legend

**get\_patches**()

return a list of patch instances in the legend

**get\_texts**()

return a list of text.Text instance in the legend

**get\_title()**

return Text instance for the legend title

**get\_window\_extent**(\*args, \*\*kwargs)

return a extent of the the legend

**set\_bbox\_to\_anchor**(bbox, transform=None)

set the bbox that the legend will be anchored.

*bbox* can be a BboxBase instance, a tuple of [left, bottom, width, height] in the given transform (normalized axes coordinate if None), or a tuple of [left, bottom] where the width and height will be assumed to be zero.

class **set\_default\_handler\_map**(handler\_map)

A class method to set the default handler map.

**set\_frame\_on**(b)

Set whether the legend box patch is drawn

ACCEPTS: [ *True* | *False* ]

**set\_title**(title)

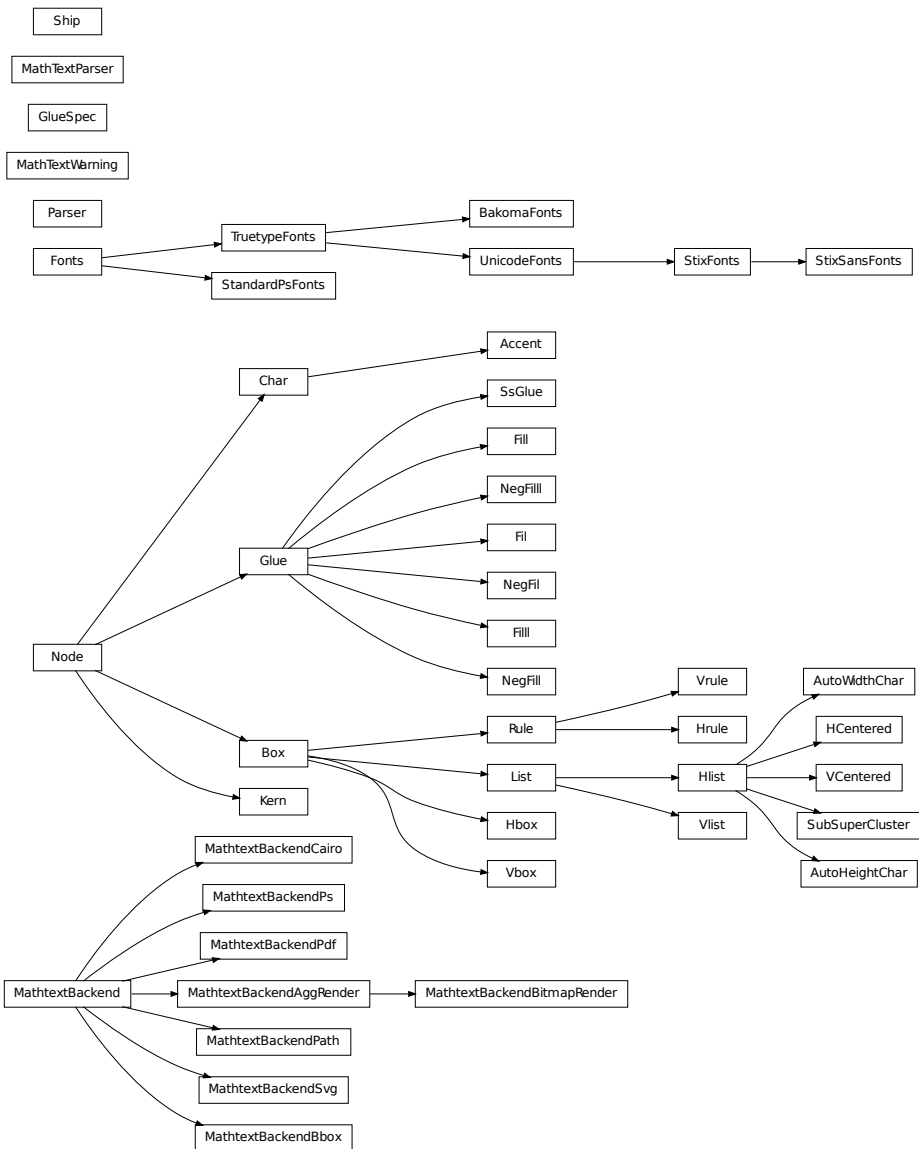
set the legend title

class **update\_default\_handler\_map**(handler\_map)

A class method to update the default handler map.



MATHTEXT





## 58.1 matplotlib.mathtext

`mathtext` is a module for parsing a subset of the TeX math syntax and drawing them to a matplotlib backend.

For a tutorial of its usage see *Writing mathematical expressions*. This document is primarily concerned with implementation details.

The module uses `pyparsing` to parse the TeX expression.

The Bakoma distribution of the TeX Computer Modern fonts, and STIX fonts are supported. There is experimental support for using arbitrary fonts, but results may vary without proper tweaking and metrics for those fonts.

If you find TeX expressions that don't parse or render properly, please email [mdroe@stsci.edu](mailto:mdroe@stsci.edu), but please check KNOWN ISSUES below first.

**class Accent**(*c, state*)

Bases: `matplotlib.mathtext.Char`

The font metrics need to be dealt with differently for accents, since they are already offset correctly from the baseline in TrueType fonts.

**grow**()

**render**(*x, y*)

Render the character to the canvas.

**shrink**()

**class AutoHeightChar**(*c, height, depth, state, always=False*)

Bases: `matplotlib.mathtext.Hlist`

`AutoHeightChar` will create a character as close to the given height and depth as possible. When using a font with multiple height versions of some characters (such as the BaKoMa fonts), the correct glyph will be selected, otherwise this will always just return a scaled version of the glyph.

**class AutoWidthChar**(*c, width, state, always=False, char\_class=<class 'matplotlib.mathtext.Char'>*)

Bases: `matplotlib.mathtext.Hlist`

`AutoWidthChar` will create a character as close to the given width as possible. When using a font with multiple width versions of some characters (such as the BaKoMa fonts), the correct glyph will be selected, otherwise this will always just return a scaled version of the glyph.

**class BakomaFonts**(*\*args, \*\*kwargs*)

Bases: `matplotlib.mathtext.TruetypeFonts`

Use the Bakoma TrueType fonts for rendering.

Symbols are strewn about a number of font files, each of which has its own proprietary 8-bit encoding.

**get\_sized\_alternatives\_for\_symbol**(*fontname, sym*)

**class Box**(*width, height, depth*)

Bases: `matplotlib.mathtext.Node`

Represents any node with a physical location.

**grow()**

**render**(*x1*, *y1*, *x2*, *y2*)

**shrink()**

**class Char**(*c*, *state*)

Bases: `matplotlib.mathtext.Node`

Represents a single character. Unlike TeX, the font information and metrics are stored with each `Char` to make it easier to lookup the font metrics when needed. Note that TeX boxes have a width, height, and depth, unlike Type1 and Truetype which use a full bounding box and an advance in the x-direction. The metrics must be converted to the TeX way, and the advance (if different from width) must be converted into a `Kern` node when the `Char` is added to its parent `Hlist`.

**get\_kerning**(*next*)

Return the amount of kerning between this and the given character. Called when characters are strung together into `Hlist` to create `Kern` nodes.

**grow()**

**is\_slanted()**

**render**(*x*, *y*)

Render the character to the canvas

**shrink()**

**Error**(*msg*)

Helper class to raise parser errors.

**FT2Font**()

FT2Font

**FT2Image**()

FT2Image

**class Fil**()

Bases: `matplotlib.mathtext.Glue`

**class Fill**()

Bases: `matplotlib.mathtext.Glue`

**class Filll**()

Bases: `matplotlib.mathtext.Glue`

**class Fonts**(*default\_font\_prop*, *mathtext\_backend*)

Bases: `object`

An abstract base class for a system of fonts to use for mathtext.

The class must be able to take symbol keys and font file names and return the character metrics. It also delegates to a backend class to do the actual drawing.

*default\_font\_prop*: A `FontProperties` object to use for the default non-math font, or the base font for Unicode (generic) font rendering.

*mathtext\_backend*: A subclass of `MathTextBackend` used to delegate the actual rendering.

### **destroy()**

Fix any cyclical references before the object is about to be destroyed.

### **get\_kern**(*font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi*)

Get the kerning distance for font between *sym1* and *sym2*.

*fontX*: one of the TeX font names:

`tt, it, rm, cal, sf, bf` **or** `default/regular` (non-math)

*fontclassX*: TODO

*symX*: a symbol in raw TeX form. e.g. '1', 'x' or 'sigma'

*fontsizeX*: the fontsize in points

*dpi*: the current dots-per-inch

### **get\_metrics**(*font, font\_class, sym, fontsize, dpi*)

*font*: one of the TeX font names:

`tt, it, rm, cal, sf, bf` **or** `default/regular` (non-math)

*font\_class*: TODO

*sym*: a symbol in raw TeX form. e.g. '1', 'x' or 'sigma'

*fontsize*: font size in points

*dpi*: current dots-per-inch

Returns an object with the following attributes:

- *advance*: The advance distance (in points) of the glyph.
- *height*: The height of the glyph in points.
- *width*: The width of the glyph in points.
- *xmin, xmax, ymin, ymax* - the ink rectangle of the glyph
- *iceberg* - the distance from the baseline to the top of the glyph. This corresponds to TeX's definition of "height".

### **get\_results**(*box*)

Get the data needed by the backend to render the math expression. The return value is backend-specific.

### **get\_sized\_alternatives\_for\_symbol**(*fontname, sym*)

Override if your font provides multiple sizes of the same symbol. Should return a list of symbols matching *sym* in various sizes. The expression renderer will select the most appropriate size for a given situation from this list.

**get\_underline\_thickness**(*font, fontsize, dpi*)

Get the line thickness that matches the given font. Used as a base unit for drawing lines such as in a fraction or radical.

**get\_used\_characters**()

Get the set of characters that were used in the math expression. Used by backends that need to subset fonts so they know which glyphs to include.

**get\_xheight**(*font, fontsize, dpi*)

Get the xheight for the given *font* and *fontsize*.

**render\_glyph**(*ox, oy, facename, font\_class, sym, fontsize, dpi*)

Draw a glyph at

- *ox, oy*: position
- *facename*: One of the TeX face names
- *font\_class*:
- *sym*: TeX symbol name or single character
- *fontsize*: fontsize in points
- *dpi*: The dpi to draw at.

**render\_rect\_filled**(*x1, y1, x2, y2*)

Draw a filled rectangle from (*x1, y1*) to (*x2, y2*).

**set\_canvas\_size**(*w, h, d*)

Set the size of the buffer used to render the math expression. Only really necessary for the bitmap backends.

**class Glue**(*glue\_type, copy=False*)

Bases: [matplotlib.mathtext.Node](#)

Most of the information in this object is stored in the underlying [GlueSpec](#) class, which is shared between multiple glue objects. (This is a memory optimization which probably doesn't matter anymore, but it's easier to stick to what TeX does.)

**grow**()

**shrink**()

**class GlueSpec**(*width=0.0, stretch=0.0, stretch\_order=0, shrink=0.0, shrink\_order=0*)

Bases: object

See [Glue](#).

**copy**()

class **factory**(*glue\_type*)

**class HCentered**(*elements*)

Bases: [matplotlib.mathtext.Hlist](#)

A convenience class to create an [Hlist](#) whose contents are centered within its enclosing box.

**class Hbox**(*width*)

Bases: `matplotlib.mathtext.Box`

A box with only width (zero height and depth).

**class Hlist**(*elements*, *w=0.0*, *m='additional'*, *do\_kern=True*)

Bases: `matplotlib.mathtext.List`

A horizontal list of boxes.

**hpack**(*w=0.0*, *m='additional'*)

The main duty of `hpack()` is to compute the dimensions of the resulting boxes, and to adjust the glue if one of those dimensions is pre-specified. The computed sizes normally enclose all of the material inside the new box; but some items may stick out if negative glue is used, if the box is overfull, or if a `\vbox` includes other boxes that have been shifted left.

- *w*: specifies a width
- *m*: is either 'exactly' or 'additional'.

Thus, `hpack(w, 'exactly')` produces a box whose width is exactly *w*, while `hpack(w, 'additional')` yields a box whose width is the natural width plus *w*. The default values produce a box with the natural width.

**kern()**

Insert `Kern` nodes between `Char` nodes to set kerning. The `Char` nodes themselves determine the amount of kerning they need (in `get_kerning()`), and this function just creates the linked list in the correct way.

**class Hrule**(*state*, *thickness=None*)

Bases: `matplotlib.mathtext.Rule`

Convenience class to create a horizontal rule.

**class Kern**(*width*)

Bases: `matplotlib.mathtext.Node`

A `Kern` node has a *width* field to specify a (normally negative) amount of spacing. This spacing correction appears in horizontal lists between letters like A and V when the font designer said that it looks better to move them closer together or further apart. A kern node can also appear in a vertical list, when its *width* denotes additional spacing in the vertical direction.

**grow()**

**shrink()**

**class List**(*elements*)

Bases: `matplotlib.mathtext.Box`

A list of nodes (either horizontal or vertical).

**grow()**

**shrink()**

**class MathTextParser**(*output*)

Bases: `object`

Create a `MathTextParser` for the given backend *output*.

**get\_depth**(*texstr*, *dpi*=120, *fontsize*=14)

Returns the offset of the baseline from the bottom of the image in pixels.

*texstr* A valid mathtext string, eg `r'IQ: \sigma_i=15$'`

*dpi* The dots-per-inch to render the text

*fontsize* The font size in points

**parse**(*s*, *dpi*=72, *prop*=None)

Parse the given math expression *s* at the given *dpi*. If *prop* is provided, it is a `FontProperties` object specifying the “default” font to use in the math expression, used for all non-math text.

The results are cached, so multiple calls to `parse()` with the same expression should be fast.

**to\_mask**(*texstr*, *dpi*=120, *fontsize*=14)

*texstr* A valid mathtext string, eg `r'IQ: \sigma_i=15$'`

*dpi* The dots-per-inch to render the text

*fontsize* The font size in points

Returns a tuple (*array*, *depth*)

- *array* is an NxM uint8 alpha ubyte mask array of rasterized tex.
- *depth* is the offset of the baseline from the bottom of the image in pixels.

**to\_png**(*filename*, *texstr*, *color*='black', *dpi*=120, *fontsize*=14)

Writes a tex expression to a PNG file.

Returns the offset of the baseline from the bottom of the image in pixels.

*filename* A writable filename or fileobject

*texstr* A valid mathtext string, eg `r'IQ: \sigma_i=15$'`

*color* A valid matplotlib color argument

*dpi* The dots-per-inch to render the text

*fontsize* The font size in points

Returns the offset of the baseline from the bottom of the image in pixels.

**to\_rgba**(*texstr*, *color*='black', *dpi*=120, *fontsize*=14)

*texstr* A valid mathtext string, eg `r'IQ: \sigma_i=15$'`

*color* Any matplotlib color argument

*dpi* The dots-per-inch to render the text

*fontsize* The font size in points

Returns a tuple (*array*, *depth*)

- *array* is an NxM uint8 alpha ubyte mask array of rasterized tex.

- depth is the offset of the baseline from the bottom of the image in pixels.

### exception `MathTextWarning`

Bases: `exceptions.Warning`

### class `MathtextBackend()`

Bases: `object`

The base class for the mathtext backend-specific code. The purpose of `MathtextBackend` subclasses is to interface between mathtext and a specific matplotlib graphics backend.

Subclasses need to override the following:

- `render_glyph()`
- `render_filled_rect()`
- `get_results()`

And optionally, if you need to use a Freetype hinting style:

- `get_hinting_type()`

### `get_hinting_type()`

Get the Freetype hinting type to use with this particular backend.

### `get_results(box)`

Return a backend-specific tuple to return to the backend after all processing is done.

### `render_filled_rect(x1, y1, x2, y2)`

Draw a filled black rectangle from  $(x1, y1)$  to  $(x2, y2)$ .

### `render_glyph(ox, oy, info)`

Draw a glyph described by *info* to the reference point  $(ox, oy)$ .

### `set_canvas_size(w, h, d)`

Dimension the drawing canvas

### `MathtextBackendAgg()`

### class `MathtextBackendAggRender()`

Bases: `matplotlib.mathtext.MathtextBackend`

Render glyphs and rectangles to an FTImage buffer, which is later transferred to the Agg image by the Agg backend.

### `get_hinting_type()`

### `get_results(box)`

### `render_glyph(ox, oy, info)`

### `render_rect_filled(x1, y1, x2, y2)`

### `set_canvas_size(w, h, d)`

### class `MathtextBackendBbox(real_backend)`

Bases: `matplotlib.mathtext.MathtextBackend`

A backend whose only purpose is to get a precise bounding box. Only required for the Agg backend.

```
get_hinting_type()
get_results(box)
render_glyph(ox, oy, info)
render_rect_filled(x1, y1, x2, y2)
```

**MathtextBackendBitmap()**

A backend to generate standalone mathtext images. No additional matplotlib backend is required.

**class MathtextBackendBitmapRender()**

Bases: `matplotlib.mathtext.MathtextBackendAggRender`

```
get_results(box)
```

**class MathtextBackendCairo()**

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the Cairo backend.

```
get_results(box)
render_glyph(ox, oy, info)
render_rect_filled(x1, y1, x2, y2)
```

**class MathtextBackendPath()**

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the text path machinery.

```
get_results(box)
render_glyph(ox, oy, info)
render_rect_filled(x1, y1, x2, y2)
```

**class MathtextBackendPdf()**

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the PDF backend.

```
get_results(box)
render_glyph(ox, oy, info)
render_rect_filled(x1, y1, x2, y2)
```

**class MathtextBackendPs()**

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the PostScript backend.

```
get_results(box)
render_glyph(ox, oy, info)
render_rect_filled(x1, y1, x2, y2)
```



**class MathtextBackendSvg()**

Bases: `matplotlib.mathtext.MathtextBackend`

Store information to write a mathtext rendering to the SVG backend.

**get\_results**(*box*)

**render\_glyph**(*ox, oy, info*)

**render\_rect\_filled**(*x1, y1, x2, y2*)

**class NegFil()**

Bases: `matplotlib.mathtext.Glue`

**class NegFill()**

Bases: `matplotlib.mathtext.Glue`

**class NegFilll()**

Bases: `matplotlib.mathtext.Glue`

**class Node()**

Bases: `object`

A node in the TeX box model

**get\_kerning**(*next*)

**grow**()

Grows one level larger. There is no limit to how big something can get.

**render**(*x, y*)

**shrink**()

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

**class Parser()**

Bases: `object`

This is the pyparsing-based parser for math expressions. It actually parses full strings *containing* math expressions, in that raw text may also appear outside of pairs of \$.

The grammar is based directly on that in TeX, though it cuts a few corners.

**class State**(*font\_output, font, font\_class, fontsize, dpi*)

Bases: `object`

Stores the state of the parser.

States are pushed and popped from a stack as necessary, and the “current” state is always at the top of the stack.

**copy**()

**font**

**accent**(*s, loc, toks*)

**auto\_sized\_delimiter**(*s, loc, toks*)

**binom**(*s, loc, toks*)

**char\_over\_chars**(*s, loc, toks*)

**clear**()  
Clear any state before parsing.

**customspace**(*s, loc, toks*)

**end\_group**(*s, loc, toks*)

**finish**(*s, loc, toks*)

**font**(*s, loc, toks*)

**frac**(*s, loc, toks*)

**function**(*s, loc, toks*)

**genfrac**(*s, loc, toks*)

**get\_state**()  
Get the current [State](#) of the parser.

**group**(*s, loc, toks*)

**is\_dropsup**(*nucleus*)

**is\_overunder**(*nucleus*)

**is\_slanted**(*nucleus*)

**math**(*s, loc, toks*)

**non\_math**(*s, loc, toks*)

**overline**(*s, loc, toks*)

**parse**(*s, fonts\_object, fontsize, dpi*)  
Parse expression *s* using the given *fonts\_object* for output, at the given *fontsize* and *dpi*.  
  
Returns the parse tree of [Node](#) instances.

**pop\_state**()  
Pop a [State](#) off of the stack.

**push\_state**()  
Push a new [State](#) onto the stack which is just a copy of the current state.

**space**(*s, loc, toks*)

**sqrt**(*s, loc, toks*)

**stackrel**(*s, loc, toks*)

**start\_group**(*s, loc, toks*)

**subsuperscript**(*s, loc, toks*)

**symbol**(*s, loc, toks*)

**class Rule**(*width, height, depth, state*)

Bases: `matplotlib.mathtext.Box`

A **Rule** node stands for a solid black rectangle; it has *width*, *depth*, and *height* fields just as in an **Hlist**. However, if any of these dimensions is `inf`, the actual value will be determined by running the rule up to the boundary of the innermost enclosing box. This is called a “running dimension.” The width is never running in an **Hlist**; the height and depth are never running in a **Vlist**.

**render**(*x, y, w, h*)

**class Ship**()

Bases: `object`

Once the boxes have been set up, this sends them to output. Since boxes can be inside of boxes inside of boxes, the main work of **Ship** is done by two mutually recursive routines, `hlist_out()` and `vlist_out()`, which traverse the **Hlist** nodes and **Vlist** nodes inside of horizontal and vertical boxes. The global variables used in TeX to store state as it processes have become member variables here.

static **clamp**(*value*)

**hlist\_out**(*box*)

**vlist\_out**(*box*)

**class SsGlue**()

Bases: `matplotlib.mathtext.Glue`

**class StandardPsFonts**(*default\_font\_prop*)

Bases: `matplotlib.mathtext.Fonts`

Use the standard postscript fonts for rendering to backend\_ps

Unlike the other font classes, `BakomaFont` and `UnicodeFont`, this one requires the Ps backend.

**get\_kern**(*font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi*)

**get\_underline\_thickness**(*font, fontsize, dpi*)

**get\_xheight**(*font, fontsize, dpi*)

**class StixFonts**(*\*args, \*\*kwargs*)

Bases: `matplotlib.mathtext.UnicodeFonts`

A font handling class for the STIX fonts.

In addition to what `UnicodeFonts` provides, this class:

- supports “virtual fonts” which are complete alpha numeric character sets with different font styles at special Unicode code points, such as “Blackboard”.
- handles sized alternative characters for the `STIXSizeX` fonts.

**get\_sized\_alternatives\_for\_symbol**(*fontname, sym*)

**class StixSansFonts**(*\*args, \*\*kwargs*)

Bases: `matplotlib.mathtext.StixFonts`

A font handling class for the STIX fonts (that uses sans-serif characters by default).

**class SubSuperCluster()**

Bases: `matplotlib.mathtext.Hlist`

`SubSuperCluster` is a sort of hack to get around that fact that this code do a two-pass parse like TeX. This lets us store enough information in the `hlist` itself, namely the nucleus, sub- and super-script, such that if another script follows that needs to be attached, it can be reconfigured on the fly.

**class TruetypeFonts(*default\_font\_prop, mathtext\_backend*)**

Bases: `matplotlib.mathtext.Fonts`

A generic base class for all font setups that use Truetype fonts (through `FT2Font`).

**class CachedFont(*font*)**

**destroy()**

**get\_kern(*font1, fontclass1, sym1, fontsize1, font2, fontclass2, sym2, fontsize2, dpi*)**

**get\_underline\_thickness(*font, fontsize, dpi*)**

**get\_xheight(*font, fontsize, dpi*)**

**class UnicodeFonts(\*args, \*\*kwargs)**

Bases: `matplotlib.mathtext.TruetypeFonts`

An abstract base class for handling Unicode fonts.

While some reasonably complete Unicode fonts (such as DejaVu) may work in some situations, the only Unicode font I'm aware of with a complete set of math symbols is STIX.

This class will “fallback” on the Bakoma fonts when a required symbol can not be found in the font.

**get\_sized\_alternatives\_for\_symbol(*fontname, sym*)**

**class VCentered(*elements*)**

Bases: `matplotlib.mathtext.Hlist`

A convenience class to create a `Vlist` whose contents are centered within its enclosing box.

**class Vbox(*height, depth*)**

Bases: `matplotlib.mathtext.Box`

A box with only height (zero width).

**class Vlist(*elements, h=0.0, m='additional'*)**

Bases: `matplotlib.mathtext.List`

A vertical list of boxes.

**vpack(*h=0.0, m='additional', l=inf*)**

The main duty of `vpack()` is to compute the dimensions of the resulting boxes, and to adjust the glue if one of those dimensions is pre-specified.

- *h*: specifies a height
- *m*: is either ‘exactly’ or ‘additional’.
- *l*: a maximum height

Thus, `vpack(h, 'exactly')` produces a box whose height is exactly  $h$ , while `vpack(h, 'additional')` yields a box whose height is the natural height plus  $h$ . The default values produce a box with the natural width.

**class `Vrule`**(*state*)

Bases: `matplotlib.mathtext.Rule`

Convenience class to create a vertical rule.

**get\_unicode\_index**(*symbol*)

`get_unicode_index(symbol)` -> integer

Return the integer index (from the Unicode table) of symbol. *symbol* can be a single unicode character, a TeX command (i.e. `r'pi'`), or a Type1 symbol name (i.e. `'phi'`).

**math\_to\_image**(*s, filename\_or\_obj, prop=None, dpi=None, format=None*)

Given a math expression, renders it in a closely-clipped bounding box to an image file.

*s* A math expression. The math portion should be enclosed in dollar signs.

*filename\_or\_obj* A filepath or writable file-like object to write the image data to.

*prop* If provided, a `FontProperties()` object describing the size and style of the text.

*dpi* Override the output dpi, otherwise use the default associated with the output format.

*format* The output format, eg. `'svg'`, `'pdf'`, `'ps'` or `'png'`. If not provided, will be deduced from the filename.

**unichr\_safe**(*index*)

Return the Unicode character corresponding to the index, or the replacement character if this is a narrow build of Python and the requested character is outside the BMP.



# MLAB

## 59.1 matplotlib.mlab

Numerical python functions written for compatability with MATLAB commands with the same names.

### 59.1.1 MATLAB compatible functions

**cohere()** Coherence (normalized cross spectral density)

**csd()** Cross spectral density using Welch's average periodogram

**detrend()** Remove the mean or best fit line from an array

**find()**

**Return the indices where some condition is true;** `numpy.nonzero` is similar but more general.

**griddata()**

**interpolate irregularly distributed data to a regular grid.**

**prctile()** find the percentiles of a sequence

**prepca()** Principal Component Analysis

**psd()** Power spectral density using Welch's average periodogram

**rk4()** A 4th order runge kutta integrator for 1D or ND systems

**specgram()** Spectrogram (power spectral density over segments of time)

### 59.1.2 Miscellaneous functions

Functions that don't exist in MATLAB, but are useful anyway:

**cohere\_pairs()** Coherence over all pairs. This is not a MATLAB function, but we compute coherence a lot in my lab, and we compute it for a lot of pairs. This function is optimized to do this efficiently by caching the direct FFTs.

**rk4()** A 4th order Runge-Kutta ODE integrator in case you ever find yourself stranded without scipy (and the far superior `scipy.integrate` tools)

**contiguous\_regions()** return the indices of the regions spanned by some logical mask

**cross\_from\_below()** return the indices where a 1D array crosses a threshold from below

**cross\_from\_above()** return the indices where a 1D array crosses a threshold from above

### 59.1.3 record array helper functions

A collection of helper methods for `numpyrecord` arrays

See *misc Examples*

**rec2txt()** pretty print a record array

**rec2csv()** store record array in CSV file

**csv2rec()** import record array from CSV file with type inspection

**rec\_append\_fields()** adds field(s)/array(s) to record array

**rec\_drop\_fields()** drop fields from record array

**rec\_join()** join two record arrays on sequence of fields

**recs\_join()** a simple join of multiple recarrays using a single column as a key

**rec\_groupby()** summarize data by groups (similar to SQL GROUP BY)

**rec\_summarize()** helper code to filter rec array fields into new fields

For the rec viewer functions (e.g. `rec2csv`), there are a bunch of `Format` objects you can pass into the functions that will do things like color negative values red, set percent formatting and scaling, etc.

Example usage:

```
r = csv2rec('somefile.csv', checkrows=0)
```

```
formatd = dict(
    weight = FormatFloat(2),
    change = FormatPercent(2),
    cost   = FormatThousands(2),
)
```

```
rec2excel(r, 'test.xls', formatd=formatd)
rec2csv(r, 'test.csv', formatd=formatd)
scroll = rec2gtk(r, formatd=formatd)
```

```
win = gtk.Window()
win.set_size_request(600,800)
win.add(scroll)
win.show_all()
gtk.main()
```



### 59.1.4 Deprecated functions

The following are deprecated; please import directly from numpy (with care—function signatures may differ):

**load()** load ASCII file - use `numpy.loadtxt`

**save()** save ASCII file - use `numpy.savetxt`

**class FIFOBuffer**(*nmax*)

A FIFO queue to hold incoming *x*, *y* data in a rotating buffer using numpy arrays under the hood. It is assumed that you will call `asarrays` much less frequently than you add data to the queue – otherwise another data structure will be faster.

This can be used to support plots where data is added from a real time feed and the plot object wants to grab data from the buffer and plot it to screen less frequently than the incoming.

If you set the *dataLim* attr to BBox (eg `matplotlib.Axes.dataLim`), the *dataLim* will be updated as new data come in.

TODO: add a grow method that will extend *nmax*

**Note:** mlab seems like the wrong place for this class.

Buffer up to *nmax* points.

**add**(*x*, *y*)

Add scalar *x* and *y* to the queue.

**asarrays**()

Return *x* and *y* as arrays; their length will be the len of data added or *nmax*.

**last**()

Get the last *x*, *y* or *None*. *None* if no data set.

**register**(*func*, *N*)

Call *func* every time *N* events are passed; *func* signature is `func(fifo)`.

**update\_datalim\_to\_current**()

Update the *datalim* in the current data in the fifo.

**class FormatBool**()

Bases: `matplotlib.mlab.FormatObj`

**fromstr**(*s*)

**toval**(*x*)

**class FormatDate**(*fmt*)

Bases: `matplotlib.mlab.FormatObj`

**fromstr**(*x*)

**toval**(*x*)

**class FormatDatetime**(*fmt*='%Y-%m-%d %H:%M:%S')

Bases: `matplotlib.mlab.FormatDate`

**fromstr**(*x*)

**class FormatFloat**(*precision=4, scale=1.0*)

Bases: `matplotlib.mlab.FormatFormatStr`

**fromstr**(*s*)

**toval**(*x*)

**class FormatFormatStr**(*fmt*)

Bases: `matplotlib.mlab.FormatObj`

**tostr**(*x*)

**class FormatInt**()

Bases: `matplotlib.mlab.FormatObj`

**fromstr**(*s*)

**tostr**(*x*)

**toval**(*x*)

**class FormatMillions**(*precision=4*)

Bases: `matplotlib.mlab.FormatFloat`

**class FormatObj**()

**fromstr**(*s*)

**tostr**(*x*)

**toval**(*x*)

**class FormatPercent**(*precision=4*)

Bases: `matplotlib.mlab.FormatFloat`

**class FormatString**()

Bases: `matplotlib.mlab.FormatObj`

**tostr**(*x*)

**class FormatThousands**(*precision=4*)

Bases: `matplotlib.mlab.FormatFloat`

**class PCA**(*a*)

compute the SVD of *a* and store data for PCA. Use `project` to project the data onto a reduced set of dimensions

Inputs:

*a*: a numobservations x numdims array

Attrs:

*a* a centered unit sigma version of input *a*

*numrows*, *numcols*: the dimensions of *a*

*mu* : a numdims array of means of *a*

*sigma* : a numdims array of atandard deviation of a

*fracs* : the proportion of variance of each of the principal components

*Wt* : the weight vector for projecting a numdims point or array into PCA space

*Y* : a projected into PCA space

The factor loadings are in the *Wt* factor, ie the factor loadings for the 1st principal component are given by *Wt*[0]

**center**(*x*)

center the data using the mean and sigma from training set a

**project**(*x*, *minfrac*=0.0)

project *x* onto the principle axes, dropping any axes where fraction of variance<*minfrac*

**amap**(*fn*, \**args*)

amap(function, sequence[, sequence, ...]) -> array.

Works like `map()`, but it returns an array. This is just a convenient shorthand for `numpy.array(map(...))`.

**base\_repr**(*number*, *base*=2, *padding*=0)

Return the representation of a *number* in any given *base*.

**binary\_repr**(*number*, *max\_length*=1025)

Return the binary representation of the input *number* as a string.

This is more efficient than using `base_repr()` with base 2.

Increase the value of *max\_length* for very large numbers. Note that on 32-bit machines, `2**1023` is the largest integer power of 2 which can be converted to a Python float.

**bivariate\_normal**(*X*, *Y*, *sigmax*=1.0, *sigmay*=1.0, *mux*=0.0, *muy*=0.0, *sigmaxy*=0.0)

Bivariate Gaussian distribution for equal shape *X*, *Y*.

See [bivariate normal](#) at mathworld.

**center\_matrix**(*M*, *dim*=0)

Return the matrix *M* with each row having zero mean and unit std.

If *dim* = 1 operate on columns instead of rows. (*dim* is opposite to the numpy axis kwarg.)

**cohere**(*x*, *y*, *NFFT*=256, *Fs*=2, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*=*'default'*, *scale\_by\_freq*=None)

The coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \quad (59.1)$$

*x*, *y* Array or sequence containing the data

Keyword arguments:

**NFFT: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**Fs: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, freqs, in cycles per time unit. The default value is 2.

**detrend: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The pylab module defines `detrend_none()`, `detrend_mean()`, and `detrend_linear()`, but you can use a custom function as well.

**window: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see `window_hanning()`, `window_none()`, `numpy.blackman()`, `numpy.hamming()`, `numpy.bartlett()`, `scipy.signal()`, `scipy.signal.get_window()`, etc. The default is `window_hanning()`. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**noverlap: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

**pad\_to: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to `fft()`. The default is None, which sets *pad\_to* equal to *NFFT*.

**sides: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

**scale\_by\_freq: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

The return value is the tuple  $(C_{xy}, f)$ , where *f* are the frequencies of the coherence vector. For coherence, scaling the individual densities by the sampling frequency has no effect, since the factors cancel out.

**See Also:**

**psd() and csd()** For information about the methods used to compute  $P_{xy}$ ,  $P_{xx}$  and  $P_{yy}$ .

**cohere\_pairs**(*X*, *ij*, *NFFT*=256, *Fs*=2, *detrend*=<function detrend\_none at 0x3110050>, *window*=<function window\_hanning at 0x310a2a8>, *noverlap*=0, *preferSpeedOverMemory*=True, *progressCallback*=<function donothing\_callback at 0x3110e60>, *returnPxx*=False)

Call signature:

```
Cxy, Phase, freqs = cohere_pairs( X, ij, ...)
```

Compute the coherence and phase for all pairs *ij*, in *X*.

$X$  is a  $numSamples * numCols$  array

$ij$  is a list of tuples. Each tuple is a pair of indexes into the columns of  $X$  for which you want to compute coherence. For example, if  $X$  has 64 columns, and you want to compute all nonredundant pairs, define  $ij$  as:

```
ij = []
for i in range(64):
    for j in range(i+1,64):
        ij.append( (i,j) )
```

*preferSpeedOverMemory* is an optional bool. Defaults to true. If False, limits the caching by only making one, rather than two, complex cache arrays. This is useful if memory becomes critical. Even when *preferSpeedOverMemory* is False, `cohere_pairs()` will still give significant performance gains over calling `cohere()` for each pair, and will use substantially less memory than if *preferSpeedOverMemory* is True. In my tests with a 43000,64 array over all nonredundant pairs, *preferSpeedOverMemory* = True delivered a 33% performance boost on a 1.7GHZ Athlon with 512MB RAM compared with *preferSpeedOverMemory* = False. But both solutions were more than 10x faster than naively crunching all possible pairs through `cohere()`.

Returns:

(Cxy, Phase, freqs)

where:

- **Cxy**: dictionary of  $(i, j)$  tuples  $\rightarrow$  coherence vector for that pair. I.e.,  $Cxy[(i,j)] = \text{cohere}(X[:,i], X[:,j])$ . Number of dictionary keys is  $\text{len}(ij)$ .
- **Phase**: dictionary of phases of the cross spectral density at each frequency for each pair. Keys are  $(i,j)$ .
- **freqs**: vector of frequencies, equal in length to either the coherence or phase vectors for any  $(i,j)$  key.

Eg., to make a coherence Bode plot:

```
subplot(211)
plot( freqs, Cxy[(12,19)])
subplot(212)
plot( freqs, Phase[(12,19)])
```

For a large number of pairs, `cohere_pairs()` can be much more efficient than just calling `cohere()` for each pair, because it caches most of the intensive computations. If  $N$  is the number of pairs, this function is  $O(N)$  for most of the heavy lifting, whereas calling `cohere` for each pair is  $O(N^2)$ . However, because of the caching, it is also more memory intensive, making 2 additional complex arrays with approximately the same number of elements as  $X$ .

See `test/cohere_pairs_test.py` in the src tree for an example script that shows that this `cohere_pairs()` and `cohere()` give the same results for a given pair.

See Also:

**psd()** For information about the methods used to compute  $P_{xy}$ ,  $P_{xx}$  and  $P_{yy}$ .

**contiguous\_regions**(*mask*)

return a list of (ind0, ind1) such that `mask[ind0:ind1].all()` is True and we cover all such regions

TODO: this is a pure python implementation which probably has a much faster numpy impl

**cross\_from\_above**(*x*, *threshold*)

return the indices into *x* where *x* crosses some threshold from below, eg the *i*'s where:

```
x[i-1]>threshold and x[i]<=threshold
```

**See Also:**

[`cross\_from\_below\(\)`](#) and [`contiguous\_regions\(\)`](#)

**cross\_from\_below**(*x*, *threshold*)

return the indices into *x* where *x* crosses some threshold from below, eg the *i*'s where:

```
x[i-1]<threshold and x[i]>=threshold
```

Example code:

```
import matplotlib.pyplot as plt
```

```
t = np.arange(0.0, 2.0, 0.1)
s = np.sin(2*np.pi*t)
```

```
fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(t, s, '-o')
ax.axhline(0.5)
ax.axhline(-0.5)
```

```
ind = cross_from_below(s, 0.5)
ax.vlines(t[ind], -1, 1)
```

```
ind = cross_from_above(s, -0.5)
ax.vlines(t[ind], -1, 1)
```

```
plt.show()
```

**See Also:**

[`cross\_from\_above\(\)`](#) and [`contiguous\_regions\(\)`](#)

**csd**(*x*, *y*, *NFFT*=256, *Fs*=2, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None)

The cross power spectral density by Welch's average periodogram method. The vectors *x* and *y* are divided into *NFFT* length blocks. Each block is detrended by the function *detrend* and windowed by the function *window*. *noverlap* gives the length of the overlap between blocks. The product of the direct FFTs of *x* and *y* are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

If  $\text{len}(x) < NFFT$  or  $\text{len}(y) < NFFT$ , they will be zero padded to  $NFFT$ .

**x, y** Array or sequence containing the data

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see [window\\_hanning\(\)](#), [window\\_none\(\)](#), [numpy.blackman\(\)](#), [numpy.hamming\(\)](#), [numpy.bartlett\(\)](#), [scipy.signal\(\)](#), [scipy.signal.get\\_window\(\)](#), etc. The default is [window\\_hanning\(\)](#). If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

Returns the tuple (*Pxy*, *freqs*).

**Refs:** Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

**csv2rec**(*fname*, *comments*='#', *skiprows*=0, *checkrows*=0, *delimiter*=',', *converterd*=None, *names*=None, *missing*='', *missingd*=None, *use\_mrecords*=False)

Load data from comma/space/tab delimited file in *fname* into a numpy record array and return the

record array.

If *names* is *None*, a header row is required to automatically assign the recarray names. The headers will be lower cased, spaces will be converted to underscores, and illegal attribute name characters removed. If *names* is not *None*, it is a sequence of names to use for the column names. In this case, it is assumed there is no header row.

- *fname*: can be a filename or a file handle. Support for gzipped files is automatic, if the filename ends in '.gz'
- *comments*: the character used to indicate the start of a comment in the file
- *skiprows*: is the number of rows from the top to skip
- *checkrows*: is the number of rows to check to validate the column data type. When set to zero all rows are validated.
- *converterd*: if not *None*, is a dictionary mapping column number or munged column name to a converter function.
- *names*: if not *None*, is a list of header names. In this case, no header will be read from the file
- *missingd* is a dictionary mapping munged column names to field values which signify that the field does not contain actual data and should be masked, e.g. '0000-00-00' or 'unused'
- *missing*: a string whose value signals a missing field regardless of the column it appears in
- *use\_mrecords*: if True, return an mrecords.fromrecords record array if any of the data are missing

If no rows are found, *None* is returned – see `examples/loadrec.py`

**csvformat\_factory**(*format*)

**demean**(*x*, *axis*=0)

Return *x* minus its mean along the specified axis

**detrend**(*x*, *key*=*None*)

**detrend\_linear**(*y*)

Return *y* minus best fit line; 'linear' detrending

**detrend\_mean**(*x*)

Return *x* minus the mean(*x*)

**detrend\_none**(*x*)

Return *x*: no detrending

**dist**(*x*, *y*)

Return the distance between two points.

**dist\_point\_to\_segment**(*p*, *s0*, *s1*)

Get the distance of a point to a segment.

*p*, *s0*, *s1* are *xy* sequences

This algorithm from [http://softsurfer.com/Archive/algorithm\\_0102/algorithm\\_0102.htm#Distance%20to%20Ray%20](http://softsurfer.com/Archive/algorithm_0102/algorithm_0102.htm#Distance%20to%20Ray%20)



**distances\_along\_curve(*X*)**

Computes the distance between a set of successive points in  $N$  dimensions.

Where  $X$  is an  $M \times N$  array or matrix. The distances between successive rows is computed. Distance is the standard Euclidean distance.

**donothing\_callback(\**args*)****entropy(*y*, *bins*)**

Return the entropy of the data in  $y$ .

$$\sum p_i \log_2(p_i) \quad (59.2)$$

where  $p_i$  is the probability of observing  $y$  in the  $i^{\text{th}}$  bin of *bins*. *bins* can be a number of bins or a range of bins; see `numpy.histogram()`.

Compare  $S$  with analytic calculation for a Gaussian:

```
x = mu + sigma * randn(2000000)
Sanalytic = 0.5 * ( 1.0 + log(2*pi*sigma**2.0) )
```

**exp\_safe(*x*)**

Compute exponentials which safely underflow to zero.

Slow, but convenient to use. Note that numpy provides proper floating point exception handling with access to the underlying hardware.

**fftsurr(*x*, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_none* at 0x310a6e0>)**

Compute an FFT phase randomized surrogate of  $x$ .

**find(*condition*)**

Return the indices where `ravel(condition)` is true

**frange(*xini*, *xfin*=None, *delta*=None, \*\**kw*)**

`frange([start,] stop[, step, keywords])` -> array of floats

Return a numpy ndarray containing a progression of floats. Similar to `numpy.arange()`, but defaults to a closed interval.

`frange(x0, x1)` returns `[x0, x0+1, x0+2, ..., x1]`; *start* defaults to 0, and the endpoint *is included*. This behavior is different from that of `range()` and `numpy.arange()`. This is deliberate, since `frange()` will probably be more useful for generating lists of points for function evaluation, and endpoints are often desired in this use. The usual behavior of `range()` can be obtained by setting the keyword `closed = 0`, in this case, `frange()` basically becomes `:func:numpy.arange`.

When *step* is given, it specifies the increment (or decrement). All arguments can be floating point numbers.

`frange(x0,x1,d)` returns `[x0,x0+d,x0+2d,...,xfin]` where  $x_{fin} \leq x1$ .

`frange()` can also be called with the keyword *npts*. This sets the number of points the list should contain (and overrides the value *step* might have been given). `numpy.arange()` doesn't offer this option.

Examples:

```
>>> frange(3)
array([ 0.,  1.,  2.,  3.])
>>> frange(3,closed=0)
array([ 0.,  1.,  2.])
>>> frange(1,6,2)
array([1, 3, 5]) or 1,3,5,7, depending on floating point vagueries
>>> frange(1,6.5,npts=5)
array([ 1.    ,  2.375,  3.75 ,  5.125,  6.5   ])
```

**get\_formatd**(*r*, *formatd*=None)

build a formatd guaranteed to have a key for every dtype name

**get\_sparse\_matrix**(*M*, *N*, *frac*=0.10000000000000001)

Return a *M* x *N* sparse matrix with *frac* elements randomly filled.

**get\_xyz\_where**(*Z*, *Cond*)

*Z* and *Cond* are *M* x *N* matrices. *Z* are data and *Cond* is a boolean matrix where some condition is satisfied. Return value is (*x*, *y*, *z*) where *x* and *y* are the indices into *Z* and *z* are the values of *Z* at those indices. *x*, *y*, and *z* are 1D arrays.

**griddata**(*x*, *y*, *z*, *xi*, *yi*, *interp*='nn')

*zi* = **griddata**(*x*, *y*, *z*, *xi*, *yi*) fits a surface of the form  $z = f(*x, y)$  to the data in the (usually) nonuniformly spaced vectors (*x*, *y*, *z*). **griddata**() interpolates this surface at the points specified by (*xi*, *yi*) to produce *zi*. *xi* and *yi* must describe a regular grid, can be either 1D or 2D, but must be monotonically increasing.

A masked array is returned if any grid points are outside convex hull defined by input data (no extrapolation is done).

If *interp* keyword is set to 'nn' (default), uses natural neighbor interpolation based on Delaunay triangulation. By default, this algorithm is provided by the `matplotlib.delaunay` package, written by Robert Kern. The triangulation algorithm in this package is known to fail on some nearly pathological cases. For this reason, a separate toolkit (`mpl_toolkits.natgrid`) has been created that provides a more robust algorithm for triangulation and interpolation. This toolkit is based on the NCAR natgrid library, which contains code that is not redistributable under a BSD-compatible license. When installed, this function will use the `mpl_toolkits.natgrid` algorithm, otherwise it will use the built-in `matplotlib.delaunay` package.

If the *interp* keyword is set to 'linear', then linear interpolation is used instead of natural neighbor. In this case, the output grid is assumed to be regular with a constant grid spacing in both the *x* and *y* directions. For regular grids with nonconstant grid spacing, you must use natural neighbor interpolation. Linear interpolation is only valid if `matplotlib.delaunay` package is used - `mpl_toolkits.natgrid` only provides natural neighbor interpolation.

The natgrid matplotlib toolkit can be downloaded from [http://sourceforge.net/project/showfiles.php?group\\_id=80706&](http://sourceforge.net/project/showfiles.php?group_id=80706&)

**identity**(*n*, *rank*=2, *dtype*='l', *typecode*=None)

Returns the identity matrix of shape (*n*, *n*, ..., *n*) (rank *r*).

For ranks higher than 2, this object is simply a multi-index Kronecker delta:

$$\text{id}[i_0, i_1, \dots, i_R] = \begin{cases} 1 & \text{if } i_0=i_1=\dots=i_R, \\ -1 & \\ 0 & \text{otherwise.} \end{cases}$$

Optionally a *dtype* (or *typecode*) may be given (it defaults to 'l').

Since rank defaults to 2, this function behaves in the default case (when only *n* is given) like `numpy.identity(n)` – but surprisingly, it is much faster.

### **inside\_poly**(*points*, *verts*)

*points* is a sequence of *x*, *y* points. *verts* is a sequence of *x*, *y* vertices of a polygon.

Return value is a sequence of indices into *points* for the points that are inside the polygon.

### **is\_closed\_polygon**(*X*)

Tests whether first and last object in a sequence are the same. These are presumably coordinates on a polygonal curve, in which case this function tests if that curve is closed.

### **ispower2**(*n*)

Returns the log base 2 of *n* if *n* is a power of 2, zero otherwise.

Note the potential ambiguity if *n* == 1: `2**0 == 1`, interpret accordingly.

### **isvector**(*X*)

Like the MATLAB function with the same name, returns *True* if the supplied numpy array or matrix *X* looks like a vector, meaning it has a one non-singleton axis (i.e., it can have multiple axes, but all must have length 1, except for one of them).

If you just want to see if the array has 1 axis, use `X.ndim == 1`.

### **l1norm**(*a*)

Return the *l1* norm of *a*, flattened out.

Implemented as a separate function (not a call to `norm()` for speed).

### **l2norm**(*a*)

Return the *l2* norm of *a*, flattened out.

Implemented as a separate function (not a call to `norm()` for speed).

### **less\_simple\_linear\_interpolation**(*x*, *y*, *xi*, *extrap=False*)

This function provides simple (but somewhat less so than `cbook.simple_linear_interpolation()`) linear interpolation. `simple_linear_interpolation()` will give a list of point between a start and an end, while this does true linear interpolation at an arbitrary set of points.

This is very inefficient linear interpolation meant to be used only for a small number of points in relatively non-intensive use cases. For real linear interpolation, use `scipy`.

### **levypdf**(*x*, *gamma*, *alpha*)

Return the levy pdf evaluated at *x* for params *gamma*, *alpha*

### **liaupunov**(*x*, *fprime*)

*x* is a very long trajectory from a map, and *fprime* returns the derivative of *x*.

This function will be removed from matplotlib.

Returns : .. math:

$$\lambda = \frac{1}{n} \sum \ln |f'(x_i)|$$

**See Also:**

**Lyapunov Exponent** Sec 10.5 Strogatz (1994) “Nonlinear Dynamics and Chaos”. [Wikipedia article on Lyapunov Exponent](#).

**Note:** What the function here calculates may not be what you really want; *caveat emptor*.

It also seems that this function’s name is badly misspelled.

**load**(*fname*, *comments*='#', *delimiter*=None, *converters*=None, *skiprows*=0, *usecols*=None, *unpack*=False, *dtype*=<type 'numpy.float64'>)  
Load ASCII data from *fname* into an array and return the array.

Deprecated: use `numpy.loadtxt`.

The data must be regular, same number of values in every row

*fname* can be a filename or a file handle. Support for gzipped files is automatic, if the filename ends in ‘.gz’.

matfile data is not supported; for that, use `scipy.io.mio` module.

Example usage:

```
X = load('test.dat') # data in two columns
t = X[:,0]
y = X[:,1]
```

Alternatively, you can do the same with “unpack”; see below:

```
X = load('test.dat') # a matrix of data
x = load('test.dat') # a single column of data
```

- *comments*: the character used to indicate the start of a comment in the file
- *delimiter* is a string-like character used to separate values in the file. If *delimiter* is unspecified or *None*, any whitespace string is a separator.
- *converters*, if not *None*, is a dictionary mapping column number to a function that will convert that column to a float (or the optional *dtype* if specified). Eg, if column 0 is a date string:  
  
`converters = {0:datestr2num}`
- *skiprows* is the number of rows from the top to skip.
- *usecols*, if not *None*, is a sequence of integer column indexes to extract where 0 is the first column, eg `usecols=[1,4,5]` to extract just the 2nd, 5th and 6th columns

- unpack*, if *True*, will transpose the matrix allowing you to unpack into named arguments on the left hand side:

```
t,y = load('test.dat', unpack=True) # for two column data
x,y,z = load('somefile.dat', usecols=[3,5,7], unpack=True)
```

- dtype*: the array will have this dtype. default: `numpy.float_`

#### See Also:

See `examples/pylab_examples/load_converter.py` in the source tree Exercises many of these options.

**log2**(*x*, *ln2*=0.69314718055994529)

Return the log(*x*) in base 2.

This is a `_slow_` function but which is guaranteed to return the correct integer value if the input is an integer exact power of 2.

**logspace**(*xmin*, *xmax*, *N*)

**longest\_contiguous\_ones**(*x*)

Return the indices of the longest stretch of contiguous ones in *x*, assuming *x* is a vector of zeros and ones. If there are two equally long stretches, pick the first.

**longest\_ones**(*x*)

alias for `longest_contiguous_ones`

**movavg**(*x*, *n*)

Compute the `len(n)` moving average of *x*.

**norm\_flat**(*a*, *p*=2)

`norm(a,p=2) -> l-p norm of a.flat`

Return the l-p norm of *a*, considered as a flat array. This is NOT a true matrix norm, since arrays of arbitrary rank are always flattened.

*p* can be a number or the string 'Infinity' to get the L-infinity norm.

**normpdf**(*x*, \**args*)

Return the normal pdf evaluated at *x*; *args* provides *mu*, *sigma*

**path\_length**(*X*)

Computes the distance travelled along a polygonal curve in *N* dimensions.

Where *X* is an *M* x *N* array or matrix. Returns an array of length *M* consisting of the distance along the curve at each point (i.e., the rows of *X*).

**poly\_below**(*xmin*, *xs*, *ys*)

Given a sequence of *xs* and *ys*, return the vertices of a polygon that has a horizontal base at *xmin* and an upper bound at the *ys*. *xmin* is a scalar.

Intended for use with `matplotlib.axes.Axes.fill()`, eg:

```
xv, yv = poly_below(0, x, y)
ax.fill(xv, yv)
```

### **poly\_between**(*x*, *ylower*, *yupper*)

Given a sequence of *x*, *ylower* and *yupper*, return the polygon that fills the regions between them. *ylower* or *yupper* can be scalar or iterable. If they are iterable, they must be equal in length to *x*.

Return value is *x*, *y* arrays for use with `matplotlib.axes.Axes.fill()`.

### **prctile**(*x*, *p*=(0.0, 25.0, 50.0, 75.0, 100.0))

Return the percentiles of *x*. *p* can either be a sequence of percentile values or a scalar. If *p* is a sequence, the *i*th element of the return sequence is the *p\*(i)-th percentile of \*x*. If *p* is a scalar, the largest value of *x* less than or equal to the *p* percentage point in the sequence is returned.

### **prctile\_rank**(*x*, *p*)

Return the rank for each element in *x*, return the rank 0..*len(p)*. Eg if *p* = (25, 50, 75), the return value will be a *len(x)* array with values in [0,1,2,3] where 0 indicates the value is less than the 25th percentile, 1 indicates the value is >= the 25th and < 50th percentile, ... and 3 indicates the value is above the 75th percentile cutoff.

*p* is either an array of percentiles in [0..100] or a scalar which indicates how many quantiles of data you want ranked.

### **prepca**(*P*, *frac*=0)

WARNING: this function is deprecated – please see class PCA instead

Compute the principal components of *P*. *P* is a (*numVars*, *numObs*) array. *frac* is the minimum fraction of variance that a component must contain to be included.

Return value is a tuple of the form (*Pcomponents*, *Trans*, *fracVar*) where:

- ***Pcomponents*** : a (*numVars*, *numObs*) array
- ***Trans*** [the weights matrix, ie, *Pcomponents* = *Trans* \*] *P*
- ***fracVar*** [the fraction of the variance accounted for by each] component returned

A similar function of the same name was in the MATLAB R13 Neural Network Toolbox but is not found in later versions; its successor seems to be called “processpcs”.

### **psd**(*x*, *NFFT*=256, *Fs*=2, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*=‘default’, *scale\_by\_freq*=None)

The power spectral density by Welch’s average periodogram method. The vector *x* is divided into *NFFT* length blocks. Each block is detrended by the function *detrend* and windowed by the function *window*. *noverlap* gives the length of the overlap between blocks. The absolute(fft(block))\*\*2 of each segment are averaged to compute *Pxx*, with a scaling to correct for power loss due to windowing.

If *len(x)* < *NFFT*, it will be zero padded to *NFFT*.

***x*** Array or sequence containing the data

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see [window\\_hanning\(\)](#), [window\\_none\(\)](#), [numpy.blackman\(\)](#), [numpy.hamming\(\)](#), [numpy.bartlett\(\)](#), [scipy.signal\(\)](#), [scipy.signal.get\\_window\(\)](#), etc. The default is [window\\_hanning\(\)](#). If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*.

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

Returns the tuple (*Pxx*, *freqs*).

Refs:

Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

**quad2cubic(*q0x*, *q0y*, *q1x*, *q1y*, *q2x*, *q2y*)**

Converts a quadratic Bezier curve to a cubic approximation.

The inputs are the *x* and *y* coordinates of the three control points of a quadratic curve, and the output is a tuple of *x* and *y* coordinates of the four control points of the cubic curve.

**rec2csv**(*r*, *fname*, *delimiter*=', ', *formatd*=None, *missing*='', *missingd*=None, *withheader*=True)

Save the data from numpy recarray *r* into a comma-/space-/tab-delimited file. The record array dtype names will be used for column headers.

**fname:** can be a filename or a file handle. Support for gzipped files is automatic, if the filename ends in '.gz'

**withheader:** if **withheader** is False, do not write the attribute names in the first row

for *formatd* type FormatFloat, we override the precision to store full precision floats in the CSV file

**See Also:**

**csv2rec()** For information about *missing* and *missingd*, which can be used to fill in masked values into your CSV file.

**rec2txt**(*r*, *header*=None, *padding*=3, *precision*=3, *fields*=None)

Returns a textual representation of a record array.

*r*: numpy recarray

*header*: list of column headers

*padding*: space between each column

**precision:** number of decimal places to use for floats. Set to an integer to apply to all floats. Set to a list of integers to apply precision individually. Precision for non-floats is simply ignored.

*fields* : if not None, a list of field names to print. *fields* can be a list of strings like ['field1', 'field2'] or a single comma separated string like 'field1,field2'

Example:

```
precision=[0,2,3]
```

Output:

| ID  | Price | Return |
|-----|-------|--------|
| ABC | 12.54 | 0.234  |
| XYZ | 6.32  | -0.076 |

**rec\_append\_fields**(*rec*, *names*, *arrs*, *dtypes*=None)

Return a new record array with field names populated with data from arrays in *arrs*. If appending a single field, then *names*, *arrs* and *dtypes* do not have to be lists. They can just be the values themselves.

**rec\_drop\_fields**(*rec*, *names*)

Return a new numpy record array with fields in *names* dropped.

**rec\_groupby**(*r*, *groupby*, *stats*)

*r* is a numpy record array

*groupby* is a sequence of record array attribute names that together form the grouping key. eg ('date', 'productcode')



*stats* is a sequence of (*attr*, *func*, *outname*) tuples which will call `x = func(attr)` and assign *x* to the record array output with attribute *outname*. For example:

```
stats = ( ('sales', len, 'numsales'), ('sales', np.mean, 'avgsale') )
```

Return record array has *dtype* names for each attribute name in the the *groupby* argument, with the associated group values, and for each *outname* name in the *stats* argument, with the associated stat summary output.

**rec\_join**(*key*, *r1*, *r2*, *jointype*='inner', *defaults*=None, *r1postfix*='1', *r2postfix*='2')

Join record arrays *r1* and *r2* on *key*; *key* is a tuple of field names – if *key* is a string it is assumed to be a single attribute name. If *r1* and *r2* have equal values on all the keys in the *key* tuple, then their fields will be merged into a new record array containing the intersection of the fields of *r1* and *r2*.

*r1* (also *r2*) must not have any duplicate keys.

The *jointype* keyword can be 'inner', 'outer', 'leftouter'. To do a rightouter join just reverse *r1* and *r2*.

The *defaults* keyword is a dictionary filled with {column\_name:default\_value} pairs.

The keywords *r1postfix* and *r2postfix* are postfixed to column names (other than keys) that are both in *r1* and *r2*.

**rec\_keep\_fields**(*rec*, *names*)

Return a new numpy record array with only fields listed in *names*

**rec\_summarize**(*r*, *summaryfuncs*)

*r* is a numpy record array

*summaryfuncs* is a list of (*attr*, *func*, *outname*) tuples which will apply *func* to the the array *r\*[attr]* and assign the output to a new attribute name *\*outname*. The returned record array is identical to *r*, with extra arrays for each element in *summaryfuncs*.

**recs\_join**(*key*, *name*, *recs*, *jointype*='outer', *missing*=0.0, *postfixes*=None)

Join a sequence of record arrays on single column key.

This function only joins a single column of the multiple record arrays

*key* is the column name that acts as a key

*name* is the name of the column that we want to join

*recs* is a list of record arrays to join

*jointype* is a string 'inner' or 'outer'

*missing* is what any missing field is replaced by

*postfixes* if not None, a len recs sequence of postfixes

returns a record array with columns [rowkey, name0, name1, ... namen-1]. or if postfixes [PF0, PF1, ..., PFN-1] are supplied, [rowkey, namePF0, namePF1, ... namePFN-1].

Example:

```
r = recs_join("date", "close", recs=[r0, r1], missing=0.)
```

**rk4**(*derivs*, *y0*, *t*)

Integrate 1D or ND system of ODEs using 4-th order Runge-Kutta. This is a toy implementation which may be useful if you find yourself stranded on a system w/o scipy. Otherwise use `scipy.integrate()`.

*y0* initial state vector

*t* sample times

*derivs* returns the derivative of the system and has the signature `dy = derivs(yi, ti)`

Example 1

```
## 2D system

def derivs6(x,t):
    d1 = x[0] + 2*x[1]
    d2 = -3*x[0] + 4*x[1]
    return (d1, d2)
dt = 0.0005
t = arange(0.0, 2.0, dt)
y0 = (1,2)
yout = rk4(derivs6, y0, t)
```

Example 2:

```
## 1D system
alpha = 2
def derivs(x,t):
    return -alpha*x + exp(-t)

y0 = 1
yout = rk4(derivs, y0, t)
```

If you have access to scipy, you should probably be using the `scipy.integrate` tools rather than this function.

**rms\_flat**(*a*)

Return the root mean square of all the elements of *a*, flattened out.

**safe\_isinf**(*x*)

`numpy.isinf()` for arbitrary types

**safe\_isnan**(*x*)

`numpy.isnan()` for arbitrary types

**save**(*fname*, *X*, *fmt*='%.18e', *delimiter*=' ')

Save the data in *X* to file *fname* using *fmt* string to convert the data to strings.

Deprecated. Use `numpy.savetxt`.

*fname* can be a filename or a file handle. If the filename ends in `'.gz'`, the file is automatically saved in compressed gzip format. The `load()` function understands gzipped files transparently.

Example usage:

```
save('test.out', X)           # X is an array
save('test1.out', (x,y,z))    # x,y,z equal sized 1D arrays
save('test2.out', x)         # x is 1D
save('test3.out', x, fmt='%1.4e') # use exponential notation
```

*delimiter* is used to separate the fields, eg. *delimiter* `','` for comma-separated values.

### **segments\_intersect**(*s1*, *s2*)

Return *True* if *s1* and *s2* intersect. *s1* and *s2* are defined as:

```
s1: (x1, y1), (x2, y2)
s2: (x3, y3), (x4, y4)
```

### **slopes**(*x*, *y*)

`slopes()` calculates the slope  $y'(x)$

The slope is estimated using the slope obtained from that of a parabola through any three consecutive points.

This method should be superior to that described in the appendix of A CONSISTENTLY WELL BEHAVED METHOD OF INTERPOLATION by Russel W. Stineman (Creative Computing July 1980) in at least one aspect:

Circles for interpolation demand a known aspect ratio between *x*- and *y*-values. For many functions, however, the abscissa are given in different dimensions, so an aspect ratio is completely arbitrary.

The parabola method gives very similar results to the circle method for most regular cases but behaves much better in special cases.

Norbert Nemec, Institute of Theoretical Physics, University of Regensburg, April 2006 Norbert.Nemec at physik.uni-regensburg.de

(inspired by a original implementation by Halldor Bjornsson, Icelandic Meteorological Office, March 2006 halldor at vedur.is)

### **specgram**(*x*, *NFFT*=256, *Fs*=2, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=128, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None)

Compute a spectrogram of data in *x*. Data are split into *NFFT* length segments and the PSD of each section is computed. The windowing function *window* is applied to each segment, and the amount of overlap of each segment is specified with *noverlap*.

If *x* is real (i.e. non-complex) only the spectrum of the positive frequency is returned. If *x* is complex then the complete spectrum is returned.

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see [window\\_hanning\(\)](#), [window\\_none\(\)](#), [numpy.blackman\(\)](#), [numpy.hamming\(\)](#), [numpy.bartlett\(\)](#), [scipy.signal\(\)](#), [scipy.signal.get\\_window\(\)](#), etc. The default is [window\\_hanning\(\)](#). If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*.

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

Returns a tuple (*Pxx*, *freqs*, *t*):

- *Pxx*: 2-D array, columns are the periodograms of successive segments
- *freqs*: 1-D array of frequencies corresponding to the rows in *Pxx*
- *t*: 1-D array of times corresponding to midpoints of segments.

**See Also:**

**[psd\(\)](#)** [psd\(\)](#) differs in the default overlap; in returning the mean of the segment periodograms; and in not returning times.

**stineman\_interp**(*xi*, *x*, *y*, *yp=None*)

Given data vectors *x* and *y*, the slope vector *yp* and a new abscissa vector *xi*, the function `stineman_interp()` uses Stineman interpolation to calculate a vector *yi* corresponding to *xi*.

Here's an example that generates a coarse sine curve, then interpolates over a finer abscissa:

```
x = linspace(0,2*pi,20); y = sin(x); yp = cos(x)
xi = linspace(0,2*pi,40);
yi = stineman_interp(xi,x,y,yp);
plot(x,y,'o',xi,yi)
```

The interpolation method is described in the article A CONSISTENTLY WELL BEHAVED METHOD OF INTERPOLATION by Russell W. Stineman. The article appeared in the July 1980 issue of Creative Computing with a note from the editor stating that while they were:

not an academic journal but once in a while something serious and original comes in adding that this was “apparently a real solution” to a well known problem.

For *yp = None*, the routine automatically determines the slopes using the `slopes()` routine.

*x* is assumed to be sorted in increasing order.

For values *xi*[*j*] < *x*[0] or *xi*[*j*] > *x*[-1], the routine tries an extrapolation. The relevance of the data obtained from this, of course, is questionable...

Original implementation by Halldor Bjornsson, Icelandic Meteorological Office, March 2006 halldor at vedur.is

Completely reworked and optimized for Python by Norbert Nemec, Institute of Theoretical Physics, University of Regensburg, April 2006 Norbert.Nemec at physik.uni-regensburg.de

**vector\_lengths**(*X*, *P=2.0*, *axis=None*)

Finds the length of a set of vectors in *n* dimensions. This is like the `numpy.norm()` function for vectors, but has the ability to work over a particular axis of the supplied array or matrix.

Computes  $(\sum (x_i)^P)^{1/P}$  for each  $\{x_i\}$  being the elements of *X* along the given axis. If *axis* is *None*, compute over all elements of *X*.

**window\_hanning**(*x*)

return *x* times the hanning window of len(*x*)

**window\_none**(*x*)

No window function; simply return *x*



# NXUTILS

## 60.1 matplotlib.nxutils

general purpose numerical utilities, eg for computational geometry, that are not available in [numpy](#)

### **pnpoly()**

inside = pnpoly(x, y, xyverts)

Return 1 if x,y is inside the polygon, 0 otherwise.

**xyverts** a sequence of x,y vertices.

A point on the boundary may be treated as inside or outside. See [pnpoly](#)

### **points\_inside\_poly()**

mask = points\_inside\_poly(xypoints, xyverts)

Return a boolean ndarray, True for points inside the polygon.

**xypoints** a sequence of N x,y pairs.

**xyverts** sequence of x,y vertices of the polygon.

**mask** an ndarray of length N.

A point on the boundary may be treated as inside or outside. See [pnpoly](#)





# PATH

## 61.1 matplotlib.path

Contains a class for managing paths (polylines).

**class Path**(*vertices*, *codes=None*, *\_interpolation\_steps=1*)  
Bases: object

**Path** represents a series of possibly disconnected, possibly closed, line and curve segments.

**The underlying storage is made up of two parallel numpy arrays:**

- *vertices*: an Nx2 float array of vertices
- *codes*: an N-length uint8 array of vertex types

These two arrays always have the same length in the first dimension. For example, to represent a cubic curve, you must provide three vertices as well as three codes CURVE3.

The code types are:

- **STOP** [1 vertex (ignored)] A marker for the end of the entire path (currently not required and ignored)
- **MOVETO** [1 vertex] Pick up the pen and move to the given vertex.
- **LINETO** [1 vertex] Draw a line from the current position to the given vertex.
- **CURVE3** [1 control point, 1 endpoint] Draw a quadratic Bezier curve from the current position, with the given control point, to the given end point.
- **CURVE4** [2 control points, 1 endpoint] Draw a cubic Bezier curve from the current position, with the given control points, to the given end point.
- **CLOSEPOLY** [1 vertex (ignored)] Draw a line segment to the start point of the current polyline.

Users of Path objects should not access the vertices and codes arrays directly. Instead, they should use `iter_segments()` to get the vertex/code pairs. This is important, since many Path objects, as an optimization, do not store a *codes* at all, but have a default one provided for them by `iter_segments()`.

Note also that the vertices and codes arrays should be treated as immutable – there are a number of optimizations and assumptions made up front in the constructor that will not change when the data changes.

Create a new path with the given vertices and codes.

*vertices* is an Nx2 numpy float array, masked array or Python sequence.

*codes* is an N-length numpy array or Python sequence of type `matplotlib.path.Path.code_type`.

These two arrays must have the same length in the first dimension.

If *codes* is None, *vertices* will be treated as a series of line segments.

If *vertices* contains masked values, they will be converted to NaNs which are then handled correctly by the Agg PathIterator and other consumers of path data, such as `iter_segments()`.

*interpolation\_steps* is used as a hint to certain projections, such as Polar, that this path should be linearly interpolated immediately before drawing. This attribute is primarily an implementation detail and is not intended for public use.

class **arc**(*theta1, theta2, n=None, is\_wedge=False*)

(staticmethod) Returns an arc on the unit circle from angle *theta1* to angle *theta2* (in degrees).

If *n* is provided, it is the number of spline segments to make. If *n* is not provided, the number of spline segments is determined based on the delta between *theta1* and *theta2*.

Masionobe, L. 2003. [Drawing an elliptical arc using polylines, quadratic or cubic Bezier curves](#).

**code\_type**

alias of `uint8`

**contains\_path**(*path, transform=None*)

Returns *True* if this path completely contains the given path.

If *transform* is not *None*, the path will be transformed before performing the test.

**contains\_point**(*point, transform=None, radius=0.0*)

Returns *True* if the path contains the given point.

If *transform* is not *None*, the path will be transformed before performing the test.

**get\_extents**(*transform=None*)

Returns the extents (*xmin, ymin, xmax, ymax*) of the path.

Unlike computing the extents on the *vertices* alone, this algorithm will take into account the curves and deal with control points appropriately.

class **hatch**(*hatchpattern, density=6*)

Given a hatch specifier, *hatchpattern*, generates a Path that can be used in a repeated hatching pattern. *density* is the number of lines per unit square.

**interpolated**(*steps*)

Returns a new path resampled to length N x steps. Does not currently handle interpolating curves.

**intersects\_bbox**(*bbox, filled=True*)

Returns *True* if this path intersects a given [Bbox](#).

*filled*, when *True*, treats the path as if it was filled. That is, if one path completely encloses the other, `intersects_path()` will return *True*.

**intersects\_path**(*other*, *filled=True*)

Returns *True* if this path intersects another given path.

*filled*, when *True*, treats the paths as if they were filled. That is, if one path completely encloses the other, **intersects\_path()** will return *True*.

**iter\_segments**(*transform=None*, *remove\_nans=True*, *clip=None*, *snap=False*, *stroke\_width=1.0*, *simplify=None*, *curves=True*)

Iterates over all of the curve segments in the path. Each iteration returns a 2-tuple (*vertices*, *code*), where *vertices* is a sequence of 1 - 3 coordinate pairs, and *code* is one of the [Path](#) codes.

Additionally, this method can provide a number of standard cleanups and conversions to the path.

**transform:** if not *None*, the given affine transformation will be applied to the path.

**remove\_nans:** if *True*, will remove all NaNs from the path and insert MOVETO commands to skip over them.

**clip:** if not *None*, must be a four-tuple (*x1*, *y1*, *x2*, *y2*) defining a rectangle in which to clip the path.

**snap:** if *None*, auto-snap to pixels, to reduce fuzziness of rectilinear lines. If *True*, force snapping, and if *False*, don't snap.

**stroke\_width:** the width of the stroke being drawn. Needed as a hint for the snapping algorithm.

**simplify:** if *True*, perform simplification, to remove vertices that do not affect the appearance of the path. If *False*, perform no simplification. If *None*, use the `should_simplify` member variable.

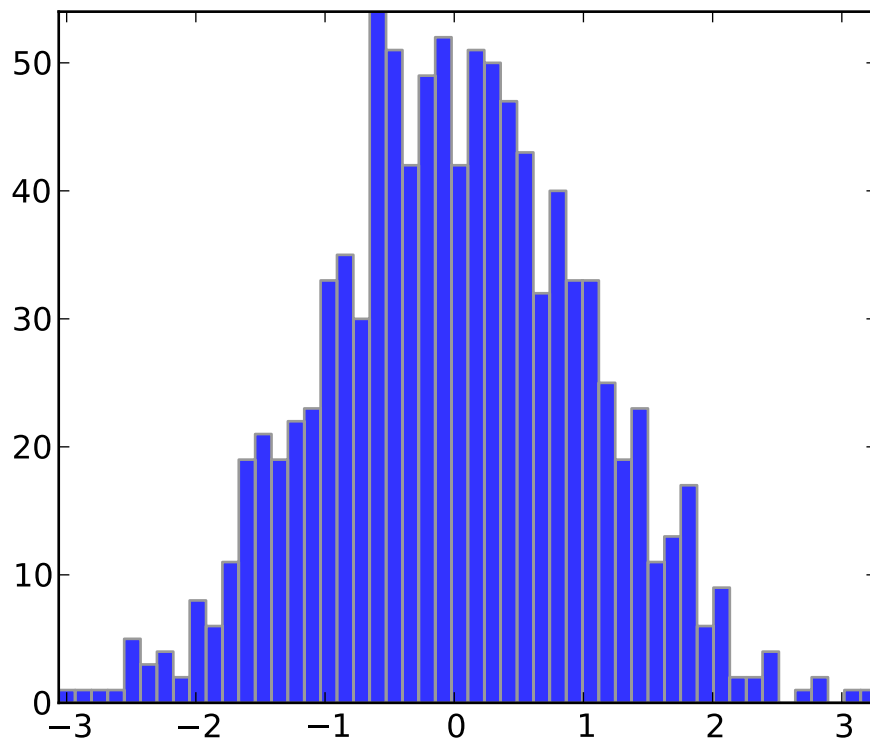
**curves:** If *True*, curve segments will be returned as curve segments. If *False*, all curves will be converted to line segments.

class **make\_compound\_path**(\*args)

(staticmethod) Make a compound path from a list of [Path](#) objects. Only polygons (not curves) are supported.

class **make\_compound\_path\_from\_polys**(XY)

(static method) Make a compound path object to draw a number of polygons with equal numbers of sides XY is a (numpolys x numsides x 2) numpy array of vertices. Return object is a [Path](#)



**to\_polygons**(*transform=None, width=0, height=0*)

Convert this path to a list of polygons. Each polygon is an Nx2 array of vertices. In other words, each polygon has no MOVETO instructions or curves. This is useful for displaying in backends that do not support compound paths or Bezier curves, such as GDK.

If *width* and *height* are both non-zero then the lines will be simplified so that vertices outside of (0, 0), (width, height) will be clipped.

**transformed**(*transform*)

Return a transformed copy of the path.

**See Also:**

**matplotlib.transforms.TransformPath** A specialized path class that will cache the transformed result and automatically update when the transform changes.

class **unit\_circle**()

(staticmethod) Returns a [Path](#) of the unit circle. The circle is approximated using cubic Bezier curves. This uses 8 splines around the circle using the approach presented here:

Lancaster, Don. [Approximating a Circle or an Ellipse Using Four Bezier Cubic Splines](#).

class **unit\_circle\_righthalf**()

(staticmethod) Returns a [Path](#) of the right half of a unit circle. The circle is approximated using

cubic Bezier curves. This uses 4 splines around the circle using the approach presented here:

Lancaster, Don. [Approximating a Circle or an Ellipse Using Four Bezier Cubic Splines](#).

class **unit\_rectangle()**

(staticmethod) Returns a [Path](#) of the unit rectangle from (0, 0) to (1, 1).

class **unit\_regular\_asterisk(*numVertices*)**

(staticmethod) Returns a [Path](#) for a unit regular asterisk with the given *numVertices* and radius of 1.0, centered at (0, 0).

class **unit\_regular\_polygon(*numVertices*)**

(staticmethod) Returns a [Path](#) for a unit regular polygon with the given *numVertices* and radius of 1.0, centered at (0, 0).

class **unit\_regular\_star(*numVertices*, *innerCircle*=0.5)**

(staticmethod) Returns a [Path](#) for a unit regular star with the given *numVertices* and radius of 1.0, centered at (0, 0).

class **wedge(*theta1*, *theta2*, *n*=None)**

(staticmethod) Returns a wedge of the unit circle from angle *theta1* to angle *theta2* (in degrees).

If *n* is provided, it is the number of spline segments to make. If *n* is not provided, the number of spline segments is determined based on the delta between *theta1* and *theta2*.

**cleanup\_path()**

cleanup\_path(path, trans, remove\_nans, clip, snap, simplify, curves)

**convert\_path\_to\_polygons()**

convert\_path\_to\_polygons(path, trans, width, height)

**get\_path\_collection\_extents(\*args)**

Given a sequence of [Path](#) objects, returns the bounding box that encapsulates all of them.

**get\_path\_extents()**

get\_path\_extents(path, trans)

**path\_in\_path()**

path\_in\_path(a, atrans, b, btrans)

**path\_intersects\_path()**

path\_intersects\_path(p1, p2)

**point\_in\_path()**

point\_in\_path(x, y, path, trans)

**point\_in\_path\_collection()**

point\_in\_path\_collection(x, y, r, trans, paths, transforms, offsets, offsetTrans, filled)



# PYPLOT

## 62.1 matplotlib.pyplot

Provides a MATLAB-like plotting framework.

pylab combines pyplot with numpy into a single namespace. This is convenient for interactive work, but for programming it is recommended that the namespaces be kept separate, e.g.:

```
import numpy as np
import matplotlib.pyplot as plt
```

```
x = np.arange(0, 5, 0.1);
y = np.sin(x)
plt.plot(x, y)
```

**acorr**(*x*, *hold=None*, *\*\*kwargs*)

call signature:

```
acorr(x, normed=True, detrend=mlab.detrend_none, usevlines=True,
      maxlags=10, **kwargs)
```

Plot the autocorrelation of *x*. If *normed = True*, normalize the data by the autocorrelation at 0-th lag. *x* is detrended by the *detrend* callable (default no normalization).

Data are plotted as `plot(lags, c, **kwargs)`

Return value is a tuple (*lags*, *c*, *line*) where:

- *lags* are a length  $2*\text{maxlags}+1$  lag vector
- *c* is the  $2*\text{maxlags}+1$  auto correlation vector
- *line* is a `Line2D` instance returned by `plot()`

The default *linestyle* is `None` and the default *marker* is `'o'`, though these can be overridden with keyword args. The cross correlation is performed with `numpy.correlate()` with *mode = 2*.

If *usevlines* is `True`, `vlines()` rather than `plot()` is used to draw vertical lines from the origin to the `acorr`. Otherwise, the plot style is determined by the *kwargs*, which are `Line2D` properties.

*maxlags* is a positive integer detailing the number of lags to show. The default value of *None* will return all  $2 \times \text{len}(x) - 1$  lags.

The return value is a tuple (*lags*, *c*, *linecol*, *b*) where

- *linecol* is the [LineCollection](#)
- *b* is the *x*-axis.

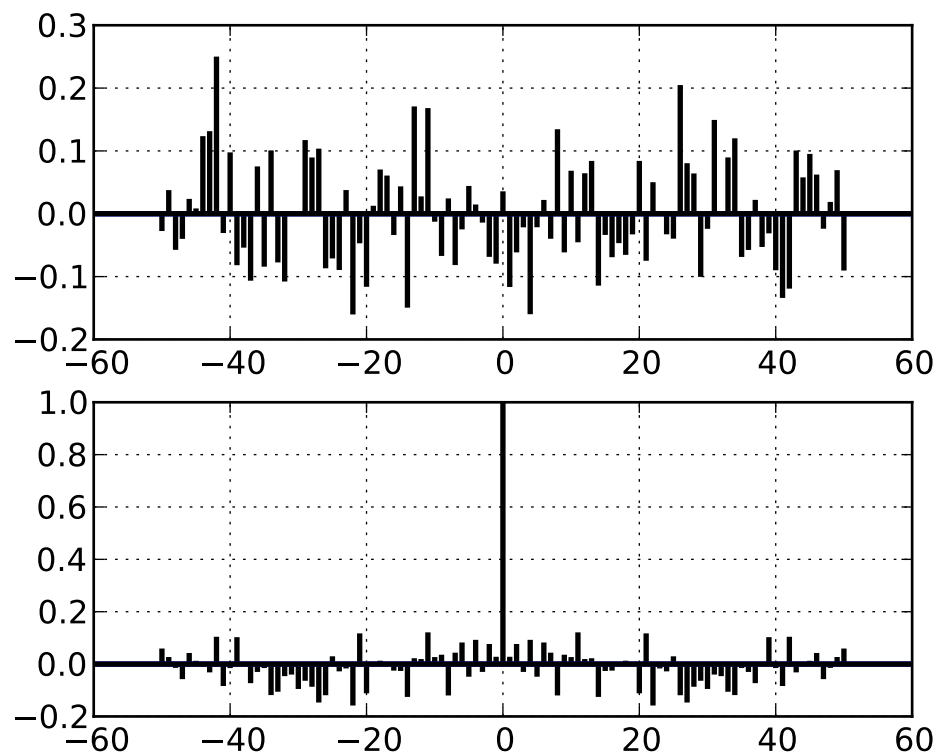
**See Also:**

[plot\(\)](#) or [vlines\(\)](#) For documentation on valid kwargs.

**Example:**

[xcorr\(\)](#) above, and [acorr\(\)](#) below.

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**annotate(\*args, \*\*kwargs)**

call signature:

```
annotate(s, xy, xytext=None, xycoords='data',
         textcoords='data', arrowprops=None, **kwargs)
```

Keyword arguments:



Annotate the  $x, y$  point  $xy$  with text  $s$  at  $x, y$  location  $xytext$ . (If  $xytext = None$ , defaults to  $xy$ , and if  $textcoords = None$ , defaults to  $xycoords$ ).

*arrowprops*, if not *None*, is a dictionary of line properties (see `matplotlib.lines.Line2D`) for the arrow that connects annotation to the point.

If the dictionary has a key *arrowstyle*, a `FancyArrowPatch` instance is created with the given dictionary and is drawn. Otherwise, a `YAArow` patch instance is created and drawn. Valid keys for `YAArow` are

| Key        | Description   |
|------------|---|
| width      | the width of the arrow in points  |
| frac       | the fraction of the arrow length occupied by the head   |
| head-width | the width of the base of the arrow head in points   |
| shrink     | oftentimes it is convenient to have the arrowtip and base a bit away from the text and point being annotated. If $d$ is the distance between the text and annotated point, shrink will shorten the arrow so the tip and base are shrink percent of the distance $d$ away from the endpoints. ie, <code>shrink=0.05</code> is 5% |
| ?          | any key for <code>matplotlib.patches.polygon</code>   |

Valid keys for `FancyArrowPatch` are

| Key             | Description   |
|-----------------|---|
| arrowstyle      | the arrow style                                       |
| connectionstyle | the connection style                                  |
| relpos          | default is (0.5, 0.5)                                 |
| patchA          | default is bounding box of the text                   |
| patchB          | default is None                                       |
| shrinkA         | default is 2 points                                   |
| shrinkB         | default is 2 points                                   |
| mutation_scale  | default is text size (in points)                      |
| mutation_aspect | default is 1.   |
| ?               | any key for <code>matplotlib.patches.PathPatch</code> |

*xycoords* and *textcoords* are strings that indicate the coordinates of  $xy$  and  $xytext$ .

| Property          | Description   |
|-------------------|---|
| 'figure points'   | points from the lower left corner of the figure   |
| 'figure pixels'   | pixels from the lower left corner of the figure   |
| 'figure fraction' | 0,0 is lower left of figure and 1,1 is upper, right   |
| 'axes points'     | points from lower left corner of axes   |
| 'axes pixels'     | pixels from lower left corner of axes   |
| 'axes fraction'   | 0,1 is lower left of axes and 1,1 is upper right  |
| 'data'            | use the coordinate system of the object being annotated (default)   |
| 'offset points'   | Specify an offset (in points) from the <i>xy</i> value  |
| 'polar'           | you can specify <i>theta</i> , <i>r</i> for the annotation, even in cartesian plots. Note that if you are using a polar axes, you do not need to specify polar for the coordinate system since that is the native “data” coordinate system. |

If a ‘points’ or ‘pixels’ option is specified, values will be added to the bottom-left and if negative, values will be subtracted from the top-right. Eg:

```
# 10 points to the right of the left border of the axes and
# 5 points below the top border
xy=(10,-5), xycoords='axes points'
```

You may use an instance of [Transform](#) or [Artist](#). See [Annotating Axes](#) for more details.

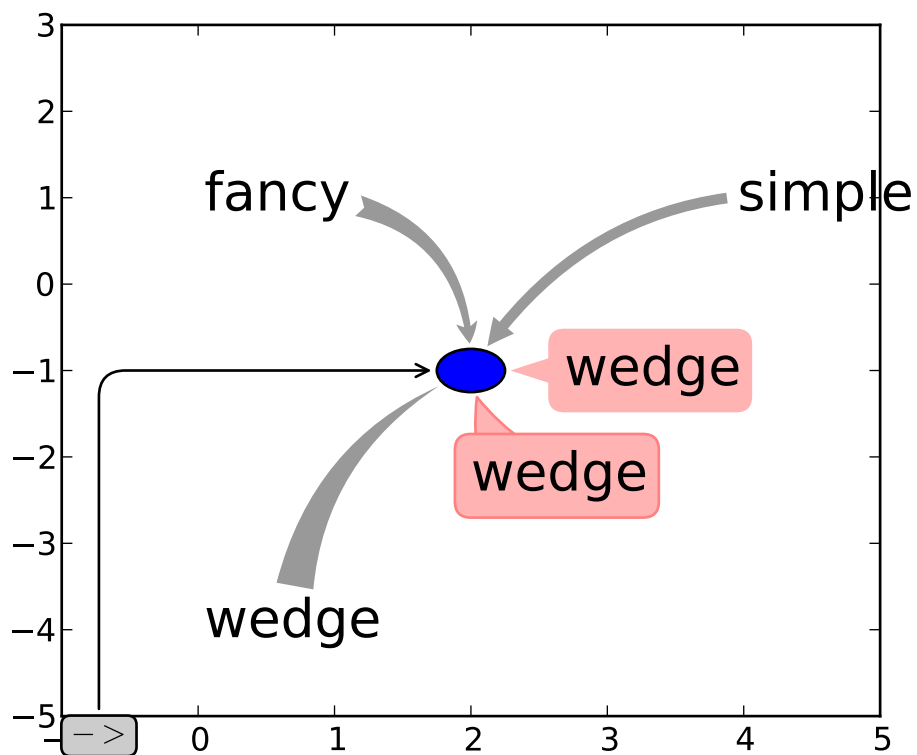
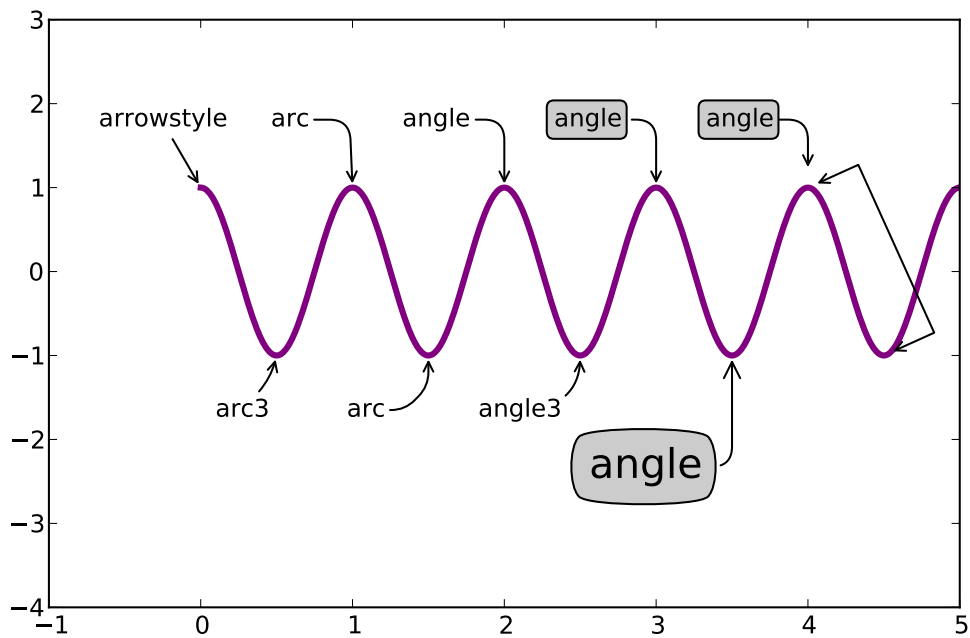
The `annotation_clip` attribute controls the visibility of the annotation when it goes outside the axes area. If True, the annotation will only be drawn when the *xy* is inside the axes. If False, the annotation will always be drawn regardless of its position. The default is *None*, which behave as True only if *xycoords* is “data”.

Additional kwargs are Text properties:

| Property                     | Description   |
|------------------------------|---|
| <code>agg_filter</code>      | unknown   |
| <code>alpha</code>           | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>        | [True   False]  |
| <code>axes</code>            | an <a href="#">Axes</a> instance  |
| <code>backgroundcolor</code> | any matplotlib color  |
| <code>bbox</code>            | rectangle prop dict   |
| <code>clip_box</code>        | a <code>matplotlib.transforms.Bbox</code> instance                                      |
| <code>clip_on</code>         | [True   False]  |
| <code>clip_path</code>       | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>           | any matplotlib color  |
| <code>contains</code>        | a callable function   |

Table 62.1 – continued from

|  |  |
|--|--|
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   ‘serif’   ‘sans-serif’   ‘cursive’   ‘fantasy’   ‘monospace’ ]  |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance   |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ ‘center’   ‘right’   ‘left’ ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ ‘left’   ‘right’   ‘center’ ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   ‘vertical’   ‘horizontal’ ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   ‘xx-small’   ‘x-small’   ‘small’   ‘medium’   ‘large’   ‘x-large’ ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   ‘ultra-condensed’   ‘extra-condensed’   ‘condensed’   ‘normal’   ‘expanded’   ‘ultra-expanded’ ] |
| <code>style</code> or <code>fontstyle</code>   | [ ‘normal’   ‘italic’   ‘oblique’ ]  |
| <code>text</code>  | string or anything printable with ‘%s’ conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>   | [ ‘normal’   ‘small-caps’ ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code>                         | [ ‘center’   ‘top’   ‘bottom’   ‘baseline’ ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>   | [ a numeric value in range 0-1000   ‘ultralight’   ‘light’   ‘normal’   ‘regular’   ‘bold’   ‘extra-bold’   ‘black’ ]                |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |



**arrow**(*x*, *y*, *dx*, *dy*, *hold=None*, *\*\*kwargs*)  
 call signature:

```
arrow(x, y, dx, dy, **kwargs)
```

Draws arrow on specified axis from  $(x, y)$  to  $(x + dx, y + dy)$ .

Optional kwargs control the arrow properties:

Constructor arguments

***length\_includes\_head***: *True* if head is counted in calculating the length.

***shape***: ['full', 'left', 'right']

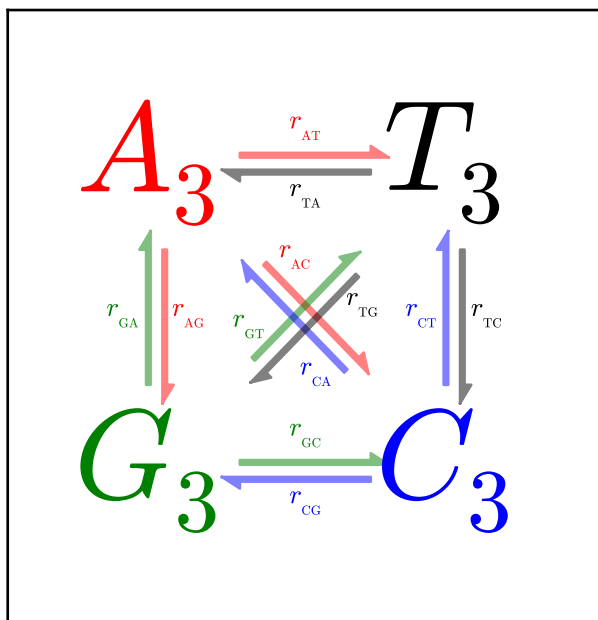
***overhang***: distance that the arrow is swept back (0 overhang means triangular shape).

***head\_starts\_at\_zero***: If *True*, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Valid kwargs are:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

#### **autogen\_docstring**(*base*)

Autogenerated wrappers will get their docstring from a base function with an addendum.

#### **autoscale**(*enable=True*, *axis='both'*, *tight=None*)

Convenience method for simple axis view autoscaling. It turns autoscaling on or off, and then, if autoscaling for either axis is on, it performs the autoscaling on the specified axis or axes.

**enable:** [**True** | **False** | **None**] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

**axis:** [**'x'** | **'y'** | **'both'**] which axis to operate on; default is 'both'

**tight:** [**True** | **False** | **None**] If True, set view limits to data limits; if False, let the locator and margins expand the view limits; if None, use tight scaling if the only artist is an image, otherwise treat *tight* as False. The *tight* setting is retained for future autoscaling until it is explicitly changed.

Returns None.

#### **autumn**()

set the default colormap to autumn and apply to current image if any. See `help(colormaps)` for more information

#### **axes**(\*args, \*\*kwargs)

Add an axes at position *rect* specified by:

- **axes()** by itself creates a default full `subplot(111)` window axis.
- **axes(rect, axisbg='w')** where *rect* = [left, bottom, width, height] in normalized (0, 1) units. *axisbg* is the background color for the axis, default white.

- `axes(h)` where *h* is an axes instance makes *h* the current axis. An [Axes](#) instance is returned.

| kwarg                | Accepts      | Description                                      |
|----------------------|--------------|--|
| <code>axisbg</code>  | color        | the axes background color                        |
| <code>frameon</code> | [True False] | display the frame?                               |
| <code>sharex</code>  | otherax      | current axes shares xaxis attribute with otherax |
| <code>sharey</code>  | otherax      | current axes shares yaxis attribute with otherax |
| <code>polar</code>   | [True False] | use a polar axes?                                |

Examples:

- `examples/pylab_examples/axes_demo.py` places custom axes.
- `examples/pylab_examples/shared_axis_demo.py` uses *sharex* and *sharey*.

**axhline**(*y=0, xmin=0, xmax=1, hold=None, \*\*kwargs*)

call signature:

```
axhline(y=0, xmin=0, xmax=1, **kwargs)
```

#### Axis Horizontal Line

Draw a horizontal line at *y* from *xmin* to *xmax*. With the default values of *xmin* = 0 and *xmax* = 1, this line will always span the horizontal extent of the axes, regardless of the *xlim* settings, even if you change them, eg. with the `set_xlim()` command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the *y* location is in data coordinates.

Return value is the [Line2D](#) instance. *kwargs* are the same as *kwargs* to `plot`, and can be used to control the line properties. Eg.,

- draw a thick red hline at *y* = 0 that spans the xrange

```
>>> axhline(linewidth=4, color='r')
```

- draw a default hline at *y* = 1 that spans the xrange

```
>>> axhline(y=1)
```

- draw a default hline at *y* = .5 that spans the the middle half of the xrange

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

Valid *kwargs* are [Line2D](#) properties, with the exception of 'transform':

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque)         |
| <code>animated</code>                       | [True   False]                                     |
| <code>antialiased</code> or <code>aa</code> | [True   False]                                     |
| <code>axes</code>                           | an <a href="#">Axes</a> instance                   |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance |

Table 62.2 – continu

|  |  |
|--|--|
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ (Path, Transform)   Patch   None ]   |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance  |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |
| <code>xdata</code>                                     | 1D array   |
| <code>ydata</code>                                     | 1D array   |
| <code>zorder</code>                                    | any number   |

**See Also:**

`axhspan()` for example plot and source code

Additional kwargs: `hold = [True|False]` overrides default hold state

**axhspan**(*ymin, ymax, xmin=0, xmax=1, hold=None, \*\*kwargs*)

call signature:



```
axhspan(ymin, ymax, xmin=0, xmax=1, **kwargs)
```

Axis Horizontal Span.

$y$  coords are in data units and  $x$  coords are in axes (relative 0-1) units.

Draw a horizontal span (rectangle) from  $ymin$  to  $ymax$ . With the default values of  $xmin = 0$  and  $xmax = 1$ , this always spans the xrange, regardless of the xlim settings, even if you change them, eg. with the `set_xlim()` command. That is, the horizontal extent is in axes coords: 0=left, 0.5=middle, 1.0=right but the  $y$  location is in data coordinates.

Return value is a `matplotlib.patches.Polygon` instance.

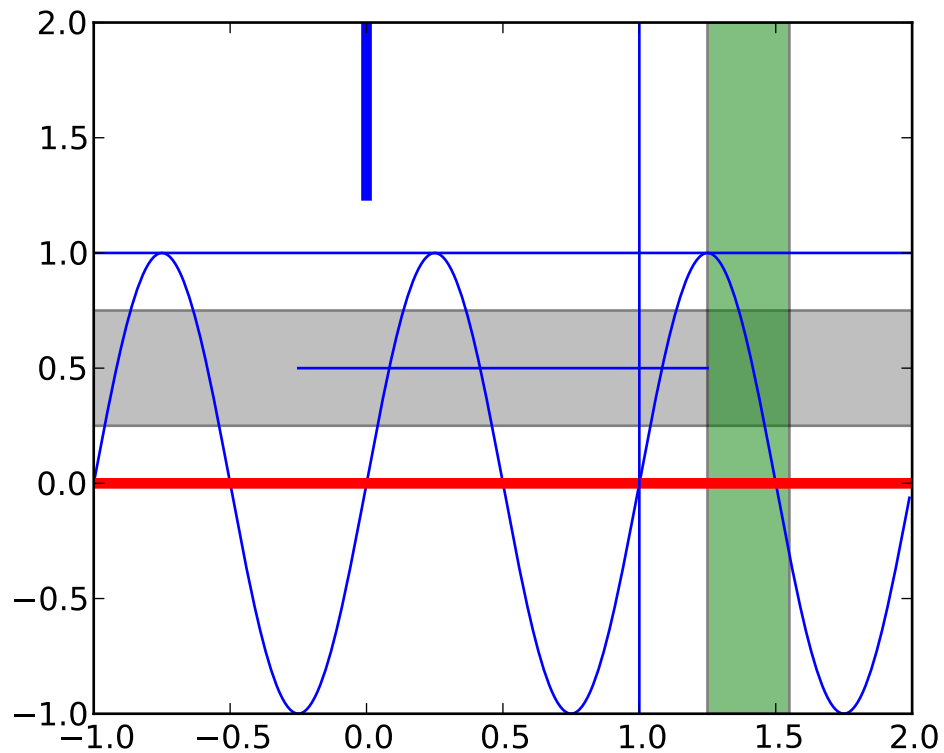
Examples:

- draw a gray rectangle from  $y = 0.25$ - $0.75$  that spans the horizontal extent of the axes

```
>>> axhspan(0.25, 0.75, facecolor='0.5', alpha=0.5)
```

Valid kwargs are `Polygon` properties:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:**

Additional kwargs: `hold = [True|False]` overrides default hold state

**axis**(\*v, \*\*kwargs)

Set/Get the axis properties:

```
>>> axis()
```

returns the current axes limits [xmin, xmax, ymin, ymax].

```
>>> axis(v)
```

sets the min and max of the x and y axes, with `v = [xmin, xmax, ymin, ymax]`.

```
>>> axis('off')
```

turns off the axis lines and labels.

```
>>> axis('equal')
```

changes limits of  $x$  or  $y$  axis so that equal increments of  $x$  and  $y$  have the same length; a circle is circular.

```
>>> axis('scaled')
```

achieves the same result by changing the dimensions of the plot box instead of the axis data limits.

```
>>> axis('tight')
```

changes  $x$  and  $y$  axis limits such that all data is shown. If all data is already shown, it will move it to the center of the figure without modifying  $(x_{max} - x_{min})$  or  $(y_{max} - y_{min})$ . Note this is slightly different than in MATLAB.

```
>>> axis('image')
```

is 'scaled' with the axis limits equal to the data limits.

```
>>> axis('auto')
```

and

```
>>> axis('normal')
```

are deprecated. They restore default behavior; axis limits are automatically scaled to make the data fit comfortably within the plot box.

if `len(*v)==0`, you can pass in  $x_{min}$ ,  $x_{max}$ ,  $y_{min}$ ,  $y_{max}$  as kwargs selectively to alter just those limits without changing the others.

The  $x_{min}$ ,  $x_{max}$ ,  $y_{min}$ ,  $y_{max}$  tuple is returned

**See Also:**

**`xlim()`, `ylim()`** For setting the  $x$ - and  $y$ -limits individually.

**`axvline`**( $x=0$ ,  $y_{min}=0$ ,  $y_{max}=1$ ,  $hold=None$ , **`**kwargs`**)  
call signature:

```
axvline(x=0, ymin=0, ymax=1, **kwargs)
```

Axis Vertical Line

Draw a vertical line at  $x$  from  $y_{min}$  to  $y_{max}$ . With the default values of  $y_{min} = 0$  and  $y_{max} = 1$ , this line will always span the vertical extent of the axes, regardless of the `ylim` settings, even if you change them, eg. with the `set_ylim()` command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the  $x$  location is in data coordinates.

Return value is the [Line2D](#) instance. kwargs are the same as kwargs to plot, and can be used to control the line properties. Eg.,

- draw a thick red vline at  $x = 0$  that spans the yrange

```
>>> axvline(linewidth=4, color='r')
```

- draw a default vline at  $x = 1$  that spans the yrange

```
>>> axvline(x=1)
```

- draw a default vline at  $x = .5$  that spans the the middle half of the yrange

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

Valid kwargs are [Line2D](#) properties, with the exception of ‘transform’:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |

Table 62.3 – continu

|                              |   |
|------------------------------|---|
| <code>solid_capstyle</code>  | <code>['butt'   'round'   'projecting']</code>          |
| <code>solid_joinstyle</code> | <code>['miter'   'round'   'bevel']</code>              |
| <code>transform</code>       | a <code>matplotlib.transforms.Transform</code> instance |
| <code>url</code>             | a url string  |
| <code>visible</code>         | <code>[True   False]</code>                             |
| <code>xdata</code>           | 1D array  |
| <code>ydata</code>           | 1D array  |
| <code>zorder</code>          | any number  |

**See Also:**

`axhspan()` for example plot and source code

Additional kwargs: `hold = [True|False]` overrides default hold state

**axvspan**(*xmin*, *xmax*, *ymin*=0, *ymax*=1, *hold*=None, *\*\*kwargs*)

call signature:

```
axvspan(xmin, xmax, ymin=0, ymax=1, **kwargs)
```

Axis Vertical Span.

*x* coords are in data units and *y* coords are in axes (relative 0-1) units.

Draw a vertical span (rectangle) from *xmin* to *xmax*. With the default values of *ymin* = 0 and *ymax* = 1, this always spans the yrange, regardless of the ylim settings, even if you change them, eg. with the `set_ylim()` command. That is, the vertical extent is in axes coords: 0=bottom, 0.5=middle, 1.0=top but the *y* location is in data coordinates.

Return value is the `matplotlib.patches.Polygon` instance.

Examples:

- draw a vertical green translucent rectangle from *x*=1.25 to 1.55 that spans the yrange of the axes

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

Valid kwargs are `Polygon` properties:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**See Also:**

`axhspan()` for example plot and source code

Additional kwargs: `hold = [True|False]` overrides default hold state

**bar**(*left, height, width=0.80000000000000004, bottom=None, hold=None, \*\*kwargs*)  
call signature:

```
bar(left, height, width=0.8, bottom=0, **kwargs)
```

Make a bar plot with rectangles bounded by:

*left, left + width, bottom, bottom + height* (left, right, bottom and top edges)

*left, height, width*, and *bottom* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

| Argument      | Description                                     |
|---------------|---|
| <i>left</i>   | the x coordinates of the left sides of the bars |
| <i>height</i> | the heights of the bars                         |

Optional keyword arguments:

| Key-word           | Description   |
|--------------------|---|
| <i>width</i>       | the widths of the bars  |
| <i>bottom</i>      | the y coordinates of the bottom edges of the bars   |
| <i>color</i>       | the colors of the bars  |
| <i>edge-color</i>  | the colors of the bar edges   |
| <i>linewidth</i>   | width of bar edges; None means use default linewidth; 0 means don't draw edges.   |
| <i>xerr</i>        | if not None, will be used to generate errorbars on the bar chart  |
| <i>yerr</i>        | if not None, will be used to generate errorbars on the bar chart  |
| <i>ecolor</i>      | specifies the color of any errorbar   |
| <i>capsize</i>     | (default 3) determines the length in points of the error bar caps   |
| <i>error_kw</i>    | dictionary of kwargs to be passed to errorbar method. <i>ecolor</i> and <i>capsize</i> may be specified here rather than as independent kwargs. |
| <i>align</i>       | 'edge' (default)   'center'   |
| <i>orientation</i> | 'vertical'   'horizontal'   |
| <i>log</i>         | [False True] False (default) leaves the orientation axis as-is; True sets it to log scale   |

For vertical bars, *align* = 'edge' aligns bars by their left edges in left, while *align* = 'center' interprets these values as the *x* coordinates of the bar centers. For horizontal bars, *align* = 'edge' aligns bars by their bottom edges in bottom, while *align* = 'center' interprets these values as the *y* coordinates of the bar centers.

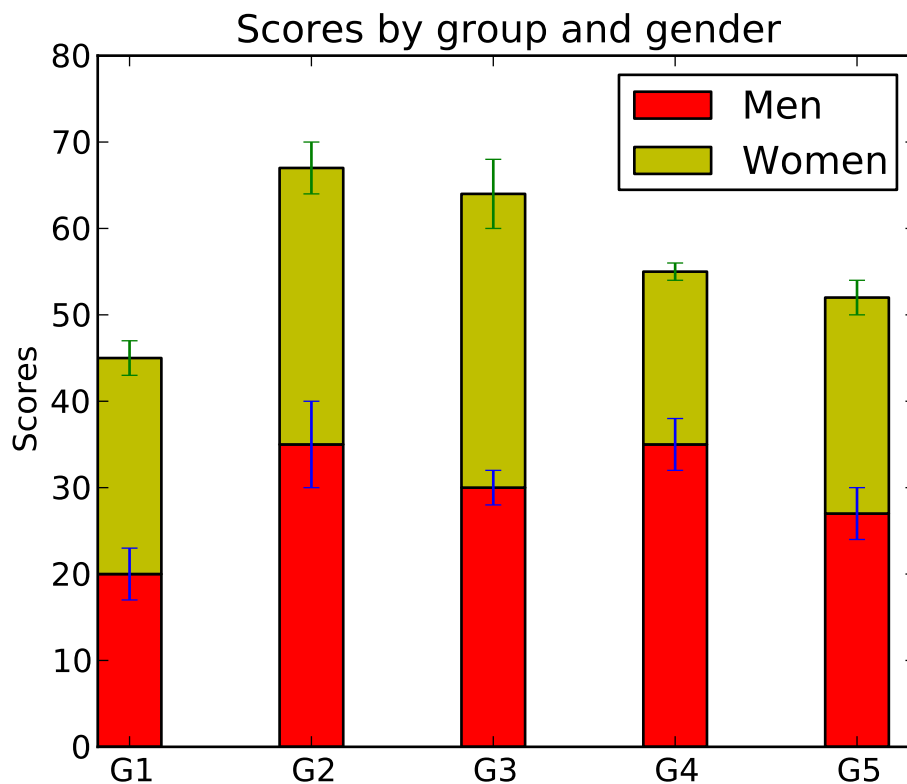
The optional arguments *color*, *edgecolor*, *linewidth*, *xerr*, and *yerr* can be either scalars or sequences of length equal to the number of bars. This enables you to use bar as the basis for stacked bar charts, or candlestick plots. Detail: *xerr* and *yerr* are passed directly to [errorbar\(\)](#), so they can also have shape 2xN for independent specification of lower and upper errors.

Other optional kwargs:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   ':'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:** A stacked bar chart.





Additional kwargs: `hold = [True|False]` overrides default hold state

**barbs**(\*args, \*\*kw)

Plot a 2-D field of barbs.

call signatures:

```
barb(U, V, **kw)
barb(U, V, C, **kw)
barb(X, Y, U, V, **kw)
barb(X, Y, U, V, C, **kw)
```

Arguments:

**X, Y:** The x and y coordinates of the barb locations (default is head of barb; see *pivot* kwarg)

**U, V:** give the x and y components of the barb shaft

**C:** an optional array used to map colors to the barbs

All arguments may be 1-D or 2-D arrays or sequences. If *X* and *Y* are absent, they will be generated as a uniform grid. If *U* and *V* are 2-D arrays but *X* and *Y* are 1-D, and if `len(X)` and `len(Y)` match the column and row dimensions of *U*, then *X* and *Y* will be expanded with `numpy.meshgrid()`.

*U*, *V*, *C* may be masked arrays, but masked *X*, *Y* are not supported at present.

Keyword arguments:

**length:** Length of the barb in points; the other parts of the barb are scaled against this. Default is 9

**pivot:** [ **'tip'** | **'middle'** ] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tip'

**barbcolor:** [ **color** | **color sequence** ] Specifies the color all parts of the barb except any flags. This parameter is analagous to the *edgecolor* parameter for polygons, which can be used instead. However this parameter will override *facecolor*.

**flagcolor:** [ **color** | **color sequence** ] Specifies the color of any flags on the barb. This parameter is analagous to the *facecolor* parameter for polygons, which can be used instead. However this parameter will override *facecolor*. If this is not set (and *C* has not either) then *flagcolor* will be set to match *barbcolor* so that the barb has a uniform color. If *C* has been set, *flagcolor* has no effect.

**sizes:** A dictionary of coefficients specifying the ratio of a given feature to the length of the barb. Only those values one wishes to override need to be included. These features include:

- 'spacing' - space between features (flags, full/half barbs)
- 'height' - height (distance from shaft to top) of a flag or full barb
- 'width' - width of a flag, twice the width of a full barb
- 'emptybarb' - radius of the circle used for low magnitudes

**fill\_empty:** A flag on whether the empty barbs (circles) that are drawn should be filled with the flag color. If they are not filled, they will be drawn such that no color is applied to the center. Default is False

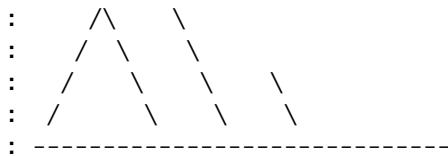
**rounding:** A flag to indicate whether the vector magnitude should be rounded when allocating barb components. If True, the magnitude is rounded to the nearest multiple of the half-barb increment. If False, the magnitude is simply truncated to the next lowest multiple. Default is True

**barb\_increments:** A dictionary of increments specifying values to associate with different parts of the barb. Only those values one wishes to override need to be included.

- 'half' - half barbs (Default is 5)
- 'full' - full barbs (Default is 10)
- 'flag' - flags (default is 50)

**flip\_barb:** Either a single boolean flag or an array of booleans. Single boolean indicates whether the lines and flags should point opposite to normal for all barbs. An array (which should be the same size as the other data arrays) indicates whether to flip for each individual barb. Normal behavior is for the barbs and lines to point right (comes from wind barbs having these features point towards low pressure in the Northern Hemisphere.) Default is False

Barbs are traditionally used in meteorology as a way to plot the speed and direction of wind observations, but can technically be used to plot any two dimensional vector quantity. As opposed to arrows, which give vector magnitude by the length of the arrow, the barbs give more quantitative information about the vector magnitude by putting slanted lines or a triangle for various increments in magnitude, as show schematically below:



The largest increment is given by a triangle (or “flag”). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset from the end of the barb so that it can be easily distinguished from barbs with a single full line. The magnitude for the barb shown above would nominally be 65, using the standard increments of 50, 10, and 5.

linewidths and edgecolors can be used to customize the barb. Additional `PolyCollection` keyword arguments:

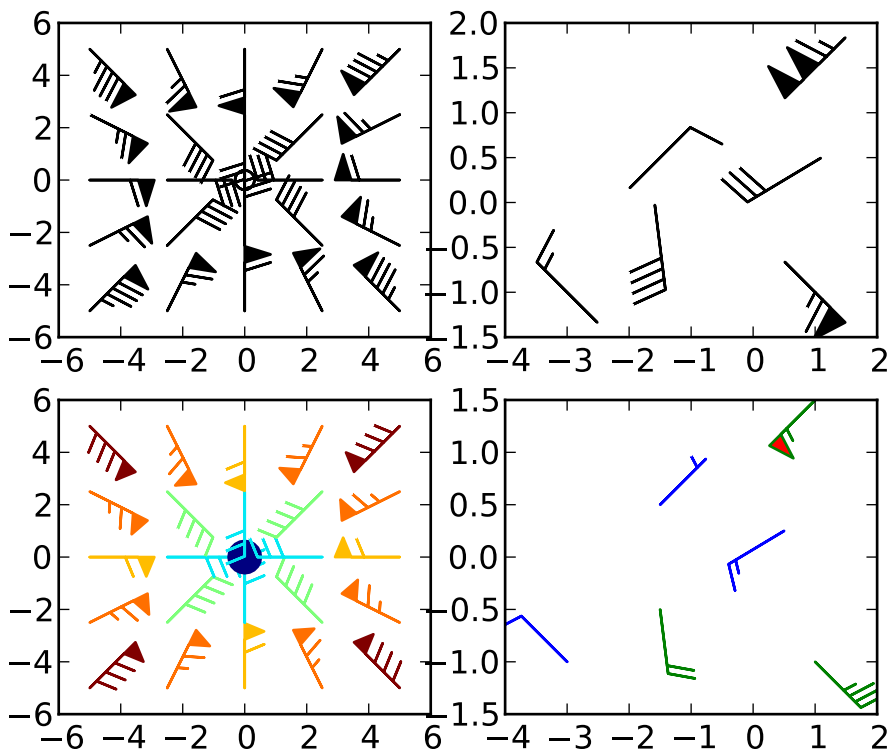
| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |

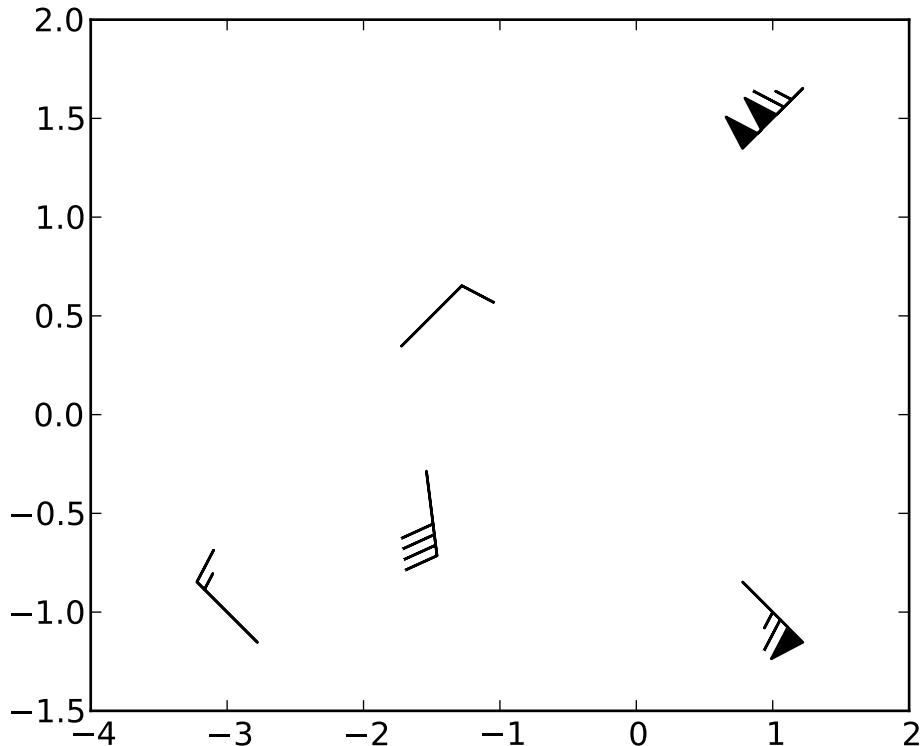
Continued on next page

Table 62.4 – continued from previous page

|                         |                                 |
|-------------------------|---------------------------------|
| <code>pickradius</code> | unknown                         |
| <code>rasterized</code> | [True   False   None]           |
| <code>snap</code>       | unknown                         |
| <code>transform</code>  | <code>Transform</code> instance |
| <code>url</code>        | a url string                    |
| <code>urls</code>       | unknown                         |
| <code>visible</code>    | [True   False]                  |
| <code>zorder</code>     | any number                      |

Example:





Additional kwargs: `hold = [True|False]` overrides default hold state

**barh**(*bottom*, *width*, *height*=0.80000000000000004, *left*=None, *hold*=None, **\*\*kwargs**)  
call signature:

`barh(bottom, width, height=0.8, left=0, **kwargs)`

Make a horizontal bar plot with rectangles bounded by:

*left*, *left + width*, *bottom*, *bottom + height* (left, right, bottom and top edges)

*bottom*, *width*, *height*, and *left* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

| Argument      | Description  |
|---------------|--|
| <i>bottom</i> | the vertical positions of the bottom edges of the bars |
| <i>width</i>  | the lengths of the bars                                |

Optional keyword arguments:

| Keyword          | Description  |
|------------------|--|
| <i>height</i>    | the heights (thicknesses) of the bars  |
| <i>left</i>      | the x coordinates of the left edges of the bars  |
| <i>color</i>     | the colors of the bars   |
| <i>edgecolor</i> | the colors of the bar edges  |
| <i>linewidth</i> | width of bar edges; None means use default linewidth; 0 means don't draw edges.          |
| <i>xerr</i>      | if not None, will be used to generate errorbars on the bar chart                         |
| <i>yerr</i>      | if not None, will be used to generate errorbars on the bar chart                         |
| <i>ecolor</i>    | specifies the color of any errorbar  |
| <i>capsize</i>   | (default 3) determines the length in points of the error bar caps                        |
| <i>align</i>     | 'edge' (default)   'center'  |
| <i>log</i>       | [False True] False (default) leaves the horizontal axis as-is; True sets it to log scale |

Setting *align* = 'edge' aligns bars by their bottom edges in bottom, while *align* = 'center' interprets these values as the y coordinates of the bar centers.

The optional arguments *color*, *edgecolor*, *linewidth*, *xerr*, and *yerr* can be either scalars or sequences of length equal to the number of bars. This enables you to use `barh` as the basis for stacked bar charts, or candlestick plots.

other optional kwargs:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

Additional kwargs: `hold` = [True|False] overrides default hold state

### **bone()**

set the default colormap to bone and apply to current image if any. See `help(colormaps)` for more information

### **box(*on=None*)**

Turn the axes box on or off according to *on*. *on* may be a boolean or a string, 'on' or 'off'.

If *on* is *None*, toggle state.

**boxplot**(*x*, *notch*=0, *sym*='b+', *vert*=1, *whis*=1.5, *positions*=None, *widths*=None, *patch\_artist*=False, *bootstrap*=None, *hold*=None)  
call signature:

```
boxplot(x, notch=0, sym='+', vert=1, whis=1.5,
        positions=None, widths=None, patch_artist=False)
```

Make a box and whisker plot for each column of *x* or each vector in sequence *x*. The box extends from the lower to upper quartile values of the data, with a line at the median. The whiskers extend from the box to show the range of the data. Flier points are those past the end of the whiskers.

*x* is an array or a sequence of vectors.

- *notch* = 0 (default) produces a rectangular box plot.

- *notch* = 1 will produce a notched box plot

*sym* (default 'b+') is the default symbol for flier points. Enter an empty string ('') if you don't want to show fliers.

- *vert* = 1 (default) makes the boxes vertical.

- *vert* = 0 makes horizontal boxes. This seems goofy, but that's how MATLAB did it.

*whis* (default 1.5) defines the length of the whiskers as a function of the inner quartile range. They extend to the most extreme data point within ( *whis*\*(75%-25%) ) data range.

*bootstrap* (default None) specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If *bootstrap*=None, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall and Stuart, 1967). Otherwise, *bootstrap* specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

*positions* (default 1,2,...,n) sets the horizontal positions of the boxes. The ticks and limits are automatically set to match the positions.

*widths* is either a scalar or a vector and sets the width of each box. The default is 0.5, or  $0.15 * (\text{distance between extreme positions})$  if that is smaller.

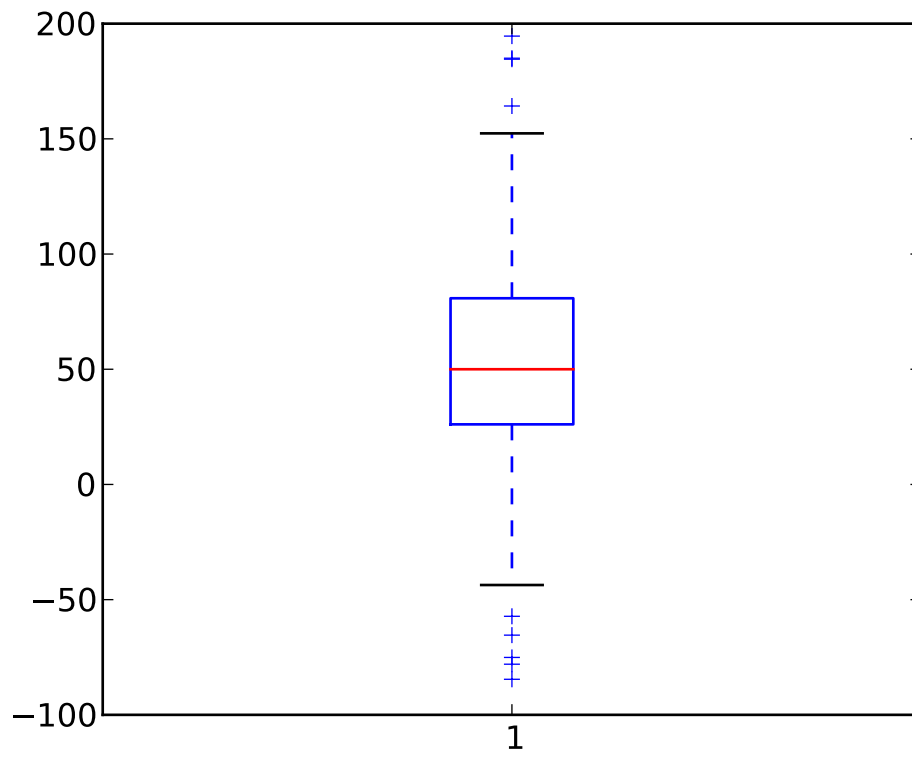
- *patch\_artist* = False (default) produces boxes with the Line2D artist

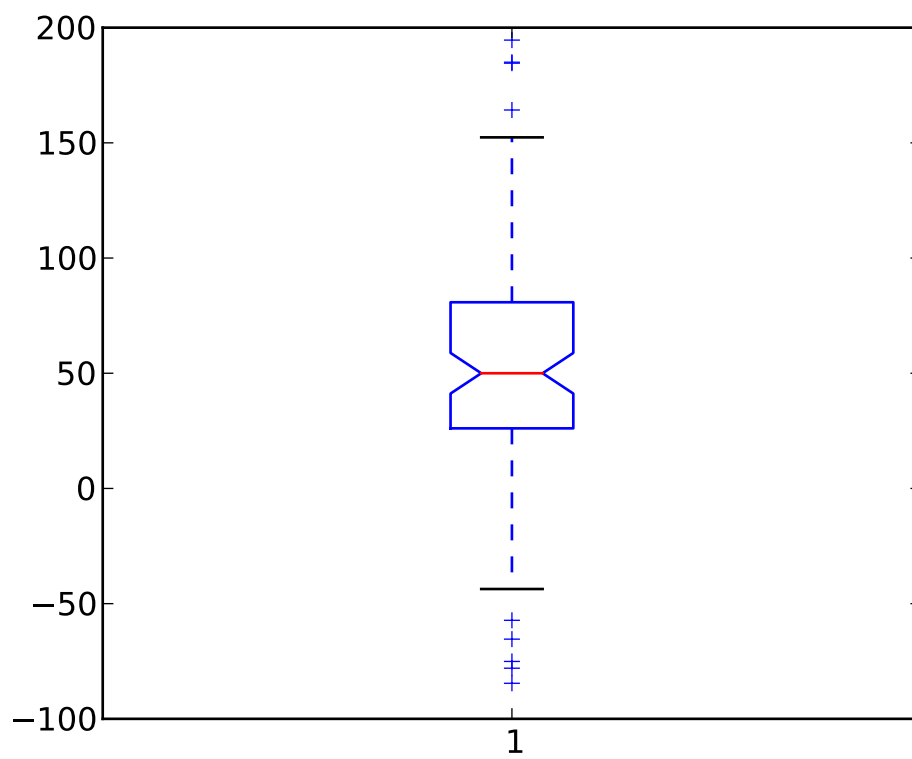
- *patch\_artist* = True produces boxes with the Patch artist

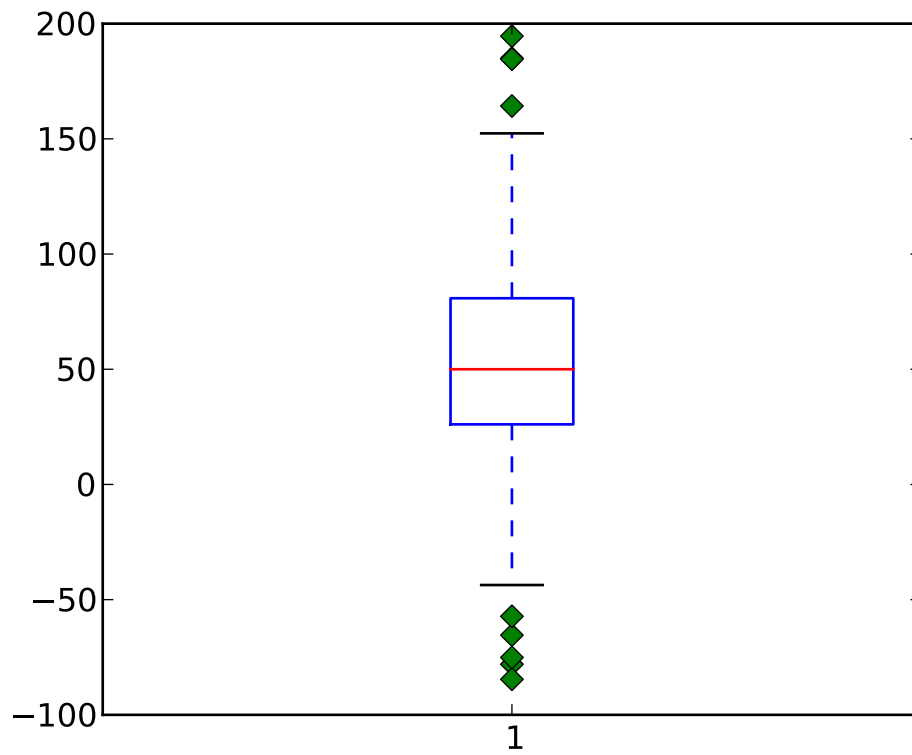
Returns a dictionary mapping each component of the boxplot to a list of the `matplotlib.lines.Line2D` instances created.

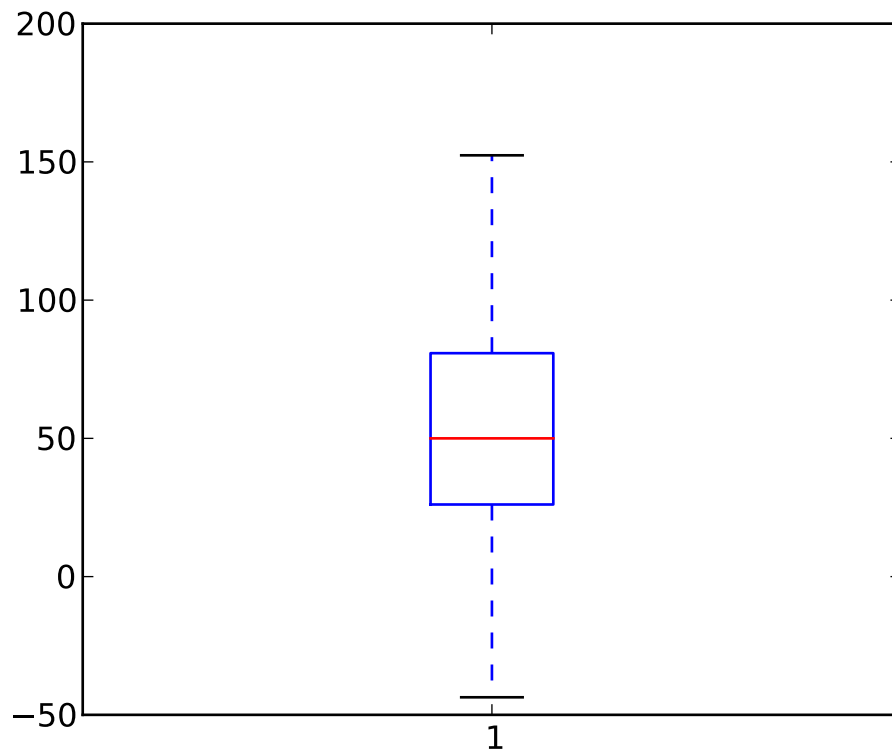
**Example:**

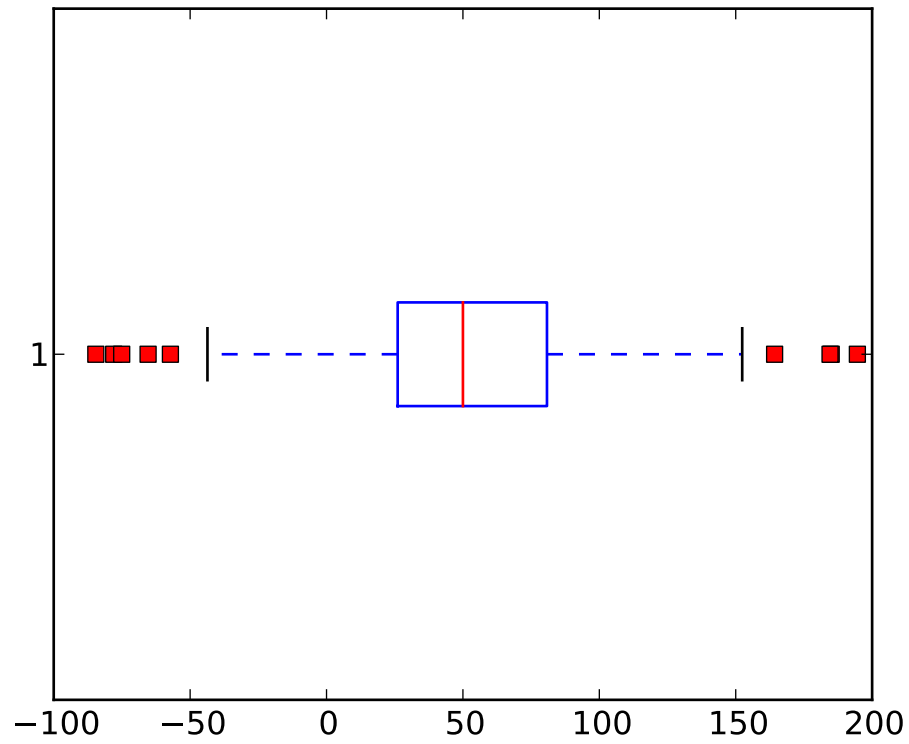


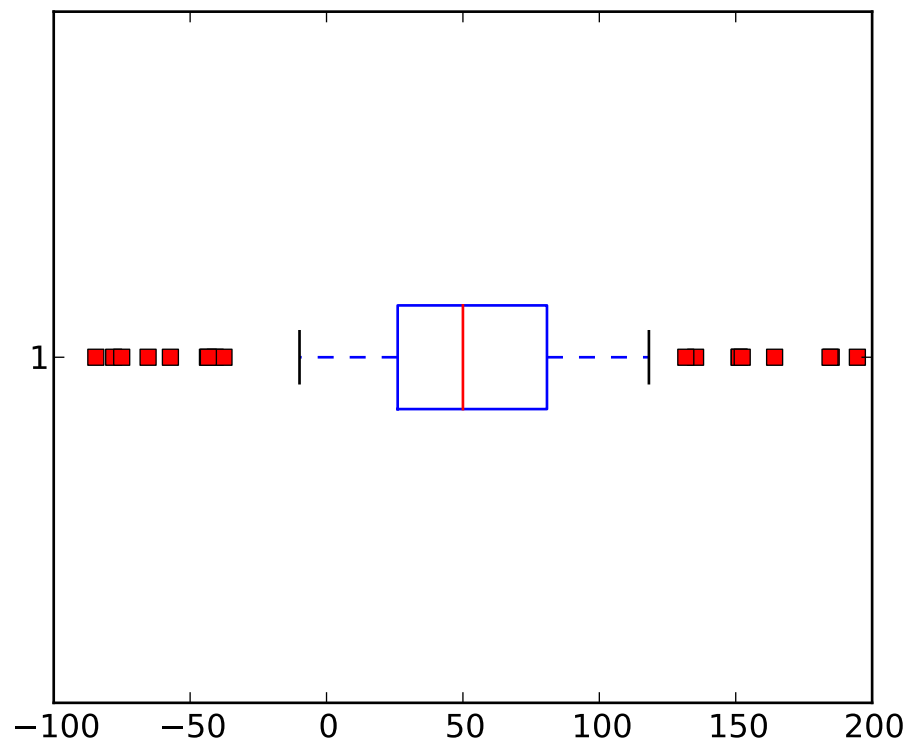


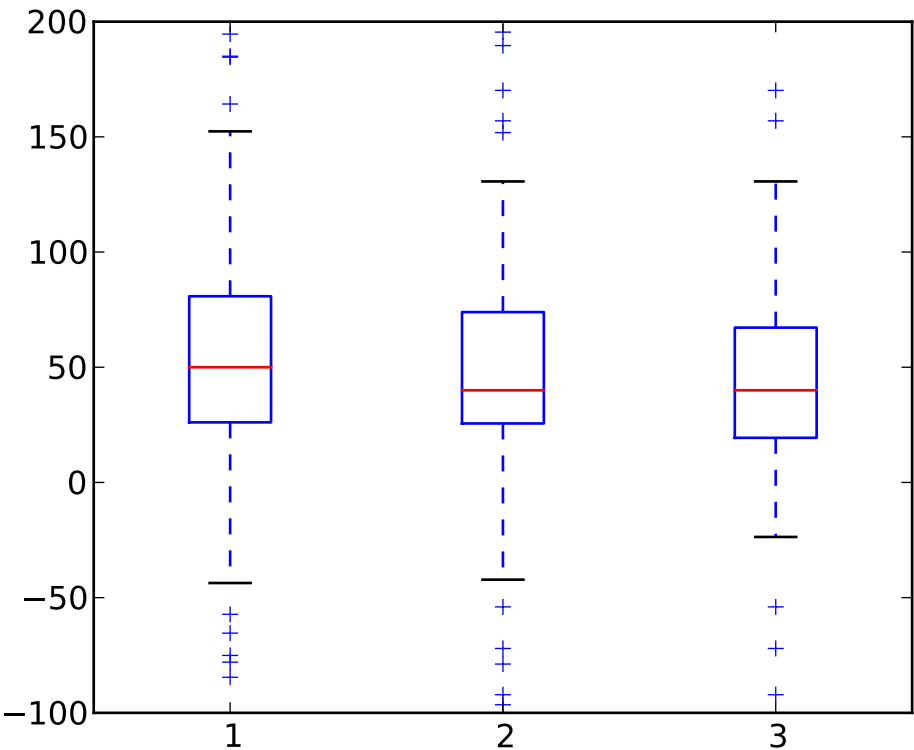












Additional kwargs: `hold = [True|False]` overrides default hold state

**broken\_barh**(*xranges*, *yrange*, *hold=None*, *\*\*kwargs*)  
call signature:

`broken_barh(self, xrange, yrange, **kwargs)`

A collection of horizontal bars spanning *yrange* with a sequence of *xranges*.

Required arguments:

| Argument       | Description                                 |
|----------------|---|
| <i>xranges</i> | sequence of ( <i>xmin</i> , <i>xwidth</i> ) |
| <i>yrange</i>  | sequence of ( <i>ymin</i> , <i>ywidth</i> ) |

kwargs are `matplotlib.collections.BrokenBarHCollection` properties:

| Property  | Description                     |
|---|---------------------------------|
| <code>agg_filter</code>                               | unknown                         |
| <code>alpha</code>                                    | float or None                   |
| <code>animated</code>                                 | [True   False]                  |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans |
| <code>array</code>                                    | unknown                         |
| <code>axes</code>                                     | an <code>Axes</code> instance   |

Continued on next page

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|  |  |
|--|--|
| <code>clim</code>  | a length 2 sequence of floats  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                     |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                   |
| <code>cmap</code>  | a colormap or registered colormap name                                 |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                        |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                       |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | ['solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>snap</code>  | unknown  |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>urls</code>  | unknown  |
| <code>visible</code>   | [True   False]   |
| <code>zorder</code>  | any number   |

these can either be a single argument, ie:

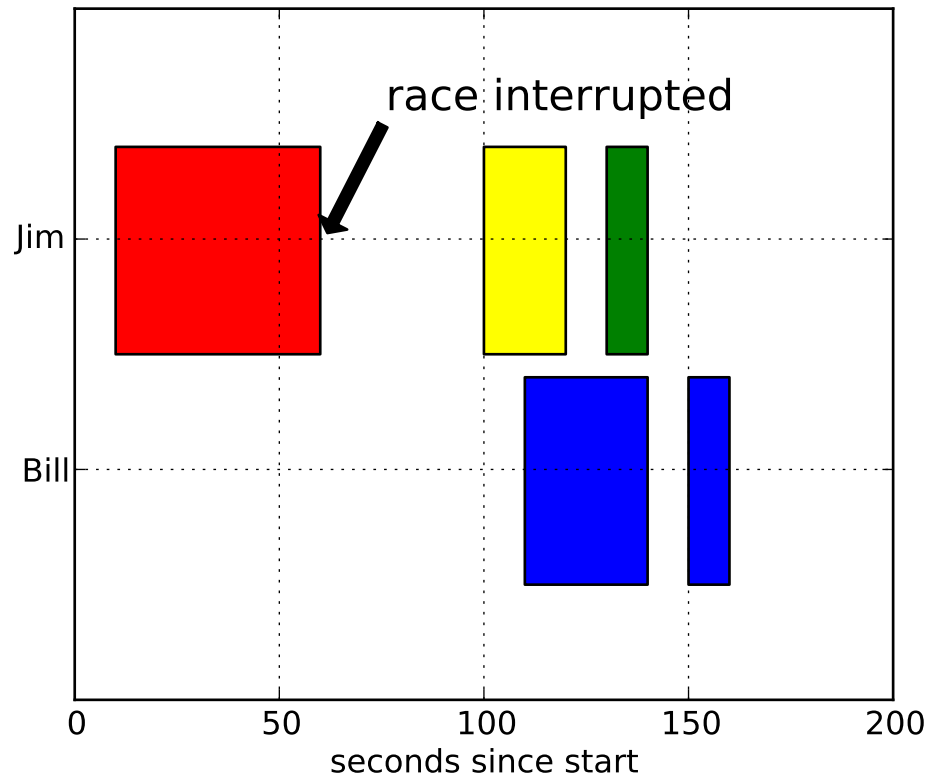
```
facecolors = 'black'
```

or a sequence of arguments for the various bars, ie:

```
facecolors = ('black', 'red', 'green')
```

**Example:**





Additional kwargs: `hold = [True|False]` overrides default hold state

**cla()**

Clear the current axes

**clabel(*CS*, *\*args*, *\*\*kwargs*)**

call signature:

`clabel(cs, **kwargs)`

adds labels to line contours in *cs*, where *cs* is a `ContourSet` object returned by `contour`.

`clabel(cs, v, **kwargs)`

only labels contours listed in *v*.

Optional keyword arguments:

**fontsize:** See <http://matplotlib.sf.net/fonts.html>

**colors:**

- if *None*, the color of each label matches the color of the corresponding contour
- if one string color, e.g. `colors = 'r'` or `colors = 'red'`, all labels will be plotted in this color

- if a tuple of matplotlib color args (string, float, rgb, etc), different labels will be plotted in different colors in the order specified

***inline***: controls whether the underlying contour is removed or not. Default is *True*.

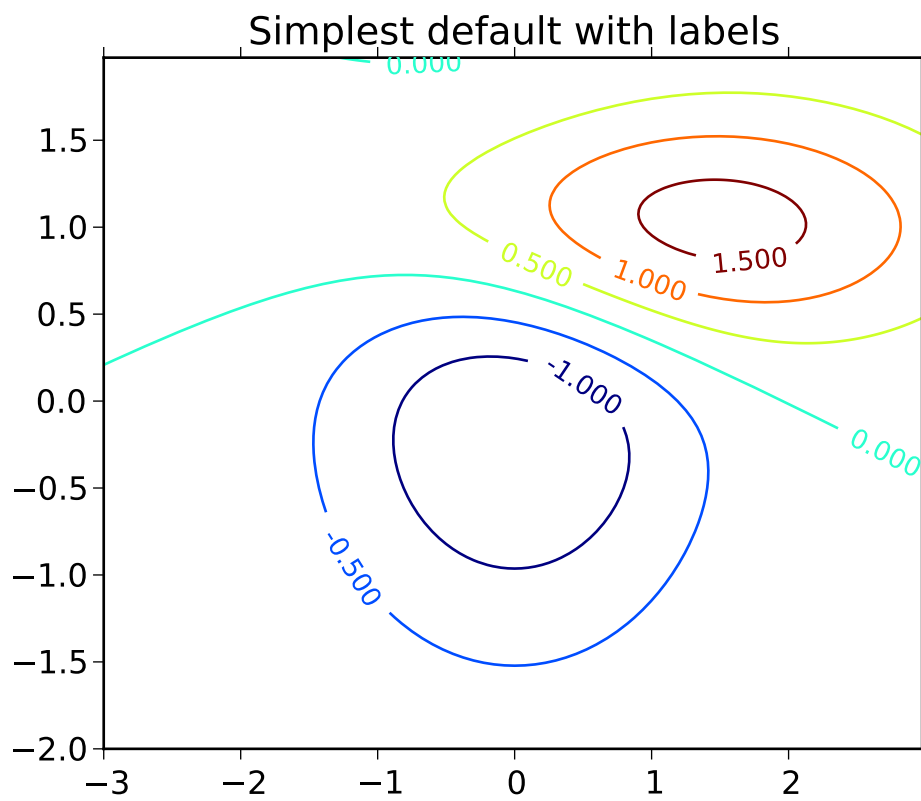
***inline\_spacing***: space in pixels to leave on each side of label when placing inline. Defaults to 5. This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

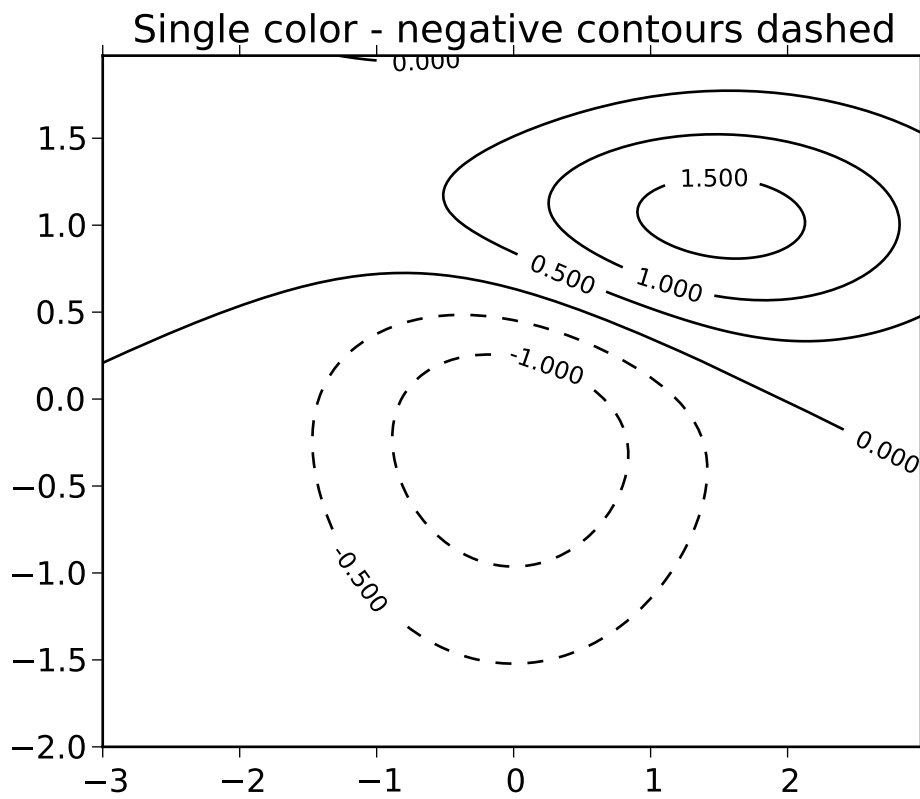
***fmt***: a format string for the label. Default is ‘%1.3f’ Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., `fmt[level]=string`), or it can be any callable, such as a [Formatter](#) instance, that returns a string when called with a numeric contour level.

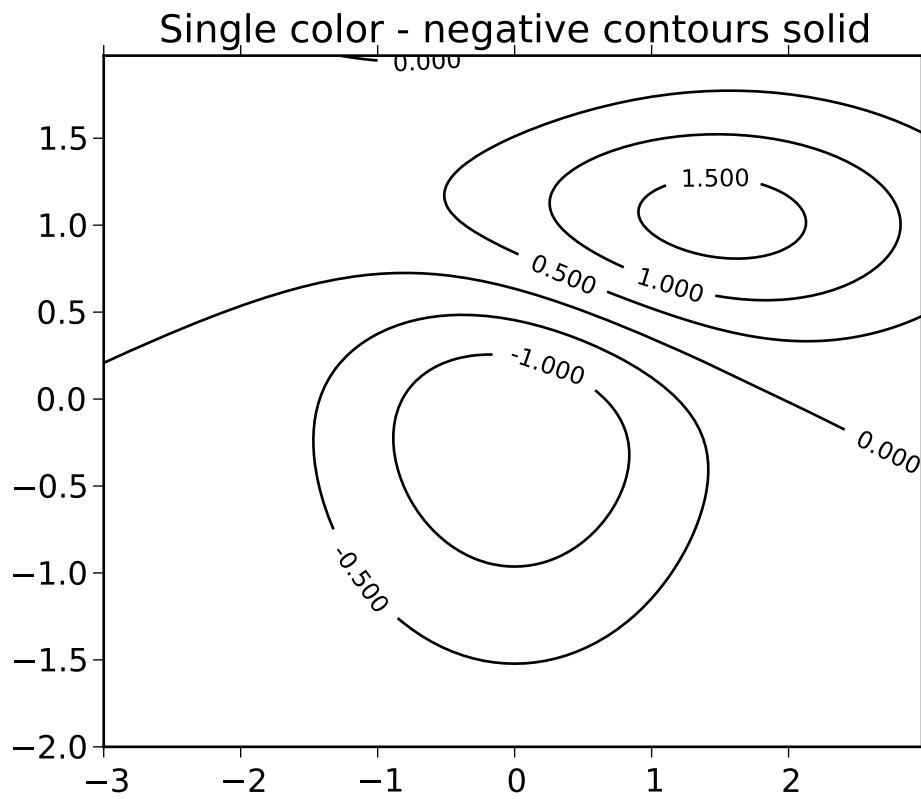
***manual***: if *True*, contour labels will be placed manually using mouse clicks. Click the first button near a contour to add a label, click the second button (or potentially both mouse buttons at once) to finish adding labels. The third button can be used to remove the last label added, but only if labels are not inline. Alternatively, the keyboard can be used to select label locations (enter to end label placement, delete or backspace act like the third mouse button, and any other key will select a label location).

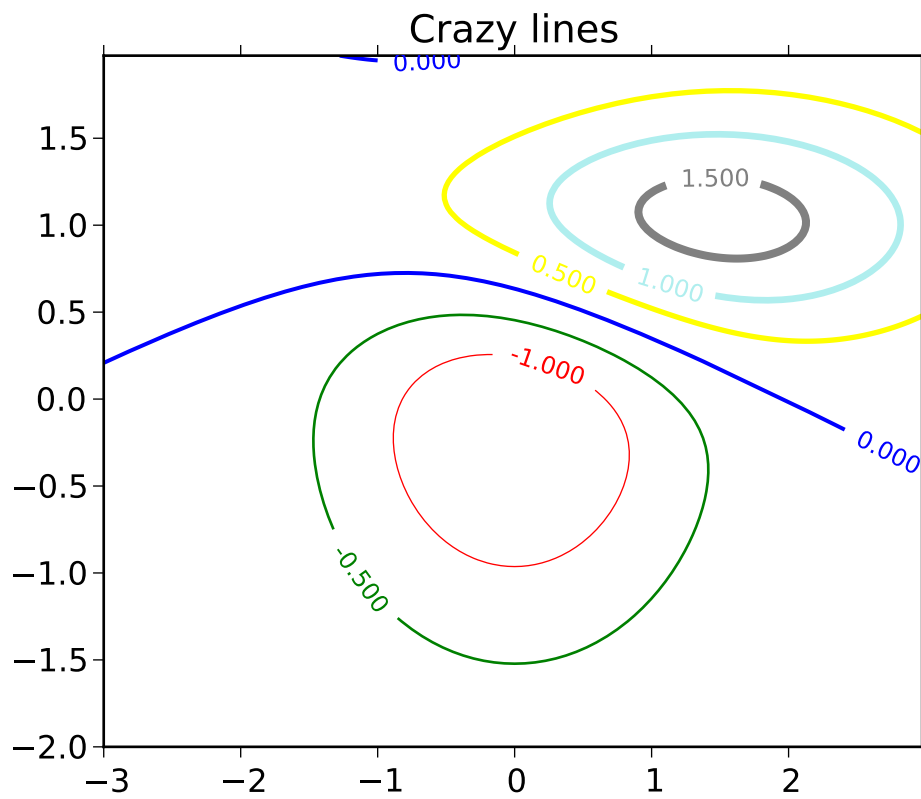
***rightside\_up***: if *True* (default), label rotations will always be plus or minus 90 degrees from level.

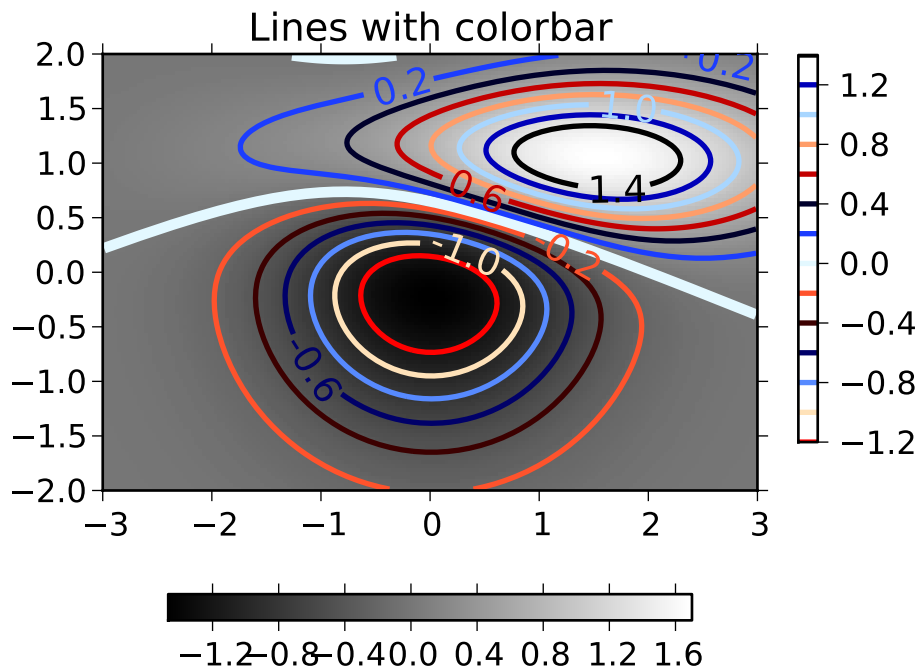
***use\_clabeltext***: if *True* (default is *False*), `ClabelText` class (instead of `matplotlib.Text`) is used to create labels. `ClabelText` recalculates rotation angles of texts during the drawing time, therefore this can be used if aspect of the axes changes.











Additional kwargs: `hold = [True|False]` overrides default hold state

**clf()**

Clear the current figure

**clim**(*vmin=None, vmax=None*)

Set the color limits of the current image

To apply clim to all axes images do:

```
clim(0, 0.5)
```

If either *vmin* or *vmax* is None, the image min/max respectively will be used for color scaling.

If you want to set the clim of multiple images, use, for example:

```
for im in gca().get_images():
    im.set_clim(0, 0.05)
```

**close**(\*args)

Close a figure window

`close()` by itself closes the current figure

`close(h)` where *h* is a Figure instance, closes that figure

`close(num)` closes figure number *num*

`close(name)` where *name* is a string, closes figure with that label

`close('all')` closes all the figure windows

**cohere**(*x*, *y*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, *hold*=None, *\*\*kwargs*)  
call signature:

```
cohere(x, y, NFFT=256, Fs=2, Fc=0, detrend = mlab.detrend_none,
       window = mlab.window_hanning, noverlap=0, pad_to=None,
       sides='default', scale_by_freq=None, **kwargs)
```

**cohere()** the coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \quad (62.1)$$

Keyword arguments:

**NFFT: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

**Fs: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

**detrend: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

**window: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

**noverlap: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

**pad\_to: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is None, which sets *pad\_to* equal to *NFFT*

**sides: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.



***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

***Fc*: integer** The center frequency of  $x$  (defaults to 0), which offsets the  $x$  extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

The return value is a tuple  $(Cxy, f)$ , where  $f$  are the frequencies of the coherence vector.

kwargs are applied to the lines.

References:

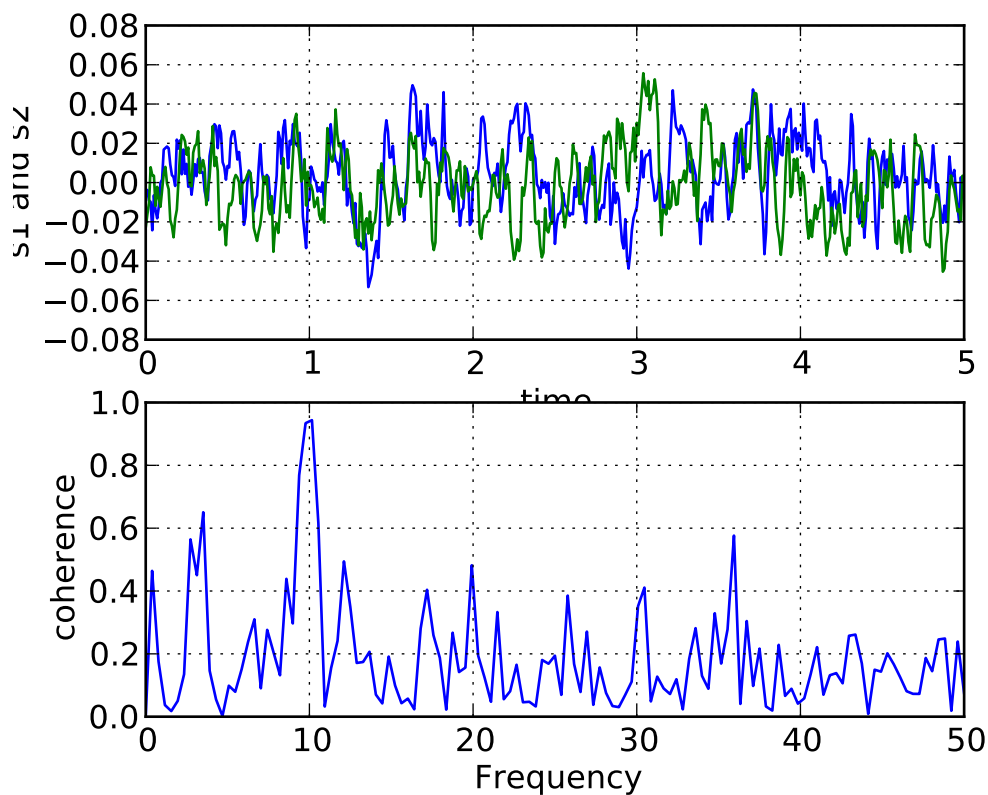
- Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

kwargs control the [Line2D](#) properties of the coherence plot:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |

Table 62.6 – continu

|                              |   |
|------------------------------|---|
| <code>picker</code>          | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>      | float distance in points  |
| <code>rasterized</code>      | [True   False   None]   |
| <code>snap</code>            | unknown   |
| <code>solid_capstyle</code>  | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code> | ['miter'   'round'   'bevel']   |
| <code>transform</code>       | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>             | a url string  |
| <code>visible</code>         | [True   False]  |
| <code>xdata</code>           | 1D array  |
| <code>ydata</code>           | 1D array  |
| <code>zorder</code>          | any number  |

**Example:**

Additional kwargs: `hold = [True|False]` overrides default hold state

**colorbar**(*mappable=None*, *cax=None*, *ax=None*, *\*\*kw*)

Add a colorbar to a plot.

Function signatures for the `pyplot` interface; all but the first are also method signatures for the

`colorbar()` method:

```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

arguments:

***mappable*** the Image, ContourSet, etc. to which the colorbar applies; this argument is mandatory for the `colorbar()` method but optional for the `colorbar()` function, which sets the default to the current image.

keyword arguments:

***cax*** None | axes object into which the colorbar will be drawn

***ax*** None | parent axes object from which space for a new colorbar axes will be stolen

***use\_gridspec*** False | If *cax* is None, a new *cax* is created as an instance of Axes. If *ax* is an instance of Subplot and *use\_gridspec* is True, *cax* is created as an instance of Subplot using the *grid\_spec* module.

Additional keyword arguments are of two kinds:

axes properties:

| Property           | Description   |
|--------------------|---|
| <i>orientation</i> | vertical or horizontal  |
| <i>fraction</i>    | 0.15; fraction of original axes to use for colorbar   |
| <i>pad</i>         | 0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes |
| <i>shrink</i>      | 1.0; fraction by which to shrink the colorbar   |
| <i>aspect</i>      | 20; ratio of long to short dimensions   |
| <i>anchor</i>      | (0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes             |
| <i>panchor</i>     | (1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes      |

colorbar properties:

| Property         | Description   |
|------------------|---|
| <i>extend</i>    | [ 'neither'   'both'   'min'   'max' ] If not 'neither', make pointed end(s) for out-of-range values. These are set for a given colormap using the colormap <i>set_under</i> and <i>set_over</i> methods.                               |
| <i>spacing</i>   | [ 'uniform'   'proportional' ] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.  |
| <i>ticks</i>     | [ None   list of ticks   Locator object ] If None, ticks are determined automatically from the input.   |
| <i>format</i>    | [ None   format string   Formatter object ] If None, the <code>ScalarFormatter</code> is used. If a format string is given, e.g. <code>'%.3f'</code> , that is used. An alternative <code>Formatter</code> object may be given instead. |
| <i>drawedges</i> | [ False   True ] If true, draw lines at color boundaries.   |

The following will probably be useful only in the context of indexed colors (that is, when the mappable has `norm=NoNorm()`), or other unusual circumstances.

| Prop-erty                 | Description  |
|---------------------------|--|
| <i>bound-aries values</i> | None or a sequence<br><br>None or a sequence which must be of length 1 less than the sequence of <i>boundaries</i> . For each region delimited by adjacent entries in <i>boundaries</i> , the color mapped to the corresponding value in <i>values</i> will be used. |

If *mappable* is a `ContourSet`, its *extend* kwarg is included automatically.

Note that the *shrink* kwarg provides a simple way to keep a vertical colorbar, for example, from being taller than the axes of the mappable to which the colorbar is attached; but it is a manual method requiring some trial and error. If the colorbar is too tall (or a horizontal colorbar is too wide) use a smaller value of *shrink*.

For more precise control, you can manually specify the positions of the axes objects in which the mappable and the colorbar are drawn. In this case, do not use any of the axes properties kwargs.

**returns:** `Colorbar` instance; see also its base class, `ColorbarBase`. Call the `set_label()` method to label the colorbar.

### **colormaps()**

matplotlib provides the following colormaps.

- autumn
- bone
- cool
- copper
- flag
- gray
- hot
- hsv
- jet
- pink
- prism
- spring
- summer
- winter
- spectral

You can set the colormap for an image, pcolor, scatter, etc, either as a keyword argument:

```
imshow(X, cmap=cm.hot)
```

or post-hoc using the corresponding pylab interface function:

```
imshow(X)
hot()
jet()
```

In interactive mode, this will update the colormap allowing you to see which one works best for your data.

### colors()

This is a do-nothing function to provide you with help on how matplotlib handles colors.

Commands which take color arguments can use several formats to specify the colors. For the basic builtin colors, you can use a single letter

| Alias | Color   |
|-------|---------|
| 'b'   | blue    |
| 'g'   | green   |
| 'r'   | red     |
| 'c'   | cyan    |
| 'm'   | magenta |
| 'y'   | yellow  |
| 'k'   | black   |
| 'w'   | white   |

For a greater range of colors, you have two options. You can specify the color using an html hex string, as in:

```
color = '#eeeeff'
```

or you can pass an R,G,B tuple, where each of R,G,B are in the range [0,1].

You can also use any legal html name for a color, for example:

```
color = 'red',
color = 'burlywood'
color = 'chartreuse'
```

The example below creates a subplot with a dark slate gray background

```
subplot(111, axisbg=(0.1843, 0.3098, 0.3098))
```

Here is an example that creates a pale turquoise title:

```
title('Is this the best color?', color='#afeeee')
```

### connect(*s*, *func*)

Connect event with string *s* to *func*. The signature of *func* is:

```
def func(event)
```

where event is a `matplotlib.backend_bases.Event`. The following events are recognized

- 'button\_press\_event'
- 'button\_release\_event'
- 'draw\_event'
- 'key\_press\_event'
- 'key\_release\_event'
- 'motion\_notify\_event'
- 'pick\_event'
- 'resize\_event'
- 'scroll\_event'
- 'figure\_enter\_event',
- 'figure\_leave\_event',
- 'axes\_enter\_event',
- 'axes\_leave\_event'
- 'close\_event'

For the location events (button and key press/release), if the mouse is over the axes, the variable `event.inaxes` will be set to the `Axes` the event occurs is over, and additionally, the variables `event.xdata` and `event.ydata` will be defined. This is the mouse location in data coords. See `KeyEvent` and `MouseEvent` for more info.

Return value is a connection id that can be used with `mpl_disconnect()`.

Example usage:

```
def on_press(event):  
    print 'you pressed', event.button, event.xdata, event.ydata  
  
cid = canvas.mpl_connect('button_press_event', on_press)
```

**contour(\*args, \*\*kwargs)**

`contour()` and `contourf()` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

`contourf()` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour()`.

call signatures:

```
contour(Z)
```

make a contour plot of an array *Z*. The level values are chosen automatically.

```
contour(X,Y,Z)
```

*X*, *Y* specify the (*x*, *y*) coordinates of the surface

```
contour(Z,N)
contour(X,Y,Z,N)
```

contour *N* automatically-chosen levels.

```
contour(Z,V)
contour(X,Y,Z,V)
```

draw contour lines at the values specified in sequence *V*

```
contourf(..., V)
```

fill the (len(*V*)-1) regions between the values in *V*

```
contour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

*X* and *Y* must both be 2-D with the same shape as *Z*, or they must both be 1-D such that len(*X*) is the number of columns in *Z* and len(*Y*) is the number of rows in *Z*.

*C* = contour(...) returns a QuadContourSet object.

Optional keyword arguments:

**colors:** [ *None* | *string* | (*mpl\_colors*) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** *float* The alpha blending value

**cmap:** [ *None* | *Colormap* ] A cm *Colormap* instance or *None*. If *cmap* is *None* and *colors* is *None*, a default *Colormap* is used.

**norm:** [ *None* | *Normalize* ] A [matplotlib.colors.Normalize](#) instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [*level0*, *level1*, ..., *leveln*] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass *levels*=[0]

**origin:** [ `None` | `'upper'` | `'lower'` | `'image'` ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If `'image'`, the rc value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**extent:** [ `None` | (*x0*,*x1*,*y0*,*y1*) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ `None` | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ `'neither'` | `'both'` | `'min'` | `'max'` ] Unless this is `'neither'`, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ `None` | registered units ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased:** [ `True` | `False` ] enable antialiasing, overriding the defaults. For filled contours, the default is `True`. For line contours, it is taken from `rcParams['lines.antialiased']`.

contour-only keyword arguments:

**linewidths:** [ `None` | number | tuple of numbers ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ `None` | `'solid'` | `'dashed'` | `'dashdot'` | `'dotted'` ] If *linestyles* is *None*, the `'solid'` is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

contourf-only keyword arguments:



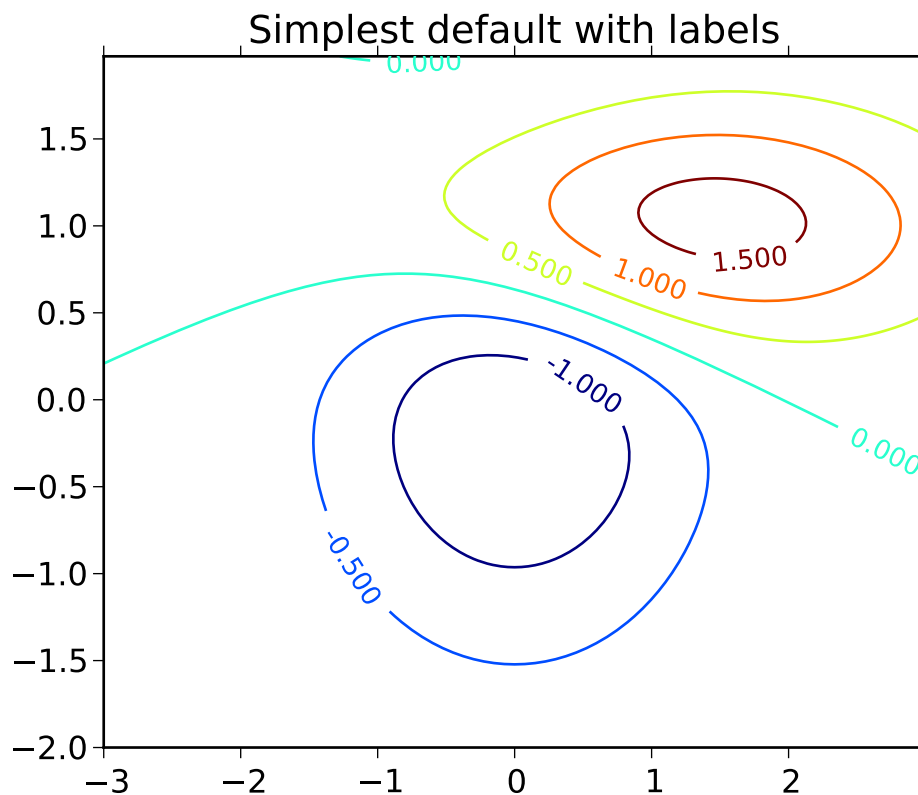
***nchunk***: [ 0 | integer ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

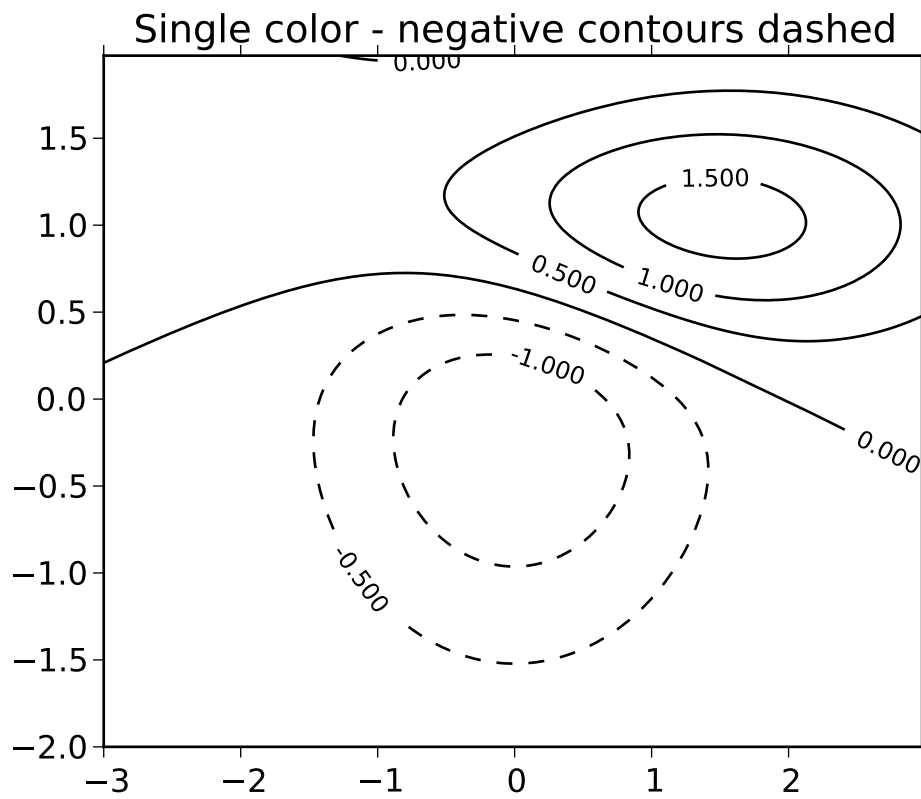
Note: `contourf` fills intervals that are closed at the top; that is, for boundaries  $z1$  and  $z2$ , the filled region is:

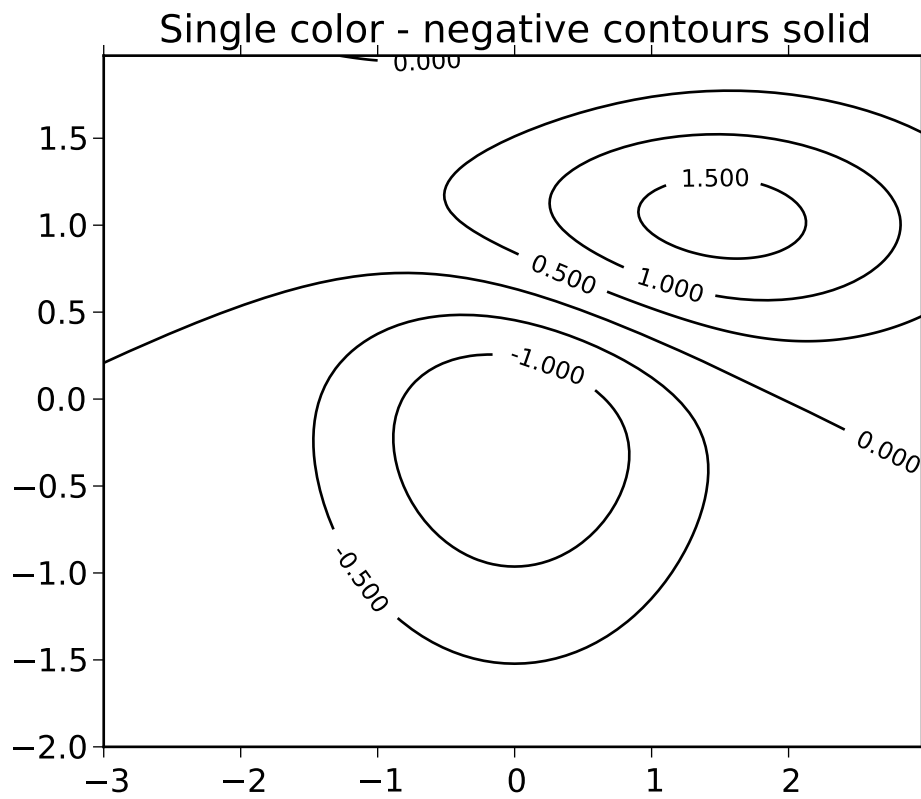
$$z1 < z \leq z2$$

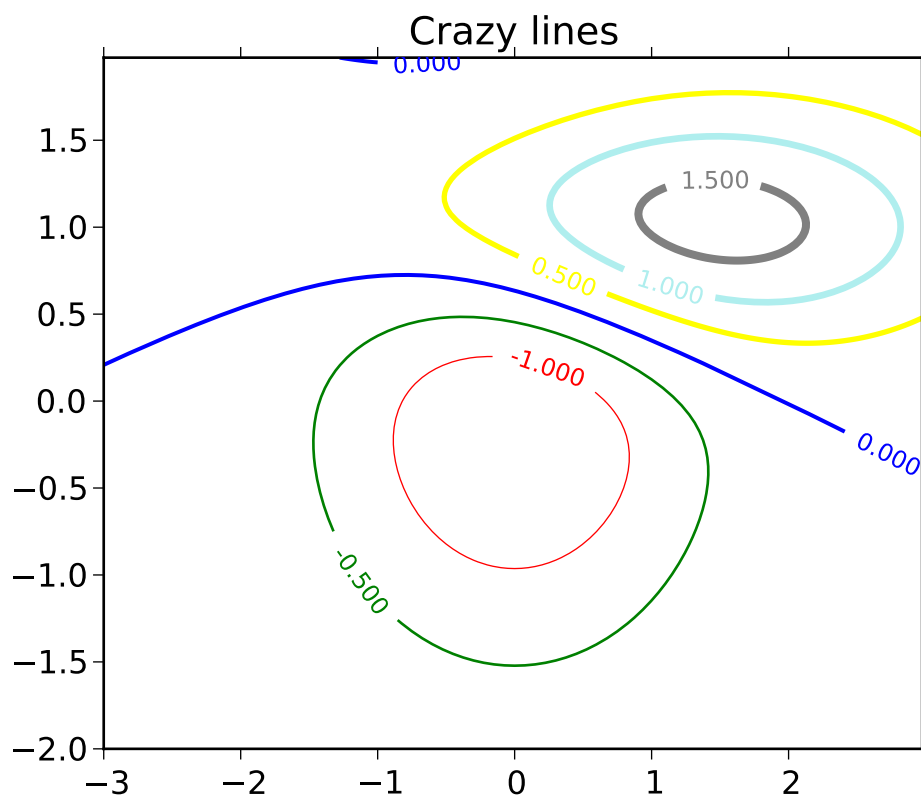
There is one exception: if the lowest boundary coincides with the minimum value of the  $z$  array, then that minimum value will be included in the lowest interval.

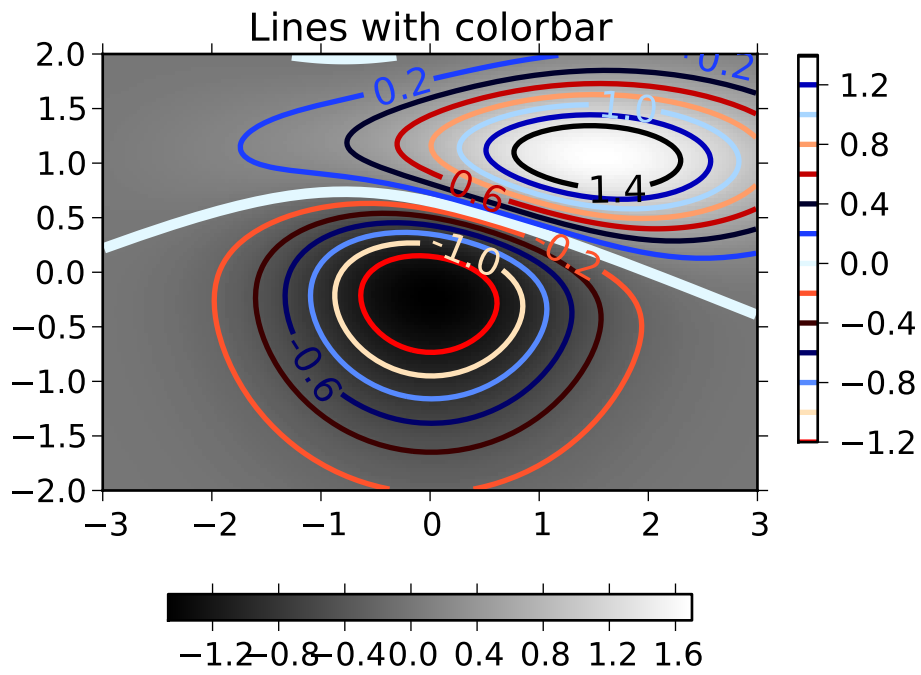
**Examples:**

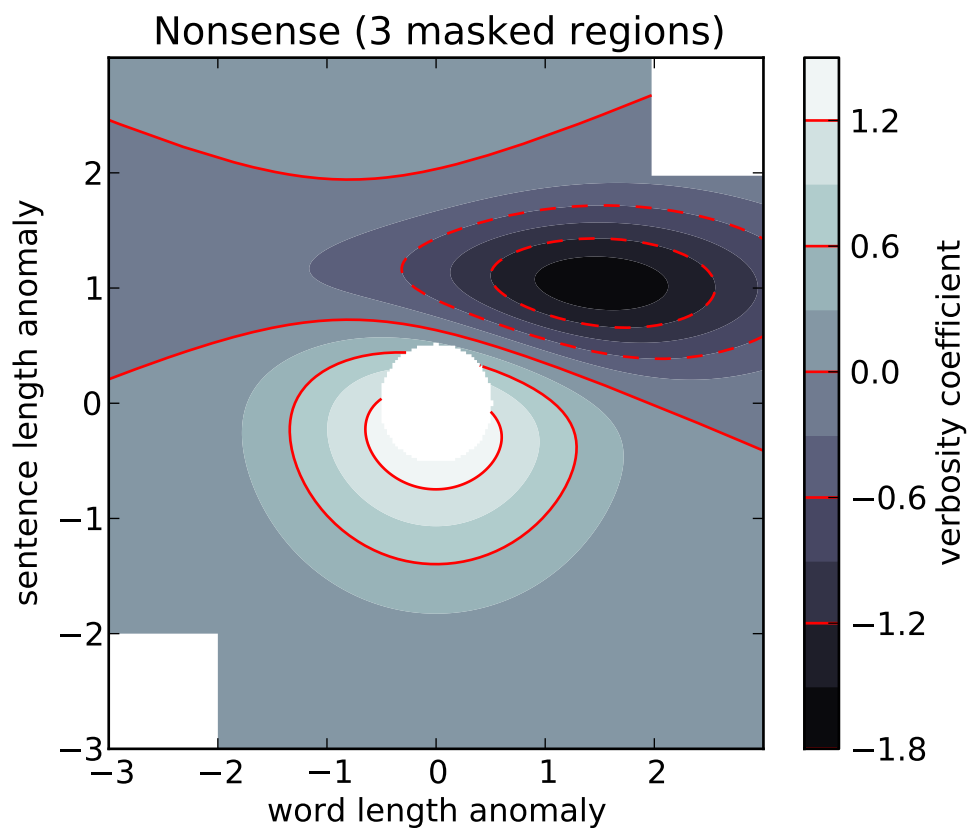


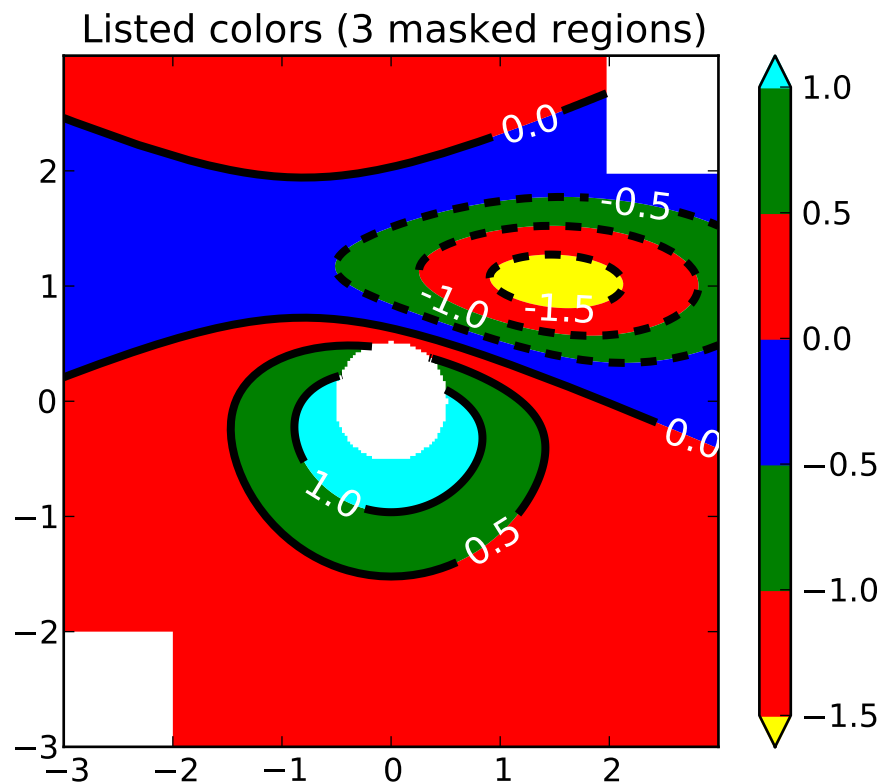












Additional kwargs: `hold = [True|False]` overrides default hold state

**contourf**(\*args, \*\*kwargs)

`contour()` and `contourf()` draw contour lines and filled contours, respectively. Except as noted, function signatures and return values are the same for both versions.

`contourf()` differs from the MATLAB version in that it does not draw the polygon edges. To draw edges, add line contours with calls to `contour()`.

call signatures:

`contour(Z)`

make a contour plot of an array `Z`. The level values are chosen automatically.

`contour(X,Y,Z)`

`X`, `Y` specify the ( $x$ ,  $y$ ) coordinates of the surface

`contour(Z,N)`

`contour(X,Y,Z,N)`

contour  $N$  automatically-chosen levels.

```
contour(Z,V)
contour(X,Y,Z,V)
```

draw contour lines at the values specified in sequence *V*

```
contourf(..., V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in *V*

```
contour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

*X* and *Y* must both be 2-D with the same shape as *Z*, or they must both be 1-D such that  $\text{len}(X)$  is the number of columns in *Z* and  $\text{len}(Y)$  is the number of rows in *Z*.

*C* = `contour(...)` returns a `QuadContourSet` object.

Optional keyword arguments:

**colors:** [ *None* | *string* | (*mpl\_colors*) ] If *None*, the colormap specified by *cmap* will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** *float* The alpha blending value

**cmap:** [ *None* | *Colormap* ] A *cm Colormap* instance or *None*. If *cmap* is *None* and *colors* is *None*, a default *Colormap* is used.

**norm:** [ *None* | *Normalize* ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [*level0*, *level1*, ..., *leveln*] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of *Z* will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**extent:** [ *None* | (*x0*,*x1*,*y0*,*y1*) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of *Z*[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of *Z*[0,0], and (*x1*, *y1*) is the position of *Z*[-1,-1].



This keyword is not active if  $X$  and  $Y$  are specified in the call to `contour`.

**locator:** [ **None** | **ticker.Locator subclass** ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ **'neither'** | **'both'** | **'min'** | **'max'** ] Unless this is *'neither'*, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ **None** | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

**antialiased:** [ **True** | **False** ] enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams['lines.antialiased']`.

contour-only keyword arguments:

**linewidths:** [ **None** | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ **None** | **'solid'** | **'dashed'** | **'dashdot'** | **'dotted'** ] If *linestyles* is *None*, the *'solid'* is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

contourf-only keyword arguments:

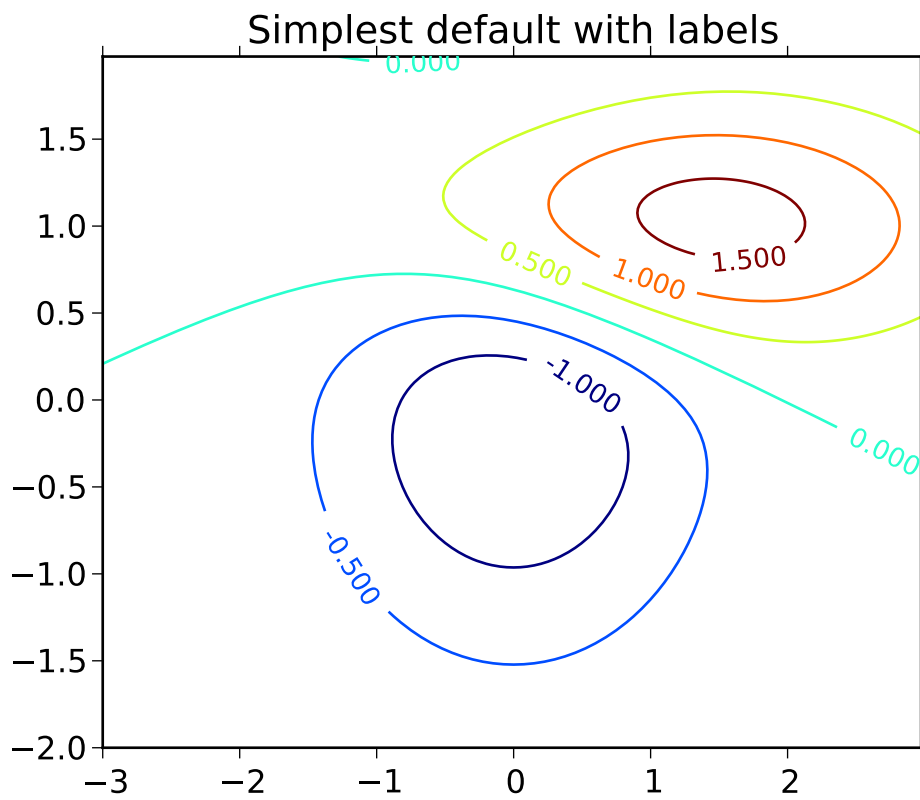
**nchunk:** [ **0** | **integer** ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

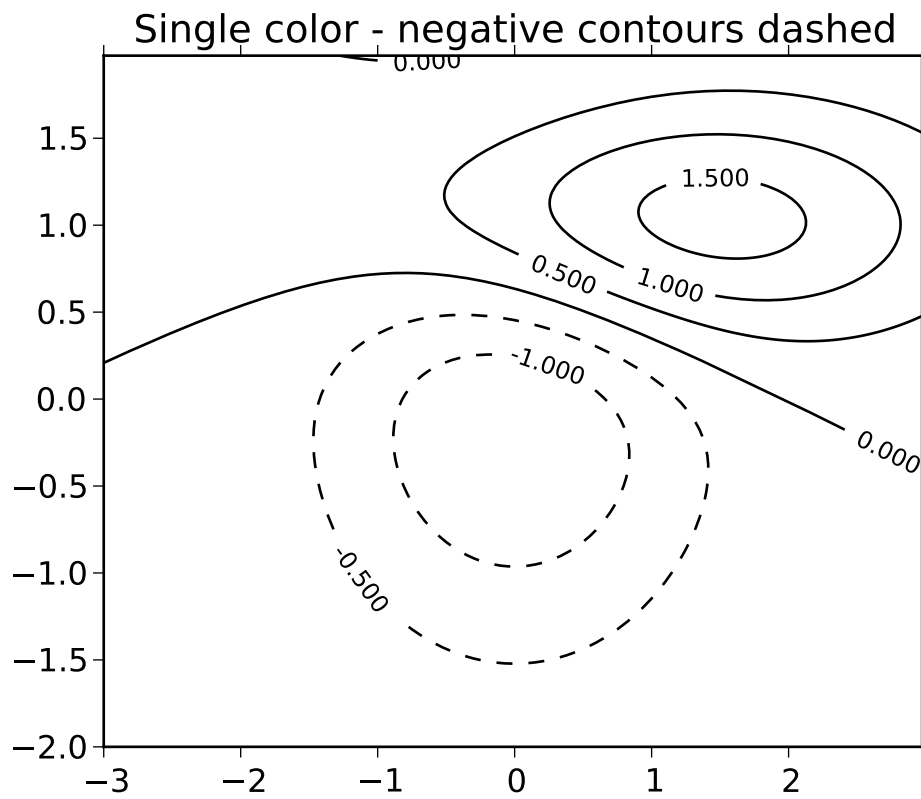
Note: `contourf` fills intervals that are closed at the top; that is, for boundaries  $z1$  and  $z2$ , the filled region is:

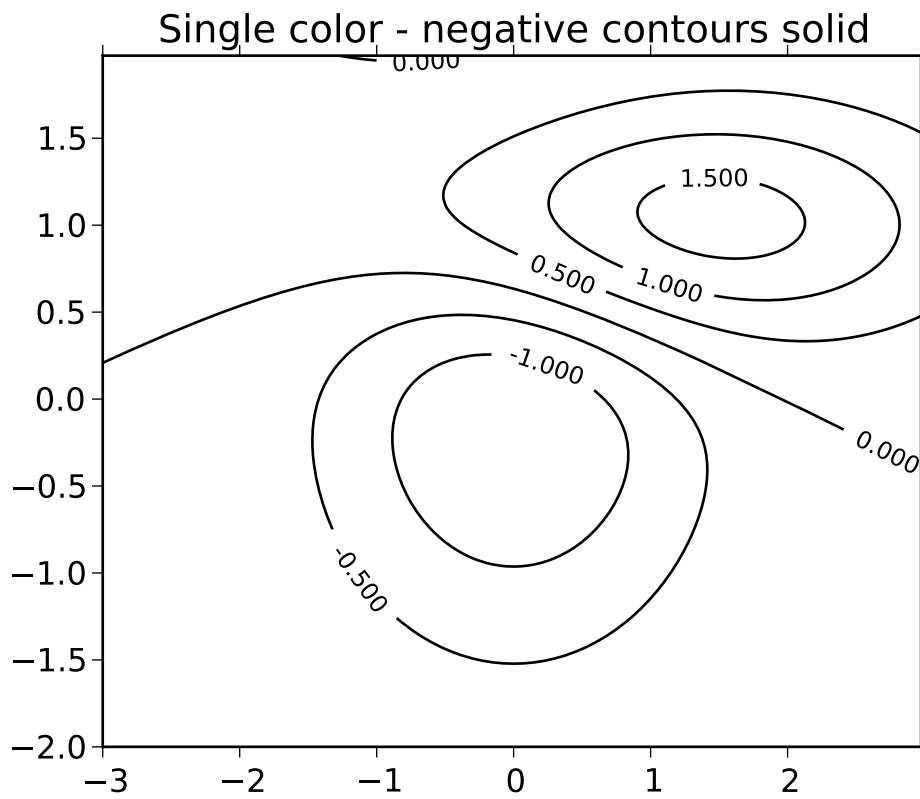
$$z1 < z \leq z2$$

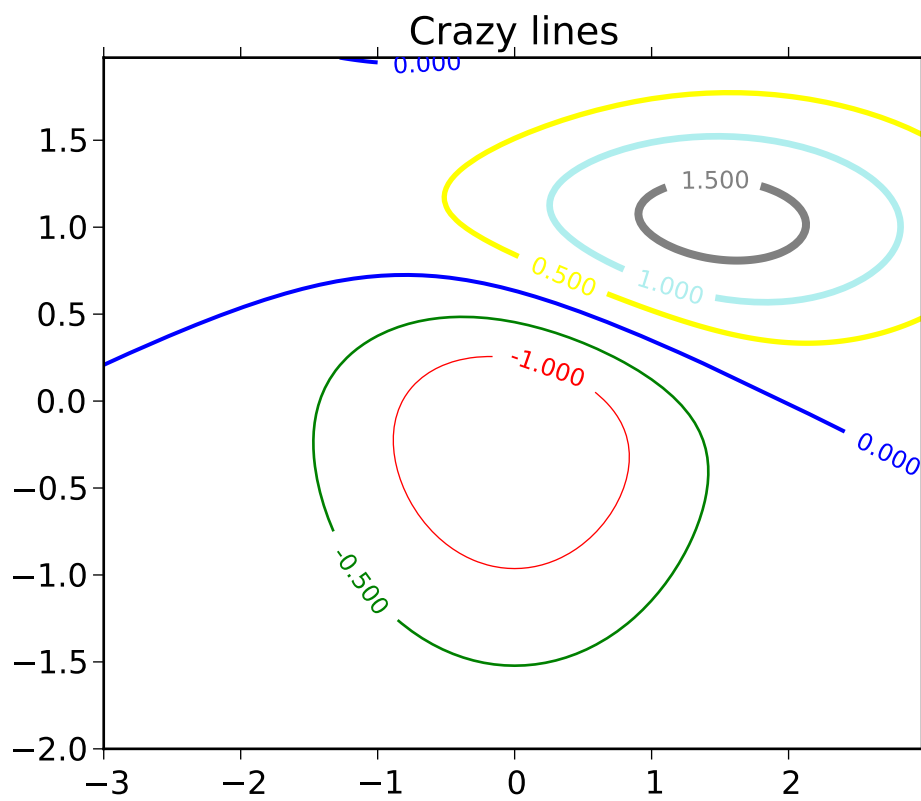
There is one exception: if the lowest boundary coincides with the minimum value of the  $z$  array, then that minimum value will be included in the lowest interval.

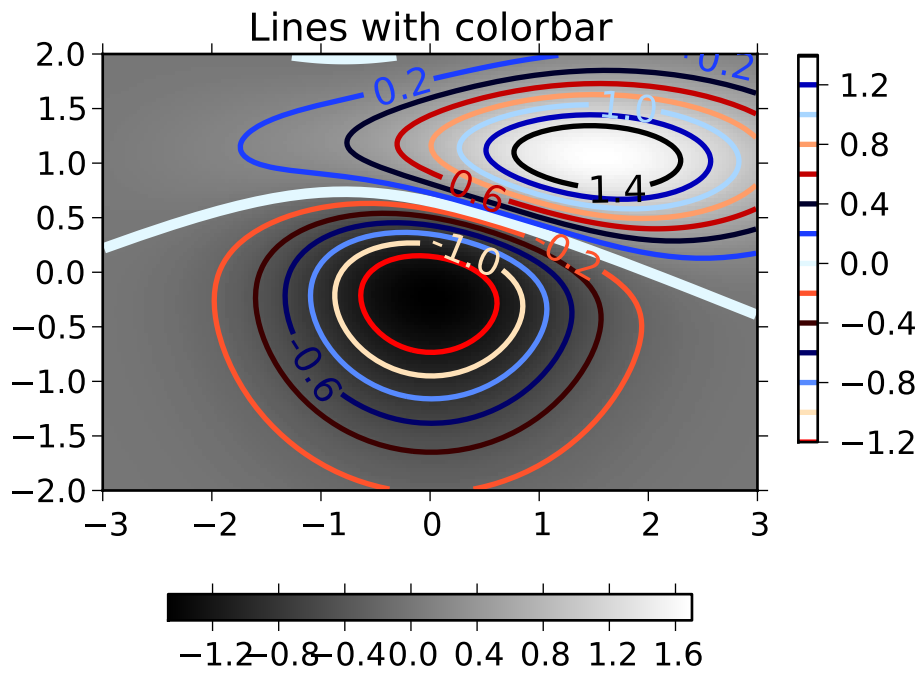
Examples:

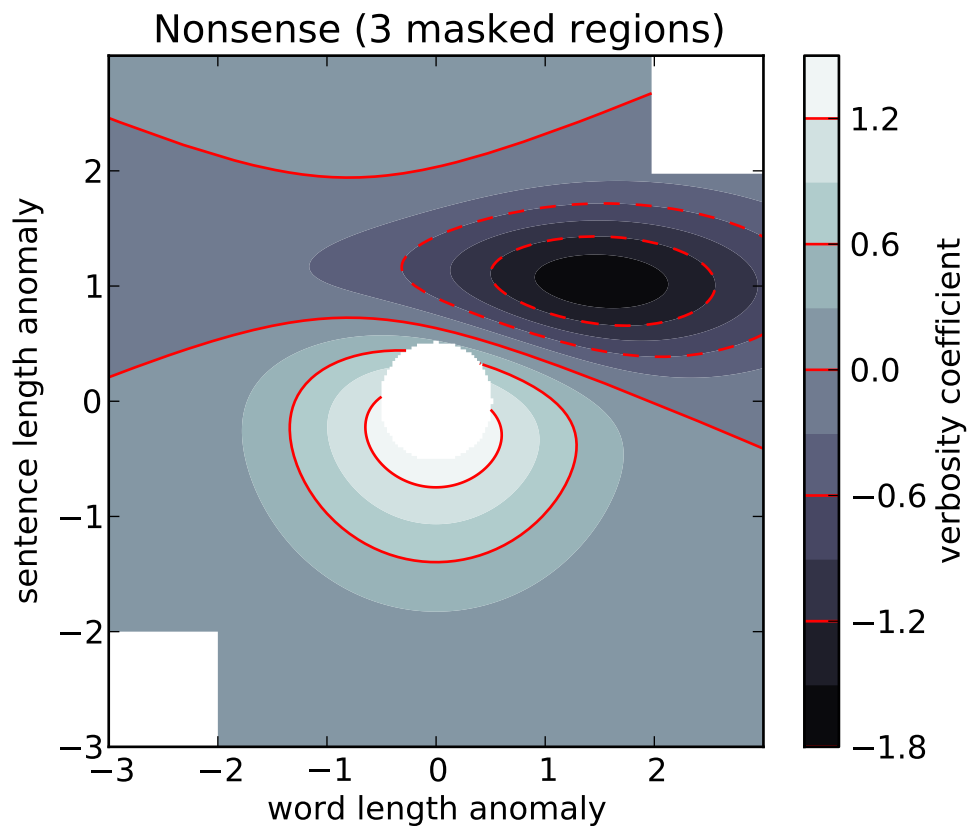


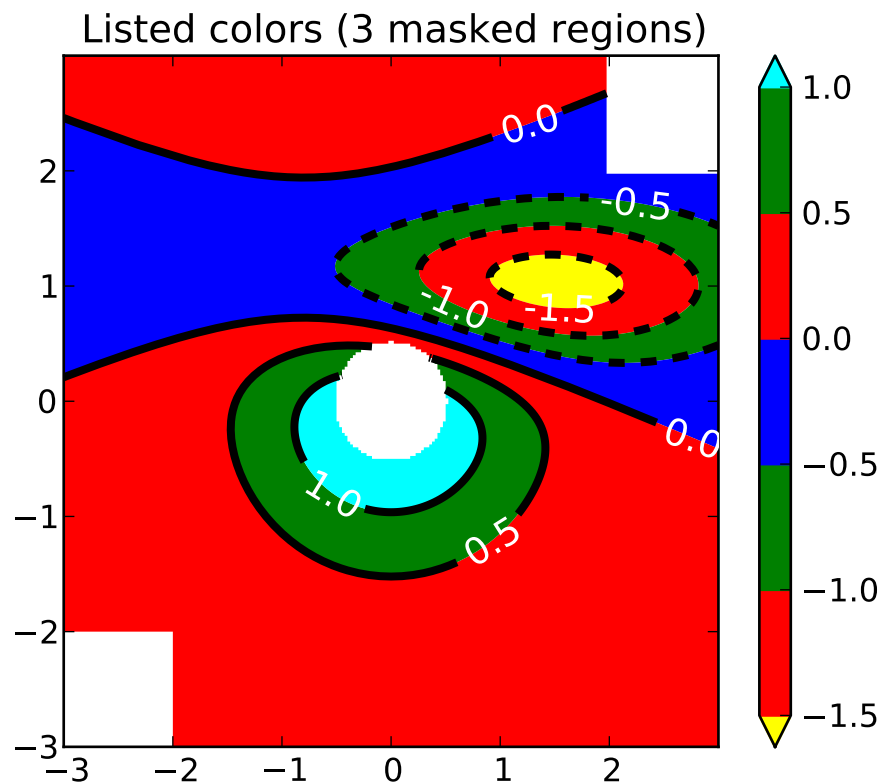












Additional kwargs: `hold = [True|False]` overrides default hold state

### **cool()**

set the default colormap to cool and apply to current image if any. See `help(colormaps)` for more information

### **copper()**

set the default colormap to copper and apply to current image if any. See `help(colormaps)` for more information

**csd**(*x*, *y*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=0, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, *hold*=None, *\*\*kwargs*)  
call signature:

```
csd(x, y, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
    window=mlab.window_hanning, noverlap=0, pad_to=None,
    sides='default', scale_by_freq=None, **kwargs)
```

The cross spectral density  $P_{xy}$  by Welch's average periodogram method. The vectors *x* and *y* are divided into *NFFT* length segments. Each segment is detrended by function *detrend* and windowed by function *window*. The product of the direct FFTs of *x* and *y* are averaged over each segment to compute  $P_{xy}$ , with a scaling to correct for power loss due to windowing.

Returns the tuple (*Pxy*, *freqs*). *P* is the cross spectrum (complex valued), and  $10 \log_{10} |P_{xy}|$  is plotted.



Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the *n* parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*.

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

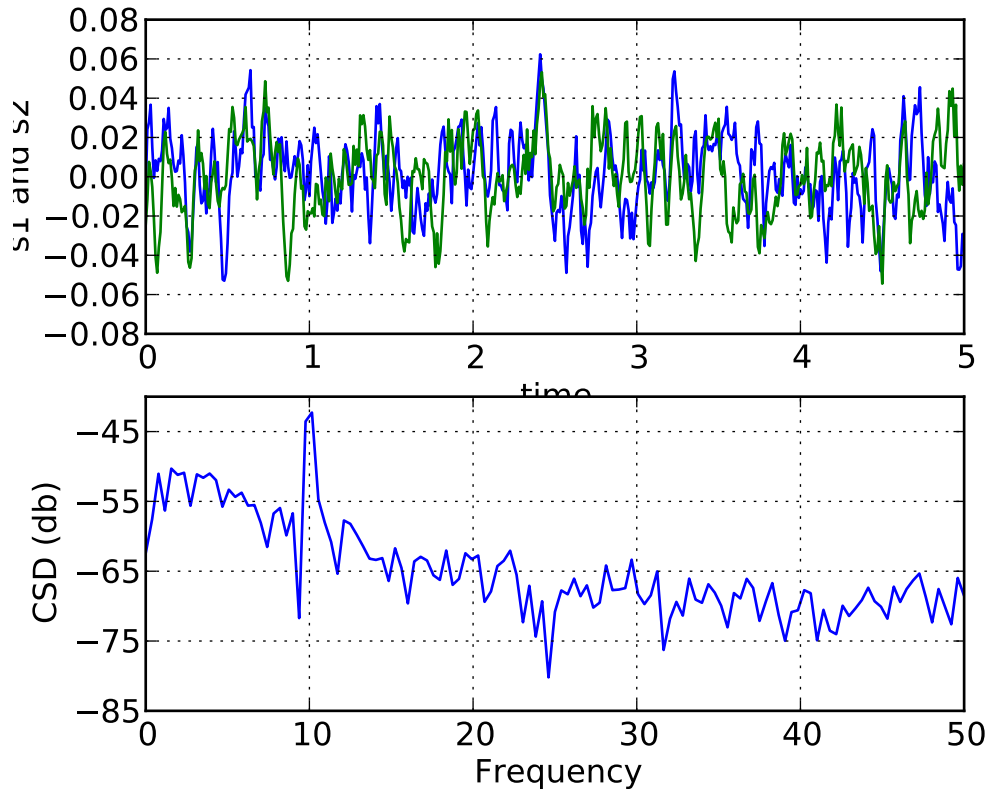
***Fc*: integer** The center frequency of *x* (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**References:** Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

kwargs control the Line2D properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance  |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

### **delaxes(\*args)**

`delaxes(ax)`: remove *ax* from the current figure. If *ax* doesn't exist, an error will be raised.

`delaxes()`: delete the current axes

### **disconnect(cid)**

disconnect callback id *cid*

Example usage:

```
cid = canvas.mpl_connect('button_press_event', on_press)
#...later
canvas.mpl_disconnect(cid)
```

### **draw()**

Redraw the current figure.

This is used in interactive mode to update a figure that has been altered using one or more plot object method calls; it is not needed if figure modification is done entirely with pyplot functions, if a sequence of modifications ends with a pyplot function, or if matplotlib is in non-interactive mode and the sequence of modifications ends with `show()` or `savefig()`.

A more object-oriented alternative, given any `Figure` instance, *fig*, that was created using a `pyplot` function, is:

```
fig.canvas.draw()
```

```
errorbar(x, y, yerr=None, xerr=None, fmt='-', ecolor=None, elinewidth=None, capsize=3,  
          barsabove=False, lolims=False, uplims=False, xlolims=False, xuplims=False, hold=None,  
          **kwargs)
```

call signature:

```
errorbar(x, y, yerr=None, xerr=None,  
          fmt='-', ecolor=None, elinewidth=None, capsize=3,  
          barsabove=False, lolims=False, uplims=False,  
          xlolims=False, xuplims=False)
```

Plot  $x$  versus  $y$  with error deltas in  $yerr$  and  $xerr$ . Vertical errorbars are plotted if  $yerr$  is not *None*. Horizontal errorbars are plotted if  $xerr$  is not *None*.

$x$ ,  $y$ ,  $xerr$ , and  $yerr$  can all be scalars, which plots a single error bar at  $x$ ,  $y$ .

Optional keyword arguments:

**$xerr/yerr$ :** [ scalar | N, Nx1, or 2xN array-like ] If a scalar number, len(N) array-like object, or an Nx1 array-like object, errorbars are drawn +/- value.

If a sequence of shape 2xN, errorbars are drawn at -row1 and +row2

**$fmt$ :** ‘-’ The plot format symbol. If  $fmt$  is *None*, only the errorbars are plotted. This is used for adding errorbars to a bar plot, for example.

**$ecolor$ :** [ None | mpl color ] a matplotlib color arg which gives the color the errorbar lines; if *None*, use the marker color.

**$elinewidth$ :** scalar the linewidth of the errorbar lines. If *None*, use the linewidth.

**$capsize$ :** scalar the size of the error bar caps in points

**$barsabove$ :** [ True | False ] if *True*, will plot the errorbars above the plot symbols. Default is below.

**$lolims/uplims/xlolims/xuplims$ :** [ False | True ] These arguments can be used to indicate that a value gives only upper/lower limits. In that case a caret symbol is used to indicate this. lims-arguments may be of the same type as  $xerr$  and  $yerr$ .

All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)  
errorbar(x, y, yerr, marker='s',  
          mfc='red', mec='green', ms=20, mew=4)
```

where  $mfc$ ,  $mec$ ,  $ms$  and  $mew$  are aliases for the longer property names, *markerfacecolor*, *markeredge-color*, *markersize* and *markeredgewidth*.

valid kwargs for the marker properties are

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance  |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

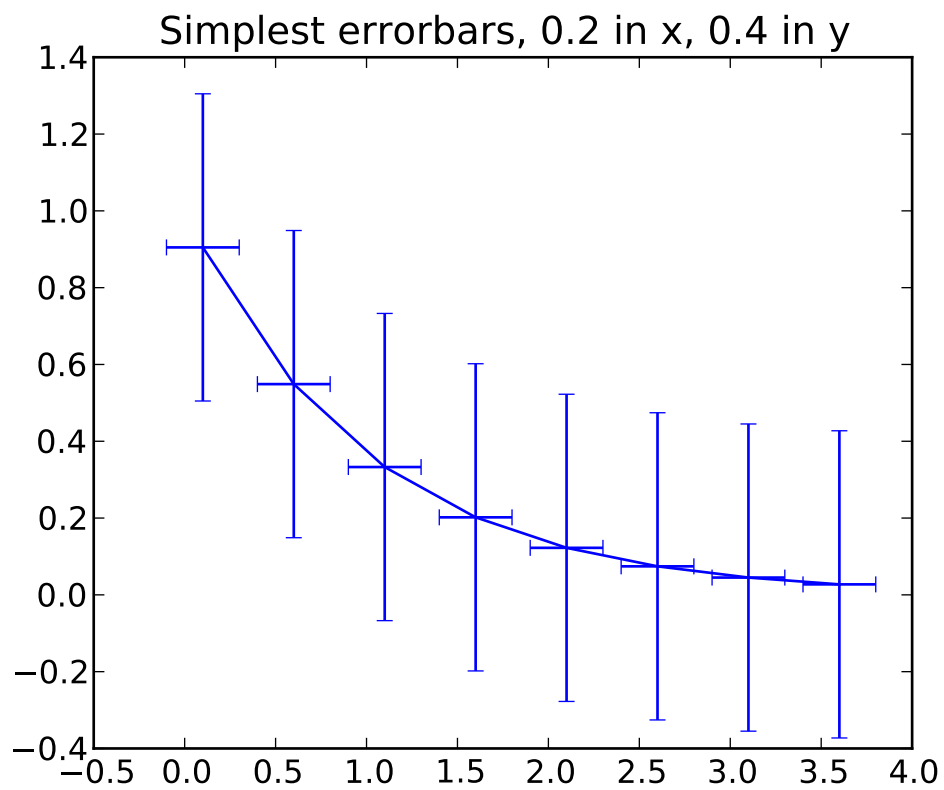
Returns (*plotline*, *caplines*, *barlinecols*):

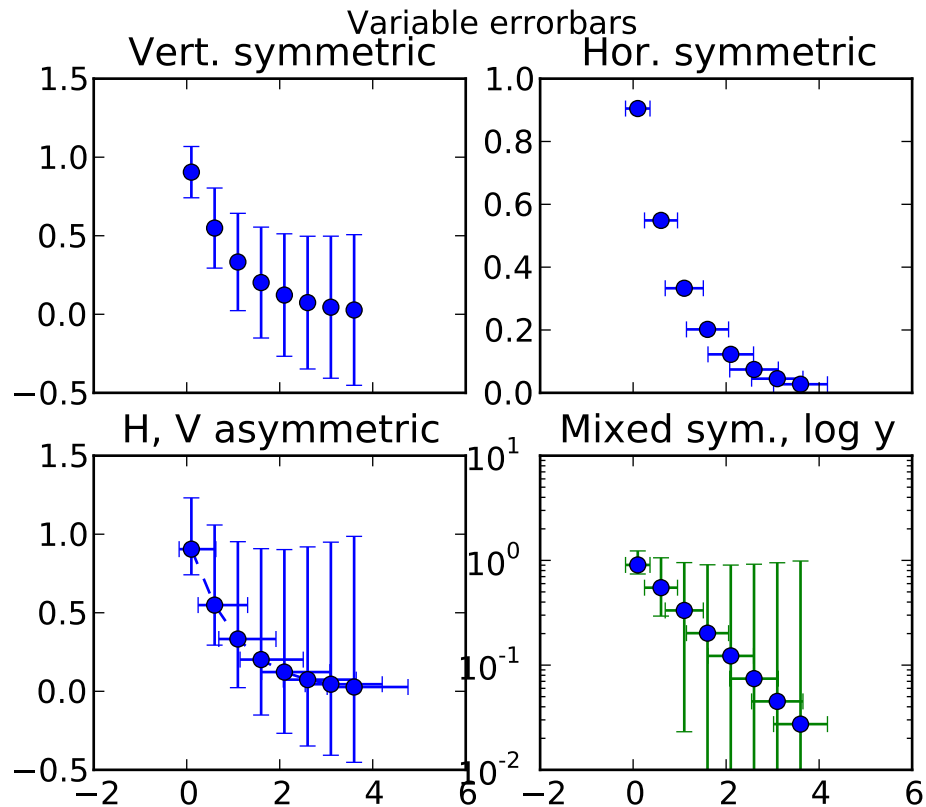
*plotline*: **Line2D** instance  $x, y$  plot markers and/or line

*caplines*: list of error bar cap **Line2D** instances

*barlinecols*: list of **LineCollection** instances for the horizontal and vertical error ranges.

**Example:**





Additional kwargs: `hold = [True|False]` overrides default hold state

**figimage**(\*args, \*\*kwargs)

call signatures:

`figimage(X, **kwargs)`

adds a non-resampled array *X* to the figure.

`figimage(X, xo, yo)`

with pixel offsets *xo*, *yo*,

*X* must be a float array:

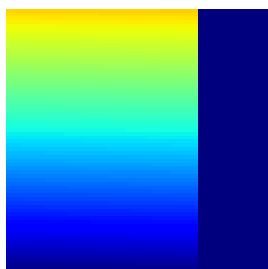
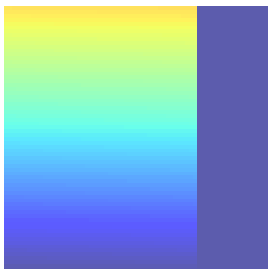
- If *X* is *M*×*N*, assume luminance (grayscale)
- If *X* is *M*×*N*×3, assume RGB
- If *X* is *M*×*N*×4, assume RGBA

Optional keyword arguments:

| Key-word  | Description  |
|-----------|--|
| xo or yo  | An integer, the x and y image offset in pixels   |
| cmap      | a <code>matplotlib.cm.ColorMap</code> instance, eg <code>cm.jet</code> . If <code>None</code> , default to the <code>rc image.cmap</code> value  |
| norm      | a <code>matplotlib.colors.Normalize</code> instance. The default is <code>normalization()</code> . This scales luminance -> 0-1  |
| vmin vmax | are used to scale a luminance image to 0-1. If either is <code>None</code> , the min and max of the luminance values will be used. Note if you pass a norm instance, the settings for <code>vmin</code> and <code>vmax</code> will be ignored. |
| alpha     | the alpha blending value, default is <code>None</code>   |
| origin    | [ 'upper'   'lower' ] Indicates where the [0,0] index of the array is in the upper left or lower left corner of the axes. Defaults to the <code>rc image.origin</code> value   |

`figimage` complements the axes image (`imshow()`) which will be resampled to fit the current axes. If you want a resampled image to fill the entire figure, you can define an `Axes` with size `[0,1,0,1]`.

An `matplotlib.image.FigureImage` instance is returned.



Additional kwargs are Artist kwargs passed on to `:class:`~matplotlib.image.FigureImage``. Additional kwargs: `hold = [True|False]` overrides default hold state

**figlegend**(*handles, labels, loc, \*\*kwargs*)

Place a legend in the figure.



*labels* a sequence of strings

*handles* a sequence of [Line2D](#) or [Patch](#) instances

*loc* can be a string or an integer specifying the legend location

A `matplotlib.legend.Legend` instance is returned.

Example:

```
figlegend( (line1, line2, line3),
           ('label1', 'label2', 'label3'),
           'upper right' )
```

**See Also:**

[legend\(\)](#)

**figtext**(\*args, \*\*kwargs)

Call signature:

```
figtext(x, y, s, fontdict=None, **kwargs)
```

Add text to figure at location *x*, *y* (relative 0-1 coords). See [text\(\)](#) for the meaning of the other arguments.

kwargs control the [Text](#) properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>  | [True   False]  |
| <code>axes</code>  | an <a href="#">Axes</a> instance  |
| <code>backgroundcolor</code>   | any matplotlib color  |
| <code>bbox</code>  | rectangle prop dict   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>   | any matplotlib color  |
| <code>contains</code>  | a callable function   |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]             |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance  |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance                          |
| <code>gid</code>   | an id string  |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]   |
| <code>label</code>   | any string  |
| <code>linespacing</code>   | float (multiple of font size)   |
| <code>lod</code>   | [True   False]  |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]   |
| <code>path_effects</code>  | unknown   |
| <code>picker</code>  | [None float boolean callable]   |

Table 62.9 – continued from

|  |  |
|--|--|
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>                           | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>                     | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'extra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>                         | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>                     | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code> | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>                       | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold' ]                          |
| <code>x</code>   | float  |
| <code>y</code>   | float  |
| <code>zorder</code>  | any number   |

**figure**(*num=None, figsize=None, dpi=None, facecolor=None, edgecolor=None, frameon=True, Figure-Class=<class 'matplotlib.figure.Figure'>, \*\*kwargs*)  
call signature:

```
figure(num=None, figsize=(8, 6), dpi=80, facecolor='w', edgecolor='k')
```

Create a new figure and return a `matplotlib.figure.Figure` instance. If *num* = *None*, the figure number will be incremented and a new figure will be created. The returned figure objects have a *number* attribute holding this number.

If *num* is an integer, and `figure(num)` already exists, make it active and return a reference to it. If `figure(num)` does not exist it will be created. Numbering starts at 1, MATLAB style:

```
figure(1)
```

The same applies if *num* is a string. In this case *num* will be used as an explicit figure label:

```
figure("today")
```

and in windowed backends, the window title will be set to this figure label.

If you are creating many figures, make sure you explicitly call “close” on the figures you are not using, because this will enable pylab to properly clean up the memory.

Optional keyword arguments:

| Keyword   | Description   |
|-----------|---|
| figsize   | width x height in inches; defaults to rc figure.figsize |
| dpi       | resolution; defaults to rc figure.dpi                   |
| facecolor | the background color; defaults to rc figure.facecolor   |
| edgecolor | the border color; defaults to rc figure.edgecolor       |

rcParams defines the default values, which can be modified in the matplotlibrc file

*FigureClass* is a [Figure](#) or derived class that will be passed on to `new_figure_manager()` in the backends which allows you to hook custom Figure classes into the pylab interface. Additional kwargs will be passed on to your figure init function.

**fill**(\*args, \*\*kwargs)

call signature:

`fill(*args, **kwargs)`

Plot filled polygons. *args* is a variable length argument, allowing for multiple *x*, *y* pairs with an optional color format string; see [plot\(\)](#) for details on the argument parsing. For example, to plot a polygon with vertices at *x*, *y* in blue.:

```
ax.fill(x,y, 'b' )
```

An arbitrary number of *x*, *y*, *color* groups can be specified:

```
ax.fill(x1, y1, 'g', x2, y2, 'r')
```

Return value is a list of [Patch](#) instances that were added.

The same color strings that [plot\(\)](#) supports are supported by the fill format string.

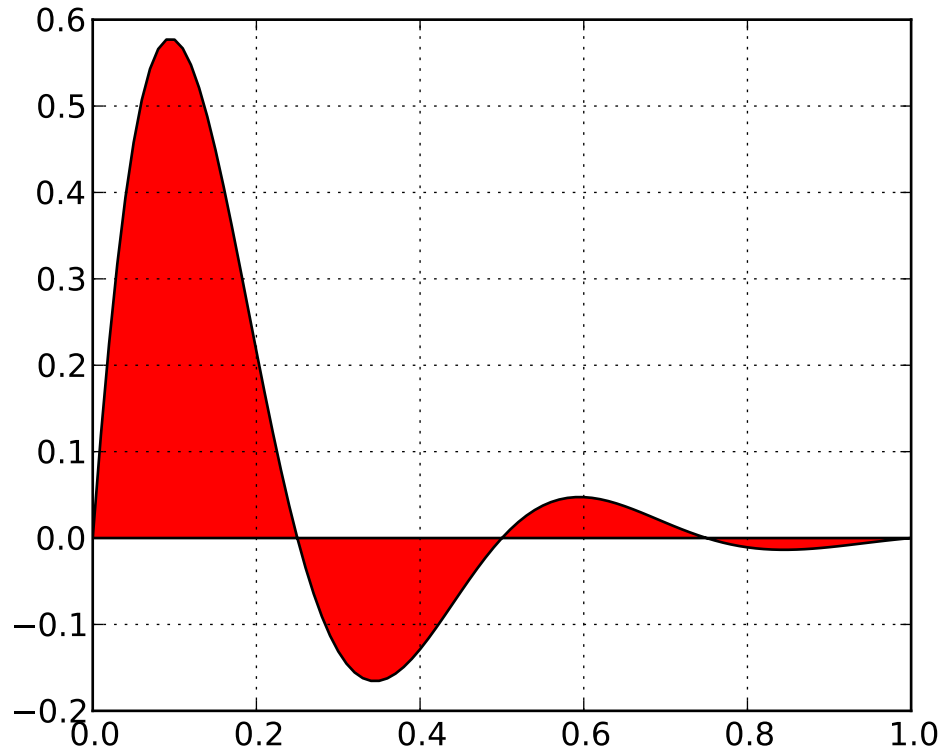
If you would like to fill below a curve, eg. shade a region between 0 and *y* along *x*, use [fill\\_between\(\)](#)

The *closed* kwarg will close the polygon when *True* (default).

kwargs control the Polygon properties:

| Property                                    | Description  |
|---|--|
| <code>agg_filter</code>                     | unknown  |
| <code>alpha</code>                          | float or None  |
| <code>animated</code>                       | [True   False]   |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default   |
| <code>axes</code>                           | an <code>Axes</code> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                             |
| <code>clip_on</code>                        | [True   False]   |
| <code>clip_path</code>                      | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ] |
| <code>color</code>                          | matplotlib color spec  |
| <code>contains</code>                       | a callable function  |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                    |
| <code>figure</code>                         | a <code>matplotlib.figure.Figure</code> instance                               |
| <code>fill</code>                           | [True   False]   |
| <code>gid</code>                            | an id string   |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                  |
| <code>label</code>                          | any string   |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']                                    |
| <code>linewidth</code> or <code>lw</code>   | float or None for default  |
| <code>lod</code>                            | [True   False]   |
| <code>path_effects</code>                   | unknown  |
| <code>picker</code>                         | [None float boolean callable]  |
| <code>rasterized</code>                     | [True   False   None]  |
| <code>snap</code>                           | unknown  |
| <code>transform</code>                      | <code>Transform</code> instance  |
| <code>url</code>                            | a url string   |
| <code>visible</code>                        | [True   False]   |
| <code>zorder</code>                         | any number   |

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**fill\_between**(*x*, *y1*, *y2*=0, *where*=None, *interpolate*=False, *hold*=None, *\*\*kwargs*)

call signature:

`fill_between(x, y1, y2=0, where=None, **kwargs)`

Create a [PolyCollection](#) filling the regions between *y1* and *y2* where *where*==True

*x* an N length np array of the x data

*y1* an N length scalar or np array of the y data

*y2* an N length scalar or np array of the y data

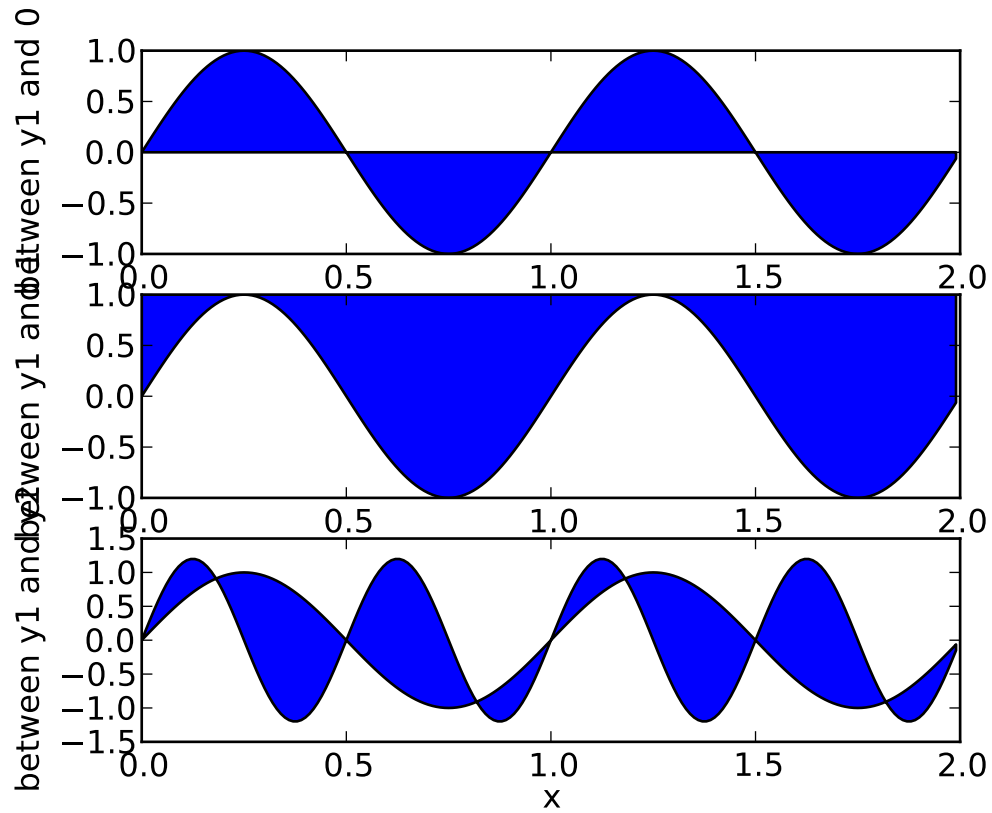
**where** if None, default to fill between everywhere. If not None, it is a N length numpy boolean array and the fill will only happen over the regions where *where*==True

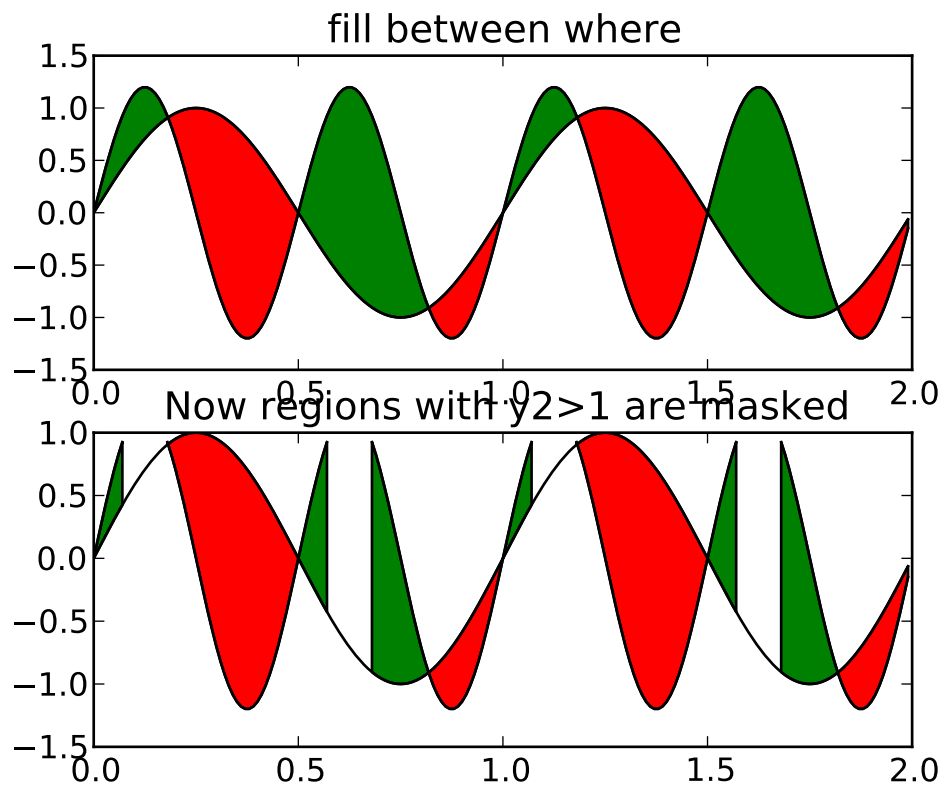
**interpolate** If True, interpolate between the two lines to find the precise point of intersection. Otherwise, the start and end points of the filled region will only occur on explicit values in the *x* array.

**kwargs** keyword args passed on to the PolyCollection

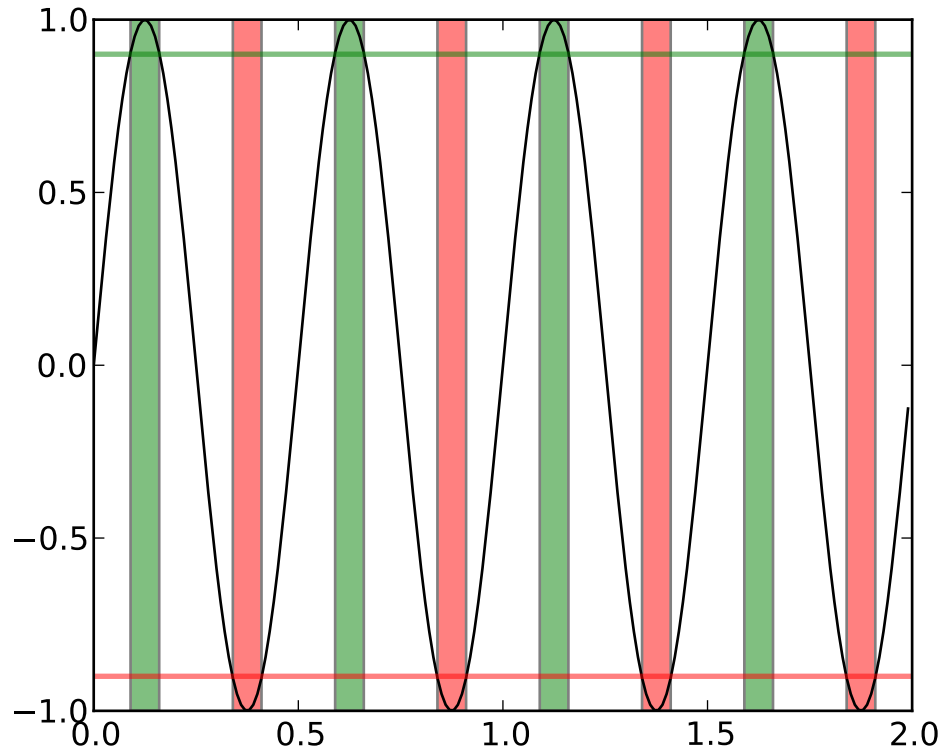
kwargs control the Polygon properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [True   False   None]   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [True   False]  |
| <code>zorder</code>  | any number  |









**See Also:**

[`fill\_betweenx\(\)`](#) for filling between two sets of x-values

Additional kwargs: `hold = [True|False]` overrides default hold state

**`fill_betweenx(y, x1, x2=0, where=None, hold=None, **kwargs)`**  
call signature:

`fill_between(y, x1, x2=0, where=None, **kwargs)`

Create a [`PolyCollection`](#) filling the regions between `x1` and `x2` where `where==True`

**`y`** an N length np array of the y data

**`x1`** an N length scalar or np array of the x data

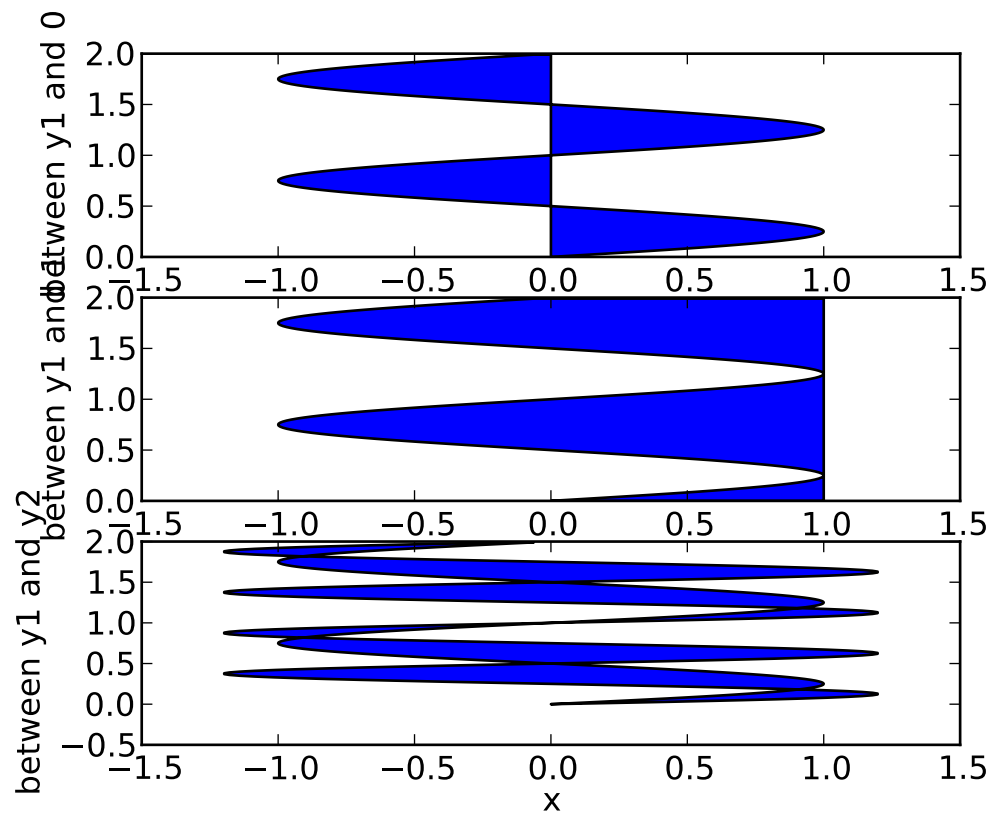
**`x2`** an N length scalar or np array of the x data

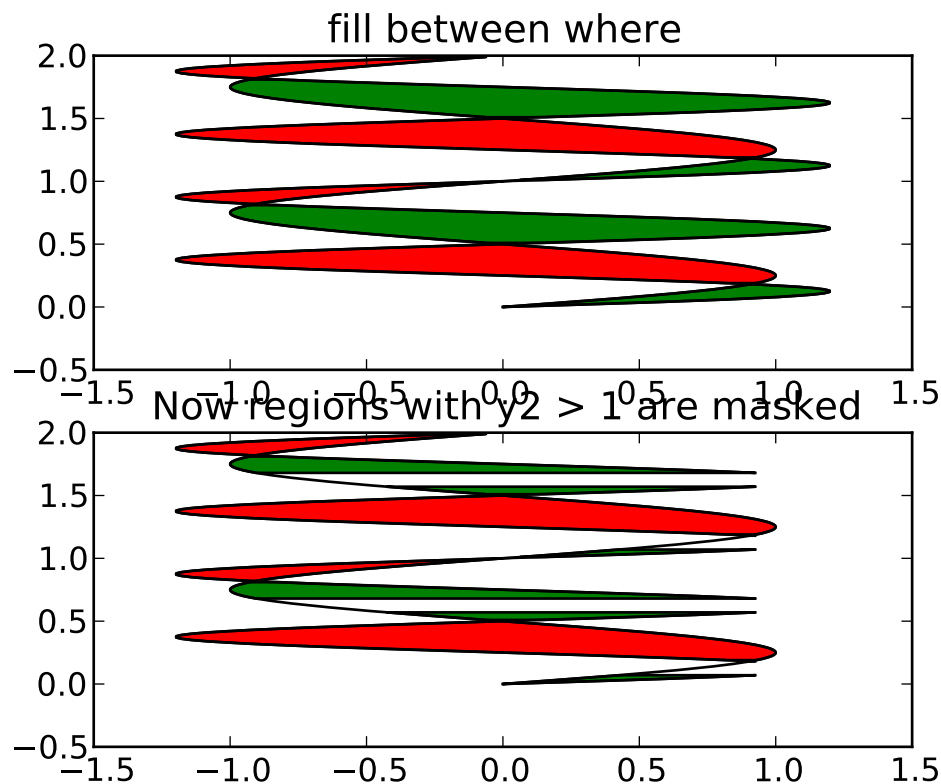
**`where`** if None, default to fill between everywhere. If not None, it is a N length numpy boolean array and the fill will only happen over the regions where `where==True`

**`kwargs`** keyword args passed on to the `PolyCollection`

kwargs control the Polygon properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [True   False   None]   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [True   False]  |
| <code>zorder</code>  | any number  |





**See Also:**

[`fill\_between\(\)`](#) for filling between two sets of y-values

Additional kwargs: `hold = [True|False]` overrides default hold state

**findobj**(*o=None, match=None*)

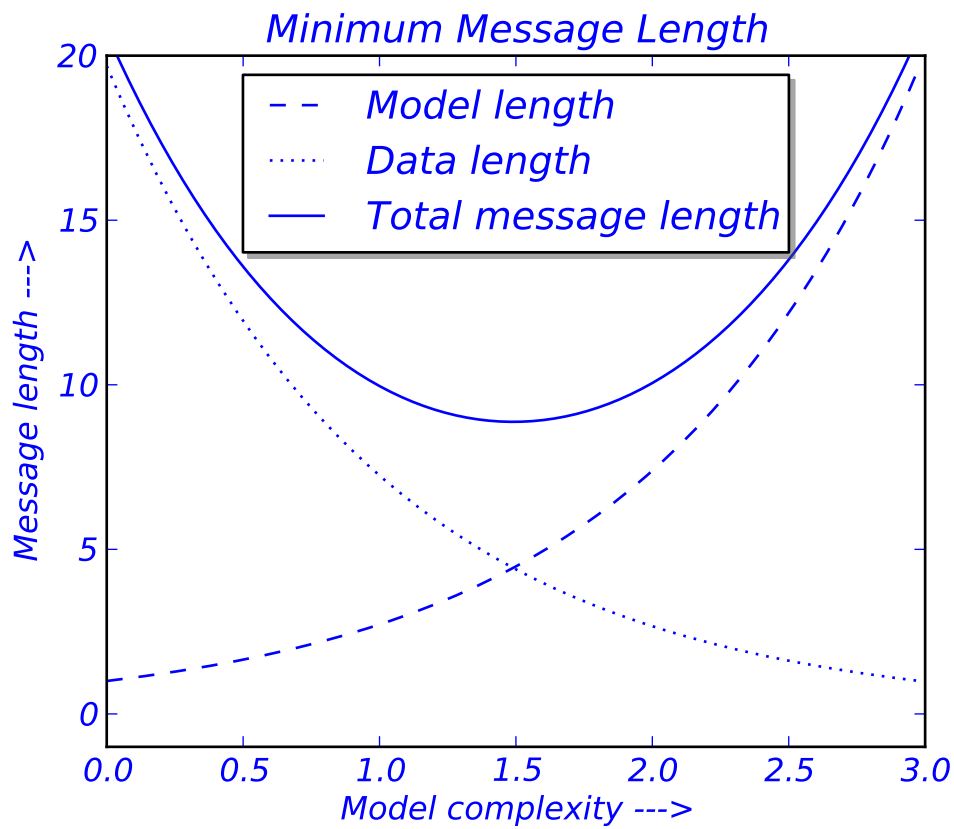
**pyplot signature:** `findobj(o=gcf(), match=None, include_self=True)`

Recursively find all `:class:matplotlib.artist.Artist` instances contained in self.

*match* can be

- `None`: return all objects contained in artist.
- function with signature `boolean = match(artist)` used to filter matches
- class instance: eg `Line2D`. Only return artists of class type.

If *include\_self* is `True` (default), include self in the list to be checked for a match.

**flag()**

set the default colormap to flag and apply to current image if any. See `help(colormaps)` for more information

**gca(\*\*kwargs)**

Return the current axis instance. This can be used to control axis properties either using `set` or the `Axes` methods, for example, setting the xaxis range:

```
plot(t,s)
set(gca(), 'xlim', [0,10])
```

or:

```
plot(t,s)
a = gca()
a.set_xlim([0,10])
```

**gcf()**

Return a reference to the current figure.

**gci()**

Get the current `ScalarMappable` instance (image or patch collection), or `None` if no images or patch collections have been defined. The commands `imshow()` and `figimage()` create `Image` instances,

and the commands `pcolor()` and `scatter()` create `Collection` instances. The current image is an attribute of the current axes, or the nearest earlier axes in the current figure that contains an image.

**`get_current_fig_manager()`**

**`get_figlabels()`**

Return a list of existing figure labels.

**`get_fignums()`**

Return a list of existing figure numbers.

**`get_plot_commands()`**

**`ginput(*args, **kwargs)`**

call signature:

```
ginput(self, n=1, timeout=30, show_clicks=True,
        mouse_add=1, mouse_pop=3, mouse_stop=2)
```

Blocking call to interact with the figure.

This will wait for *n* clicks from the user and return a list of the coordinates of each click.

If *timeout* is zero or negative, does not timeout.

If *n* is zero or negative, accumulate clicks until a middle click (or potentially both mouse buttons at once) terminates the input.

Right clicking cancels last input.

The buttons used for the various actions (adding points, removing points, terminating the inputs) can be overridden via the arguments *mouse\_add*, *mouse\_pop* and *mouse\_stop*, that give the associated mouse button: 1 for left, 2 for middle, 3 for right.

The keyboard can also be used to select points in case your mouse does not have one or more of the buttons. The delete and backspace keys act like right clicking (i.e., remove last point), the enter key terminates input and any other key (not already used by the window manager) selects a point.

**`gray()`**

set the default colormap to gray and apply to current image if any. See `help(colormaps)` for more information

**`grid(b=None, which='major', axis='both', **kwargs)`**

call signature:

```
grid(self, b=None, which='major', axis='both', **kwargs)
```

Set the axes grids on or off; *b* is a boolean. (For MATLAB compatibility, *b* may also be a string, 'on' or 'off'.)

If *b* is *None* and `len(kwargs)==0`, toggle the grid state. If *kwargs* are supplied, it is assumed that you want a grid and *b* is thus set to *True*.

*which* can be 'major' (default), 'minor', or 'both' to control whether major tick grids, minor tick grids, or both are affected.

*axis* can be ‘both’ (default), ‘x’, or ‘y’ to control which set of gridlines are drawn.

*kwargs* are used to set the grid line properties, eg:

```
ax.grid(color='r', linestyle='-', linewidth=2)
```

Valid [Line2D](#) kwargs are

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance   |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |

|                     |            |
|---------------------|------------|
| <code>xdata</code>  | 1D array   |
| <code>ydata</code>  | 1D array   |
| <code>zorder</code> | any number |

**hexbin**(*x*, *y*, *C*=None, *gridsize*=100, *bins*=None, *xscale*='linear', *yscale*='linear', *extent*=None, *cmap*=None, *norm*=None, *vmin*=None, *vmax*=None, *alpha*=None, *linewidths*=None, *edgecolors*='none', *reduce\_C\_function*=<function mean at 0x23ea758>, *mincnt*=None, *marginals*=False, *hold*=None, *\*\*kwargs*)  
 call signature:

```
hexbin(x, y, C = None, gridsize = 100, bins = None,
       xscale = 'linear', yscale = 'linear',
       cmap=None, norm=None, vmin=None, vmax=None,
       alpha=None, linewidths=None, edgecolors='none'
       reduce_C_function = np.mean, mincnt=None, marginals=True
       **kwargs)
```

Make a hexagonal binning plot of *x* versus *y*, where *x*, *y* are 1-D sequences of the same length, *N*. If *C* is None (the default), this is a histogram of the number of occurrences of the observations at (*x*[*i*],*y*[*i*]).

If *C* is specified, it specifies values at the coordinate (*x*[*i*],*y*[*i*]). These values are accumulated for each hexagonal bin and then reduced according to *reduce\_C\_function*, which defaults to numpy's mean function (*np.mean*). (If *C* is specified, it must also be a 1-D sequence of the same length as *x* and *y*.)

*x*, *y* and/or *C* may be masked arrays, in which case only unmasked points will be plotted.

Optional keyword arguments:

**gridsize:** [ **100** | **integer** ] The number of hexagons in the *x*-direction, default is 100. The corresponding number of hexagons in the *y*-direction is chosen such that the hexagons are approximately regular. Alternatively, *gridsize* can be a tuple with two elements specifying the number of hexagons in the *x*-direction and the *y*-direction.

**bins:** [ **None** | **'log'** | **integer** | **sequence** ] If *None*, no binning is applied; the color of each hexagon directly corresponds to its count value.

If **'log'**, use a logarithmic scale for the color map. Internally,  $\log_{10}(i + 1)$  is used to determine the hexagon color.

If an integer, divide the counts in the specified number of bins, and color the hexagons accordingly.

If a sequence of values, the values of the lower bound of the bins to be used.

**xscale:** [ **'linear'** | **'log'** ] Use a linear or log10 scale on the horizontal axis.

**yscale:** [ **'linear'** | **'log'** ] Use a linear or log10 scale on the vertical axis.

**mincnt:** **None** | **a positive integer** If not *None*, only display cells with more than *mincnt* number of points in the cell



**marginals:** **True|False** if marginals is True, plot the marginal density as colormapped rectangles along the bottom of the x-axis and left of the y-axis

**extent:** [ **None** | **scalars (left, right, bottom, top)** ] The limits of the bins. The default assigns the limits based on gridsize, x, y, xscale and yscale.

Other keyword arguments controlling color mapping and normalization arguments:

**cmap:** [ **None** | **Colormap** ] a `matplotlib.cm.Colormap` instance. If *None*, defaults to `rc.image.cmap`.

**norm:** [ **None** | **Normalize** ] `matplotlib.colors.Normalize` instance is used to scale luminance data to 0,1.

**vmin/vmax:** **scalar** *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. Note if you pass a norm instance, your settings for *vmin* and *vmax* will be ignored.

**alpha:** **scalar between 0 and 1, or None** the alpha value for the patches

**linewidths:** [ **None** | **scalar** ] If *None*, defaults to `rc.lines.linewidth`. Note that this is a tuple, and if you set the linewidths argument you must set it as a sequence of floats, as required by `RegularPolyCollection`.

Other keyword arguments controlling the Collection properties:

**edgecolors:** [ **None** | **mpl color** | **color sequence** ] If 'none', draws the edges in the same color as the fill color. This is the default, as it avoids unsightly unpainted pixels between the hexagons.

If *None*, draws the outlines in the default color.

If a matplotlib color arg or sequence of rgba tuples, draws the outlines in the specified color.

Here are the standard descriptions of all the `Collection` kwargs:

| Property  | Description  |
|---|--|
| <code>agg_filter</code>                               | unknown  |
| <code>alpha</code>                                    | float or None                                      |
| <code>animated</code>                                 | [True   False]                                     |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans                    |
| <code>array</code>                                    | unknown  |
| <code>axes</code>                                     | an <code>Axes</code> instance                      |
| <code>clim</code>                                     | a length 2 sequence of floats                      |
| <code>clip_box</code>                                 | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>                                  | [True   False]                                     |
| <code>clip_path</code>                                | [ (Path, Transform)   Patch   None ]               |
| <code>cmap</code>                                     | a colormap or registered colormap name             |
| <code>color</code>                                    | matplotlib color arg or sequence of rgba tuples    |
| <code>colorbar</code>                                 | unknown  |
| <code>contains</code>                                 | a callable function                                |
| <code>edgecolor</code> or <code>edgecolors</code>     | matplotlib color arg or sequence of rgba tuples    |
| <code>facecolor</code> or <code>facecolors</code>     | matplotlib color arg or sequence of rgba tuples    |
| <code>figure</code>                                   | a <code>matplotlib.figure.Figure</code> instance   |

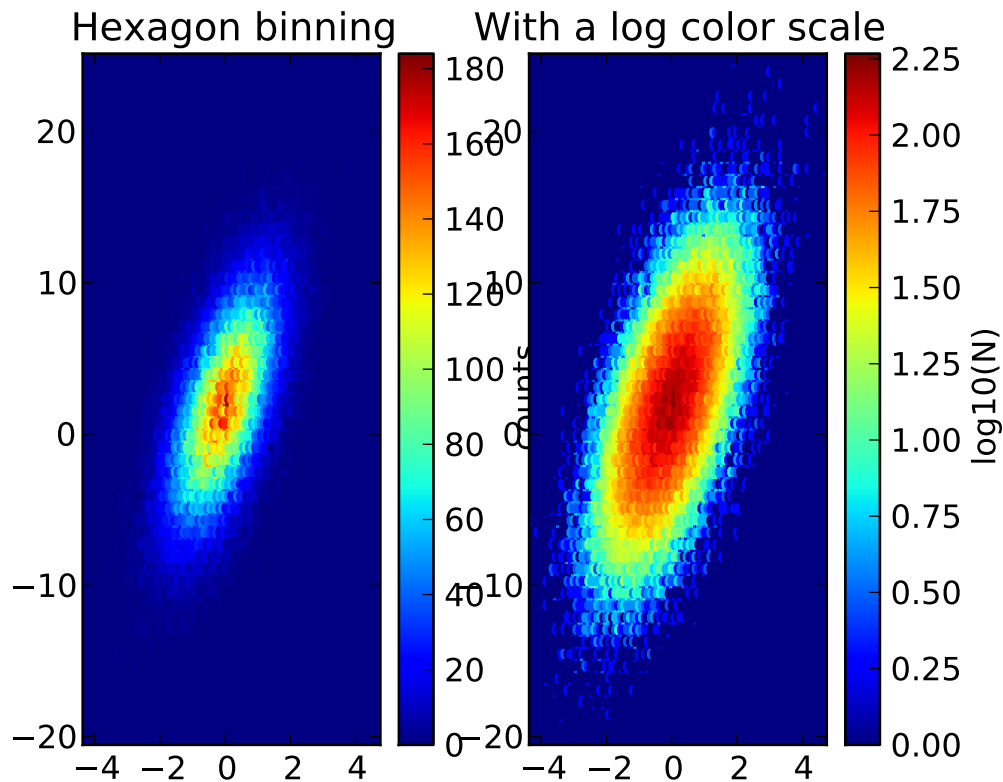
Continued on next page

Table 62.13 – continued from previous page

|  |   |
|--|---|
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ <code>'solid'</code>   <code>'dashed'</code> , <code>'dashdot'</code> , <code>'dotted'</code>   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [ <code>None</code>  float boolean callable]  |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [ <code>True</code>   <code>False</code>   <code>None</code> ]  |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <a href="#">Transform</a> instance  |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>zorder</code>  | any number  |

The return value is a [PolyCollection](#) instance; use `get_array()` on this [PolyCollection](#) to get the counts in each hexagon. If `marginals` is `True`, horizontal bar and vertical bar (both [PolyCollections](#)) will be attached to the return collection as attributes *hbar* and *vbar*

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**hist**(*x*, *bins*=10, *range*=None, *normed*=False, *weights*=None, *cumulative*=False, *bottom*=None, *histtype*='bar', *align*='mid', *orientation*='vertical', *rwidth*=None, *log*=False, *color*=None, *label*=None, *hold*=None, *\*\*kwargs*)  
call signature:

```
def hist(x, bins=10, range=None, normed=False, weights=None,
        cumulative=False, bottom=None, histtype='bar', align='mid',
        orientation='vertical', rwidth=None, log=False,
        color=None, label=None,
        **kwargs):
```

Compute and draw the histogram of *x*. The return value is a tuple (*n*, *bins*, *patches*) or (*[n0, n1, ...]*, *bins*, *[patches0, patches1, ...]*) if the input contains multiple data.

Multiple data can be provided via *x* as a list of datasets of potentially different length (*[x0, x1, ...]*), or as a 2-D ndarray in which each column is a dataset. Note that the ndarray form is transposed relative to the list form.

Masked arrays are not supported at present.

Keyword arguments:

***bins***: Either an integer number of bins or a sequence giving the bins. If *bins* is an integer, *bins* + 1 bin edges will be returned, consistent with `numpy.histogram()` for numpy

version  $\geq 1.3$ , and with the `new = True` argument in earlier versions. Unequally spaced bins are supported if `bins` is a sequence.

**range:** The lower and upper range of the bins. Lower and upper outliers are ignored. If not provided, `range` is `(x.min(), x.max())`. Range has no effect if `bins` is a sequence.

If `bins` is a sequence or `range` is specified, autoscaling is based on the specified bin range instead of the range of `x`.

**normed:** If `True`, the first element of the return tuple will be the counts normalized to form a probability density, i.e.,  $n/(\text{len}(x)*\text{dbin})$ . In a probability density, the integral of the histogram should be 1; you can verify that with a trapezoidal integration of the probability density function:

```
pdf, bins, patches = ax.hist(...)
print np.sum(pdf * np.diff(bins))
```

**Note:** Until numpy release 1.5, the underlying numpy histogram function was incorrect with `normed*=True` if bin sizes were unequal. MPL inherited that error. It is now corrected within MPL when using earlier numpy versions

**weights** An array of weights, of the same shape as `x`. Each value in `x` only contributes its associated weight towards the bin count (instead of 1). If `normed` is `True`, the weights are normalized, so that the integral of the density over the range remains 1.

**cumulative:** If `True`, then a histogram is computed where each bin gives the counts in that bin plus all bins for smaller values. The last bin gives the total number of datapoints. If `normed` is also `True` then the histogram is normalized such that the last bin equals 1. If `cumulative` evaluates to less than 0 (e.g. -1), the direction of accumulation is reversed. In this case, if `normed` is also `True`, then the histogram is normalized such that the first bin equals 1.

**histtype:** [ `'bar'` | `'barstacked'` | `'step'` | `'stepfilled'` ] The type of histogram to draw.

- `'bar'` is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- `'barstacked'` is a bar-type histogram where multiple data are stacked on top of each other.
- `'step'` generates a lineplot that is by default unfilled.
- `'stepfilled'` generates a lineplot that is by default filled.

**align:** [ `'left'` | `'mid'` | `'right'` ] Controls how the histogram is plotted.

- `'left'`: bars are centered on the left bin edges.
- `'mid'`: bars are centered between the bin edges.
- `'right'`: bars are centered on the right bin edges.

**orientation:** [ `'horizontal'` | `'vertical'` ] If `'horizontal'`, `barh()` will be used for bar-type histograms and the `bottom` kwarg will be the left edges.

***rwidth***: The relative width of the bars as a fraction of the bin width. If *None*, automatically compute the width. Ignored if *histtype* = ‘step’ or ‘stepfilled’.

***log***: If *True*, the histogram axis will be set to a log scale. If *log* is *True* and *x* is a 1D array, empty bins will be filtered out and only the non-empty (*n*, *bins*, *patches*) will be returned.

***color***: Color spec or sequence of color specs, one per dataset. Default (*None*) uses the standard line color sequence.

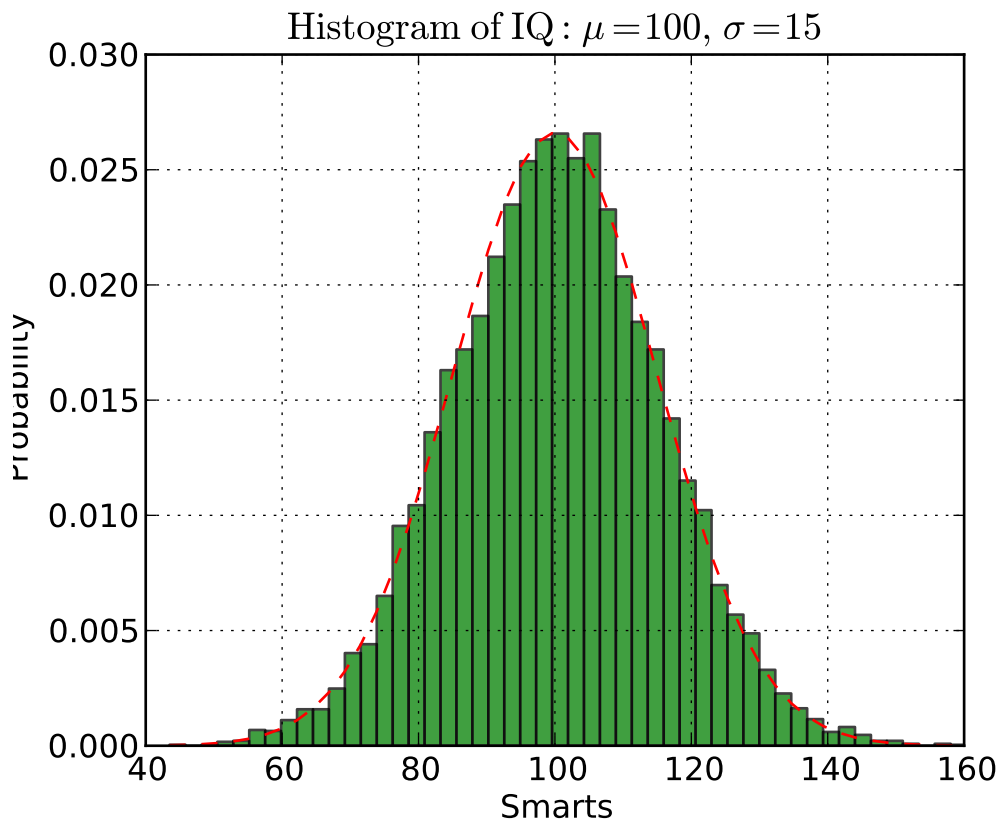
***label***: String, or sequence of strings to match multiple datasets. Bar charts yield multiple patches per dataset, but only the first gets the label, so that the legend command will work as expected:

```
ax.hist(10+2*np.random.randn(1000), label='men')
ax.hist(12+3*np.random.randn(1000), label='women', alpha=0.5)
ax.legend()
```

kwargs are used to update the properties of the [Patch](#) instances returned by *hist*:

| Property  | Description   |
|---|---|
| <a href="#">agg_filter</a>                        | unknown   |
| <a href="#">alpha</a>                             | float or None   |
| <a href="#">animated</a>                          | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">aa</a> | [True   False] or None for default  |
| <a href="#">axes</a>                              | an <a href="#">Axes</a> instance  |
| <a href="#">clip_box</a>                          | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <a href="#">clip_on</a>                           | [True   False]  |
| <a href="#">clip_path</a>                         | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <a href="#">color</a>                             | matplotlib color spec   |
| <a href="#">contains</a>                          | a callable function   |
| <a href="#">edgecolor</a> or <a href="#">ec</a>   | mpl color spec, or None for default, or ‘none’ for no color                             |
| <a href="#">facecolor</a> or <a href="#">fc</a>   | mpl color spec, or None for default, or ‘none’ for no color                             |
| <a href="#">figure</a>                            | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <a href="#">fill</a>                              | [True   False]  |
| <a href="#">gid</a>                               | an id string  |
| <a href="#">hatch</a>                             | [ ‘/’   ‘\’   ‘ ’   ‘-’   ‘+’   ‘x’   ‘o’   ‘O’   ‘.’   ‘*’ ]                           |
| <a href="#">label</a>                             | any string  |
| <a href="#">linestyle</a> or <a href="#">ls</a>   | [ ‘solid’   ‘dashed’   ‘dashdot’   ‘dotted’ ]   |
| <a href="#">linewidth</a> or <a href="#">lw</a>   | float or None for default   |
| <a href="#">lod</a>                               | [True   False]  |
| <a href="#">path_effects</a>                      | unknown   |
| <a href="#">picker</a>                            | [None float boolean callable]   |
| <a href="#">rasterized</a>                        | [True   False   None]   |
| <a href="#">snap</a>                              | unknown   |
| <a href="#">transform</a>                         | <a href="#">Transform</a> instance  |
| <a href="#">url</a>                               | a url string  |
| <a href="#">visible</a>                           | [True   False]  |
| <a href="#">zorder</a>                            | any number  |

Example:



Additional kwargs: `hold = [True|False]` overrides default hold state

**hlines**(*y*, *xmin*, *xmax*, *colors*='k', *linestyles*='solid', *label*='', *hold*=None, *\*\*kwargs*)

call signature:

`hlines(y, xmin, xmax, colors='k', linestyles='solid', **kwargs)`

Plot horizontal lines at each *y* from *xmin* to *xmax*.

Returns the [LineCollection](#) that was added.

Required arguments:

**y**: a 1-D numpy array or iterable.

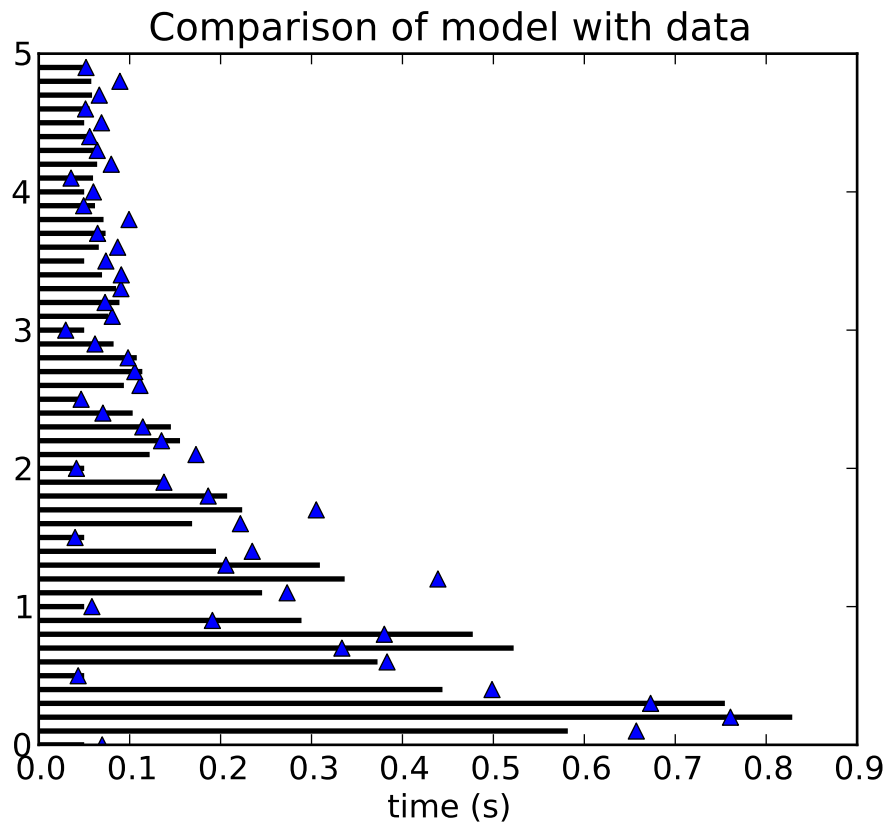
***xmin* and *xmax***: can be scalars or `len(x)` numpy arrays. If they are scalars, then the respective values are constant, else the widths of the lines are determined by *xmin* and *xmax*.

Optional keyword arguments:

***colors***: a line collections color argument, either a single color or a `len(y)` list of colors

***linestyles***: [ 'solid' | 'dashed' | 'dashdot' | 'dotted' ]

Example:



Additional kwargs: `hold = [True|False]` overrides default hold state

### **hold**(*b=None*)

Set the hold state. If *b* is `None` (default), toggle the hold state, else set the hold state to boolean value *b*:

```
hold()      # toggle hold
hold(True)  # hold is on
hold(False) # hold is off
```

When *hold* is `True`, subsequent plot commands will be added to the current axes. When *hold* is `False`, the current axes and figure will be cleared on the next plot command.

### **hot**()

set the default colormap to `hot` and apply to current image if any. See `help(colormaps)` for more information

### **hsv**()

set the default colormap to `hsv` and apply to current image if any. See `help(colormaps)` for more information

### **imread**(\*args, \*\*kwargs)

Return image file in *fname* as `numpy.array`. *fname* may be a string path or a Python file-like object.

If *format* is provided, will try to read file of that type, otherwise the format is deduced from the filename. If nothing can be deduced, PNG is tried.

Return value is a `numpy.array`. For grayscale images, the return array is  $M \times N$ . For RGB images, the return value is  $M \times N \times 3$ . For RGBA images the return value is  $M \times N \times 4$ .

matplotlib can only read PNGs natively, but if `PIL` is installed, it will use it to load the image and return an array (if possible) which can be used with `imshow()`.

**imsave**(\*args, \*\*kwargs)

Saves a 2D `numpy.array` as an image with one pixel per element. The output formats available depend on the backend being used.

**Arguments:**

**fname:** A string containing a path to a filename, or a Python file-like object. If *format* is *None* and *fname* is a string, the output format is deduced from the extension of the filename.

**arr:** A 2D array.

**Keyword arguments:**

**vmin/vmax:** [ *None* | *scalar* ] *vmin* and *vmax* set the color scaling for the image by fixing the values that map to the colormap color limits. If either *vmin* or *vmax* is *None*, that limit is determined from the *arr* min/max value.

**cmap:** *cmap* is a `colors.Colormap` instance, eg `cm.jet`. If *None*, default to the `rc image.cmap` value.

**format:** One of the file extensions supported by the active backend. Most backends support `png`, `pdf`, `ps`, `eps` and `svg`.

**origin** [ 'upper' | 'lower' ] Indicates where the [0,0] index of the array is in the upper left or lower left corner of the axes. Defaults to the `rc image.origin` value.

**dpi** The DPI to store in the metadata of the file. This does not affect the resolution of the output image.

**imshow**(*X*, *cmap=None*, *norm=None*, *aspect=None*, *interpolation=None*, *alpha=None*, *vmin=None*, *vmax=None*, *origin=None*, *extent=None*, *shape=None*, *filternorm=1*, *filterrad=4.0*, *imlim=None*, *resample=None*, *url=None*, *hold=None*, \*\*kwargs)  
call signature:

```
imshow(X, cmap=None, norm=None, aspect=None, interpolation=None,
       alpha=None, vmin=None, vmax=None, origin=None, extent=None,
       **kwargs)
```

Display the image in *X* to current axes. *X* may be a float array, a `uint8` array or a `PIL` image. If *X* is an array, *X* can have the following shapes:

- $M \times N$  – luminance (grayscale, float array only)
- $M \times N \times 3$  – RGB (float or `uint8` array)
- $M \times N \times 4$  – RGBA (float or `uint8` array)

The value for each component of  $M \times N \times 3$  and  $M \times N \times 4$  float arrays should be in the range 0.0 to 1.0;  $M \times N$  float arrays may be normalised.

An `matplotlib.image.AxesImage` instance is returned.



Keyword arguments:

**cmap:** [ **None** | **Colormap** ] A `matplotlib.cm.Colormap` instance, eg. `cm.jet`. If *None*, default to `rc image.cmap` value.

*cmap* is ignored when *X* has RGB(A) information

**aspect:** [ **None** | **'auto'** | **'equal'** | **scalar** ] If **'auto'**, changes the image aspect ratio to match that of the axes

If **'equal'**, and *extent* is *None*, changes the axes aspect ratio to match that of the image. If *extent* is not *None*, the axes aspect ratio is changed to match that of the extent.

If *None*, default to `rc image.aspect` value.

*interpolation:*

Acceptable values are *None*, **'none'**, **'nearest'**, **'bilinear'**, **'bicubic'**, **'spline16'**, **'spline36'**, **'hanning'**, **'hamming'**, **'hermite'**, **'kaiser'**, **'quadric'**, **'catrom'**, **'gaussian'**, **'bessel'**, **'mitchell'**, **'sinc'**, **'lanczos'**

If *interpolation* is *None*, default to `rc image.interpolation`. See also the *filtnorm* and *filterrad* parameters

If *interpolation* is **'none'**, then no interpolation is performed on the Agg, ps and pdf backends. Other backends will fall back to **'nearest'**.

**norm:** [ **None** | **Normalize** ] An `matplotlib.colors.Normalize` instance; if *None*, default is `normalization()`. This scales luminance -> 0-1

*norm* is only used for an MxN float array.

**vmin/vmax:** [ **None** | **scalar** ] Used to scale a luminance image to 0-1. If either is *None*, the min and max of the luminance values will be used. Note if *norm* is not *None*, the settings for *vmin* and *vmax* will be ignored.

**alpha:** **scalar** The alpha blending value, between 0 (transparent) and 1 (opaque) or *None*

**origin:** [ **None** | **'upper'** | **'lower'** ] Place the [0,0] index of the array in the upper left or lower left corner of the axes. If *None*, default to `rc image.origin`.

**extent:** [ **None** | **scalars (left, right, bottom, top)** ] Data limits for the axes. The default assigns zero-based row, column indices to the x, y centers of the pixels.

**shape:** [ **None** | **scalars (columns, rows)** ] For raw buffer images

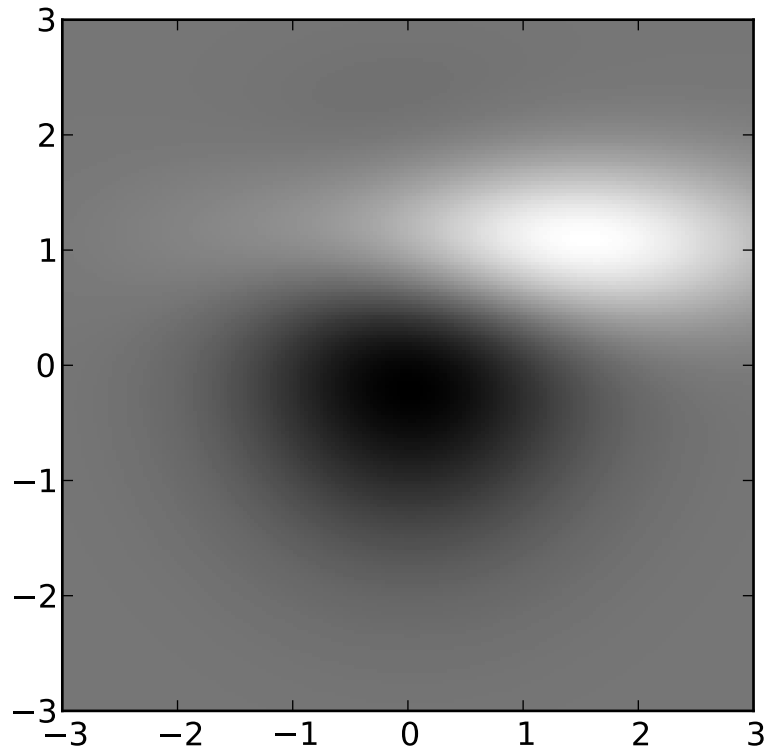
**filtnorm:** A parameter for the antigrain image resize filter. From the antigrain documentation, if *filtnorm* = 1, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule of 1.0 which means that any sum of pixel weights must be equal to 1.0. So, the filter function must produce a graph of the proper shape.

**filterrad:** The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: **'sinc'**, **'lanczos'** or **'blackman'**

Additional kwargs are [Artist](#) properties:

| Property                | Description  |
|-------------------------|--|
| <code>agg_filter</code> | unknown  |
| <code>alpha</code>      | float (0.0 transparent through 1.0 opaque)         |
| <code>animated</code>   | [True   False]                                     |
| <code>axes</code>       | an <code>Axes</code> instance                      |
| <code>clip_box</code>   | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>    | [True   False]                                     |
| <code>clip_path</code>  | [ (Path, Transform)   Patch   None ]               |
| <code>contains</code>   | a callable function                                |
| <code>figure</code>     | a <code>matplotlib.figure.Figure</code> instance   |
| <code>gid</code>        | an id string                                       |
| <code>label</code>      | any string   |
| <code>lod</code>        | [True   False]                                     |
| <code>picker</code>     | [None float boolean callable]                      |
| <code>rasterized</code> | [True   False   None]                              |
| <code>snap</code>       | unknown  |
| <code>transform</code>  | <code>Transform</code> instance                    |
| <code>url</code>        | a url string                                       |
| <code>visible</code>    | [True   False]                                     |
| <code>zorder</code>     | any number   |

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**ioff()**

Turn interactive mode off.

**ion()**

Turn interactive mode on.

**ishold()**

Return the hold status of the current axes

**isinteractive()**

Return *True* if matplotlib is in interactive mode, *False* otherwise.

**jet()**

set the default colormap to jet and apply to current image if any. See `help(colormaps)` for more information

**legend(\*args, \*\*kwargs)**

call signature:

```
legend(*args, **kwargs)
```

Place a legend on the current axes at location *loc*. Labels are a sequence of strings and *loc* can be a string or an integer specifying the legend location.

To make a legend with existing lines:

```
legend()
```

`legend()` by itself will try and build a legend using the label property of the lines/patches/collections. You can set the label of a line by doing:

```
plot(x, y, label='my data')
```

or:

```
line.set_label('my data').
```

If label is set to `'_nolegend_'`, the item will not be shown in legend.

To automatically generate the legend from labels:

```
legend( ('label1', 'label2', 'label3') )
```

To make a legend for a list of lines and labels:

```
legend( (line1, line2, line3), ('label1', 'label2', 'label3') )
```

To make a legend at a given location, using a location argument:

```
legend( ('label1', 'label2', 'label3'), loc='upper left')
```

or:

```
legend( (line1, line2, line3), ('label1', 'label2', 'label3'), loc=2)
```

The location codes are

| Location String | Location Code |
|-----------------|---------------|
| 'best'          | 0             |
| 'upper right'   | 1             |
| 'upper left'    | 2             |
| 'lower left'    | 3             |
| 'lower right'   | 4             |
| 'right'         | 5             |
| 'center left'   | 6             |
| 'center right'  | 7             |
| 'lower center'  | 8             |
| 'upper center'  | 9             |
| 'center'        | 10            |

Users can specify any arbitrary location for the legend using the *bbox\_to\_anchor* keyword argument. *bbox\_to\_anchor* can be an instance of *BboxBase*(or its derivatives) or a tuple of 2 or 4 floats. For example,

```
loc = 'upper right', bbox_to_anchor = (0.5, 0.5)
```

will place the legend so that the upper right corner of the legend at the center of the axes.

The legend location can be specified in other coordinate, by using the *bbox\_transform* keyword.

The *loc* itself can be a 2-tuple giving x,y of the lower-left corner of the legend in axes coords (*bbox\_to\_anchor* is ignored).

Keyword arguments:

**prop:** [ **None** | **FontProperties** | **dict** ] A `matplotlib.font_manager.FontProperties` instance. If *prop* is a dictionary, a new instance will be created with *prop*. If *None*, use rc settings.

**numpoints:** **integer** The number of points in the legend for line

**scatterpoints:** **integer** The number of points in the legend for scatter plot

**scatteroffsets:** **list of floats** a list of yoffsets for scatter symbols in legend

**markerscale:** [ **None** | **scalar** ] The relative size of legend markers vs. original. If *None*, use rc settings.

**frameon:** [ **True** | **False** ] if *True*, draw a frame around the legend. The default is set by the rcParam 'legend.frameon'

**fancybox:** [ **None** | **False** | **True** ] if *True*, draw a frame with a round fancybox. If *None*, use rc

**shadow:** [ **None** | **False** | **True** ] If *True*, draw a shadow behind legend. If *None*, use rc settings.

**ncol** [integer] number of columns. default is 1

**mode** [[ “expand” | None ]] if mode is “expand”, the legend will be horizontally expanded to fill the axes area (or *bbox\_to\_anchor*)

**bbox\_to\_anchor** [an instance of BboxBase or a tuple of 2 or 4 floats] the bbox that the legend will be anchored.

**bbox\_transform** [[ an instance of Transform | None ]] the transform for the bbox. transAxes if None.

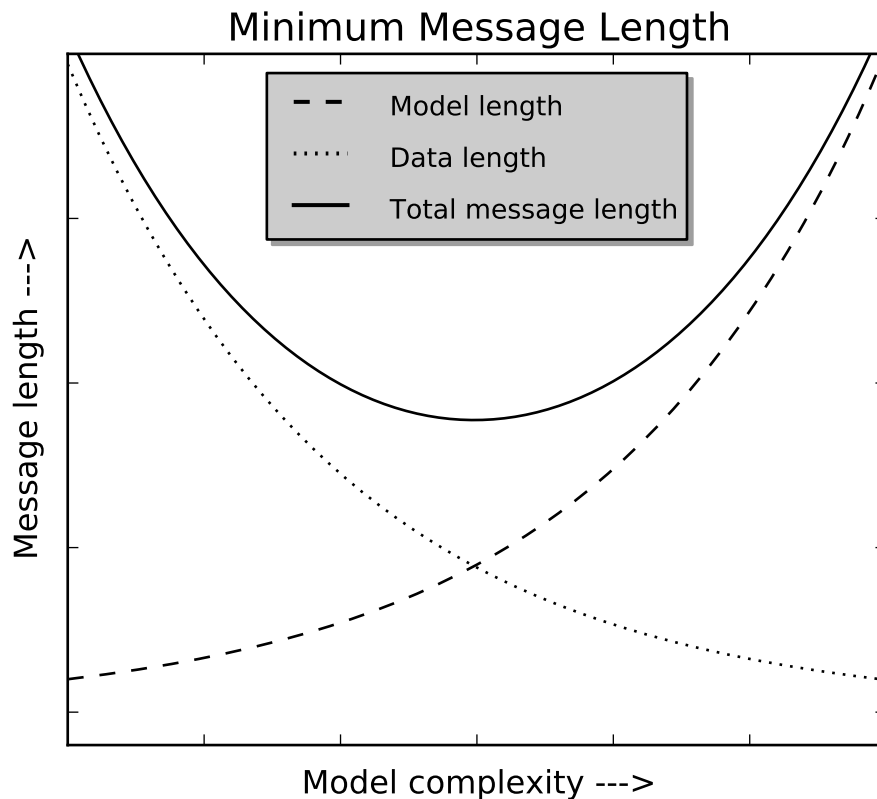
**title** [string] the legend title

Padding and spacing between various elements use following keywords parameters. These values are measure in font-size units. E.g., a fontsize of 10 points and a handlelength=5 implies a handlelength of 50 points. Values from rcParams will be used if None.

| Keyword       | Description  |
|---------------|--|
| borderpad     | the fractional whitespace inside the legend border |
| labelspacing  | the vertical space between the legend entries      |
| handlelength  | the length of the legend handles                   |
| handletextpad | the pad between the legend handle and text         |
| borderaxespad | the pad between the axes and legend border         |
| columnspacing | the spacing between columns                        |

**Note:** Not all kinds of artist are supported by the legend command. See [LINK](#) (FIXME) for details.

**Example:**



Also see [Legend guide](#).

**locator\_params**(*axis*='both', *tight*=None, *\*\*kwargs*)

Convenience method for controlling tick locators.

Keyword arguments:

**axis** ['x' | 'y' | 'both'] Axis on which to operate; default is 'both'.

**tight** [True | False | None] Parameter passed to `autoscale_view()`. Default is None, for no change.

Remaining keyword arguments are passed to directly to the `set_params()` method.

Typically one might want to reduce the maximum number of ticks and use tight bounds when plotting small subplots, for example:

```
ax.locator_params(tight=True, nbins=4)
```

Because the locator is involved in autoscaling, `autoscale_view()` is called automatically after the parameters are changed.

This presently works only for the `MaxNLocator` used by default on linear axes, but it may be generalized.

**loglog**(*\*args*, *\*\*kwargs*)

call signature:

```
loglog(*args, **kwargs)
```

Make a plot with log scaling on the *x* and *y* axis.

`loglog()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_xscale()` / `matplotlib.axes.Axes.set_yscale()`.

Notable keyword arguments:

**basex/basey**: **scalar > 1** base of the *x*/*y* logarithm

**subsx/subsy**: [ **None** | **sequence** ] the location of the minor *x*/*y* ticks; *None* defaults to autosubs, which depend on the number of decades in the plot; see `matplotlib.axes.Axes.set_xscale()` / `matplotlib.axes.Axes.set_yscale()` for details

**nonposx/nonposy**: ['mask' | 'clip' ] non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

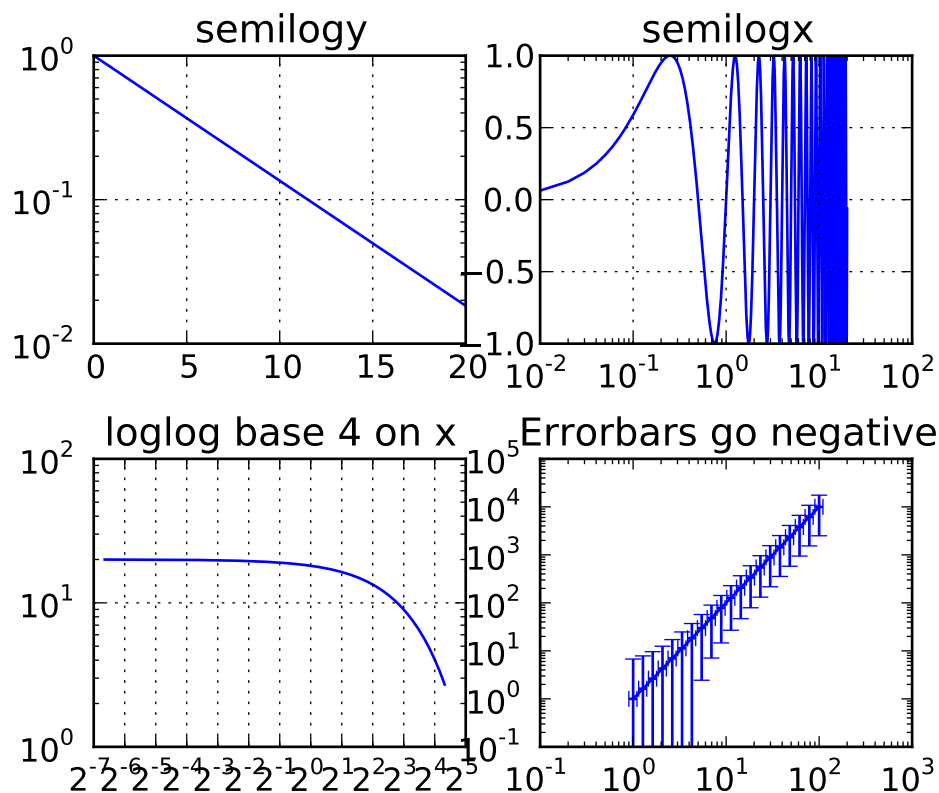
The remaining valid kwargs are `Line2D` properties:

| Property                                    | Description                                |
|---|--|
| <code>agg_filter</code>                     | unknown                                    |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque) |
| <code>animated</code>                       | [True   False]                             |
| <code>antialiased</code> or <code>aa</code> | [True   False]                             |
| <code>axes</code>                           | an <code>Axes</code> instance              |

Table 62.14 – continu

|  |  |
|--|--|
| <code>clip_box</code>                                  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]                     |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance  |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |
| <code>xdata</code>                                     | 1D array   |
| <code>ydata</code>                                     | 1D array   |
| <code>zorder</code>                                    | any number   |

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**margins**(\*args, \*\*kw)

Convenience method to set or retrieve autoscaling margins.

signatures:

`margins()`

returns `xmargin`, `ymargin`

`margins(margin)`

`margins(xmargin, ymargin)`

`margins(x=xmargin, y=ymargin)`

`margins(..., tight=False)`

All three forms above set the `xmargin` and `ymargin` parameters. All keyword parameters are optional. A single argument specifies both `xmargin` and `ymargin`. The *tight* parameter is passed to `autoscale_view()`, which is executed after a margin is changed; the default here is *True*, on the assumption that when margins are specified, no additional padding to match tick marks is usually desired. Setting *tight* to *None* will preserve the previous setting.



Specifying any margin changes only the autoscaling; for example, if *xmargin* is not *None*, then *xmargin* times the X data interval will be added to each end of that interval before it is used in autoscaling.

**matshow**(*A*, *fignum*=*None*, *\*\*kw*)

Display an array as a matrix in a new figure window.

The origin is set at the upper left hand corner and rows (first dimension of the array) are displayed horizontally. The aspect ratio of the figure window is that of the array, unless this would make an excessively short or narrow figure.

Tick labels for the xaxis are placed on top.

With the exception of *fignum*, keyword arguments are passed to [imshow\(\)](#). You may set the *origin* kwarg to “lower” if you want the first row in the array to be at the bottom instead of the top.

**fignum:** [ *None* | *integer* | *False* ] By default, [matshow\(\)](#) creates a new figure window with automatic numbering. If *fignum* is given as an integer, the created figure will use this figure number. Because of how [matshow\(\)](#) tries to set the figure aspect ratio to be the one of the array, if you provide the number of an already existing figure, strange things may happen.

If *fignum* is *False* or 0, a new figure window will **NOT** be created.

**minorticks\_off**()

Remove minor ticks from the current plot.

**minorticks\_on**()

Display minor ticks on the current plot.

Displaying minor ticks reduces performance; turn them off using [minorticks\\_off\(\)](#) if drawing speed is a problem.

**over**(*func*, *\*args*, *\*\*kwargs*)

over calls:

`func(*args, **kwargs)`

with `hold(True)` and then restores the hold state.

**pause**(*interval*)

Pause for *interval* seconds.

If there is an active figure it will be updated and displayed, and the gui event loop will run during the pause.

If there is no active figure, or if a non-interactive backend is in use, this executes `time.sleep(interval)`.

This can be used for crude animation. For more complex animation, see [matplotlib.animation](#).

This function is experimental; its behavior may be changed or extended in a future release.

**pcolor**(*\*args*, *\*\*kwargs*)

call signatures:

`pcolor(C, **kwargs)`

`pcolor(X, Y, C, **kwargs)`

Create a pseudocolor plot of a 2-D array.

$C$  is the array of color values.

$X$  and  $Y$ , if given, specify the  $(x, y)$  coordinates of the colored quadrilaterals; the quadrilateral for  $C[i,j]$  has corners at:

```
(X[i, j], Y[i, j]),  
(X[i, j+1], Y[i, j+1]),  
(X[i+1, j], Y[i+1, j]),  
(X[i+1, j+1], Y[i+1, j+1]).
```

Ideally the dimensions of  $X$  and  $Y$  should be one greater than those of  $C$ ; if the dimensions are the same, then the last row and column of  $C$  will be ignored.

Note that the column index corresponds to the  $x$ -coordinate, and the row index corresponds to  $y$ ; for details, see the [Grid Orientation](#) section below.

If either or both of  $X$  and  $Y$  are 1-D arrays or column vectors, they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

$X$ ,  $Y$  and  $C$  may be masked arrays. If either  $C[i, j]$ , or one of the vertices surrounding  $C[i, j]$  ( $X$  or  $Y$  at  $[i, j]$ ,  $[i+1, j]$ ,  $[i, j+1]$ ,  $[i+1, j+1]$ ) is masked, nothing is plotted.

Keyword arguments:

**cmap:** [ *None* | **Colormap** ] A `matplotlib.cm.Colormap` instance. If *None*, use rc settings.

**norm:** [ *None* | **Normalize** ] An `matplotlib.colors.Normalize` instance is used to scale luminance data to 0,1. If *None*, defaults to `normalize()`.

**vmin/vmax:** [ *None* | **scalar** ] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array  $C$  is used. If you pass a *norm* instance, *vmin* and *vmax* will be ignored.

**shading:** [ **'flat'** | **'faceted'** ] If **'faceted'**, a black grid is drawn around each rectangle; if **'flat'**, edges are not drawn. Default is **'flat'**, contrary to MATLAB.

**This kwarg is deprecated; please use 'edgecolors' instead:**

- shading='flat' – edgecolors='none'
- shading='faceted' – edgecolors='k'

**edgecolors:** [ *None* | **'none'** | **color** | **color sequence** ] If *None*, the rc setting is used by default.

If **'none'**, edges will not be visible.

An mpl color or sequence of colors will set the edge color

**alpha:**  $0 \leq \text{scalar} \leq 1$  or *None* the alpha blending value

Return value is a `matplotlib.collection.Collection` instance.

The grid orientation follows the MATLAB convention: an array  $C$  with shape  $(nrows, ncolumns)$  is plotted with the column number as  $X$  and the row number as  $Y$ , increasing up; hence it is plotted the way the array would be printed, except that the  $Y$  axis is reversed. That is,  $C$  is taken as  $C^*(y, x)$ .

Similarly for `meshgrid()`:

```
x = np.arange(5)
y = np.arange(3)
X, Y = meshgrid(x,y)
```

is equivalent to:

```
X = array([[0, 1, 2, 3, 4], [0, 1, 2, 3, 4], [0, 1, 2, 3, 4]])
Y = array([[0, 0, 0, 0, 0], [1, 1, 1, 1, 1], [2, 2, 2, 2, 2]])
```

so if you have:

```
C = rand( len(x), len(y))
```

then you need:

```
pcolor(X, Y, C.T)
```

or:

```
pcolor(C.T)
```

MATLAB `pcolor()` always discards the last row and column of  $C$ , but matplotlib displays the last row and column if  $X$  and  $Y$  are not specified, or if  $X$  and  $Y$  have one more row and column than  $C$ .

kwargs can be used to control the `PolyCollection` properties:

| Property  | Description  |
|---|--|
| <code>agg_filter</code>                               | unknown  |
| <code>alpha</code>                                    | float or None                                      |
| <code>animated</code>                                 | [True   False]                                     |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans                    |
| <code>array</code>                                    | unknown  |
| <code>axes</code>                                     | an <code>Axes</code> instance                      |
| <code>clim</code>                                     | a length 2 sequence of floats                      |
| <code>clip_box</code>                                 | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>                                  | [True   False]                                     |
| <code>clip_path</code>                                | [ (Path, Transform)   Patch   None ]               |
| <code>cmap</code>                                     | a colormap or registered colormap name             |
| <code>color</code>                                    | matplotlib color arg or sequence of rgba tuples    |
| <code>colorbar</code>                                 | unknown  |
| <code>contains</code>                                 | a callable function                                |
| <code>edgecolor</code> or <code>edgecolors</code>     | matplotlib color arg or sequence of rgba tuples    |
| <code>facecolor</code> or <code>facecolors</code>     | matplotlib color arg or sequence of rgba tuples    |

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|  |   |
|--|---|
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance  |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ <code>'solid'</code>   <code>'dashed'</code> , <code>'dashdot'</code> , <code>'dotted'</code>   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [ <code>None</code>  float boolean callable]  |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [ <code>True</code>   <code>False</code>   <code>None</code> ]  |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [ <code>True</code>   <code>False</code> ]  |
| <code>zorder</code>  | any number  |

Note: the default *antialiaseds* is `False` if the default *edgecolors*\*=`"none"` is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of *alpha*. If *\*edgecolors* is not `"none"`, then the default *antialiaseds* is taken from `rcParams['patch.antialiased']`, which defaults to `True`. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

Additional kwargs: `hold` = [`True`|`False`] overrides default hold state

**pcolormesh**(\*args, \*\*kwargs)

call signatures:

```
pcolormesh(C)
pcolormesh(X, Y, C)
pcolormesh(C, **kwargs)
```

*C* may be a masked array, but *X* and *Y* may not. Masked array support is implemented via *cmap* and *norm*; in contrast, `pcolor()` simply does not draw quadrilaterals with masked colors or vertices.

Keyword arguments:

**cmap:** [ `None` | `Colormap` ] A `matplotlib.cm.Colormap` instance. If `None`, use rc settings.

**norm:** [ `None` | `Normalize` ] A `matplotlib.colors.Normalize` instance is used to scale luminance data to 0,1. If `None`, defaults to `normalize()`.

**vmin/vmax:** [ `None` | `scalar` ] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are `None`, the min and max of the color array *C* is used. If you pass a *norm* instance, *vmin* and *vmax* will be ignored.

**shading:** [ 'flat' | 'faceted' | 'gouraud' ] If 'faceted', a black grid is drawn around each rectangle; if 'flat', edges are not drawn. Default is 'flat', contrary to MATLAB.

**This kwarg is deprecated; please use 'edgecolors' instead:**

- shading='flat' – edgecolors='None'
- shading='faceted' – edgecolors='k'

**edgecolors:** [ None | 'None' | color | color sequence ] If None, the rc setting is used by default.

If 'None', edges will not be visible.

An mpl color or sequence of colors will set the edge color

**alpha:**  $0 \leq \text{scalar} \leq 1$  or *None* the alpha blending value

Return value is a `matplotlib.collection.QuadMesh` object.

kwargs can be used to control the `matplotlib.collections.QuadMesh` properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float or None  |
| <code>animated</code>  | [True   False]   |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans  |
| <code>array</code>   | unknown  |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>clim</code>  | a length 2 sequence of floats  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                     |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                   |
| <code>cmap</code>  | a colormap or registered colormap name                                 |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                        |
| <code>colorbar</code>  | unknown  |
| <code>contains</code>  | a callable function  |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                        |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                       |
| <code>gid</code>   | an id string   |
| <code>label</code>   | any string   |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | ['solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats  |
| <code>lod</code>   | [True   False]   |
| <code>norm</code>  | unknown  |
| <code>offsets</code>   | float or sequence of floats  |
| <code>paths</code>   | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>pickradius</code>  | unknown  |
| <code>rasterized</code>  | [True   False   None]  |

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|                        |                                 |
|------------------------|---------------------------------|
| <code>snap</code>      | unknown                         |
| <code>transform</code> | <code>Transform</code> instance |
| <code>url</code>       | a url string                    |
| <code>urls</code>      | unknown                         |
| <code>visible</code>   | [True   False]                  |
| <code>zorder</code>    | any number                      |

**See Also:**

**`pcolor()`** For an explanation of the grid orientation and the expansion of 1-D *X* and/or *Y* to 2-D arrays.

Additional kwargs: `hold = [True|False]` overrides default hold state

**`pie(x, explode=None, labels=None, colors=None, autopct=None, pctdistance=0.59999999999999998, shadow=False, labeldistance=1.1000000000000001, hold=None)`**  
call signature:

```
pie(x, explode=None, labels=None,
    colors=('b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'),
    autopct=None, pctdistance=0.6, labeldistance=1.1, shadow=False)
```

Make a pie chart of array *x*. The fractional area of each wedge is given by *x*/sum(*x*). If sum(*x*) <= 1, then the values of *x* give the fractional area directly and the array will not be normalized.

Keyword arguments:

**`explode`:** [ **None** | **len(*x*) sequence** ] If not *None*, is a len(*x*) array which specifies the fraction of the radius with which to offset each wedge.

**`colors`:** [ **None** | **color sequence** ] A sequence of matplotlib color args through which the pie chart will cycle.

**`labels`:** [ **None** | **len(*x*) sequence of strings** ] A sequence of strings providing the labels for each wedge

**`autopct`:** [ **None** | **format string** | **format function** ] If not *None*, is a string or function used to label the wedges with their numeric value. The label will be placed inside the wedge. If it is a format string, the label will be `fmt%pct`. If it is a function, it will be called.

**`pctdistance`:** **scalar** The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*; default is 0.6.

**`labeldistance`:** **scalar** The radial distance at which the pie labels are drawn

**`shadow`:** [ **False** | **True** ] Draw a shadow beneath the pie.

The pie chart will probably look best if the figure and axes are square. Eg.:

```
figure(figsize=(8,8))
ax = axes([0.1, 0.1, 0.8, 0.8])
```

**Return value:** If *autopct* is *None*, return the tuple (*patches*, *texts*):

- *patches* is a sequence of `matplotlib.patches.Wedge` instances
- *texts* is a list of the label `matplotlib.text.Text` instances.

If *autopct* is not *None*, return the tuple (*patches*, *texts*, *autotexts*), where *patches* and *texts* are as above, and *autotexts* is a list of `Text` instances for the numeric labels.

Additional kwargs: `hold = [True|False]` overrides default hold state

### **pink()**

set the default colormap to pink and apply to current image if any. See `help(colormaps)` for more information

### **plot(\*args, \*\*kwargs)**

Plot lines and/or markers to the `Axes`. *args* is a variable length argument, allowing for multiple *x*, *y* pairs with an optional format string. For example, each of the following is legal:

```
plot(x, y)           # plot x and y using default line style and color
plot(x, y, 'bo')      # plot x and y using blue circle markers
plot(y)              # plot y using x as index array 0..N-1
plot(y, 'r+')         # ditto, but with red plusses
```

If *x* and/or *y* is 2-dimensional, then the corresponding columns will be plotted.

An arbitrary number of *x*, *y*, *fmt* groups can be specified, as in:

```
a.plot(x1, y1, 'g^', x2, y2, 'g-')
```

Return value is a list of lines that were added.

The following format string characters are accepted to control the line style or marker:

| character | description           |
|-----------|-----------------------|
| '_'       | solid line style      |
| '--'      | dashed line style     |
| '-.'      | dash-dot line style   |
| ':'       | dotted line style     |
| '.'       | point marker          |
| ','       | pixel marker          |
| 'o'       | circle marker         |
| 'v'       | triangle_down marker  |
| '^'       | triangle_up marker    |
| '<'       | triangle_left marker  |
| '>'       | triangle_right marker |
| '1'       | tri_down marker       |
| '2'       | tri_up marker         |
| '3'       | tri_left marker       |
| '4'       | tri_right marker      |
| 's'       | square marker         |
| 'p'       | pentagon marker       |
| '*'       | star marker           |
| 'h'       | hexagon1 marker       |
| 'H'       | hexagon2 marker       |
| '+'       | plus marker           |
| 'x'       | x marker              |
| 'D'       | diamond marker        |
| 'd'       | thin_diamond marker   |
| ' '       | vline marker          |
| '-'       | hline marker          |

The following color abbreviations are supported:

| character | color   |
|-----------|---------|
| 'b'       | blue    |
| 'g'       | green   |
| 'r'       | red     |
| 'c'       | cyan    |
| 'm'       | magenta |
| 'y'       | yellow  |
| 'k'       | black   |
| 'w'       | white   |

In addition, you can specify colors in many weird and wonderful ways, including full names ('green'), hex strings ('#008000'), RGB or RGBA tuples ((0,1,0,1)) or grayscale intensities as a string ('0.8'). Of these, the string specifications can be used in place of a `fmt` group, but the tuple forms can be used only as `kwargs`.

Line styles and colors are combined in a single format string, as in 'bo' for blue circles.

The *kwargs* can be used to set line properties (any property that has a `set_*` method). You can use this to set a line label (for auto legends), linewidth, antialiasing, marker face color, etc. Here is an example:



```
plot([1,2,3], [1,2,3], 'go-', label='line 1', linewidth=2)
plot([1,2,3], [1,4,9], 'rs', label='line 2')
axis([0, 4, 0, 10])
legend()
```

If you make multiple lines with one plot command, the kwargs apply to all those lines, e.g.:

```
plot(x1, y1, x2, y2, antialiased=False)
```

Neither line will be antialiased.

You do not need to use format strings, which are just abbreviations. All of the line properties can be controlled by keyword arguments. For example, you can set the color, marker, linestyle, and markercolor with:

```
plot(x, y, color='green', linestyle='dashed', marker='o',
      markerfacecolor='blue', markersize=12). See
      :class:`~matplotlib.lines.Line2D` for details.
```

The kwargs are [Line2D](#) properties:

| Property   | Description   |
|--|---|
| <a href="#">agg_filter</a>                             | unknown   |
| <a href="#">alpha</a>                                  | float (0.0 transparent through 1.0 opaque)  |
| <a href="#">animated</a>                               | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">aa</a>      | [True   False]  |
| <a href="#">axes</a>                                   | an <a href="#">Axes</a> instance  |
| <a href="#">clip_box</a>                               | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <a href="#">clip_on</a>                                | [True   False]  |
| <a href="#">clip_path</a>                              | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <a href="#">color</a> or <a href="#">c</a>             | any matplotlib color  |
| <a href="#">contains</a>                               | a callable function   |
| <a href="#">dash_capstyle</a>                          | ['butt'   'round'   'projecting']   |
| <a href="#">dash_joinstyle</a>                         | ['miter'   'round'   'bevel']   |
| <a href="#">dashes</a>                                 | sequence of on/off ink in points  |
| <a href="#">data</a>                                   | 2D array (rows are x, y) or two 1D arrays   |
| <a href="#">drawstyle</a>                              | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <a href="#">figure</a>                                 | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <a href="#">fillstyle</a>                              | ['full'   'left'   'right'   'bottom'   'top']  |
| <a href="#">gid</a>                                    | an id string  |
| <a href="#">label</a>                                  | any string  |
| <a href="#">linestyle</a> or <a href="#">ls</a>        | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <a href="#">linewidth</a> or <a href="#">lw</a>        | float value in points   |
| <a href="#">lod</a>                                    | [True   False]  |
| <a href="#">marker</a>                                 | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <a href="#">markeredgecolor</a> or <a href="#">mec</a> | any matplotlib color  |
| <a href="#">markeredgewidth</a> or <a href="#">mew</a> | float value in points   |

|  |   |
|--|---|
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code> |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance                           |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

kwargs `scalex` and `scaley`, if defined, are passed on to `autoscale_view()` to determine whether the *x* and *y* axes are autoscaled; the default is *True*.

Additional kwargs: `hold` = [True|False] overrides default hold state

**plot\_date**(*x*, *y*, *fmt*='bo', *tz*=None, *xdate*=True, *ydate*=False, *hold*=None, **\*\*kwargs**)

call signature:

```
plot_date(x, y, fmt='bo', tz=None, xdate=True, ydate=False, **kwargs)
```

Similar to the `plot()` command, except the *x* or *y* (or both) data is considered to be dates, and the axis is labeled accordingly.

*x* and/or *y* can be a sequence of dates represented as float days since 0001-01-01 UTC.

Keyword arguments:

**fmt: string** The plot format string.

**tz: [ None | timezone string | tzinfo instance ]** The time zone to use in labeling dates. If *None*, defaults to rc value.

**xdate: [ True | False ]** If *True*, the *x*-axis will be labeled with dates.

**ydate: [ False | True ]** If *True*, the *y*-axis will be labeled with dates.

Note if you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to `plot_date()` since `plot_date()` will set the default tick locator to `matplotlib.dates.AutoDateLocator` (if the tick locator is not already set to a `matplotlib.dates.DateLocator` instance) and the default tick formatter to `matplotlib.dates.AutoDateFormatter` (if the tick formatter is not already set to a `matplotlib.dates.DateFormatter` instance).

Valid kwargs are [Line2D](#) properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <code>matplotlib.transforms.Bbox</code> instance  |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '-'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance   |
| <code>url</code>                                       | a url string  |
| <code>visible</code>                                   | [True   False]  |
| <code>xdata</code>                                     | 1D array  |
| <code>ydata</code>                                     | 1D array  |
| <code>zorder</code>                                    | any number  |

See Also:

`dates` for helper functions

`date2num()`, `num2date()` and `drange()` for help on creating the required floating point dates.

Additional kwargs: `hold = [True|False]` overrides default hold state

**plotfile**(*fname*, *cols*=(0, ), *plotfuncs*=None, *comments*='#', *skiprows*=0, *checkrows*=5, *delimiter*=', ', *names*=None, *subplots*=True, *newfig*=True, *\*\*kwargs*)  
Plot the data in *fname*

*cols* is a sequence of column identifiers to plot. An identifier is either an int or a string. If it is an int, it indicates the column number. If it is a string, it indicates the column header. matplotlib will make column headers lower case, replace spaces with underscores, and remove all illegal characters; so 'Adj Close\*' will have name 'adj\_close'.

- If `len(cols) == 1`, only that column will be plotted on the y axis.
- If `len(cols) > 1`, the first element will be an identifier for data for the x axis and the remaining elements will be the column indexes for multiple subplots if *subplots* is *True* (the default), or for lines in a single subplot if *subplots* is *False*.

*plotfuncs*, if not *None*, is a dictionary mapping identifier to an [Axes](#) plotting function as a string. Default is 'plot', other choices are 'semilogy', 'fill', 'bar', etc. You must use the same type of identifier in the *cols* vector as you use in the *plotfuncs* dictionary, eg., integer column numbers in both or column names in both. If *subplots* is *False*, then including any function such as 'semilogy' that changes the axis scaling will set the scaling for all columns.

*comments*, *skiprows*, *checkrows*, *delimiter*, and *names* are all passed on to `matplotlib.pyplot.csv2rec()` to load the data into a record array.

If *newfig* is *True*, the plot always will be made in a new figure; if *False*, it will be made in the current figure if one exists, else in a new figure.

kwargs are passed on to plotting functions.

Example usage:

```
# plot the 2nd and 4th column against the 1st in two subplots
plotfile(fname, (0,1,3))

# plot using column names; specify an alternate plot type for volume
plotfile(fname, ('date', 'volume', 'adj_close'),
          plotfuncs={'volume': 'semilogy'})
```

Note: `plotfile` is intended as a convenience for quickly plotting data from flat files; it is not intended as an alternative interface to general plotting with `pyplot` or `matplotlib`.

## plotting()

Plotting commands

| Command           | Description                           |
|-------------------|---------------------------------------|
| <code>axes</code> | Create a new axes                     |
| <code>axis</code> | Set or return the current axis limits |
| <code>bar</code>  | make a bar chart                      |

Table 62.19 – continued from previous page

|               |   |
|---------------|---|
| boxplot       | make a box and whiskers chart   |
| cla           | clear current axes  |
| clabel        | label a contour plot  |
| clf           | clear a figure window   |
| close         | close a figure window   |
| colorbar      | add a colorbar to the current figure  |
| cohere        | make a plot of coherence  |
| contour       | make a contour plot   |
| contourf      | make a filled contour plot  |
| csd           | make a plot of cross spectral density   |
| draw          | force a redraw of the current figure  |
| errorbar      | make an errorbar graph  |
| figlegend     | add a legend to the figure  |
| figimage      | add an image to the figure, w/o resampling  |
| figtext       | add text in figure coords   |
| figure        | create or change active figure  |
| fill          | make filled polygons  |
| fill_between  | make filled polygons between two sets of y-values   |
| fill_betweenx | make filled polygons between two sets of x-values   |
| gca           | return the current axes   |
| gcf           | return the current figure   |
| gci           | get the current image, or None  |
| getp          | get a graphics property   |
| hist          | make a histogram  |
| hold          | set the hold state on current axes  |
| legend        | add a legend to the axes  |
| loglog        | a log log plot  |
| imread        | load image file into array  |
| imsave        | save array as an image file   |
| imshow        | plot image data   |
| matshow       | display a matrix in a new figure preserving aspect  |
| pcolor        | make a pseudocolor plot   |
| plot          | make a line plot  |
| plotfile      | plot data from a flat file  |
| psd           | make a plot of power spectral density   |
| quiver        | make a direction field (arrows) plot  |
| rc            | control the default params  |
| savefig       | save the current figure   |
| scatter       | make a scatter plot   |
| setp          | set a graphics property   |
| semilogx      | log x axis  |
| semilogy      | log y axis  |
| show          | in non-interactive mode, display all figures and block until they have been closed; in interactive mode, show |
| specgram      | a spectrogram plot  |
| stem          | make a stem plot  |
| subplot       | make a subplot (numrows, numcols, axesnum)  |

Table 62.19 – continued from previous page

|        |   |
|--------|---|
| table  | add a table to the axes                           |
| text   | add some text at location x,y to the current axes |
| title  | add a title to the current axes                   |
| xlabel | add an xlabel to the current axes                 |
| ylabel | add a ylabel to the current axes                  |

The following commands will set the default colormap accordingly:

- autumn
- bone
- cool
- copper
- flag
- gray
- hot
- hsv
- jet
- pink
- prism
- spring
- summer
- winter
- spectral

**polar**(\*args, \*\*kwargs)

call signature:

`polar(theta, r, **kwargs)`

Make a polar plot. Multiple *theta*, *r* arguments are supported, with format strings, as in `plot()`.

An optional kwarg *resolution* sets the number of vertices to interpolate between each pair of points. The default is 1, which disables interpolation.

**prism**()

set the default colormap to prism and apply to current image if any. See `help(colormaps)` for more information

**psd**(x, NFFT=256, Fs=2, Fc=0, detrend=<function detrend\_none at 0x3110050>, window=<function window\_hanning at 0x310a2a8>, noverlap=0, pad\_to=None, sides='default', scale\_by\_freq=None, hold=None, \*\*kwargs)

call signature:

```
psd(x, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
    window=mlab.window_hanning, noverlap=0, pad_to=None,
    sides='default', scale_by_freq=None, **kwargs)
```

The power spectral density by Welch's average periodogram method. The vector  $x$  is divided into  $NFFT$  length segments. Each segment is detrended by function *detrend* and windowed by function *window*. *noverlap* gives the length of the overlap between segments. The  $|fft(i)|^2$  of each segment  $i$  are averaged to compute  $P_{xx}$ , with a scaling to correct for power loss due to windowing.  $Fs$  is the sampling frequency.

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length *NFFT*. To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from *NFFT*, which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to *NFFT*.

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

**Fc: integer** The center frequency of  $x$  (defaults to 0), which offsets the x extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

Returns the tuple  $(P_{xx}, freqs)$ .

For plotting, the power is plotted as  $10 \log_{10}(P_{xx})$  for decibels, though  $P_{xx}$  itself is returned.

**References:** Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

kwargs control the [Line2D](#) properties:

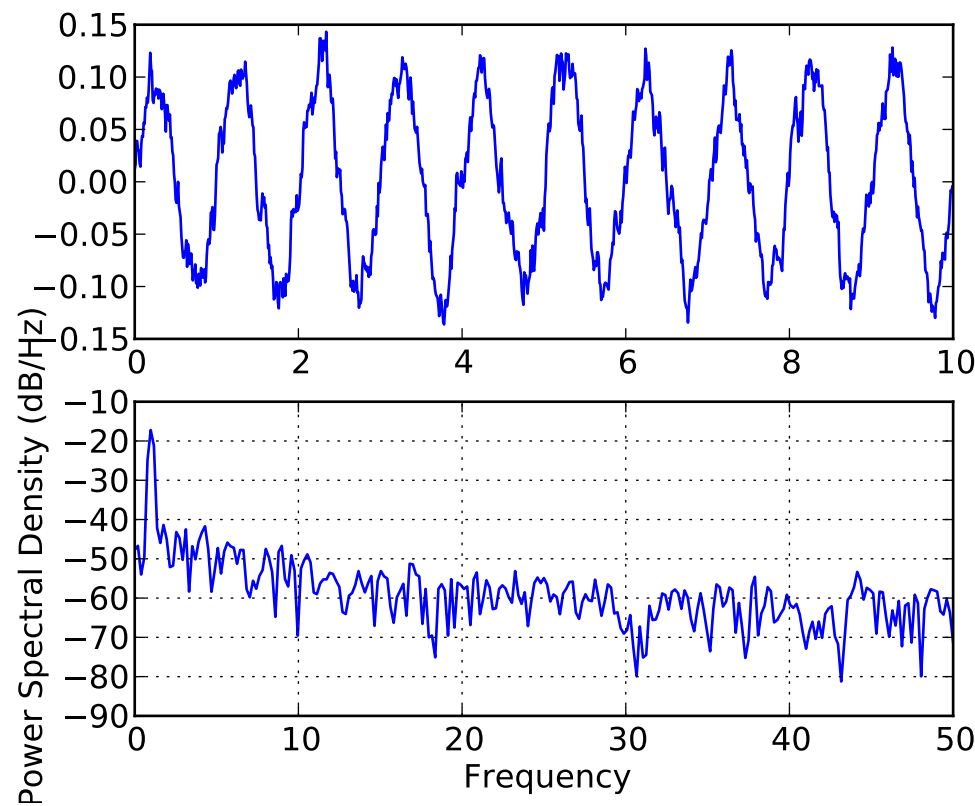
| Property   | Description   |
|--|---|
| <code>agg_filter</code>                                | unknown   |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                                  | [True   False]  |
| <code>antialiased</code> or <code>aa</code>            | [True   False]  |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance   |
| <code>clip_on</code>                                   | [True   False]  |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]             |
| <code>color</code> or <code>c</code>                   | any matplotlib color  |
| <code>contains</code>                                  | a callable function   |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']   |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']   |
| <code>dashes</code>                                    | sequence of on/off ink in points  |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                  |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance   |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']  |
| <code>gid</code>                                       | an id string  |
| <code>label</code>                                     | any string  |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   ' ' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points   |
| <code>lod</code>                                       | [True   False]  |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ' '   'None'   None   ' '   '8'   'p'   ' '   ' ' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color  |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points   |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color  |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color  |
| <code>markersize</code> or <code>ms</code>             | float   |
| <code>markevery</code>                                 | None   integer   (startind, stride)   |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                   |
| <code>pickradius</code>                                | float distance in points  |
| <code>rasterized</code>                                | [True   False   None]   |
| <code>snap</code>                                      | unknown   |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']   |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']   |



Table 62.20 – continu

|                        |   |
|------------------------|---|
| <code>transform</code> | a <code>matplotlib.transforms.Transform</code> instance |
| <code>url</code>       | a url string  |
| <code>visible</code>   | [True   False]  |
| <code>xdata</code>     | 1D array  |
| <code>ydata</code>     | 1D array  |
| <code>zorder</code>    | any number  |

Example:



Additional kwargs: `hold = [True|False]` overrides default hold state

**quiver**(\*args, \*\*kw)

Plot a 2-D field of arrows.

call signatures:

```
quiver(U, V, **kw)
quiver(U, V, C, **kw)
quiver(X, Y, U, V, **kw)
quiver(X, Y, U, V, C, **kw)
```

Arguments:

*X, Y*:

The *x* and *y* coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

*U, V*:

give the *x* and *y* components of the arrow vectors

*C*: an optional array used to map colors to the arrows

All arguments may be 1-D or 2-D arrays or sequences. If *X* and *Y* are absent, they will be generated as a uniform grid. If *U* and *V* are 2-D arrays but *X* and *Y* are 1-D, and if `len(X)` and `len(Y)` match the column and row dimensions of *U*, then *X* and *Y* will be expanded with `numpy.meshgrid()`.

*U, V, C* may be masked arrays, but masked *X, Y* are not supported at present.

Keyword arguments:

***units***: ['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy']

arrow units; the arrow dimensions *except for length* are in multiples of this unit.

- 'width' or 'height': the width or height of the axes
- 'dots' or 'inches': pixels or inches, based on the figure dpi
- 'x', 'y', or 'xy': *X, Y*, or  $\sqrt{X^2+Y^2}$  data units

The arrows scale differently depending on the units. For 'x' or 'y', the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For 'width' or 'height', the arrow size increases with the width and height of the axes, respectively, when the window is resized; for 'dots' or 'inches', resizing does not change the arrows.

***angles***: ['uv' | 'xy' | array] With the default 'uv', the arrow aspect ratio is 1, so that if  $U==V$  the angle of the arrow on the plot is 45 degrees CCW from the *x*-axis. With 'xy', the arrow points from (*x,y*) to (*x+u, y+v*). Alternatively, arbitrary angles may be specified as an array of values in degrees, CCW from the *x*-axis.

***scale***: [ None | float ]

data units per arrow length unit, e.g. m/s per plot width; a smaller scale parameter makes the arrow longer. If *None*, a simple autoscaling algorithm is used, based on the average vector length and the number of vectors. The arrow length unit is given by the *scale\_units* parameter

***scale\_units***: *None*, or any of the *units* options. For example, if *scale\_units* is 'inches', *scale* is 2.0, and (*u,v*) = (1,0), then the vector will be 0.5 inches long. If *scale\_units* is 'width', then the vector will be half the width of the axes. If *scale\_units* is 'x' then the vector will be 0.5 *x*-axis units. To plot vectors in the *x-y* plane, with *u* and *v* having the same units as *x* and *y*, use "angles='xy', scale\_units='xy', scale=1".

**width:** shaft width in arrow units; default depends on choice of units, above, and number of vectors; a typical starting value is about 0.005 times the width of the plot.

**headwidth:** **scalar** head width as multiple of shaft width, default is 3

**headlength:** **scalar** head length as multiple of shaft width, default is 5

**headaxislength:** **scalar** head length at shaft intersection, default is 4.5

**minshaft:** **scalar** length below which arrow scales, in units of head length. Do not set this to less than 1, or small arrows will look terrible! Default is 1

**minlength:** **scalar** minimum length as a multiple of shaft width; if an arrow length is less than this, plot a dot (hexagon) of this diameter instead. Default is 1.

**pivot:** [ **'tail'** | **'middle'** | **'tip'** ] The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*.

**color:** [ **color** | **color sequence** ] This is a synonym for the [PolyCollection](#) facecolor kwarg. If *C* has been set, *color* has no effect.

The defaults give a slightly swept-back arrow; to make the head a triangle, make *headaxislength* the same as *headlength*. To make the arrow more pointed, reduce *headwidth* or increase *headlength* and *headaxislength*. To make the head smaller relative to the shaft, scale down all the head parameters. You will probably do best to leave minshaft alone.

linewidths and edgecolors can be used to customize the arrow outlines. Additional [PolyCollection](#) keyword arguments:

| Property  | Description   |
|---|---|
| <a href="#">agg_filter</a>  | unknown   |
| <a href="#">alpha</a>   | float or None   |
| <a href="#">animated</a>  | [True   False]  |
| <a href="#">antialiased</a> or <a href="#">antialiaseds</a>                       | Boolean or sequence of booleans   |
| <a href="#">array</a>   | unknown   |
| <a href="#">axes</a>  | an <a href="#">Axes</a> instance  |
| <a href="#">clim</a>  | a length 2 sequence of floats   |
| <a href="#">clip_box</a>  | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <a href="#">clip_on</a>   | [True   False]  |
| <a href="#">clip_path</a>   | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <a href="#">cmap</a>  | a colormap or registered colormap name  |
| <a href="#">color</a>   | matplotlib color arg or sequence of rgba tuples   |
| <a href="#">colorbar</a>  | unknown   |
| <a href="#">contains</a>  | a callable function   |
| <a href="#">edgecolor</a> or <a href="#">edgecolors</a>                           | matplotlib color arg or sequence of rgba tuples   |
| <a href="#">facecolor</a> or <a href="#">facecolors</a>                           | matplotlib color arg or sequence of rgba tuples   |
| <a href="#">figure</a>  | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <a href="#">gid</a>   | an id string  |
| <a href="#">label</a>   | any string  |
| <a href="#">linestyle</a> or <a href="#">linestyles</a> or <a href="#">dashes</a> | ['solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ]                  |
| <a href="#">linewidth</a> or <a href="#">lw</a> or <a href="#">linewidths</a>     | float or sequence of floats   |

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|                         |                                 |
|-------------------------|---------------------------------|
| <code>lod</code>        | [True   False]                  |
| <code>norm</code>       | unknown                         |
| <code>offsets</code>    | float or sequence of floats     |
| <code>paths</code>      | unknown                         |
| <code>picker</code>     | [None float boolean callable]   |
| <code>pickradius</code> | unknown                         |
| <code>rasterized</code> | [True   False   None]           |
| <code>snap</code>       | unknown                         |
| <code>transform</code>  | <code>Transform</code> instance |
| <code>url</code>        | a url string                    |
| <code>urls</code>       | unknown                         |
| <code>visible</code>    | [True   False]                  |
| <code>zorder</code>     | any number                      |

Additional kwargs: `hold = [True|False]` overrides default hold state

**quiverkey**(\*args, \*\*kw)

Add a key to a quiver plot.

call signature:

`quiverkey(Q, X, Y, U, label, **kw)`

Arguments:

**Q**: The Quiver instance returned by a call to `quiver`.

**X, Y**: The location of the key; additional explanation follows.

**U**: The length of the key

**label**: a string with the length and units of the key

Keyword arguments:

**coordinates** = [ 'axes' | 'figure' | 'data' | 'inches' ] Coordinate system and units for X, Y: 'axes' and 'figure' are normalized coordinate systems with 0,0 in the lower left and 1,1 in the upper right; 'data' are the axes data coordinates (used for the locations of the vectors in the quiver plot itself); 'inches' is position in the figure in inches, with 0,0 at the lower left corner.

**color**: overrides face and edge colors from *Q*.

**labelpos** = [ 'N' | 'S' | 'E' | 'W' ] Position the label above, below, to the right, to the left of the arrow, respectively.

**labelsep**: Distance in inches between the arrow and the label. Default is 0.1

**labelcolor**: defaults to default `Text` color.

**fontproperties:** A dictionary with keyword arguments accepted by the `FontProperties` initializer: *family, style, variant, size, weight*

Any additional keyword arguments are used to override vector properties taken from *Q*.

The positioning of the key depends on *X, Y, coordinates*, and *labelpos*. If *labelpos* is 'N' or 'S', *X, Y* give the position of the middle of the key arrow. If *labelpos* is 'E', *X, Y* positions the head, and if *labelpos* is 'W', *X, Y* positions the tail; in either of these two cases, *X, Y* is somewhere in the middle of the arrow+label key object.

Additional kwargs: `hold = [True|False]` overrides default hold state

**rc(\*args, \*\*kwargs)**

Set the current rc params. Group is the grouping for the rc, eg. for `lines.linewidth` the group is `lines`, for `axes.facecolor`, the group is `axes`, and so on. Group may also be a list or tuple of group names, eg. (*xtick, ytick*). *kwargs* is a dictionary attribute name/value pairs, eg:

```
rc('lines', linewidth=2, color='r')
```

sets the current rc params and is equivalent to:

```
rcParams['lines.linewidth'] = 2
rcParams['lines.color'] = 'r'
```

The following aliases are available to save typing for interactive users:

| Alias | Property          |
|-------|-------------------|
| 'lw'  | 'linewidth'       |
| 'ls'  | 'linestyle'       |
| 'c'   | 'color'           |
| 'fc'  | 'facecolor'       |
| 'ec'  | 'edgecolor'       |
| 'mew' | 'markeredgewidth' |
| 'aa'  | 'antialiased'     |

Thus you could abbreviate the above rc command as:

```
rc('lines', lw=2, c='r')
```

Note you can use python's kwargs dictionary facility to store dictionaries of default parameters. Eg, you can customize the font rc as follows:

```
font = {'family' : 'monospace',
        'weight' : 'bold',
        'size'   : 'larger'}
```

```
rc('font', **font) # pass in the font dict as kwargs
```

This enables you to easily switch between several configurations. Use `rcdefaults()` to restore the default rc params after changes.

**rcdefaults()**

Restore the default rc params - these are not the params loaded by the rc file, but mpl's internal params. See `rc_file_defaults` for reloading the default params from the rc file

**rgrids(\*args, \*\*kwargs)**

Set/Get the radial locations of the gridlines and ticklabels on a polar plot.

call signatures:

```
lines, labels = rgrids()
lines, labels = rgrids(radii, labels=None, angle=22.5, **kwargs)
```

When called with no arguments, `rgrid()` simply returns the tuple *(lines, labels)*, where *lines* is an array of radial gridlines ([Line2D](#) instances) and *labels* is an array of tick labels ([Text](#) instances). When called with arguments, the labels will appear at the specified radial distances and angles.

*labels*, if not *None*, is a `len(radii)` list of strings of the labels to use at each angle.

If *labels* is *None*, the `rformatter` will be used

Examples:

```
# set the locations of the radial gridlines and labels
lines, labels = rgrids( (0.25, 0.5, 1.0) )

# set the locations and labels of the radial gridlines and labels
lines, labels = rgrids( (0.25, 0.5, 1.0), ('Tom', 'Dick', 'Harry' )
```

**savefig(\*args, \*\*kwargs)**

call signature:

```
savefig(fname, dpi=None, facecolor='w', edgecolor='w',
        orientation='portrait', papertype=None, format=None,
        transparent=False, bbox_inches=None, pad_inches=0.1):
```

Save the current figure.

The output formats available depend on the backend being used.

Arguments:

***fname***: A string containing a path to a filename, or a Python file-like object, or possibly some backend-dependent object such as [PdfPages](#).

If *format* is *None* and *fname* is a string, the output format is deduced from the extension of the filename. If the filename has no extension, the value of the rc parameter `savefig.extension` is used. If that value is 'auto', the backend determines the extension.

If *fname* is not a string, remember to specify *format* to ensure that the correct backend is used.

Keyword arguments:

**dpi:** [ *None* | scalar > 0 ] The resolution in dots per inch. If *None* it will default to the value `savefig.dpi` in the `matplotlibrc` file.

**facecolor, edgecolor:** the colors of the figure rectangle

**orientation:** [ 'landscape' | 'portrait' ] not supported on all backends; currently only on postscript output

**papertype:** One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.

**format:** One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

**transparent:** If *True*, the axes patches will all be transparent; the figure patch will also be transparent unless `facecolor` and/or `edgecolor` are specified via `kwargs`. This is useful, for example, for displaying a plot on top of a colored background on a web page. The transparency of these patches will be restored to their original values upon exit of this function.

**bbox\_inches:** Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure.

**pad\_inches:** Amount of padding around the figure when `bbox_inches` is 'tight'.

**bbox\_extra\_artists:** A list of extra artists that will be considered when the tight bbox is calculated.

### **sca**(*ax*)

Set the current Axes instance to *ax*. The current Figure is updated to the parent of *ax*.

**scatter**(*x*, *y*, *s*=20, *c*='b', *marker*='o', *cmap*=None, *norm*=None, *vmin*=None, *vmax*=None, *alpha*=None, *linewidths*=None, *faceted*=True, *verts*=None, *hold*=None, *\*\*kwargs*)  
call signatures:

```
scatter(x, y, s=20, c='b', marker='o', cmap=None, norm=None,
        vmin=None, vmax=None, alpha=None, linewidths=None,
        verts=None, **kwargs)
```

Make a scatter plot of *x* versus *y*, where *x*, *y* are converted to 1-D sequences which must be of the same length, *N*.

Keyword arguments:

**s:** size in points<sup>2</sup>. It is a scalar or an array of the same length as *x* and *y*.

**c:** a color. *c* can be a single color format string, or a sequence of color specifications of length *N*, or a sequence of *N* numbers to be mapped to colors using the *cmap* and *norm* specified via `kwargs` (see below). Note that *c* should not be a single numeric RGB or RGBA sequence because that is indistinguishable from an array of values to be colormapped. *c* can be a 2-D array in which the rows are RGB or RGBA, however.

**marker:** can be one of:

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| marker                          | description                            |
|---------------------------------|--|
| 7                               | caretdown                              |
| 4                               | caretleft                              |
| 5                               | caretright                             |
| 6                               | caretup                                |
| 'o'                             | circle                                 |
| 'D'                             | diamond                                |
| 'h'                             | hexagon1                               |
| 'H'                             | hexagon2                               |
| '_'                             | hline                                  |
| ''                              | nothing                                |
| 'None'                          | nothing                                |
| None                            | nothing                                |
| ','                             | nothing                                |
| '8'                             | octagon                                |
| 'p'                             | pentagon                               |
| ','                             | pixel                                  |
| '+'                             | plus                                   |
| '.'                             | point                                  |
| 's'                             | square                                 |
| '*'                             | star                                   |
| 'd'                             | thin_diamond                           |
| 3                               | tickdown                               |
| 0                               | tickleft                               |
| 1                               | tickright                              |
| 2                               | tickup                                 |
| '1'                             | tri_down                               |
| '3'                             | tri_left                               |
| '4'                             | tri_right                              |
| '2'                             | tri_up                                 |
| 'v'                             | triangle_down                          |
| '<'                             | triangle_left                          |
| '>'                             | triangle_right                         |
| '^'                             | triangle_up                            |
| ' '                             | vline                                  |
| 'x'                             | x                                      |
| '\$...\$'                       | render the string using mathtext       |
| <i>verts</i>                    | a list of (x, y) pairs in range (0, 1) |
| <i>(numsides, style, angle)</i> | see below                              |

The marker can also be a tuple (*numsides*, *style*, *angle*), which will create a custom, regular symbol.

***numsides***: the number of sides

***style***: the style of the regular symbol:



| Value | Description   |
|-------|---|
| 0     | a regular polygon                                       |
| 1     | a star-like symbol                                      |
| 2     | an asterisk   |
| 3     | a circle ( <i>numsides</i> and <i>angle</i> is ignored) |

**angle:** the angle of rotation of the symbol

For backward compatibility, the form (*verts*, 0) is also accepted, but it is equivalent to just *verts* for giving a raw set of vertices that define the shape.

Any or all of *x*, *y*, *s*, and *c* may be masked arrays, in which case all masks will be combined and only unmasked points will be plotted.

Other keyword arguments: the color mapping and normalization arguments will be used only if *c* is an array of floats.

**cmap:** [ **None** | **Colormap** ] A `matplotlib.colors.Colormap` instance or registered name. If *None*, defaults to `rc.image.cmap`. *cmap* is only used if *c* is an array of floats.

**norm:** [ **None** | **Normalize** ] A `matplotlib.colors.Normalize` instance is used to scale luminance data to 0, 1. If *None*, use the default `normalize()`. *norm* is only used if *c* is an array of floats.

**vmin/vmax:** *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If either are *None*, the min and max of the color array *C* is used. Note if you pass a *norm* instance, your settings for *vmin* and *vmax* will be ignored.

**alpha:**  $0 \leq \text{scalar} \leq 1$  or **None** The alpha value for the patches

**linewidths:** [ **None** | **scalar** | **sequence** ] If *None*, defaults to `(lines.linewidth,)`. Note that this is a tuple, and if you set the *linewidths* argument you must set it as a sequence of floats, as required by `RegularPolyCollection`.

Optional kwargs control the `Collection` properties; in particular:

**edgecolors:** The string 'none' to plot faces with no outlines

**facecolors:** The string 'none' to plot unfilled outlines

Here are the standard descriptions of all the `Collection` kwargs:

| Property  | Description  |
|---|--|
| <code>agg_filter</code>                               | unknown  |
| <code>alpha</code>                                    | float or None                                      |
| <code>animated</code>                                 | [True   False]                                     |
| <code>antialiased</code> or <code>antialiaseds</code> | Boolean or sequence of booleans                    |
| <code>array</code>                                    | unknown  |
| <code>axes</code>                                     | an <code>Axes</code> instance                      |
| <code>clim</code>                                     | a length 2 sequence of floats                      |
| <code>clip_box</code>                                 | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>                                  | [True   False]                                     |

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|  |   |
|--|---|
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [ True   False ]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [ None   float   boolean   callable ]                                   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [ True   False   None ]   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | Transform instance  |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>visible</code>   | [ True   False ]  |
| <code>zorder</code>  | any number  |

A `Collection` instance is returned.

Additional kwargs: `hold = [True|False]` overrides default hold state

### `sci(im)`

Set the current image (target of colormap commands like `jet()`, `hot()` or `clim()`). The current image is an attribute of the current axes.

### `semilogx(*args, **kwargs)`

call signature:

```
semilogx(*args, **kwargs)
```

Make a plot with log scaling on the x axis.

`semilogx()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_xscale()`.

Notable keyword arguments:

***basex*: scalar > 1** base of the *x* logarithm

**subsx:** [ **None** | **sequence** ] The location of the minor xticks; *None* defaults to autosubs, which depend on the number of decades in the plot; see `set_xscale()` for details.

**nonposx:** ['mask' | 'clip' ] non-positive values in *x* can be masked as invalid, or clipped to a very small positive number

The remaining valid kwargs are [Line2D](#) properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>                                | unknown  |
| <code>alpha</code>                                     | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>                                  | [True   False]   |
| <code>antialiased</code> or <code>aa</code>            | [True   False]   |
| <code>axes</code>                                      | an <a href="#">Axes</a> instance   |
| <code>clip_box</code>                                  | a <a href="#">matplotlib.transforms.Bbox</a> instance  |
| <code>clip_on</code>                                   | [True   False]   |
| <code>clip_path</code>                                 | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ]            |
| <code>color</code> or <code>c</code>                   | any matplotlib color   |
| <code>contains</code>                                  | a callable function  |
| <code>dash_capstyle</code>                             | ['butt'   'round'   'projecting']  |
| <code>dash_joinstyle</code>                            | ['miter'   'round'   'bevel']  |
| <code>dashes</code>                                    | sequence of on/off ink in points   |
| <code>data</code>                                      | 2D array (rows are x, y) or two 1D arrays  |
| <code>drawstyle</code>                                 | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                                 |
| <code>figure</code>                                    | a <a href="#">matplotlib.figure.Figure</a> instance  |
| <code>fillstyle</code>                                 | ['full'   'left'   'right'   'bottom'   'top']   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a            |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [True   False]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   ']' ] |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                  |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [True   False   None]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | ['butt'   'round'   'projecting']  |
| <code>solid_joinstyle</code>                           | ['miter'   'round'   'bevel']  |
| <code>transform</code>                                 | a <a href="#">matplotlib.transforms.Transform</a> instance   |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [True   False]   |
| <code>xdata</code>                                     | 1D array   |

|                     |            |
|---------------------|------------|
| <code>ydata</code>  | 1D array   |
| <code>zorder</code> | any number |

**See Also:**

**loglog()** For example code and figure

Additional kwargs: `hold = [True|False]` overrides default hold state

**semilogy(\*args, \*\*kwargs)**  
call signature:

```
semilogy(*args, **kwargs)
```

Make a plot with log scaling on the y axis.

`semilogy()` supports all the keyword arguments of `plot()` and `matplotlib.axes.Axes.set_yscale()`.

Notable keyword arguments:

**basey:** `scalar > 1` Base of the y logarithm

**subsy:** [ `None` | `sequence` ] The location of the minor yticks; *None* defaults to autosubs, which depend on the number of decades in the plot; see `set_yscale()` for details.

**nonposy:** [ `'mask'` | `'clip'` ] non-positive values in y can be masked as invalid, or clipped to a very small positive number

The remaining valid kwargs are [Line2D](#) properties:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float (0.0 transparent through 1.0 opaque)  |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False]  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <code>matplotlib.transforms.Bbox</code> instance                                      |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code> or <code>c</code>        | any matplotlib color  |
| <code>contains</code>                       | a callable function   |
| <code>dash_capstyle</code>                  | [ 'butt'   'round'   'projecting' ]   |
| <code>dash_joinstyle</code>                 | [ 'miter'   'round'   'bevel' ]   |
| <code>dashes</code>                         | sequence of on/off ink in points  |
| <code>data</code>                           | 2D array (rows are x, y) or two 1D arrays   |
| <code>drawstyle</code>                      | [ 'default'   'steps'   'steps-pre'   'steps-mid'   'steps-post' ]                      |

Table 62.25 – continu

|  |  |
|--|--|
| <code>figure</code>                                    | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fillstyle</code>                                 | [ 'full'   'left'   'right'   'bottom'   'top' ]   |
| <code>gid</code>                                       | an id string   |
| <code>label</code>                                     | any string   |
| <code>linestyle</code> or <code>ls</code>              | [ '-'   '--'   '-.'   ':'   'None'   ' '   '' ] and any drawstyle in combination with a          |
| <code>linewidth</code> or <code>lw</code>              | float value in points  |
| <code>lod</code>                                       | [ True   False ]   |
| <code>marker</code>                                    | [ 7   4   5   6   'o'   'D'   'h'   'H'   '_'   ''   'None'   None   ' '   '8'   'p'   ','   'v' |
| <code>markeredgecolor</code> or <code>mec</code>       | any matplotlib color   |
| <code>markeredgewidth</code> or <code>mew</code>       | float value in points  |
| <code>markerfacecolor</code> or <code>mfc</code>       | any matplotlib color   |
| <code>markerfacecoloralt</code> or <code>mfcalt</code> | any matplotlib color   |
| <code>markersize</code> or <code>ms</code>             | float  |
| <code>markevery</code>                                 | None   integer   (startind, stride)  |
| <code>picker</code>                                    | float distance in points or callable pick function <code>fn(artist, event)</code>                |
| <code>pickradius</code>                                | float distance in points   |
| <code>rasterized</code>                                | [ True   False   None ]  |
| <code>snap</code>                                      | unknown  |
| <code>solid_capstyle</code>                            | [ 'butt'   'round'   'projecting' ]  |
| <code>solid_joinstyle</code>                           | [ 'miter'   'round'   'bevel' ]  |
| <code>transform</code>                                 | a <code>matplotlib.transforms.Transform</code> instance  |
| <code>url</code>                                       | a url string   |
| <code>visible</code>                                   | [ True   False ]   |
| <code>xdata</code>                                     | 1D array   |
| <code>ydata</code>                                     | 1D array   |
| <code>zorder</code>                                    | any number   |

### See Also:

**loglog()** For example code and figure

Additional kwargs: hold = [True|False] overrides default hold state

**set\_cmap**(*cmap*)

set the default colormap to *cmap* and apply to current image if any. See `help(colormaps)` for more information.

*cmap* must be a `colors.Colormap` instance, or the name of a registered colormap.

See `register_cmap()` and `get_cmap()`.

**setp(\*args, \*\*kwargs)**

matplotlib supports the use of `setp()` (“set property”) and `getp()` to set and get object properties, as well as to do introspection on the object. For example, to set the linestyle of a line to be dashed, you can do:

```
>>> line, = plot([1,2,3])
>>> setp(line, linestyle='--')
```

If you want to know the valid types of arguments, you can provide the name of the property you want to set without a value:

```
>>> setp(line, 'linestyle')
linestyle: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' ]
```

If you want to see all the properties that can be set, and their possible values, you can do:

```
>>> setp(line)
... long output listing omitted
```

`setp()` operates on a single instance or a list of instances. If you are in query mode introspecting the possible values, only the first instance in the sequence is used. When actually setting values, all the instances will be set. E.g., suppose you have a list of two lines, the following will make both lines thicker and red:

```
>>> x = arange(0,1.0,0.01)
>>> y1 = sin(2*pi*x)
>>> y2 = sin(4*pi*x)
>>> lines = plot(x, y1, x, y2)
>>> setp(lines, linewidth=2, color='r')
```

`setp()` works with the MATLAB style string/value pairs or with python kwargs. For example, the following are equivalent:

```
>>> setp(lines, 'linewidth', 2, 'color', 'r') # MATLAB style
>>> setp(lines, linewidth=2, color='r')      # python style
```

**show(\*args, \*\*kw)**

When running in ipython with its pylab mode, display all figures and return to the ipython prompt.

In non-interactive mode, display all figures and block until the figures have been closed; in interactive mode it has no effect unless figures were created prior to a change from non-interactive to interactive mode (not recommended). In that case it displays the figures but does not block.

A single experimental keyword argument, *block*, may be set to True or False to override the blocking behavior described above.

**specgram**(*x*, *NFFT*=256, *Fs*=2, *Fc*=0, *detrend*=<function *detrend\_none* at 0x3110050>, *window*=<function *window\_hanning* at 0x310a2a8>, *noverlap*=128, *cmap*=None, *xextent*=None, *pad\_to*=None, *sides*='default', *scale\_by\_freq*=None, *hold*=None, \*\*kwargs)  
call signature:

```
specgram(x, NFFT=256, Fs=2, Fc=0, detrend=mlab.detrend_none,
         window=mlab.window_hanning, noverlap=128,
```

```
cmap=None, xextent=None, pad_to=None, sides='default',
scale_by_freq=None, **kwargs)
```

Compute a spectrogram of data in  $x$ . Data are split into  $NFFT$  length segments and the PSD of each section is computed. The windowing function *window* is applied to each segment, and the amount of overlap of each segment is specified with *noverlap*.

Keyword arguments:

***NFFT*: integer** The number of data points used in each block for the FFT. Must be even; a power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad\_to* for this instead.

***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, *freqs*, in cycles per time unit. The default value is 2.

***detrend*: callable** The function applied to each segment before fft-ing, designed to remove the mean or linear trend. Unlike in MATLAB, where the *detrend* parameter is a vector, in matplotlib it is a function. The *pylab* module defines *detrend\_none()*, *detrend\_mean()*, and *detrend\_linear()*, but you can use a custom function as well.

***window*: callable or ndarray** A function or a vector of length  $NFFT$ . To create window vectors see *window\_hanning()*, *window\_none()*, *numpy.blackman()*, *numpy.hamming()*, *numpy.bartlett()*, *scipy.signal()*, *scipy.signal.get\_window()*, etc. The default is *window\_hanning()*. If a function is passed as the argument, it must take a data segment as an argument and return the windowed version of the segment.

***noverlap*: integer** The number of points of overlap between blocks. The default value is 0 (no overlap).

***pad\_to*: integer** The number of points to which the data segment is padded when performing the FFT. This can be different from  $NFFT$ , which specifies the number of data points used. While not increasing the actual resolution of the psd (the minimum distance between resolvable peaks), this can give more points in the plot, allowing for more detail. This corresponds to the  $n$  parameter in the call to *fft()*. The default is *None*, which sets *pad\_to* equal to  $NFFT$ .

***sides*: [ 'default' | 'onesided' | 'twosided' ]** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale\_by\_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of  $\text{Hz}^{-1}$ . This allows for integration over the returned frequency values. The default is *True* for MATLAB compatibility.

***Fc*: integer** The center frequency of  $x$  (defaults to 0), which offsets the y extents of the plot to reflect the frequency range used when a signal is acquired and then filtered and downsampled to baseband.

**cmap:** A `matplotlib.cm.Colormap` instance; if *None* use default determined by `rc`

**xextent:** The image extent along the x-axis. `xextent = (xmin,xmax)` The default is `(0,max(bins))`, where `bins` is the return value from `mlab.specgram()`

**kwargs:**

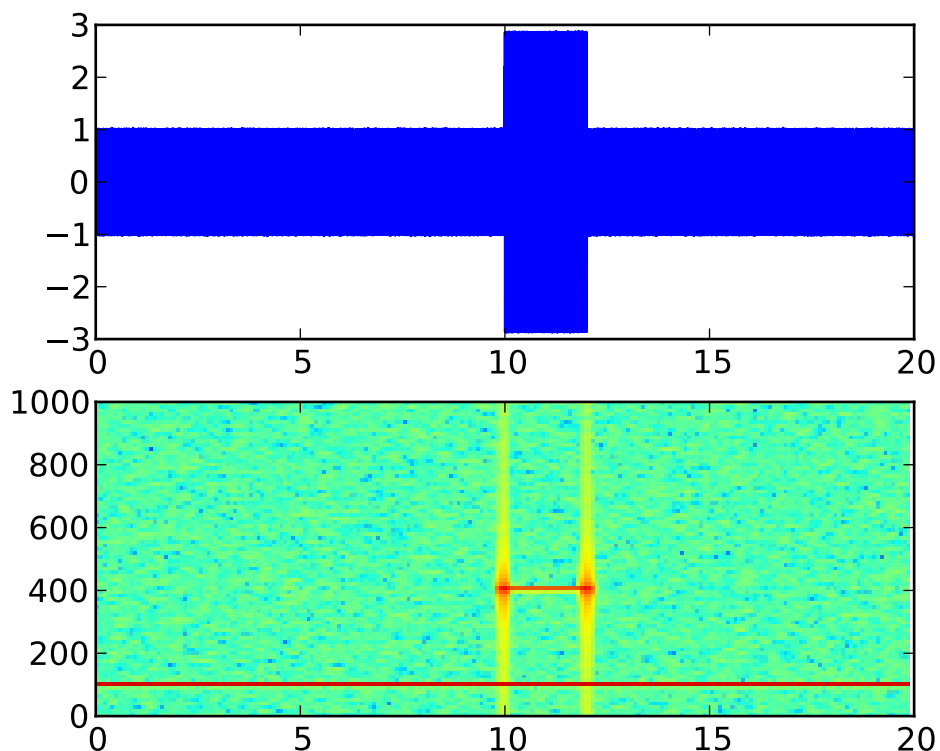
Additional kwargs are passed on to `imshow` which makes the spectrogram image

Return value is `(Pxx, freqs, bins, im)`:

- *bins* are the time points the spectrogram is calculated over
- *freqs* is an array of frequencies
- *Pxx* is a `len(times) x len(freqs)` array of power
- *im* is a `matplotlib.image.AxesImage` instance

Note: If *x* is real (i.e. non-complex), only the positive spectrum is shown. If *x* is complex, both positive and negative parts of the spectrum are shown. This can be overridden using the *sides* keyword argument.

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**spectral()**

set the default colormap to `spectral` and apply to current image if any. See `help(colormaps)` for more



information

### **spring()**

set the default colormap to spring and apply to current image if any. See `help(colormaps)` for more information

**spy**(*Z*, *precision*=0, *marker*=None, *markersize*=None, *aspect*='equal', *hold*=None, **\*\*kwargs**)

call signature:

```
spy(Z, precision=0, marker=None, markersize=None,
    aspect='equal', **kwargs)
```

`spy(Z)` plots the sparsity pattern of the 2-D array *Z*.

If *precision* is 0, any non-zero value will be plotted; else, values of  $|Z| > precision$  will be plotted.

For `scipy.sparse.spmatrix` instances, there is a special case: if *precision* is 'present', any value present in the array will be plotted, even if it is identically zero.

The array will be plotted as it would be printed, with the first index (row) increasing down and the second index (column) increasing to the right.

By default *aspect* is 'equal', so that each array element occupies a square space; set the *aspect* kwarg to 'auto' to allow the plot to fill the plot box, or to any scalar number to specify the aspect ratio of an array element directly.

Two plotting styles are available: image or marker. Both are available for full arrays, but only the marker style works for `scipy.sparse.spmatrix` instances.

If *marker* and *markersize* are None, an image will be returned and any remaining kwargs are passed to `imshow()`; else, a `Line2D` object will be returned with the value of *marker* determining the marker type, and any remaining kwargs passed to the `plot()` method.

If *marker* and *markersize* are None, useful kwargs include:

- *cmap*
- *alpha*

### **See Also:**

[`imshow\(\)`](#) For image options.

For controlling colors, e.g. cyan background and red marks, use:

```
cmap = mcolors.ListedColormap(['c', 'r'])
```

If *marker* or *markersize* is not None, useful kwargs include:

- *marker*
- *markersize*
- *color*

Useful values for *marker* include:

- 's' square (default)
- 'o' circle
- '.' point
- ',' pixel

**See Also:**

**plot()** For plotting options

Additional kwargs: `hold = [True|False]` overrides default hold state

**stem**(*x*, *y*, *linefmt*='b-', *markerfmt*='bo', *basefmt*='r-', *hold*=None)  
call signature:

```
stem(x, y, linefmt='b-', markerfmt='bo', basefmt='r-')
```

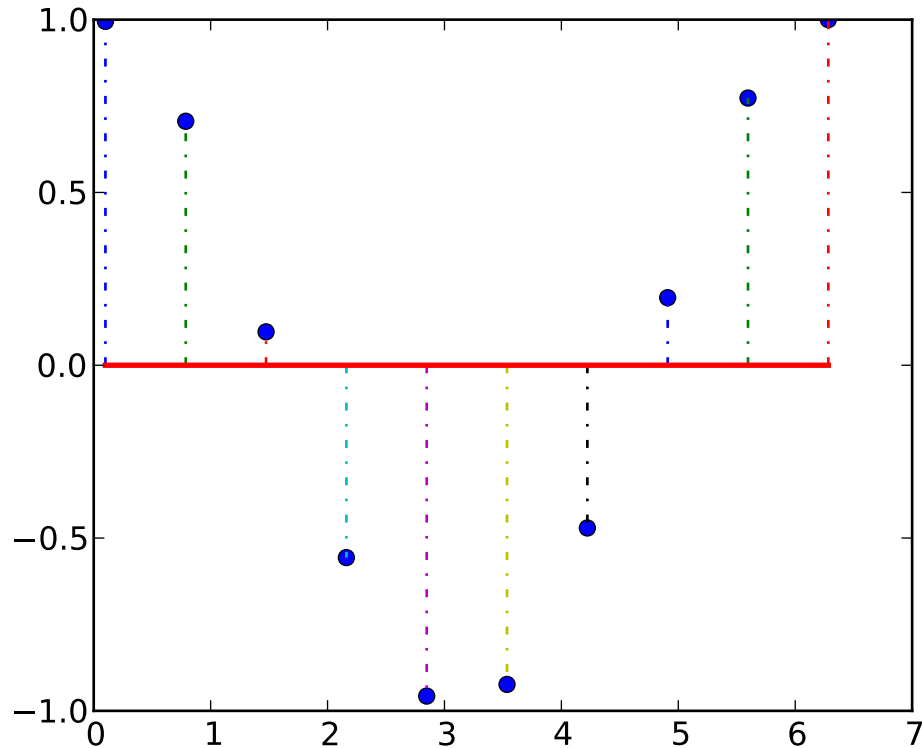
A stem plot plots vertical lines (using *linefmt*) at each *x* location from the baseline to *y*, and places a marker there using *markerfmt*. A horizontal line at 0 is plotted using *basefmt*.

Return value is a tuple (*markerline*, *stemlines*, *baseline*).

**See Also:**

This [document](#) for details.

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**step**(*x*, *y*, *\*args*, *\*\*kwargs*)

call signature:

`step(x, y, *args, **kwargs)`

Make a step plot. Additional keyword args to `step()` are the same as those for `plot()`.

*x* and *y* must be 1-D sequences, and it is assumed, but not checked, that *x* is uniformly increasing.

Keyword arguments:

**where:** [ **'pre'** | **'post'** | **'mid'** ] If **'pre'**, the interval from *x*[*i*] to *x*[*i*+1] has level *y*[*i*+1]

If **'post'**, that interval has level *y*[*i*]

If **'mid'**, the jumps in *y* occur half-way between the *x*-values.

Additional kwargs: `hold = [True|False]` overrides default hold state

**subplot**(*\*args*, *\*\*kwargs*)

Create a subplot command, creating axes with:

`subplot(numRows, numCols, plotNum)`

where *plotNum* = 1 is the first plot number and increasing *plotNums* fill rows first.  $\max(\text{plotNum}) == \text{numRows} * \text{numCols}$

You can leave out the commas if  $\text{numRows} \leq \text{numCols} \leq \text{plotNum} < 10$ , as in:

```
subplot(211)    # 2 rows, 1 column, first (upper) plot
```

`subplot(111)` is the default axis.

New subplots that overlap old will delete the old axes. If you do not want this behavior, use `matplotlib.figure.Figure.add_subplot()` or the `axes()` command. Eg.:

```
from pylab import *
plot([1,2,3]) # implicitly creates subplot(111)
subplot(211)  # overlaps, subplot(111) is killed
plot(rand(12), rand(12))
subplot(212, axisbg='y') # creates 2nd subplot with yellow background
```

Keyword arguments:

***axisbg***: The background color of the subplot, which can be any valid color specifier. See [matplotlib.colors](#) for more information.

***polar***: A boolean flag indicating whether the subplot plot should be a polar projection. Defaults to False.

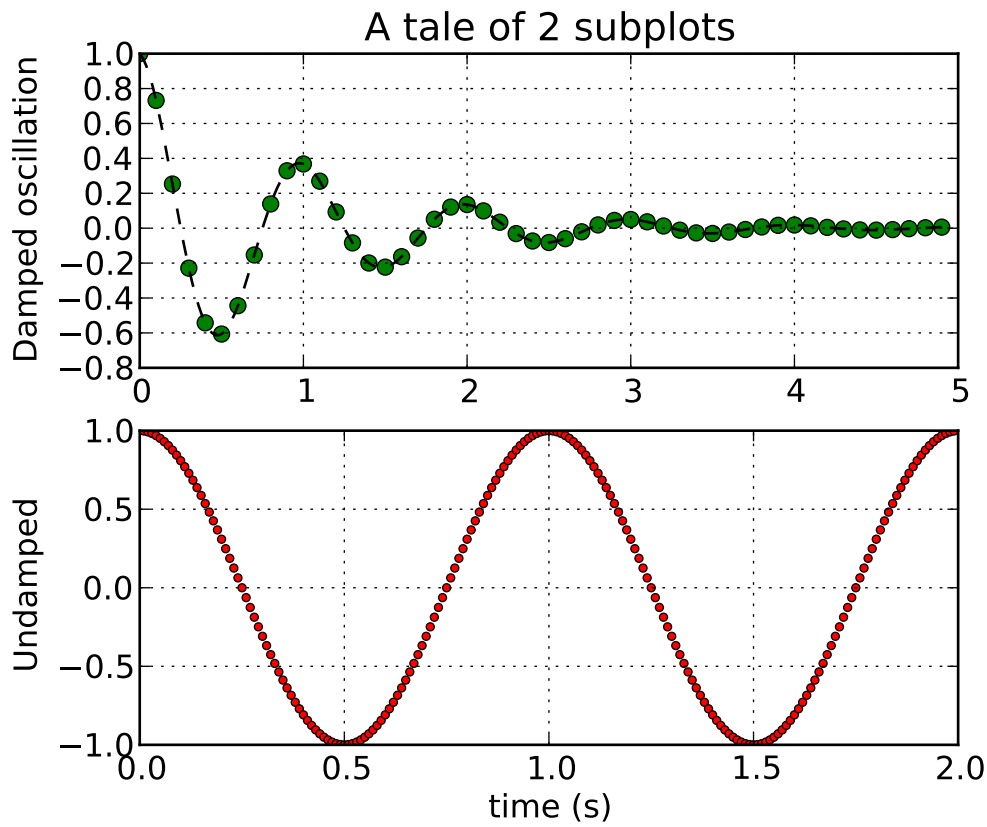
***projection***: A string giving the name of a custom projection to be used for the subplot. This projection must have been previously registered. See `matplotlib.projections.register_projection()`

**See Also:**

[axes\(\)](#) For additional information on `axes()` and `subplot()` keyword arguments.

[examples/pylab\\_examples/polar\\_scatter.py](#) For an example

**Example:**



**subplot2grid**(*shape*, *loc*, *rowspan*=1, *colspan*=1, *\*\*kwargs*)

It creates a subplot in a grid of *shape*, at location of *loc*, spanning *rowspan*, *colspan* cells in each direction. The index for *loc* is 0-based.

```
subplot2grid(shape, loc, rowspan=1, colspan=1)
```

is identical to

```
gridspec=GridSpec(shape[0], shape[2])
subplotspec=gridspec.new_subplotspec(loc, rowspan, colspan)
subplot(subplotspec)
```

**subplot\_tool**(*targetfig*=None)

Launch a subplot tool window for *targetfig* (default gcf).

A `matplotlib.widgets.SubplotTool` instance is returned.

**subplots**(*nrows*=1, *ncols*=1, *sharex*=False, *sharey*=False, *squeeze*=True, *subplot\_kw*=None, *\*\*fig\_kw*)

Create a figure with a set of subplots already made.

This utility wrapper makes it convenient to create common layouts of subplots, including the enclosing figure object, in a single call.

Keyword arguments:

**nrows** [int] Number of rows of the subplot grid. Defaults to 1.

**ncols** [int] Number of columns of the subplot grid. Defaults to 1.

**sharex** [bool] If True, the X axis will be shared amongst all subplots. If True and you have multiple rows, the x tick labels on all but the last row of plots will have visible set to False

**sharey** [bool] If True, the Y axis will be shared amongst all subplots. If True and you have multiple columns, the y tick labels on all but the first column of plots will have visible set to False

**squeeze** [bool] If True, extra dimensions are squeezed out from the returned axis object:

- if only one subplot is constructed (nrows=ncols=1), the resulting single Axis object is returned as a scalar.
- for Nx1 or 1xN subplots, the returned object is a 1-d numpy object array of Axis objects are returned as numpy 1-d arrays.
- for NxM subplots with N>1 and M>1 are returned as a 2d array.

If False, no squeezing at all is done: the returned axis object is always a 2-d array containing Axis instances, even if it ends up being 1x1.

**subplot\_kw** [dict] Dict with keywords passed to the add\_subplot() call used to create each subplots.

**fig\_kw** [dict] Dict with keywords passed to the figure() call. Note that all keywords not recognized above will be automatically included here.

Returns:

fig, ax : tuple

- fig is the Matplotlib Figure object
- ax can be either a single axis object or an array of axis objects if more than one subplot was created. The dimensions of the resulting array can be controlled with the squeeze keyword, see above.

### Examples:

```
x = np.linspace(0, 2*np.pi, 400) y = np.sin(x**2)
```

```
# Just a figure and one subplot f, ax = plt.subplots() ax.plot(x, y) ax.set_title('Simple plot')
```

```
# Two subplots, unpack the output array immediately f, (ax1, ax2) = plt.subplots(1, 2, sharey=True)
ax1.plot(x, y) ax1.set_title('Sharing Y axis') ax2.scatter(x, y)
```

```
# Four polar axes plt.subplots(2, 2, subplot_kw=dict(polar=True))
```

**subplots\_adjust**(\*args, \*\*kwargs)

call signature:

```
subplots_adjust(left=None, bottom=None, right=None, top=None,
                wspace=None, hspace=None)
```

Tune the subplot layout via the `matplotlib.figure.SubplotParams` mechanism. The parameter meanings (and suggested defaults) are:

```

left = 0.125 # the left side of the subplots of the figure
right = 0.9 # the right side of the subplots of the figure
bottom = 0.1 # the bottom of the subplots of the figure
top = 0.9 # the top of the subplots of the figure
wspace = 0.2 # the amount of width reserved for blank space between subplots
hspace = 0.2 # the amount of height reserved for white space between subplots

```

The actual defaults are controlled by the rc file

### **summer()**

set the default colormap to summer and apply to current image if any. See `help(colormaps)` for more information

### **suptitle(\*args, \*\*kwargs)**

Add a centered title to the figure.

kwargs are `matplotlib.text.Text` properties. Using figure coordinates, the defaults are:

- **x = 0.5** the x location of text in figure coords
- **y = 0.98** the y location of the text in figure coords
- **horizontalalignment = 'center'** the horizontal alignment of the text
- **verticalalignment = 'top'** the vertical alignment of the text

A `matplotlib.text.Text` instance is returned.

Example:

```
fig.suptitle('this is the figure title', fontsize=12)
```

### **switch\_backend(newbackend)**

Switch the default backend to newbackend. This feature is **experimental**, and is only expected to work switching to an image backend. Eg, if you have a bunch of PostScript scripts that you want to run from an interactive ipython session, you may want to switch to the PS backend before running them to avoid having a bunch of GUI windows popup. If you try to interactively switch from one GUI backend to another, you will explode.

Calling this command will close all open windows.

### **table(\*\*kwargs)**

call signature:

```

table(cellText=None, cellColours=None,
      cellLoc='right', colWidths=None,
      rowLabels=None, rowColours=None, rowLoc='left',
      colLabels=None, colColours=None, colLoc='center',
      loc='bottom', bbox=None):

```

Add a table to the current axes. Returns a `matplotlib.table.Table` instance. For finer grained control over tables, use the `Table` class and add it to the axes with `add_table()`.

Thanks to John Gill for providing the class and table.

kwargs control the Table properties:

| Property                | Description  |
|-------------------------|--|
| <code>agg_filter</code> | unknown  |
| <code>alpha</code>      | float (0.0 transparent through 1.0 opaque)         |
| <code>animated</code>   | [True   False]                                     |
| <code>axes</code>       | an <code>Axes</code> instance                      |
| <code>clip_box</code>   | a <code>matplotlib.transforms.Bbox</code> instance |
| <code>clip_on</code>    | [True   False]                                     |
| <code>clip_path</code>  | [ (Path, Transform)   Patch   None ]               |
| <code>contains</code>   | a callable function                                |
| <code>figure</code>     | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontsize</code>   | a float in points                                  |
| <code>gid</code>        | an id string                                       |
| <code>label</code>      | any string   |
| <code>lod</code>        | [True   False]                                     |
| <code>picker</code>     | [None float boolean callable]                      |
| <code>rasterized</code> | [True   False   None]                              |
| <code>snap</code>       | unknown  |
| <code>transform</code>  | <code>Transform</code> instance                    |
| <code>url</code>        | a url string                                       |
| <code>visible</code>    | [True   False]                                     |
| <code>zorder</code>     | any number   |

**text**(*x*, *y*, *s*, *fontdict*=None, *withdash*=False, *\*\*kwargs*)

call signature:

```
text(x, y, s, fontdict=None, **kwargs)
```

Add text in string *s* to axis at location *x*, *y*, data coordinates.

Keyword arguments:

**fontdict:** A dictionary to override the default text properties. If *fontdict* is *None*, the defaults are determined by your rc parameters.

**withdash:** [ False | True ] Creates a `TextWithDash` instance instead of a `Text` instance.

Individual keyword arguments can be used to override any given parameter:

```
text(x, y, s, fontsize=12)
```

The default transform specifies that text is in data coords, alternatively, you can specify text in axis coords (0,0 is lower-left and 1,1 is upper-right). The example below places text in the center of the axes:

```
text(0.5, 0.5, 'matplotlib',
     horizontalalignment='center',
     verticalalignment='center',
     transform = ax.transAxes)
```



You can put a rectangular box around the text instance (eg. to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of `matplotlib.patches.Rectangle` properties. For example:

```
text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

Valid kwargs are `matplotlib.text.Text` properties:

| Property   | Description  |
|--|--|
| <code>agg_filter</code>  | unknown  |
| <code>alpha</code>   | float (0.0 transparent through 1.0 opaque)   |
| <code>animated</code>  | [True   False]   |
| <code>axes</code>  | an <code>Axes</code> instance  |
| <code>backgroundcolor</code>   | any matplotlib color   |
| <code>bbox</code>  | rectangle prop dict  |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance   |
| <code>clip_on</code>   | [True   False]   |
| <code>clip_path</code>   | [ ( <code>Path</code> , <code>Transform</code> )   <code>Patch</code>   None ]   |
| <code>color</code>   | any matplotlib color   |
| <code>contains</code>  | a callable function  |
| <code>family</code> or <code>fontfamily</code> or <code>fontname</code> or <code>name</code> | [ FONTNAME   'serif'   'sans-serif'   'cursive'   'fantasy'   'monospace' ]  |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance   |
| <code>fontproperties</code> or <code>font_properties</code>                                  | a <code>matplotlib.font_manager.FontProperties</code> instance   |
| <code>gid</code>   | an id string   |
| <code>horizontalalignment</code> or <code>ha</code>  | [ 'center'   'right'   'left' ]  |
| <code>label</code>   | any string   |
| <code>linespacing</code>   | float (multiple of font size)  |
| <code>lod</code>   | [True   False]   |
| <code>multialignment</code>  | [ 'left'   'right'   'center' ]  |
| <code>path_effects</code>  | unknown  |
| <code>picker</code>  | [None float boolean callable]  |
| <code>position</code>  | (x,y)  |
| <code>rasterized</code>  | [True   False   None]  |
| <code>rotation</code>  | [ angle in degrees   'vertical'   'horizontal' ]   |
| <code>rotation_mode</code>   | unknown  |
| <code>size</code> or <code>fontsize</code>   | [ size in points   'xx-small'   'x-small'   'small'   'medium'   'large'   'x-large' ]   |
| <code>snap</code>  | unknown  |
| <code>stretch</code> or <code>fontstretch</code>   | [ a numeric value in range 0-1000   'ultra-condensed'   'extra-condensed'   'condensed'   'normal'   'expanded'   'ultra-expanded' ] |
| <code>style</code> or <code>fontstyle</code>   | [ 'normal'   'italic'   'oblique' ]  |
| <code>text</code>  | string or anything printable with '%s' conversion.   |
| <code>transform</code>   | <code>Transform</code> instance  |
| <code>url</code>   | a url string   |
| <code>variant</code> or <code>fontvariant</code>   | [ 'normal'   'small-caps' ]  |
| <code>verticalalignment</code> or <code>va</code> or <code>ma</code>                         | [ 'center'   'top'   'bottom'   'baseline' ]   |
| <code>visible</code>   | [True   False]   |
| <code>weight</code> or <code>fontweight</code>   | [ a numeric value in range 0-1000   'ultralight'   'light'   'normal'   'regular'   'bold'   'extra-bold'   'black' ]                |
| <code>x</code>   | float  |
| <code>y</code>   | float  |

|                     |            |
|---------------------|------------|
| <code>zorder</code> | any number |
|---------------------|------------|

**thetagrids**(\*args, \*\*kwargs)

Set/Get the theta locations of the gridlines and ticklabels.

If no arguments are passed, return a tuple (*lines*, *labels*) where *lines* is an array of radial gridlines (`Line2D` instances) and *labels* is an array of tick labels (`Text` instances):

```
lines, labels = thetagrids()
```

Otherwise the syntax is:

```
lines, labels = thetagrids(angles, labels=None, fmt='%d', frac = 1.1)
```

set the angles at which to place the theta grids (these gridlines are equal along the theta dimension).

*angles* is in degrees.

*labels*, if not *None*, is a len(*angles*) list of strings of the labels to use at each angle.

If *labels* is *None*, the labels will be `fmt%angle`.

*frac* is the fraction of the polar axes radius at which to place the label (1 is the edge). Eg. 1.05 is outside the axes and 0.95 is inside the axes.

Return value is a list of tuples (*lines*, *labels*):

- *lines* are `Line2D` instances
- *labels* are `Text` instances.

Note that on input, the *labels* argument is a list of strings, and on output it is a list of `Text` instances.

Examples:

```
# set the locations of the radial gridlines and labels
```

```
lines, labels = thetagrids( range(45,360,90) )
```

```
# set the locations and labels of the radial gridlines and labels
```

```
lines, labels = thetagrids( range(45,360,90), ('NE', 'NW', 'SW', 'SE') )
```

**tick\_params**(axis='both', \*\*kwargs)

Convenience method for changing the appearance of ticks and tick labels.

Keyword arguments:

**axis** ['x' | 'y' | 'both'] Axis on which to operate; default is 'both'.

**reset** [True | False] If *True*, set all parameters to defaults before processing other keyword arguments. Default is *False*.

**which** ['major' | 'minor' | 'both'] Default is 'major': apply arguments to major ticks only.

**direction** ['in' | 'out'] Puts ticks inside or outside the axes.

**length** Tick length in points.

**width** Tick width in points.

**color** Tick color; accepts any mpl color spec.

**pad** Distance in points between tick and label.

**labelsize** Tick label font size in points or as a string (e.g. 'large').

**labelcolor** Tick label color; mpl color spec.

**colors** Changes the tick color and the label color to the same value: mpl color spec.

**zorder** Tick and label zorder.

**bottom, top, left, right** Boolean or ['on' | 'off'], controls whether to draw the respective ticks.

**labelbottom, labeltop, labelleft, labelright** Boolean or ['on' | 'off'], controls whether to draw the respective tick labels.

Example:

```
ax.tick_params(direction='out', length=6, width=2, colors='r')
```

This will make all major ticks be red, pointing out of the box, and with dimensions 6 points by 2 points. Tick labels will also be red.

**ticklabel\_format(\*\*kwargs)**

Convenience method for manipulating the `ScalarFormatter` used by default for linear axes.

Optional keyword arguments:

| Key-word           | Description  |
|--------------------|--|
| <i>style</i>       | [ 'sci' (or 'scientific')   'plain' ] plain turns off scientific notation  |
| <i>scilimits</i>   | (m, n), pair of integers; if <i>style</i> is 'sci', scientific notation will be used for numbers outside the range $10^m$ to $10^n$ . Use (0,0) to include all numbers.  |
| <i>use-Offset</i>  | [True   False   offset]; if True, the offset will be calculated as needed; if False, no offset will be used; if a numeric offset is specified, it will be used.  |
| <i>axis</i>        | [ 'x'   'y'   'both' ]   |
| <i>use-Lo-cale</i> | If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the <code>axes.formatter.use_locale</code> rcparam. |

Only the major ticks are affected. If the method is called when the `ScalarFormatter` is not the `Formatter` being used, an `AttributeError` will be raised.

**tight\_layout(pad=1.2, h\_pad=None, w\_pad=None)**

Adjust subplot parameters to give specified padding.

Parameters:

**pad** [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

**h\_pad, w\_pad** [float] padding (height/width) between edges of adjacent subplots. Defaults to *pad\_inches*.

**title**(*s*, \**args*, \*\**kwargs*)

Set the title of the current axis to *s*.

Default font override is:

```
override = {'fontsize': 'medium',  
            'verticalalignment': 'baseline',  
            'horizontalalignment': 'center'}
```

**See Also:**

[`text\(\)`](#) for information on how override and the optional args work.

**tricontour**(\**args*, \*\**kwargs*)

[`tricontour\(\)`](#) and [`tricontourf\(\)`](#) draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either:

```
tricontour(triangulation, ...)
```

where *triangulation* is a `Triangulation` object, or

```
tricontour(x, y, ...)  
tricontour(x, y, triangles, ...)  
tricontour(x, y, triangles=triangles, ...)  
tricontour(x, y, mask=mask, ...)  
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See [Triangulation](#) for a explanation of these possibilities.

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour *N* automatically-chosen levels.

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in  $V$

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

`C = tricontour(...)` returns a `TriContourSet` object.

Optional keyword arguments:

**colors:** [ `None` | `string` | (`mpl_colors`) ] If *None*, the colormap specified by `cmap` will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** `float` The alpha blending value

**cmap:** [ `None` | `Colormap` ] A cm `Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default `Colormap` is used.

**norm:** [ `None` | `Normalize` ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [`level0`, `level1`, ..., `leveln`] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ `None` | 'upper' | 'lower' | 'image' ] If *None*, the first value of  $Z$  will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if  $X$  and  $Y$  are specified in the call to `contour`.

**extent:** [ `None` | (`x0`,`x1`,`y0`,`y1`) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of  $Z[0,0]$  is the center of the pixel, not a corner. If *origin* is *None*, then (`x0`, `y0`) is the position of  $Z[0,0]$ , and (`x1`, `y1`) is the position of  $Z[-1,-1]$ .

This keyword is not active if  $X$  and  $Y$  are specified in the call to `contour`.

**locator:** [ `None` | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the  $V$  argument.

**extend:** [ 'neither' | 'both' | 'min' | 'max' ] Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that

all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

***xunits, yunits:*** [ **None** | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

***linewidths:*** [ **None** | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

***linestyles:*** [ **None** | **'solid'** | **'dashed'** | **'dashdot'** | **'dotted'** ] If *linestyles* is *None*, the **'solid'** is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

tricontourf-only keyword arguments:

***antialiased:*** [ **True** | **False** ] enable antialiasing

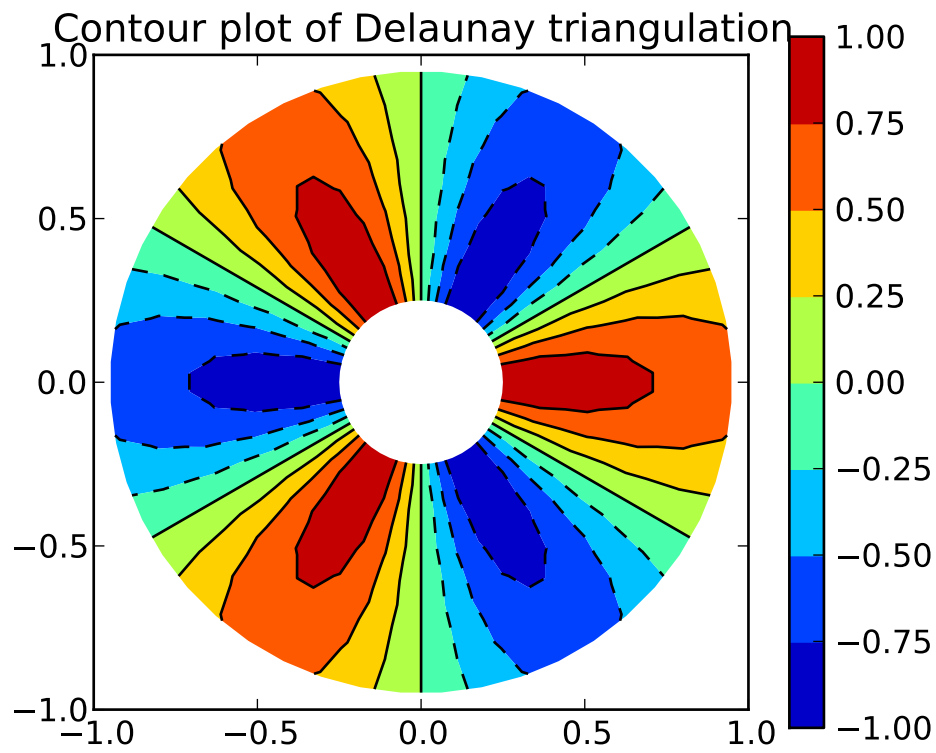
***nchunk:*** [ **0** | **integer** ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

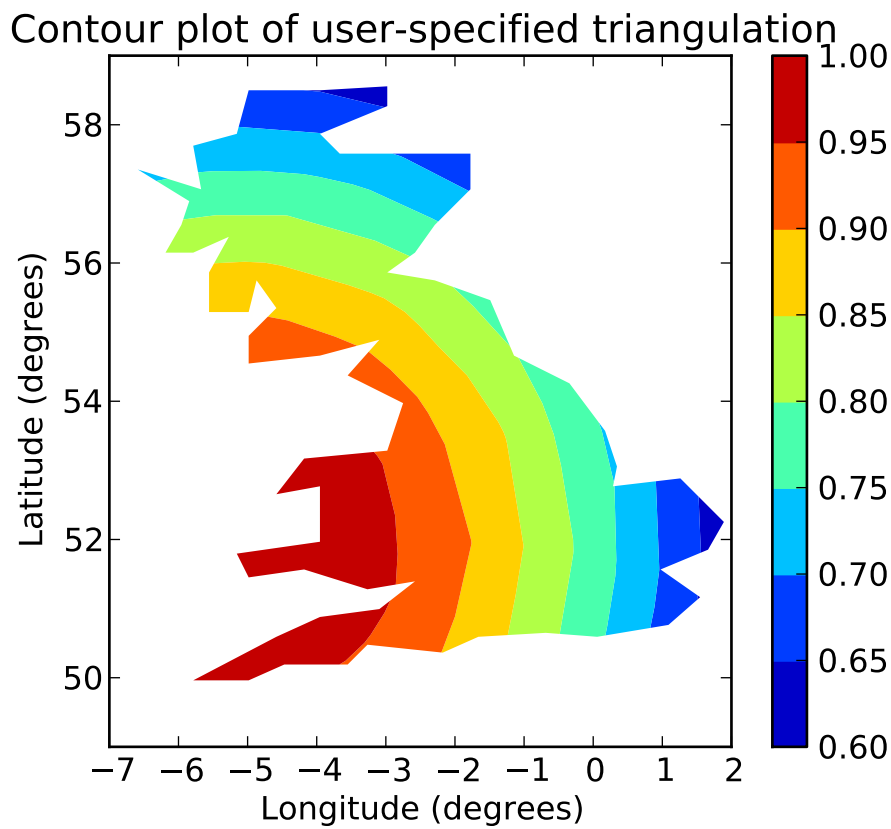
Note: `tricontourf` fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$$z1 < z \leq z2$$

There is one exception: if the lowest boundary coincides with the minimum value of the *z* array, then that minimum value will be included in the lowest interval.

**Examples:**





Additional kwargs: `hold = [True|False]` overrides default hold state

**tricontourf**(\*args, \*\*kwargs)

`tricontour()` and `tricontourf()` draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

The triangulation can be specified in one of two ways; either:

```
tricontour(triangulation, ...)
```

where `triangulation` is a `Triangulation` object, or

```
tricontour(x, y, ...)
tricontour(x, y, triangles, ...)
tricontour(x, y, triangles=triangles, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See `Triangulation` for an explanation of these possibilities.

The remaining arguments may be:



```
tricontour(..., Z)
```

where  $Z$  is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour  $N$  automatically-chosen levels.

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence  $V$

```
tricontourf(..., Z, V)
```

fill the  $(\text{len}(V)-1)$  regions between the values in  $V$

```
tricontour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

$C = \text{tricontour}(\dots)$  returns a `TriContourSet` object.

Optional keyword arguments:

**colors:** [ *None* | string | (mpl\_colors) ] If *None*, the colormap specified by `cmap` will be used.

If a string, like 'r' or 'red', all levels will be plotted in this color.

If a tuple of matplotlib color args (string, float, rgb, etc), different levels will be plotted in different colors in the order specified.

**alpha:** float The alpha blending value

**cmap:** [ *None* | Colormap ] A cm Colormap instance or *None*. If *cmap* is *None* and *colors* is *None*, a default Colormap is used.

**norm:** [ *None* | Normalize ] A `matplotlib.colors.Normalize` instance for scaling data values to colors. If *norm* is *None* and *colors* is *None*, the default linear scaling is used.

**levels** [level0, level1, ..., leveln] A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

**origin:** [ *None* | 'upper' | 'lower' | 'image' ] If *None*, the first value of  $Z$  will correspond to the lower left corner, location (0,0). If 'image', the rc value for `image.origin` will be used.

This keyword is not active if  $X$  and  $Y$  are specified in the call to contour.

**extent:** [ *None* | (x0,x1,y0,y1) ]

If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of `Z[0,0]` is the center of the pixel, not a corner. If *origin* is *None*, then `(x0, y0)` is the position of `Z[0,0]`, and `(x1, y1)` is the position of `Z[-1,-1]`.

This keyword is not active if *X* and *Y* are specified in the call to `contour`.

**locator:** [ *None* | `ticker.Locator` subclass ] If *locator* is *None*, the default `MaxNLocator` is used. The locator is used to determine the contour levels if they are not given explicitly via the *V* argument.

**extend:** [ *'neither'* | *'both'* | *'min'* | *'max'* ] Unless this is *'neither'*, contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can be set via `matplotlib.colors.Colormap.set_under()` and `matplotlib.colors.Colormap.set_over()` methods.

**xunits, yunits:** [ *None* | **registered units** ] Override axis units by specifying an instance of a `matplotlib.units.ConversionInterface`.

tricontour-only keyword arguments:

**linewidths:** [ *None* | **number** | **tuple of numbers** ] If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

If a number, all levels will be plotted with this linewidth.

If a tuple, different levels will be plotted with different linewidths in the order specified

**linestyles:** [ *None* | *'solid'* | *'dashed'* | *'dashdot'* | *'dotted'* ] If *linestyles* is *None*, the *'solid'* is used.

*linestyles* can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

If `contour` is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

tricontourf-only keyword arguments:

**antialiased:** [ **True** | **False** ] enable antialiasing

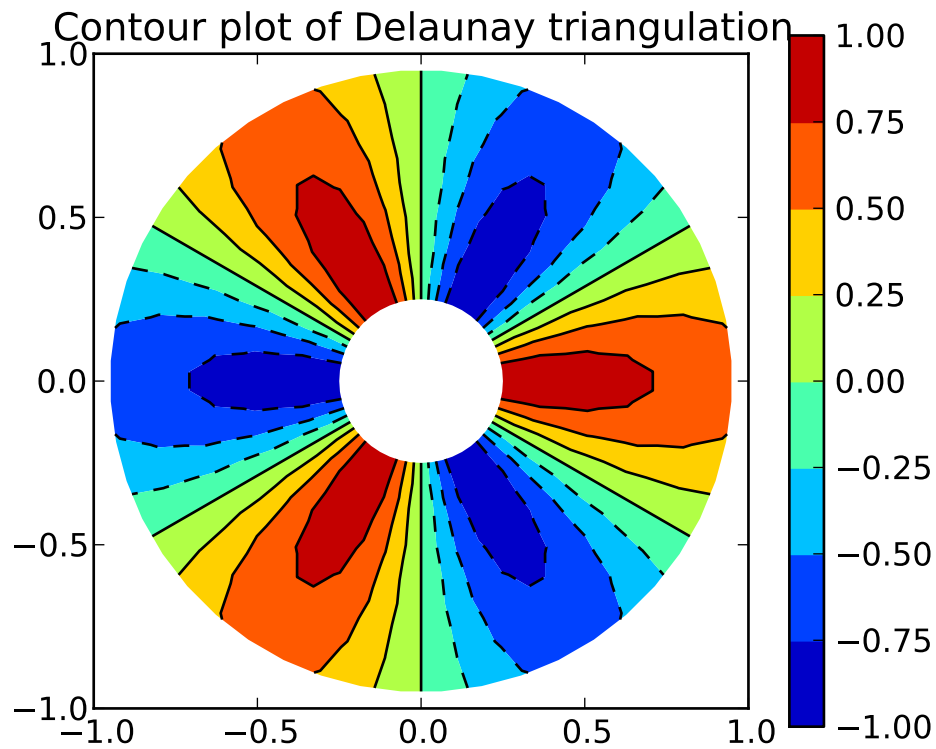
**nchunk:** [ **0** | **integer** ] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

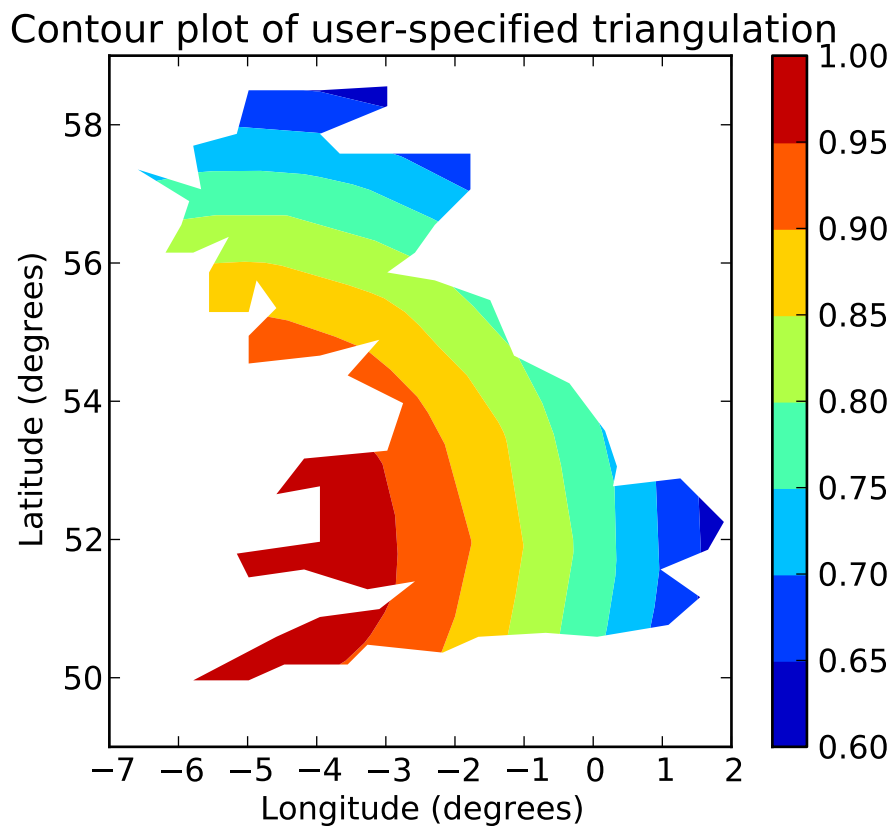
Note: `tricontourf` fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

$z1 < z \leq z2$

There is one exception: if the lowest boundary coincides with the minimum value of the  $z$  array, then that minimum value will be included in the lowest interval.

**Examples:**





Additional kwargs: `hold = [True|False]` overrides default hold state

**tripcolor**(\*args, \*\*kwargs)

Create a pseudocolor plot of an unstructured triangular grid to the [Axes](#).

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where `triangulation` is a `Triangulation` object, or

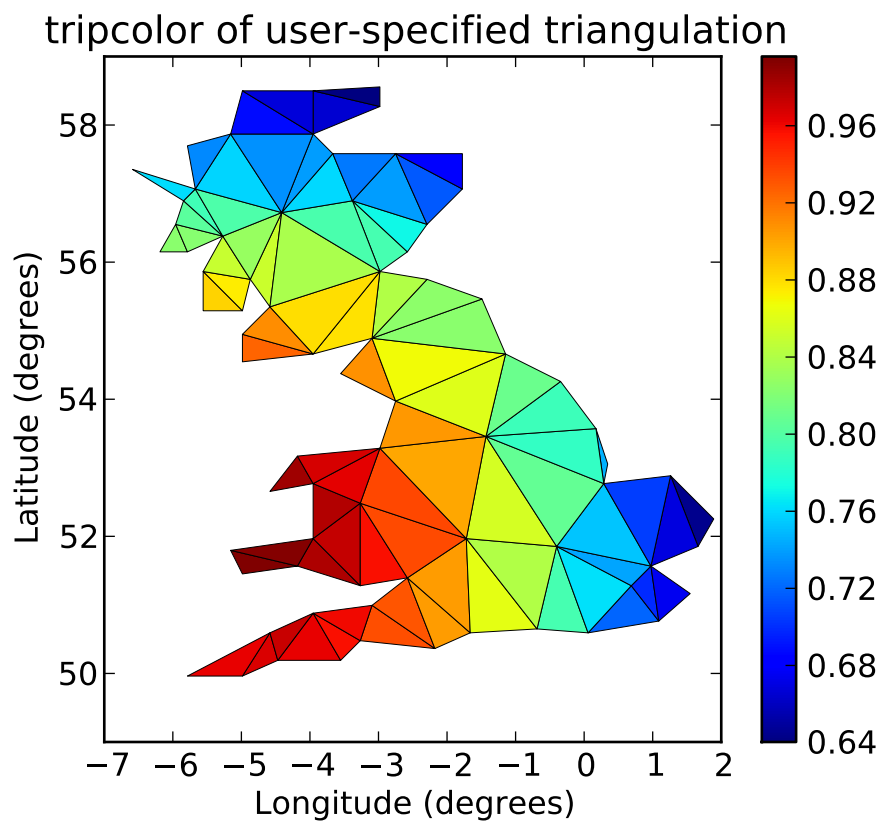
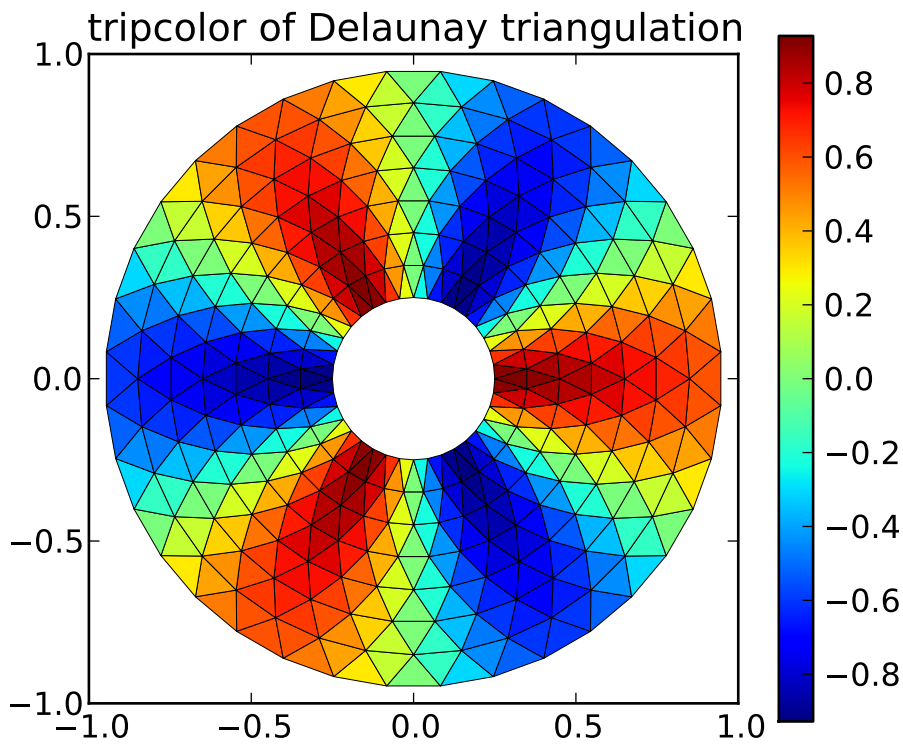
```
tripcolor(x, y, ...)
tripcolor(x, y, triangles, ...)
tripcolor(x, y, triangles=triangles, ...)
tripcolor(x, y, mask=mask, ...)
tripcolor(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See [Triangulation](#) for a explanation of these possibilities.

The next argument must be `C`, the array of color values, one per point in the triangulation. The colors used for each triangle are from the mean `C` of the triangle's three points.

The remaining kwargs are the same as for [pcolor\(\)](#).

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**triplot**(\*args, \*\*kwargs)

Draw a unstructured triangular grid as lines and/or markers to the [Axes](#).

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

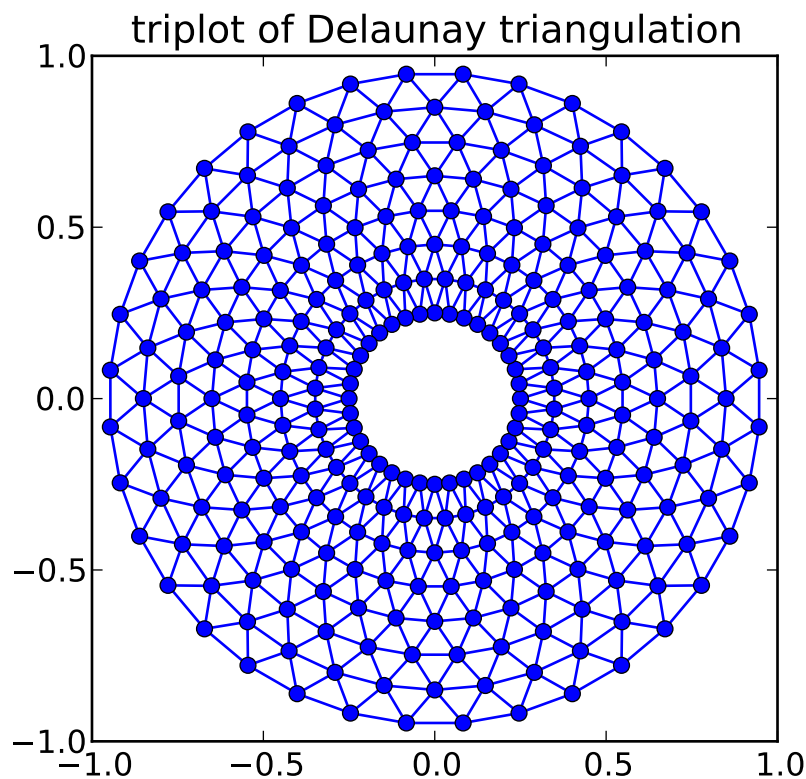
where triangulation is a `Triangulation` object, or

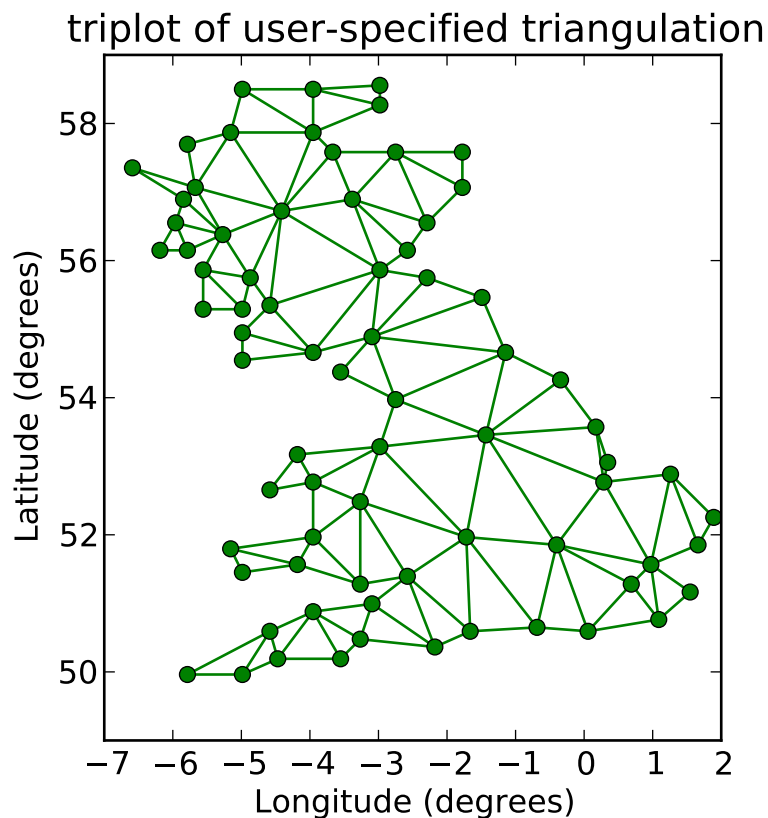
```
triplot(x, y, ...)
triplot(x, y, triangles, ...)
triplot(x, y, triangles=triangles, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, mask=mask, ...)
```

in which case a `Triangulation` object will be created. See [Triangulation](#) for a explanation of these possibilities.

The remaining args and kwargs are the same as for [plot\(\)](#).

**Example:**





Additional kwargs: `hold = [True|False]` overrides default hold state

**twinx**(*ax=None*)

Make a second axes overlay *ax* (or the current axes if *ax* is *None*) sharing the xaxis. The ticks for *ax2* will be placed on the right, and the *ax2* instance is returned.

**See Also:**

**examples/api\_examples/two\_scales.py** For an example

**twiny**(*ax=None*)

Make a second axes overlay *ax* (or the current axes if *ax* is *None*) sharing the yaxis. The ticks for *ax2* will be placed on the top, and the *ax2* instance is returned.

**vlines**(*x, ymin, ymax, colors='k', linestyle='solid', label='', hold=None, \*\*kwargs*)

call signature:

```
vlines(x, ymin, ymax, color='k', linestyle='solid')
```

Plot vertical lines at each *x* from *ymin* to *ymax*. *ymin* or *ymax* can be scalars or `len(x)` numpy arrays. If they are scalars, then the respective values are constant, else the heights of the lines are determined by *ymin* and *ymax*.

**colors** a line collections color args, either a single color or a `len(x)` list of colors

*linestyles*

one of [ 'solid' | 'dashed' | 'dashdot' | 'dotted' ]

Returns the `matplotlib.collections.LineCollection` that was added.

kwargs are `LineCollection` properties:

| Property   | Description   |
|--|---|
| <code>agg_filter</code>  | unknown   |
| <code>alpha</code>   | float or None   |
| <code>animated</code>  | [True   False]  |
| <code>antialiased</code> or <code>antialiaseds</code>                    | Boolean or sequence of booleans   |
| <code>array</code>   | unknown   |
| <code>axes</code>  | an <code>Axes</code> instance   |
| <code>clim</code>  | a length 2 sequence of floats   |
| <code>clip_box</code>  | a <code>matplotlib.transforms.Bbox</code> instance                      |
| <code>clip_on</code>   | [True   False]  |
| <code>clip_path</code>   | [ (Path, Transform)   Patch   None ]                                    |
| <code>cmap</code>  | a colormap or registered colormap name                                  |
| <code>color</code>   | matplotlib color arg or sequence of rgba tuples                         |
| <code>colorbar</code>  | unknown   |
| <code>contains</code>  | a callable function   |
| <code>edgecolor</code> or <code>edgecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>facecolor</code> or <code>facecolors</code>                        | matplotlib color arg or sequence of rgba tuples                         |
| <code>figure</code>  | a <code>matplotlib.figure.Figure</code> instance                        |
| <code>gid</code>   | an id string  |
| <code>label</code>   | any string  |
| <code>linestyle</code> or <code>linestyles</code> or <code>dashes</code> | [ 'solid'   'dashed', 'dashdot', 'dotted'   (offset, on-off-dash-seq) ] |
| <code>linewidth</code> or <code>lw</code> or <code>linewidths</code>     | float or sequence of floats   |
| <code>lod</code>   | [True   False]  |
| <code>norm</code>  | unknown   |
| <code>offsets</code>   | float or sequence of floats   |
| <code>paths</code>   | unknown   |
| <code>picker</code>  | [None float boolean callable]   |
| <code>pickradius</code>  | unknown   |
| <code>rasterized</code>  | [True   False   None]   |
| <code>segments</code>  | unknown   |
| <code>snap</code>  | unknown   |
| <code>transform</code>   | <code>Transform</code> instance   |
| <code>url</code>   | a url string  |
| <code>urls</code>  | unknown   |
| <code>verts</code>   | unknown   |
| <code>visible</code>   | [True   False]  |
| <code>zorder</code>  | any number  |

Additional kwargs: `hold = [True|False]` overrides default hold state



**waitforbuttonpress**(\*args, \*\*kwargs)

call signature:

```
waitforbuttonpress(self, timeout=-1)
```

Blocking call to interact with the figure.

This will return True if a key was pressed, False if a mouse button was pressed and None if *timeout* was reached without either being pressed.

If *timeout* is negative, does not timeout.

**winter**()

set the default colormap to winter and apply to current image if any. See `help(colormaps)` for more information

**xcorr**(*x*, *y*, *normed*=True, *detrend*=<function detrend\_none at 0x3110050>, *usevlines*=True, *maxlags*=10, *hold*=None, \*\*kwargs)

call signature:

```
def xcorr(self, x, y, normed=True, detrend=mlab.detrend_none,
          usevlines=True, maxlags=10, **kwargs):
```

Plot the cross correlation between *x* and *y*. If *normed* = True, normalize the data by the cross correlation at 0-th lag. *x* and *y* are detrended by the *detrend* callable (default no normalization). *x* and *y* must be equal length.

Data are plotted as `plot(lags, c, **kwargs)`

Return value is a tuple (*lags*, *c*, *line*) where:

- *lags* are a length  $2 \cdot \text{maxlags} + 1$  lag vector
- *c* is the  $2 \cdot \text{maxlags} + 1$  auto correlation vector
- *line* is a **Line2D** instance returned by `plot()`.

The default *linestyle* is None and the default *marker* is 'o', though these can be overridden with keyword args. The cross correlation is performed with `numpy.correlate()` with *mode* = 2.

If *usevlines* is True:

`vlines()` rather than `plot()` is used to draw vertical lines from the origin to the xcorr. Otherwise the plotstyle is determined by the kwargs, which are **Line2D** properties.

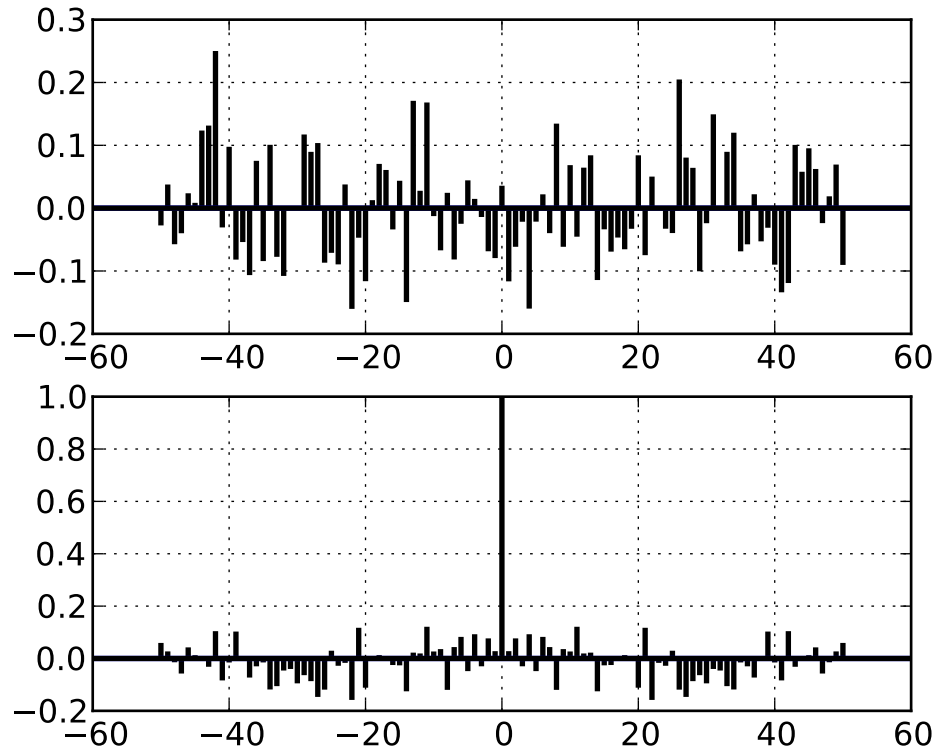
The return value is a tuple (*lags*, *c*, *linecol*, *b*) where *linecol* is the `matplotlib.collections.LineCollection` instance and *b* is the x-axis.

*maxlags* is a positive integer detailing the number of lags to show. The default value of None will return all  $(2 \cdot \text{len}(x) - 1)$  lags.

**Example:**

`xcorr()` above, and `acorr()` below.

**Example:**



Additional kwargs: `hold = [True|False]` overrides default hold state

**xlabel**(*s*, \*args, \*\*kwargs)

Set the *x* axis label of the current axis to *s*

Default override is:

```
override = {
    'fontsize'           : 'small',
    'verticalalignment'  : 'top',
    'horizontalalignment': 'center'
}
```

**See Also:**

**text()** For information on how override and the optional args work

**xlim**(\*args, \*\*kwargs)

Set/Get the xlims of the current axes:

```
xmin, xmax = xlim()    # return the current xlim
xlim( (xmin, xmax) )   # set the xlim to xmin, xmax
xlim( xmin, xmax )     # set the xlim to xmin, xmax
```

If you do not specify args, you can pass the xmin and xmax as kwargs, eg.:

```
xlim(xmax=3) # adjust the max leaving min unchanged
xlim(xmin=1) # adjust the min leaving max unchanged
```

Setting limits turns autoscaling off for the x-axis.

The new axis limits are returned as a length 2 tuple.

**xscale**(\*args, \*\*kwargs)

call signature:

```
xscale(scale, **kwargs)
```

Set the scaling for the x-axis: 'linear' | 'log' | 'symlog'

Different keywords may be accepted, depending on the scale:

'linear'

'log'

**basex/basey:** The base of the logarithm

**nonposx/nonposy:** ['mask' | 'clip' ] non-positive values in x or y can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

'symlog'

**basex/basey:** The base of the logarithm

**linthreshx/linthreshy:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**xticks**(\*args, \*\*kwargs)

Set/Get the xlimits of the current ticklocs and labels:

```
# return locs, labels where locs is an array of tick locations and
# labels is an array of tick labels.
locs, labels = xticks()
```

```
# set the locations of the xticks
xticks( arange(6) )
```

```
# set the locations and labels of the xticks
xticks( arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue') )
```

The keyword args, if any, are `Text` properties. For example, to rotate long labels:

```
xticks( arange(12), calendar.month_name[1:13], rotation=17 )
```

**ylabel**(*s*, \*args, \*\*kwargs)

Set the y axis label of the current axis to *s*.

Defaults override is:

```
override = {
    'fontsize'           : 'small',
    'verticalalignment'  : 'center',
    'horizontalalignment': 'right',
    'rotation'='vertical': }
```

**See Also:**

**text()** For information on how override and the optional args work.

**ylim**(\*args, \*\*kwargs)

Set/Get the ylimits of the current axes:

```
ymin, ymax = ylim()    # return the current ylim
ylim( (ymin, ymax) )   # set the ylim to ymin, ymax
ylim( ymin, ymax )     # set the ylim to ymin, ymax
```

If you do not specify args, you can pass the *ymin* and *ymax* as kwargs, eg.:

```
ylim(ymax=3) # adjust the max leaving min unchanged
ylim(ymin=1) # adjust the min leaving max unchanged
```

Setting limits turns autoscaling off for the y-axis.

The new axis limits are returned as a length 2 tuple.

**yscale**(\*args, \*\*kwargs)

call signature:

```
yscale(scale, **kwargs)
```

Set the scaling for the y-axis: 'linear' | 'log' | 'symlog'

Different keywords may be accepted, depending on the scale:

'linear'

'log'

*base*/*basey*: The base of the logarithm

**nonposx/nonposy:** ['mask' | 'clip' ] non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

'symlog'

**basex/basey:** The base of the logarithm

**linthreshx/linthreshy:** The range  $(-x, x)$  within which the plot is linear (to avoid having the plot go to infinity around zero).

**subsx/subsy:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: [2, 3, 4, 5, 6, 7, 8, 9]

will place 8 logarithmically spaced minor ticks between each major tick.

**yticks(\*args, \*\*kwargs)**

Set/Get the ylimits of the current ticklocs and labels:

```
# return locs, labels where locs is an array of tick locations and
# labels is an array of tick labels.
```

```
locs, labels = yticks()
```

```
# set the locations of the yticks
```

```
yticks( arange(6) )
```

```
# set the locations and labels of the yticks
```

```
yticks( arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue') )
```

The keyword args, if any, are `Text` properties. For example, to rotate long labels:

```
yticks( arange(12), calendar.month_name[1:13], rotation=45 )
```



# SPINES

## 63.1 matplotlib.spines

**class Spine**(*axes, spine\_type, path, \*\*kwargs*)

Bases: `matplotlib.patches.Patch`

an axis spine – the line noting the data area boundaries

Spines are the lines connecting the axis tick marks and noting the boundaries of the data area. They can be placed at arbitrary positions. See function:~matplotlib.spines.Spine.set\_position for more information.

The default position is ('outward', 0).

Spines are subclasses of class:~matplotlib.patches.Patch, and inherit much of their behavior.

Spines draw a line or a circle, depending if function:~matplotlib.spines.Spine.set\_patch\_line or function:~matplotlib.spines.Spine.set\_patch\_circle has been called. Line-like is the default.

- *axes* : the Axes instance containing the spine
- *spine\_type* : a string specifying the spine type
- *path* : the path instance used to draw the spine

Valid kwargs are:

| Property                                    | Description   |
|---|---|
| <code>agg_filter</code>                     | unknown   |
| <code>alpha</code>                          | float or None   |
| <code>animated</code>                       | [True   False]  |
| <code>antialiased</code> or <code>aa</code> | [True   False] or None for default  |
| <code>axes</code>                           | an <a href="#">Axes</a> instance  |
| <code>clip_box</code>                       | a <a href="#">matplotlib.transforms.Bbox</a> instance                                   |
| <code>clip_on</code>                        | [True   False]  |
| <code>clip_path</code>                      | [ ( <a href="#">Path</a> , <a href="#">Transform</a> )   <a href="#">Patch</a>   None ] |
| <code>color</code>                          | matplotlib color spec   |
| <code>contains</code>                       | a callable function   |
| <code>edgecolor</code> or <code>ec</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>facecolor</code> or <code>fc</code>   | mpl color spec, or None for default, or 'none' for no color                             |
| <code>figure</code>                         | a <a href="#">matplotlib.figure.Figure</a> instance                                     |
| <code>fill</code>                           | [True   False]  |
| <code>gid</code>                            | an id string  |
| <code>hatch</code>                          | [ '/'   '\'   ' '   '-'   '+'   'x'   'o'   'O'   '.'   '*' ]                           |
| <code>label</code>                          | any string  |
| <code>linestyle</code> or <code>ls</code>   | ['solid'   'dashed'   'dashdot'   'dotted']   |
| <code>linewidth</code> or <code>lw</code>   | float or None for default   |
| <code>lod</code>                            | [True   False]  |
| <code>path_effects</code>                   | unknown   |
| <code>picker</code>                         | [None float boolean callable]   |
| <code>rasterized</code>                     | [True   False   None]   |
| <code>snap</code>                           | unknown   |
| <code>transform</code>                      | <a href="#">Transform</a> instance  |
| <code>url</code>                            | a url string  |
| <code>visible</code>                        | [True   False]  |
| <code>zorder</code>                         | any number  |

class **circular\_spine**(*axes*, *center*, *radius*, *\*\*kwargs*)  
(staticmethod) Returns a circular [Spine](#).

**cla()**  
Clear the current spine

**draw**(*artist*, *renderer*, *\*args*, *\*\*kwargs*)

**get\_bounds()**  
Get the bounds of the spine.

**get\_patch\_transform()**

**get\_path()**

**get\_position()**  
get the spine position

**get\_smart\_bounds()**  
get whether the spine has smart bounds

**get\_spine\_transform()**



get the spine transform

**is\_frame\_like()**

return True if directly on axes frame

This is useful for determining if a spine is the edge of an old style MPL plot. If so, this function will return True.

class **linear\_spine**(*axes, spine\_type, \*\*kwargs*)

(staticmethod) Returns a linear [Spine](#).

**register\_axis**(*axis*)

register an axis

An axis should be registered with its corresponding spine from the Axes instance. This allows the spine to clear any axis properties when needed.

**set\_bounds**(*low, high*)

Set the bounds of the spine.

**set\_color**(*c*)

Set the edgecolor.

ACCEPTS: matplotlib color arg or sequence of rgba tuples

**See Also:**

**set\_facecolor()**, **set\_edgecolor()** For setting the edge or face color individually.

**set\_patch\_circle**(*center, radius*)

set the spine to be circular

**set\_patch\_line**()

set the spine to be linear

**set\_position**(*position*)

set the position of the spine

Spine position is specified by a 2 tuple of (position type, amount). The position types are:

- ‘outward’ : place the spine out from the data area by the specified number of points. (Negative values specify placing the spine inward.)
- ‘axes’ : place the spine at the specified Axes coordinate (from 0.0-1.0).
- ‘data’ : place the spine at the specified data coordinate.

Additionally, shorthand notations define a special positions:

- ‘center’ -> (‘axes’, 0.5)
- ‘zero’ -> (‘data’, 0.0)

**set\_smart\_bounds**(*value*)

set the spine and associated axis to have smart bounds



# TICKER

## 64.1 matplotlib.ticker

### 64.1.1 Tick locating and formatting

This module contains classes to support completely configurable tick locating and formatting. Although the locators know nothing about major or minor ticks, they are used by the `Axis` class to support major and minor tick locating and formatting. Generic tick locators and formatters are provided, as well as domain specific custom ones..

#### Tick locating

The `Locator` class is the base class for all tick locators. The locators handle autoscaling of the view limits based on the data limits, and the choosing of tick locations. A useful semi-automatic tick locator is `MultipleLocator`. You initialize this with a base, eg 10, and it picks axis limits and ticks that are multiples of your base.

The `Locator` subclasses defined here are

**`NullLocator`** No ticks

**`FixedLocator`** Tick locations are fixed

**`IndexLocator`** locator for index plots (eg. where  $x = \text{range}(\text{len}(y))$ )

**`LinearLocator`** evenly spaced ticks from min to max

**`LogLocator`** logarithmically ticks from min to max

**`MultipleLocator`**

**ticks and range are a multiple of base;** either integer or float

**`OldAutoLocator`** choose a `MultipleLocator` and dynamically reassign it for intelligent ticking during navigation

**`MaxNLocator`** finds up to a max number of ticks at nice locations

**`AutoLocator`** `MaxNLocator` with simple defaults. This is the default tick locator for most plotting.

**AutoMinorLocator** locator for minor ticks when the axis is linear and the major ticks are uniformly spaced. It subdivides the major tick interval into a specified number of minor intervals, defaulting to 4 or 5 depending on the major interval.

There are a number of locators specialized for date locations - see the dates module

You can define your own locator by deriving from `Locator`. You must override the `__call__` method, which returns a sequence of locations, and you will probably want to override the `autoscale` method to set the view limits from the data limits.

If you want to override the default locator, use one of the above or a custom locator and pass it to the x or y axis instance. The relevant methods are:

```
ax.xaxis.set_major_locator( xmajorLocator )
ax.xaxis.set_minor_locator( xminorLocator )
ax.yaxis.set_major_locator( ymajorLocator )
ax.yaxis.set_minor_locator( yminorLocator )
```

The default minor locator is the `NullLocator`, eg no minor ticks on by default.

## Tick formatting

Tick formatting is controlled by classes derived from `Formatter`. The formatter operates on a single tick value and returns a string to the axis.

**NullFormatter** no labels on the ticks

**IndexFormatter** set the strings from a list of labels

**FixedFormatter** set the strings manually for the labels

**FuncFormatter** user defined function sets the labels

**FormatStrFormatter** use a sprintf format string

**ScalarFormatter** default formatter for scalars; autopick the fmt string

**LogFormatter** formatter for log axes

You can derive your own formatter from the `Formatter` base class by simply overriding the `__call__` method. The formatter class has access to the axis view and data limits.

To control the major and minor tick label formats, use one of the following methods:

```
ax.xaxis.set_major_formatter( xmajorFormatter )
ax.xaxis.set_minor_formatter( xminorFormatter )
ax.yaxis.set_major_formatter( ymajorFormatter )
ax.yaxis.set_minor_formatter( yminorFormatter )
```

See *pylab\_examples example code: major\_minor\_demo1.py* for an example of setting major and minor ticks. See the `matplotlib.dates` module for more information and examples of using date locators and formatters.

```
class TickHelper()
```

```
    class DummyAxis()
```

```
        get_data_interval()
```

```
        get_view_interval()
```

```
        set_data_interval(vmin, vmax)
```

```
        set_view_interval(vmin, vmax)
```

```
    create_dummy_axis()
```

```
    set_axis(axis)
```

```
    set_bounds(vmin, vmax)
```

```
    set_data_interval(vmin, vmax)
```

```
    set_view_interval(vmin, vmax)
```

```
class Formatter()
```

```
    Bases: matplotlib.ticker.TickHelper
```

```
    Convert the tick location to a string
```

```
    fix_minus(s)
```

some classes may want to replace a hyphen for minus with the proper unicode symbol as described [here](#). The default is to do nothing

Note, if you use this method, eg in `:meth'format_data'` or call, you probably don't want to use it for `format_data_short()` since the toolbar uses this for interactive coord reporting and I doubt we can expect GUIs across platforms will handle the unicode correctly. So for now the classes that override `fix_minus()` should have an explicit `format_data_short()` method

```
    format_data(value)
```

```
    format_data_short(value)
```

```
        return a short string version
```

```
    get_offset()
```

```
    set_locs(locs)
```

```
class FixedFormatter(seq)
```

```
    Bases: matplotlib.ticker.Formatter
```

```
    Return fixed strings for tick labels
```

`seq` is a sequence of strings. For positions `i < len(seq)` return `seq[i]` regardless of `x`. Otherwise return ""

```
    get_offset()
```

```
    set_offset_string(ofs)
```

**class NullFormatter()**

Bases: `matplotlib.ticker.Formatter`

Always return the empty string

**class FuncFormatter(*func*)**

Bases: `matplotlib.ticker.Formatter`

User defined function for formatting

**class FormatStrFormatter(*fnt*)**

Bases: `matplotlib.ticker.Formatter`

Use a format string to format the tick

**class ScalarFormatter(*useOffset=True, useMathText=False, useLocale=None*)**

Bases: `matplotlib.ticker.Formatter`

Tick location is a plain old number. If `useOffset==True` and the data range is much smaller than the data average, then an offset will be determined such that the tick labels are meaningful. Scientific notation is used for data  $< 10^{-n}$  or data  $\geq 10^m$ , where  $n$  and  $m$  are the power limits set using `set_powerlimits((n,m))`. The defaults for these are controlled by the `axes.formatter.limits` rc parameter.

**fix\_minus(*s*)**

use a unicode minus rather than hyphen

**format\_data(*value*)**

return a formatted string representation of a number

**format\_data\_short(*value*)**

return a short formatted string representation of a number

**get\_offset()**

Return scientific notation, plus offset

**get\_useLocale()**

**get\_useOffset()**

**pprint\_val(*x*)**

**set\_locs(*locs*)**

set the locations of the ticks

**set\_powerlimits(*lims*)**

Sets size thresholds for scientific notation.

e.g. `formatter.set_powerlimits((-3, 4))` sets the pre-2007 default in which scientific notation is used for numbers less than  $1e-3$  or greater than  $1e4$ . See also `set_scientific()`.

**set\_scientific(*b*)**

True or False to turn scientific notation on or off see also `set_powerlimits()`

**set\_useLocale(*val*)**

**set\_useOffset(*val*)**

**useLocale**

**useOffset**

**class LogFormatter**(*base=10.0, labelOnlyBase=True*)

Bases: [matplotlib.ticker.Formatter](#)

Format values for log axis;

if attribute *decadeOnly* is True, only the decades will be labelled.

*base* is used to locate the decade tick, which will be the only one to be labeled if *labelOnlyBase* is False

**base**(*base*)

change the *base* for labeling - warning: should always match the base used for [LogLocator](#)

**format\_data**(*value*)

**format\_data\_short**(*value*)

return a short formatted string representation of a number

**label\_minor**(*labelOnlyBase*)

switch on/off minor ticks labeling

**pprint\_val**(*x, d*)

**class LogFormatterExponent**(*base=10.0, labelOnlyBase=True*)

Bases: [matplotlib.ticker.LogFormatter](#)

Format values for log axis; using `exponent = log_base(value)`

*base* is used to locate the decade tick, which will be the only one to be labeled if *labelOnlyBase* is False

**class LogFormatterMathtext**(*base=10.0, labelOnlyBase=True*)

Bases: [matplotlib.ticker.LogFormatter](#)

Format values for log axis; using `exponent = log_base(value)`

*base* is used to locate the decade tick, which will be the only one to be labeled if *labelOnlyBase* is False

**class Locator**()

Bases: [matplotlib.ticker.TickHelper](#)

Determine the tick locations;

Note, you should not use the same locator between different [Axis](#) because the locator stores references to the Axis data and view limits

**autoscale**()

autoscale the view limits

**pan**(*numsteps*)

Pan numticks (can be positive or negative)

**raise\_if\_exceeds**(*locs*)

raise a RuntimeError if Locator attempts to create more than MAXTICKS locs

**refresh()**

refresh internal information based on current lim

**view\_limits**(*vmin*, *vmax*)

select a scale for the range from vmin to vmax

Normally This will be overridden.

**zoom**(*direction*)

Zoom in/out on axis; if direction is >0 zoom in, else zoom out

**class IndexLocator**(*base*, *offset*)

Bases: `matplotlib.ticker.Locator`

Place a tick on every multiple of some base number of points plotted, eg on every 5th point. It is assumed that you are doing index plotting; ie the axis is 0, len(data). This is mainly useful for x ticks.

place ticks on the i-th data points where (i-offset)%base==0

**class FixedLocator**(*locs*, *nbins*=None)

Bases: `matplotlib.ticker.Locator`

Tick locations are fixed. If nbins is not None, the array of possible positions will be subsampled to keep the number of ticks <= nbins + 1. The subsampling will be done so as to include the smallest absolute value; for example, if zero is included in the array of possibilities, then it is guaranteed to be one of the chosen ticks.

**class NullLocator**()

Bases: `matplotlib.ticker.Locator`

No ticks

**class LinearLocator**(*numticks*=None, *presets*=None)

Bases: `matplotlib.ticker.Locator`

Determine the tick locations

The first time this function is called it will try to set the number of ticks to make a nice tick partitioning. Thereafter the number of ticks will be fixed so that interactive navigation will be nice

Use presets to set locs based on lom. A dict mapping vmin, vmax->locs

**view\_limits**(*vmin*, *vmax*)

Try to choose the view limits intelligently

**class LogLocator**(*base*=10.0, *subs*=, [1.0], *numdecs*=4)

Bases: `matplotlib.ticker.Locator`

Determine the tick locations for log axes

place ticks on the location= base\*\*i\*subs[j]

**base**(*base*)

set the base of the log scaling (major tick every base\*\*i, i integer)

**subs**(*subs*)

set the minor ticks the log scaling every base\*\*i\*subs[j]



**view\_limits**(*vmin*, *vmax*)

Try to choose the view limits intelligently

**class AutoLocator**()

Bases: `matplotlib.ticker.MaxNLocator`

**class MultipleLocator**(*base=1.0*)

Bases: `matplotlib.ticker.Locator`

Set a tick on every integer that is multiple of base in the view interval

**view\_limits**(*dmin*, *dmax*)

Set the view limits to the nearest multiples of base that contain the data

**class MaxNLocator**(\*args, \*\*kwargs)

Bases: `matplotlib.ticker.Locator`

Select no more than N intervals at nice locations.

Keyword args:

**nbins** Maximum number of intervals; one less than max number of ticks.

**steps** Sequence of nice numbers starting with 1 and ending with 10; e.g., [1, 2, 4, 5, 10]

**integer** If True, ticks will take only integer values.

**symmetric** If True, autoscaling will result in a range symmetric about zero.

**prune** ['lower' | 'upper' | 'both' | None] Remove edge ticks – useful for stacked or ganged plots where the upper tick of one axes overlaps with the lower tick of the axes above it. If `prune=='lower'`, the smallest tick will be removed. If `prune=='upper'`, the largest tick will be removed. If `prune=='both'`, the largest and smallest ticks will be removed. If `prune==None`, no ticks will be removed.

**bin\_boundaries**(*vmin*, *vmax*)

**set\_params**(\*\*kwargs)

**view\_limits**(*dmin*, *dmax*)

**class AutoMinorLocator**(*n=None*)

Bases: `matplotlib.ticker.Locator`

Dynamically find minor tick positions based on the positions of major ticks. Assumes the scale is linear and major ticks are evenly spaced.

*n* is the number of subdivisions of the interval between major ticks; e.g., *n*=2 will place a single minor tick midway between major ticks.

If *n* is omitted or None, it will be set to 5 or 4.



# TIGHT\_LAYOUT

## 65.1 matplotlib.tight\_layout

This module provides routines to adjust subplot params so that subplots are nicely fit in the figure. In doing so, only axis labels, tick labels and axes titles are currently considered.

Internally, it assumes that the margins (`left_margin`, etc.) which are differences between `ax.get_tightbbox` and `ax.bbox` are independent of axes position. This may fail if `Axes.adjustable` is `datalim`. Also, This will fail for some cases (for example, left or right margin is affected by `xlabel`).

**auto\_adjust\_subplotpars**(*fig, renderer, nrows\_ncols, num1num2\_list, subplot\_list, ax\_bbox\_list=None, pad=1.2, h\_pad=None, w\_pad=None, rect=None*)

Return a dictionary of subplot parameters so that spacing between subplots are adjusted. Note that this function ignore geometry information of subplot itself, but uses what is given by `nrows_ncols` and `num1num2_list` parameteres. Also, the results could be incorrect if some subplots have `adjustable=datalim`.

Parameters:

**nrows\_ncols** number of rows and number of columns of the grid.

**num1num2\_list** list of numbers specifying the area occupied by the subplot

**subplot\_list** list of subplots that will be used to calculate optimal subplot\_params.

**pad** [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

**h\_pad, w\_pad** [float]

**padding (height/width) between edges of adjacent subplots.** Defaults to `pad_inches`.

**rect** [left, bottom, right, top] in normalized (0, 1) figure coordinates.

**get\_renderer**(*fig*)



# UNITS

## 66.1 matplotlib.units

The classes here provide support for using custom classes with matplotlib, eg those that do not expose the array interface but know how to convert themselves to arrays. It also supports classes with units and units conversion. Use cases include converters for custom objects, eg a list of datetime objects, as well as for objects that are unit aware. We don't assume any particular units implementation, rather a units implementation must provide a ConversionInterface, and the register with the Registry converter dictionary. For example, here is a complete implementation which supports plotting with native datetime objects:

```
import matplotlib.units as units
import matplotlib.dates as dates
import matplotlib.ticker as ticker
import datetime

class DateConverter(units.ConversionInterface):

    @staticmethod
    def convert(value, unit, axis):
        'convert value to a scalar or array'
        return dates.date2num(value)

    @staticmethod
    def axisinfo(unit, axis):
        'return major and minor tick locators and formatters'
        if unit != 'date': return None
        majloc = dates.AutoDateLocator()
        majfmt = dates.AutoDateFormatter(majloc)
        return AxisInfo(majloc=majloc,
                        majfmt=majfmt,
                        label='date')

    @staticmethod
    def default_units(x, axis):
        'return the default unit for x or None'
        return 'date'
```

```
# finally we register our object type with a converter
units.registry[datetime.date] = DateConverter()
```

**class AxisInfo**(majloc=None, minloc=None, majfmt=None, minfmt=None, label=None, default\_limits=None)

information to support default axis labeling and tick labeling, and default limits

majloc and minloc: TickLocators for the major and minor ticks majfmt and minfmt: TickFormatters for the major and minor ticks label: the default axis label default\_limits: the default min, max of the axis if no data is present If any of the above are None, the axis will simply use the default

**class ConversionInterface**()

The minimal interface for a converter to take custom instances (or sequences) and convert them to values mpl can use

static **axisinfo**(unit, axis)

return an units.AxisInfo instance for axis with the specified units

static **convert**(obj, unit, axis)

convert obj using unit for the specified axis. If obj is a sequence, return the converted sequence. The output must be a sequence of scalars that can be used by the numpy array layer

static **default\_units**(x, axis)

return the default unit for x or None for the given axis

static **is\_numlike**(x)

The matplotlib datalim, autoscaling, locators etc work with scalars which are the units converted to floats given the current unit. The converter may be passed these floats, or arrays of them, even when units are set. Derived conversion interfaces may opt to pass plain-ol unitless numbers through the conversion interface and this is a helper function for them.

**class Registry**()

Bases: dict

register types with conversion interface

**get\_converter**(x)

get the converter interface instance for x, or None

# WIDGETS

## 67.1 matplotlib.widgets

### 67.1.1 GUI Neutral widgets

Widgets that are designed to work for any of the GUI backends. All of these widgets require you to pre-define an `matplotlib.axes.Axes` instance and pass that as the first arg. matplotlib doesn't try to be too smart with respect to layout – you will have to figure out how wide and tall you want your Axes to be to accommodate your widget.

**class Button**(*ax, label, image=None, color='0.85', hovercolor='0.95'*)

Bases: `matplotlib.widgets.Widget`

A GUI neutral button

The following attributes are accessible

***ax*** The `matplotlib.axes.Axes` the button renders into.

***label*** A `matplotlib.text.Text` instance.

***color*** The color of the button when not hovering.

***hovercolor*** The color of the button when hovering.

Call `on_clicked()` to connect to the button

***ax*** The `matplotlib.axes.Axes` instance the button will be placed into.

***label*** The button text. Accepts string.

***image*** The image to place in the button, if not `None`. Can be any legal arg to `imshow` (numpy array, matplotlib Image instance, or PIL image).

***color*** The color of the button when not activated

***hovercolor*** The color of the button when the mouse is over it

**`disconnect`**(*cid*)

remove the observer with connection id *cid*

**on\_clicked**(*func*)

When the button is clicked, call this *func* with event

A connection id is returned which can be used to disconnect

**class CheckButtons**(*ax, labels, actives*)

Bases: `matplotlib.widgets.Widget`

A GUI neutral radio button

The following attributes are exposed

**ax** The `matplotlib.axes.Axes` instance the buttons are located in

**labels** List of `matplotlib.text.Text` instances

**lines** List of (line1, line2) tuples for the x's in the check boxes. These lines exist for each box, but have `set_visible(False)` when its box is not checked.

**rectangles** List of `matplotlib.patches.Rectangle` instances

Connect to the CheckButtons with the `on_clicked()` method

Add check buttons to `matplotlib.axes.Axes` instance *ax*

**labels** A len(buttons) list of labels as strings

**actives**

A len(buttons) list of booleans indicating whether the button is active

**disconnect**(*cid*)

remove the observer with connection id *cid*

**on\_clicked**(*func*)

When the button is clicked, call *func* with button label

A connection id is returned which can be used to disconnect

**class Cursor**(*ax, useblit=False, \*\*lineprops*)

A horizontal and vertical line span the axes that and move with the pointer. You can turn off the hline or vline spectively with the attributes

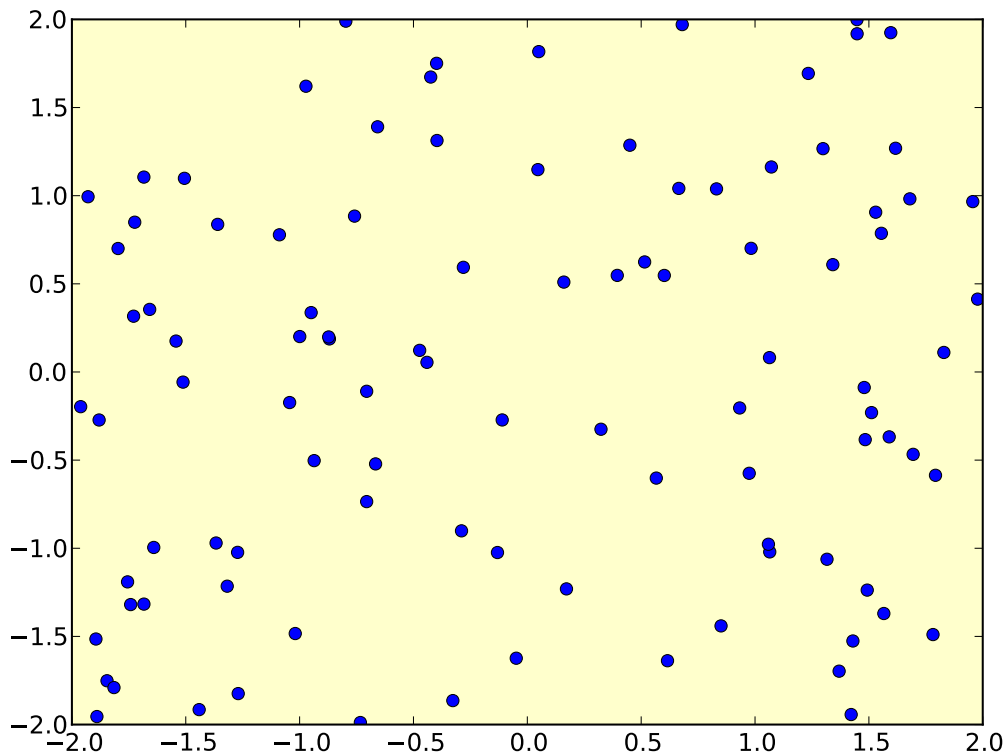
**horizOn** Controls the visibility of the horizontal line

**vertOn** Controls the visibility of the horizontal line

and the visibility of the cursor itself with the *visible* attribute

Add a cursor to *ax*. If `useblit=True`, use the backend- dependent blitting features for faster updates (GTKAgg only for now). *lineprops* is a dictionary of line properties.





**clear**(*event*)  
clear the cursor

**onmove**(*event*)  
on mouse motion draw the cursor if visible

**class HorizontalSpanSelector**(*ax, onselect, \*\*kwargs*)  
Bases: `matplotlib.widgets.SpanSelector`

**class Lasso**(*ax, xy, callback=None, useblit=True*)  
Bases: `matplotlib.widgets.Widget`

**onmove**(*event*)

**onrelease**(*event*)

**class LockDraw**()

Some widgets, like the cursor, draw onto the canvas, and this is not desirable under all circumstances, like when the toolbar is in zoom-to-rect mode and drawing a rectangle. The module level “lock” allows someone to grab the lock and prevent other widgets from drawing. Use `matplotlib.widgets.lock(someobj)` to pr

**available**(*o*)  
drawing is available to *o*

**isowner**(*o*)

Return True if *o* owns this lock

**locked()**

Return True if the lock is currently held by an owner

**release(*o*)**

release the lock

**class MultiCursor**(*canvas, axes, useblit=True, \*\*lineprops*)

Provide a vertical line cursor shared between multiple axes

Example usage:

```
from matplotlib.widgets import MultiCursor
from pylab import figure, show, nx

t = nx.arange(0.0, 2.0, 0.01)
s1 = nx.sin(2*nx.pi*t)
s2 = nx.sin(4*nx.pi*t)
fig = figure()
ax1 = fig.add_subplot(211)
ax1.plot(t, s1)

ax2 = fig.add_subplot(212, sharex=ax1)
ax2.plot(t, s2)

multi = MultiCursor(fig.canvas, (ax1, ax2), color='r', lw=1)
show()

clear(event)
    clear the cursor

onmove(event)
```

**class RadioButtons**(*ax, labels, active=0, activecolor='blue'*)

Bases: `matplotlib.widgets.Widget`

A GUI neutral radio button

The following attributes are exposed

***ax*** The `matplotlib.axes.Axes` instance the buttons are in

***activecolor*** The color of the button when clicked

***labels*** A list of `matplotlib.text.Text` instances

***circles*** A list of `matplotlib.patches.Circle` instances

Connect to the RadioButtons with the `on_clicked()` method

Add radio buttons to `matplotlib.axes.Axes` instance *ax*

***labels*** A len(buttons) list of labels as strings

***active*** The index into labels for the button that is active

**activecolor** The color of the button when clicked

**disconnect**(*cid*)

remove the observer with connection id *cid*

**on\_clicked**(*func*)

When the button is clicked, call *func* with button label

A connection id is returned which can be used to disconnect

**class RectangleSelector**(*ax*, *onselect*, *drawtype*='box', *minspanx*=None, *minspany*=None, *useblit*=False, *lineprops*=None, *rectprops*=None, *spancoords*='data', *button*=None)

Select a min/max range of the x axes for a matplotlib Axes

Example usage:

```
from matplotlib.widgets import RectangleSelector
from pylab import *

def onselect(eclick, erelease):
    'eclick and erelease are matplotlib events at press and release'
    print ' startposition : (%f, %f)' % (eclick.xdata, eclick.ydata)
    print ' endposition   : (%f, %f)' % (erelease.xdata, erelease.ydata)
    print ' used button    : ', eclick.button

def toggle_selector(event):
    print ' Key pressed.'
    if event.key in ['Q', 'q'] and toggle_selector.RS.active:
        print ' RectangleSelector deactivated.'
        toggle_selector.RS.set_active(False)
    if event.key in ['A', 'a'] and not toggle_selector.RS.active:
        print ' RectangleSelector activated.'
        toggle_selector.RS.set_active(True)

x = arange(100)/(99.0)
y = sin(x)
fig = figure
ax = subplot(111)
ax.plot(x,y)

toggle_selector.RS = RectangleSelector(ax, onselect, drawtype='line')
connect('key_press_event', toggle_selector)
show()
```

Create a selector in *ax*. When a selection is made, clear the span and call onselect with:

```
onselect(pos_1, pos_2)
```

and clear the drawn box/line. The *pos\_1* and *pos\_2* are arrays of length 2 containing the x- and y-coordinate.

If *minspanx* is not None then events smaller than *minspanx* in x direction are ignored (it's the same for y).

The rectangle is drawn with *rectprops*; default:

```
rectprops = dict(facecolor='red', edgecolor = 'black',  
                 alpha=0.5, fill=False)
```

The line is drawn with *lineprops*; default:

```
lineprops = dict(color='black', linestyle='-',  
                 linewidth = 2, alpha=0.5)
```

Use *drawtype* if you want the mouse to draw a line, a box or nothing between click and actual position by setting

`drawtype = 'line', drawtype='box' or drawtype = 'none'.`

*spancoords* is one of 'data' or 'pixels'. If 'data', *minspanx* and *minspany* will be interpreted in the same coordinates as the x and y axis. If 'pixels', they are in pixels.

*button* is a list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is `None`, which does not limit which button can be used.

**Note, typically:** 1 = left mouse button 2 = center mouse button (scroll wheel) 3 = right mouse button

**get\_active()**

Get status of active mode (boolean variable)

**ignore(event)**

return True if *event* should be ignored

**onmove(event)**

on motion notify event if box/line is wanted

**press(event)**

on button press event

**release(event)**

on button release event

**set\_active(active)**

Use this to activate / deactivate the RectangleSelector from your program with an boolean parameter *active*.

**update()**

draw using newfangled blit or oldfangled draw depending on useblit

**update\_background(event)**

force an update of the background

**class Slider**(*ax, label, valmin, valmax, valinit=0.5, valfmt='%1.2f', closedmin=True, closedmax=True, slidermin=None, slidermax=None, dragging=True, \*\*kwargs*)

Bases: `matplotlib.widgets.Widget`

A slider representing a floating point range

The following attributes are defined *ax* : the slider `matplotlib.axes.Axes` instance

*val* : the current slider value

*vline* [a `matplotlib.lines.Line2D` instance] representing the initial value of the slider

*poly* [A `matplotlib.patches.Polygon` instance] which is the slider knob

*valfmt* : the format string for formatting the slider text

*label* [a `matplotlib.text.Text` instance] for the slider label

*closedmin* : whether the slider is closed on the minimum

*closedmax* : whether the slider is closed on the maximum

*slidermin* [another slider - if not `None`, this slider must be] greater than *slidermin*

*slidermax* [another slider - if not `None`, this slider must be] less than *slidermax*

*dragging* : allow for mouse dragging on slider

Call `on_changed()` to connect to the slider event

Create a slider from *valmin* to *valmax* in axes *ax*

*valinit* The slider initial position

*label* The slider label

*valfmt* Used to format the slider value

*closedmin* and *closedmax* Indicate whether the slider interval is closed

*slidermin* and *slidermax* Used to constrain the value of this slider to the values of other sliders.

additional kwargs are passed on to `self.poly` which is the `matplotlib.patches.Rectangle` which draws the slider knob. See the `matplotlib.patches.Rectangle` documentation valid property names (e.g., *facecolor*, *edgecolor*, *alpha*, ...)

**disconnect**(*cid*)

remove the observer with connection id *cid*

**on\_changed**(*func*)

When the slider value is changed, call *func* with the new slider position

A connection id is returned which can be used to disconnect

**reset**()

reset the slider to the initial value if needed

**set\_val**(*val*)

**class SpanSelector**(*ax*, *onselect*, *direction*, *minspan=None*, *useblit=False*, *rectprops=None*, *onmove\_callback=None*)

Select a min/max range of the x or y axes for a matplotlib Axes

Example usage:

```
ax = subplot(111)
ax.plot(x,y)

def onselect(vmin, vmax):
    print vmin, vmax
span = SpanSelector(ax, onselect, 'horizontal')
```

***onmove\_callback*** is an optional callback that is called on mouse move within the span range

Create a span selector in *ax*. When a selection is made, clear the span and call *onselect* with:

```
onselect(vmin, vmax)
```

and clear the span.

*direction* must be 'horizontal' or 'vertical'

If *minspan* is not None, ignore events smaller than *minspan*

**The span rectangle is drawn with *rectprops*; default::** `rectprops = dict(facecolor='red', alpha=0.5)`

Set the visible attribute to False if you want to turn off the functionality of the span selector

***ignore(event)***  
return True if *event* should be ignored

***new\_axes(ax)***

***onmove(event)***  
on motion notify event

***press(event)***  
on button press event

***release(event)***  
on button release event

***update()***  
Draw using newfangled blit or oldfangled draw depending on *useblit*

***update\_background(event)***  
force an update of the background

**class SubplotTool(*targetfig, toolfig*)**  
Bases: `matplotlib.widgets.Widget`

A tool to adjust to subplot params of a `matplotlib.figure.Figure`

***targetfig*** The figure instance to adjust

***toolfig*** The figure instance to embed the subplot tool into. If None, a default figure will be created. If you are using this from the GUI

***funcbottom(val)***

**funcspace**(*val*)

**funcleft**(*val*)

**funcright**(*val*)

**functop**(*val*)

**funcwspace**(*val*)

**class Widget()**

Bases: object

Abstract base class for GUI neutral widgets





# **Part VI**

## **Glossary**



**AGG** The Anti-Grain Geometry ([Agg](#)) rendering engine, capable of rendering high-quality images

**Cairo** The [Cairo](#) graphics engine

**dateutil** The [dateutil](#) library provides extensions to the standard datetime module

**EPS** Encapsulated Postscript ([EPS](#))

**FLTK** [FLTK](#) (pronounced “fulltick”) is a cross-platform C++ GUI toolkit for UNIX/Linux (X11), Microsoft Windows, and MacOS X

**freetype** [freetype](#) is a font rasterization library used by matplotlib which supports TrueType, Type 1, and OpenType fonts.

**GDK** The Gimp Drawing Kit for GTK+

**GTK** The GIMP Toolkit ([GTK](#)) graphical user interface library

**JPG** The Joint Photographic Experts Group ([JPEG](#)) compression method and file format for photographic images

**numpy** [numpy](#) is the standard numerical array library for python, the successor to Numeric and numarray. numpy provides fast operations for homogeneous data sets and common mathematical operations like correlations, standard deviation, fourier transforms, and convolutions.

**PDF** Adobe’s Portable Document Format ([PDF](#))

**PNG** Portable Network Graphics ([PNG](#)), a raster graphics format that employs lossless data compression which is more suitable for line art than the lossy jpg format. Unlike the gif format, png is not encumbered by requirements for a patent license.

**PS** Postscript ([PS](#)) is a vector graphics ASCII text language widely used in printers and publishing. Postscript was developed by adobe systems and is starting to show its age: for example it does not have an alpha channel. PDF was designed in part as a next-generation document format to replace postscript

**pyfltk** [pyfltk](#) provides python wrappers for the [FLTK](#) widgets library for use with FLTKAgg

**pygtk** [pygtk](#) provides python wrappers for the [GTK](#) widgets library for use with the GTK or GTKAgg backend. Widely used on linux, and is often packaged as ‘python-gtk2’

**pyqt** [pyqt](#) provides python wrappers for the [Qt](#) widgets library and is required by the matplotlib QtAgg and Qt4Agg backends. Widely used on linux and windows; many linux distributions package this as ‘python-qt3’ or ‘python-qt4’.

**python** [python](#) is an object oriented interpreted language widely used for scripting, application development, web application servers, scientific computing and more.

**pytz** [pytz](#) provides the Olson tz database in Python. it allows accurate and cross platform timezone calculations and solves the issue of ambiguous times at the end of daylight savings

**Qt** [Qt](#) is a cross-platform application framework for desktop and embedded development.

**Qt4** [Qt4](#) is the most recent version of Qt cross-platform application framework for desktop and embedded development.

**raster graphics** [Raster graphics](#), or bitmaps, represent an image as an array of pixels which is resolution dependent. Raster graphics are generally most practical for photo-realistic images, but do not scale easily without loss of quality.

**SVG** The Scalable Vector Graphics format ([SVG](#)). An XML based vector graphics format supported by many web browsers.

**TIFF** Tagged Image File Format ([TIFF](#)) is a file format for storing images, including photographs and line art.

**Tk** [Tk](#) is a graphical user interface for Tcl and many other dynamic languages. It can produce rich, native applications that run unchanged across Windows, Mac OS X, Linux and more.

**vector graphics** [vector graphics](#) use geometrical primitives based upon mathematical equations to represent images in computer graphics. Primitives can include points, lines, curves, and shapes or polygons. Vector graphics are scalable, which means that they can be resized without suffering from issues related to inherent resolution like are seen in raster graphics. Vector graphics are generally most practical for typesetting and graphic design applications.

**wxpython** [wxpython](#) provides python wrappers for the [wxWidgets](#) library for use with the WX and WXAgg backends. Widely used on linux, OS-X and windows, it is often packaged by linux distributions as ‘python-wxgtk’

**wxWidgets** [WX](#) is cross-platform GUI and tools library for GTK, MS Windows, and MacOS. It uses native widgets for each operating system, so applications will have the look-and-feel that users on that operating system expect.

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