Matplotlib

Release 1.0.0

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Part I

User's Guide

CHAPTER

ONE

INTRODUCTION

matplotlib is a library for making 2D plots of arrays in Python. Although it has its origins in emulating the MATLAB® [1] 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 and 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 steam 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.

[1] 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.

CHAPTER

TWO

INSTALLING

There are lots of 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 pretty much every major linux distribution, so if you are on linux your package manager will probably provide matplotlib prebuilt.

One single click installer and you are done.

2.1 OK, so you want to do it the hard way?

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 (2.5 or 2.6) and your platform (macosx or win32) and you should be good to go. If you have any problems, please check the *Installation FAQ*, google around a little bit, and post a question the mailing list. If you are on debian/unbuntu 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, in ipython's "pylab" mode you 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)
```

Instructions for installing our OSX binaries are found in the FAQ ref:*install_osx_binaries*.

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*.

2.2 Installing from source

If you are interested perhaps in contributing to matplotlib development, running the latest greatest 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, or if you want to develop matplotlib or just need the latest bugfixed version, grab the latest svn version *Install from svn*.

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

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

We provide a setup.cfg file that lives along `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.

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, you may need to install the development packages (look for a "-dev" postfix) in addition to the libraries themselves.

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 1.1 (or later) library for loading and saving *PNG* files (download). libpng requires zlib. If you are a windows user, you can ignore this since 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 **2.6 or later** The python wrappers for the wx widgets library for use with the WXAgg backend

wxpython **2.8 or later** The python wrappers for the wx widgets library for use with the WX 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 :file:'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 png and freetype requirements from (darwinports, fink, /usr/X11R6) and the different architectures (x86, ppc, universal) and the different OSX version (10.4 and 10.5). We recommend that you build the way we do for the OSX release: by grabbing the tarbar or svn repository, cd-ing into the release/osx dir, and following the instruction in the

README. This directory has a Makefile which will automatically grab the zlib, png and freetype dependencies from the web, build them with the right flags to make universal libraries, and then build the matplotlib source and binary installers.

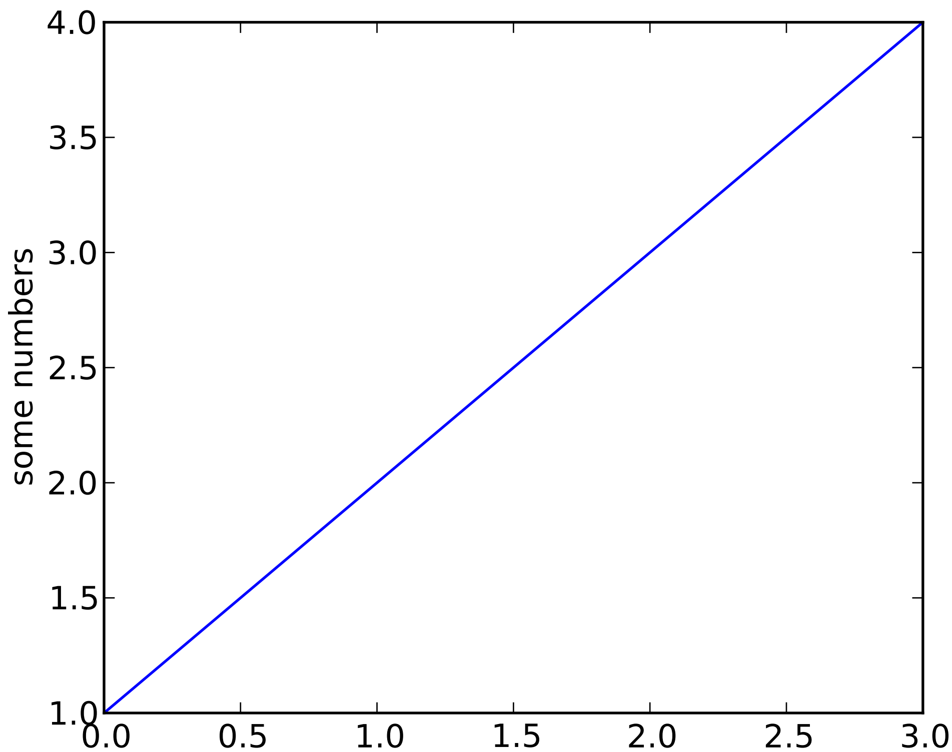
CHAPTER

THREE

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()
```



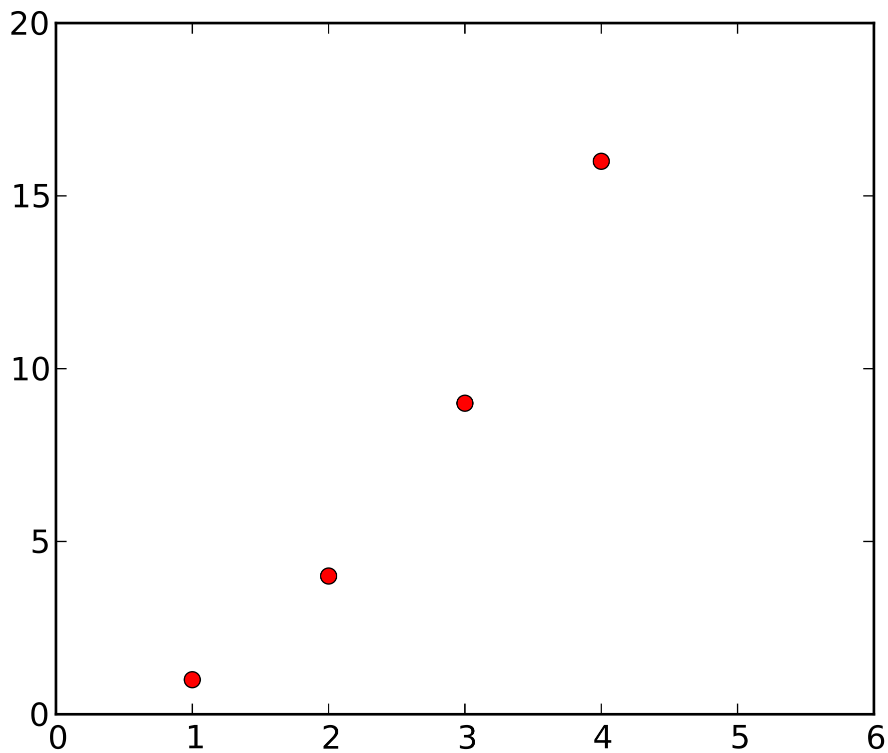
You may be wondering why the x-axis ranges from 0-2 and the y-axis from 1-3. If you provide a single list or array to the `plot()` command, matplotlib assumes it is a sequence of y values, and automatically generates the x values for you. Since python ranges start with 0, the default x vector has the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

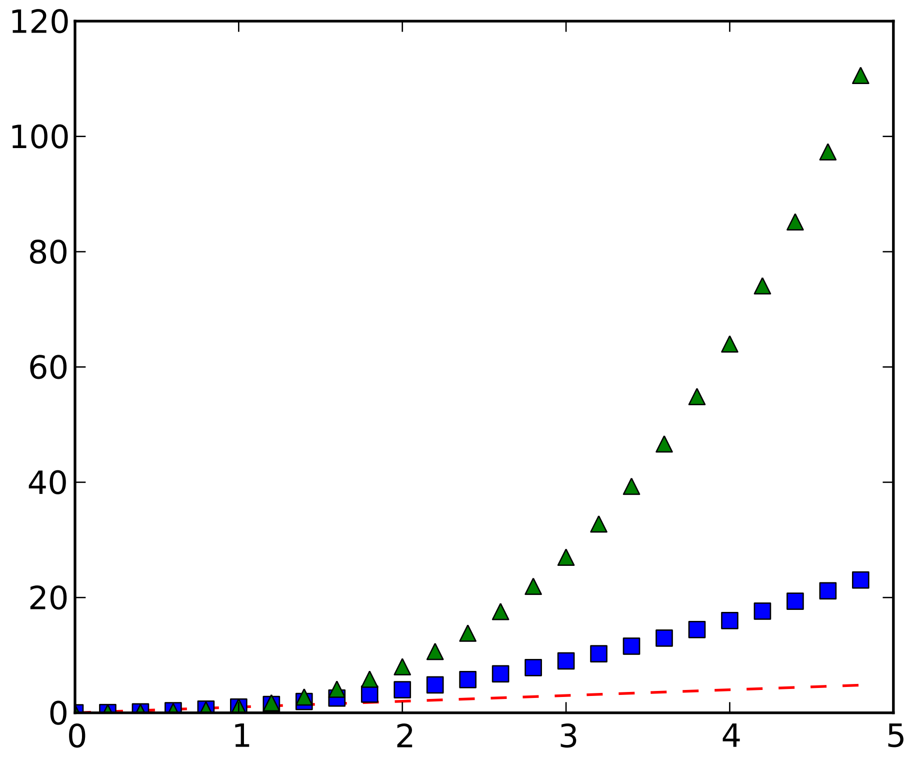
```
import matplotlib.pyplot as plt
plt.plot([1,2,3,4], [1,4,9,16], 'ro')
plt.axis([0, 6, 0, 20])
```



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 antialising
```

- 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.

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

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
```

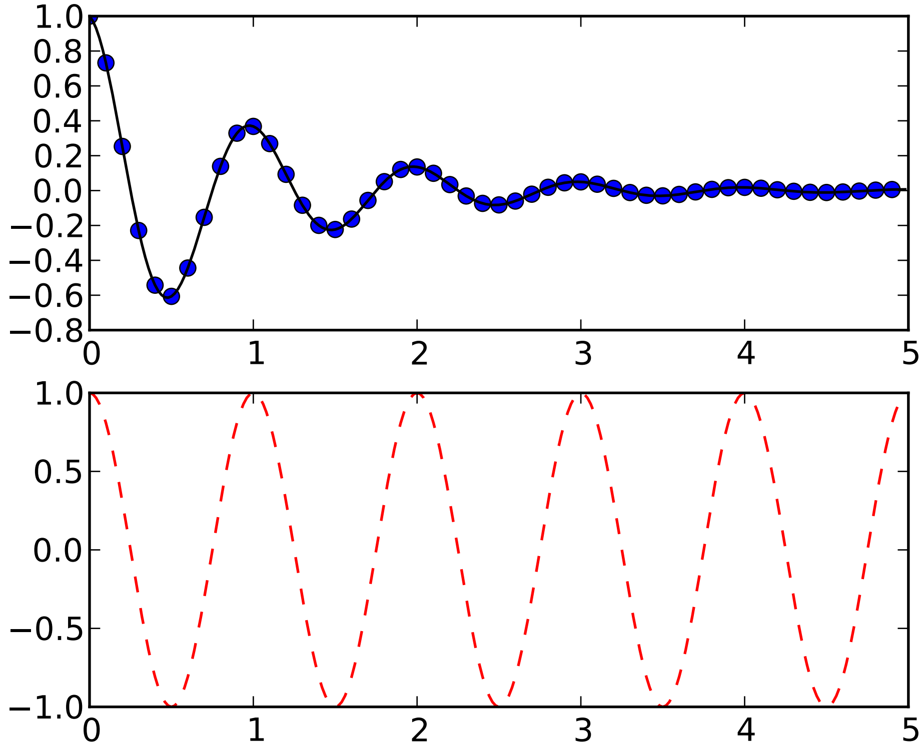
3.2 Working with multiple figures and axes

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
```

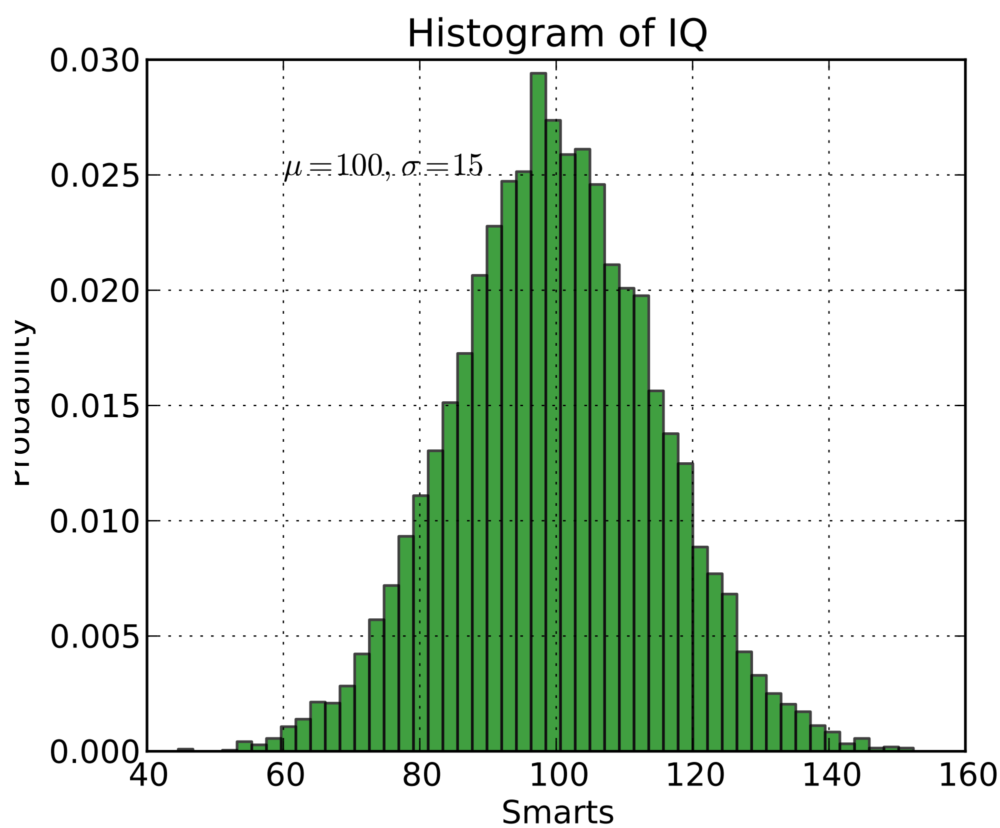
You can clear the current figure with `clf()` and the current axes with `cla()`. If you find this statefulness, annoying, don't despair, this is just a thin stateful wrapper around an object oriented API, which you can use instead (see *Artist tutorial*)

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'$\sigma_i=15$')
```

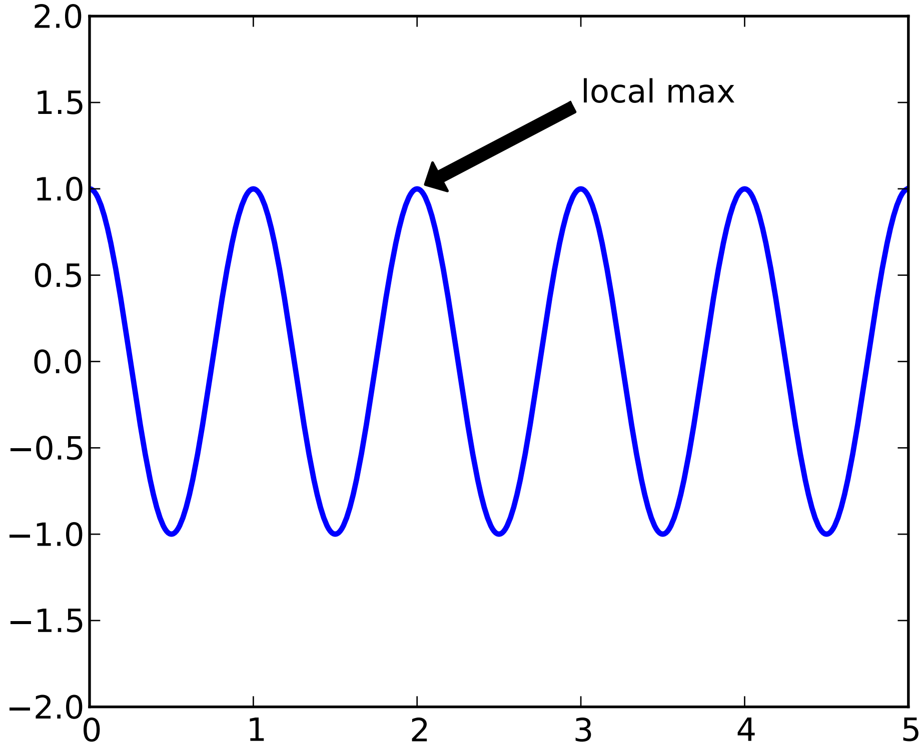
The `r` preceeding the title string is important – it signifies that the string is a *raw* string and not to treate backslashes and python escapes. matplotlib has a built-in TeX expression parser and layout engine, and ships its own math fonts – for details see *Writing mathematical expressions*. Thus 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()
```

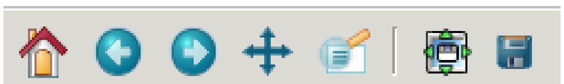
In this basic example, both the `xy` (arrow tip) and `xytext` locations (text location) are in data coordinates. There are a variety of other coordinate systems one can choose – see *Annotating text* and *Annotating Axes* for details. More examples can be found in *pylab_examples example code: annotation_demo.py*.


local max
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0
1
2
3
4
5

CHAPTER

FOUR

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 and axes 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	**h** or **r** or **home**
Back	**c** or **left arrow** or **backspace**
Forward	**v** or **right arrow**
Pan/Zoom	**p**
Zoom-to-rect	**o**
Save	**s**
Toggle fullscreen	**f**
Constrain pan/zoom to x axis	hold **x**
Constrain pan/zoom to y axis	hold **y**
Preserve aspect ratio	hold **CONTROL**
Toggle grid	**g**
Toggle x axis scale (log/linear)	**L** or **k**
Toggle y axis scale (log/linear)	**l**

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()
```

CHAPTER

FIVE

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      : GTKAgg
```

```
# if you are runing pyplot inside a GUI and your backend choice
# conflicts, we will automatically try and 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 antialised (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 antialised (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 B
#font.sans-serif     : Bitstream Vera Sans, Lucida Grande, Verdana, Geneva, Lucid, Arial, Helvetica, Ava
#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,
                            # type1cm, 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 any 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.unicode_minus  : True    # use unicode for the minus symbol
                               # rather than hypen.  See http://en.wikipedia.org/wiki/Plus_sig
#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 whitspace 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  # the vertical space between the legend entries
#legend.handlelen     : 0.05   # the length of the legend lines
#legend.handletextsep : 0.02   # the space between the legend line and legend text
#legend.axespad       : 0.02   # the border between the axes and legend edge
#legend.shadow        : False

### 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.embed_char_paths : True       # embed character outlines in the SVG file

# 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
```

CHAPTER

SIX

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)
```

CHAPTER

SEVEN

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

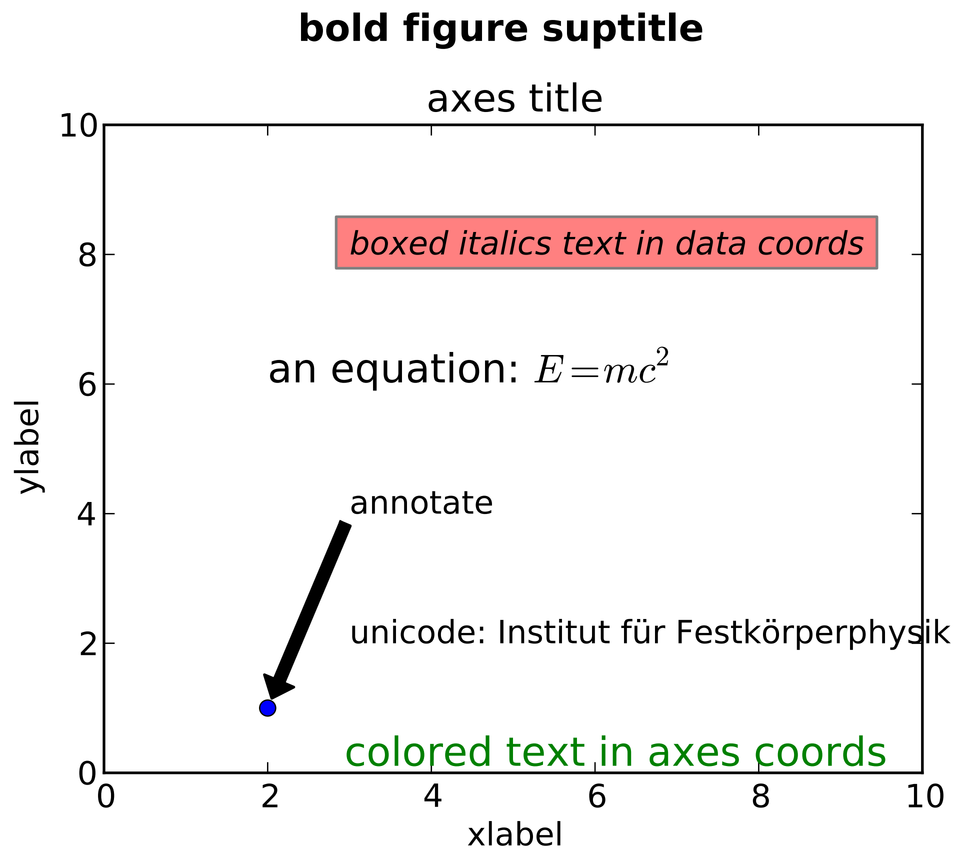
- `text()` - add text at an arbitrary location to the `Axes`; `matplotlib.axes.Axes.text()` in the API.
- `xlabel()` - add an axis label to the x-axis; `matplotlib.axes.Axes.set_xlabel()` in the API.
- `ylabel()` - add an axis label to the y-axis; `matplotlib.axes.Axes.set_ylabel()` in the API.
- `title()` - 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 bew 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 suptitle', 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

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()
```

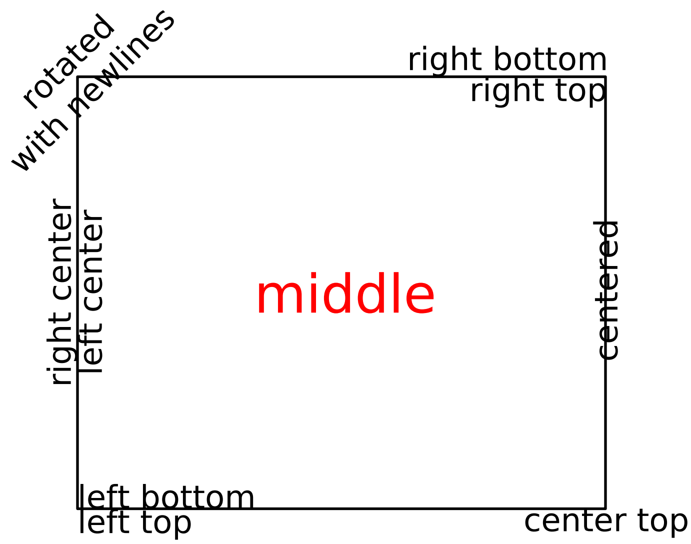
7.4 Writing mathematical expressions

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 (preceed 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 (with 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 ∞, 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

$$\frac{3}{4}\binom{3}{4}\stackrel{3}{4} \tag{7.3}$$

Fractions can be arbitrarily nested:

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

produces

$$\frac{5-\frac{1}{x}}{4} \tag{7.4}$$

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

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

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

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

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

7.4.3 Radicals

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

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

$$\sqrt{2} \tag{7.7}$$

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

$$\sqrt[3]{x} \tag{7.8}$$

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

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

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

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

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 caligraphy `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)
```

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

The choices available with all fonts are:

Command	Result
`\mathrm{Roman}`	Roman
`\mathit{Italic}`	*Italic*
`\mathtt{Typewriter}`	`Typewriter`
`\mathcal{CALLIGRAPHY}`	$\mathcal{CALLIGRAPHY}$

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

Command	Result
`\mathbb{blackboard}`	⋖ᗜ⅂⋊ᗜ⟍
`\mathrm{\mathbb{blackboard}}`	⋖ᗜ⅂⋊ᗜ⟍
`\mathfrak{Fraktur}`	$\mathfrak{Fraktur}$
`\mathsf{sansserif}`	$\mathsf{sansserif}$
`\mathrm{\mathsf{sansserif}}`	$\mathsf{sansserif}$

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
`mathtext.it`	`\mathit{}` or default italic
`mathtext.rm`	`\mathrm{}` Roman (upright)
`mathtext.tt`	`\mathtt{}` Typewriter (monospace)
`mathtext.bf`	`\mathbf{}` bold italic
`mathtext.cal`	`\mathcal{}` calligraphic
`mathtext.sf`	`\mathsf{}` 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
`\acute a` or `\'a`	$\acute{a}$
`\bar a`	$\bar{a}$
`\breve a`	$\breve{a}$
`\ddot a` or `\"a`	$\ddot{a}$
`\dot a` or `\.a`	$\dot{a}$
`\grave a` or `` \`a ``	$\grave{a}$
`\hat a` or `\^a`	$\hat{a}$
`\tilde a` or `\~a`	$\tilde{a}$
`\vec a`	$\vec{a}$

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

Command	Result
`\widehat{xyz}`	$\widehat{xyz}$
`\widetilde{xyz}`	$\widetilde{xyz}$

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

$$\hat i\ \hat \imath \tag{7.12}$$

7.4.6 Symbols

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

Lower-case Greek

α `\alpha`	β `\beta`	χ `\chi`	δ `\delta`	$\digamma$ `\digamma`
ϵ `\epsilon`	η `\eta`	γ `\gamma`	ι `\iota`	κ `\kappa`
λ `\lambda`	μ `\mu`	ν `\nu`	ω `\omega`	ϕ `\phi`
π `\pi`	ψ `\psi`	ρ `\rho`	σ `\sigma`	τ `\tau`
θ `\theta`	υ `\upsilon`	ε `\varepsilon`	$\varkappa$ `\varkappa`	φ `\varphi`
ϖ `\varpi`	ϱ `\varrho`	ς `\varsigma`	ϑ `\vartheta`	ξ `\xi`
ζ `\zeta`				

Upper-case Greek

Δ `\Delta`	Γ `\Gamma`	Λ `\Lambda`	Ω `\Omega`	Φ `\Phi`	Π `\Pi`
Ψ `\Psi`	Σ `\Sigma`	Θ `\Theta`	Υ `\Upsilon`	Ξ `\Xi`	$\mho$ `\mho`
∇ `\nabla`					

Hebrew

$\aleph$ `\aleph`	$\beth$ `\beth`	$\daleth$ `\daleth`	$\gimel$ `\gimel`

Delimiters

<table>
<tr><td>/ <code>/</code></td><td>[<code>[</code></td><td>$\Downarrow$ <code>\Downarrow</code></td><td>$\Uparrow$ <code>\Uparrow</code></td><td>$\Vert$ <code>\Vert</code></td><td>$\backslash$ <code>\backslash</code></td></tr>
<tr><td>$\downarrow$ <code>\downarrow</code></td><td>$\langle$ <code>\langle</code></td><td>$\lceil$ <code>\lceil</code></td><td>$\lfloor$ <code>\lfloor</code></td><td>$\llcorner$ <code>\llcorner</code></td><td>$\lrcorner$ <code>\lrcorner</code></td></tr>
<tr><td>$\rangle$ <code>\rangle</code></td><td>$\rceil$ <code>\rceil</code></td><td>$\rfloor$ <code>\rfloor</code></td><td>$\ulcorner$ <code>\ulcorner</code></td><td>$\uparrow$ <code>\uparrow</code></td><td>$\urcorner$ <code>\urcorner</code></td></tr>
<tr><td>$\vert$ <code>\vert</code></td><td>$\{$ <code>\{</code></td><td>$\|$ <code>\|</code></td><td>$\}$ <code>\}</code></td><td>] <code>]</code></td><td>$|$ <code>|</code></td></tr>
</table>

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`
$\liminf$ `\liminf`	$\limsup$ `\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

$\Bumpeq$ \Bumpeq	$\Cap$ \Cap	$\Cup$ \Cup
$\Doteq$ \Doteq	$\Join$ \Join	$\Subset$ \Subset
$\Supset$ \Supset	$\Vdash$ \Vdash	$\Vvdash$ \Vvdash
$\approx$ \approx	$\approxeq$ \approxeq	$\ast$ \ast
$\asymp$ \asymp	$\backepsilon$ \backepsilon	$\backsim$ \backsim
$\backsimeq$ \backsimeq	$\barwedge$ \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	$\circeq$ \circeq
$\coloneq$ \coloneq	$\cong$ \cong	$\cup$ \cup
$\curlyeqprec$ \curlyeqprec	$\curlyeqsucc$ \curlyeqsucc	$\curlyvee$ \curlyvee
$\curlywedge$ \curlywedge	$\dag$ \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

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

⋬ \ntrianglelefteq	⋫ \ntriangleright	⋭ \ntrianglerighteq
⊯ \nvDash	⊬ \nvdash	⊙ \odot
⊖ \ominus	⊕ \oplus	⊘ \oslash
⊗ \otimes	∥ \parallel	⊥ \perp
⋔ \pitchfork	± \pm	≺ \prec
⪷ \precapprox	≼ \preccurlyeq	⪯ \preceq
⪹ \precnapprox	⋨ \precnsim	≾ \precsim
∝ \propto	⋌ \rightthreetimes	≓ \risingdotseq
⋊ \rtimes	∼ \sim	≃ \simeq
/ \slash	⌣ \smile	⊓ \sqcap
⊔ \sqcup	⊏ \sqsubset	⊏ \sqsubset
⊑ \sqsubseteq	⊐ \sqsupset	⊐ \sqsupset
⊒ \sqsupseteq	⋆ \star	⊂ \subset
⊆ \subseteq	⫅ \subseteqq	⊊ \subsetneq
⫋ \subsetneqq	≻ \succ	⪸ \succapprox
≽ \succcurlyeq	⪰ \succeq	⪺ \succnapprox
⋩ \succnsim	≿ \succsim	⊃ \supset
⊇ \supseteq	⫆ \supseteqq	⊋ \supsetneq
⫌ \supsetneqq	∴ \therefore	× \times
⊤ \top	◂ \triangleleft	⊴ \trianglelefteq

≜ \triangleq	▸ \triangleright	⊵ \trianglerighteq
⊎ \uplus	⊨ \vDash	∝ \varpropto
⊲ \vartriangleleft	⊳ \vartriangleright	⊢ \vdash
∨ \vee	⊻ \veebar	∧ \wedge
≀ \wr		

Arrow symbols

⇓ \Downarrow	⇐ \Leftarrow
⇔ \Leftrightarrow	⇚ \Lleftarrow
⟸ \Longleftarrow	⟺ \Longleftrightarrow
⟹ \Longrightarrow	↰ \Lsh
⇗ \Nearrow	⇖ \Nwarrow
⇒ \Rightarrow	⇛ \Rrightarrow
↱ \Rsh	⇘ \Searrow
⇙ \Swarrow	⇑ \Uparrow
⇕ \Updownarrow	↺ \circlearrowleft
↻ \circlearrowright	↶ \curvearrowleft
↷ \curvearrowright	⇠ \dashleftarrow
⇢ \dashrightarrow	↓ \downarrow
⇊ \downdownarrows	⇃ \downharpoonleft
⇂ \downharpoonright	↩ \hookleftarrow
↪ \hookrightarrow	⇝ \leadsto
← \leftarrow	↢ \leftarrowtail
↽ \leftharpoondown	↼ \leftharpoonup
⇇ \leftleftarrows	↔ \leftrightarrow
⇆ \leftrightarrows	⇋ \leftrightharpoons
↭ \leftrightsquigarrow	⇜ \leftsquigarrow

⟵ \longleftarrow	⟷ \longleftrightarrow
⟼ \longmapsto	⟶ \longrightarrow
↫ \looparrowleft	↬ \looparrowright
↦ \mapsto	⊸ \multimap
⇍ \nLeftarrow	⇎ \nLeftrightarrow
⇏ \nRightarrow	↗ \nearrow
↚ \nleftarrow	↮ \nleftrightarrow
↛ \nrightarrow	↖ \nwarrow
→ \rightarrow	↣ \rightarrowtail
⇁ \rightharpoondown	⇀ \rightharpoonup
⇄ \rightleftarrows	⇄ \rightleftarrows
⇌ \rightleftharpoons	⇌ \rightleftharpoons
⇉ \rightrightarrows	⇉ \rightrightarrows
⇝ \rightsquigarrow	↘ \searrow
↙ \swarrow	→ \to
↞ \twoheadleftarrow	↠ \twoheadrightarrow
↑ \uparrow	↕ \updownarrow
↕ \updownarrow	↿ \upharpoonleft
↾ \upharpoonright	⇈ \upuparrows

Miscellaneous symbols

$ \$	Å \AA	Ⅎ \Finv
⅁ \Game	ℑ \Im	¶ \P
ℜ \Re	§ \S	∠ \angle
‵ \backprime	★ \bigstar	■ \blacksquare
▲ \blacktriangle	▼ \blacktriangledown	⋯ \cdots
✓ \checkmark	® \circledR	Ⓢ \circledS
♣ \clubsuit	∁ \complement	© \copyright
⋱ \ddots	◇ \diamondsuit	ℓ \ell
∅ \emptyset	ð \eth	∃ \exists
♭ \flat	∀ \forall	ℏ \hbar
♡ \heartsuit	ℏ \hslash	∭ \iiint
∬ \iint	∬ \iint	ı \imath
∞ \infty	ȷ \jmath	… \ldots
∡ \measuredangle	♮ \natural	¬ \neg
∄ \nexists	∰ \oiiint	∂ \partial
′ \prime	♯ \sharp	♠ \spadesuit
∢ \sphericalangle	\ss	▽ \triangledown
∅ \varnothing	△ \vartriangle	⋮ \vdots
℘ \wp	¥ \yen	

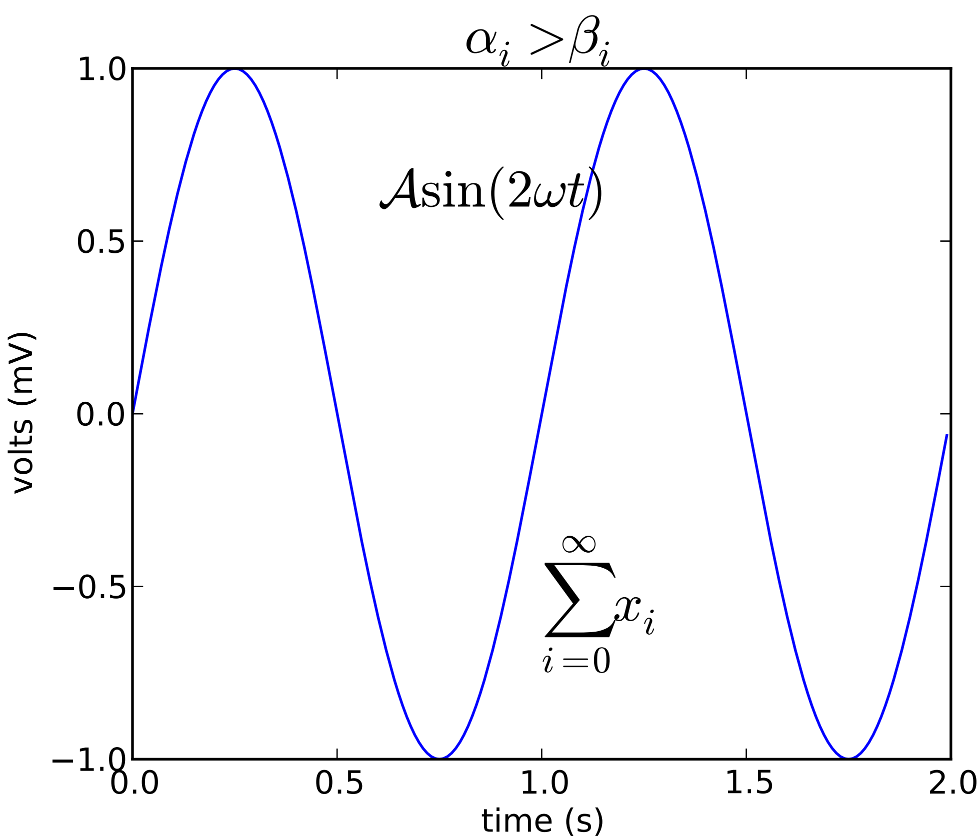
If a particular symbol does not have a name (as is true of many of the more obscure symbols in the STIX fonts), Unicode characters can also be used:

```
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()
```

Exception occurred rendering plot.

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()
```

Exception occurred rendering plot.

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 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*

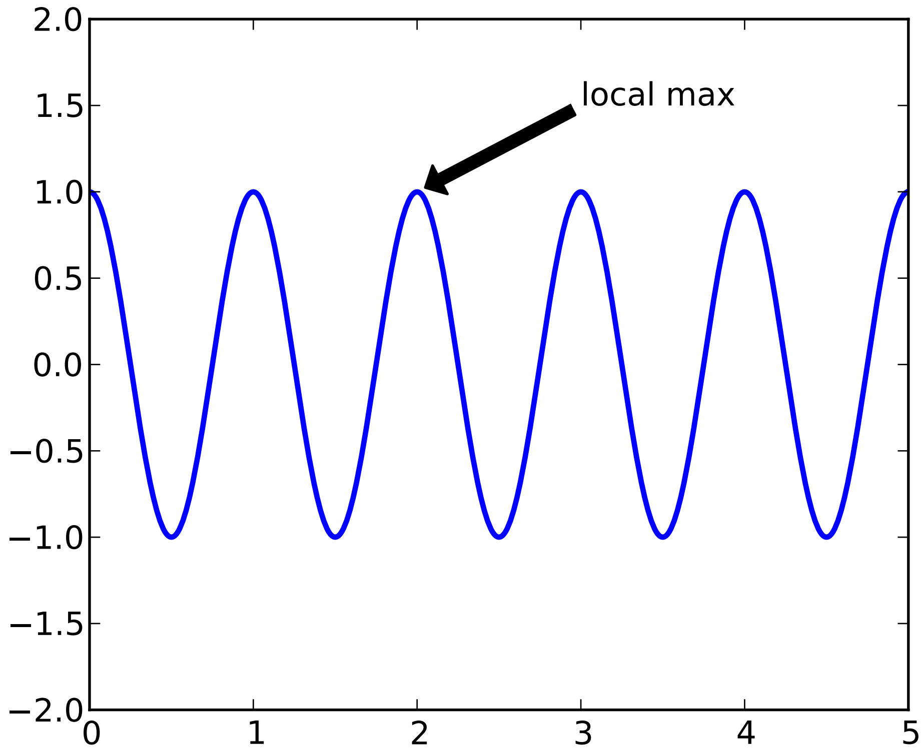
7.6 Annotating text

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.

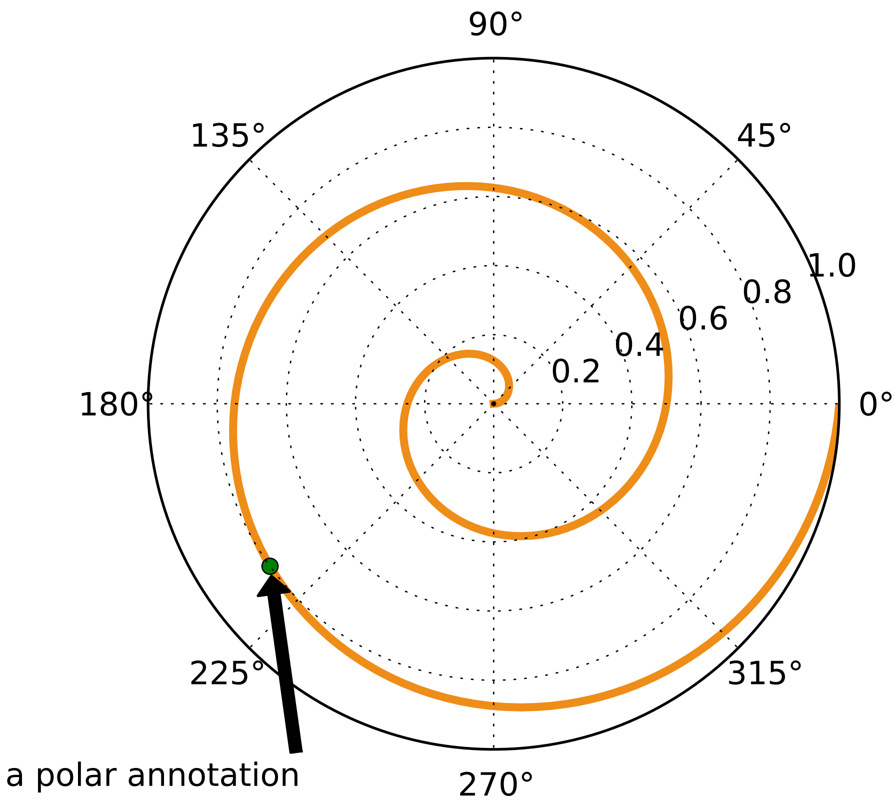
Optionally, you can specify arrow properties which draws an arrow from the text to the annotated point by giving a dictionary of arrow properties in the optional keyword argument `arrowprops`.

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 `matplotlib.patches.Polygon`, e.g. `facecolor`

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*.


90°
135°
45°
1.0
0.8
0.6
0.4
0.2
180°
0°
225°
315°
270°
a polar annotation

CHAPTER

EIGHT

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]],

       [[ 0.41960785,  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)
```

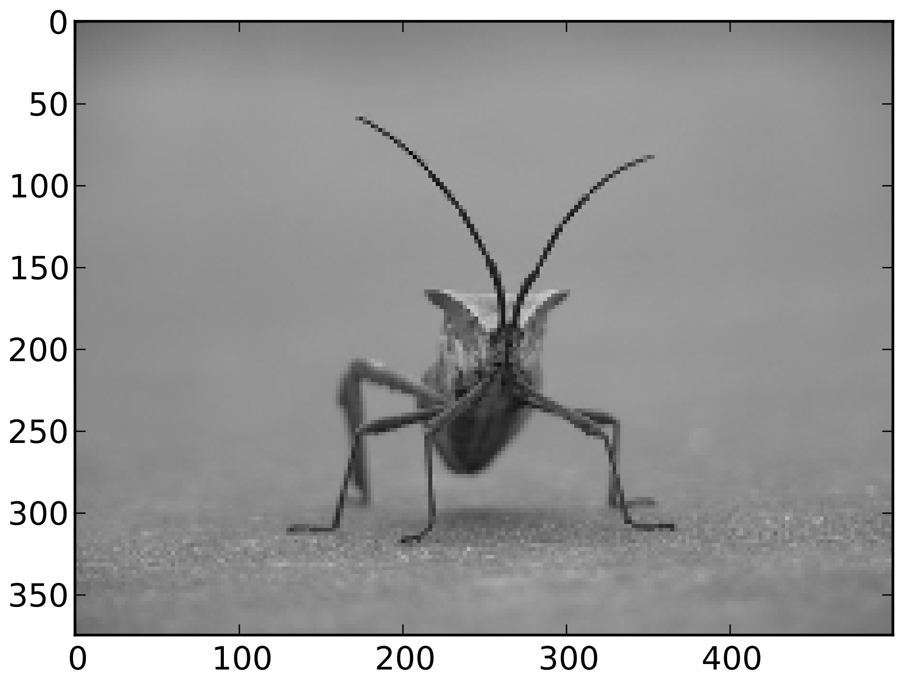
Note the dtype there - float32. Matplotlib has rescaled the 8 bit data from each channel to floating point data between 0.0 and 1.0. As a side note, the only datatype that PIL can work with is uint8. Matplotlib plotting can handle float32 and uint8, but image reading/writing for any format other than 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

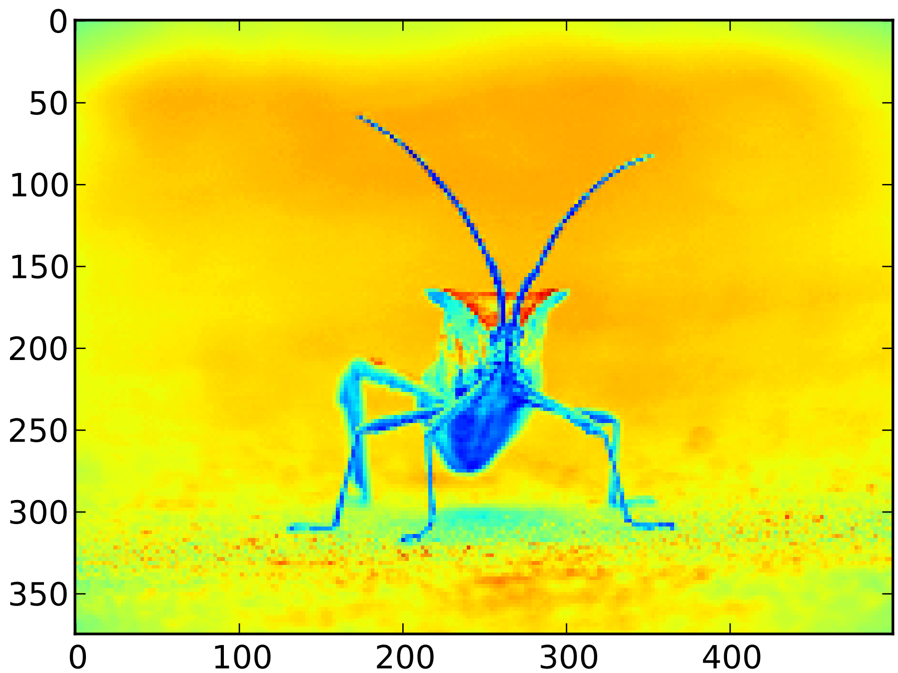
Pseudocolor can be a useful tool for enhancing contrast and visualizing your data more easily. This is especially useful when making presentations of your data using projectors - their contrast is typically quite poor.

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:

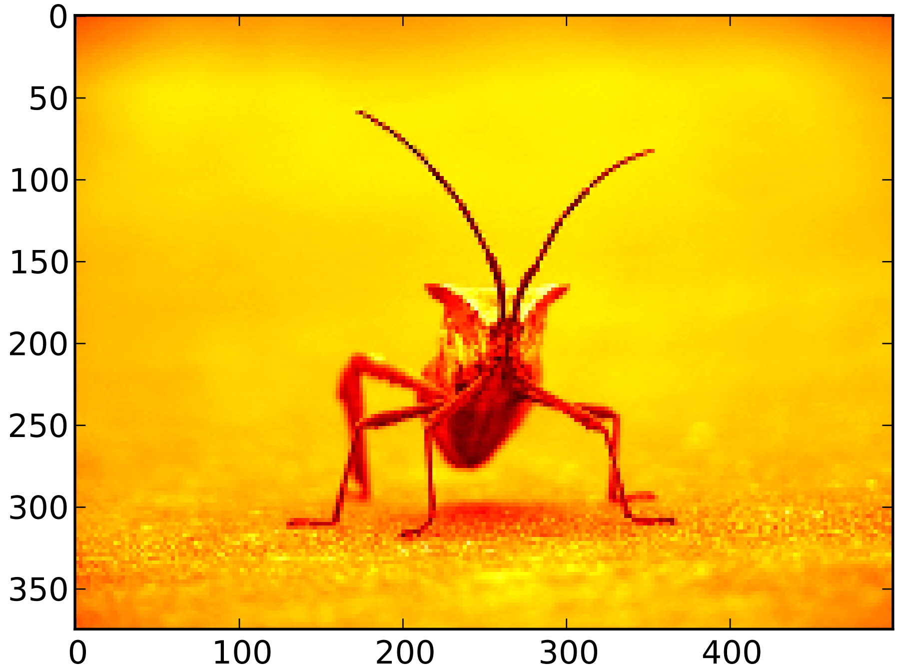
```
In [8]: imgplot.set_cmap('hot')
```

```
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.

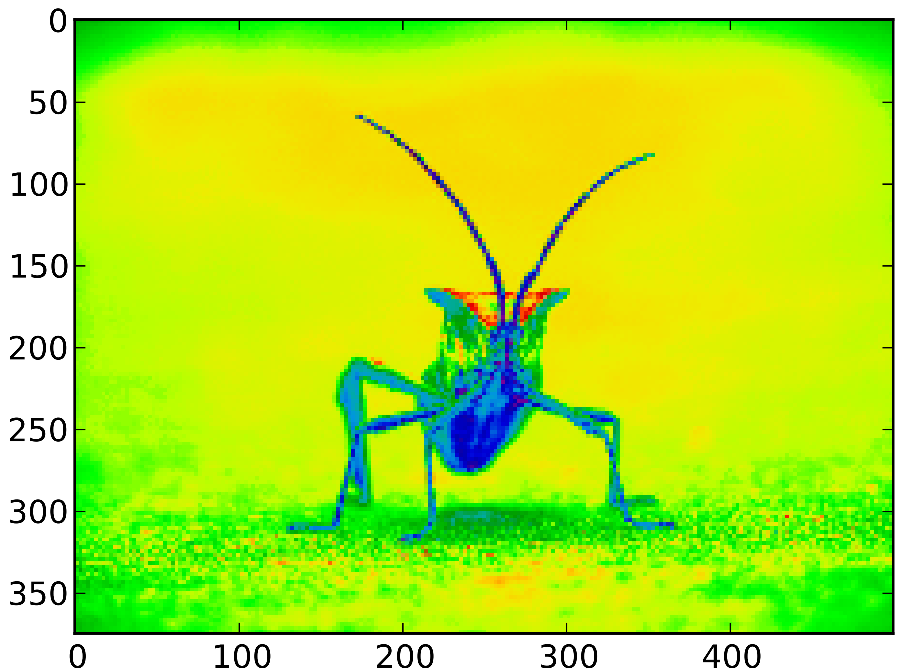
8.3.3 Examining a specific data range

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

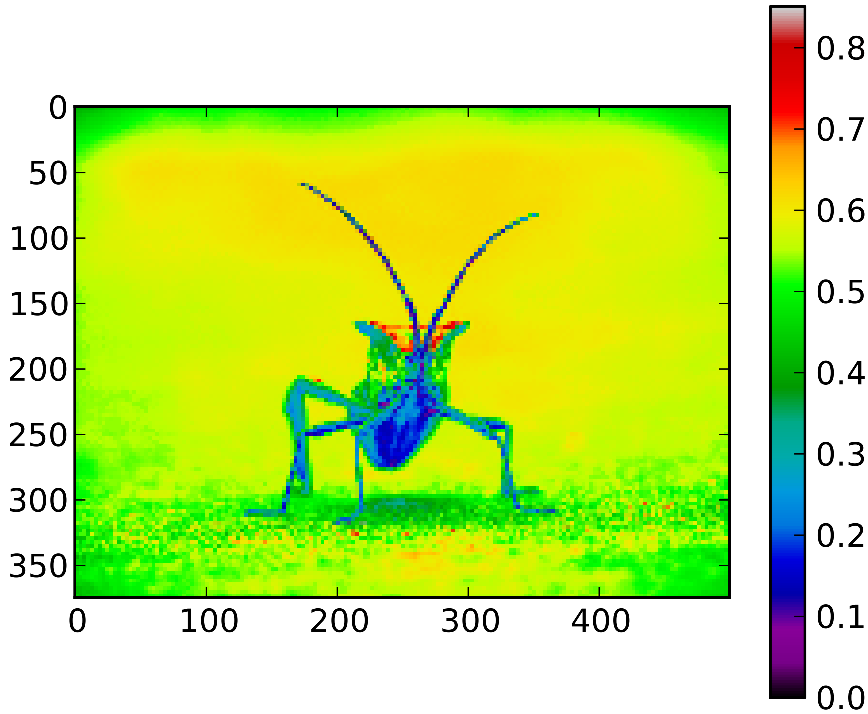
Interpolation calculates what the color or value of a pixel "should" be, according to different mathematical schemes. One common place that this happens is when you resize an image. The number of pixels change, but you want the same information. Since pixels are discrete, there's missing space. Interpolation 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.

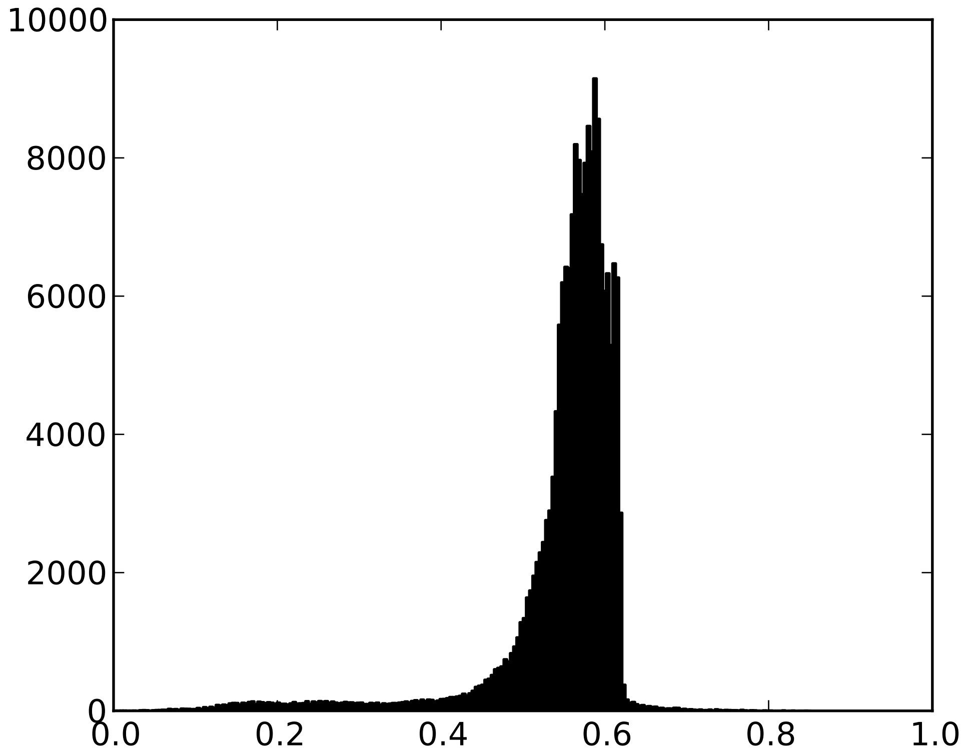
Let's try some others:

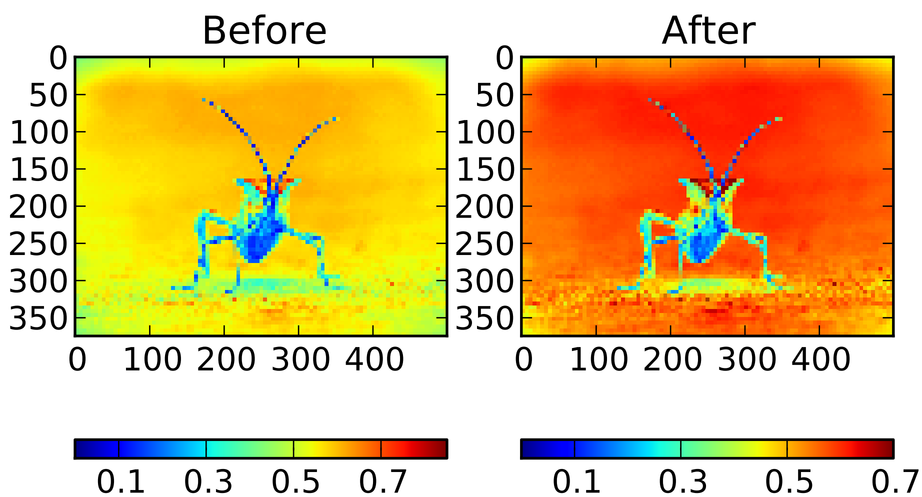
```
In [10]: imgplot.set_interpolation('nearest')
```

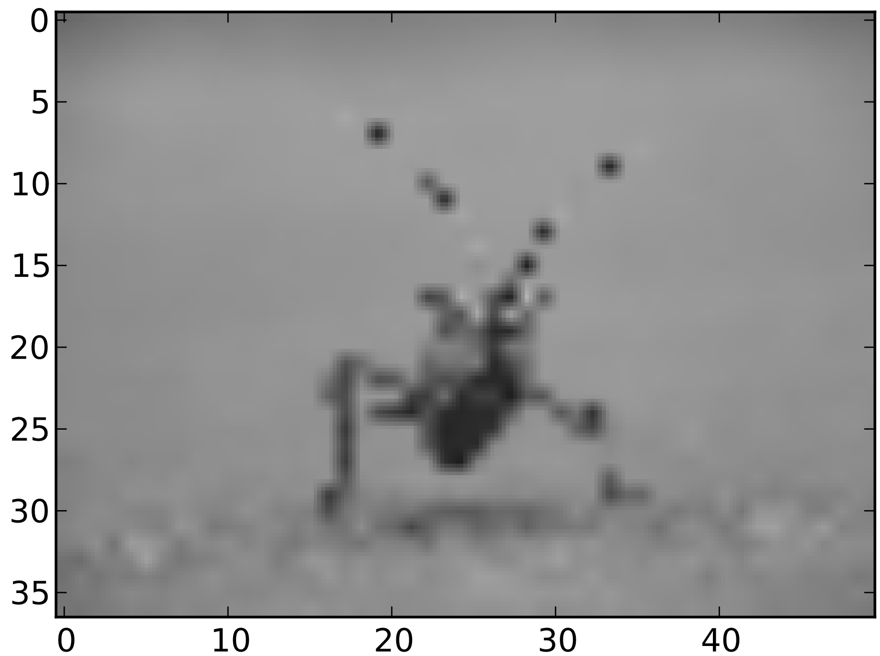



```
In [10]: imgplot.set_interpolation('bicubic')
```

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


10000
8000
6000
4000
2000
0
0.0
0.2
0.4
0.6
0.8
1.0


Before
After
0
50
100
150
200
250
300
350
0 100 200 300 400
0.1 0.3 0.5 0.7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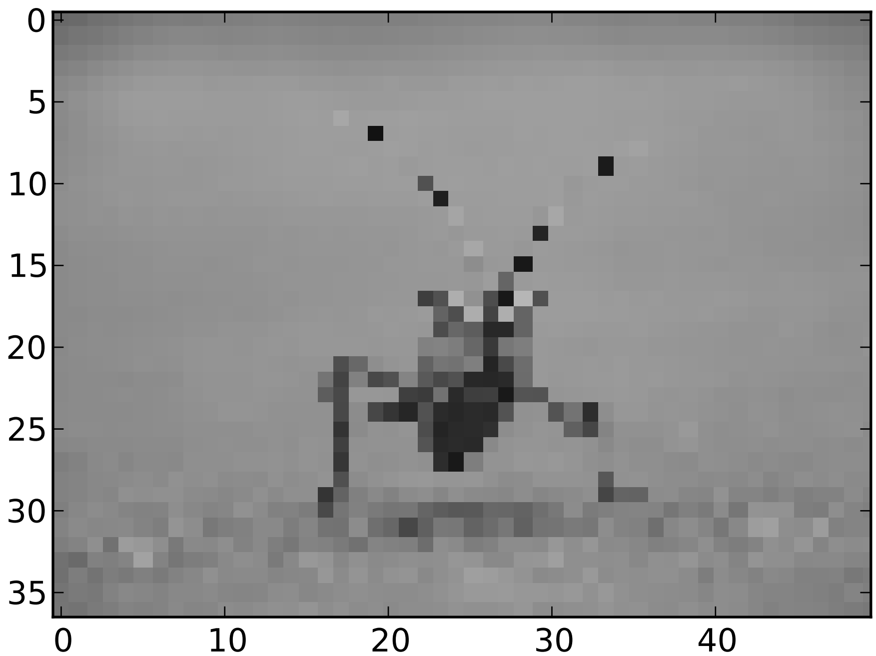
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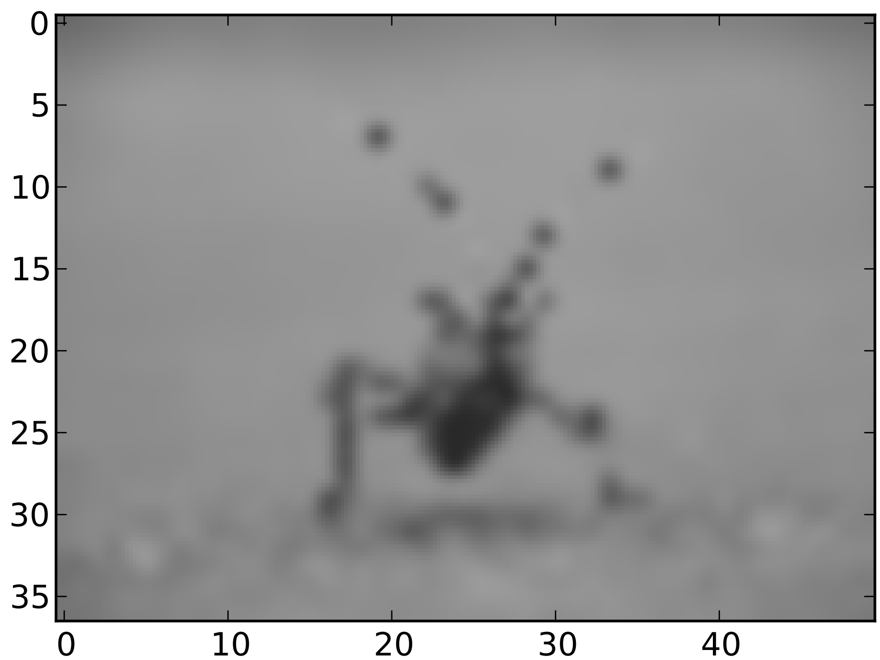
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CHAPTER

NINE

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:

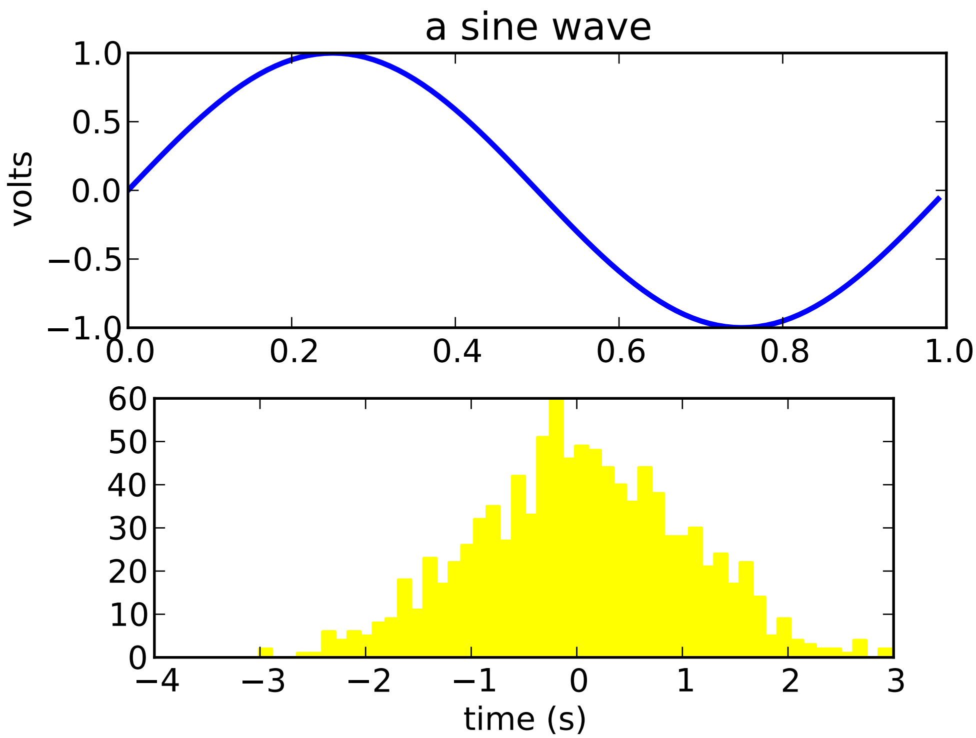
```
xtext = ax.set_xlabel('my xdata') # returns a Text instance
ytext = ax.set_ylabel('my xdata')
```

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 *matplotlib 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

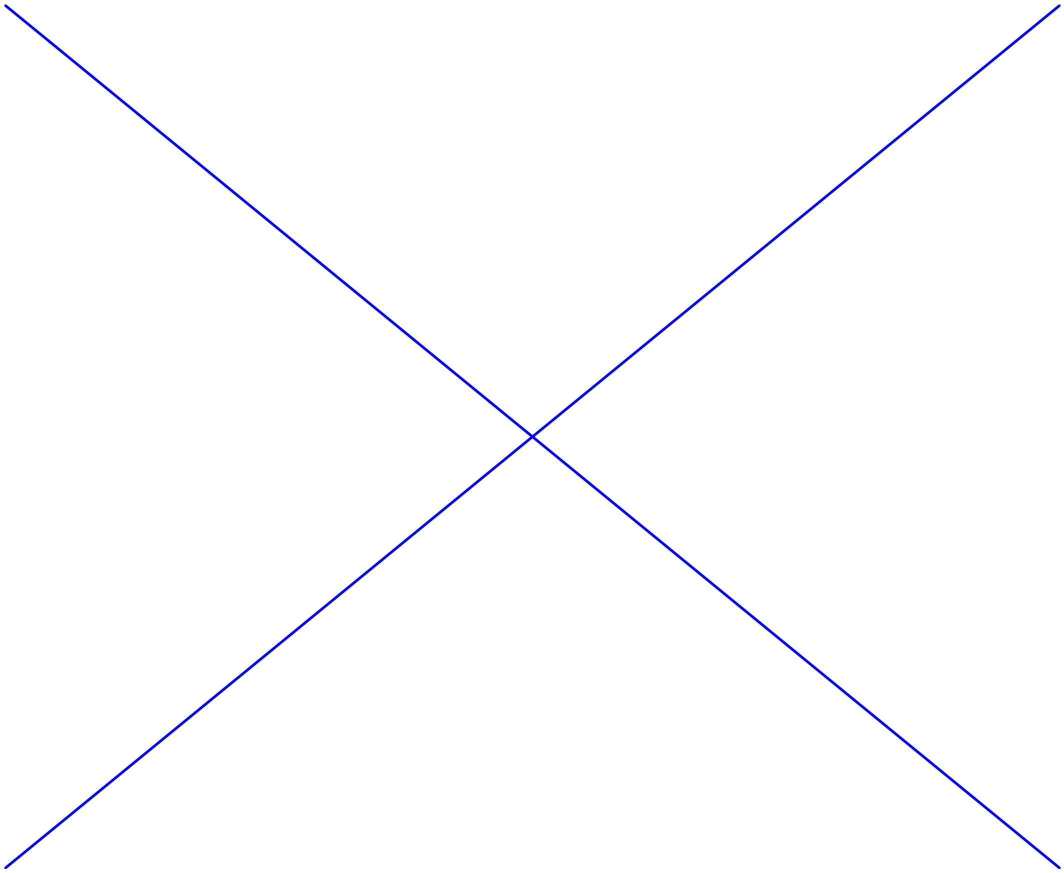


Figure attribute	Description
axes	A list of Axes instances (includes Subplot)
patch	The Rectangle background
images	A list of FigureImages patches - useful for raw pixel display
legends	A list of Figure Legend instances (different from Axes.legends)
lines	A list of Figure Line2D instances (rarely used,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

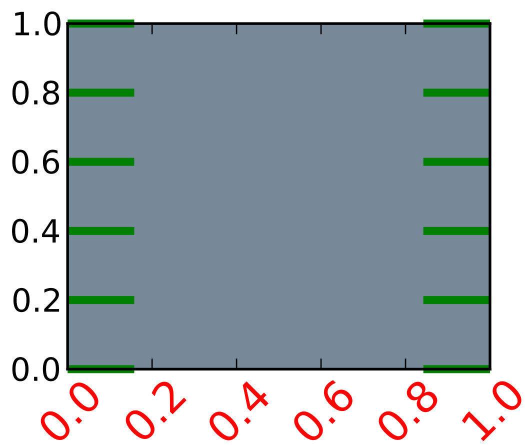
Here is a summary of some of the useful accessor methods of the `Axis` (these have corresponding setters where useful, such as set_major_formatter)

Accessor method	Description
get_scale	The scale of the axis, eg 'log' or 'linear'
get_view_interval	The interval instance of the axis view limits
get_data_interval	The interval instance of the axis data limits
get_gridlines	A list of grid lines for the Axis
get_label	The axis label - a Text instance
get_ticklabels	A list of Text instances - keyword minor=True|False
get_ticklines	A list of Line2D instances - keyword minor=True|False
get_ticklocs	A list of Tick locations - keyword minor=True|False
get_major_locator	The matplotlib.ticker.Locator instance for major ticks
get_major_formatter	The matplotlib.ticker.Formatter instance for major ticks
get_minor_locator	The matplotlib.ticker.Locator instance for minor ticks
get_minor_formatter	The matplotlib.ticker.Formatter instance for minor ticks
get_major_ticks	A list of Tick instances for major ticks
get_minor_ticks	A list of Tick instances for minor ticks
grid	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_markeredgewidth(3)
```



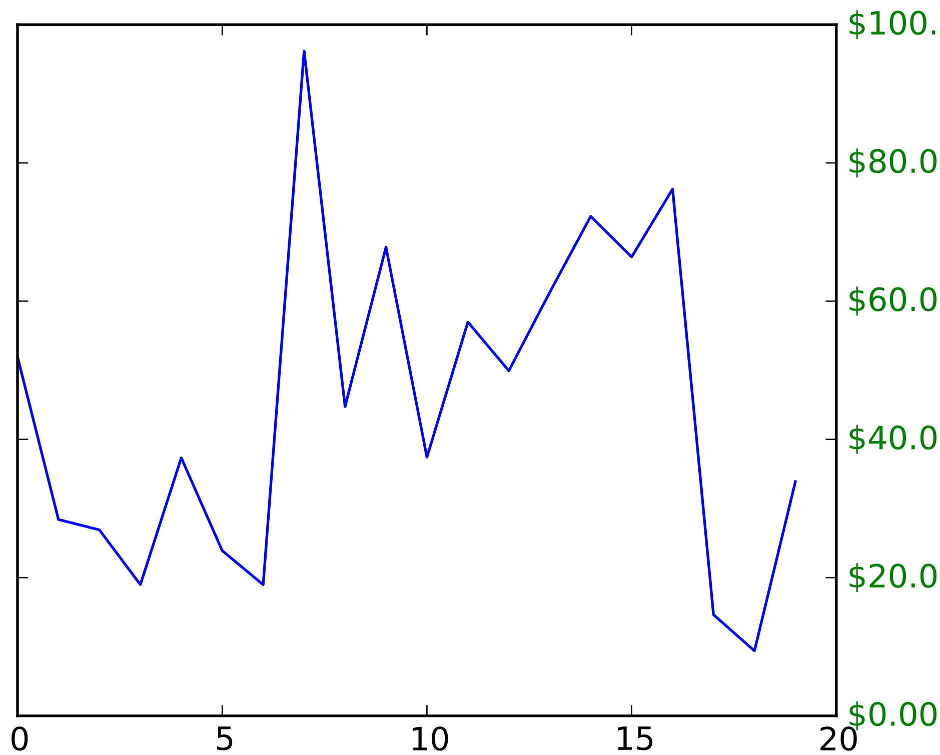
9.6 Tick containers

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
tick1line	Line2D instance
tick2line	Line2D instance
gridline	Line2D instance
label1	Text instance
label2	Text instance
gridOn	boolean which determines whether to draw the tickline
tick1On	boolean which determines whether to draw the 1st tickline
tick2On	boolean which determines whether to draw the 2nd tickline
label1On	boolean which determines whether to draw tick label
label2On	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')
```


$100.0
$80.00
$60.00
$40.00
$20.00
$0.00
0
5
10
15
20

CHAPTER

TEN

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.

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.

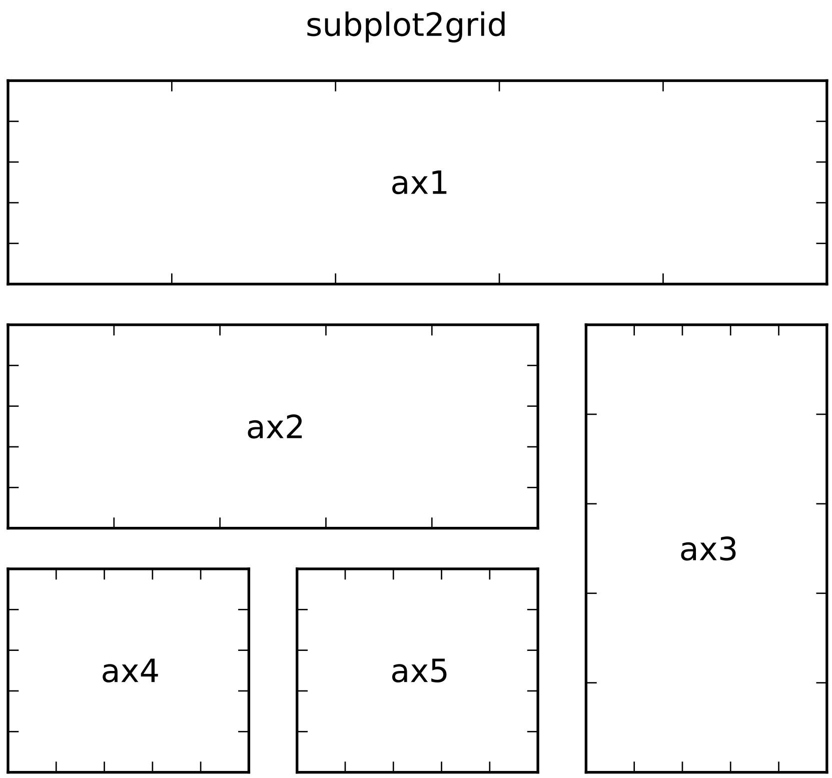
To create a subplot that spans multiple cells,

```
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



10.1 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

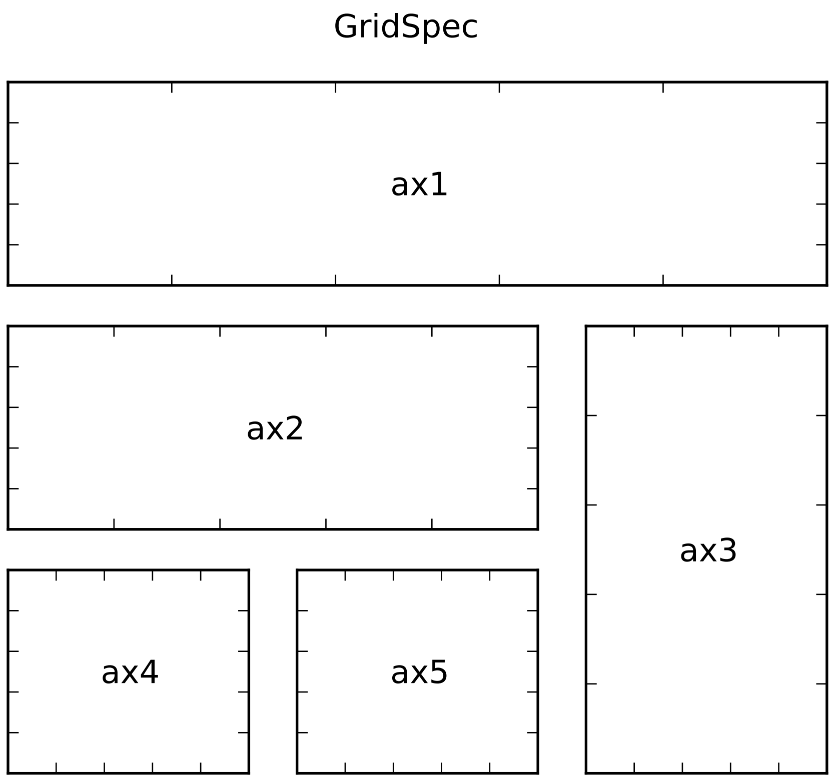
```
import matplotlib.gridspec as gridspec
gs = gridspec.GridSpec(2, 2)
ax = plt.subplot(gs[0, 0])
```

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])
```



10.2 Adjust GridSpec layout

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

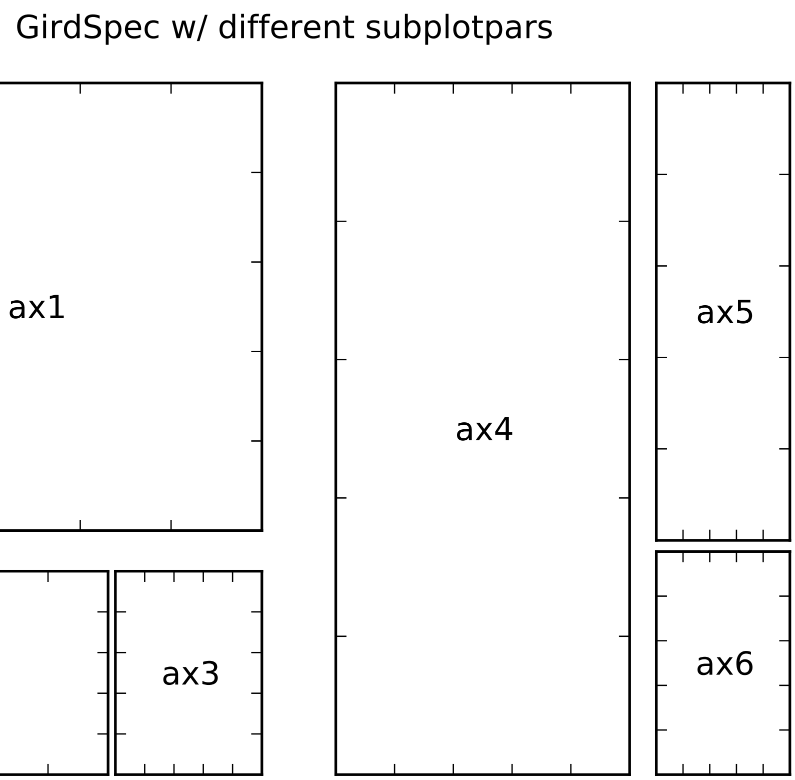
```
gs1 = gridspec.GridSpec(3, 3)
gs1.update(left=0.05, right=0.48, wspace=0.05)
```

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

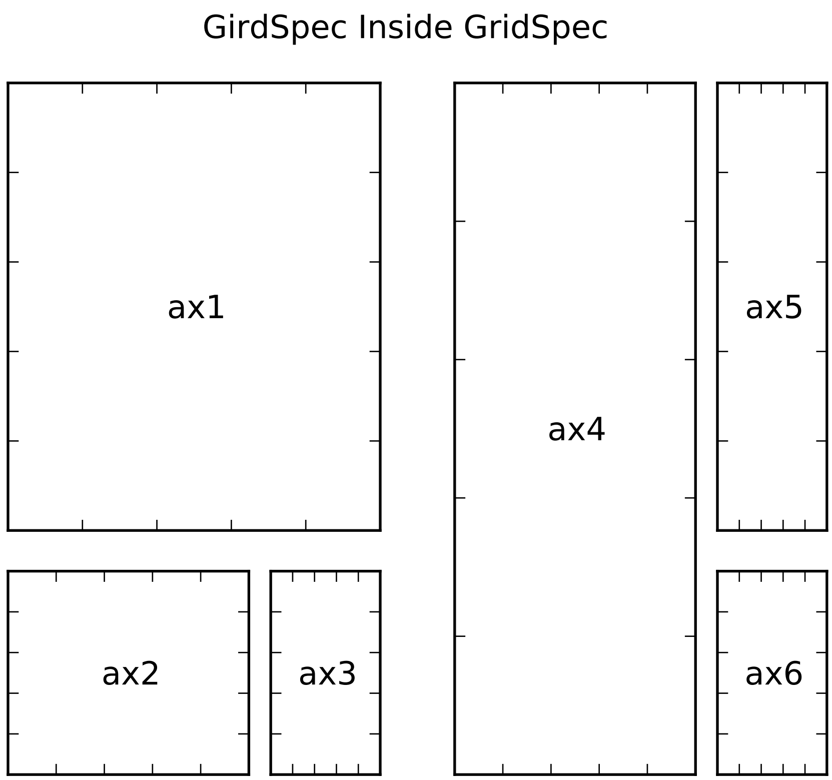


10.3 GridSpec using SubplotSpec

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)
```

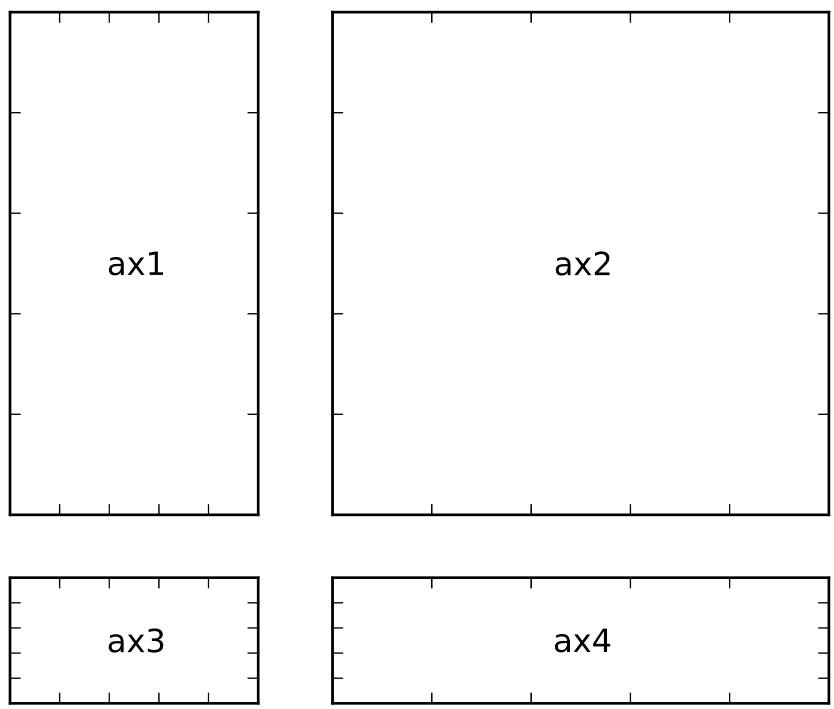
```
gs00 = gridspec.GridSpecFromSubplotSpec(3, 3, subplot_spec=gs0[0])
gs01 = gridspec.GridSpecFromSubplotSpec(3, 3, subplot_spec=gs0[1])
```



10.4 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])
```


ax1
ax2
ax3
ax4

CHAPTER

ELEVEN

LEGEND GUIDE

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

11.1 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 all artists in *ax.lines* and *ax.patches* and some 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 "_", that artist will be ignored.

- Note that not all kind of artists are supported by the legend. The following is the list of artists that are currently supported.
  - `Line2D`
  - `Patch`
  - `LineCollection`
  - `RegularPolyCollection`

  Unfortunately, there is no easy workaround when you need legend for an artist not in the above list (You may use one of the supported artist as a proxy. See below), or customize it beyond what is supported by `matplotlib.legend.Legend`.

- Remember that some *pyplot* commands return artist not supported by legend, e.g., `fill_between()` returns `PolyCollection` that is not supported. Or some return multiple artists. For example, `plot()` returns list of `Line2D` instances, and `errorbar()` returns a length 3 tuple of `Line2D` instances.
- The legend does not care about the axes that given artists belongs, i.e., the artists may belong to other axes or even none.

11.1.1 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 a two options. First, you can keep lists of artists and labels, and explicitly use these for the first two argument 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)
```

11.1.2 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"])
```

11.2 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.

11.3 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

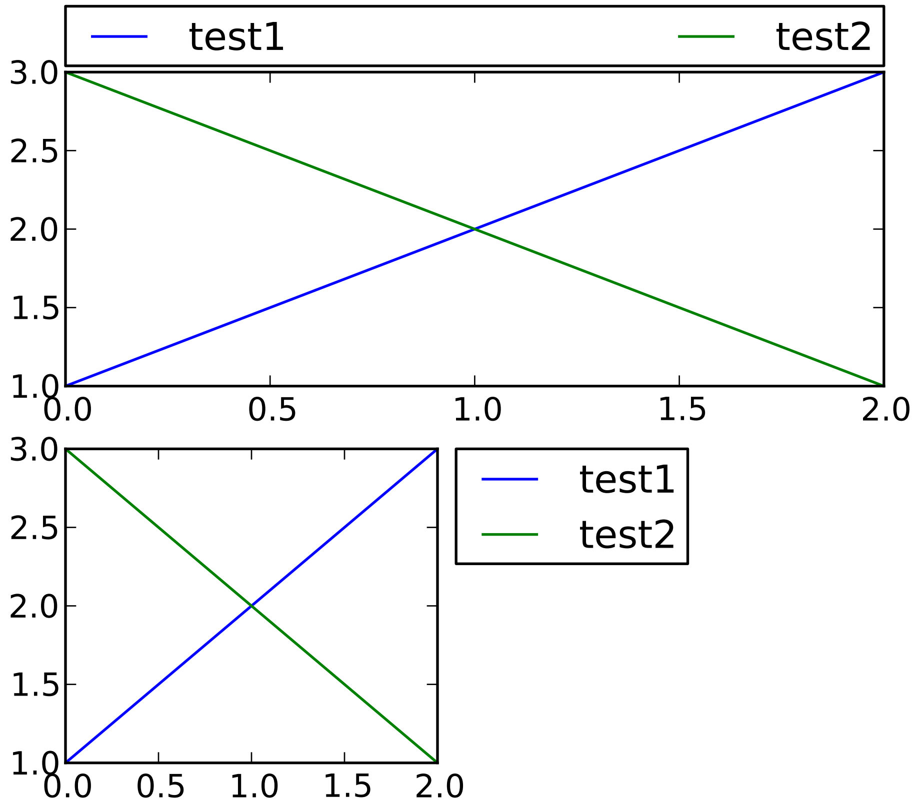
By default, the legend will anchor to the bbox of the axes (for legend) or the bbox of the figure (figlegend). You can specify your own bbox using *bbox_to_anchor* argument. *bbox_to_anchor* can be an instance of `BboxBase`, a tuple of 4 floats (x, y, width, height of the bbox), or a tuple of 2 floats (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()
```



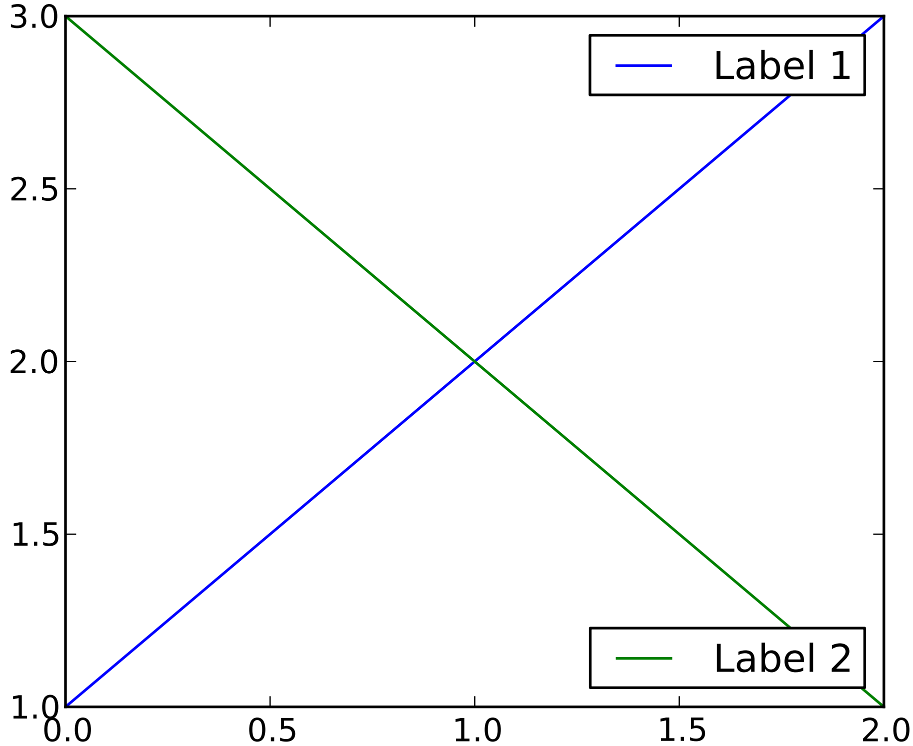
11.4 Multiple Legend

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()
```



3.0
2.5
2.0
1.5
1.0
0.0
0.5
1.0
1.5
2.0
Label 1
Label 2

CHAPTER

TWELVE

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.

12.1 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)
```

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'	MouseEvent - mouse button is pressed
'button_release_event'	MouseEvent - mouse button is released
'draw_event'	DrawEvent - canvas draw
'key_press_event'	KeyEvent - key is pressed
'key_release_event'	KeyEvent - key is released
'motion_notify_event'	MouseEvent - mouse motion
'pick_event'	PickEvent - an object in the canvas is selected
'resize_event'	ResizeEvent - figure canvas is resized
'scroll_event'	MouseEvent - mouse scroll wheel is rolled
'figure_enter_event'	LocationEvent - mouse enters a new figure
'figure_leave_event'	LocationEvent - mouse leaves a figure
'axes_enter_event'	LocationEvent - mouse enters a new axes
'axes_leave_event'	LocationEvent - mouse leaves an axes

12.2 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'

12.2.1 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:

```python
# 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()
```

12.3 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:

```python
"""
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()
```

12.4 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)

12.4.1 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 it 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()
```

12.4.2 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()
```

CHAPTER

THIRTEEN

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.

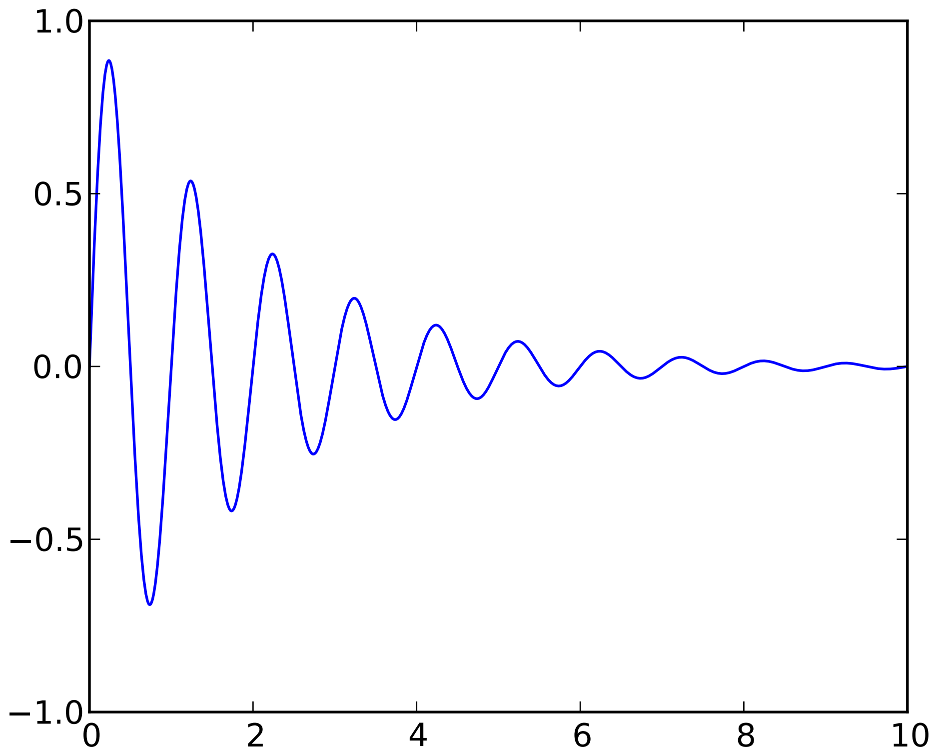
Coordinate	Transformation Object	Description
data	`ax.transData`	The userland data coordinate system, controlled by the xlim and ylim
axes	`ax.transAxes`	The coordinate system of the `Axes`; (0,0) is bottom left of the axes, and (1,1) is top right of the axes
figure	`fig.transFigure`	The coordinate system of the `Figure`; (0,0) is bottom left of the figure, and (1,1) is top right of the figure
display	*None*	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.

13.1 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:

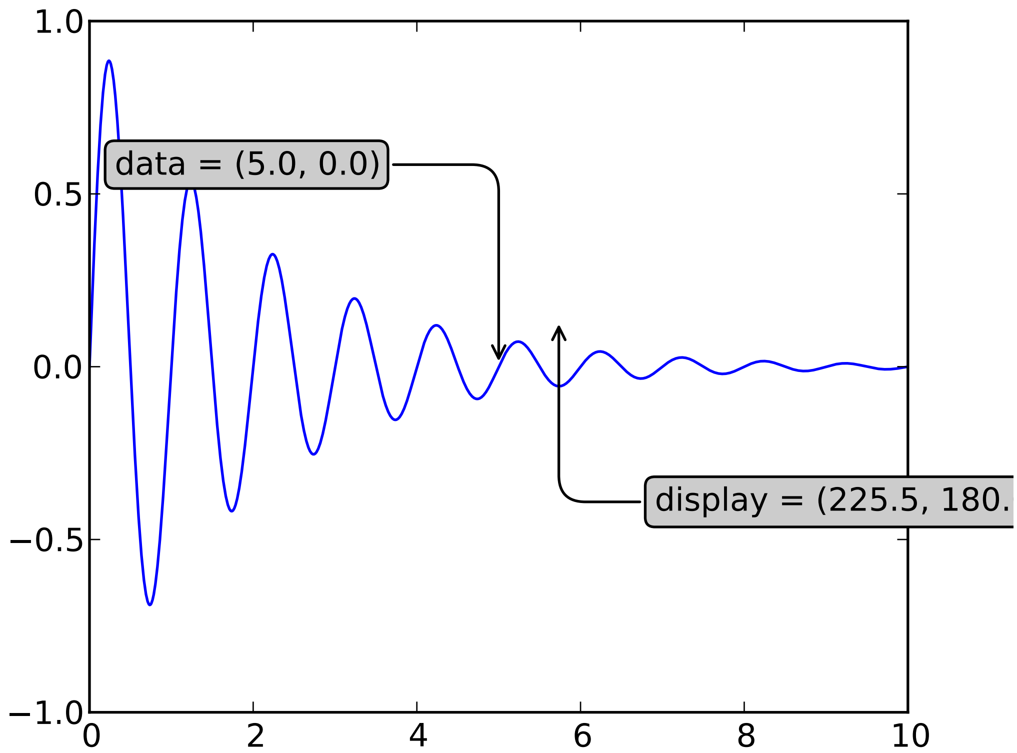
```
In [14]: type(ax.transData)
Out[14]: <class 'matplotlib.transforms.CompositeGenericTransform'>

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 your 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.

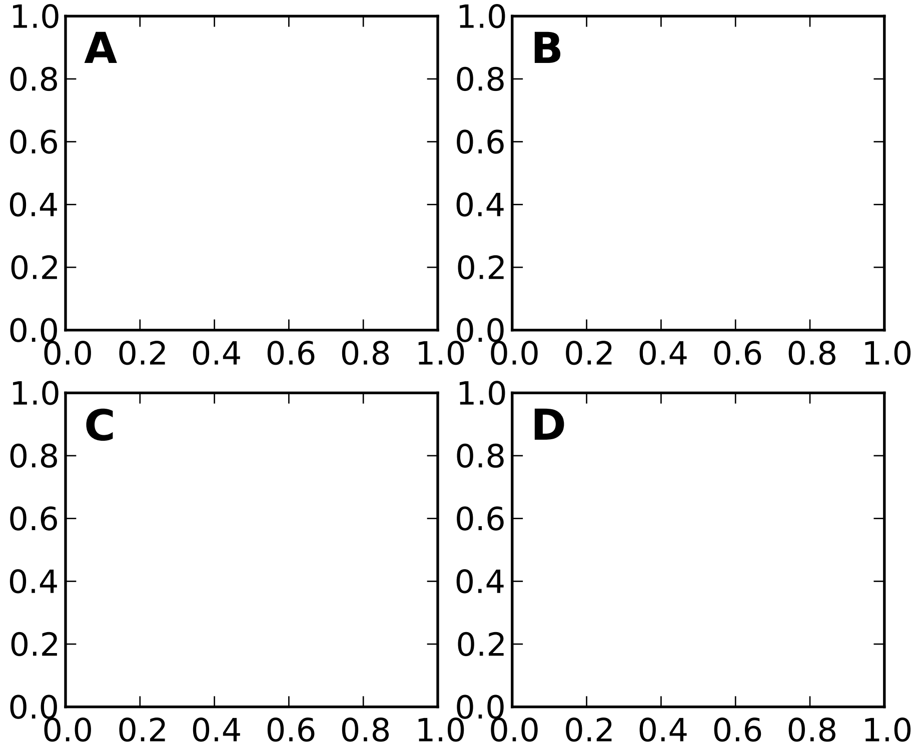
```
In [54]: ax.transData.transform((5, 0))
Out[54]: array([ 335.175,  247.   ])

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])
```

13.2 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()
```

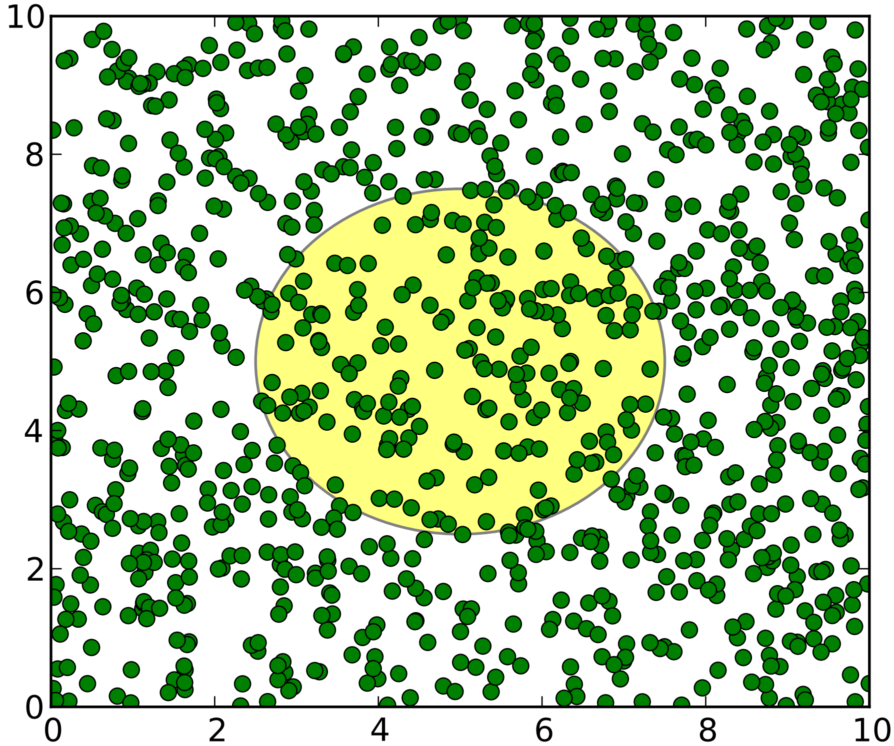
You can also make lines or patches in the axes coordinate system, but this is less useful in my experience than using ax.transAxes for placing text. Nonetheless, here is a silly example which plots some random dots in *data* space, and overlays a semi-transparent Circle centered in the middle of the 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()
```

13.3 Blended transformations

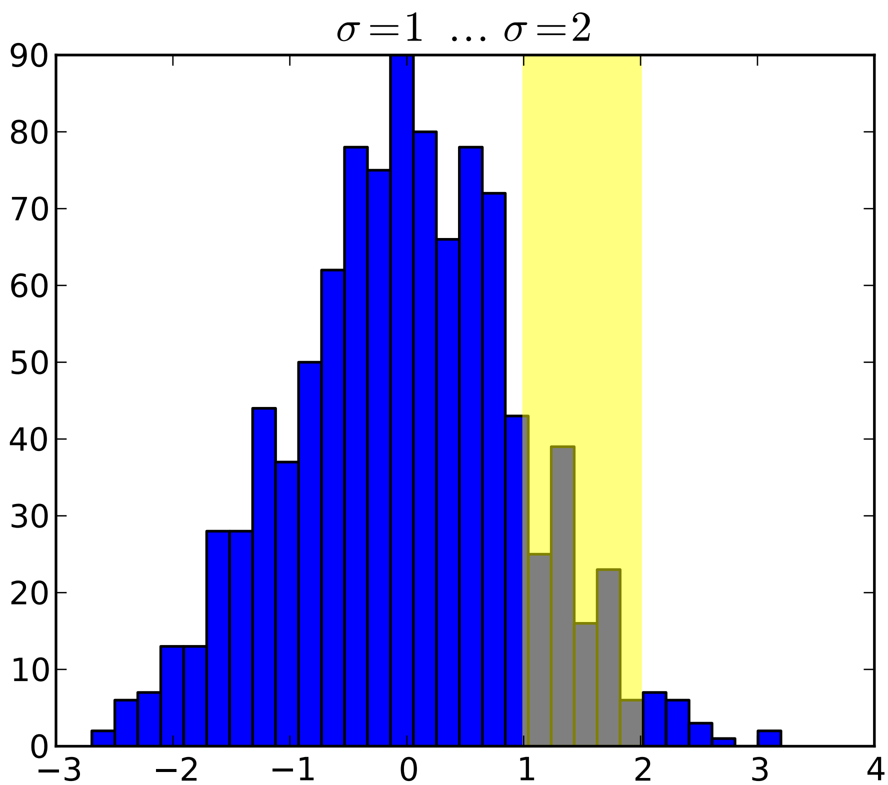
Drawing in *blended* coordinate spaces which mix *axes* with *data* coordinates is extremely useful, for example to create a horizontal span which highlights some region of the y-data but spans across the x-axis regardless of the data limits, pan or zoom level, etc. In fact these blended lines and spans 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'$\sigma=1 \/ \dots \/ \sigma=2$', 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()
```



13.4 Using offset transforms to create a shadow effect

One use of transformations is to create a new transformation that is offset from another annotation, 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:

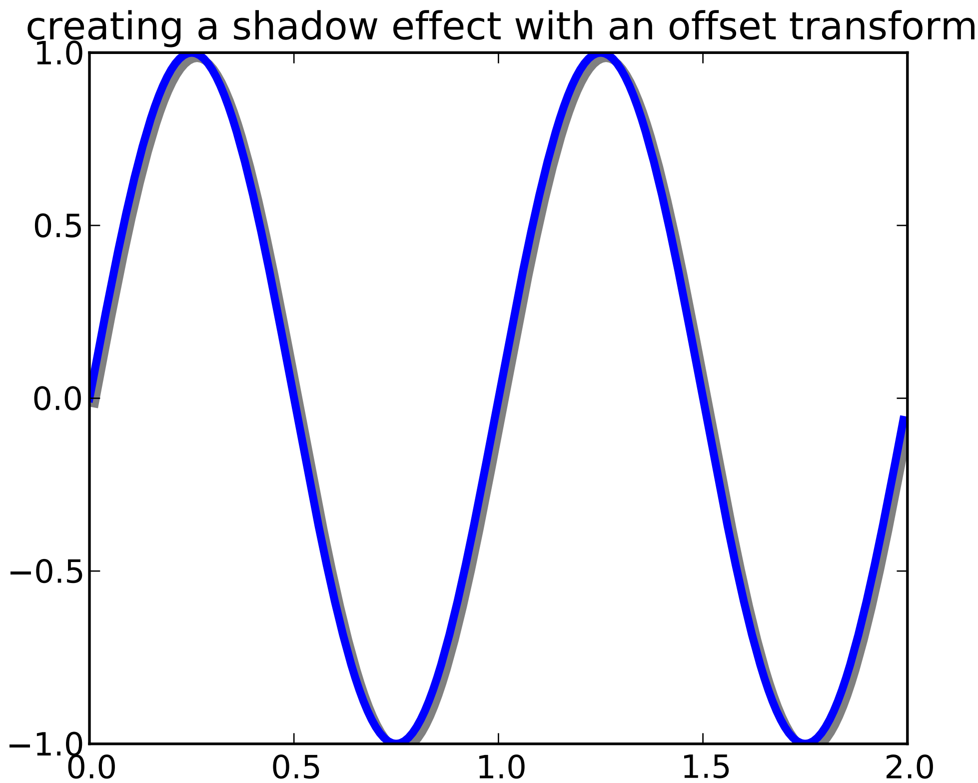
```
offset = transforms.ScaledTranslation(dx, dy,
  fig.dpi_scale_trans)
shadow_transform = ax.transData + offset
```

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.

```
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()
```

13.5 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*.

CHAPTER

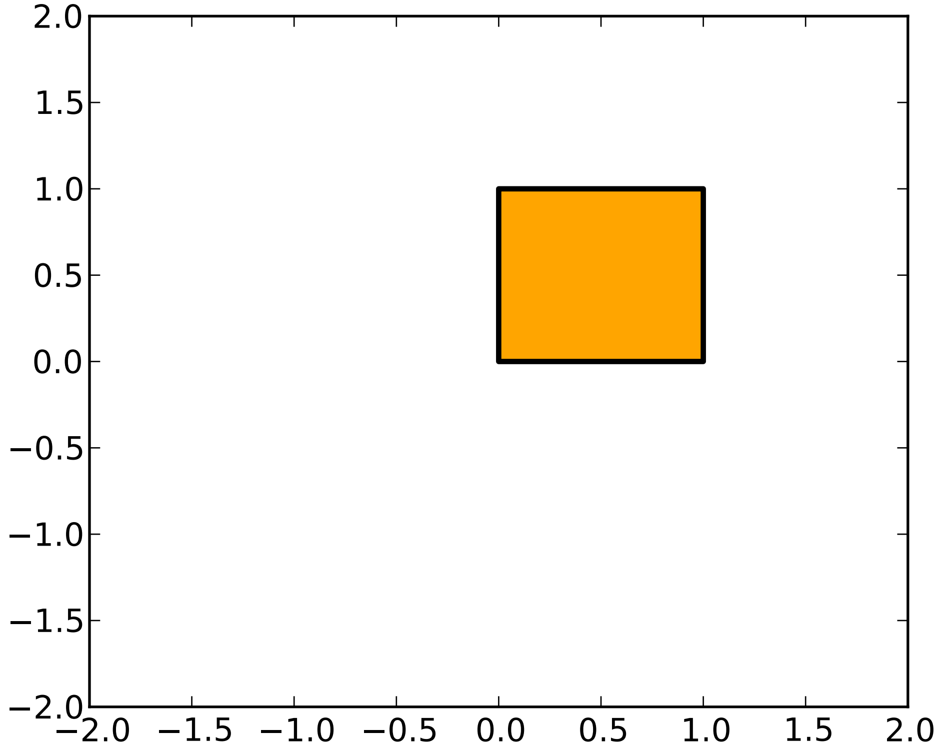
FOURTEEN

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`	1 (point itself is ignored)	Draw a line segment to the start point of the current polyline.

14.1 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

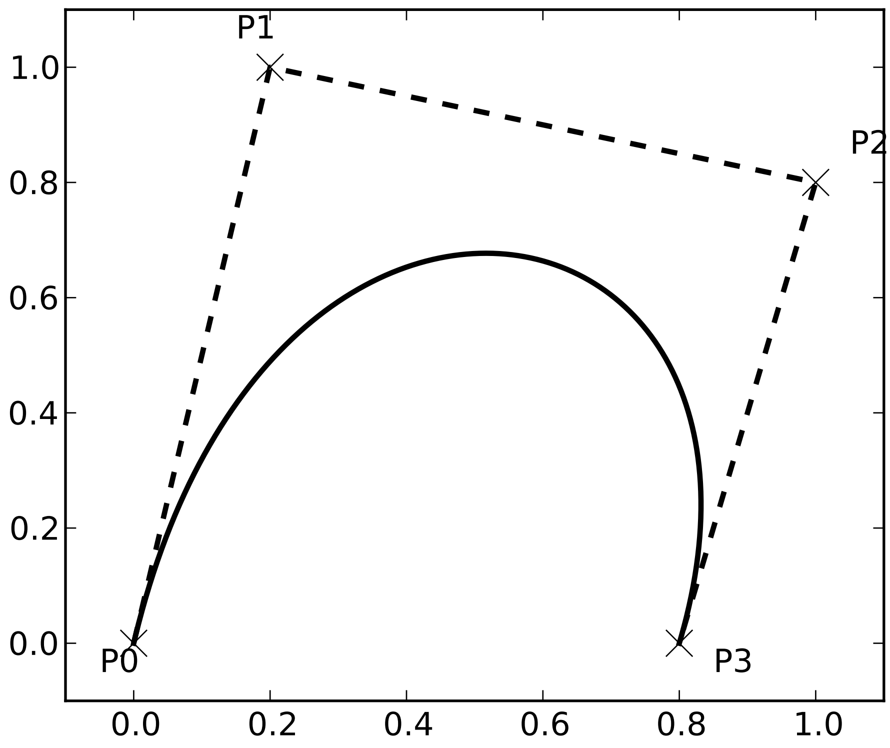
```
import matplotlib.pyplot as plt
from matplotlib.path import Path
```

```
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()
```

14.2 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:

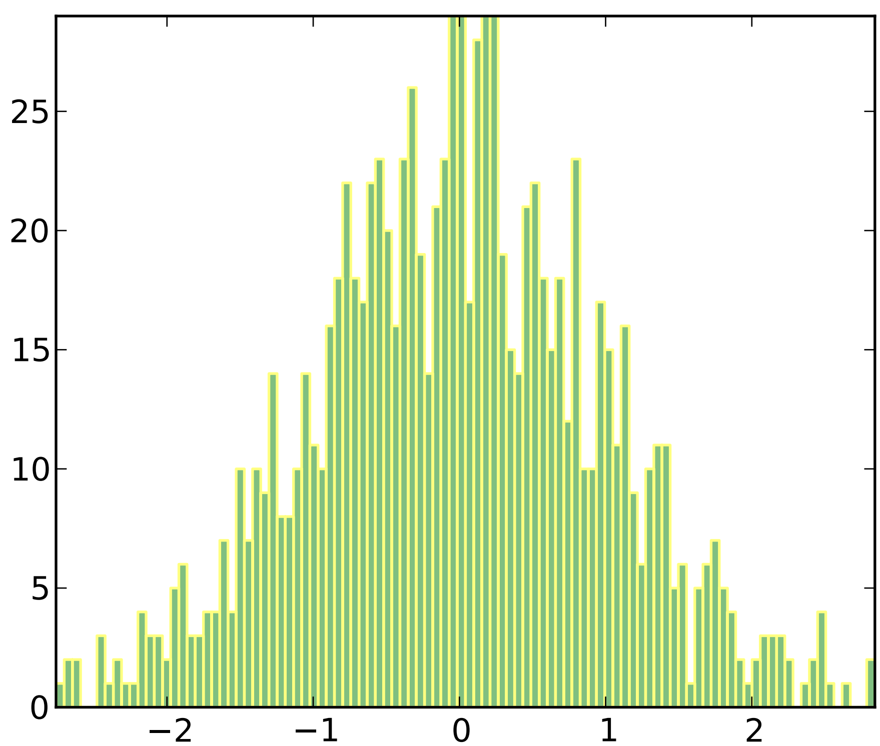
```
nverts = nrects*(1+3+1)
verts = np.zeros((nverts, 2))
codes = np.ones(nverts, int) * path.Path.LINETO
codes[0::5] = path.Path.MOVETO
```

```
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



CHAPTER

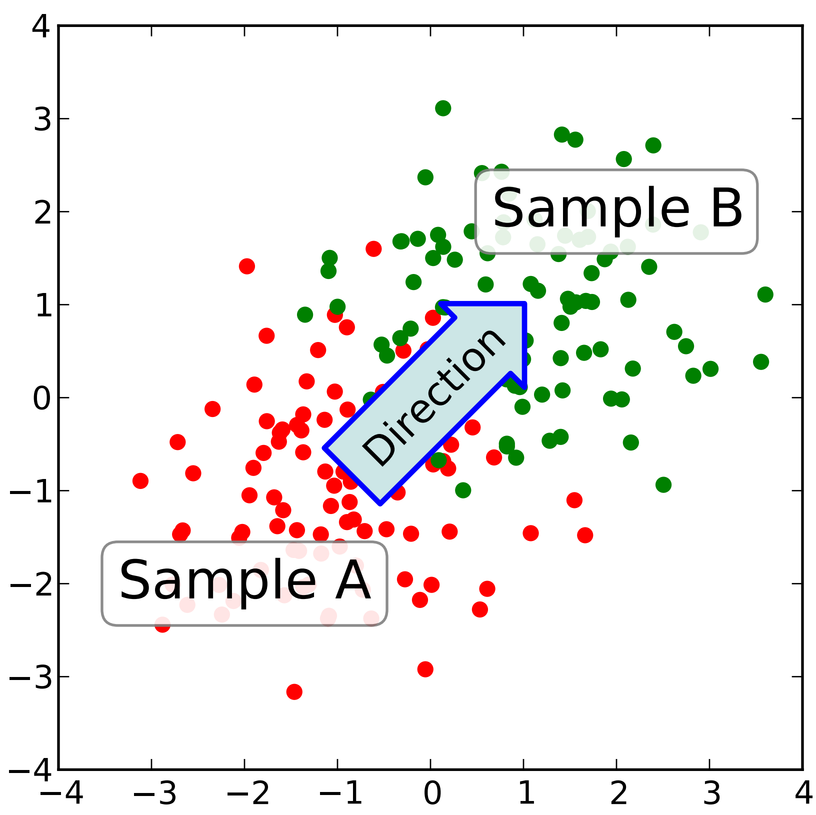
FIFTEEN

ANNOTATING AXES

Do not proceed unless you already have read *Annotating text*, `text()` and `annotate()`!

15.1 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)

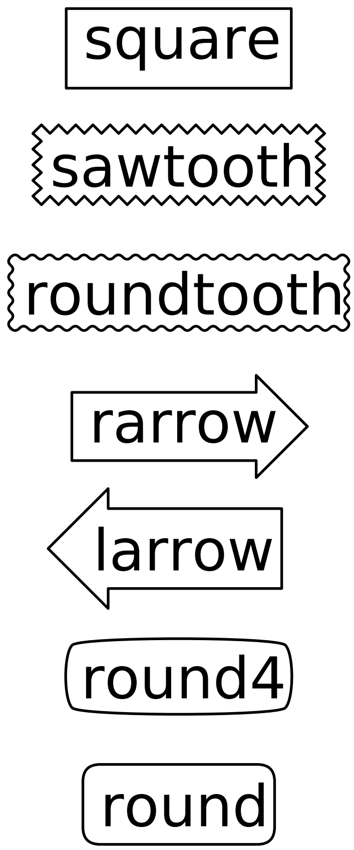
```
bb.set_boxstyle("rarrow,pad=0.6")
```

15.2 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.

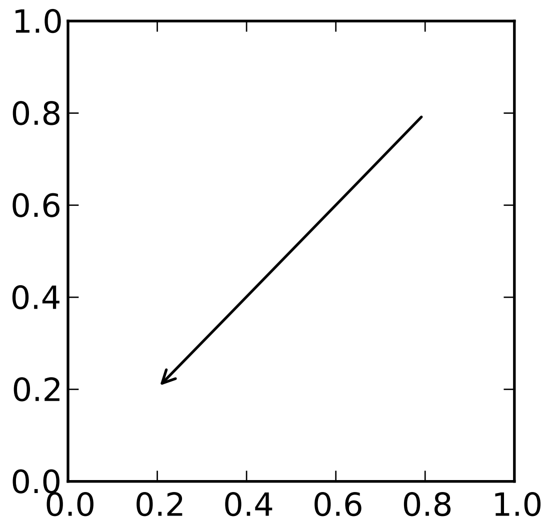
```
ax.annotate("Annotation",
            xy=(x1, y1), xycoords='data',
            xytext=(x2, y2), textcoords='offset points',
            )
```

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.


square
sawtooth
roundtooth
rarrow
larrow
round4
round

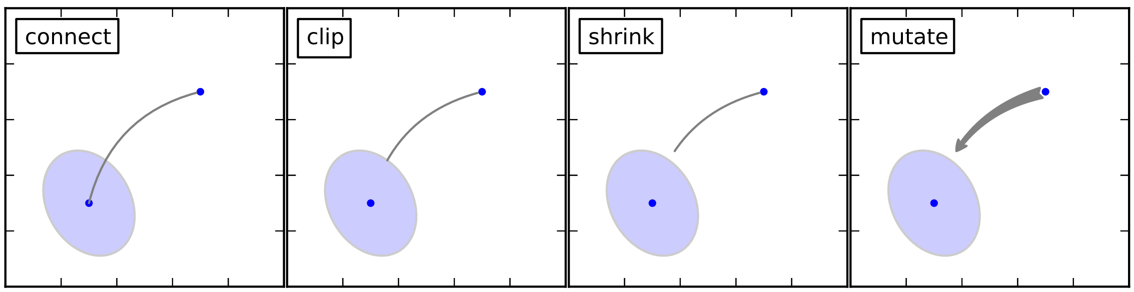
An arrow connecting two point (xy & xytext) can be optionally drawn by specifying the `arrowprops` argument. To draw only an arrow, use empty string as the first argument.

```
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 (*shirnkA* & *shrinkB*)
4. The path is transmuted to arrow patch, which is controlled by the `arrowstyle` key value.

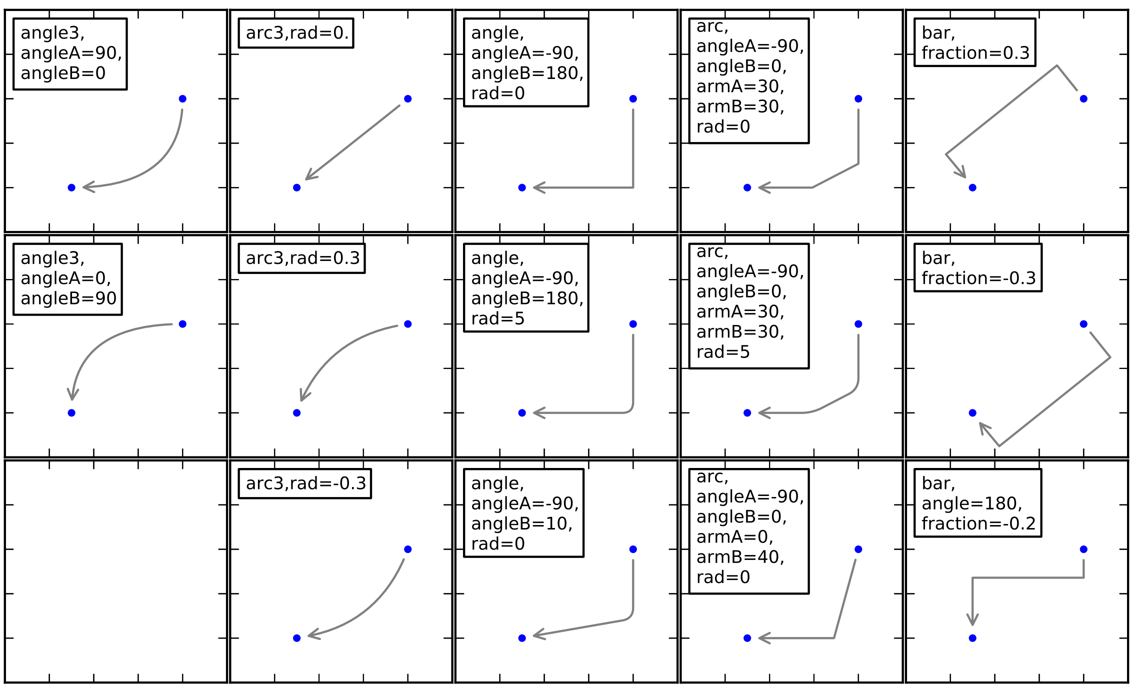


The creation of the connecting path between two points is controlled by `connectionstyle` key and following styles are available.

Name	Attrs
`angle`	angleA=90,angleB=0,rad=0.0
`angle3`	angleA=90,angleB=0
`arc`	angleA=0,angleB=0,armA=None,armB=None,rad=0.0
`arc3`	rad=0.0
`bar`	armA=0.0,armB=0.0,fraction=0.3,angle=None

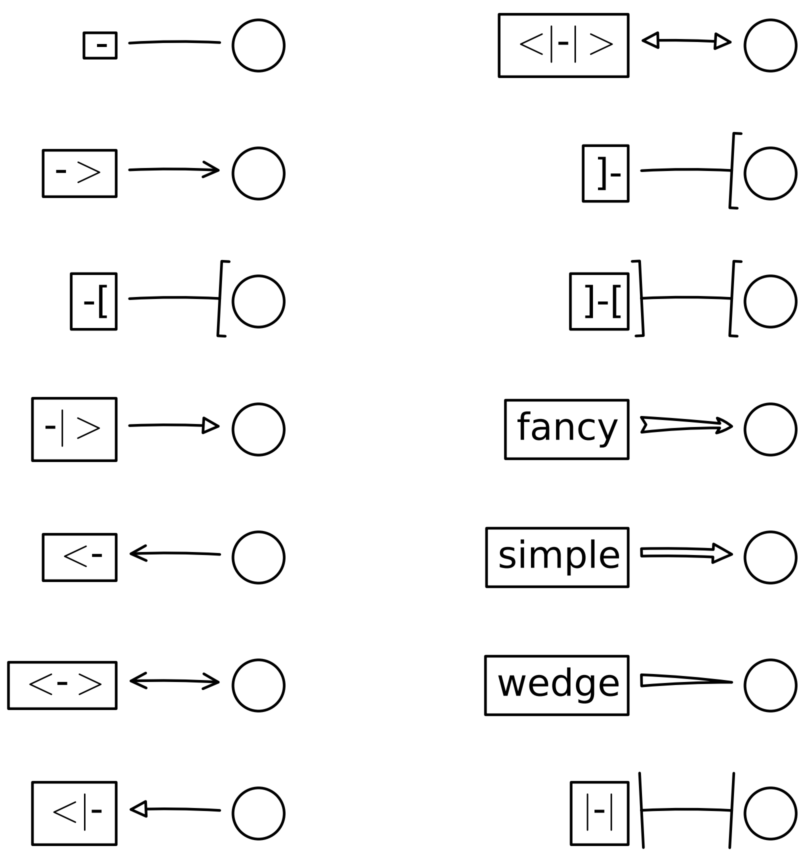
Note that "3" in `angle3` and `arc3` is meant to indicate that the resulting path is a quadratic spline segment (three control points). As will be discussed below, some arrow style option only can be used when the connecting path is a quadratic spline.

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
`-|>`	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

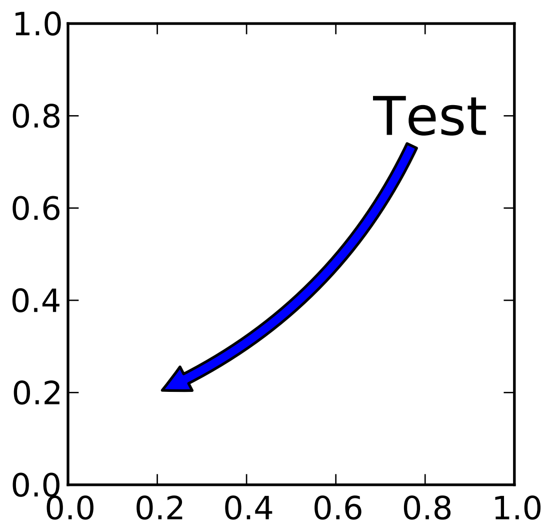


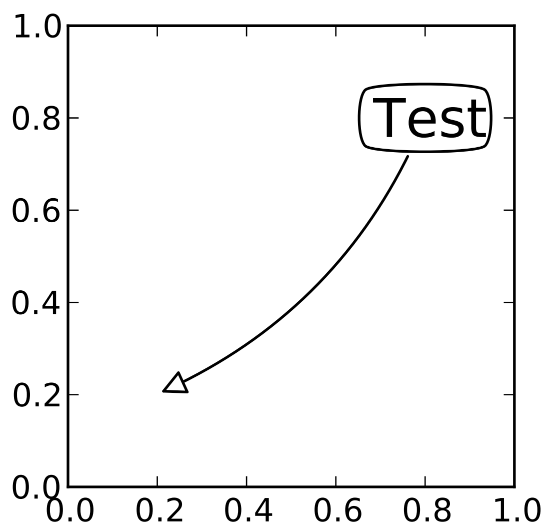
Some arrowstyles only work with connection style that generates a quadratic-spline segment. They are `fancy`, `simple`, and `wedge`. For these arrow styles, you must use "angle3" or "arc3" connection style.

If the annotation string is given, the patchA is set to the bbox patch of the text by default.

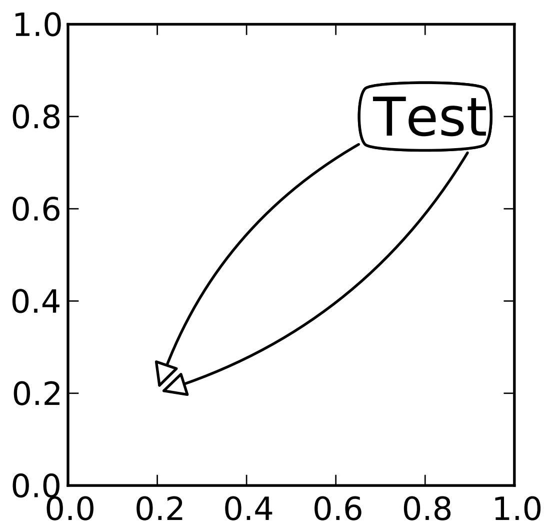
As in the text command, a box around the text can be drawn using the `bbox` argument.

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


Test
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0


Test
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0

(1,1) means top-right.



15.3 Placing Artist at the anchored location of the Axes

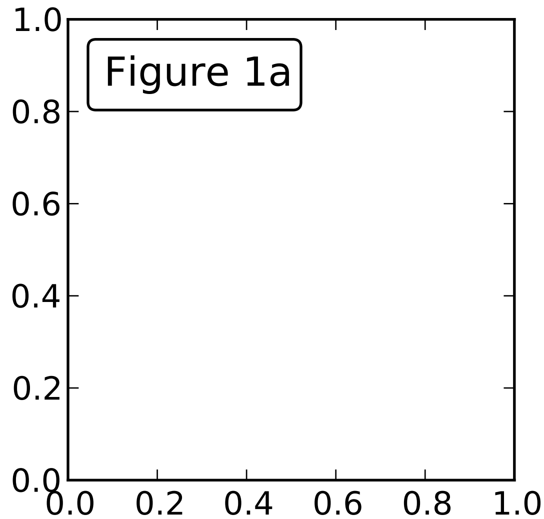
There are class of artist that can be placed at the anchored location of the Axes. A common example is the legend. This type of artists can be created by using the OffsetBox class. A few predefined classes are available in `mpl_toolkits.axes_grid.anchored_artists`.

```
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.

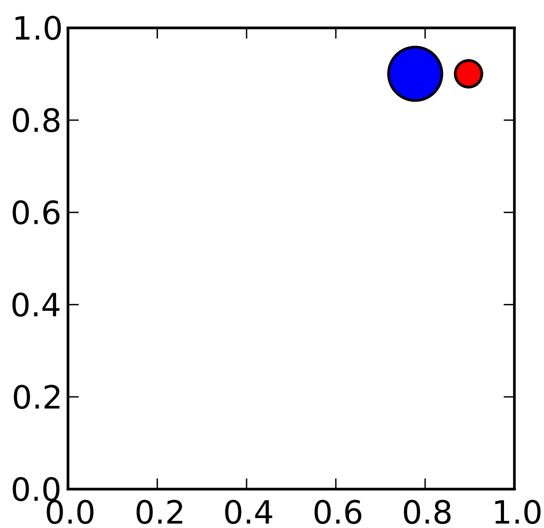
A simple application is when the size of the artist (or collection of artists) is known in pixel size during the time of creation. For example, If you want to draw a circle with fixed size of 20 pixel x 20 pixel (radius = 10 pixel), you can utilize `AnchoredDrawingArea`. The instance is created with 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)
```

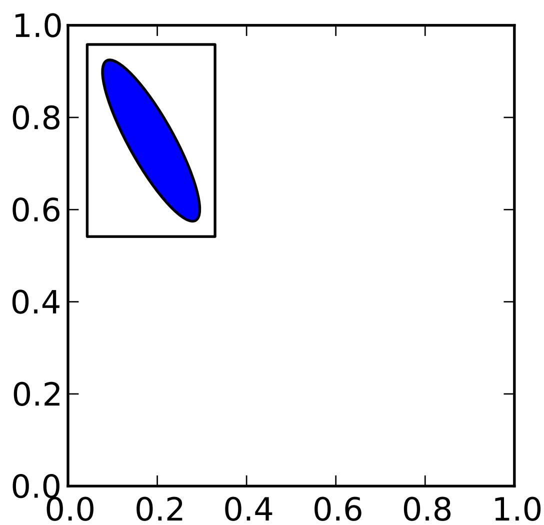
The artists that are added to the drawing area should not have transform set (they will be overridden) and the dimension of those artists are interpreted as a pixel coordinate, i.e., the radius of the circles in above example are 10 pixel and 5 pixel, respectively.



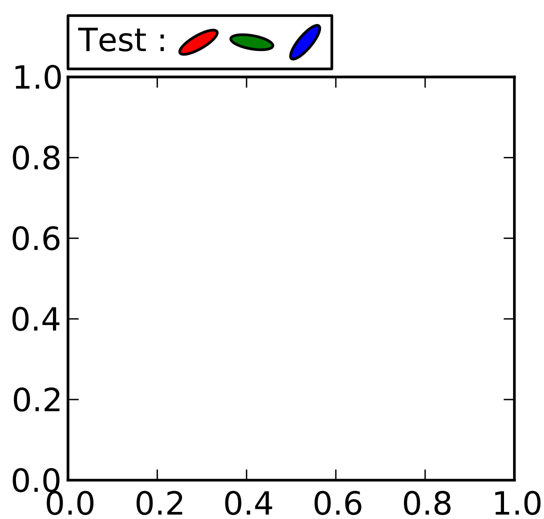
Sometimes, you want to your artists scale with data coordinate (or other coordinate than canvas pixel). You can use `AnchoredAuxTransformBox` class. This is similar to `AnchoredDrawingArea` except that the extent of the artist is determined during the drawing time respecting the specified transform.

```
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.

15.4 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

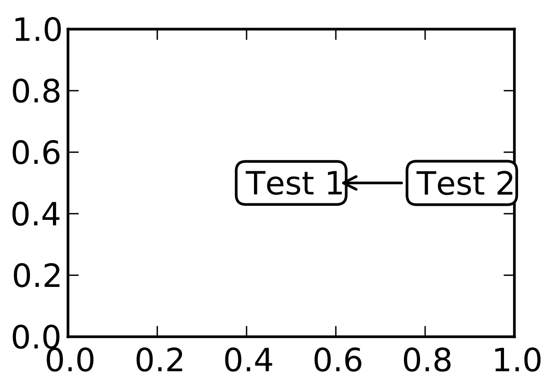
   ```
   ax.annotate("Test", xy=(0.5, 0.5), xycoords="axes fraction")
   ```

   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

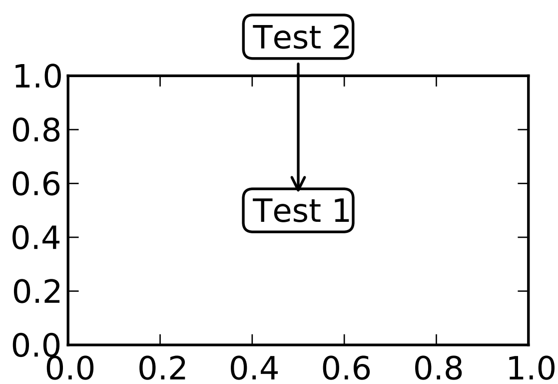
```
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1,
                  xytext=(30,0), textcoords="offset points")
an2 = ax.annotate("Test 2", xy=(1, 0.5), xycoords=an1.get_window_extent,
                  xytext=(30,0), textcoords="offset points")
```

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 atist or transform as with a tuple. For example,

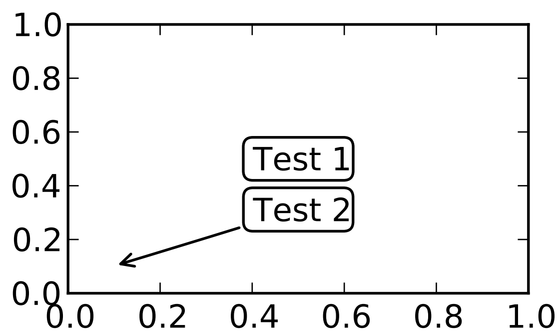
```
import matplotlib.pyplot as plt

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*.

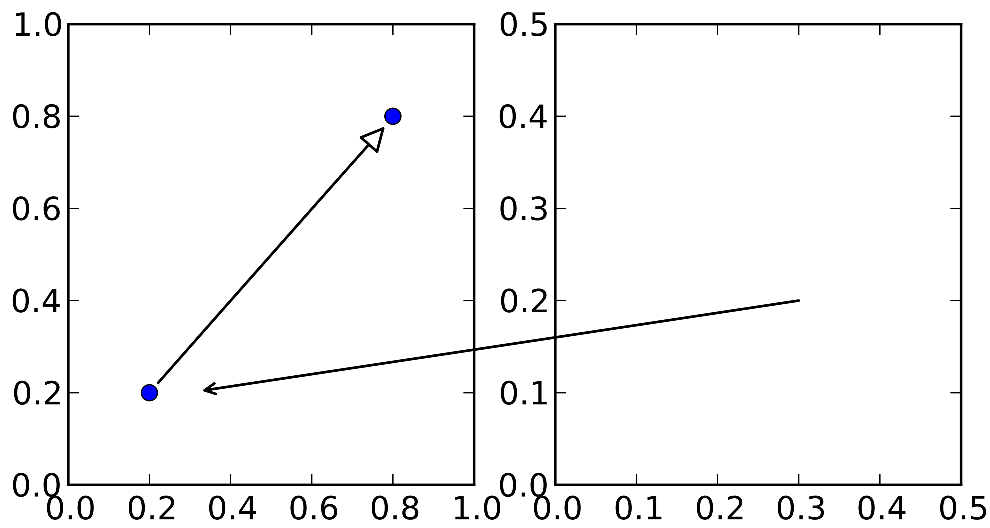
15.5 Using ConnectorPatch

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 int 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.



15.5.1 Advanced Topics

15.6 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.

Exception occurred rendering plot.

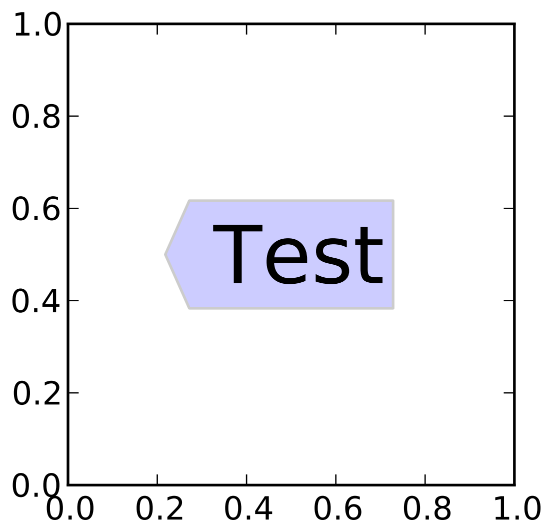
15.7 Define Custom BoxStyle

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-ration for the mutation.
    """
    path = ...
    return path
```

Here is a complete example.

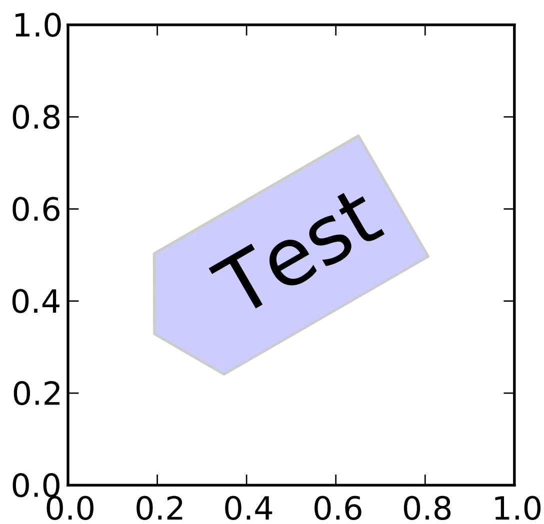
However, it is recommended that you derive from the matplotlib.patches.BoxStyle._Base as demonstrated below.




```
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 overide 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.


Test
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0

CHAPTER

SIXTEEN

TOOLKITS

Toolkits are collections of application-specific functions that extend matplotlib.

16.1 Basemap

Plots data on map projections, with continental and political boundaries, see basemap docs.

16.2 GTK Tools

mpl_toolkits.gtktools provides some utilities for working with GTK. This toolkit ships with matplotlib, but requires pygtk.

16.3 Excel Tools

mpl_toolkits.exceltools provides some utilities for working with Excel. This toolkit ships with matplotlib, but requires pyExcelerator

16.4 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.

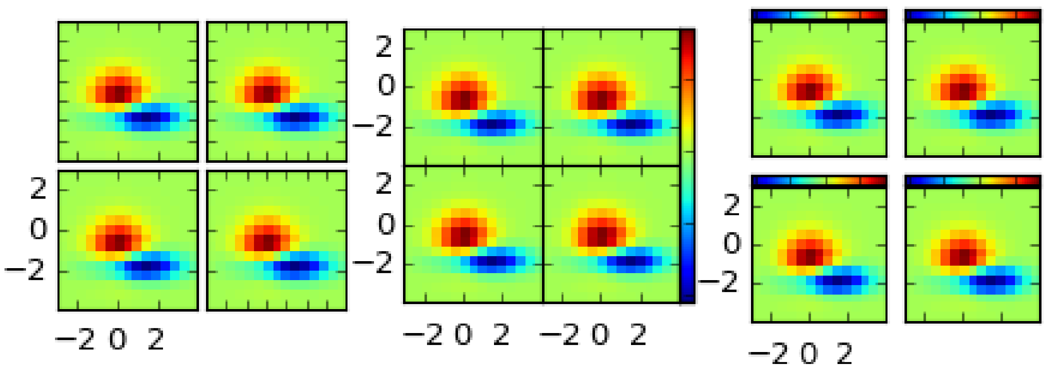
16.5 mplot3d

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.

16.6 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.

CHAPTER

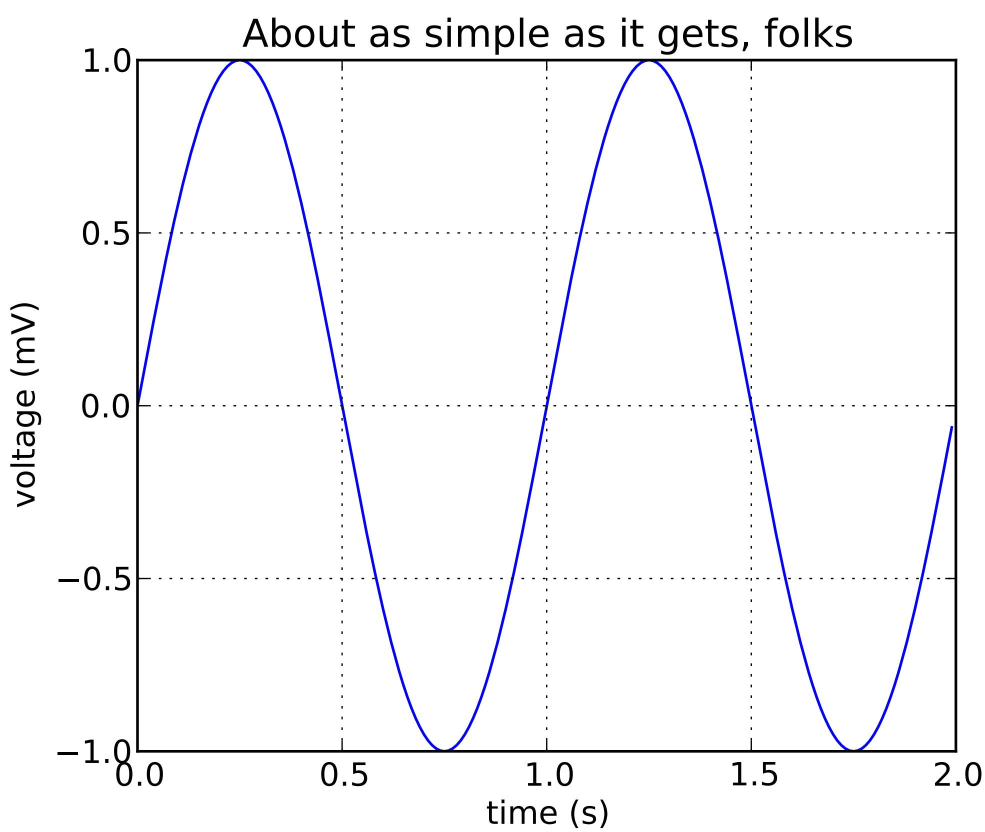
SEVENTEEN

SCREENSHOTS

Here you will find a host of example figures with the code that generated them

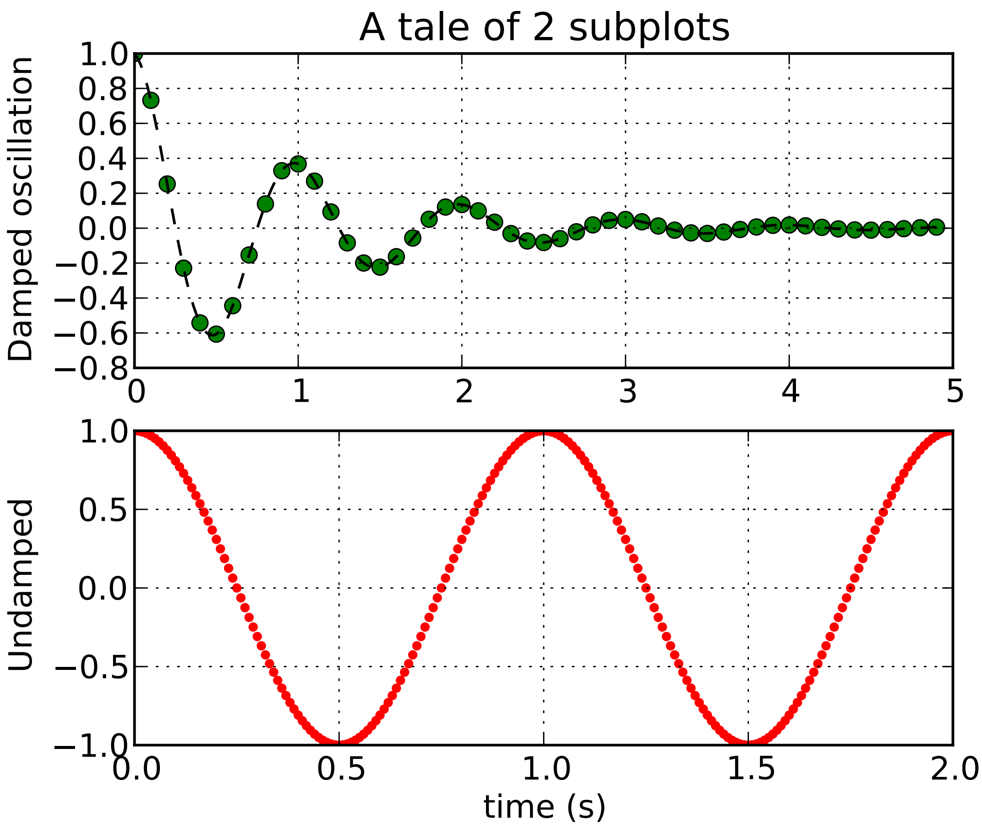
17.1 Simple Plot

The most basic `plot()`, with text labels



17.2 Subplot demo

Multiple regular axes (numrows by numcolumns) are created with the `subplot()` command.



17.3 Histograms

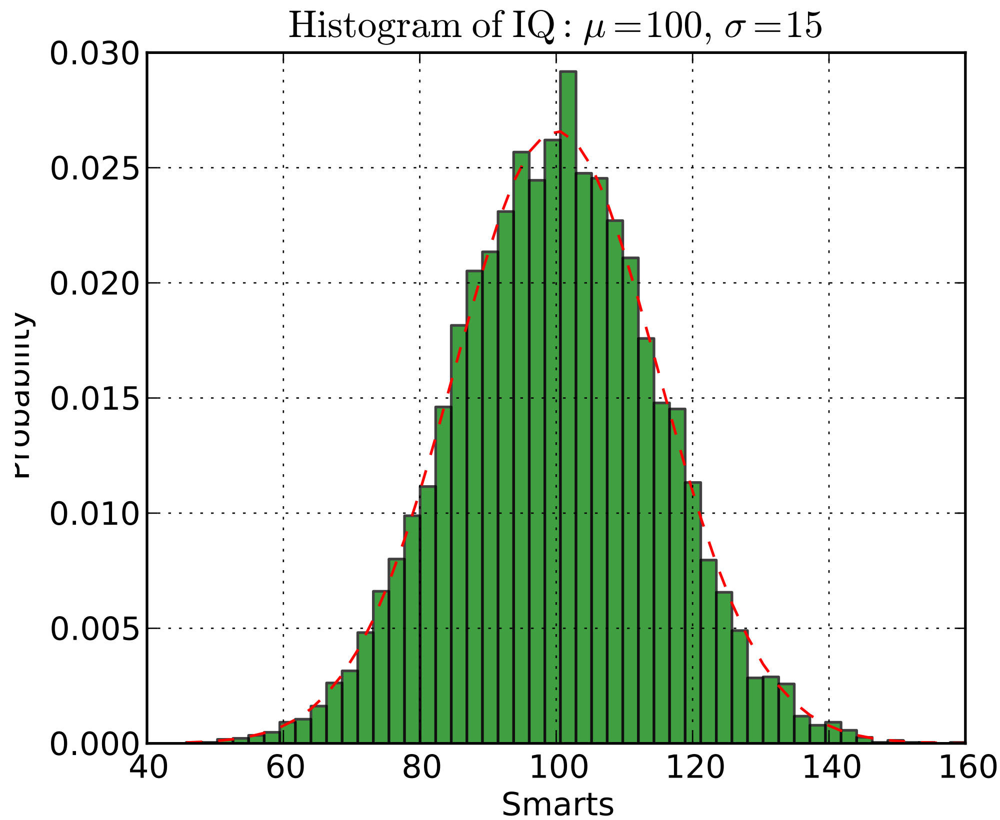
The `hist()` command automatically generates histograms and will return the bin counts or probabilities

17.4 Path demo

You can add aribitrary paths in matplotlib as of release 0.98. See the `matplotlib.path`.

17.5 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 matlpotlib-0.99). Thanks to John Porter, Jonathon Taylor and Reinier Heeres for the mplot3d toolkit. The toolkit is included with all standard matplotlib installs.



17.6 Ellipses

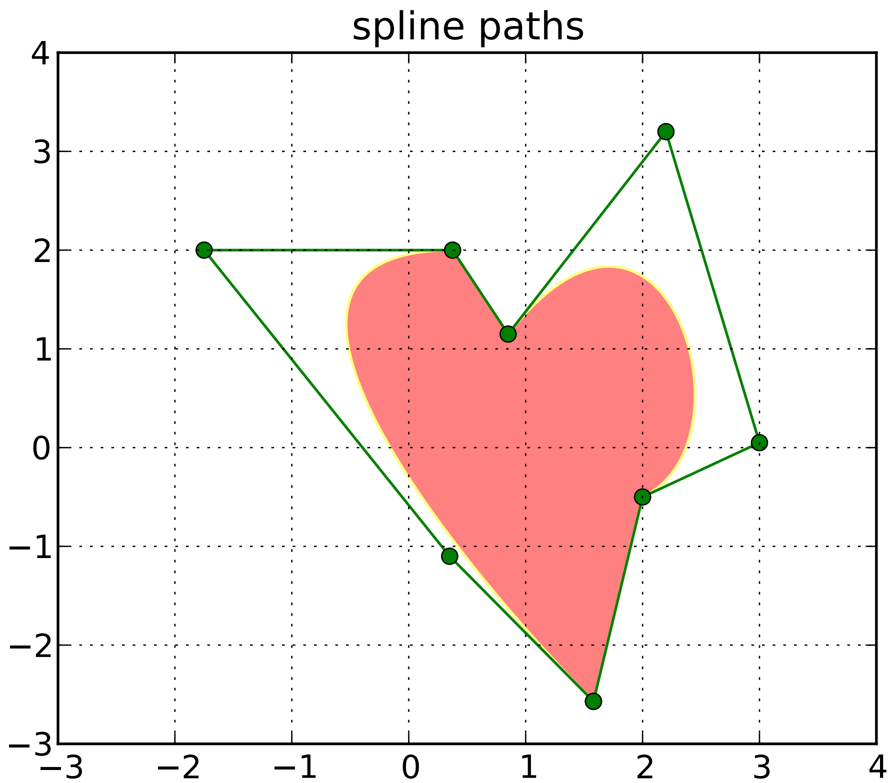
In support of the Phoenix mission to Mars, which used matplotlib in ground tracking of the spacecraft, Michael Droettboom built on work by Charlie Moad to provide an extremely accurate 8-spline approximation to elliptical arcs (see `Arc`) in the viewport. This provides a scale free, accurate graph of the arc regardless of zoom level

17.7 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.

17.8 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.



17.9 Table demo

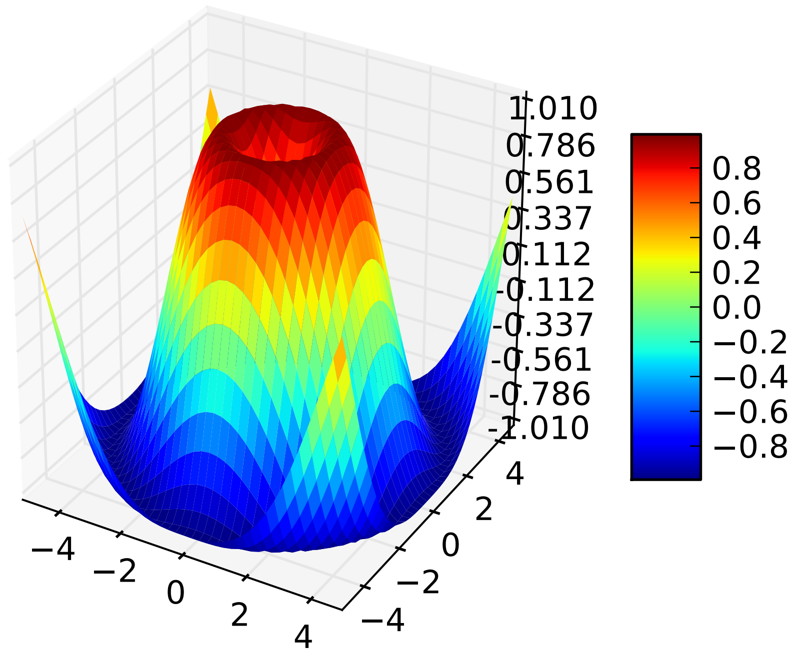
The `table()` command will place a text table on the axes

17.10 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?*)

17.11 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>*



17.12 Fill demo

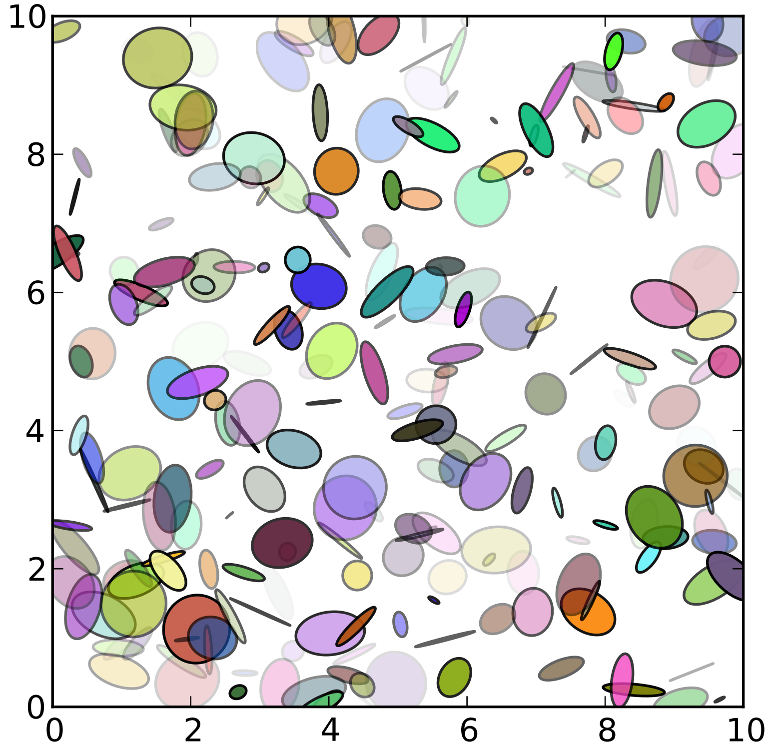
The `fill()` command lets you plot filled polygons. Thanks to Andrew Straw for providing this function

17.13 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.

17.14 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!



17.15 Basemap demo

Jeff Whitaker provided this example showing how to efficiently plot a collection of lines over a colormap image using the *Basemap* . Many map projections are handled via the proj4 library: cylindrical equidistant, mercator, lambert conformal conic, lambert azimuthal equal area, albers equal area conic and stereographic. See the tutorial entry on the wiki.

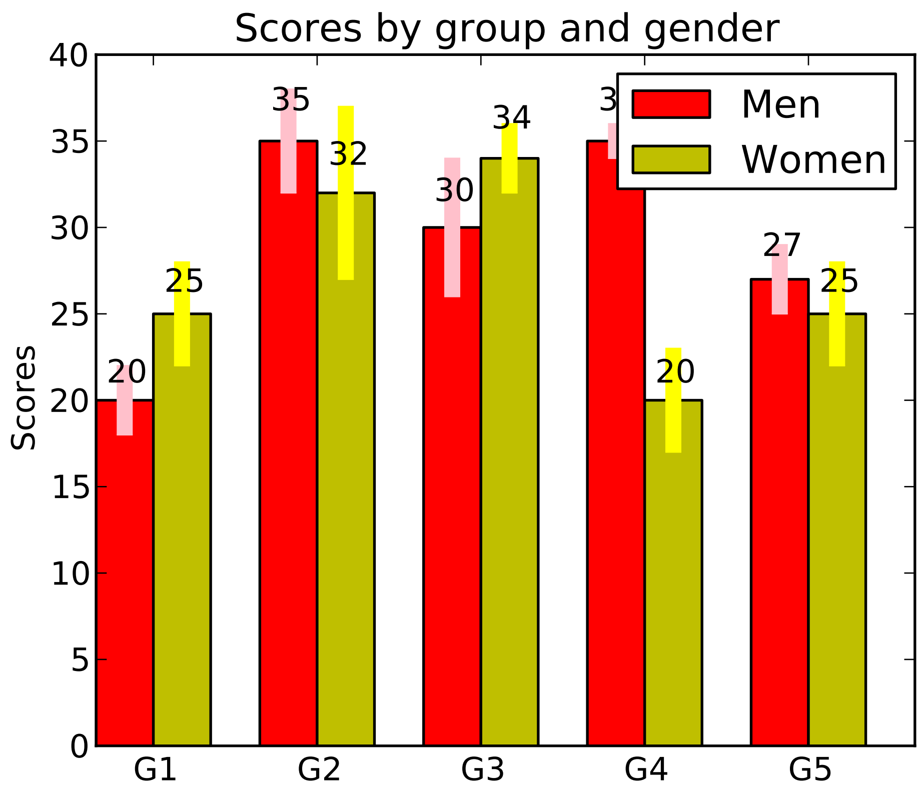
Exception occurred rendering plot.

17.16 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.

17.17 Polar plots

The `polar()` command generates polar plots.



17.18 Legends

The `legend()` command automatically generates figure legends, with MATLAB compatible legend placement commands. Thanks to Charles Twardy for input on the legend command

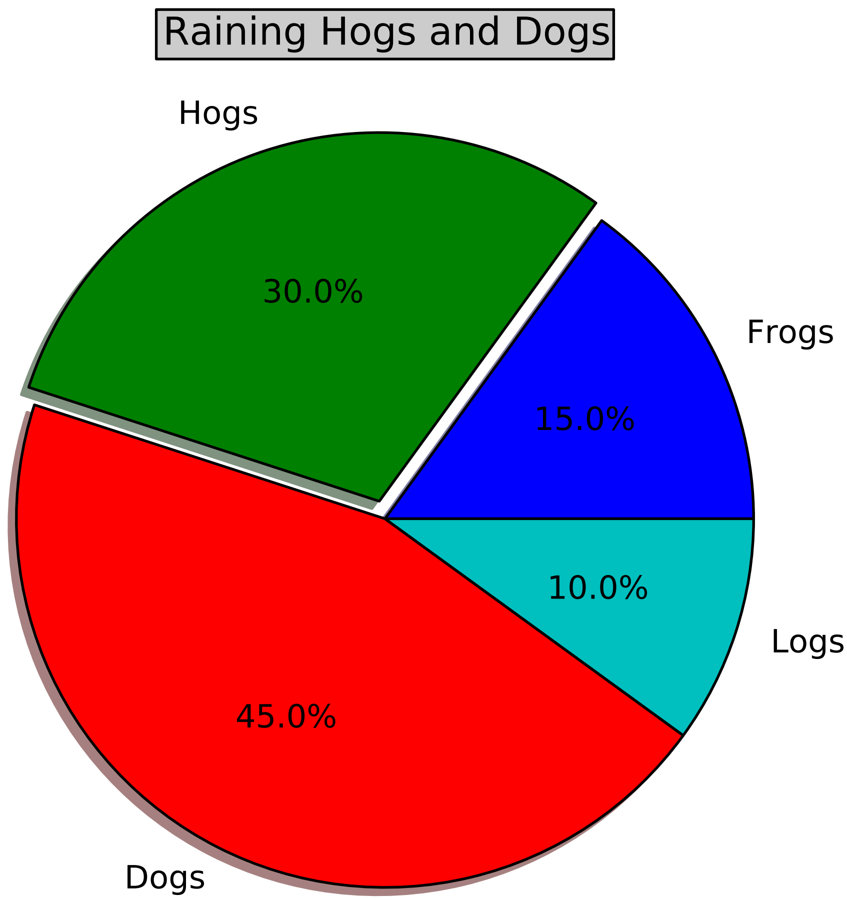
17.19 Mathtext_examples

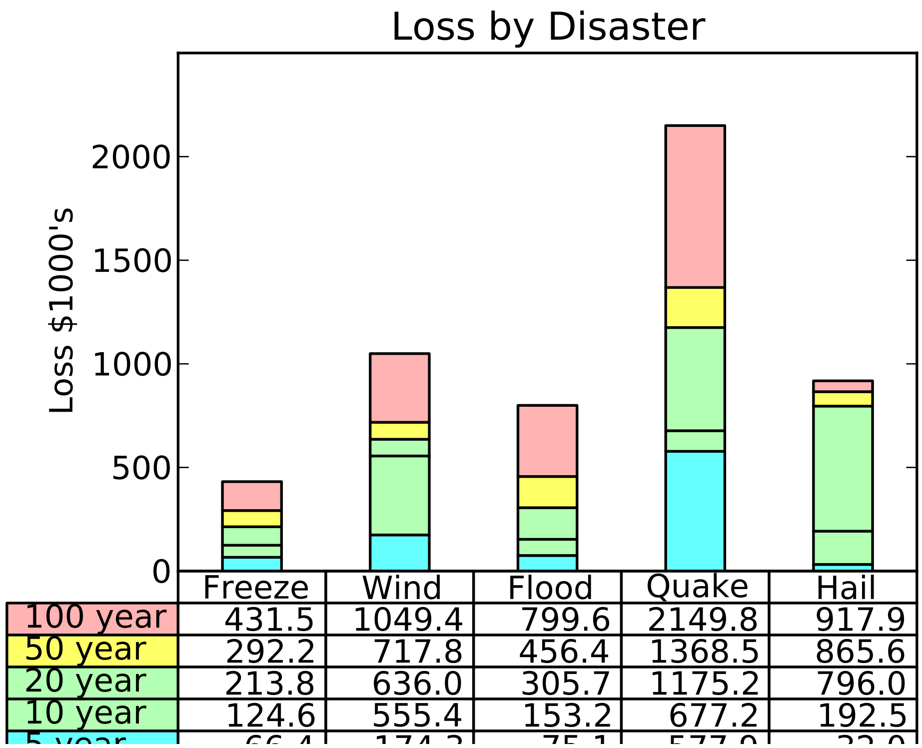
A sampling of the many TeX expressions now supported by matplotlib's internal mathtext engine. The mathtext module provides TeX style mathematical expressions using freetype2 and the BaKoMa computer modern or STIX fonts. See the `matplotlib.mathtext` module for additional. matplotlib mathtext is an independent implementation, and does not required TeX or any external packages installed on your computer. See the tutorial at *Writing mathematical expressions*.

17.20 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.

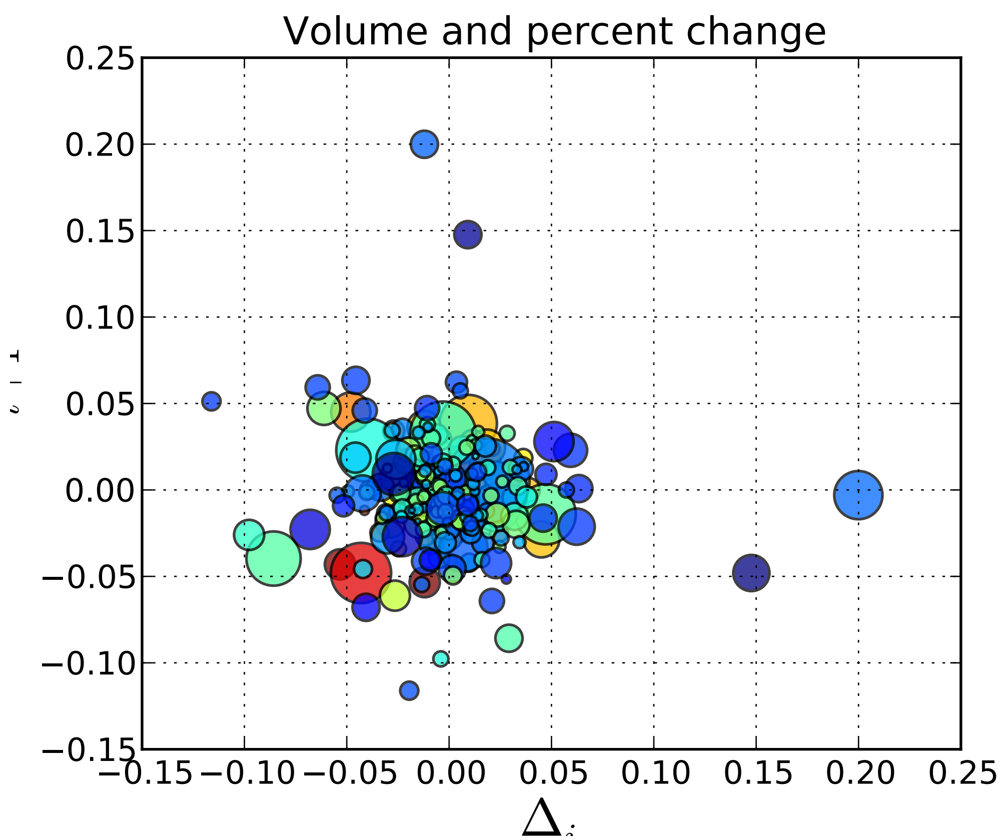
Exception occurred rendering plot.

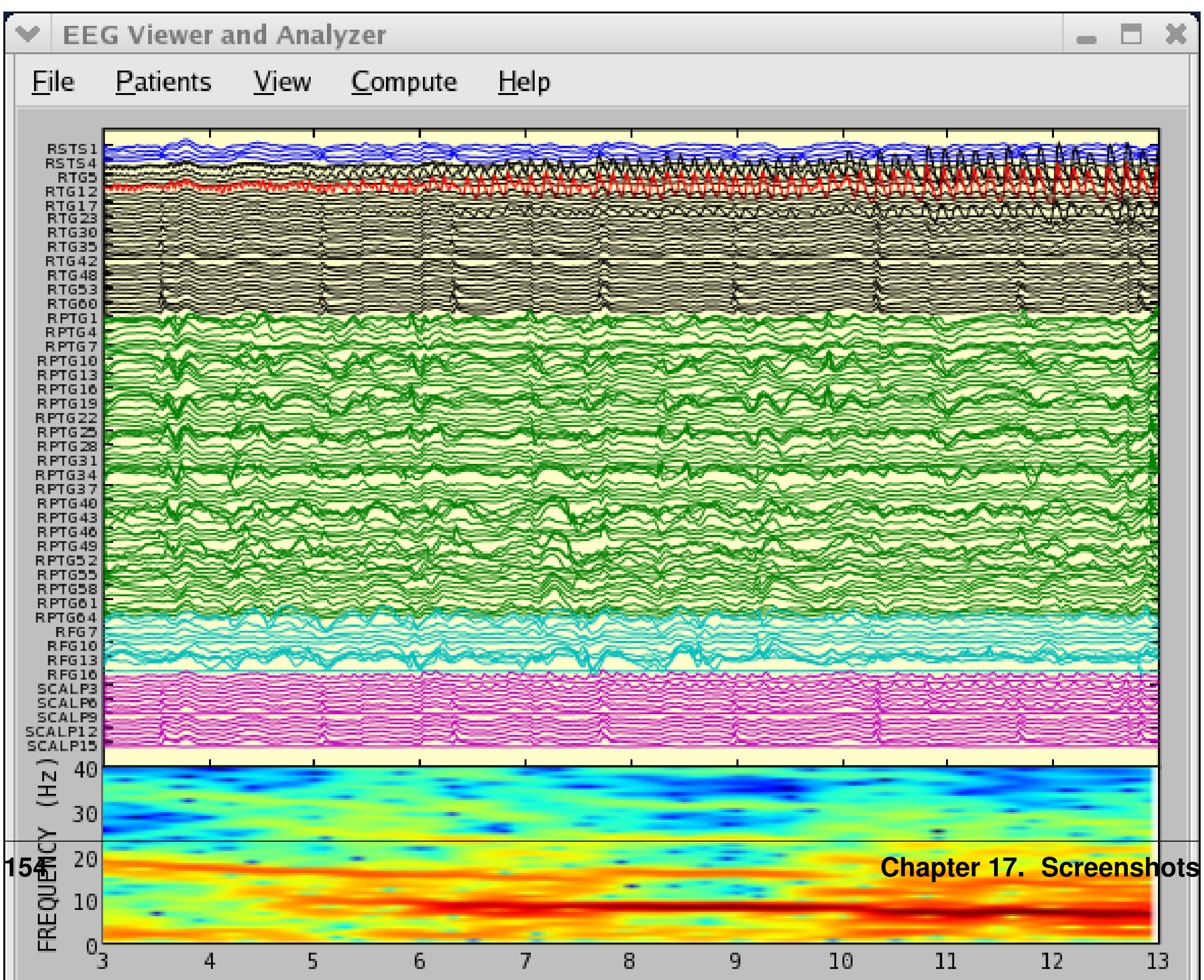

Raining Hogs and Dogs
Hogs
30.0%
Frogs
15.0%
10.0%
Logs
45.0%
Dogs

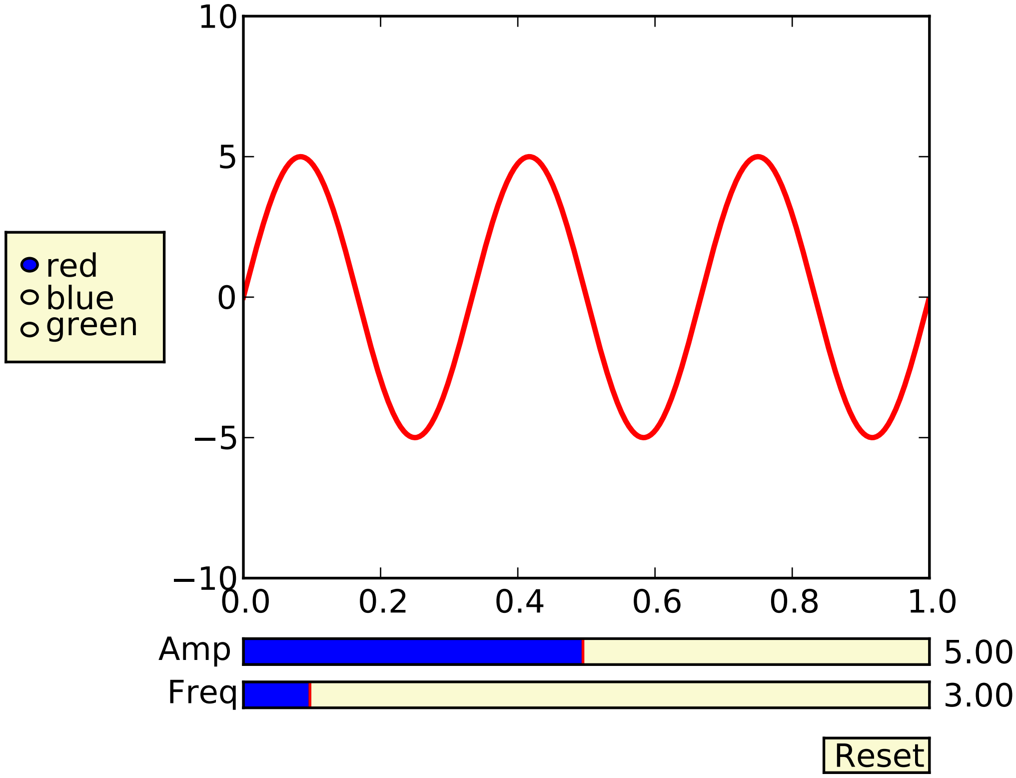


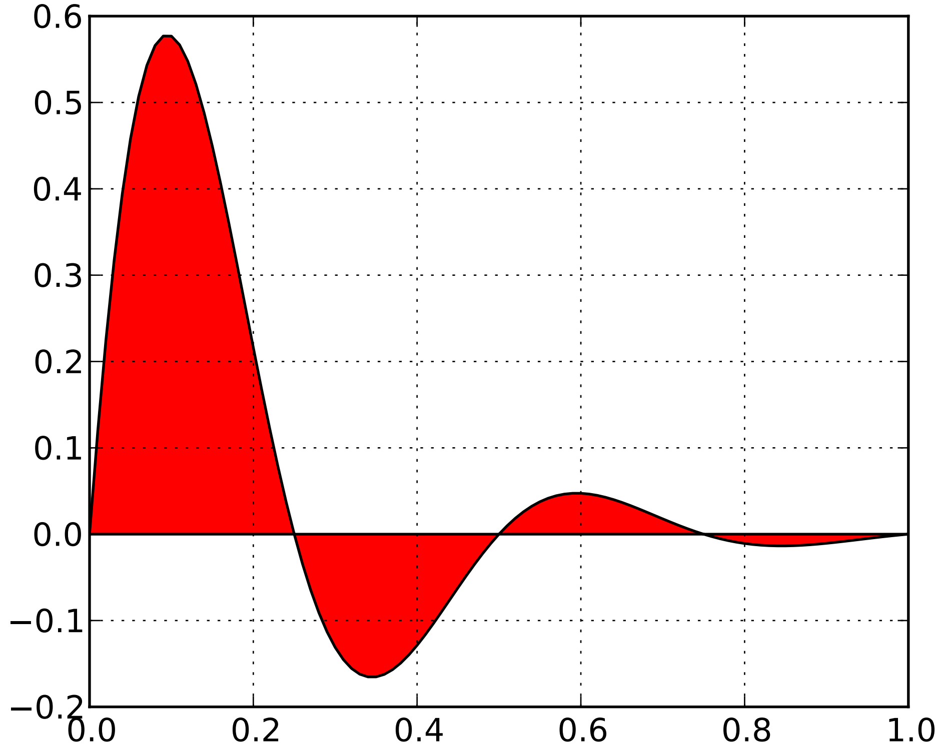
17.21 EEG demo

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*.

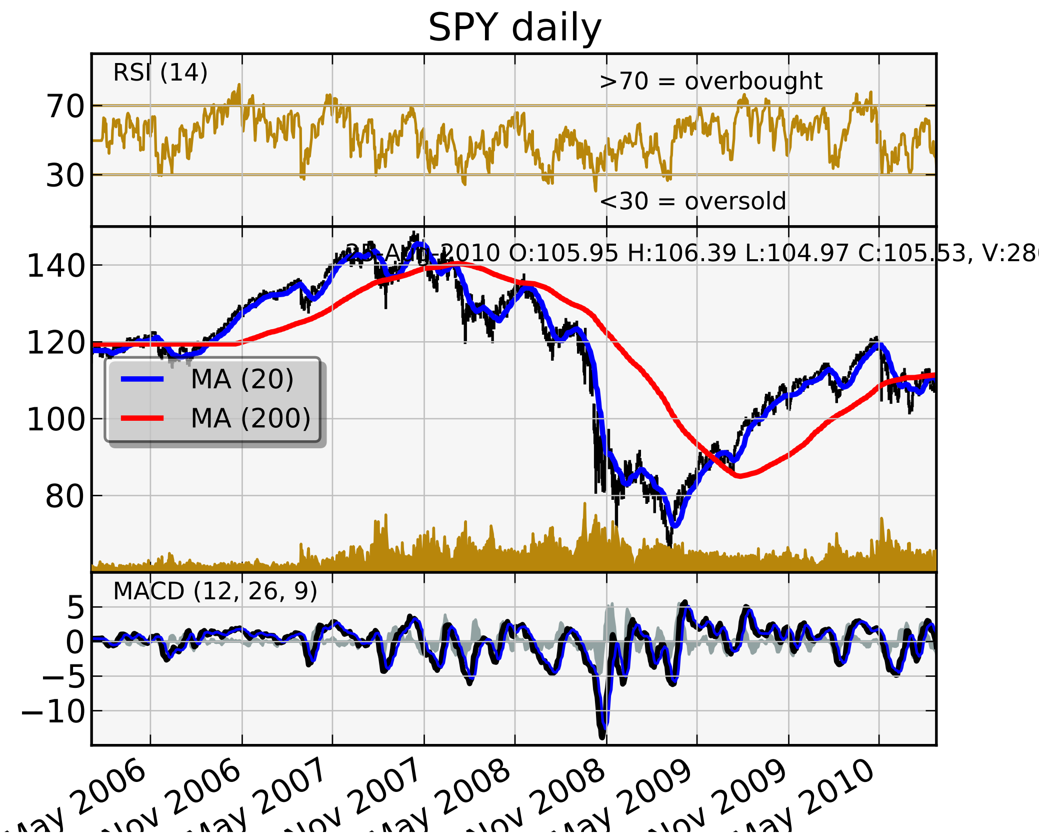

Volume and percent change
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
−0.10
−0.15
−0.15 −0.10 −0.05 0.00 0.05 0.10 0.15 0.20 0.25
Δ_i

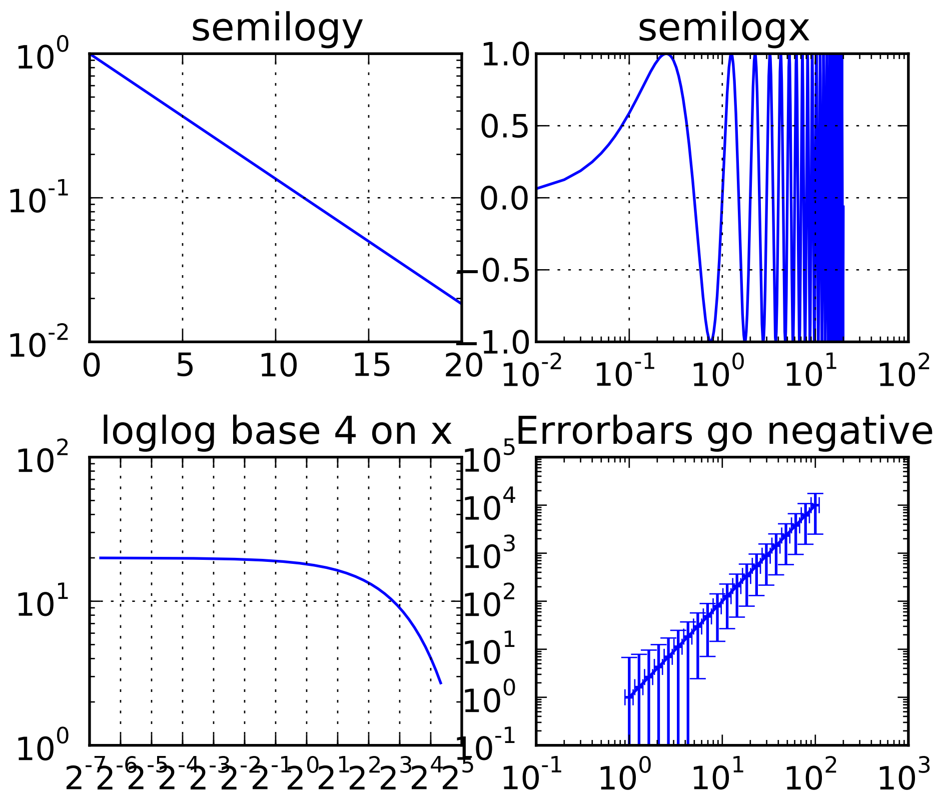

EEG Viewer and Analyzer
File Patients View Compute Help
RSTS1
RSTS4
RTG5
RTG12
RTG17
RTG23
RTG30
RTG35
RTG42
RTG48
RTG53
RTG60
RPTG1
RPTG4
RPTG7
RPTG10
RPTG13
RPTG16
RPTG19
RPTG22
RPTG25
RPTG28
RPTG31
RPTG34
RPTG37
RPTG40
RPTG43
RPTG46
RPTG49
RPTG52
RPTG55
RPTG58
RPTG61
RPTG64
RFG7
RFG10
RFG13
RFG16
SCALP3
SCALP6
SCALP9
SCALP12
SCALP15
FREQUENCY (Hz)
40
30
20
10
0
3 4 5 6 7 8 9 10 11 12 13

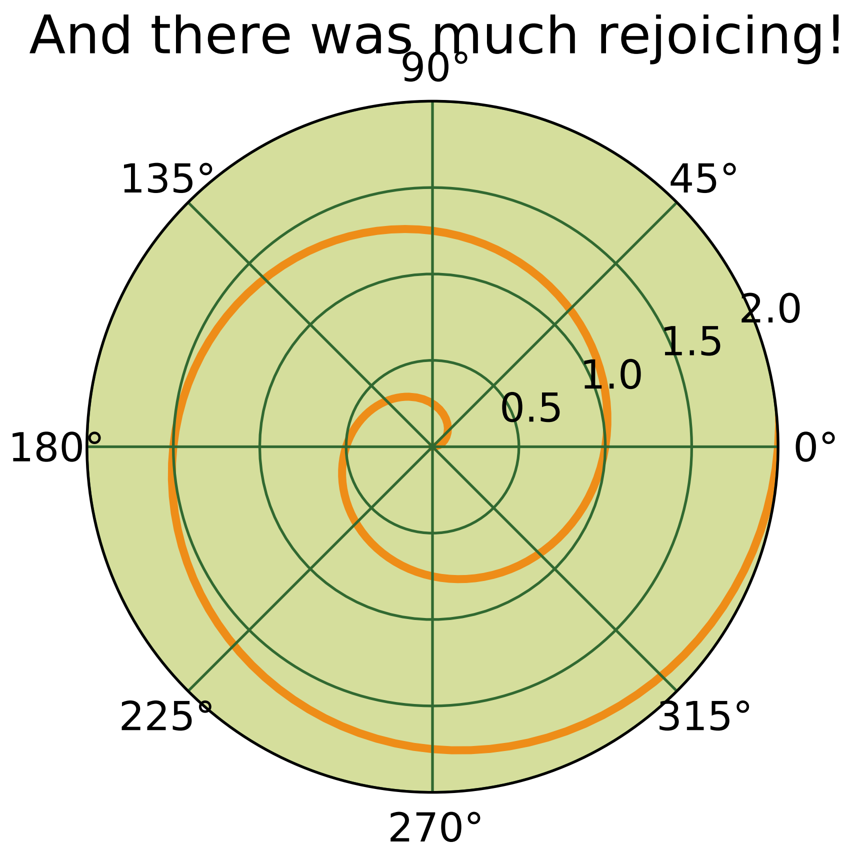

red
blue
green
10
5
0
−5
−10
0.0
0.2
0.4
0.6
0.8
1.0
Amp
5.00
Freq
3.00
Reset

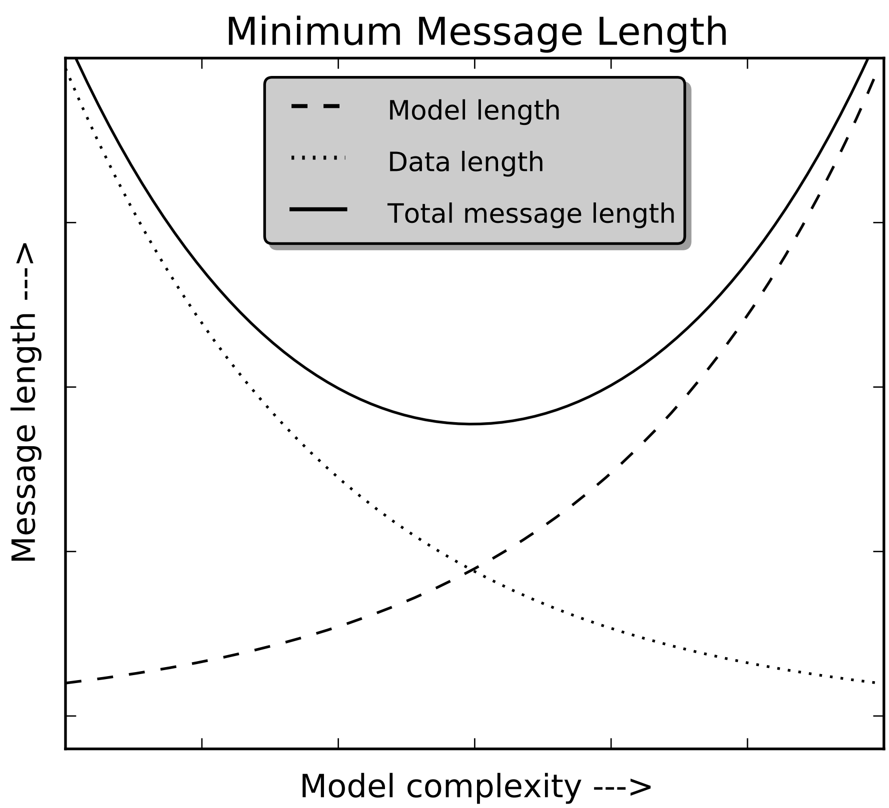

0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

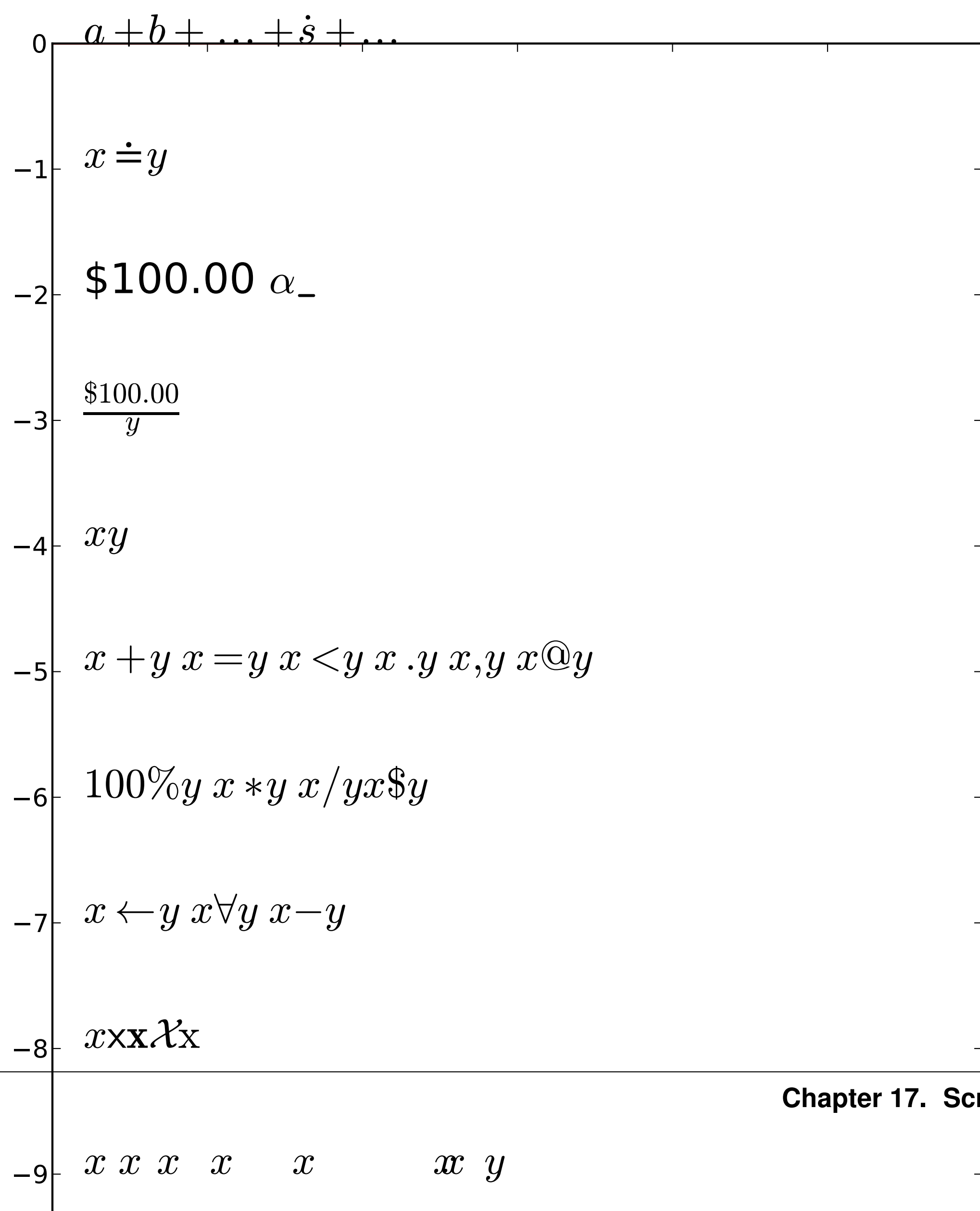

800
700
600
500
400
300
200
100
2004
2005
2006
2007
2008
2009


SPY daily
RSI (14)
>70 = overbought
<30 = oversold
70
30
140
120
100
80
O:105.95 H:106.39 L:104.97 C:105.53
MA (20)
MA (200)
MACD (12, 26, 9)
5
0
−5
−10


semilogy
semilogx
loglog base 4 on x
Errorbars go negative


And there was much rejoicing!
90°
45°
135°
180°
0°
225°
270°
315°
0.5
1.0
1.5
2.0


Minimum Message Length
Model length
Data length
Total message length
Message length --->
Model complexity --->


$a+b+\dots+\dot{s}+\dots$
0
$x \doteq y$
−1
$100.00 $\alpha\_$
−2
$\frac{\$100.00}{y}$
−3
xy
−4
$x+y\ x=y\ x<y\ x.y\ x,y\ x@y$
−5
$100\%y\ x*y\ x/y x\$y$
−6
$x \leftarrow y\ x\forall y\ x-y$
−7
$x\mathrm{x}\mathbf{x}\mathcal{X}\mathrm{x}$
−8
$x\ x\ x\ \ x\ \ \ x\ \ \ \ xx\ y$
−9

CHAPTER EIGHTEEN

WHAT'S NEW IN MATPLOTLIB

This page just covers the highlights – for the full story, see the CHANGELOG

18.1 new in matplotlib-1.0

18.1.1 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.

18.1.2 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.

18.1.3 Easy pythonic subplots

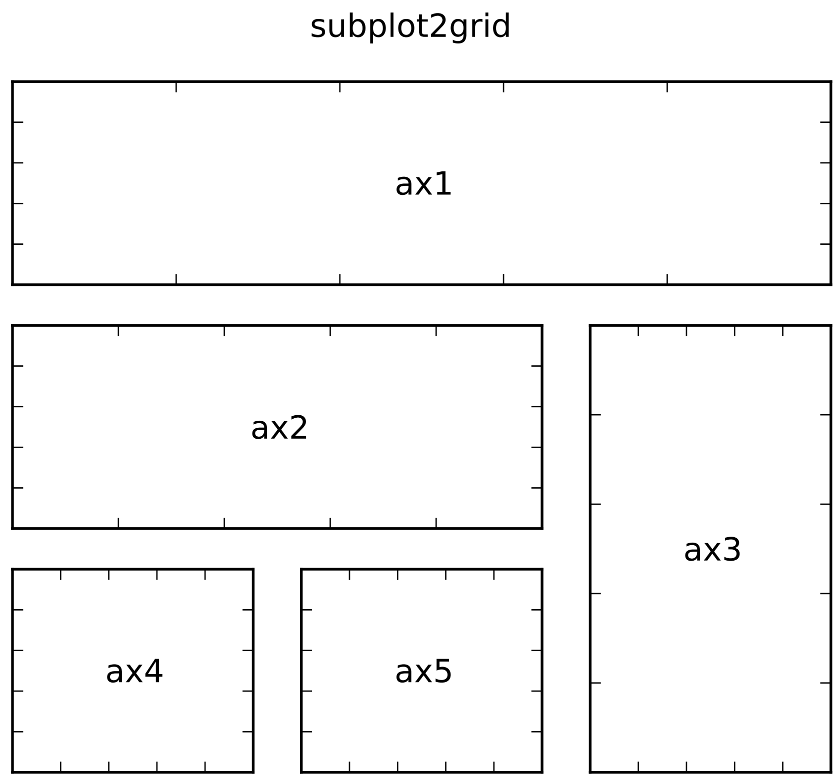
Fernando Perez got tired of all the boilerplate code needed to create a figure and multiple subplots when using the matplotlib API, and wrote a `subplots()` helper function. Basic usage allows you to create the figure and an array of subplots with numpy indexing (starts with 0). Eg:

```
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.

18.1.4 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.



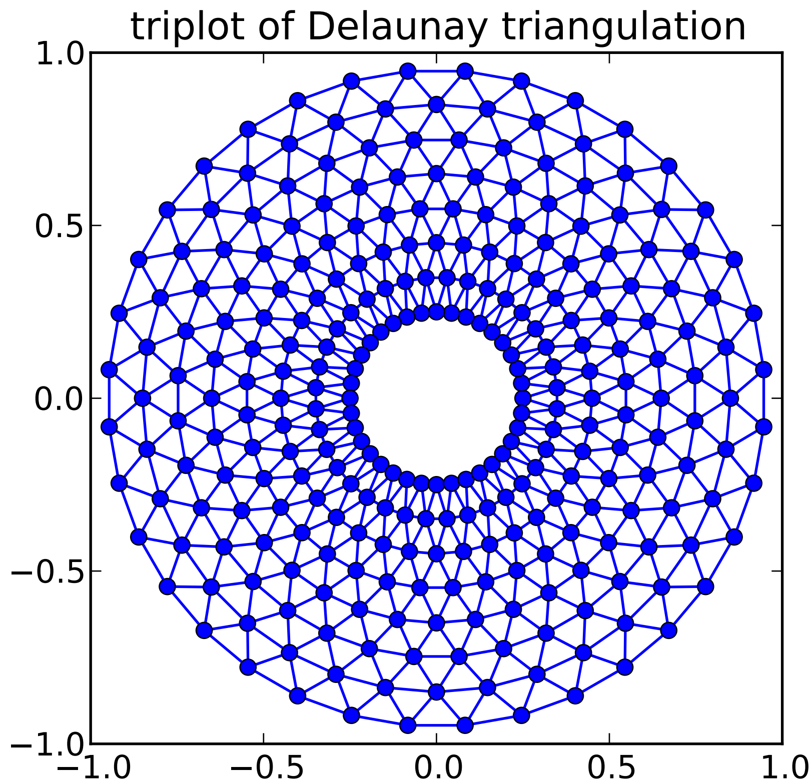
Additionally, he has contributed a new module *matplotlib.tri* and helper function `triplot()` for creating and plotting unstructured triangular grids.

18.1.5 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.

18.1.6 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.



18.1.7 tick_params

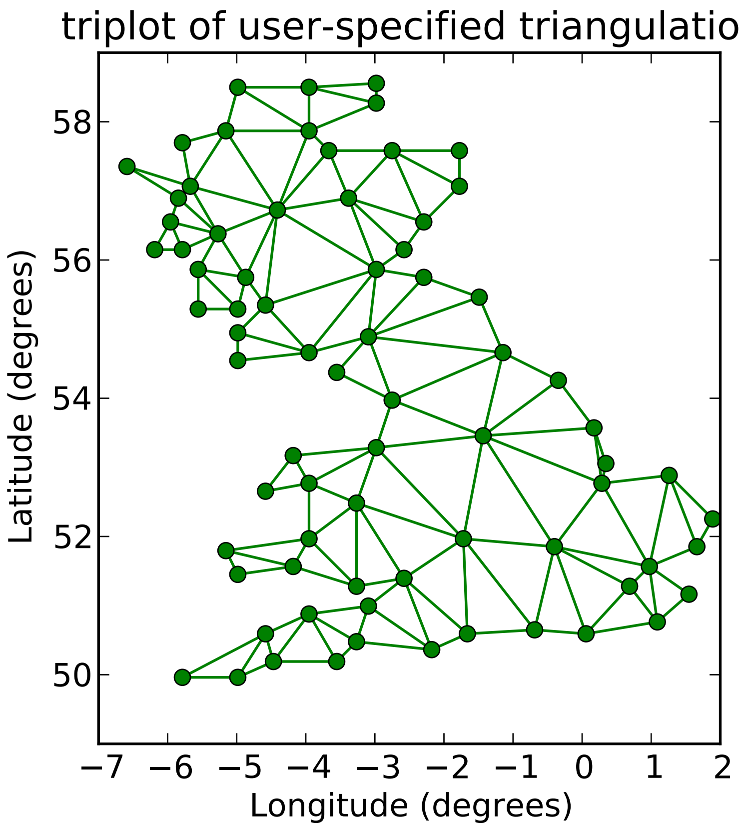
Eric Firing wrote tick_params, a convenience method for changing the appearance of ticks and tick labels. See pyplot function `tick_params()` and associated Axes method `tick_params()`.

18.1.8 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

18.1.9 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.

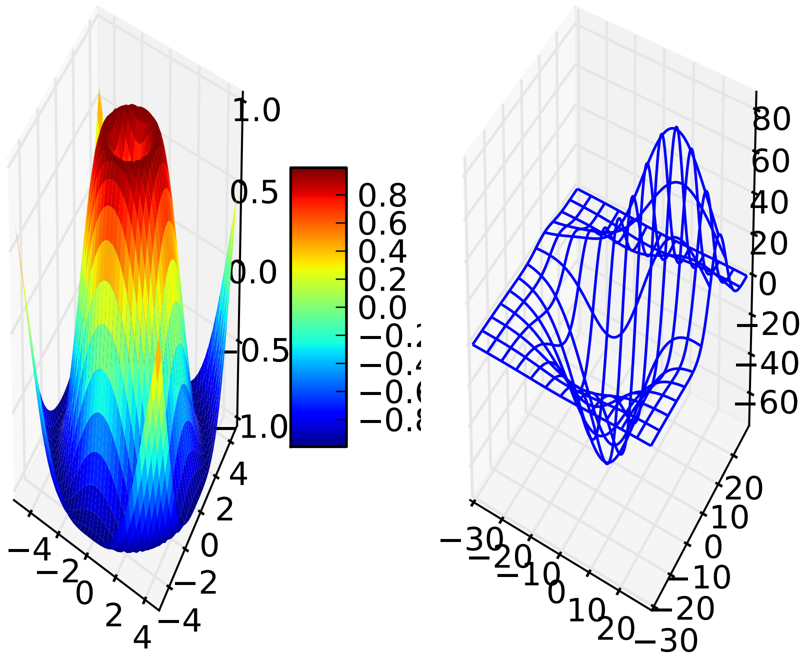
18.1.10 Bugfix marathon

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.

18.2 new in matplotlib-0.99

18.2.1 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*.



18.2.2 mplot3d

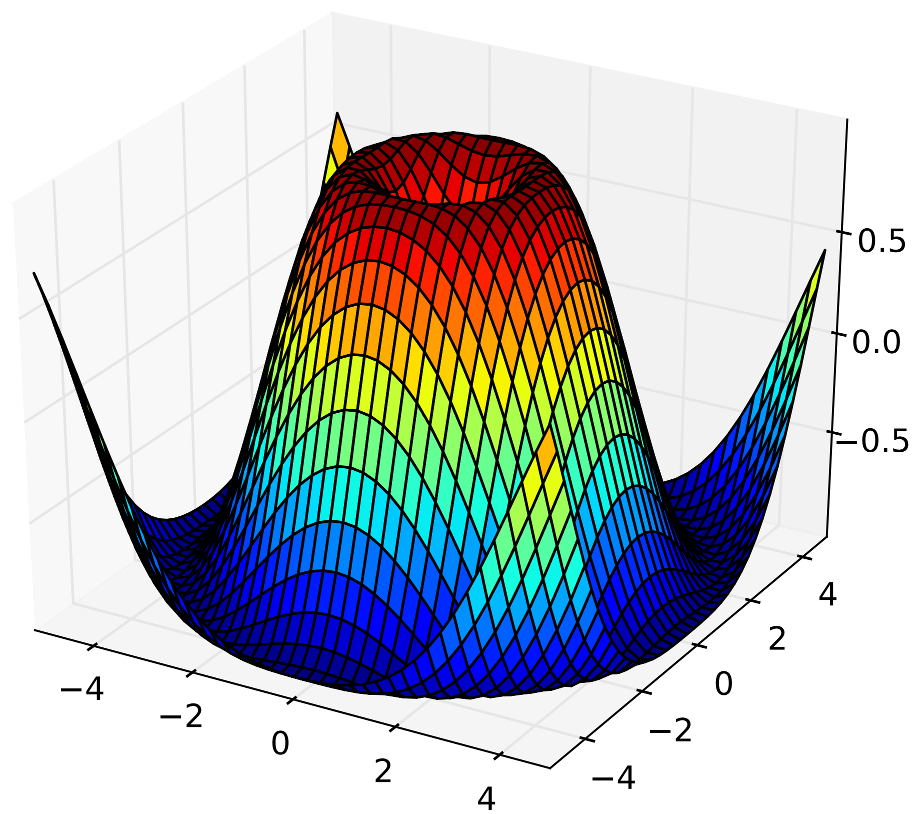
Reinier Heeres has ported John Porter's mplot3d over to the new matplotlib transformations framework, and it is now available as a toolkit mpl_toolkits.mplot3d (which now comes standard with all mpl installs). See *mplot3d Examples* and *mplot3d tutorial*

18.2.3 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*.

18.2.4 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`.



18.3 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.

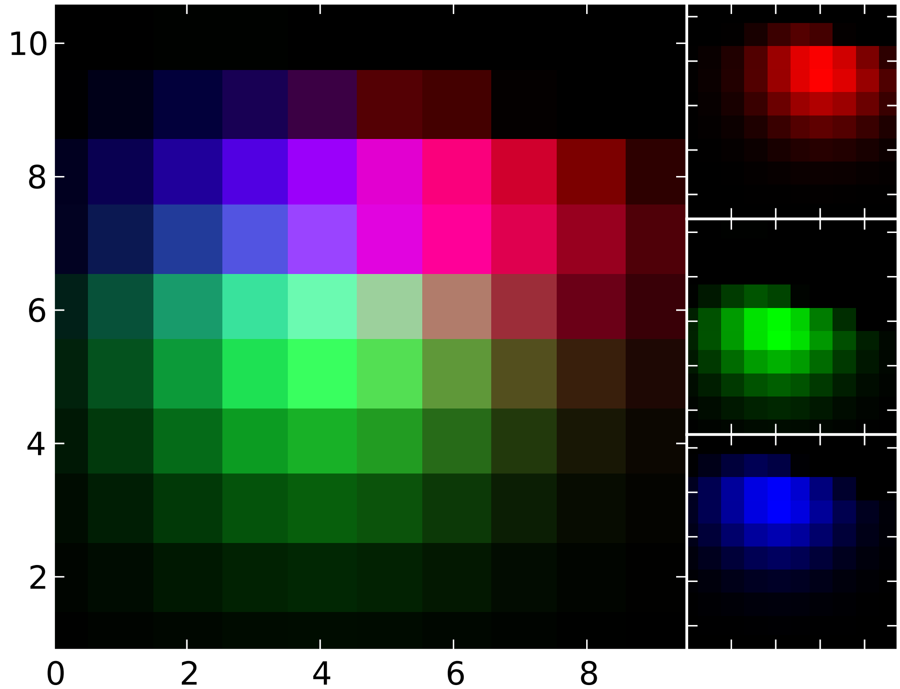
Thanks to Charlie Moad for testing and preparing the source release, including binaries for OS X and Windows for python 2.4 and 2.5 (2.6 and 3.0 will not be available until numpy is available on those releases). Thanks to the many developers who contributed to this release, with contributions from Jae-Joon 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

18.3.1 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`.

18.3.2 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`.



18.3.3 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:

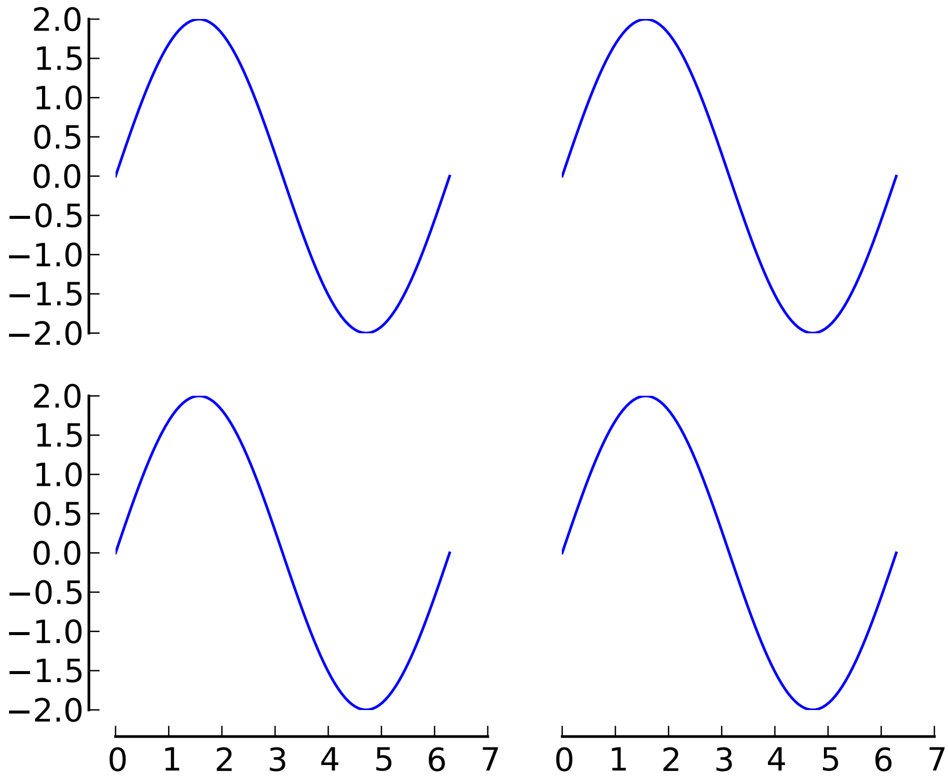
```
> python myfile.py -dmacosx
```

18.3.4 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 compatabililty and increase scaling options.

18.3.5 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 betweem, and an optional *where* argument

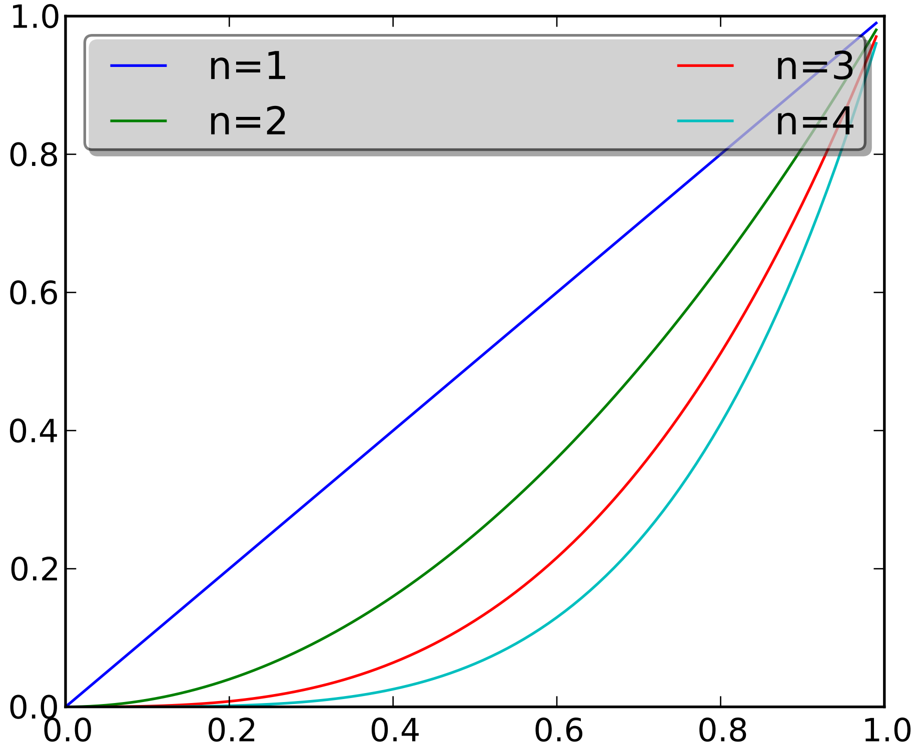


which is a logical mask where you want to do the filling.

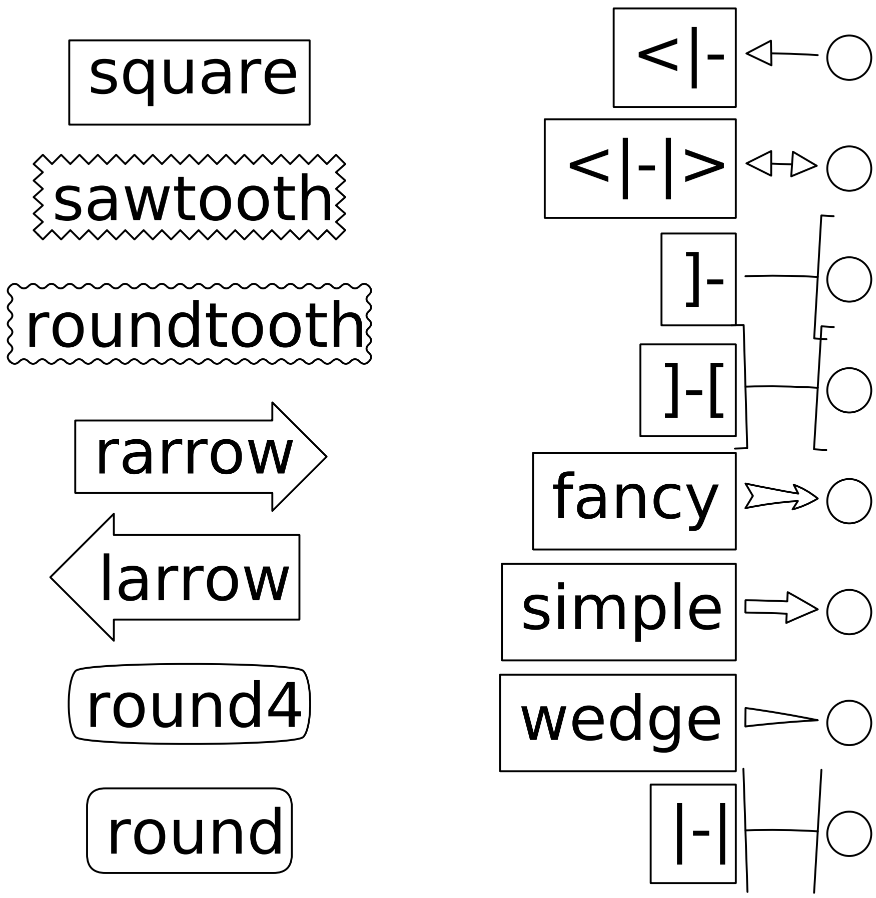
18.3.6 Lots more

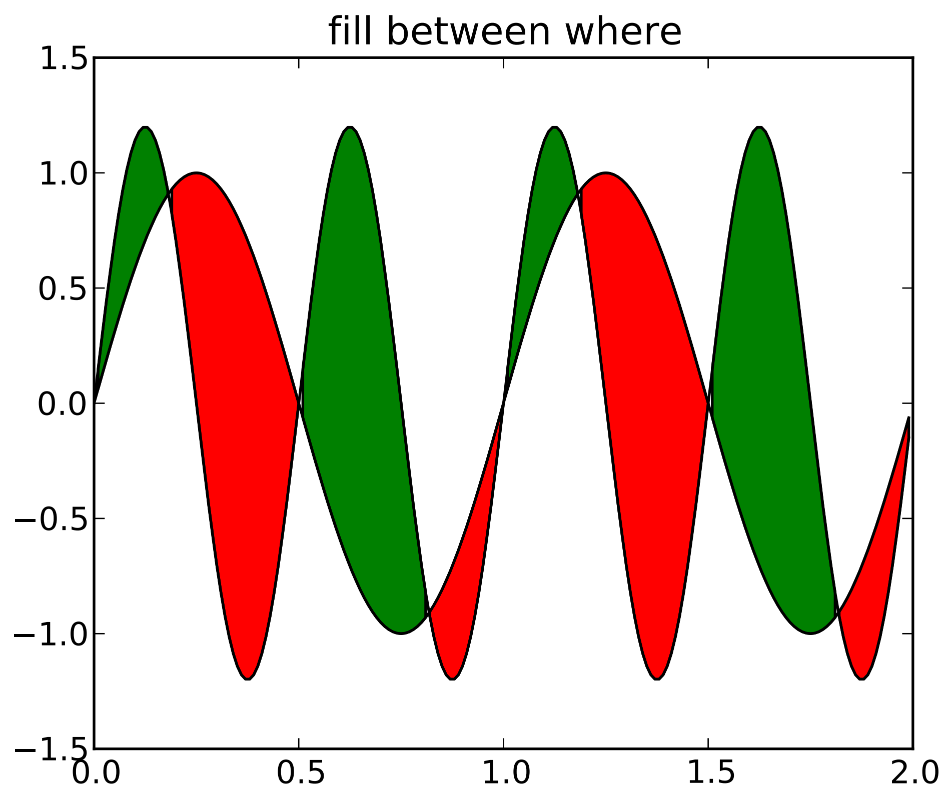
Here are the 0.98.4 notes from the CHANGELOG:

```
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
```


square
sawtooth
roundtooth
rarrow
larrow
round4
round
<|-
<|-|>
]-
]-[
fancy
simple
wedge
|-|




```
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 alignement,
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, respecitively.  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 wep 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
```

CHAPTER

NINETEEN

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CHAPTER

TWENTY

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 traited 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* tookit

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 infrastruture 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

CHAPTER

TWENTYONE

INSTALLATION FAQ

Contents

21.1 Report a compilation problem

See *Report a problem*.

21.2 matplotlib compiled fine, but nothing shows up with plot

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`, or 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*.

21.3 Cleanly rebuild and reinstall everything

The steps depend on your platform and installation method.

21.3.1 Easy Install

1. Delete the caches from your *.matplotlib configuration directory*.
2. Run:

   ```
   easy_install -m PackageName
   ```

3. Delete any .egg files or directories from your *installation directory*.

21.3.2 Windows installer

1. Delete the caches from your *.matplotlib configuration directory*.
2. Use *Start* → *Control Panel* to start the **Add and Remove Software** utility.

21.3.3 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 <locating-matplotlib-install>*

21.4 Install from svn

Checking out the main source:

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk/matplotlib matplotlib
```

and build and install as usual with:

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

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. Then, if you want to update your **matplotlib** at any time, just do:

```
> svn update
```

When you run *svn update*, 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 setupegg develop* command again to compile them.

There is more information on *using Subversion* in the developer docs.

21.5 Install from git

See *Using git*.

21.6 Backends

21.6.1 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 capabililities is called a backend; the "frontend" is the user facing code, ie the plotting code, whereas the "backend" does all the dirty 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) and hardcopy backends to make image files (PNG, SVG, PDF, PS).

There are a two primary ways to configure your backend. One is to set the `backend` parameter in you `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`.

If you are unsure what to do, and just want to get cranking, just set your backend to `TkAgg`. This will do the right thing for 95% of the users. It gives you the option of running your scripts in batch or working interactively from the python shell, with the least amount of hassles, and is smart enough to do the right thing when you ask for postscript, or pdf, or other image formats.

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 antigrain C++ library to make a raster (pixel) image of the figure. All of the user interfaces can be used with agg rendering, eg `WXAgg`, `GTKAgg`, `QTAgg`, `TkAgg`, `CocoaAgg`. 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 represenation 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):

Renderer	Filetypes	Description
AGG	*png*	*raster graphics* – high quality images using the Anti-Grain Geometry engine
PS	*ps eps*	*vector graphics* – Postscript output
PDF	*pdf*	*vector graphics* – Portable Document Format
SVG	*svg*	*vector graphics* – Scalable Vector Graphics
Cairo	*png ps pdf svg* ...	*vector graphics* – Cairo graphics
GDK	*png jpg tiff* ...	*raster graphics* – the Gimp Drawing Kit

And here are the user interfaces and renderer combinations supported:

Backend	Description
GTKAgg	Agg rendering to a *GTK* canvas (requires PyGTK)
GTK	GDK rendering to a *GTK* canvas (not recommended) (requires PyGTK)
GTKCairo	Cairo rendering to a *GTK* Canvas (requires PyGTK)
WXAgg	Agg rendering to to a *wxWidgets* canvas (requires wxPython)
WX	Native *wxWidgets* drawing to a *wxWidgets* Canvas (not recommended) (requires wxPython)
TkAgg	Agg rendering to a *Tk* canvas (requires TkInter)
QtAgg	Agg rendering to a *Qt* canvas (requires PyQt)
Qt4Agg	Agg rendering to a *Qt4* canvas (requires PyQt4)
FLTKAgg	Agg rendering to a *FLTK* canvas (requires pyFLTK)
macosx	Cocoa rendering in OSX windows

21.6.2 Compile matplotlib with PyGTK-2.4

There is a bug in PyGTK-2.4. You need to edit `pygobject.h` to add the `G_BEGIN_DECLS` and `G_END_DECLS` macros, and rename `typename` parameter to `typename_`:

```
-                       const char *typename,
+                       const char *typename_,
```

21.7 OS-X questions

21.7.1 Which python for OS X?

Apple ships with its own python, many users have had trouble with it so there are alternatives. If it is feasible for you, we recommend the enthought python distribution EPD for OS X (which comes with matplotlib and much more) or the MacPython or the official OS X version from python.org.

21.7.2 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 an binary OSX egg, which you can install via setuptools easy_install.

The mkpg installer will have a "zip" extension, and will have a name like file:*matplotlib-0.99.0.rc1-py2.5-macosx10.5_mpkg.zip* depending on the python, matplotlib, and OSX versions. You need to unzip this file using either the "unzip" command on OSX, or simply double clicking on it to run StuffIt Expander. When you double click on the resultant mpkd directory, which will have a name like file:*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 file:*/Library/Python/2.5/site-packages/*, again depedending on your python version. This directory may not be in your python path, so you can 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*.

21.7.3 easy_install from egg

You can also us 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 the naming conventions for OSX eggs appear to be broken (see below) so 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 with

> > easy_install –install-dir=~/dev/lib/python2.5/site-packages/ matplotlib-0.99.0.rc1-py2.5-macosx-10.5-i386.egg

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 with 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.

21.7.4 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:

1. 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`).

1. Save the following as a shell script , for example `./install-matplotlib-epd-osx.sh`

```
NAME=matplotlib
VERSION=0_99
PREFIX=$HOME
#branch="release"
branch="trunk"
if [  $branch = "trunk" ]
   then
   echo getting the trunk
   svn co https://matplotlib.svn.sourceforge.net/svnroot/$NAME/trunk/$NAME $NAME
   cd $NAME

 fi
 if [ $branch = "release" ]
    then
    echo getting the maintenance branch
    svn co https://matplotlib.svn.sf.net/svnroot/matplotlib/branches/v${VERSION}_maint $NAME$VERSI
    cd $NAME$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
 python setup.py install #--prefix=$PREFIX #Use this if you don't want it installed into your defa
 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 svn, builds and installs it. The backend seems to be set to MacOSX.

21.8 Windows questions

21.8.1 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)

CHAPTER

TWENTYTWO

USAGE

Contents

22.1 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 a MATLAB-style state-machine interface to the underlying object-oriented plotting library in matplotlib.

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. 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.

We have been gradually converting the matplotlib examples from pure MATLAB-style, using "from pylab import *", to a preferred style in which pyplot is used for some convenience functions, either pyplot or the object-oriented style is used for the remainder of the plotting code, and numpy is used explicitly for numeric array operations.

In this preferred style, the imports at the top are:

```
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.

Example, pure MATLAB-style:

```
from pylab import *
x = arange(0, 10, 0.2)
y = sin(x)
```

```
plot(x, y)
show()
```

Now in preferred style, but still using pyplot interface:

```
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()
```

And using pyplot convenience functions, but object-orientation 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()
```

So, why do all the extra typing required as one moves away from the pure MATLAB-style? For very simple things like this example, the only advantage is educational: the wordier styles are more explicit, more clear as to where things come from and what is going on. For more complicated applications, the explicitness and clarity become increasingly valuable, and the richer and more complete object-oriented interface will likely make the program easier to write and maintain.

CHAPTER

TWENTYTHREE

HOWTO

Contents

23.1 Plotting: howto

23.1.1 Find all objects in 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')
```

23.1.2 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 to affect the screen displayed version as well, you can set the alpha properties directly. The figure has a `matplotlib.patches.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)
```

23.1.3 Save multiple plots in 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:

```
savefig(pp, format='pdf')
```

A simpler way is to call PdfPages.savefig:

```
pp.savefig()
```

Finally, the multipage pdf object has to be closed:

```
pp.close()
```

23.1.4 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 matplotlib.figure.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 axes_demo.py for an example of placing axes manually.

23.1.5 Automatically make room for tick labels

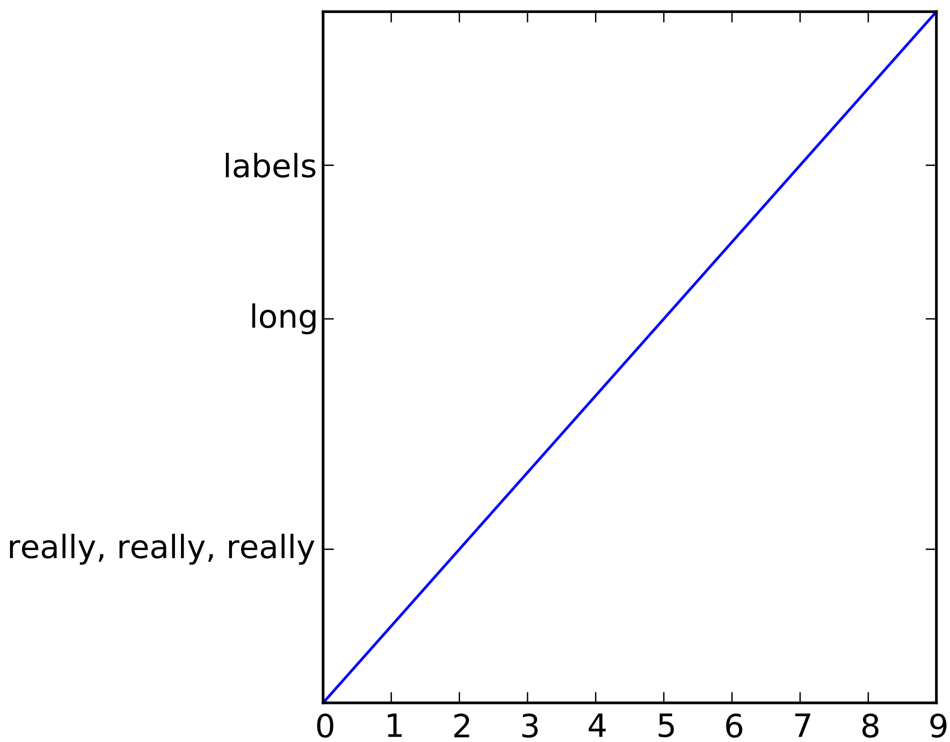
In most use cases, it is enough to simpy change the subplots adjust parameters as described in *Move the edge of an axes to make room for tick labels*. But in some cases, you don't know ahead of time what your tick labels will be, or how large they will be (data and labels outside your control may be 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 `matplotlib.text.Text` instance can report its extent in window coordinates (a negative x coordinate is outside the window), but there is a rub.

The `matplotlib.backend_bases.RendererBase` instance, which is used to calculate the text size, is not known until the figure is drawn (`matplotlib.figure.Figure.draw()`). After the window is drawn and the text instance knows its renderer, you can call `matplotlib.text.Text.get_window_extent()`. One way to solve this chicken and egg problem is to wait until the figure is draw by connecting (`matplotlib.backend_bases.FigureCanvasBase.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 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()
```



23.1.6 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`, `markeredgecolor`, `markeredgewidth`, `markersize`. For more information on configuring ticks, see *Axis containers* and *Tick containers*.

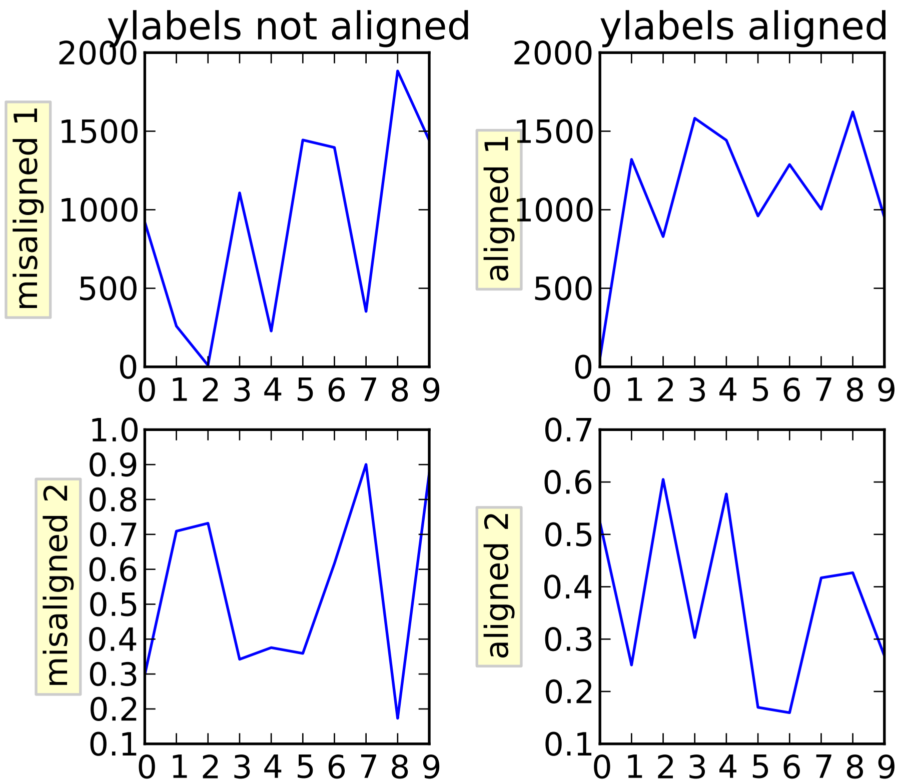
23.1.7 Align my ylabels across multiple subplots

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()
```

23.1.8 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-xaxis, 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 indicies, 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:




```python
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()
```

23.1.9 Test whether a point is inside a polygon

The matplotlib.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, False,  True, False, True], dtype=bool)
```

23.1.10 Control the depth of plot elements

Within an axes, the order that the various lines, markers, text, collections, etc appear is determined by the matplotlib.artist.Artist.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 matplotlib.axes.Axes.set_axisbelow() to control whether the grid lines are placed above or below your other plot elements.

23.1.11 Make the aspect ratio for plots equal

The Axes property `matplotlib.axes.Axes.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')
```

23.1.12 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")
```

23.1.13 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, since both scales do not get the signals.

The approach `twinx()` (and its sister `twiny()`) uses is 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 since the two axes are independent:

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

fig = plt.figure()
ax1 = fig.add_subplot(111)
t = np.arange(0.01, 10.0, 0.01)
s1 = np.exp(t)
ax1.plot(t, s1, 'b-')
ax1.set_xlabel('time (s)')
ax1.set_ylabel('exp')

ax2 = ax1.twinx()
s2 = np.sin(2*np.pi*t)
ax2.plot(t, s2, 'r.')
ax2.set_ylabel('sin')
plt.show()
```

23.1.14 Generate images without having a window popup

The easiest way to do this is use an image backend (see *What is a backend?*) such as Agg (for PNGs), PDF, SVG or PS. In your figure generating script, just place call `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.

23.1.15 Use `show()`

The user interface backends need to start the GUI mainloop, and this is what `show()` does. It tells matplotlib to raise all of the figure windows and start the mainloop. Because the mainloop is blocking, you should only call this once per script, at the end. If you are using matplotlib to generate images only and do not want a user interface window, you do not need to call `show` (see *Generate images without having a window popup* and *What is a backend?*).

Because it is expensive to draw, matplotlib does not want to redrawing the 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()
```

It is *possible* to force matplotlib to draw after every command, which is what you usually 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 script has executed. 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 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 the figure is closed, and then allows 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 some progress towards supporting blocking events.

23.2 Contributing: howto

23.2.1 Submit a patch

First obtain a copy of matplotlib svn (see *Install from svn*) and make your changes to the matplotlib source code or documentation and apply a *svn diff*. If it is feasible, do your diff from the top level directory, the one that contains `setup.py`. Eg,:

```
> cd /path/to/matplotlib/source
> svn diff > mypatch.diff
```

and then post your patch to the matplotlib-devel mailing list. If you do not get a response within 24 hours, post your patch to the sourceforge patch tracker, and follow up on the mailing list with a link to the sourceforge patch submissions. If you still do not hear anything within a week (this shouldn't happen!), send us a kind and gentle reminder on the mailing list.

If you have made lots of local changes and do not want to a diff against the entire tree, but rather against a single directory or file, that is fine, but we do prefer svn diffs against the top level (where setup.py lives) since it is nice to have a consistent way to apply them.

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 svn diffs against HEAD or the branch they are patching. It just makes life simpler 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. The original 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*.

23.2.2 Contribute to matplotlib documentation

matplotlib is a big library, which is used in many ways, and the documentation we have only scratches 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 write most of the documentation. Just pulled your hair out compiling matplotlib for windows? Write a FAQ or a section for the *Installing* 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 a 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 *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 svn. See *Install from svn* and *Submit a patch*. Looking for something to do? Search for TODO.

23.3 Matplotlib in a web application server

Many users report initial problems trying to use maptlotlib 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 altogeher, which will give you a little more control, by calling the API directly as shown in 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 objectm 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)
```

23.3.1 matplotlib with apache

TODO; see *Contribute to matplotlib documentation*.

23.3.2 matplotlib with django

TODO; see *Contribute to matplotlib documentation*.

23.3.3 matplotlib with zope

TODO; see *Contribute to matplotlib documentation*.

23.3.4 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.

23.4 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 and in every example. So if you want to search for an example that uses an ellipse, *Search Page* for `codex ellipse`.

CHAPTER

TWENTYFOUR

TROUBLESHOOTING

Contents

24.1 Obtaining matplotlib version

To find out your matplotlib version number, import it and print the `__version__` attribute:

```
>>> import matplotlib
>>> matplotlib.__version__
'0.98.0'
```

24.2 `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'
```

24.3 `.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*.

24.4 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; on Linux/UNIX 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 matlotlib 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 `setupext.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.

24.5 Problems with recent svn versions

First make sure you have a clean build and install (see *Cleanly rebuild and reinstall everything*), get the latest svn update, install it and run a simple test script in debug mode:

```
rm -rf build
rm -rf /path/to/site-packages/matplotlib*
svn up
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 svn 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*.

Part III

The Matplotlib Developers' Guide

CHAPTER

TWENTYFIVE

CODING GUIDE

25.1 Version control

25.1.1 svn checkouts

Checking out everything in the trunk (matplotlib and toolkits):

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk \
matplotlib --username=youruser --password=yourpass
```

Checking out the main source:

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk/\
matplotlib mpl --username=youruser --password=yourpass
```

Branch checkouts, eg the 1.0.x maintenance branch:

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/branches/\
v1_0_maint mpl1 --username=youruser --password=yourpass
```

25.1.2 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 `unit/nose_tests.py` 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 branch (0.91) the latest release branch (eg 0.98.4) and trunk in sync where it makes sense. If there is a bug on both that needs fixing, use svnmerge.py to keep them in sync. See *Using svnmerge* below.

25.1.3 Using svnmerge

svnmerge is useful for making bugfixes to a maintenance branch, and then bringing those changes into the trunk.

The basic procedure is:

- install `svnmerge.py` in your PATH:

  ```
  > wget http://svn.apache.org/repos/asf/subversion/trunk/contrib/\
    client-side/svnmerge/svnmerge.py
  ```

- get a svn checkout of the branch you'll be making bugfixes to and the trunk (see above)
- Create and commit the bugfix on the branch.
- Then make sure you svn upped on the trunk and have no local modifications, and then from your checkout of the svn trunk do:

  ```
  svnmerge.py merge -S BRANCHNAME
  ```

  Where BRANCHNAME is the name of the branch to merge *from*, e.g. v1_0_maint.

  If you wish to merge only specific revisions (in an unusual situation), do:

  ```
  > svnmerge.py merge -rNNN1-NNN2
  ```

  where the `NNN` are the revision numbers. Ranges are also acceptable.

  The merge may have found some conflicts (code that must be manually resolved). Correct those conflicts, build matplotlib and test your choices. If you have resolved any conflicts, you can let svn clean up the conflict files for you:

  ```
  > svn -R resolved .
  ```

  `svnmerge.py` automatically creates a file containing the commit messages, so you are ready to make the commit:

  ```
  > svn commit -F svnmerge-commit-message.txt
  ```

Setting up svnmerge

Note: The following applies only to release managers when there is a new release. Most developers will not have to concern themselves with this.

- Creating a new branch from the trunk (if the release version is 1.0 at revision 8503):

  ```
  > svn copy \
  https://matplotlib.svn.sf.net/svnroot/matplotlib/trunk/matplotlib@8503 \
  https://matplotlib.svn.sf.net/svnroot/matplotlib/branches/v1_0_maint \
  -m "Creating maintenance branch for 1.0"
  ```

- You can add a new branch for the trunk to "track" using "svnmerge.py init", e.g., from a working copy of the trunk:

  ```
  > svnmerge.py init https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/branches/v1_0_maint
  property 'svnmerge-integrated' set on '.'
  ```

  After doing a "svn commit" on this, this merge tracking is available to everyone, so there's no need for anyone else to do the "svnmerge init".

- Tracking can later be removed with the "svnmerge.py uninit" command, e.g.:

  ```
  > svnmerge.py -S v1_0_maint uninit
  ```

25.1.4 Using git

Some matplotlib developers are experimenting with using git on top of the subversion repository. Developers are not required to use git, as subversion will remain the canonical central repository for the foreseeable future.

Cloning the git mirror

There is an experimental matplotlib github mirror of the subversion repository. To make a local clone of it in the directory `matplotlib`, enter the following commands:

```
# Download the entire git repository into "matplotlib", name the source repository "svn".
git clone --origin svn git@github.com:astraw/matplotlib.git

# Change into the newly created git repository.
cd matplotlib

# Setup the subversion mirroring.
git svn init --trunk=trunk/matplotlib --prefix=svn/ https://matplotlib.svn.sourceforge.net/svnroot/matpl

# Tell git svn to analyze the subversion history
git svn rebase -l
```

To install from this cloned repository, use the commands in the *svn installation* section:

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

Note that it is not possible to interact with the matplotlib maintenance branches through git due to different representations of source code repositories in svnmerge and git.

An example git workflow

The following is a suggested workflow for git/git-svn.

Start with a virgin tree in sync with the svn trunk on the git branch "trunk":

```
git checkout trunk
git svn rebase
```

To create a new, local branch called "whizbang-branch":

```
git checkout -b whizbang-branch
```

Do make commits to the local branch:

```
# hack on a bunch of files
git add bunch of files
git commit -m "modified a bunch of files"
# repeat this as necessary
```

Now, go back to the trunk branch and append the history of your branch to the git trunk branch, which will end up as the svn trunk:

```
git checkout trunk
git svn rebase # Ensure we have most recent svn
git rebase whizbang-branch # Append whizbang changes to trunk branch
git svn dcommit -n # Check that this will apply to svn
git svn dcommit # Actually apply to svn
```

Finally, you may want to continue working on your whizbang-branch, so rebase it to the new trunk:

```
git checkout whizbang-branch
git rebase trunk
```

How was this git mirror set up?

These are notes for those interested in mirroring a subversion repository on github. I pieced this together by lots of trial-and-error.

Step 1: Create a local mirror of the svn repository

```
rsync -avzP rsync://matplotlib.svn.sourceforge.net/svn/matplotlib/ matplotlib-svn-rsync/
```

Step 2: Import the svn history into a new git repository

```
#!/bin/bash
set -e

TARGET=mpl.git.fixed
GIT=/home/astraw/git/bin/git
TRUNKBRANCH=trunk
SVNBRANCHPREFIX="svn/"

rm -rf $TARGET
mkdir $TARGET
cd $TARGET

$GIT init
$GIT svn init --rewrite-root=https://matplotlib.svn.sourceforge.net/svnroot/matplotlib \
   --trunk=trunk/matplotlib --prefix=$SVNBRANCHPREFIX file:///mnt/workdisk/tmp/matplotlib-svn-rsync
$GIT svn fetch

# now, make master branch track ${SVNBRANCHPREFIX}trunk
$GIT checkout master -b tmp
$GIT branch -d master
$GIT checkout ${SVNBRANCHPREFIX}trunk -b $TRUNKBRANCH
$GIT branch -D tmp
$GIT svn rebase -l
```

Step 3: Upload the git repository to github

```
#!/bin/bash
set -e

TARGET=mpl.git.fixed
GIT=/home/astraw/git/bin/git
TRUNKBRANCH=trunk
SVNBRANCHPREFIX="svn/"

cd $TARGET

$GIT remote add github git@github.com:astraw/matplotlib.git
git push github $TRUNKBRANCH:master
```

25.2 Style guide

25.2.1 Importing and name spaces

For numpy, use:

```python
import numpy as np
a = np.array([1,2,3])
```

For masked arrays, use:

```python
import numpy.ma as ma
```

For matplotlib main module, use:

```python
import matplotlib as mpl
mpl.rcParams['xtick.major.pad'] = 6
```

For matplotlib modules (or any other modules), use:

```python
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:

```python
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
```

25.2.2 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 checking changes into svn.

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 svn 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)))
```

25.2.3 Keyword argument processing

Matplotlib makes extensive use of `**kwargs` for pass-through customizations from one function to another. A typical example is in `matplotlib.pylab.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...
```

25.3 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 automagically.

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 some manual hacks in this case, violating the "single entry point" requirement above – see the `artist.kwdocd['Patch']` setting in `matplotlib.patches`.

25.4 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 is 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
  ```

25.5 Writing examples

We have hundreds of examples in subdirectories of file:*matplotlib/examples* in the trunk, and these are automatically generated when the website it 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 provided through the sample_data svn directory, which can then be accessed using `matplotlib.cbook.get_sample_data()`. First get a copy of the repository and svn add your data:

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk/sample_data
cp ~/path/to/mydata.dat sample_data/
cd sample_data
svn add mydata.dat
svn commit -m 'added my data'
```

and 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 svn repo using urllib and updated when the revision number changes.

If you prefer just to get the full path to the file instead of an file object:

```
import matplotlib.cbook as cbook
datafile = cbook.get_sample_data('mydata.dat', asfileobj=False)
print 'datafile', datafile
```

25.6 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.)

25.6.1 Running the tests

Running the tests is simple. Make sure you have nose installed and type from within Python:

```
import matplotlib
matplotlib.test()
```

To run a single test from the command line, you can provide a dot-separated path to the module and function, eg. (this is assuming the test is installed):

```
nosetests matplotlib.tests.test_simplification:test_clipping
```

25.6.2 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.

25.6.3 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 respository 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.)

25.6.4 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.

25.6.5 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`.

25.7 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.

25.7.1 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.

CHAPTER

TWENTYSIX

DOCUMENTING MATPLOTLIB

26.1 Getting started

The documentation for matplotlib is generated from ReStructured Text using the Sphinx documentation generation tool. Sphinx-0.5 or later is required. You might still run into problems, so most developers work from the sphinx source repository (Mercurial based) because it is a rapidly evolving project:

```
hg clone http://bitbucket.org/birkenfeld/sphinx/
cd sphinx
python setup.py install
```

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/`.

26.2 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
```

26.3 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 consistant 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:

  $$\int_{-\infty}^{\infty}\frac{e^{i\phi}}{1+x^2\frac{e^{i\phi}}{1+x^2}} \tag{26.1}$$

- 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 [1] can be added using `[#]_`, followed later by:

  ```
  .. 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:

[1] For example.

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.

26.3.1 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.

26.4 Figures

26.4.1 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. Several figures will be saved with the same basename as the filename when the documentation is generated (low and high res PNGs, a PDF). Matplotlib includes a Sphinx extension (`sphinxext/plot_directive.py`) for generating the images from the python script and including either a png copy for html or a pdf for latex:

```
.. plot:: pyplots/pyplot_simple.py
   :include-source:
```

If the script produces multiple figures (through multiple calls to `pyplot.figure()`), each will be given a numbered file name and included.

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 SVN. Plots from the `examples` directory may be referenced through the symlink `mpl_examples` in the `doc` directory. eg.:

```
.. 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. `:include-source:` will present the contents of the file, marked up as source code.

26.4.2 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 svn. 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:
```

26.4.3 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 -*-
```

26.5 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)

26.6 Internal section references

To maximize internal consistency in section labeling and references, use hypen 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 necesssary, 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.

26.7 Section names, etc

For everything but top level chapters, please use `Upper lower` for section titles, eg `Possible hangups` rather than `Possible Hangups`

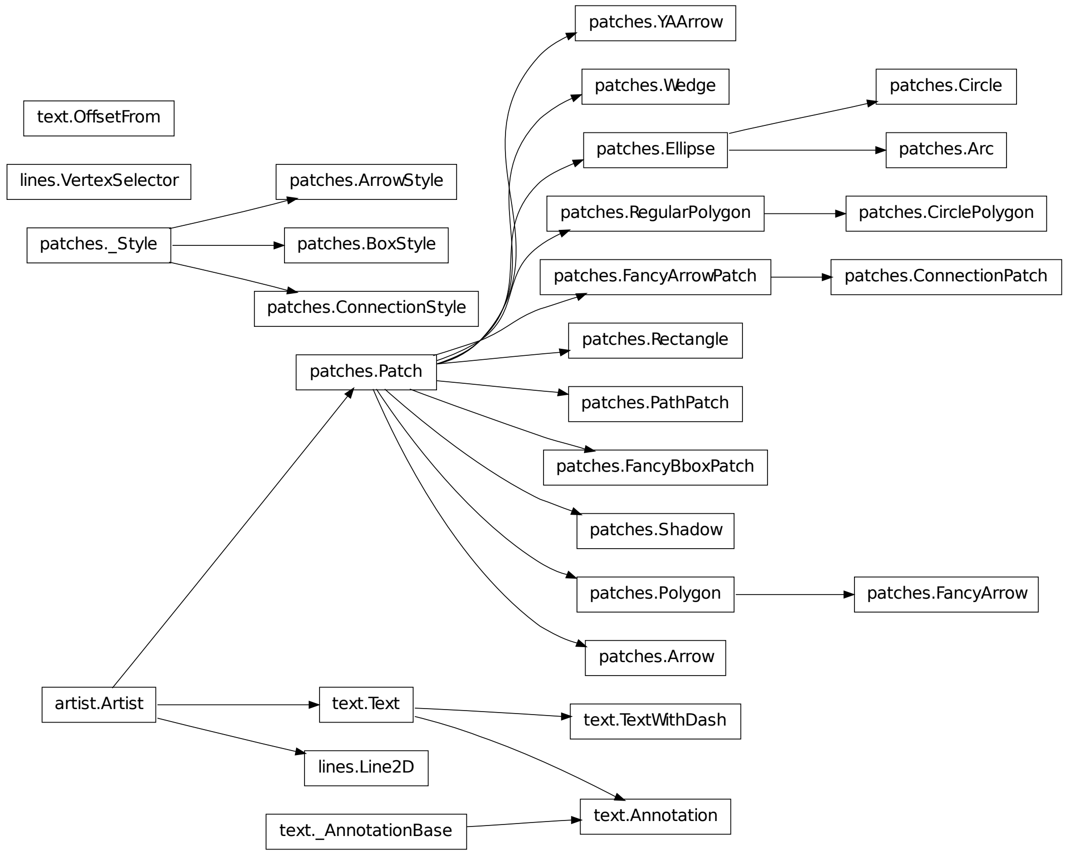
26.8 Inheritance diagrams

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
```



26.9 Emacs helpers

There is an emacs mode rst.el which automates many important ReST tasks like building and updateing 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
```

CHAPTER

TWENTYSEVEN

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

27.1 Testing

- Make sure `examples/tests/backend_driver.py` runs without errors and check the output of the PNG, PDF, PS and SVG backends
- Run `unit/memleak_hawaii3.py` and make sure there are no memory leaks
- Run `unit/nose_tests.py` and make sure all the unit tests are passing
- 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

27.2 Branching

Once all the tests are passing and you are ready to do a release, you need to create a release branch and configure svn-merge to use it; Michael Droettboom should probably handle this step, but if he is not available see instructions at *Setting up svnmerge*. On the bracnh, do any additional testing you want to do, and then build binaries and source distributions for testing as release candidates.

27.3 Packaging

- Make sure the `MANIFEST.in` us up to date and remove `MANIFEST` so it will be rebuilt by MANIFEST.in
- run svn-clean from in the mpl svn 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

27.4 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-candidat
```

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 with svn-merge; see *Using svnmerge*. When the release candidate is signed off on, build the final sdist, binaries and eggs, and upload them to the sourceforge release area.

27.5 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> svn-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 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"

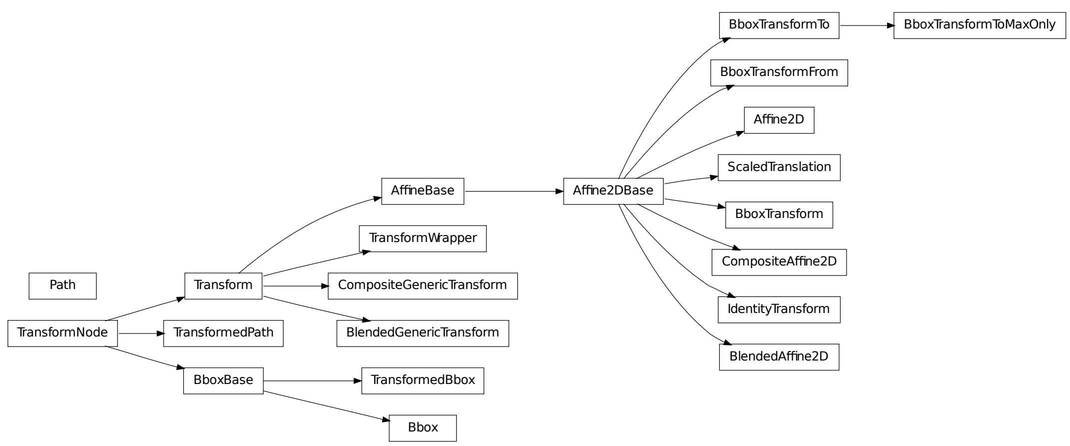
27.6 Announcing

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.

CHAPTER

TWENTYEIGHT

WORKING WITH TRANSFORMATIONS

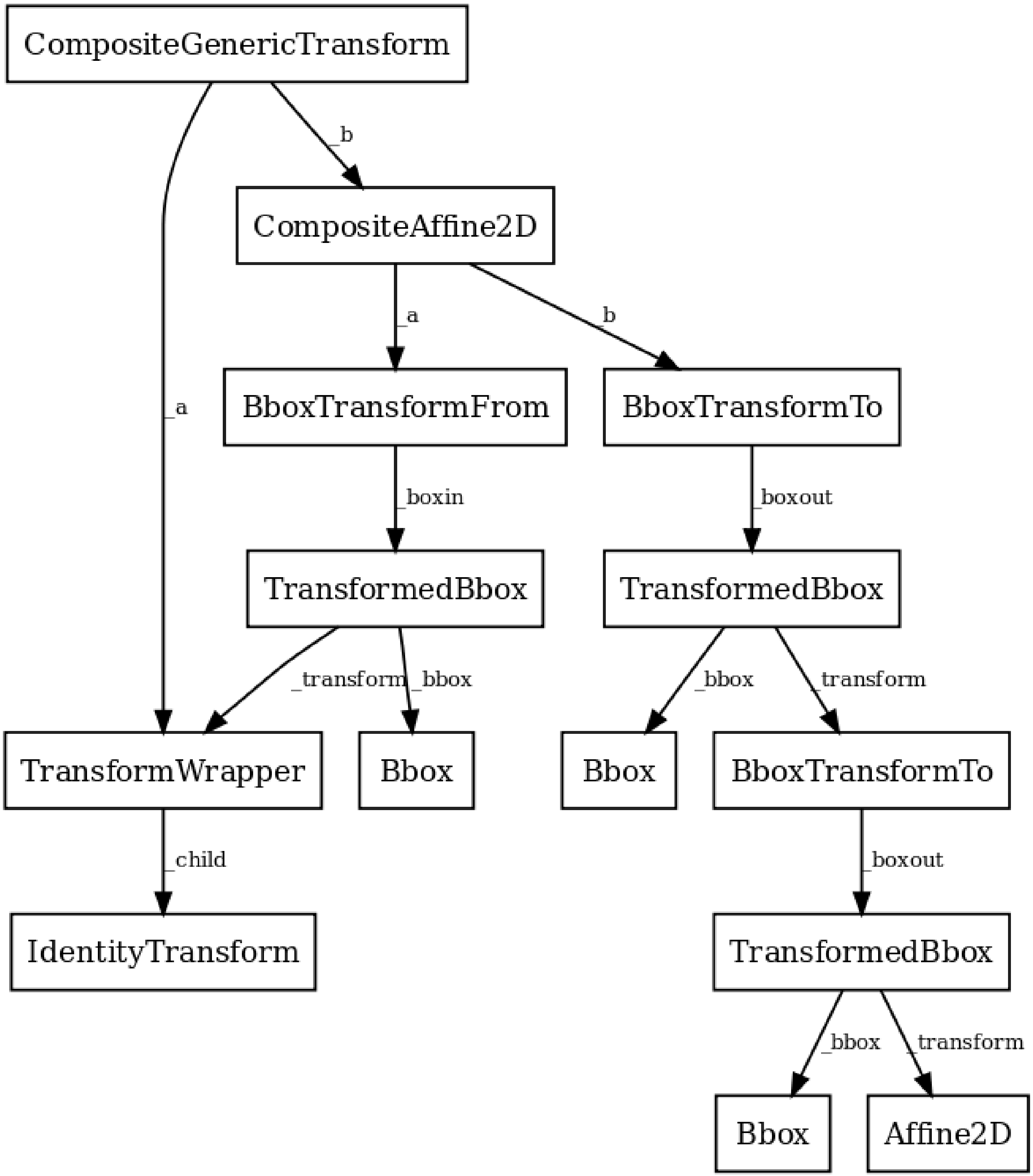


28.1 matplotlib.transforms

matplotlib includes a framework for arbitrary geometric transformations that is used 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 explicity.

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.splitx(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 mathplotlib.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 transformad 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.

CHAPTER

TWENTYNINE

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_xscale()`. 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.

29.1 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.

29.2 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.

29.3 API documentation

29.3.1 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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*).

***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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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]

29.3.2 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*)
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 ymax (for the radius maximum). The theta range is always fixed to (0, 2π).

get_matrix()
Get the underlying transformation matrix as a numpy array.

class **PolarTransform**(*axis=None*)
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_zoom`()
Return True if this axes support the zoom box

`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

`set_rgrids`(*radii, labels=None, angle=None, rpad=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.

rpad 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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function
`family` or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
`figure`	a `matplotlib.figure.Figure` instance

Table 29.1 – continued fro

fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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_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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color

Table 29.2 – continued fro

contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	any number

ACCEPTS: sequence of floats

CHAPTER

THIRTY

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 30.1 – 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 ouline 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 30.2 – continued from previous page

backend_wxagg		needs conversion
backends/tkagg		needs conversion
config/checkdep	Darren	needs conversion
config/cutils	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 30.2 – 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!

30.1 Reviewer notes

If you want to make notes for the authorwhen you have reviewed a submission, you can put them here. As the author cleans them up or addresses them, they should be removed.

30.1.1 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 readin ghte 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

The Matplotlib API

CHAPTER

THIRTYONE

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.

31.1 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 :class:'~matplotlib.collections.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,
                     linestyles, antialiaseds, urls)

# is now

draw_path_collection(self, gc, master_transform, paths, all_transforms,
                     offsets, offsetTrans, facecolors, edgecolors,
                     linewidths, linestyles, 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.

31.2 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.

31.3 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.fignum_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, *scatteryoffsets*, *fancybox* and *columnspacing* are added as keyword parameters.

Deprecated	New
pad	borderpad
labelsep	labelspacing
handlelen	handlelength
handlestextsep	handletextpad
axespad	borderaxespad

- 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.

31.4 Changes for 0.98.1

- Removed broken `matplotlib.axes3d` support and replaced it with a non-implemented error pointing to 0.91.x

31.5 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`)

31.5.1 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
Bbox.get_bounds()	transforms.Bbox.bounds
Bbox.width()	transforms.Bbox.width
Bbox.height()	transforms.Bbox.height
Bbox.intervalx().get_bounds()	transforms.Bbox.intervalx
Bbox.intervalx().set_bounds()	[Bbox.intervalx is now a property.]
Bbox.intervaly().get_bounds()	transforms.Bbox.intervaly
Bbox.intervaly().set_bounds()	[Bbox.intervaly is now a property.]
Bbox.xmin()	transforms.Bbox.x0 or transforms.Bbox.xmin [1]
Bbox.ymin()	transforms.Bbox.y0 or transforms.Bbox.ymin [1]
Bbox.xmax()	transforms.Bbox.x1 or transforms.Bbox.xmax [1]
Bbox.ymax()	transforms.Bbox.y1 or transforms.Bbox.ymax [1]
Bbox.overlaps(bboxes)	*Bbox.count_overlaps(bboxes)*
bbox_all(bboxes)	*Bbox.union(bboxes)* [transforms.Bbox.union() is a staticmethod.]
lbwh_to_bbox(l, b, w, h)	*Bbox.from_bounds(x0, y0, w, h)* [transforms.Bbox.from_bounds() is a staticmethod.]
inverse_transform_bbox(trans, bbox)	*Bbox.inverse_transformed(trans)*
Interval.contains_open(v)	*interval_contains_open(tuple, v)*
Interval.contains(v)	*interval_contains(tuple, v)*
identity_transform()	matplotlib.transforms.IdentityTransform
blend_xy_sep_transform(xtrans, ytrans)	*blended_transform_factory(xtrans, ytrans)*
scale_transform(xs, ys)	*Affine2D().scale(xs[, ys])*
get_bbox_transform(boxin, boxout)	*BboxTransform(boxin, boxout)* or *BboxTransformFrom(boxin)* or *BboxTransformTo(boxout)*
Transform.seq_xy_tup(points)	*Transform.transform(points)*
Transform.inverse_xy_tup(points)	*Transform.inverted().transform(points)*

[1] 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
Axes.get_position()	matplotlib.axes.Axes.get_position() [2]
Axes.set_position()	matplotlib.axes.Axes.set_position() [3]
Axes.toggle_log_lineary()	matplotlib.axes.Axes.set_yscale() [4]
Subplot class	removed.

The Polar class has moved to matplotlib.projections.polar.

matplotlib.artist

Old method	New method
Artist.set_clip_path(path)	*Artist.set_clip_path(path, transform)* [5]

matplotlib.collections

Old method	New method
linestyle	*linestyles* [6]

matplotlib.colors

Old method	New method
ColorConvertor.to_rgba_list(c)	*ColorConvertor.to_rgba_array(c)* [matplotlib.colors.ColorConvertor.to_rgba_array() returns an Nx4 Numpy array of RGBA color quadruples.]

matplotlib.contour

Old method	New method
Contour._segments	matplotlib.contour.Contour.get_paths'() [Returns a list of matplotlib.path.Path instances.]

[2] matplotlib.axes.Axes.get_position() used to return a list of points, now it returns a matplotlib.transforms.Bbox instance.

[3] matplotlib.axes.Axes.set_position() now accepts either four scalars or a matplotlib.transforms.Bbox instance.

[4] Since the recfactoring allows for more than two scale types ('log' or 'linear'), it no longer makes sense to have a toggle. *Axes.toggle_log_lineary()* has been removed.

[5] 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.

[6] 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
Figure.dpi.get() / Figure.dpi.set()	`matplotlib.figure.Figure.dpi` *(a property)*

matplotlib.patches

Old method	New method
Patch.get_verts()	`matplotlib.patches.Patch.get_path()` [Returns a `matplotlib.path.Path` instance]

matplotlib.backend_bases

Old method	New method
GraphicsContext.set_clip_rectangle(tuple)	*GraphicsContext.set_clip_rectangle(bbox)*
GraphicsContext.get_clip_path()	*GraphicsContext.get_clip_path()* [7]
GraphicsContext.set_clip_path()	*GraphicsContext.set_clip_path()* [8]

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*

[7] `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.

[8] `matplotlib.backend_bases.GraphicsContext.set_clip_path()` now only accepts a `matplotlib.transforms.TransformedPath` instance.

- *draw_lines*
- *draw_point*
- *draw_quad_mesh*
- *draw_poly_collection*
- *draw_polygon*
- *draw_rectangle*
- *draw_regpoly_collection*

31.6 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__`

31.7 Changes for 0.91.1

31.8 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 doesnt 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 edgecolor 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.

31.9 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 int he 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 returns 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/ttffont.cache before installing
```

31.10 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
```

31.11 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 explicitely 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.
```

31.12 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.
```

31.13 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 hof 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.
```

31.14 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.
```

31.15 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.
```

31.16 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)
```

31.17 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].
```

31.18 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
```

31.19 Changes for 0.73

```
- Removed deprecated ColormapJet and friends

- Removed all error handling from the verbose object

- figure num of zero is now allowed
```

31.20 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
```

31.21 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)
```

31.22 Changes for 0.70

```
MplEvent factored into a base class Event and derived classes
MouseEvent and KeyEvent

Removed definct set_measurement in wx toolbar
```

31.23 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.
```

31.24 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 (obligue, etc) or the rotation of the
text.  Use style and rotation instead.
```

31.25 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
```

31.26 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, evet)
```

31.27 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
```

31.28 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.
```

31.29 Changes for 0.54

31.29.1 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 propertes 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'$\rm{Histogram\ of\ IQ:}\ \mu=100,\ \sigma=15$')
```

31.29.2 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 or 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 gemoetry 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 eave it unchanged)

Transformations

The entire transformation architecture has been rewritten. Previously the x and y transformations where stored in the xaxis and yaxis insstances. 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 implemetations, 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 possibily nonlinear transformations of x and y. The 2 most frequently used transformations, data cordinates -> 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.

31.30 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 in now intialized 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.
```

31.31 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 frmo 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
```

31.32 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 intance 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

  * _matlab_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.
```

CHAPTER

THIRTYTWO

MATPLOTLIB CONFIGURATION

32.1 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 overridded 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®, 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 - the ones that were created at matplotlib load time.

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 callthis 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 supporess the warnings

CHAPTER

THIRTYTHREE

MATPLOTLIB AFM

33.1 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.

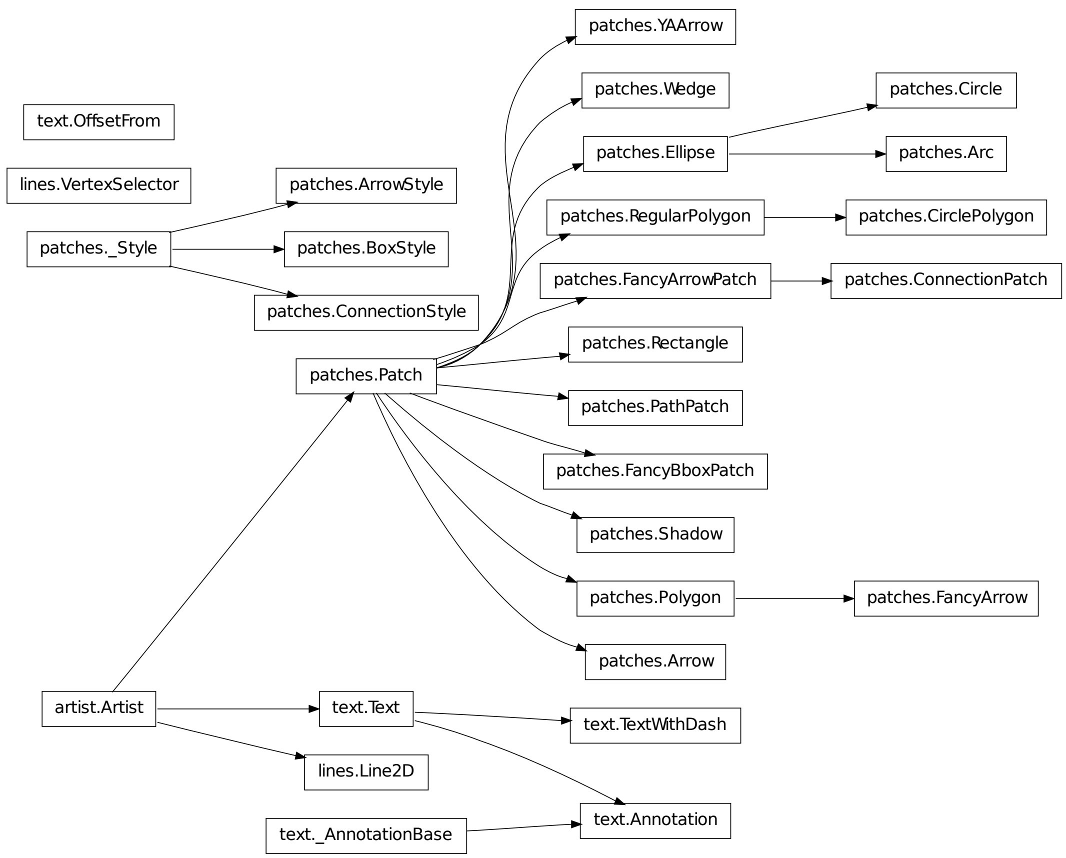
`parse_afm(fh)`
Parse the Adobe Font Metics file in file handle *fh*. Return value is a (*dhead*, *dcmetrics*, *dkernpairs*, *dcomposite*) tuple where *dhead* is a `_parse_header()` dict, *dcmetrics* is a

`_parse_composites()` dict, *dkernpairs* is a `_parse_kern_pairs()` dict (possibly {}), and *dcomposite* is a `_parse_composites()` dict (possibly {})

CHAPTER

THIRTYFOUR

MATPLOTLIB ARTISTS



34.1 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*)

pyplot signature: findobj(o=gcf(), match=None)

Recursively find all :class:matplotlib.artist.Artist instances contained in self.

match can be

- None: return all objects contained in artist (including artist)
- function with signature `boolean = match(artist)` used to filter matches
- class instance: eg Line2D. Only return artists of class type

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

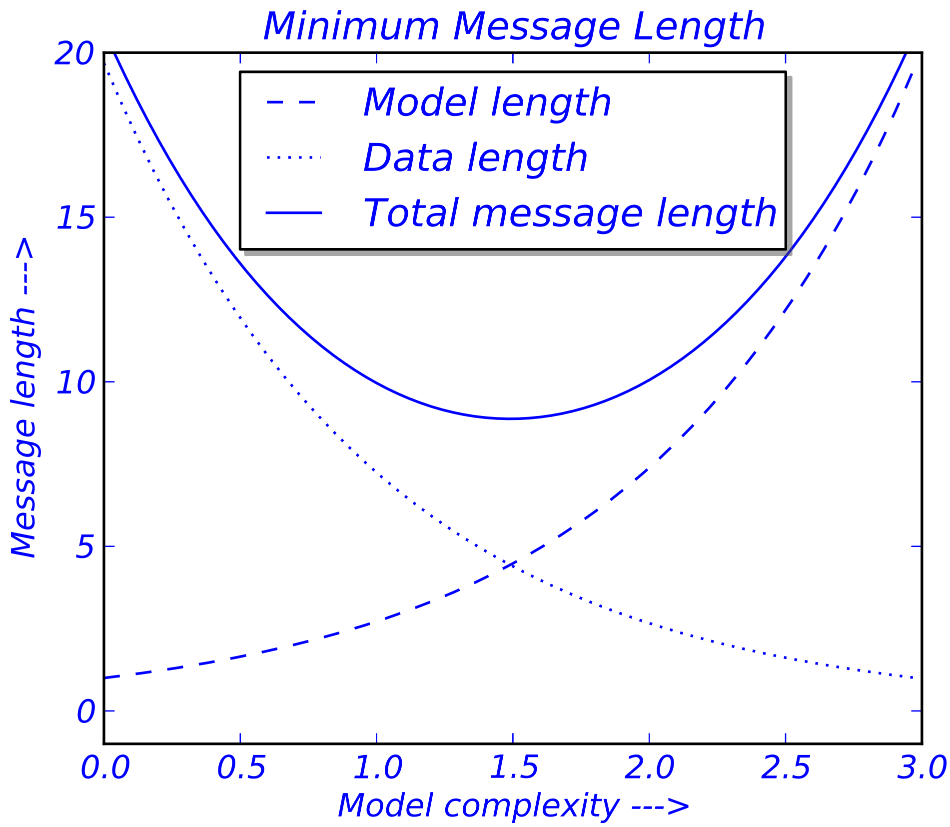
get_axes()
Return the `Axes` instance the artist resides in, or *None*

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 visiblity

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 visiblity.

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 it's 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 properies 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 properies 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
```

34.2 `matplotlib.legend`

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,

Return value is a sequence of text, line instances that make up the legend

class DraggableLegend(*legend, use_blit=False*)
Bases: `matplotlib.offsetbox.DraggableOffsetBox`

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, handletextpad=None, borderaxespad=None, columnspacing=None, ncol=1, mode=None, fancybox=None, shadow=None, title=None, bbox_to_anchor=None, bbox_transform=None, frameon=True*)
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 noramilzed coordinate values with respect its parent.

Return value is a sequence of text, line instances that make up the legend

- *parent* : the artist that contains the legend
- *handles* : a list of artists (lines, patches) to add to the legend
- *labels* : a list of strings to label the legend

Optional keyword arguments:

Keyword	Description
loc	a location code
prop	the font property
markerscale	the relative size of legend markers vs. original
numpoints	the number of points in the legend for line
scatterpoints	the number of points in the legend for scatter plot
scatteryoffsets	a list of yoffsets for scatter symbols in legend
frameon	if True, draw a frame (default is True)
fancybox	if True, draw a frame with a round fancybox. If None, use rc
shadow	if True, draw a shadow behind legend
ncol	number of columns
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
title	the legend title
bbox_to_anchor	the bbox that the legend will be anchored.
bbox_transform	the transform for the bbox. transAxes if None.

The pad and spacing parameters 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.

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*)
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.

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

get_frame()
return the Rectangle instance used to frame the legend

get_frame_on()
Get whether the legend box patch is drawn

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()
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.

set_frame_on(*b*)
Set whether the legend box patch is drawn

ACCEPTS: [*True* | *False*]

set_title(*title*)
set the legend title

34.3 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, markersize=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:

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td><code>agg_filter</code></td><td>unknown</td></tr>
<tr><td><code>alpha</code></td><td>float (0.0 transparent through 1.0 opaque)</td></tr>
<tr><td><code>animated</code></td><td>[True | False]</td></tr>
<tr><td><code>antialiased</code> or aa</td><td>[True | False]</td></tr>
<tr><td><code>axes</code></td><td>an <code>Axes</code> instance</td></tr>
<tr><td><code>clip_box</code></td><td>a <code>matplotlib.transforms.Bbox</code> instance</td></tr>
<tr><td><code>clip_on</code></td><td>[True | False]</td></tr>
<tr><td><code>clip_path</code></td><td>[(<code>Path</code>, <code>Transform</code>) | <code>Patch</code> | None]</td></tr>
<tr><td><code>color</code> or c</td><td>any matplotlib color</td></tr>
<tr><td><code>contains</code></td><td>a callable function</td></tr>
<tr><td><code>dash_capstyle</code></td><td>[’butt’ | ‘round’ | ‘projecting’]</td></tr>
<tr><td><code>dash_joinstyle</code></td><td>[’miter’ | ‘round’ | ‘bevel’]</td></tr>
<tr><td><code>dashes</code></td><td>sequence of on/off ink in points</td></tr>
<tr><td><code>data</code></td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td><code>drawstyle</code></td><td>[‘default’ | ‘steps’ | ‘steps-pre’ | ‘steps-mid’ | ‘steps-post’]</td></tr>
<tr><td><code>figure</code></td><td>a <code>matplotlib.figure.Figure</code> instance</td></tr>
<tr><td><code>fillstyle</code></td><td>[’full’ | ‘left’ | ‘right’ | ‘bottom’ | ‘top’]</td></tr>
<tr><td><code>gid</code></td><td>an id string</td></tr>
<tr><td><code>label</code></td><td>any string</td></tr>
<tr><td><code>linestyle</code> or ls</td><td>[<code>'-'</code> | <code>'--'</code> | <code>'-.'</code> | <code>':'</code> | <code>'None'</code> | <code>' '</code> | ”] and any drawstyle in combination with a</td></tr>
<tr><td><code>linewidth</code> or lw</td><td>float value in points</td></tr>
<tr><td><code>lod</code></td><td>[True | False]</td></tr>
<tr><td><code>marker</code></td><td>[<code>'+'</code> | <code>'*'</code> | <code>','</code> | <code>'.'</code> | <code>'1'</code> | <code>'2'</code> | <code>'3'</code> | <code>'4'</code> | <code>'<'</code> | <code>'>'</code> | <code>'D'</code> | <code>'H'</code> | <code>'^'</code> | <code>'_'</code> | <code>'d'</code> |</td></tr>
<tr><td><code>markeredgecolor</code> or mec</td><td>any matplotlib color</td></tr>
<tr><td><code>markeredgewidth</code> or mew</td><td>float value in points</td></tr>
<tr><td><code>markerfacecolor</code> or mfc</td><td>any matplotlib color</td></tr>
<tr><td><code>markerfacecoloralt</code> or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td><code>markersize</code> or ms</td><td>float</td></tr>
<tr><td><code>markevery</code></td><td>None | integer | (startind, stride)</td></tr>
<tr><td><code>picker</code></td><td>float distance in points or callable pick function <code>fn(artist, event)</code></td></tr>
<tr><td><code>pickradius</code></td><td>float distance in points</td></tr>
<tr><td><code>rasterized</code></td><td>[True | False | None]</td></tr>
<tr><td><code>snap</code></td><td>unknown</td></tr>
<tr><td><code>solid_capstyle</code></td><td>[’butt’ | ‘round’ | ‘projecting’]</td></tr>
<tr><td><code>solid_joinstyle</code></td><td>[’miter’ | ‘round’ | ‘bevel’]</td></tr>
<tr><td><code>transform</code></td><td>a <code>matplotlib.transforms.Transform</code> instance</td></tr>
<tr><td><code>url</code></td><td>a url string</td></tr>
<tr><td><code>visible</code></td><td>[True | False]</td></tr>
<tr><td><code>xdata</code></td><td>1D array</td></tr>
<tr><td><code>ydata</code></td><td>1D array</td></tr>
<tr><td><code>zorder</code></td><td>any number</td></tr>
</table>

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_markeredgecolor()

get_markeredgewidth()

get_markerfacecolor()

get_markerfacecoloralt()

get_markersize()

get_markevery()
return the markevery setting

get_mec()
alias for get_markeredgecolor

get_mew()
alias for get_markeredgewidth

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 drawin 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
`'.'`	point
`','`	pixel
`'o'`	circle
`'v'`	triangle_down
`'^'`	triangle_up
`'<'`	triangle_left
`'>'`	triangle_right
`'1'`	tri_down
`'2'`	tri_up
`'3'`	tri_left
`'4'`	tri_right
`'s'`	square
`'p'`	pentagon
`'*'`	star
`'h'`	hexagon1
`'H'`	hexagon2
`'+'`	plus
`'x'`	x

Continued on next page

Table 34.2 – continued from previous page

'D'	diamond
'd'	thin_diamond
'|'	vline
'_'	hline
TICKLEFT	tickleft
TICKRIGHT	tickright
TICKUP	tickup
TICKDOWN	tickdown
CARETLEFT	caretleft
CARETRIGHT	caretright
CARETUP	caretup
CARETDOWN	caretdown
'None'	nothing
' '	nothing
”	nothing
‘$...$’	render the string using mathtext

ACCEPTS: ['+' | '*' | ',' | '.' '1' | '2' | '3' | '4'
'<' | '>' | 'D' | 'H'
'^' | '_' | 'd' | 'h'
'o' | 'p' | 's' | 'v'
'x' | '|'
TICKUP | TICKDOWN | TICKLEFT | TICKRIGHT
CARETUP | CARETDOWN | CARETLEFT | CARETRIGHT
'None' | ' ' | ” | ’$...$’]

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 indicies.

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.

34.4 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	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 be 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
CurveFilledAB	`<|-|>`	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 an 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 witch 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 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

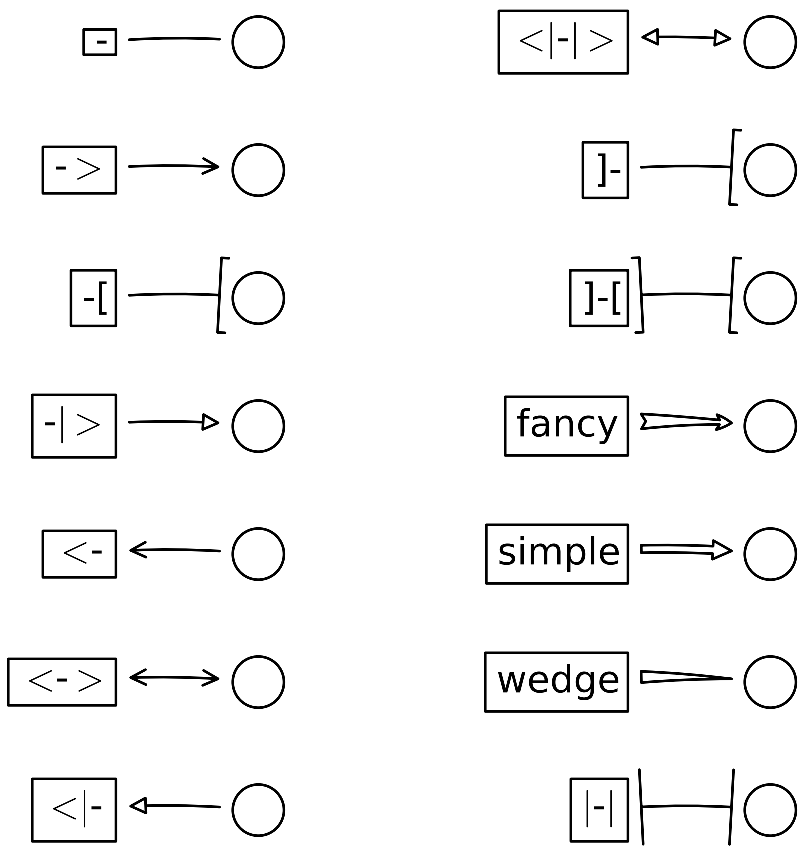
angleB angle between the bracket and the line

class `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


-
->
-[
-|>
<-
<->
<|-
<|-|>
]-
]-[
fancy
simple
wedge
|-|

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_with 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_with 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 wokrs 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:

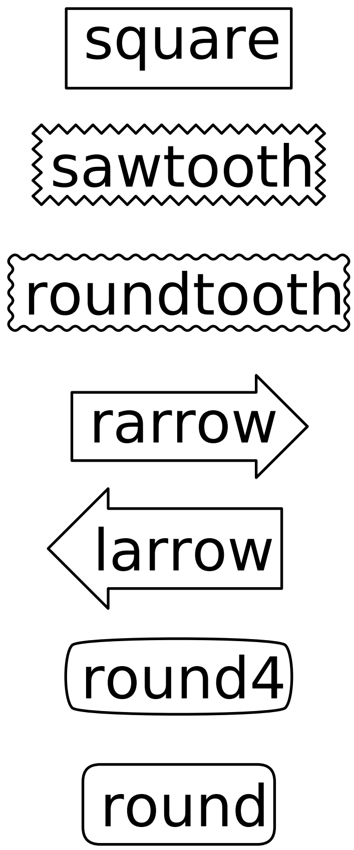
```
__call__(self, x0, y0, width, height, mutation_size, aspect_ratio=1.)
```

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.

class LArrow(*pad=0.29999999999999999*)

Bases: `matplotlib.patches._Base`

(left) Arrow Box


square
sawtooth
roundtooth
rarrow
larrow
round4
round

`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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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, **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 `matplotlib.patches.PathPatch`

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 *xy* value
'polar'	you can specify *theta*, *r* 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 picewise 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 contol 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* : anlge 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

class FancyArrowPatch(*posA=None, posB=None, path=None, arrowstyle='simple', arrow_transmuter=None, connectionstyle='arc3', connector=None, patchA=None, patchB=None, shrinkA=2.0, shrinkB=2.0, mutation_scale=1.0, mutation_aspect=None, **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.

<table>
<tr><th>Class</th><th>Name</th><th>Attrs</th></tr>
<tr><td>Curve</td><td><code>-</code></td><td>None</td></tr>
<tr><td>CurveB</td><td><code>-></code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>BracketB</td><td><code>-[</code></td><td>widthB=1.0,lengthB=0.2,angleB=None</td></tr>
<tr><td>CurveFilledB</td><td><code>-|></code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>CurveA</td><td><code><-</code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>CurveAB</td><td><code><-></code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>CurveFilledA</td><td><code><|-</code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>Curve-FilledAB</td><td><code><|-|></code></td><td>head_length=0.4,head_width=0.2</td></tr>
<tr><td>BracketA</td><td><code>]-</code></td><td>widthA=1.0,lengthA=0.2,angleA=None</td></tr>
<tr><td>BracketAB</td><td><code>]-[</code></td><td>widthA=1.0,lengthA=0.2,angleA=None,widthB=1.0,lengthB=0.2,angleB=None</td></tr>
<tr><td>Fancy</td><td><code>fancy</code></td><td>head_length=0.4,head_width=0.4,tail_width=0.4</td></tr>
<tr><td>Simple</td><td><code>simple</code></td><td>head_length=0.5,head_width=0.5,tail_width=0.2</td></tr>
<tr><td>Wedge</td><td><code>wedge</code></td><td>tail_width=0.3,shrink_factor=0.5</td></tr>
<tr><td>BarAB</td><td><code>|-|</code></td><td>widthA=1.0,angleA=None,widthB=1.0,angleB=None</td></tr>
</table>

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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

draw(*renderer*)

get_arrowstyle()
Return the arrowstyle object

get_connectionstyle()
Return the ConnectionStyle instance

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() medthod to retrieve the arrow path in the disaply 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 probided 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_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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	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

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td>agg_filter</td><td>unknown</td></tr>
<tr><td>alpha</td><td>float or None</td></tr>
<tr><td>animated</td><td>[True | False]</td></tr>
<tr><td>antialiased or aa</td><td>[True | False] or None for default</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color</td><td>matplotlib color spec</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>edgecolor or ec</td><td>mpl color spec, or None for default, or ‘none’ for no color</td></tr>
<tr><td>facecolor or fc</td><td>mpl color spec, or None for default, or ‘none’ for no color</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fill</td><td>[True | False]</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>hatch</td><td>[‘/’ | ‘\’ | ‘|’ | ‘-‘ | ‘+’ | ‘x’ | ‘o’ | ‘O’ | ‘.’ | ‘*’]</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>[’solid’ | ‘dashed’ | ‘dashdot’ | ‘dotted’]</td></tr>
<tr><td>linewidth or lw</td><td>float or None for default</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>path_effects</td><td>unknown</td></tr>
<tr><td>picker</td><td>[None|float|boolean|callable]</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>transform</td><td>Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
<tr><td>zorder</td><td>any number</td></tr>
</table>

contains(*mouseevent*)
Test whether the mouse event occurred in the patch.

Returns T/F, {}

contains_point(*point*)
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*.

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 tranparency 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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 have the same color as the face, but darkened.

kwargs are

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td>agg_filter</td><td>unknown</td></tr>
<tr><td>alpha</td><td>float or None</td></tr>
<tr><td>animated</td><td>[True | False]</td></tr>
<tr><td>antialiased or aa</td><td>[True | False] or None for default</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color</td><td>matplotlib color spec</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>edgecolor or ec</td><td>mpl color spec, or None for default, or ‘none’ for no color</td></tr>
<tr><td>facecolor or fc</td><td>mpl color spec, or None for default, or ‘none’ for no color</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fill</td><td>[True | False]</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>hatch</td><td>[‘/’ | ‘\’ | ‘|’ | ‘-‘ | ‘+’ | ‘x’ | ‘o’ | ‘O’ | ‘.’ | ‘*’]</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>[’solid’ | ‘dashed’ | ‘dashdot’ | ‘dotted’]</td></tr>
<tr><td>linewidth or lw</td><td>float or None for default</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>path_effects</td><td>unknown</td></tr>
<tr><td>picker</td><td>[None|float|boolean|callable]</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>transform</td><td>Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
<tr><td>zorder</td><td>any number</td></tr>
</table>

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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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.

34.5 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 *d* is the distance between the text and annotated point, shrink will shorten the arrow so the tip and base are shink percent of the distance *d* away from the endpoints. ie, `shrink=0.05 is 5%`
?	any key for `matplotlib.patches.polygon`

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 `matplotlib.patches.PathPatch`

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 *xy* value
'polar'	you can specify *theta*, *r* 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 contols 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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function

Table 34.3 – continued fro

family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.

Table 34.4 – continued fror

transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 bu 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 alignement 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.

CHAPTER

THIRTYFIVE

MATPLOTLIB AXES

35.1 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*maxlags+1 lag vector
- *c* is the 2*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 $2imes\text{len}(x) - 1$ lags.

The return value is a tuple (*lags*, *c*, *linecol*, *b*) where

- *linecol* is the `LineCollection`
- *b* is the *x*-axis.

See Also:

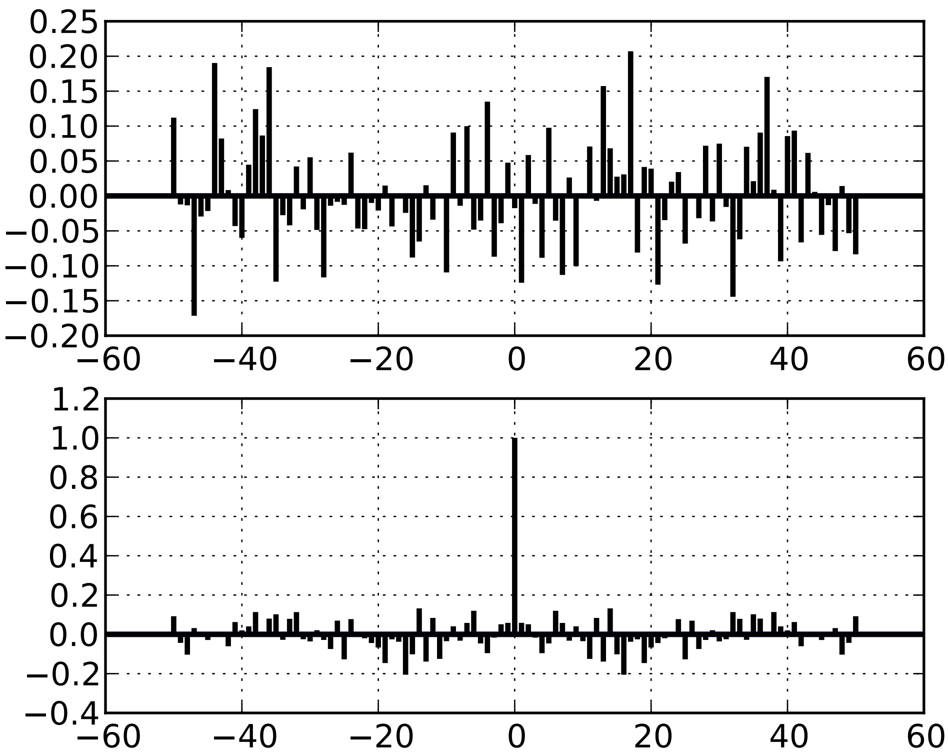
`plot()` or `vlines()`

For documentation on valid kwargs.

Example:

`xcorr()` above, and `acorr()` below.

Example:



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_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 *d* is the distance between the text and annotated point, shrink will shorten the arrow so the tip and base are shink percent of the distance *d* away from the endpoints. ie, shrink=0.05 is 5%
?	any key for matplotlib.patches.polygon

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 `matplotlib.patches.PathPatch`

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 *xy* value
'polar'	you can specify *theta*, *r* 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.

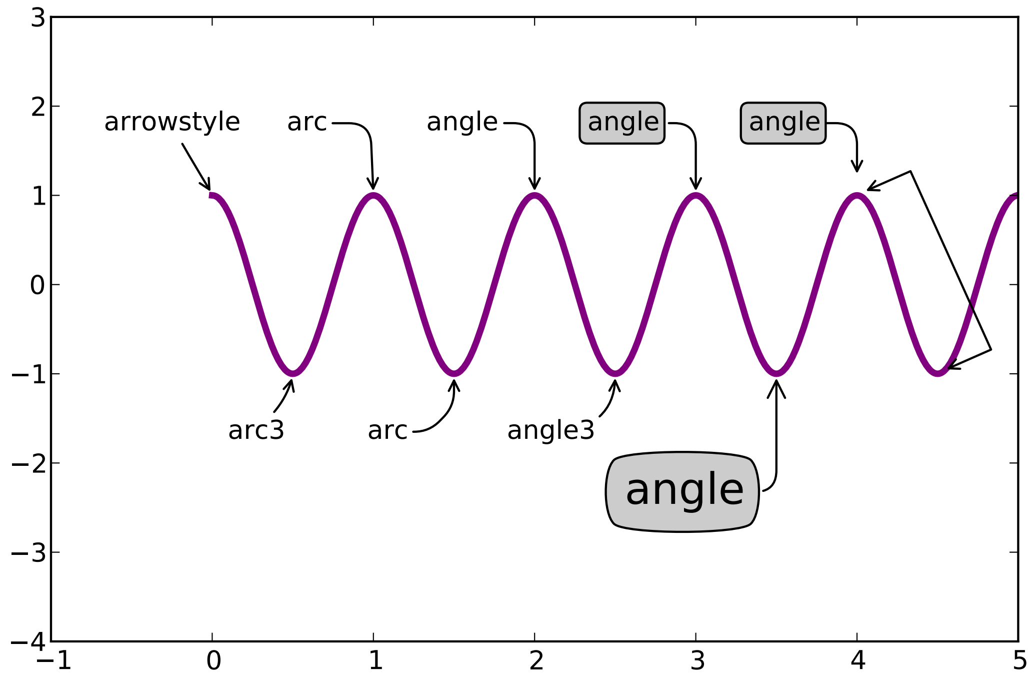
The *annotation_clip* attribute contols the visibility of the annotation when it goes outside the axes area. If True, the annotation will only be drawn when the *xy* is inside the axes. If False, the annotation will always be drawn regardless of its position. The default is *None*, which behave as True only if *xycoords* is"data".

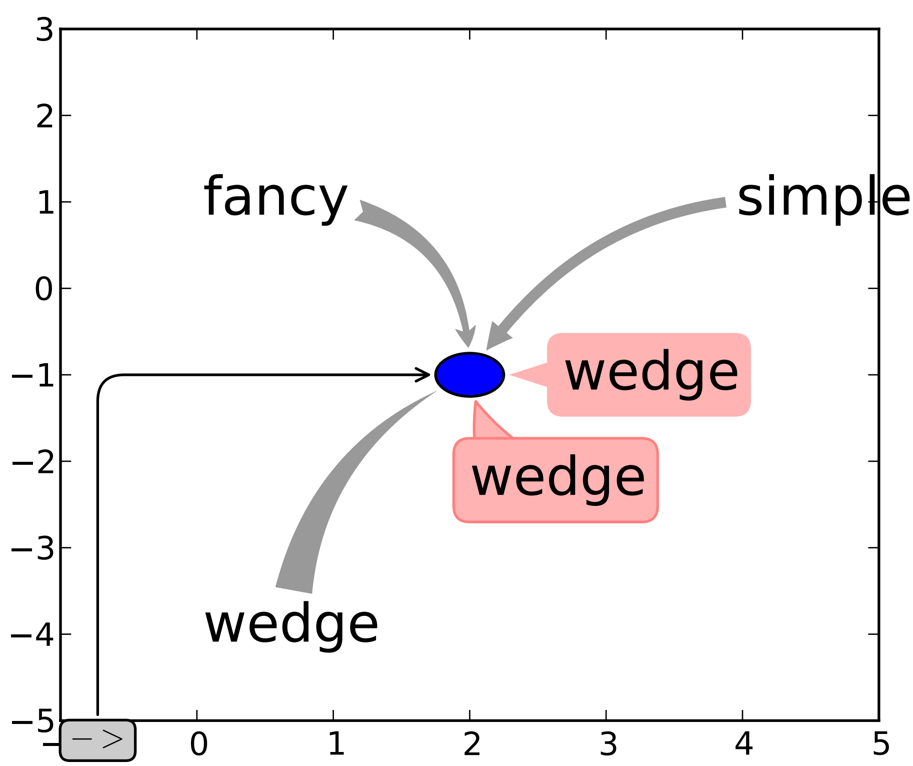
Additional kwargs are Text properties:

Property	Description
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	any number

apply_aspect(*position=None*)

Use `_aspect()` and `_adjustable()` to modify the axes box or the view limits.


arrowstyle
arc
angle
angle
angle
arc3
arc
angle3
angle
3
2
1
0
−1
−2
−3
−4
−1
0
1
2
3
4
5


fancy
simple
wedge
wedge
wedge
−>
3
2
1
0
−1
−2
−3
−4
−5
0
1
2
3
4
5

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:

Property	Description
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

Example:

Exception occurred rendering plot.

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.

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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]

color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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)
```

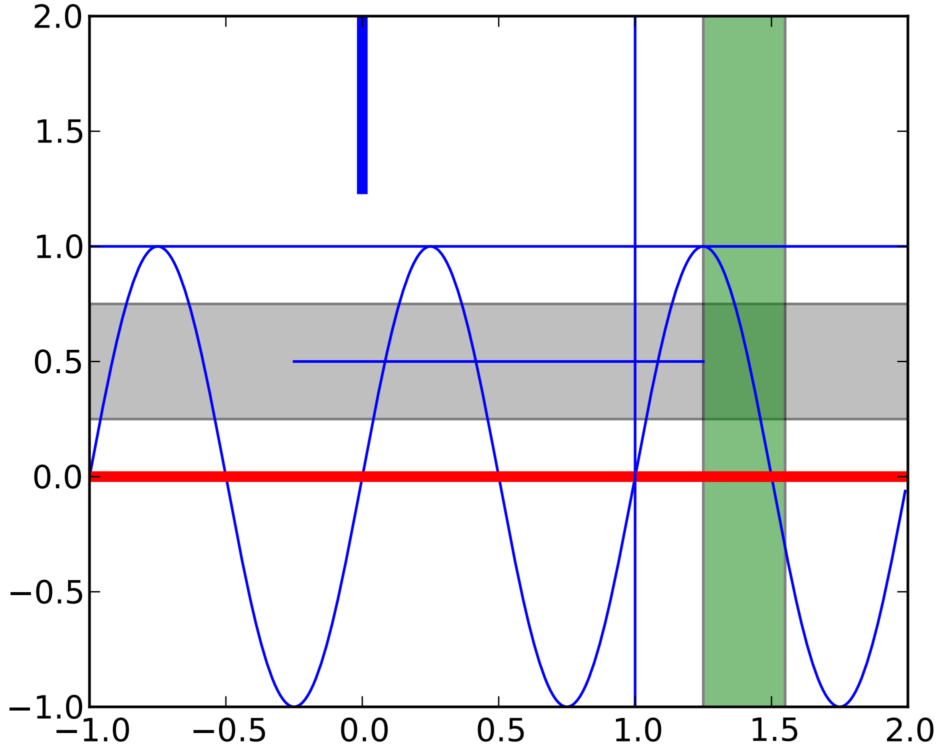
Valid kwargs are `Polygon` properties:

Property	Description
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	any number

Example:

axis(**v*, ***kwargs*)

Convenience method for manipulating the x and y view limits and the aspect ratio of the plot.



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':

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td>agg_filter</td><td>unknown</td></tr>
<tr><td>alpha</td><td>float (0.0 transparent through 1.0 opaque)</td></tr>
<tr><td>animated</td><td>[True | False]</td></tr>
<tr><td>antialiased or aa</td><td>[True | False]</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
</table>

visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
left	the x coordinates of the left sides of the bars
height	the heights of the bars

Optional keyword arguments:

Keyword	Description
width	the widths of the bars
bottom	the y coordinates of the bottom edges of the bars
color	the colors of the bars
edgecolor	the colors of the bar edges
linewidth	width of bar edges; None means use default linewidth; 0 means don't draw edges.
xerr	if not None, will be used to generate errorbars on the bar chart
yerr	if not None, will be used to generate errorbars on the bar chart
ecolor	specifies the color of any errorbar
capsize	(default 3) determines the length in points of the error bar caps
error_kw	dictionary of kwargs to be passed to errorbar method. *ecolor* and *capsize* may be specified here rather than as independent kwargs.
align	'edge' (default) | 'center'
orientation	'vertical' | 'horizontal'
log	[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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

Example: A stacked bar chart.

barbs(**args*, ***kw*)

Plot a 2-D field of barbs.

call signatures:

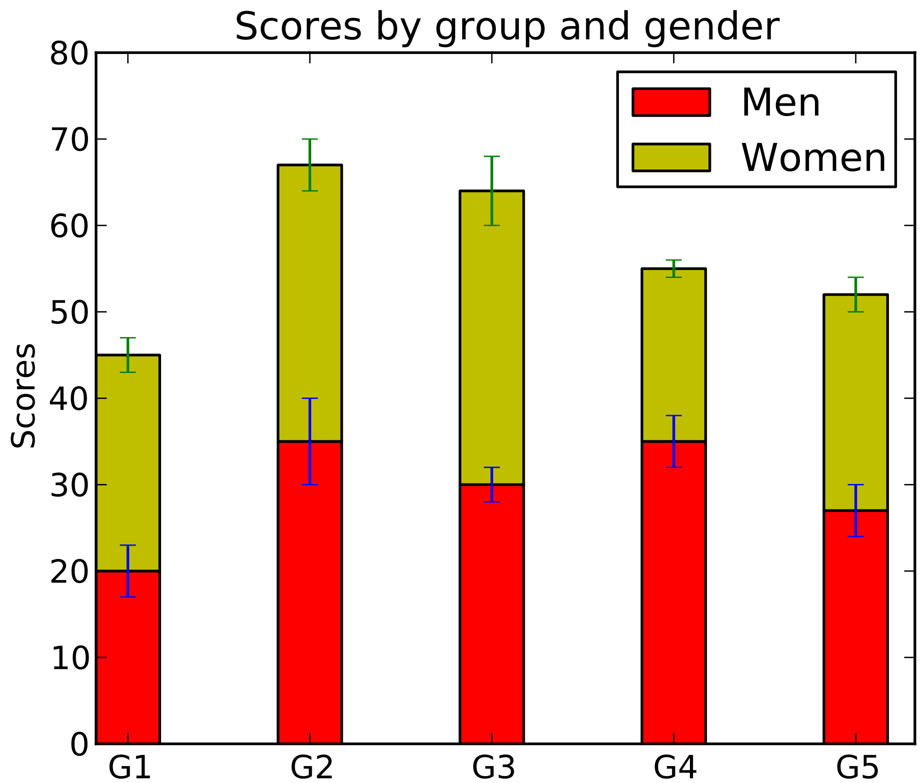
```
barb(U, V, **kw)
barb(U, V, C, **kw)
barb(X, Y, U, V, **kw)
barb(X, Y, U, V, C, **kw)
```

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:

```
:      /\    \
:     /  \    \
:    /    \    \    \
:   /      \    \    \
:  ------------------------------
```

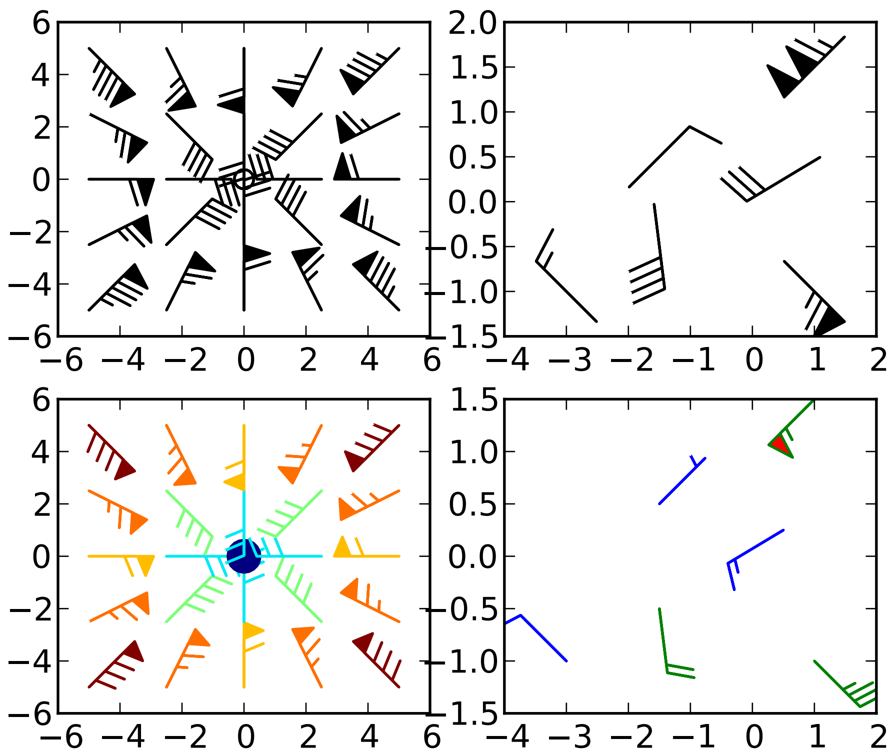
The largest increment is given by a triangle (or "flag"). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]
`pickradius`	unknown
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`urls`	unknown
`visible`	[True | False]
`zorder`	any number

Example:

barh(*bottom, width, height=0.80000000000000004, left=None, **kwargs*)
call signature:




```
barh(bottom, width, height=0.8, left=0, **kwargs)
```

Make a horizontal bar plot with rectangles bounded by:

$$\boldsymbol{left, left + width, bottom, bottom + height} \quad \text{(left, right, bottom and top edges)}$$

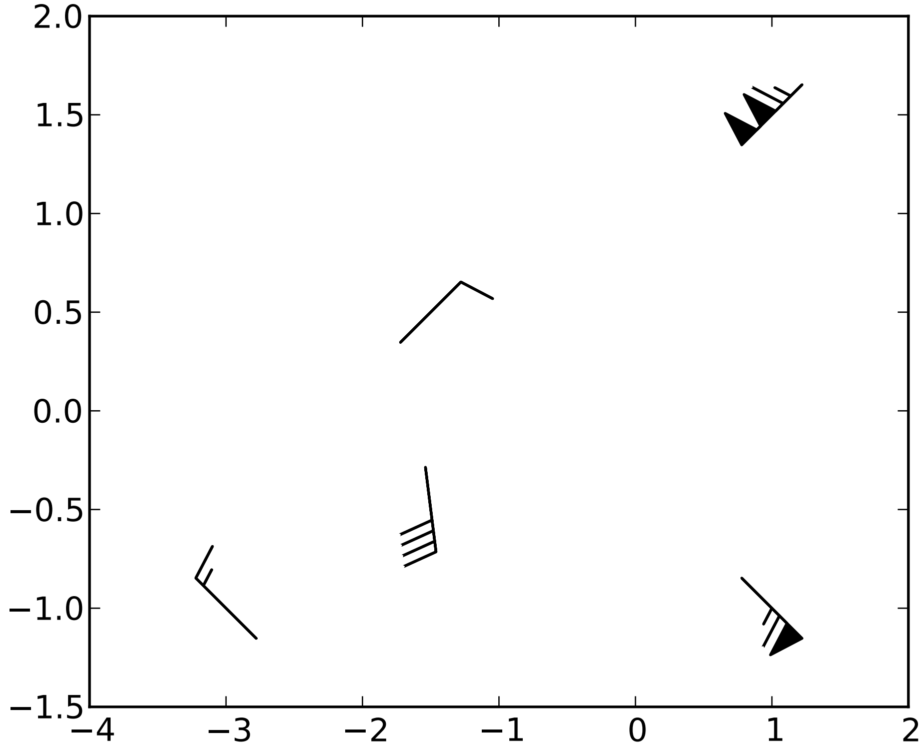
bottom, *width*, *height*, and *left* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

Argument	Description
bottom	the vertical positions of the bottom edges of the bars
width	the lengths of the bars

Optional keyword arguments:



Keyword	Description
height	the heights (thicknesses) of the bars
left	the x coordinates of the left edges of the bars
color	the colors of the bars
edgecolor	the colors of the bar edges
linewidth	width of bar edges; None means use default linewidth; 0 means don't draw edges.
xerr	if not None, will be used to generate errorbars on the bar chart
yerr	if not None, will be used to generate errorbars on the bar chart
ecolor	specifies the color of any errorbar
capsize	(default 3) determines the length in points of the error bar caps
align	'edge' (default) | 'center'
log	[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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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 it's 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
xranges	sequence of (*xmin*, *xwidth*)
yrange	sequence of (*ymin*, *ywidth*)

kwargs are `matplotlib.collections.BrokenBarHCollection` properties:

Property	Description
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
	Continued on next page

Table 35.5 – continued from previous page

clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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_zoom()

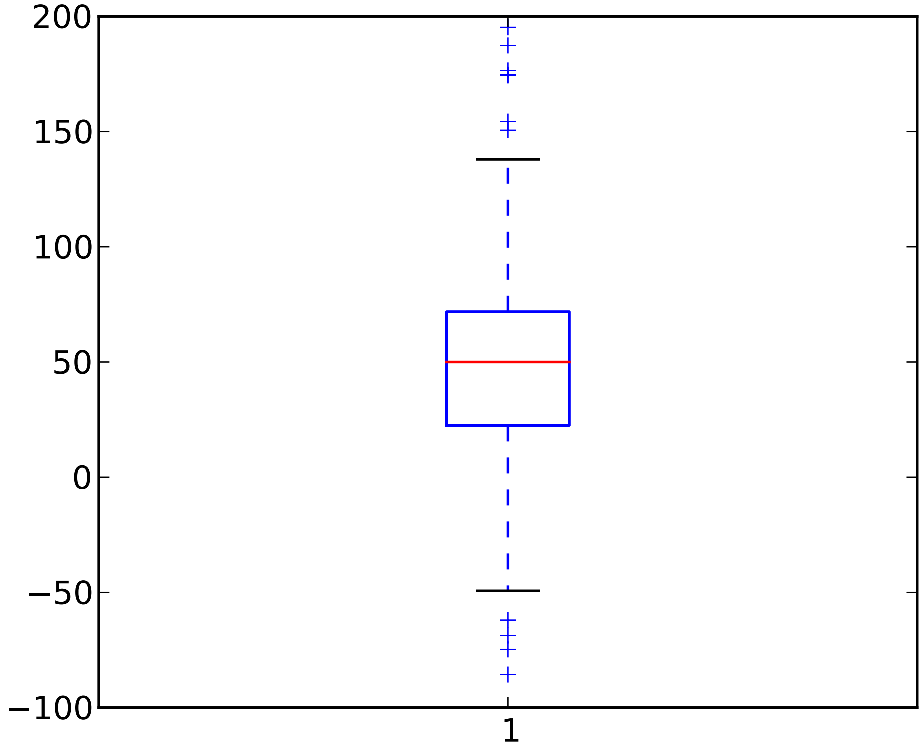
Return *True* if this axes support the zoom box

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*.

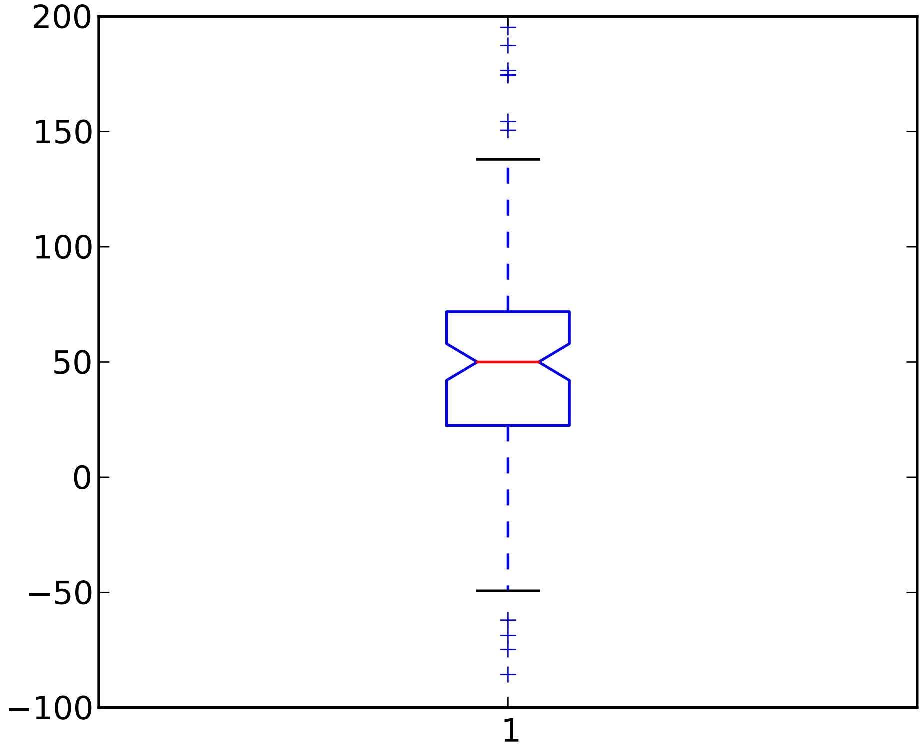
Optional keyword arguments:

***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.

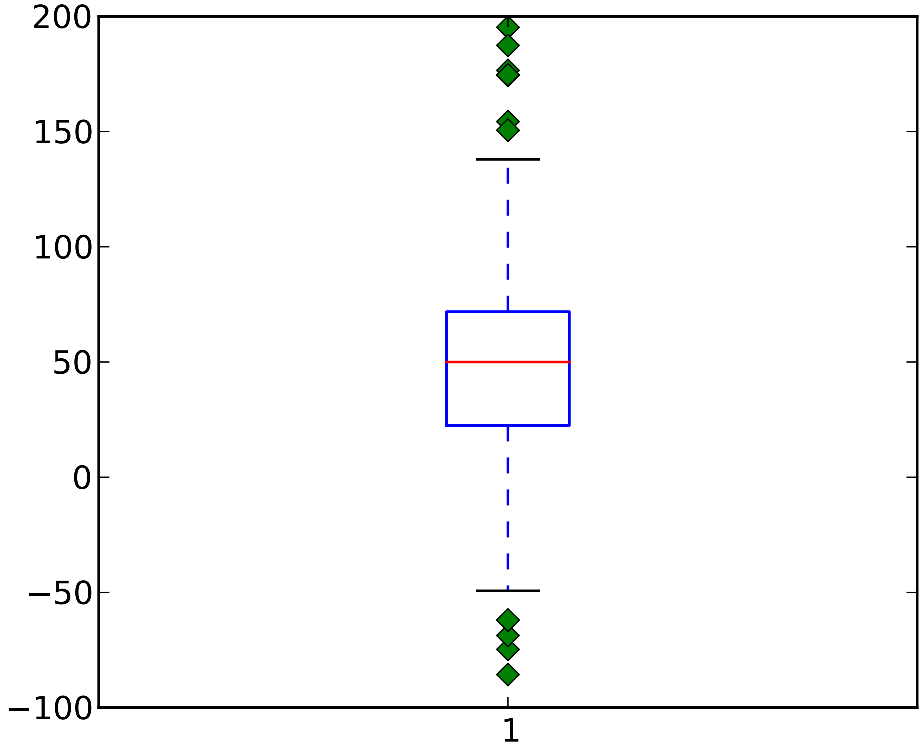
fmt: a format string for the label. Default is '%1.3f' Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., fmt[level]=string)

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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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:

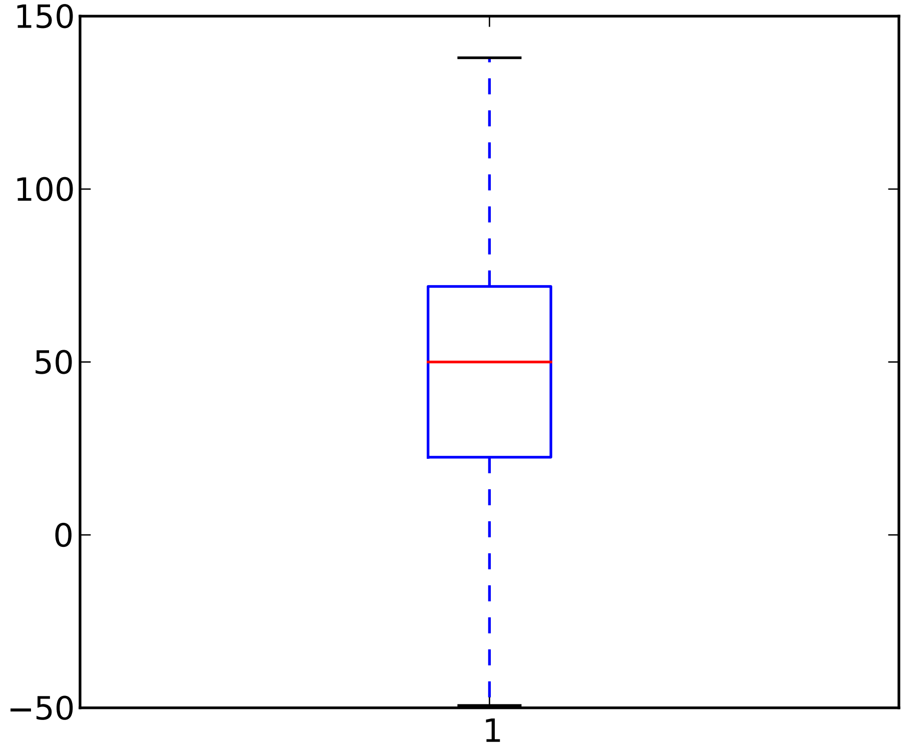
$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \tag{35.1}$$

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.

***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 is it a function. The `pylab` module defines



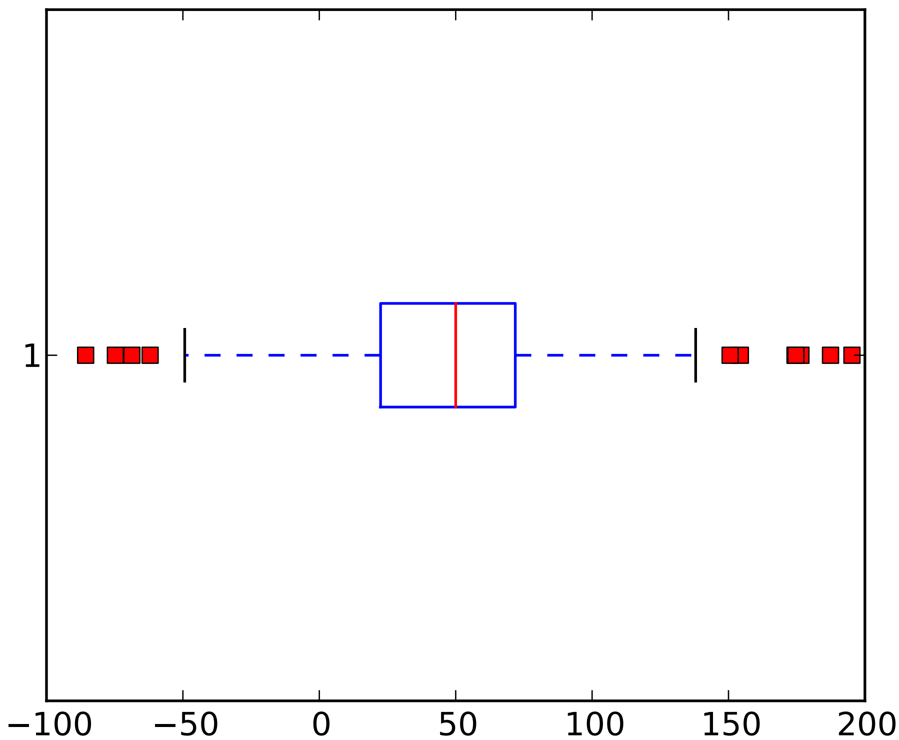
detrend_none(), detrend_mean(), and detrend_linear(), but you can use a custom function as well.

***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 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:

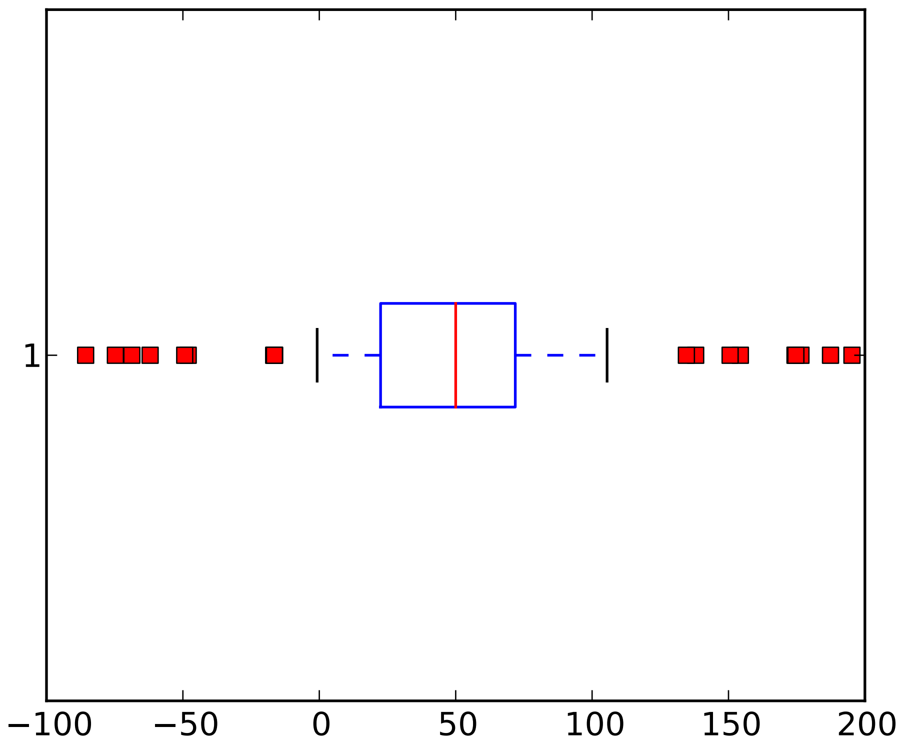
Property	Description
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]

<table>
<tr><td>antialiased or aa</td><td>[True | False]</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | ''] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
<tr><td>xdata</td><td>1D array</td></tr>
<tr><td>ydata</td><td>1D array</td></tr>
<tr><td>zorder</td><td>any number</td></tr>
</table>

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 is returned - you can use this with disconnect to disconnect from the axes event

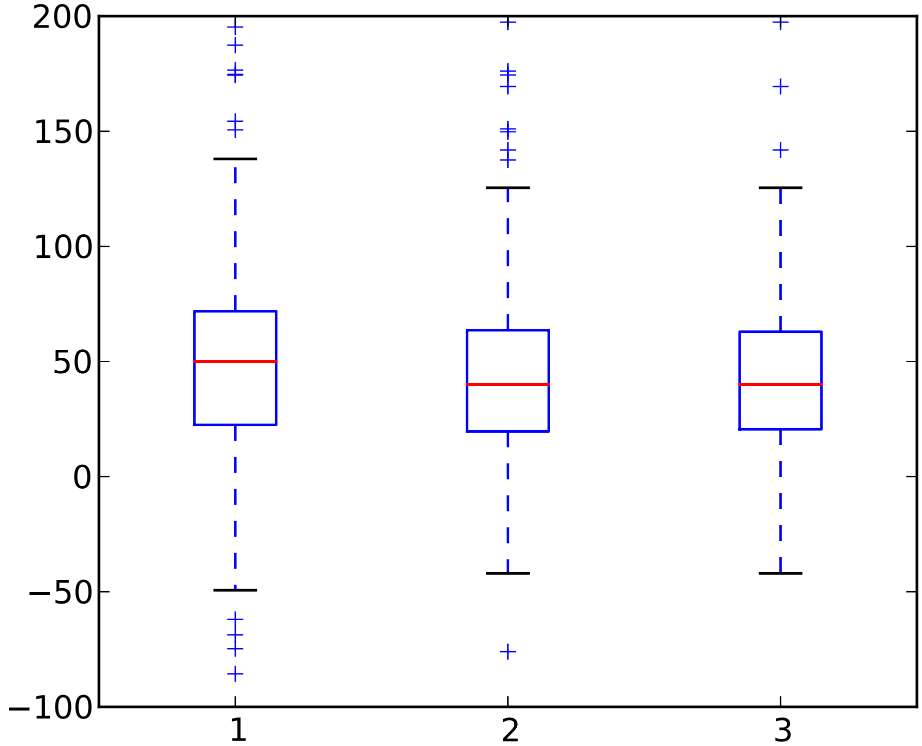
contains(*mouseevent*)
Test whether the mouse event occured in the axes.

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)
```

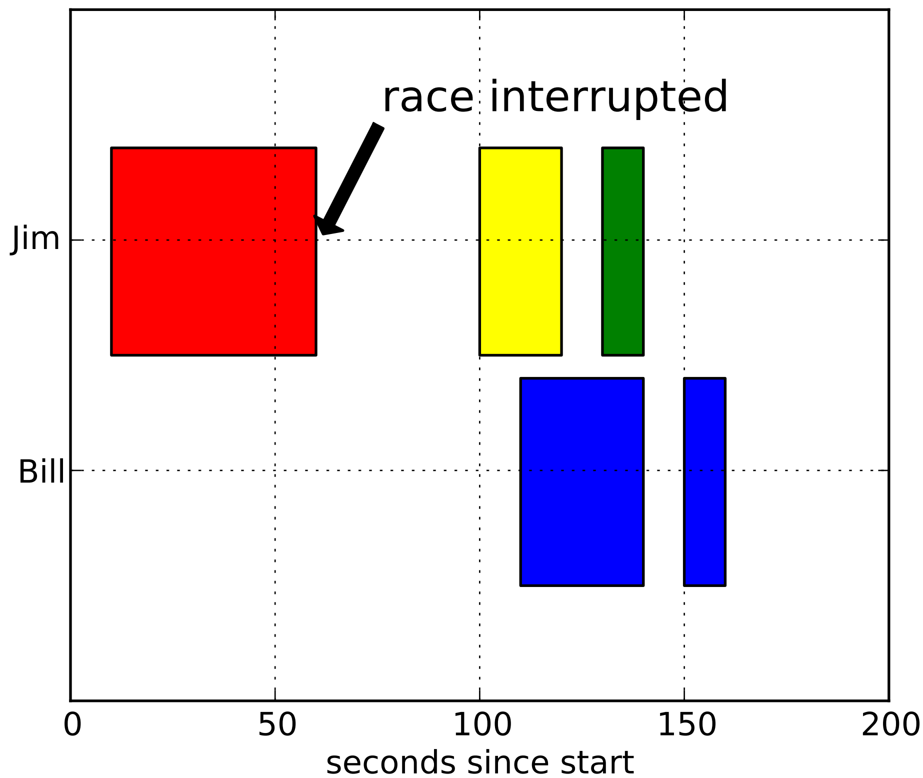
contour *N* automatically-chosen levels.

```
contour(Z,V)
contour(X,Y,Z,V)
```

draw contour lines at the values specified in sequence *V*

```
contourf(..., V)
```

fill the (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, *Y*, and *Z* must be arrays with the same dimensions.

Z may be a masked array, but filled contouring may not handle internal masked regions correctly.

`C = contour(...)` returns a `QuadContourSet` object.

Optional keyword arguments:

***colors*: [None | string | (mpl_colors)]** If *None*, the colormap specified by cmap will be used.

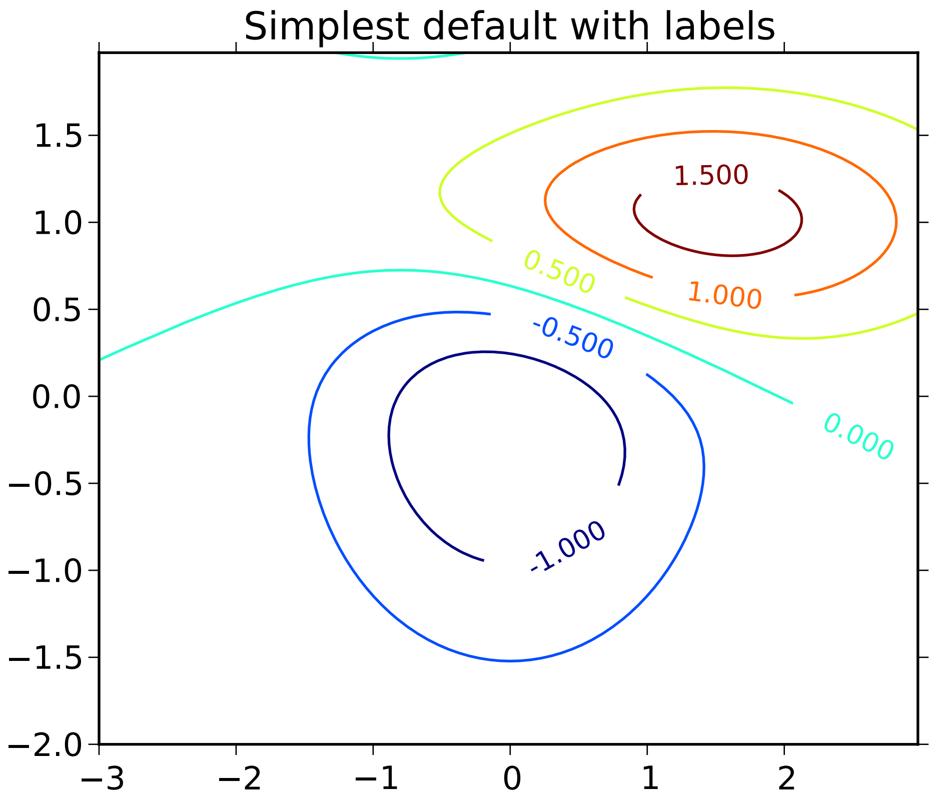
If a string, like 'r' or 'red', all levels will be plotted in this color.

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 scal-



ing 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.

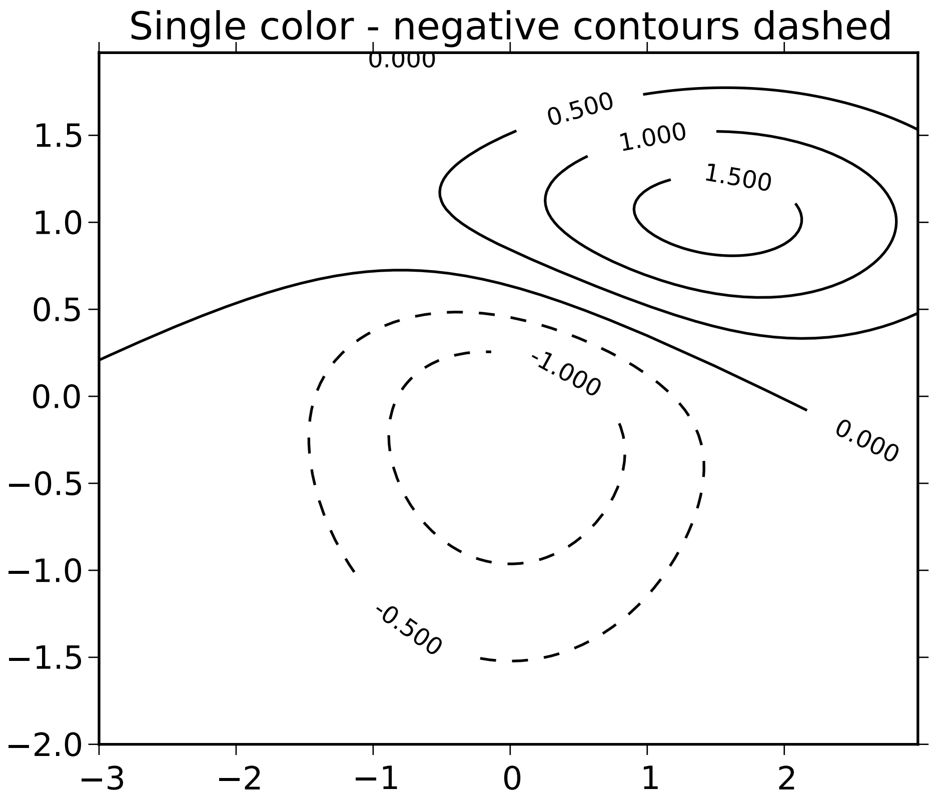
This keyword is not active if *X* and *Y* are specified in the call to contour.

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`.

contour-only keyword arguments:

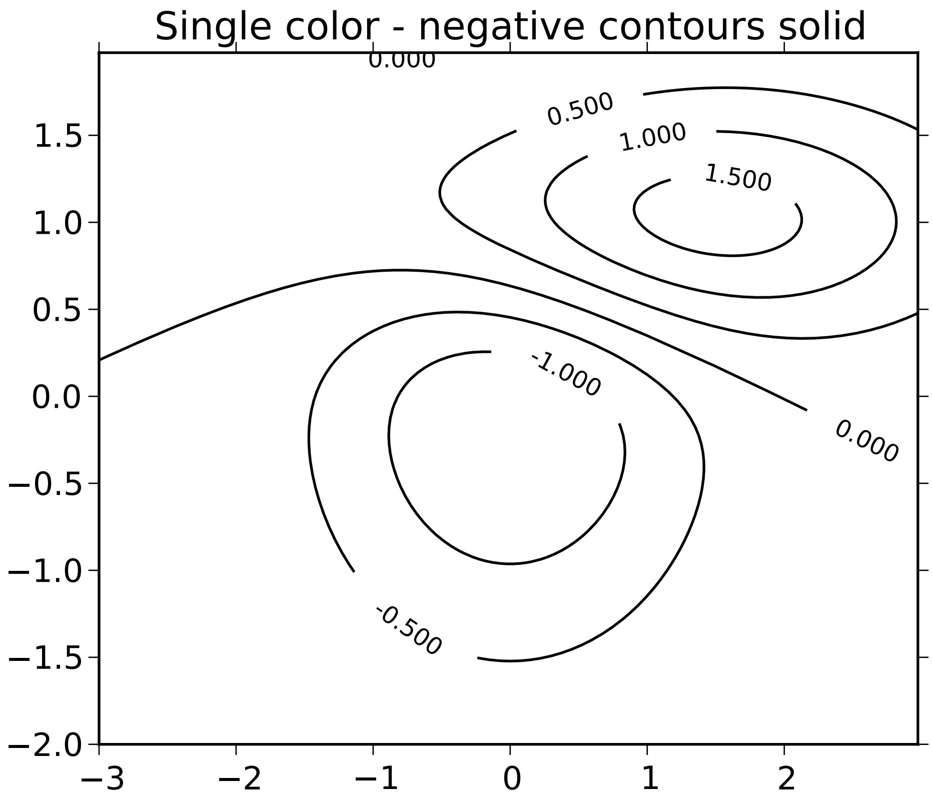
***linewidths*: [None | number | tuple of numbers]** If *linewidths* is *None*, the default width in `lines.linewidth` in `matplotlibrc` is used.

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:

***antialiased*: [True | False]** enable antialiasing

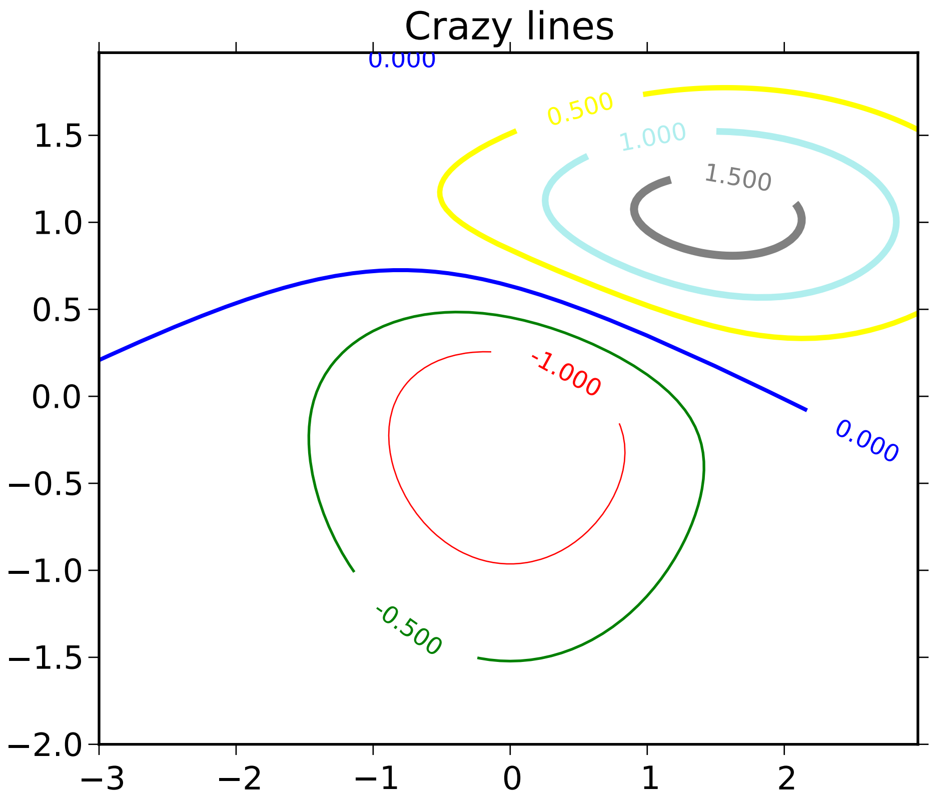
***nchunk*: [0 | integer]** If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *antialiased* is *False*.

Note: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

```
z1 < z <= 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)
```

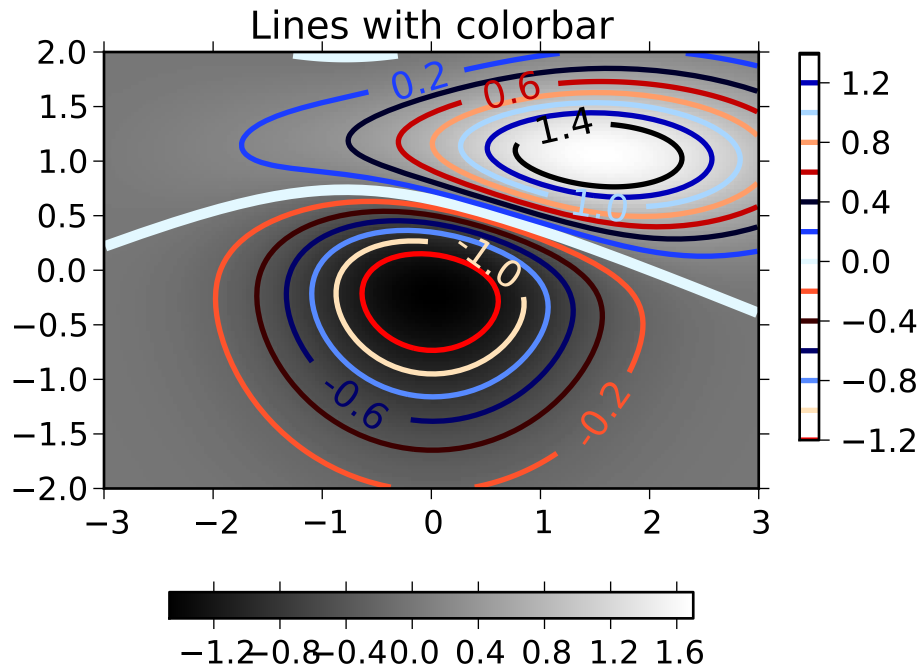
make a contour plot of an array *Z*. The level values are chosen automatically.

```
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 (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, *Y*, and *Z* must be arrays with the same dimensions.

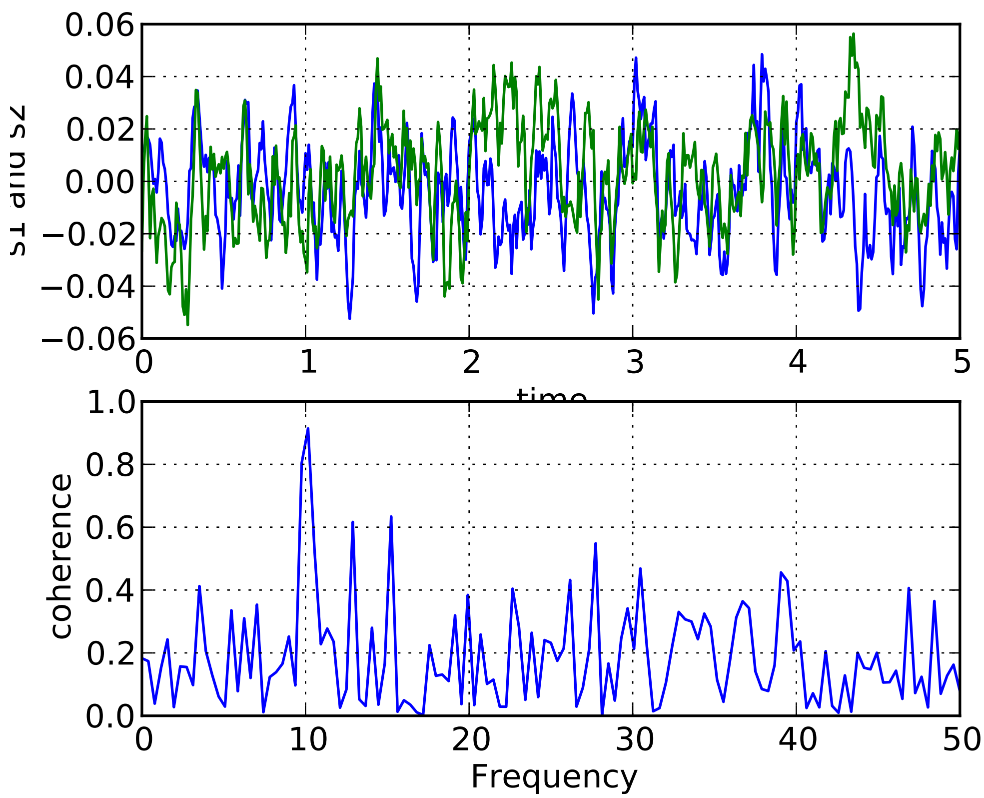
Z may be a masked array, but filled contouring may not handle internal masked regions correctly.

`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.

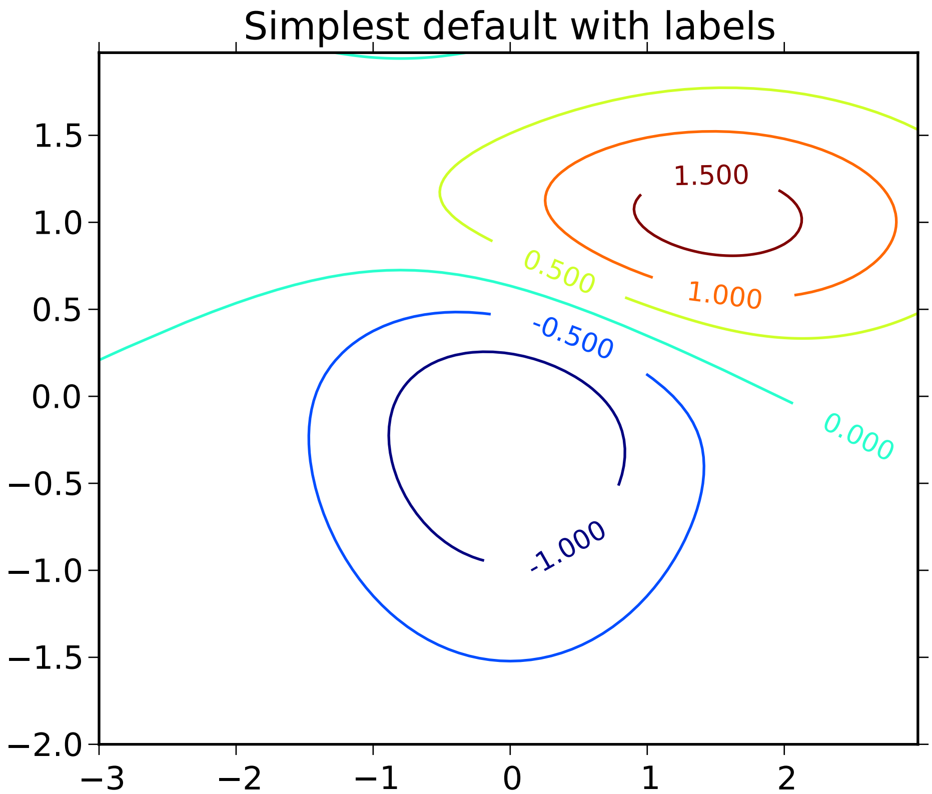
***levels* [level0, level1, ..., leveln]** A list of floating point numbers indicating the level curves to draw; eg to draw just the zero contour pass `levels=[0]`

***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.

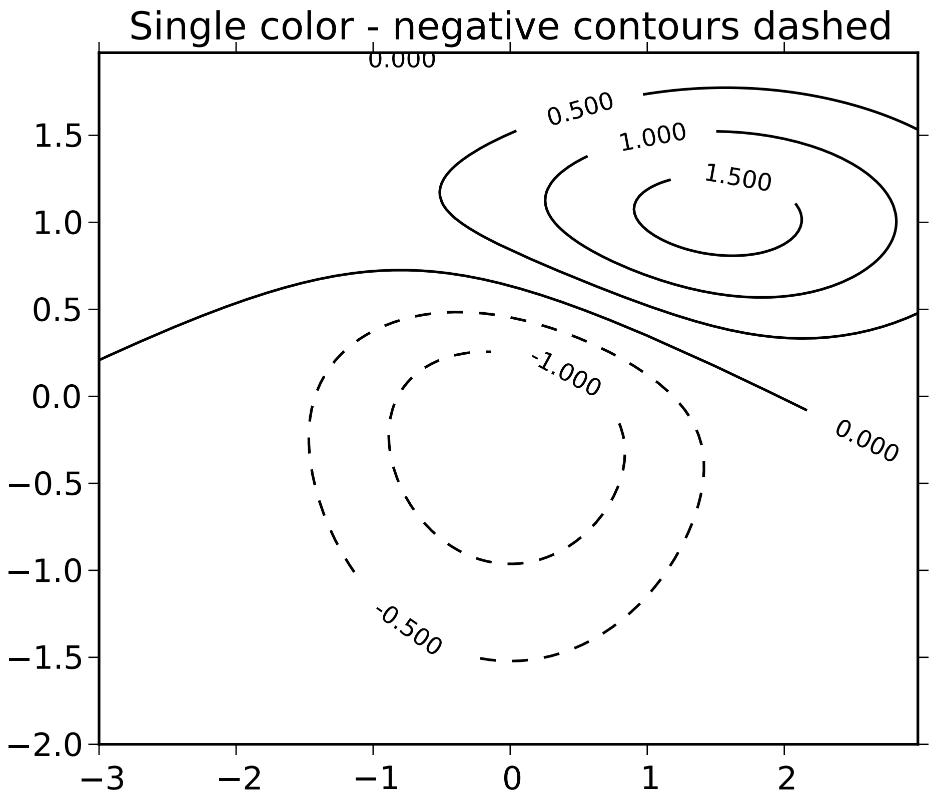
***extend*: ['neither' | 'both' | 'min' | 'max']** Unless this is 'neither', contour levels are automatically added to one or both ends of the range so that all data are included. These added ranges are then mapped to the special colormap values which default to the ends of the colormap range, but can 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`.

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.

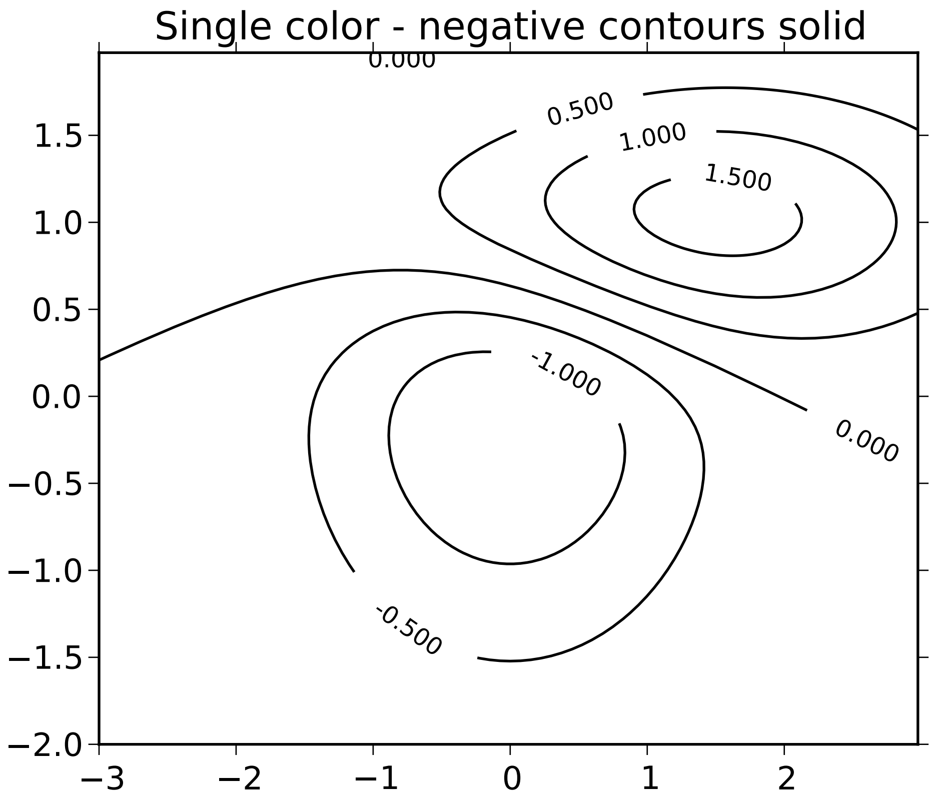
If contour is using a monochrome colormap and the contour level is less than 0, then the linestyle specified in `contour.negative_linestyle` in `matplotlibrc` will be used.

contourf-only keyword arguments:

***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: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:




```
z1 < z <= 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.

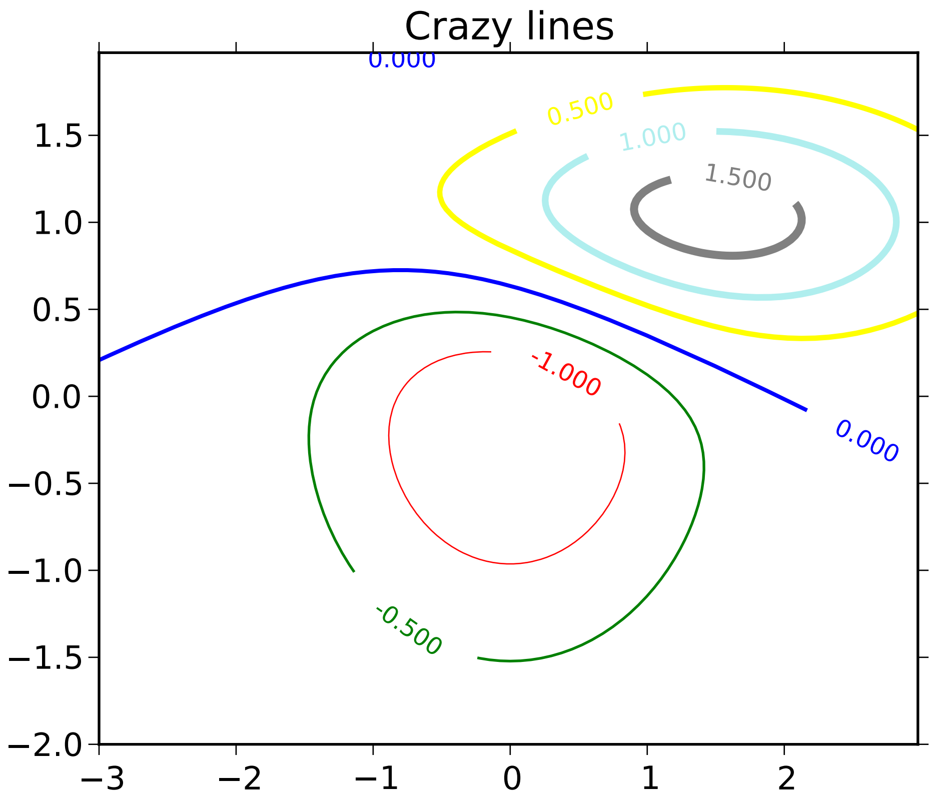
Examples:

csd(*x, y, NFFT=256, Fs=2, Fc=0, detrend=<function detrend_none at 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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.

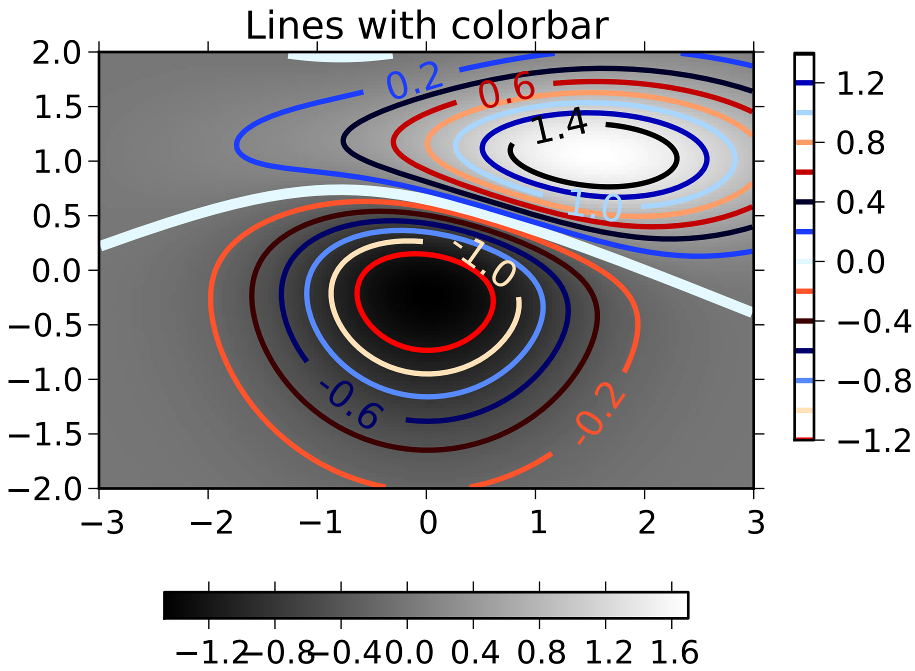
***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, freqs, in cycles per time unit. The default value is 2.

***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 is it 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 per-



forming 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*

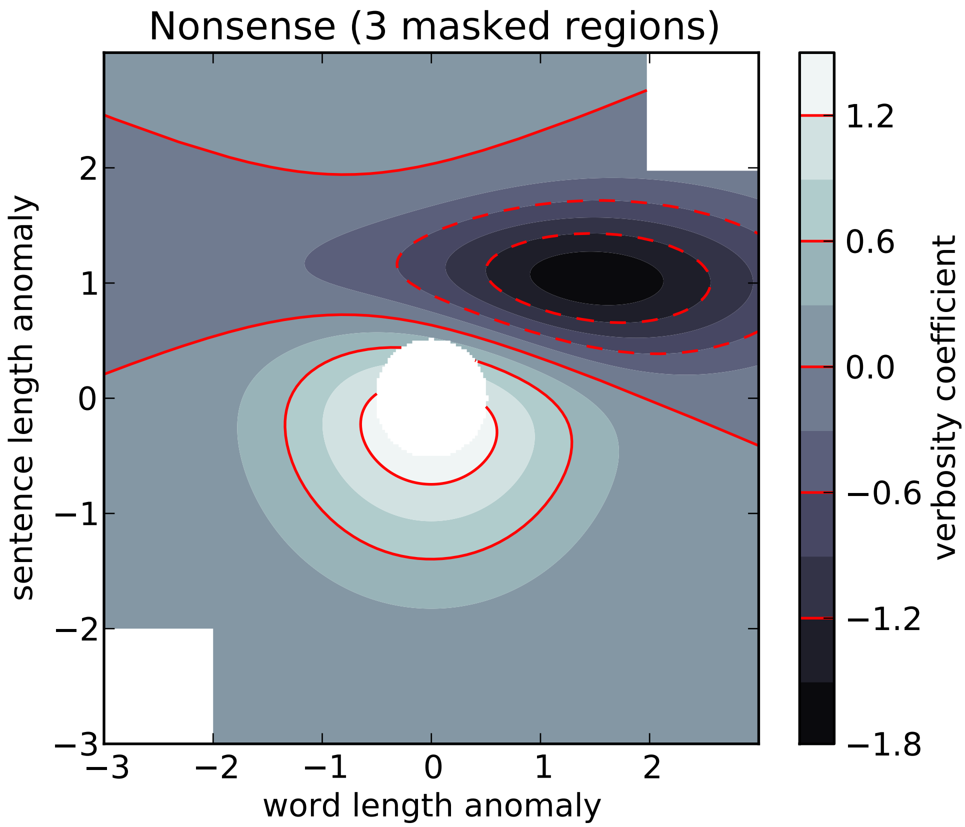
***sides*: ['default' | 'onesided' | 'twosided']** Specifies which sides of the PSD to return. Default gives the default behavior, which returns one-sided for real data and both for complex data. 'onesided' forces the return of a one-sided PSD, while 'twosided' forces two-sided.

***scale_by_freq*: boolean** Specifies whether the resulting density values should be scaled by the scaling frequency, which gives density in units of 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string

linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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

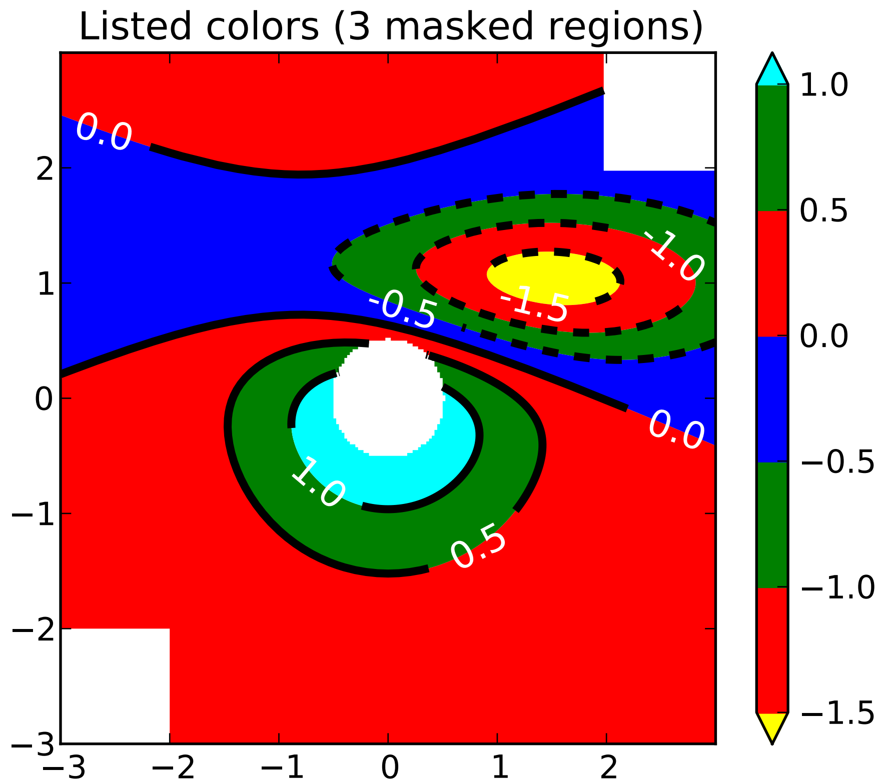
key is a "shift" key

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:

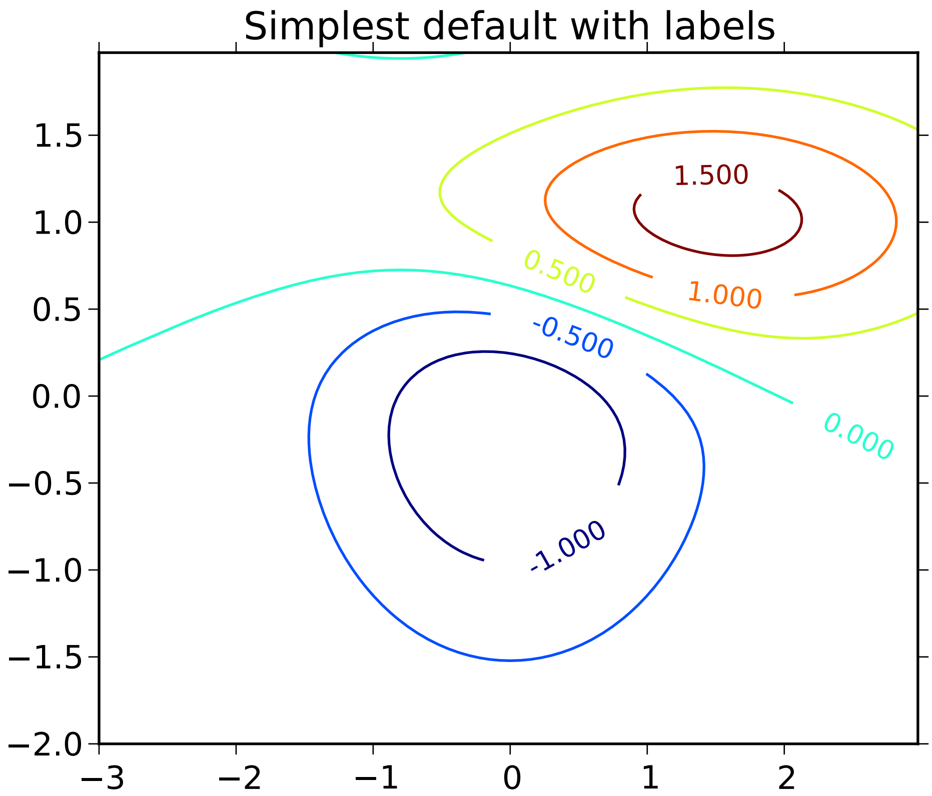
```
errorbar(x, y, yerr=None, xerr=None,
         fmt='-', ecolor=None, elinewidth=None, capsize=3,
         barsabove=False, lolims=False, uplims=False,
         xlolims=False, xuplims=False)
```

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.

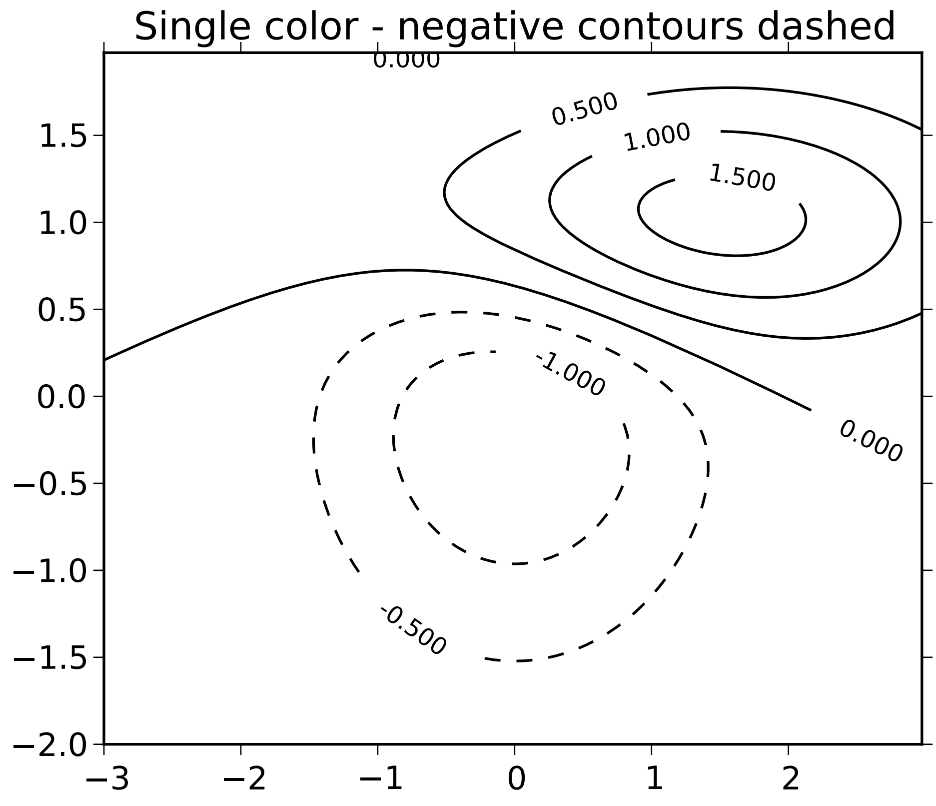
***capsize*: scalar** the size of the error bar caps in points

***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 *markeredgewith*.

valid kwargs for the marker properties are

Property	Description
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance

fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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.

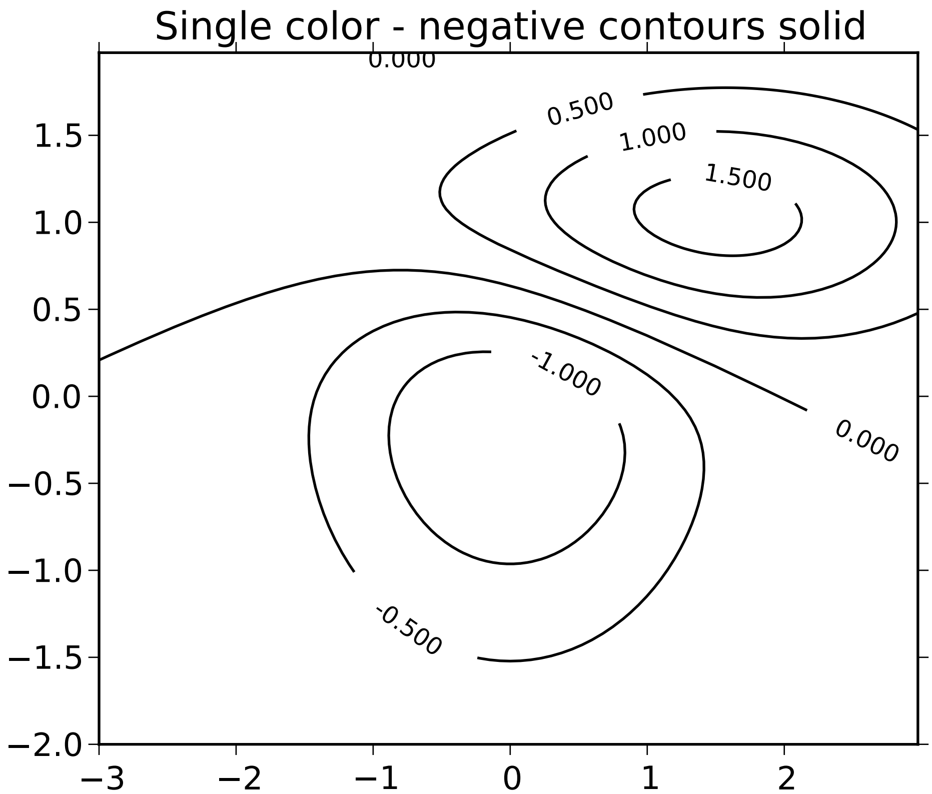
Example:

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')
```

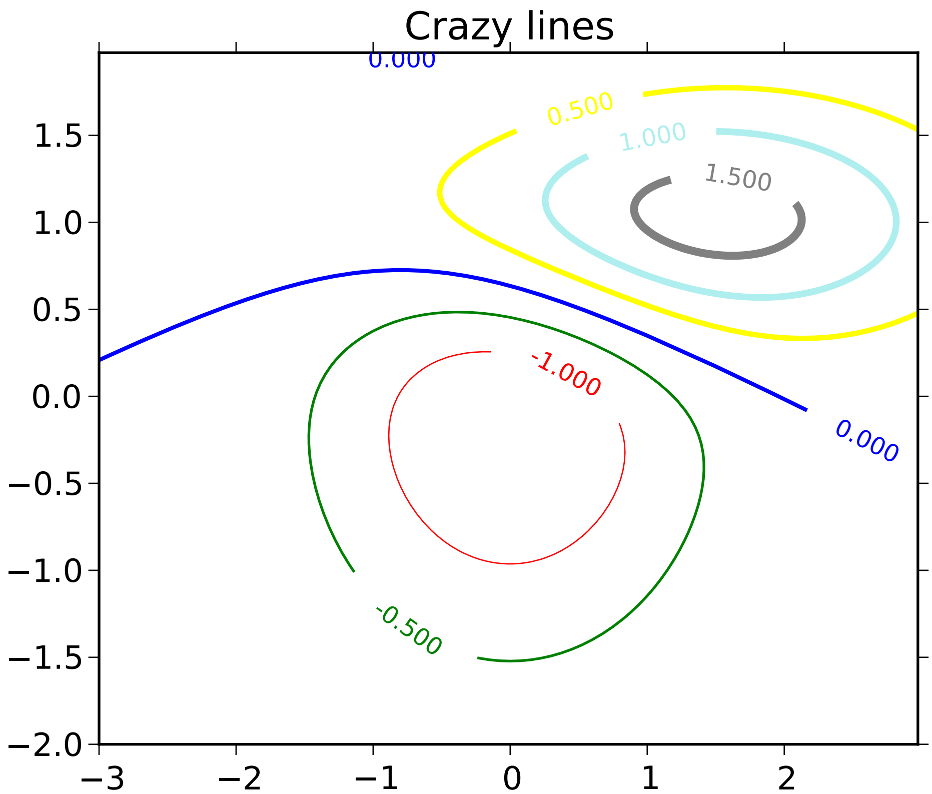
Return value is a list of `Patch` instances that were added.

The same color strings that `plot()` supports are supported by the fill format string.

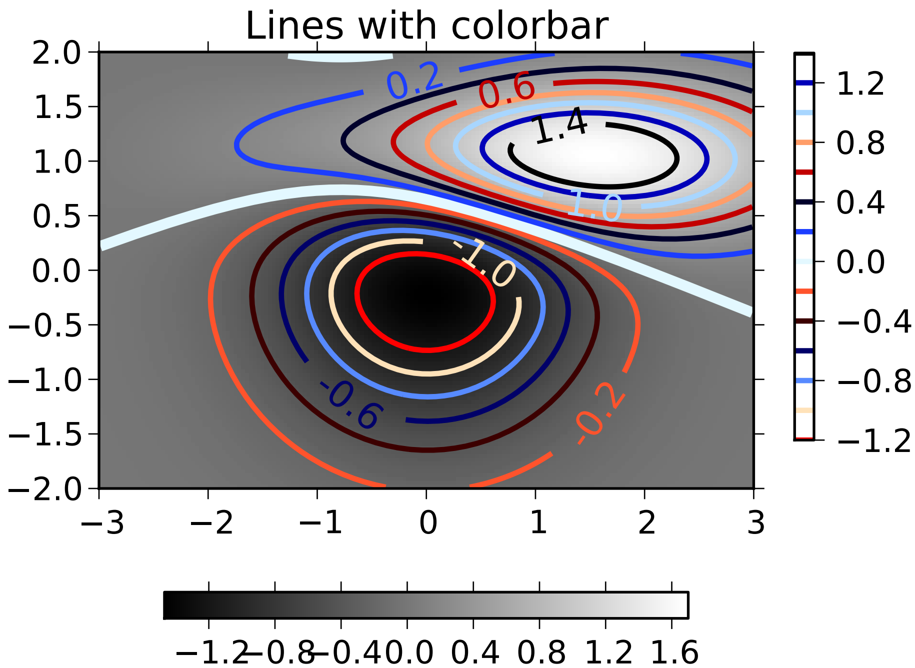
If you would like to fill below a curve, eg. shade a region between 0 and *y* along *x*, use `fill_between()`

The *closed* kwarg will close the polygon when *True* (default).

kwargs control the Polygon properties:



Property	Description
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]



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

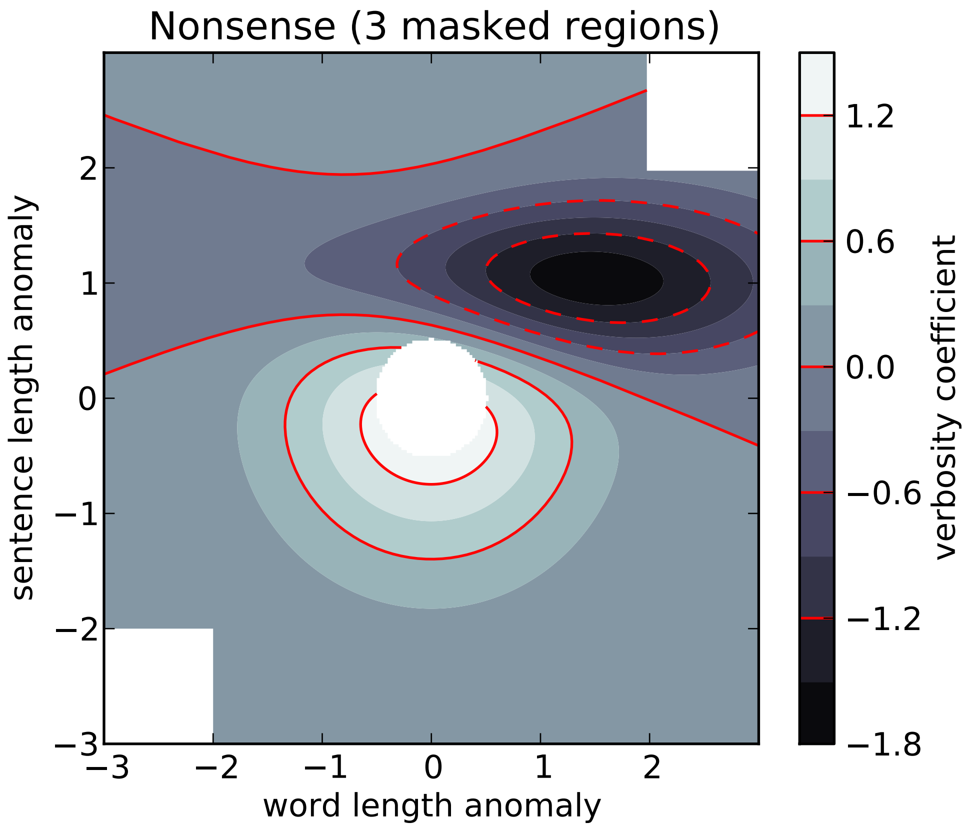
y2 an N length scalar or np array of the y data

where if None, default to fill between everywhere. If not None, it is a 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string

Continued on next page

Table 35.9 – continued from previous page

linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance

Continued on next page

Table 35.10 – continued from previous page

clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	any number

See Also:

fill_between() for filling between two sets of y-values

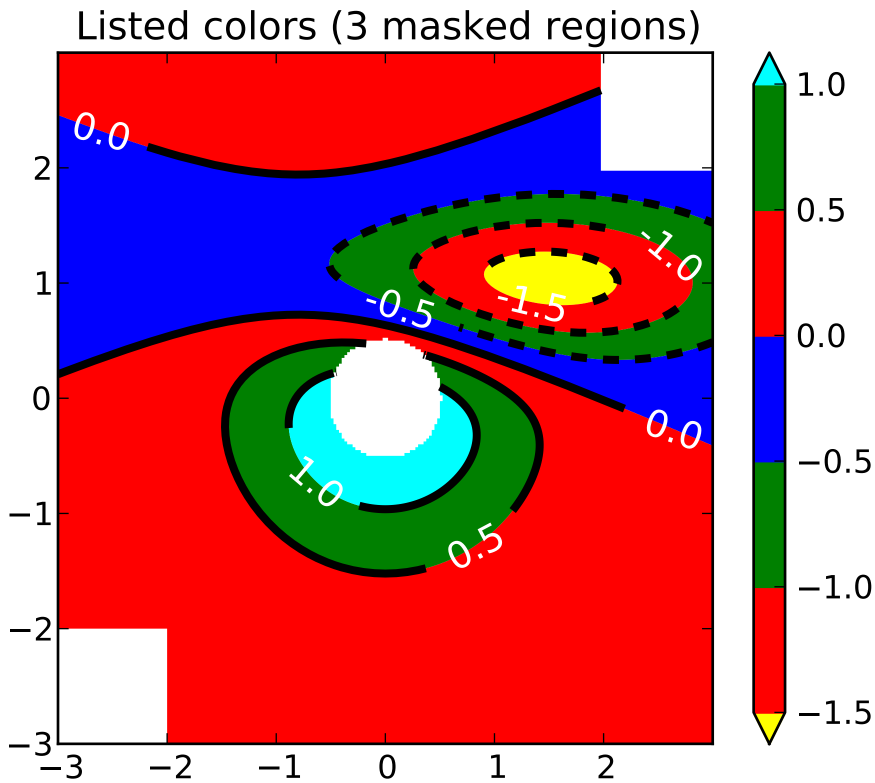
format_coord(*x*, *y*)
return a format string formatting the *x*, *y* coord

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

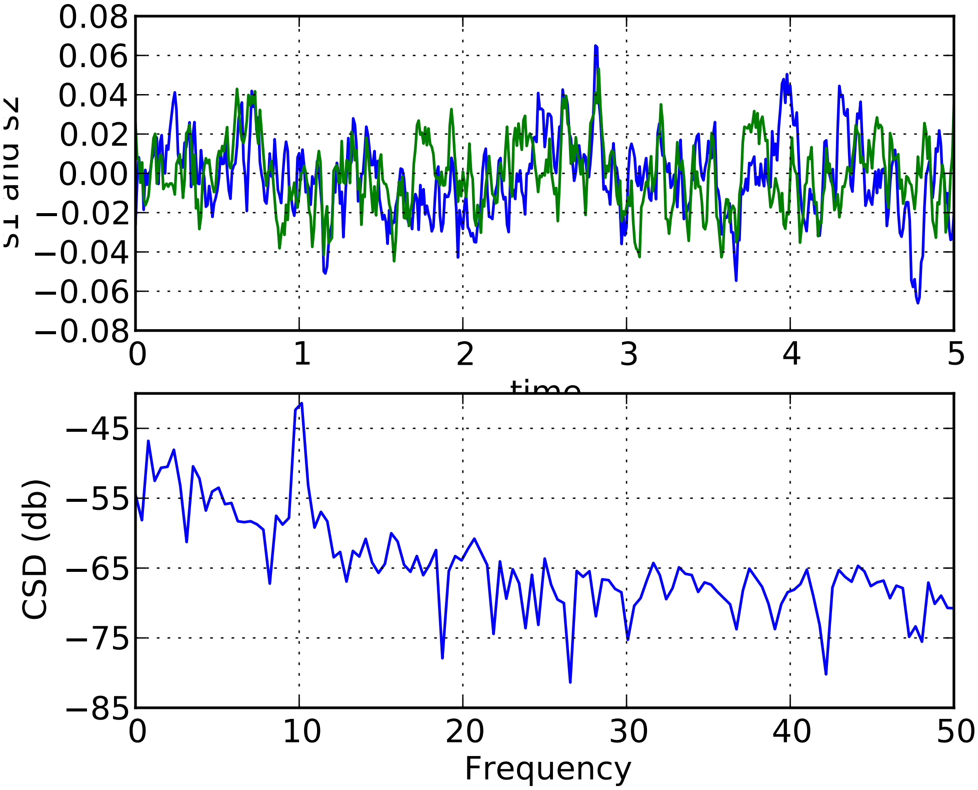
get_axes_locator()
return axes_locator

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 propertiess 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.

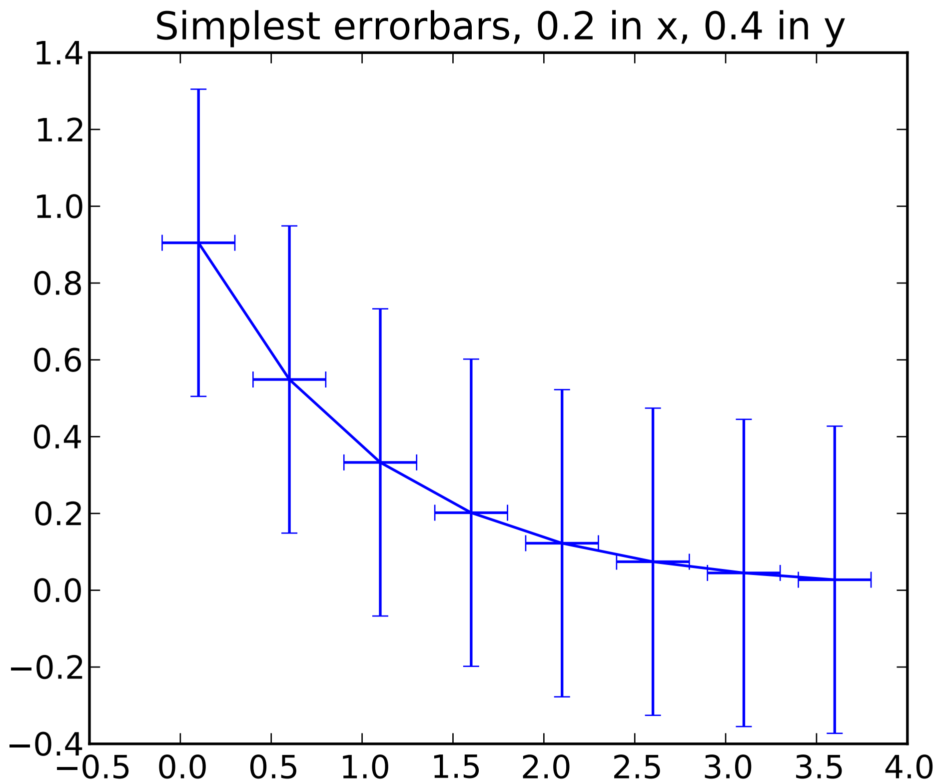
get_frame()
Return the axes Rectangle frame

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()



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

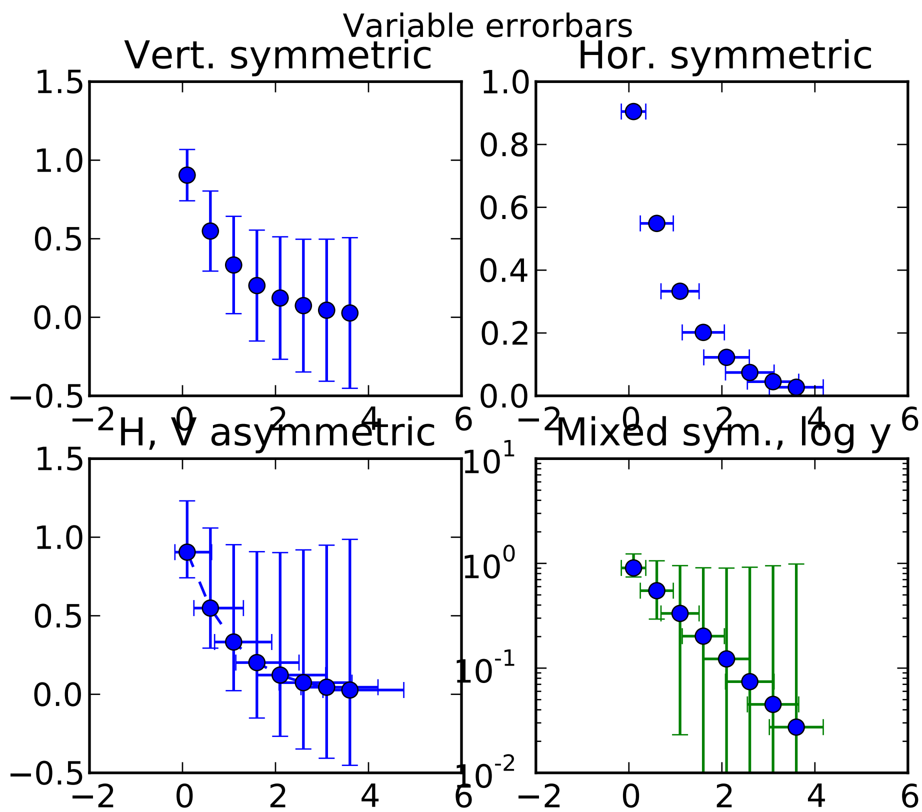
get_navigate_mode()
Get the navigation toolbar button status: 'PAN', 'ZOOM', or None

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*)
return the tight bounding box of the axes. The dimension of the Bbox in canvas coordinate.

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

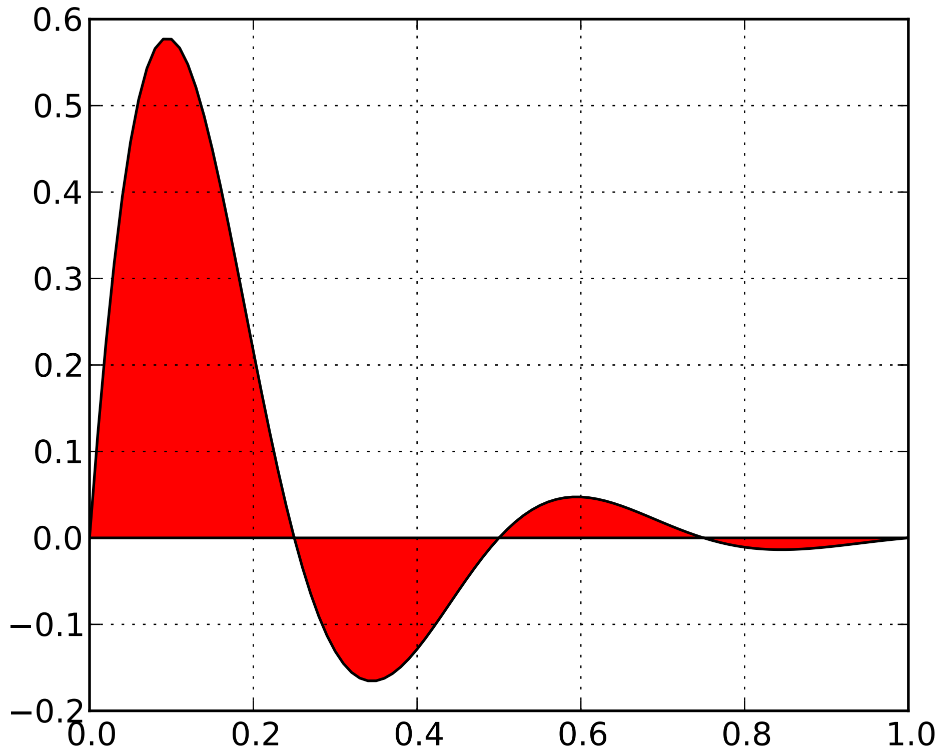
get_xaxis()
Return the XAxis instance

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.

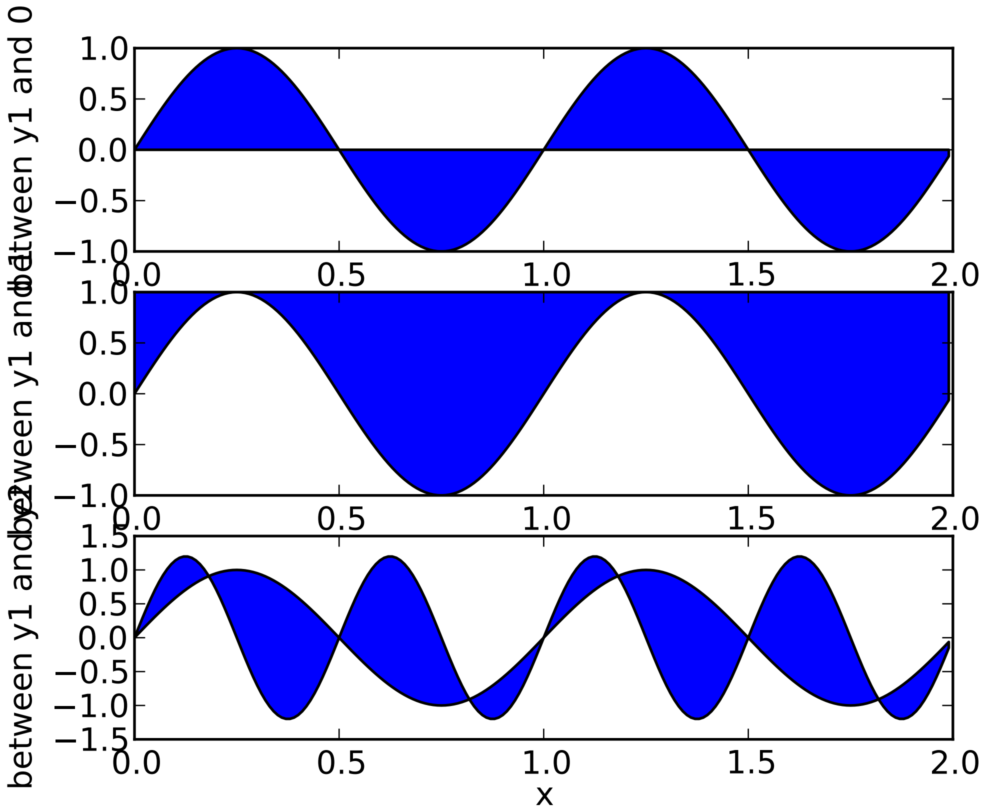
get_xaxis_transform(*which='grid'*)

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*]

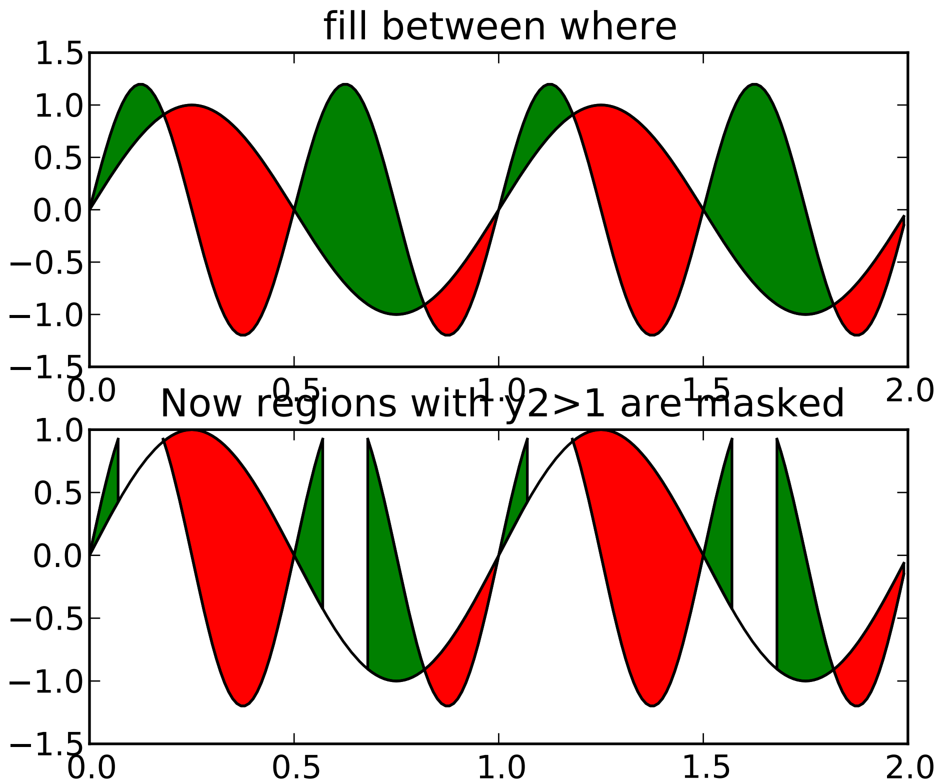
get_xmajorticklabels()
Get the xtick labels as a list of Text instances

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

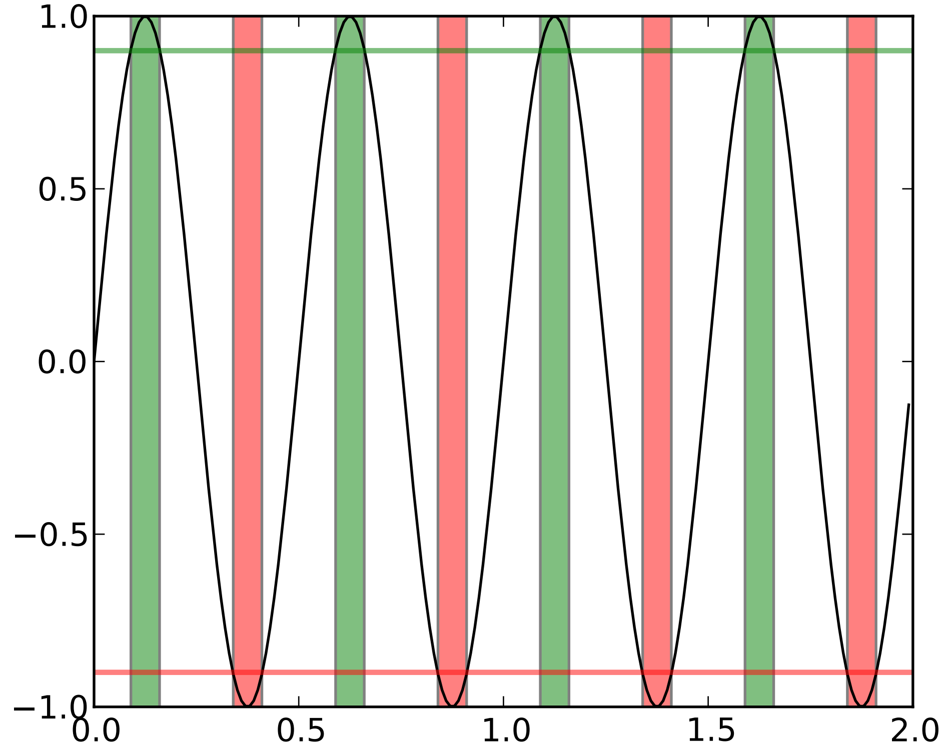
get_yaxis_text1_transform(*pad_points*)
Get the transformation used for drawing y-axis labels, which will add the given amount of padding (in points) between the axes and the label. The x-direction is in axis coordinates and the y-direction is in data coordinates. Returns a 3-tuple of the form:

```
(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.

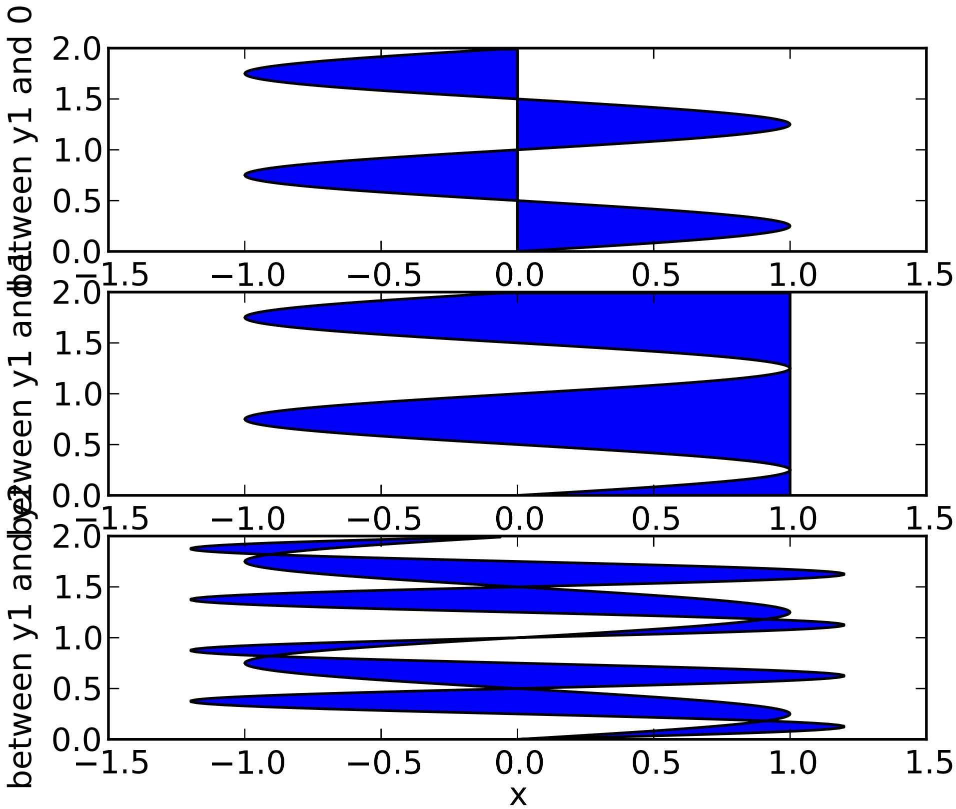
Note: This transformation is primarily used by the `Axis` class, and is meant to be overridden by new kinds of projections that may need to place axis elements in different locations.

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

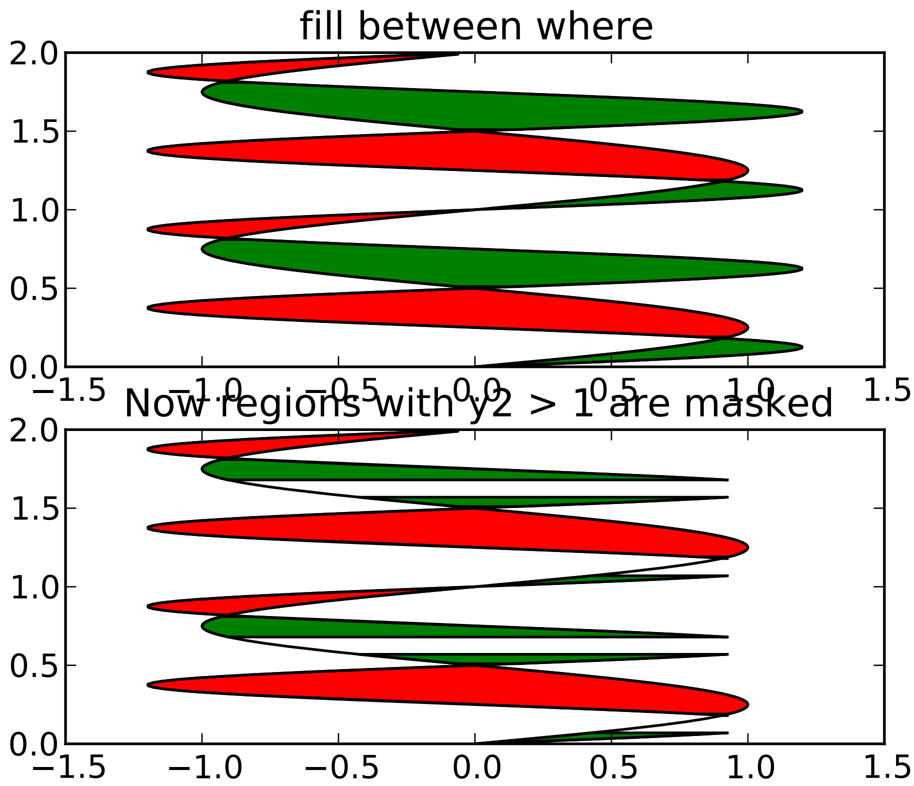
get_yticklines()
Get the ytick lines as a list of Line2D instances

get_yticks(*minor=False*)
Return the y ticks as a list of locations

grid(*b=None, which='major', **kwargs*)
call signature:

```
grid(self, b=None, which='major', **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.

kawrgs are used to set the grid line properties, eg:

```
ax.grid(color='r', linestyle='-', linewidth=2)
```

Valid `Line2D` kwargs are

Property	Description
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color` or c	any matplotlib color
`contains`	a callable function

<table>
<tr><td><code>dash_capstyle</code></td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td><code>dash_joinstyle</code></td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td><code>dashes</code></td><td>sequence of on/off ink in points</td></tr>
<tr><td><code>data</code></td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td><code>drawstyle</code></td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td><code>figure</code></td><td>a <code>matplotlib.figure.Figure</code> instance</td></tr>
<tr><td><code>fillstyle</code></td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td><code>gid</code></td><td>an id string</td></tr>
<tr><td><code>label</code></td><td>any string</td></tr>
<tr><td><code>linestyle</code> or ls</td><td>[<code>'-'</code> | <code>'--'</code> | <code>'-.'</code> | <code>':'</code> | <code>'None'</code> | <code>' '</code> | ''] and any drawstyle in combination with a</td></tr>
<tr><td><code>linewidth</code> or lw</td><td>float value in points</td></tr>
<tr><td><code>lod</code></td><td>[True | False]</td></tr>
<tr><td><code>marker</code></td><td>[<code>'+'</code> | <code>'*'</code> | <code>','</code> | <code>'.'</code> | <code>'1'</code> | <code>'2'</code> | <code>'3'</code> | <code>'4'</code> | <code>'<'</code> | <code>'>'</code> | <code>'D'</code> | <code>'H'</code> | <code>'^'</code> | <code>'_'</code> | <code>'d'</code> |</td></tr>
<tr><td><code>markeredgecolor</code> or mec</td><td>any matplotlib color</td></tr>
<tr><td><code>markeredgewidth</code> or mew</td><td>float value in points</td></tr>
<tr><td><code>markerfacecolor</code> or mfc</td><td>any matplotlib color</td></tr>
<tr><td><code>markerfacecoloralt</code> or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td><code>markersize</code> or ms</td><td>float</td></tr>
<tr><td><code>markevery</code></td><td>None | integer | (startind, stride)</td></tr>
<tr><td><code>picker</code></td><td>float distance in points or callable pick function <code>fn(artist, event)</code></td></tr>
<tr><td><code>pickradius</code></td><td>float distance in points</td></tr>
<tr><td><code>rasterized</code></td><td>[True | False | None]</td></tr>
<tr><td><code>snap</code></td><td>unknown</td></tr>
<tr><td><code>solid_capstyle</code></td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td><code>solid_joinstyle</code></td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td><code>transform</code></td><td>a <code>matplotlib.transforms.Transform</code> instance</td></tr>
<tr><td><code>url</code></td><td>a url string</td></tr>
<tr><td><code>visible</code></td><td>[True | False]</td></tr>
<tr><td><code>xdata</code></td><td>1D array</td></tr>
<tr><td><code>ydata</code></td><td>1D array</td></tr>
<tr><td><code>zorder</code></td><td>any number</td></tr>
</table>

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 0x2d3a578>, 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 occurences 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.

***scale*: ['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 rectagles 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]

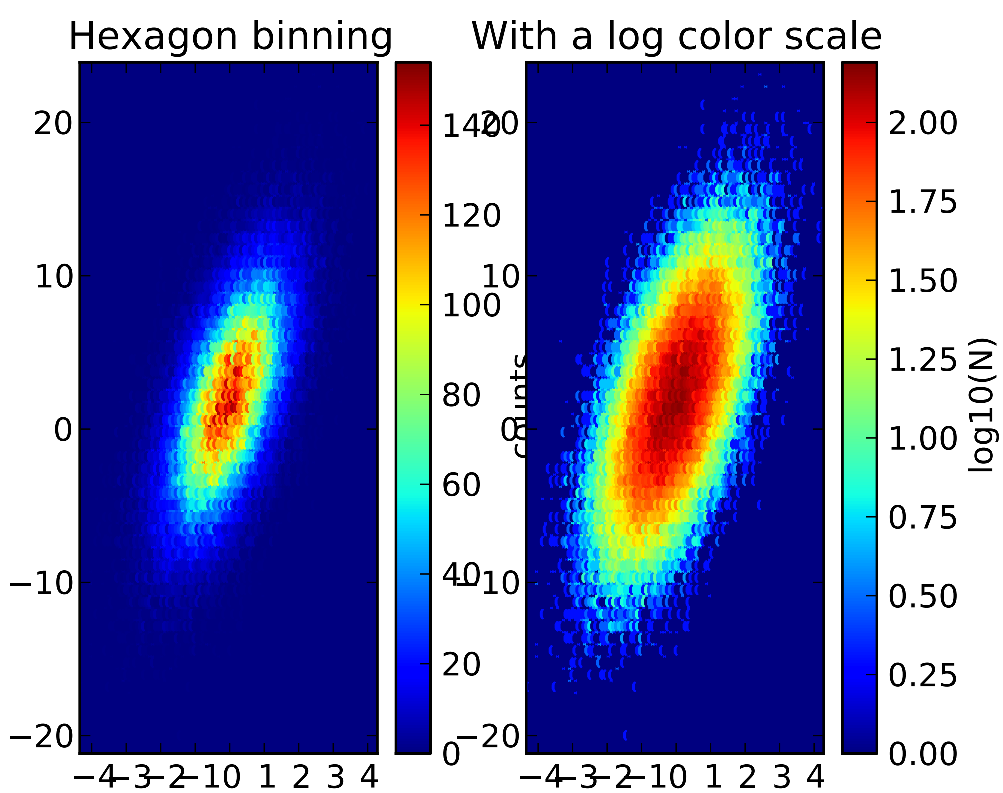
Continued on next page

Table 35.12 – continued from previous page

pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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:

```
hist(x, bins=10, range=None, normed=False, cumulative=False,
     bottom=None, histtype='bar', align='mid',
     orientation='vertical', rwidth=None, log=False, **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 >= 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/(len(x)*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))
```

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 aranged 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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.

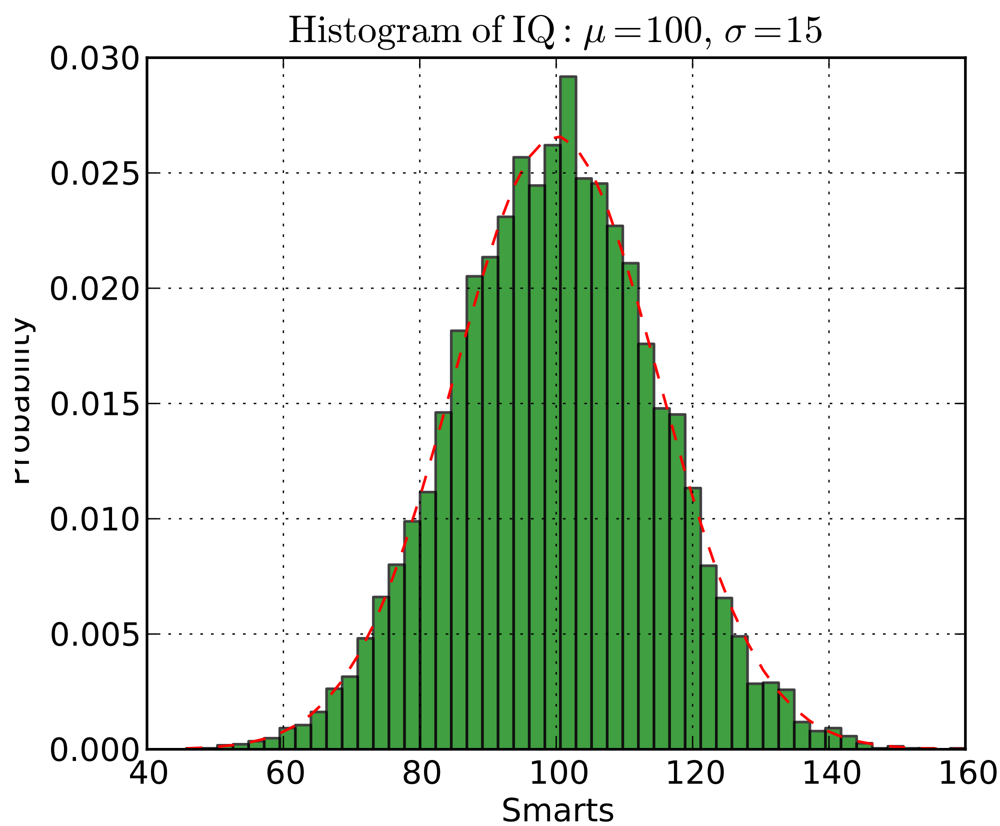
Required arguments:

***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)
```

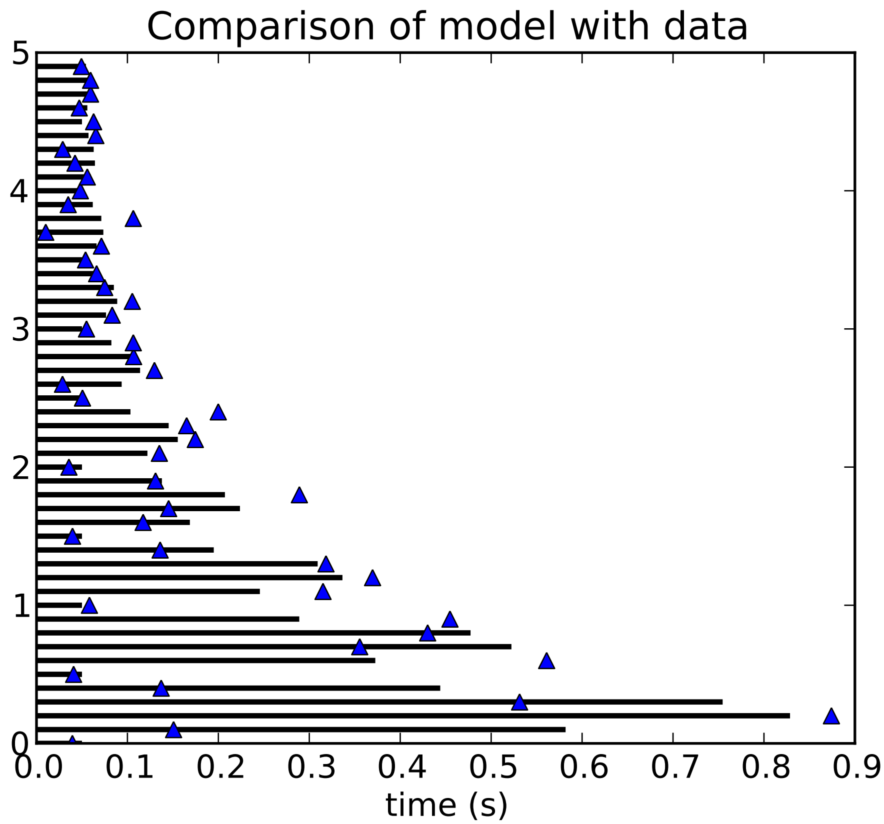
Set the hold state. If *hold* is *None* (default), toggle the *hold* state. Else set the *hold* state to boolean value *b*.

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, filternorm=1, filterrad=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:

- MxN – luminance (grayscale, float array only)
- MxNx3 – RGB (float or uint8 array)
- MxNx4 – RGBA (float or uint8 array)

The value for each component of MxNx3 and MxNx4 float arrays should be in the range 0.0 to 1.0; MxN 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*, '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 *filternorm* and *filterrad* parameters

***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

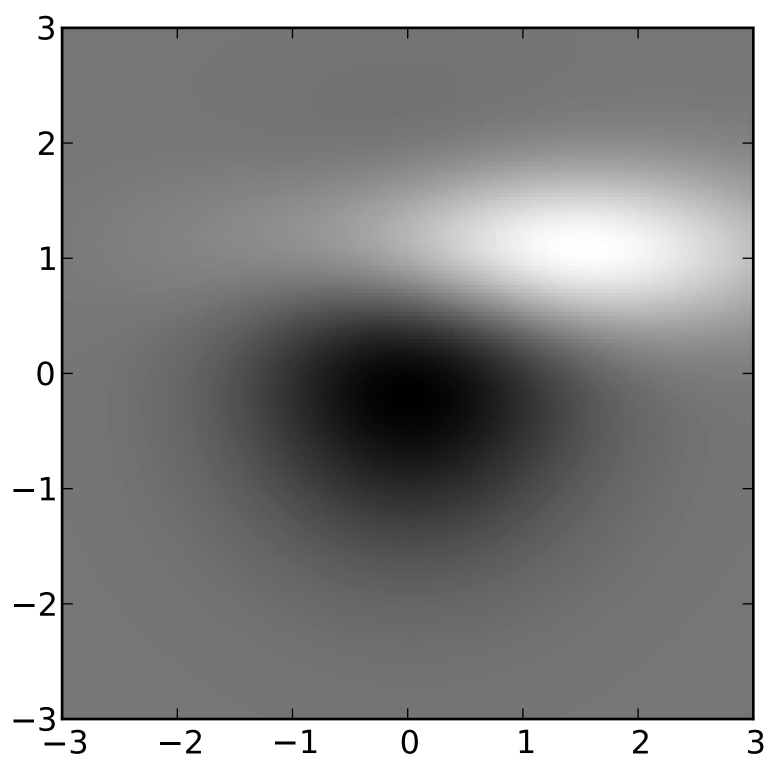
***filternorm*:** A parameter for the antigrain image resize filter. From the antigrain documentation, if *filternorm* = 1, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
contains	a callable function
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
lod	[True | False]
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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 itslef 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. Default is True

***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.

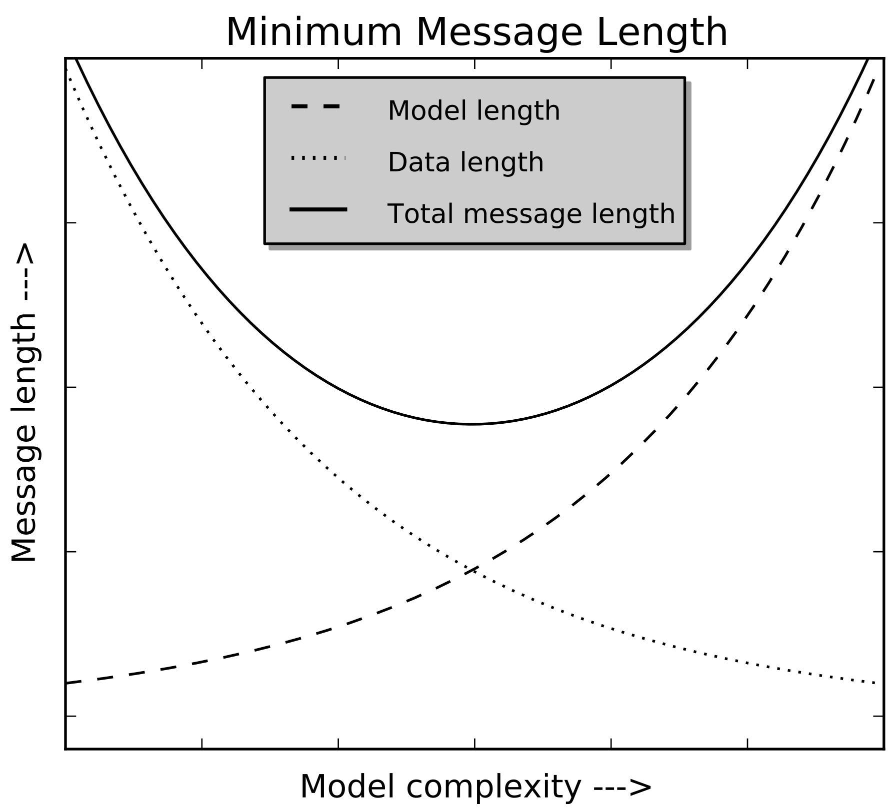
bbox_transform [[an instance of Transform | None]] the transform for the bbox. transAxes if None.

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

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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]

<table>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
<tr><td>xdata</td><td>1D array</td></tr>
<tr><td>ydata</td><td>1D array</td></tr>
<tr><td>zorder</td><td>any number</td></tr>
</table>

Example:

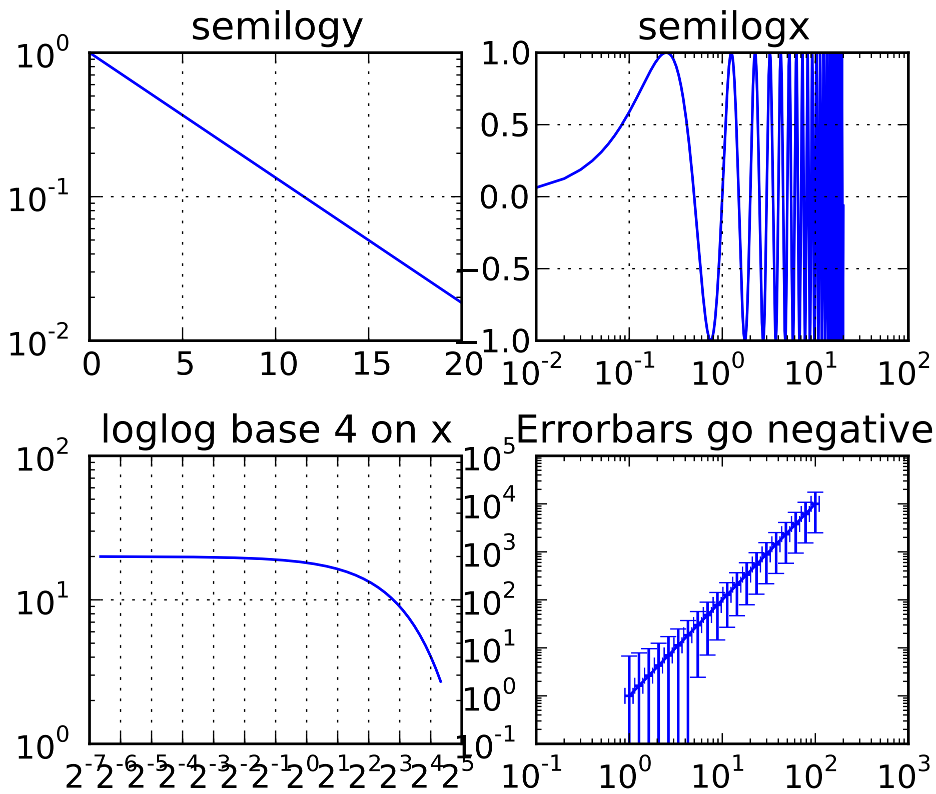
margins(**args, **kw*)

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 *extent*, *origin*, *interpolation*, and *aspect*; use care in overriding the *extent* and *origin* kwargs, because they interact. (Also, if you want to change them, you probably should be using imshow directly in your own version of matshow.)

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 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]
`pickradius`	unknown
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`urls`	unknown
`visible`	[True | False]
`zorder`	any number

Note: the default *antialiaseds* is taken from rcParams['patch.antialiased'], which defaults to *True*. In some cases, particularly if *alpha* is 1, you may be able to reduce rendering artifacts (light or dark patch boundaries) by setting it to *False*. An alternative it to set *edgecolors* to 'face'. Unfortunately, there seems to be no single combination of parameters that eliminates artifacts under all conditions.

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 *x0* to *x1* as the second index of *C* goes from 0 to *nc*, etc. (*x0*, *y0*) is the outermost corner of cell (0,0), and (*x1*, *y1*) 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 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 <= scalar <= 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown

Continued on next page

Table 35.15 – continued from previous page

axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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, anitialising, 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, antialised=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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']

`gid`	an id string
`label`	any string
`linestyle` or ls	[`'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | ''] and any drawstyle in combination with a
`linewidth` or lw	float value in points
`lod`	[True | False]
`marker`	[`'+'` | `'*'` | `','` | `'.'` | `'1'` | `'2'` | `'3'` | `'4'` | `'<'` | `'>'` | `'D'` | `'H'` | `'^'` | `'_'` | `'d'` |
`markeredgecolor` or mec	any matplotlib color
`markeredgewidth` or mew	float value in points
`markerfacecolor` or mfc	any matplotlib color
`markerfacecoloralt` or mfcalt	any matplotlib color
`markersize` or ms	float
`markevery`	None | integer | (startind, stride)
`picker`	float distance in points or callable pick function `fn(artist, event)`
`pickradius`	float distance in points
`rasterized`	[True | False | None]
`snap`	unknown
`solid_capstyle`	['butt' | 'round' | 'projecting']
`solid_joinstyle`	['miter' | 'round' | 'bevel']
`transform`	a `matplotlib.transforms.Transform` instance
`url`	a url string
`visible`	[True | False]
`xdata`	1D array
`ydata`	1D array
`zorder`	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]** 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:

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td>agg_filter</td><td>unknown</td></tr>
<tr><td>alpha</td><td>float (0.0 transparent through 1.0 opaque)</td></tr>
<tr><td>animated</td><td>[True | False]</td></tr>
<tr><td>antialiased or aa</td><td>[True | False]</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | ''] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
</table>

visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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 $|\mathrm{fft}(i)|^2$ 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.

***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 is it 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 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 (*Pxx*, *freqs*).

For plotting, the power is plotted as $10\log_{10}(P_{xx})$ for decibels, though *Pxx* itself is returned.

References: Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

kwargs control the `Line2D` properties:

Property	Description
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color` or c	any matplotlib color
`contains`	a callable function
`dash_capstyle`	['butt' | 'round' | 'projecting']
`dash_joinstyle`	['miter' | 'round' | 'bevel']
`dashes`	sequence of on/off ink in points
`data`	2D array (rows are x, y) or two 1D arrays
`drawstyle`	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
`figure`	a `matplotlib.figure.Figure` instance
`fillstyle`	['full' | 'left' | 'right' | 'bottom' | 'top']

gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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)
```

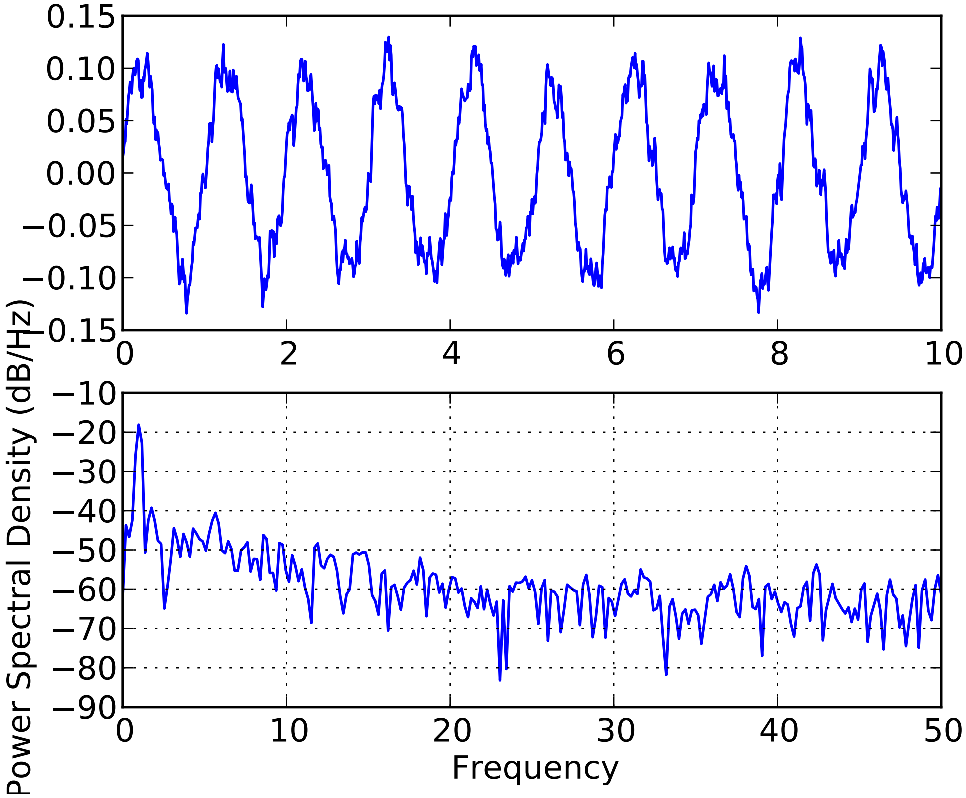
Arguments:

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 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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

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^2. 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:

Value	Description
's'	square
'o'	circle
'^'	triangle up
'>'	triangle right
'v'	triangle down
'<'	triangle left
'd'	diamond
'p'	pentagon
'h'	hexagon
'8'	octagon
'+'	plus
'x'	cross

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 (*numsides* and *angle* is ignored)

***angle*:** the angle of rotation of the symbol

Finally, *marker* can be (*verts*, 0): *verts* is a sequence of (*x*, *y*) vertices for a custom scatter symbol. Alternatively, use the kwarg combination *marker* = *None*, *verts* = *verts*.

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 <= scalar <= 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]
`pickradius`	unknown
`rasterized`	[True | False | None]
`snap`	unknown

Continued on next page

Table 35.20 – continued from previous page

transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']

figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | ''] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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 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:

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td>agg_filter</td><td>unknown</td></tr>
<tr><td>alpha</td><td>float (0.0 transparent through 1.0 opaque)</td></tr>
<tr><td>animated</td><td>[True | False]</td></tr>
<tr><td>antialiased or aa</td><td>[True | False]</td></tr>
<tr><td>axes</td><td>an Axes instance</td></tr>
<tr><td>clip_box</td><td>a matplotlib.transforms.Bbox instance</td></tr>
<tr><td>clip_on</td><td>[True | False]</td></tr>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
</table>

xdata	1D array
ydata	1D array
zorder	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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 xaxis.

labelpad is the spacing in points between the label and the x-axis

Valid kwargs are Text properties:

Property	Description
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | '
style or fontstyle	['normal' | 'italic' | 'oblique']

Table 35.24 – continued fro

text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 xlimits 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 _autoscaleYon 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c

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style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 ylimits 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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.

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 is it 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 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 specgram 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:

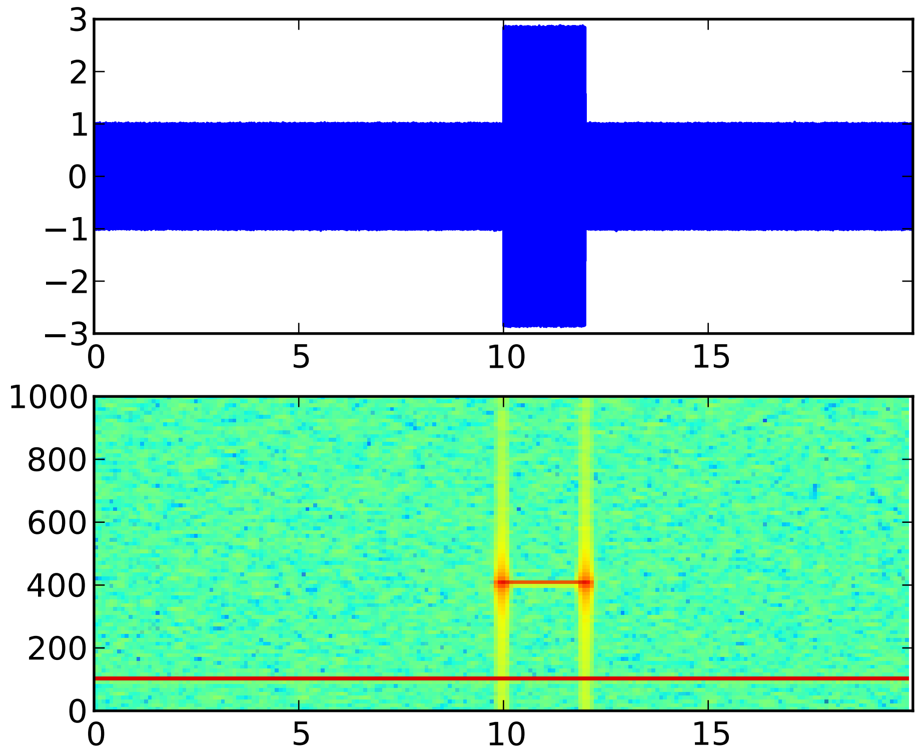
```
spy(Z, precision=0, marker=None, markersize=None,
    aspect='equal', **kwargs)
```

`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-'*)
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 is plotted using *basefmt*.

Return value is a tuple (*markerline*, *stemlines*, *baseline*).

See Also:

this document for details

`examples/pylab_examples/stem_plot.py` for a demo

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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`contains`	a callable function
`figure`	a `matplotlib.figure.Figure` instance
`fontsize`	a float in points
`gid`	an id string
`label`	any string
`lod`	[True | False]
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function
`family` or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
`figure`	a `matplotlib.figure.Figure` instance
`fontproperties` or font_properties	a `matplotlib.font_manager.FontProperties` instance
`gid`	an id string

Table 35.28 – continued fro

horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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:

Keyword	Description
style	['sci' (or 'scientific') | 'plain'] plain turns off scientific notation
scilimits	(m, n), pair of integers; if *style* is 'sci', scientific notation will be used for numbers outside the range 10'-m':sup: to 10'n':sup:. Use (0,0) to include all numbers.
useOffset	[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.
axis	['x' | 'y' | 'both']

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, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, 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 (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

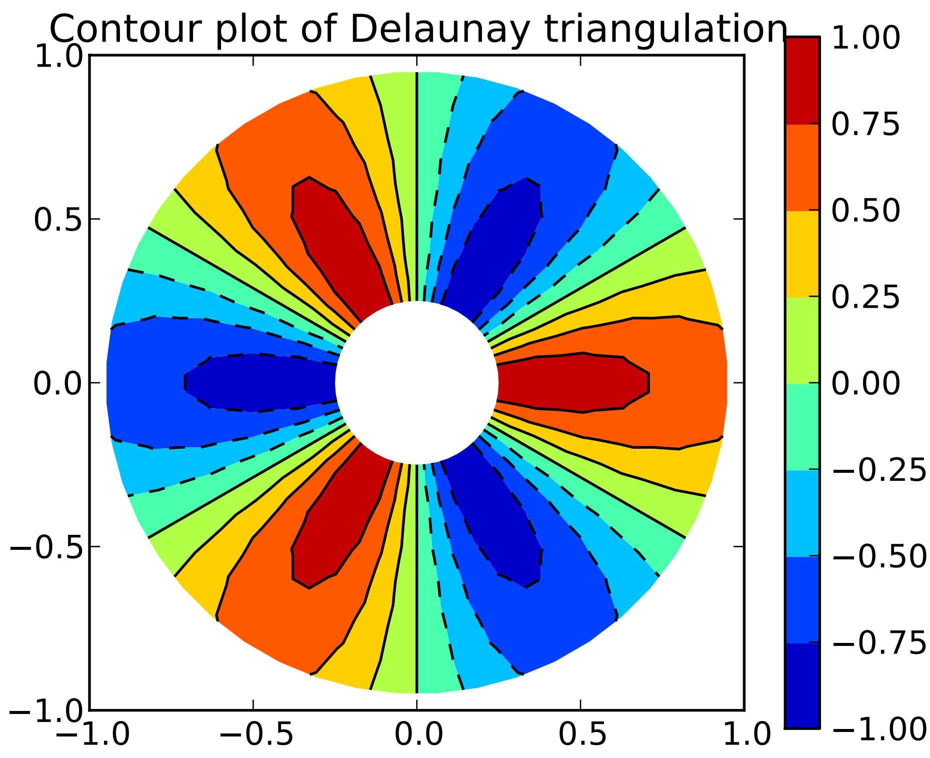
***nchunk*: [0 | integer]** If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *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 <= 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*)

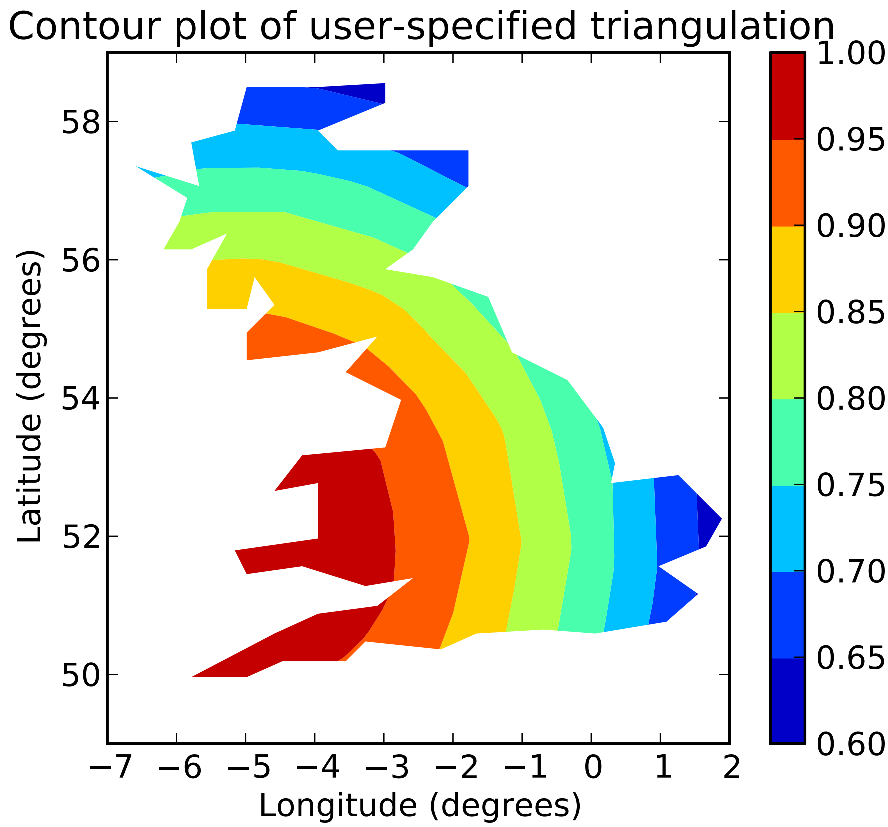
tricontour() and tricontourf() draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

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, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, 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 (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 <= 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.

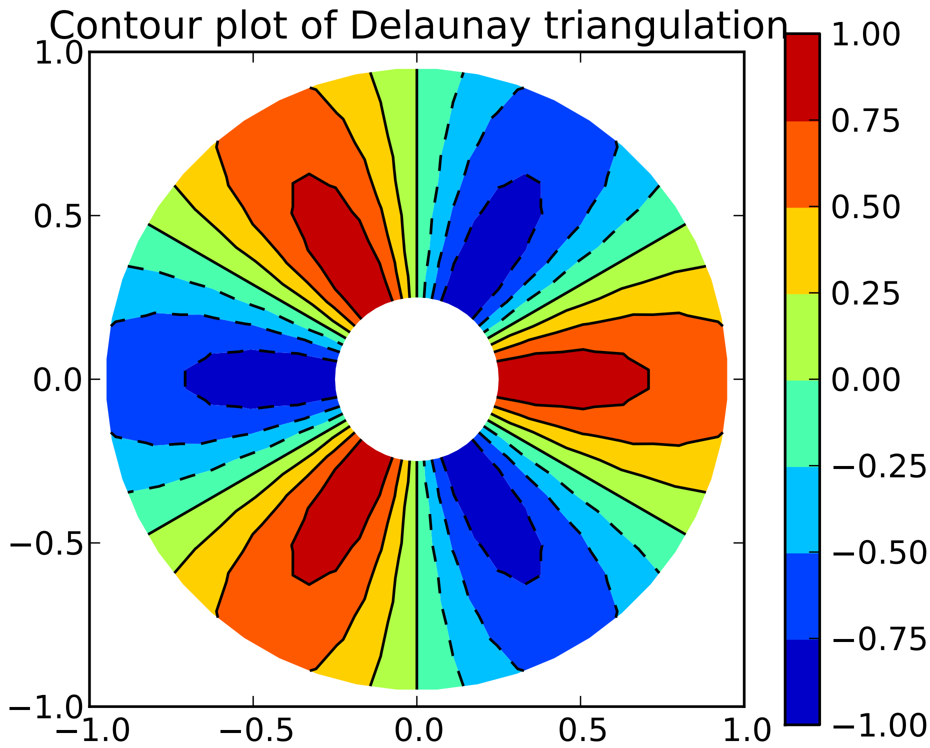
Examples:

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, ...)
tripcolor(x, y, mask=mask, ...)
tripcolor(x, y, triangles, 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.

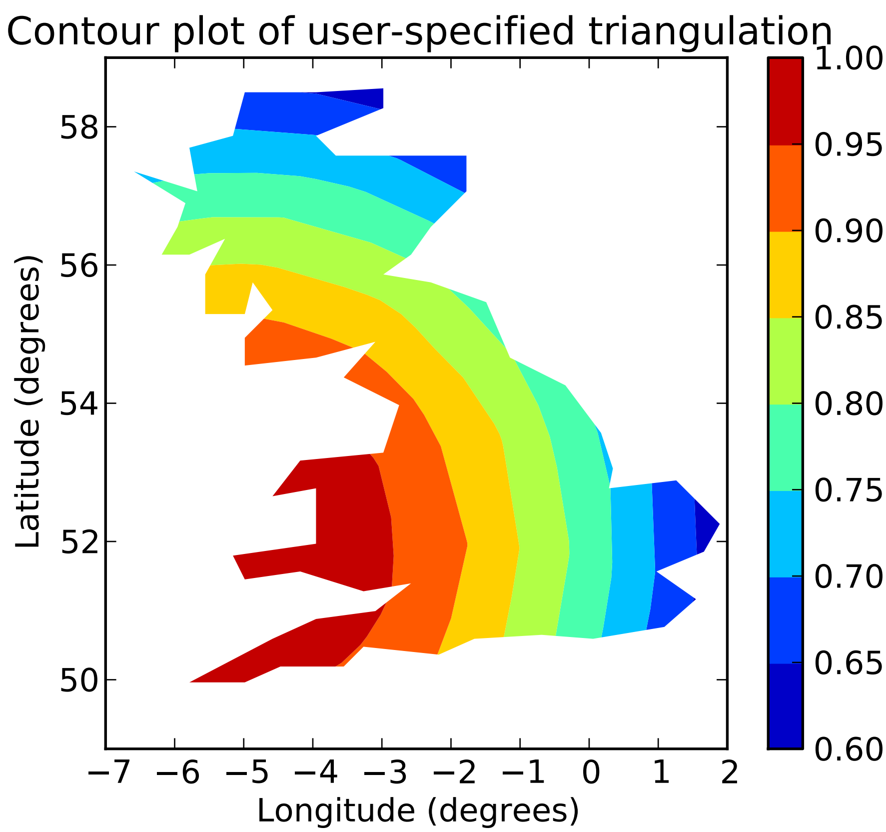
The remaining kwargs are the same as for `pcolor()`.

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, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, mask, ...)
triplot(x, y, triangles, mask=mask, ...)
```

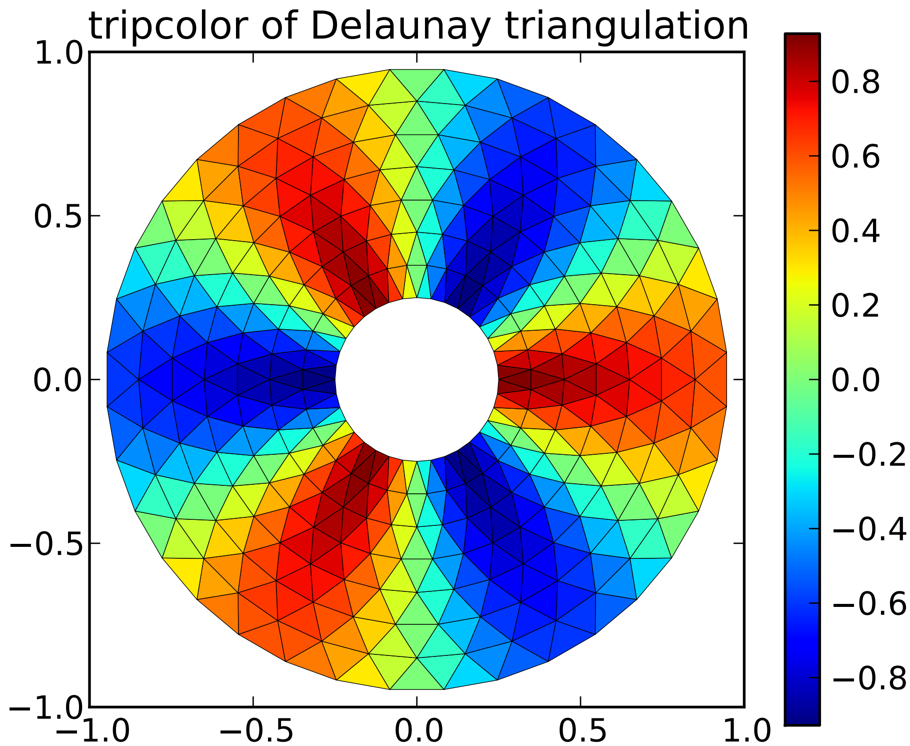
in which case a Triangulation object will be created. See `Triangulation` for a explanation of these possibilities.

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 sharex 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()
```

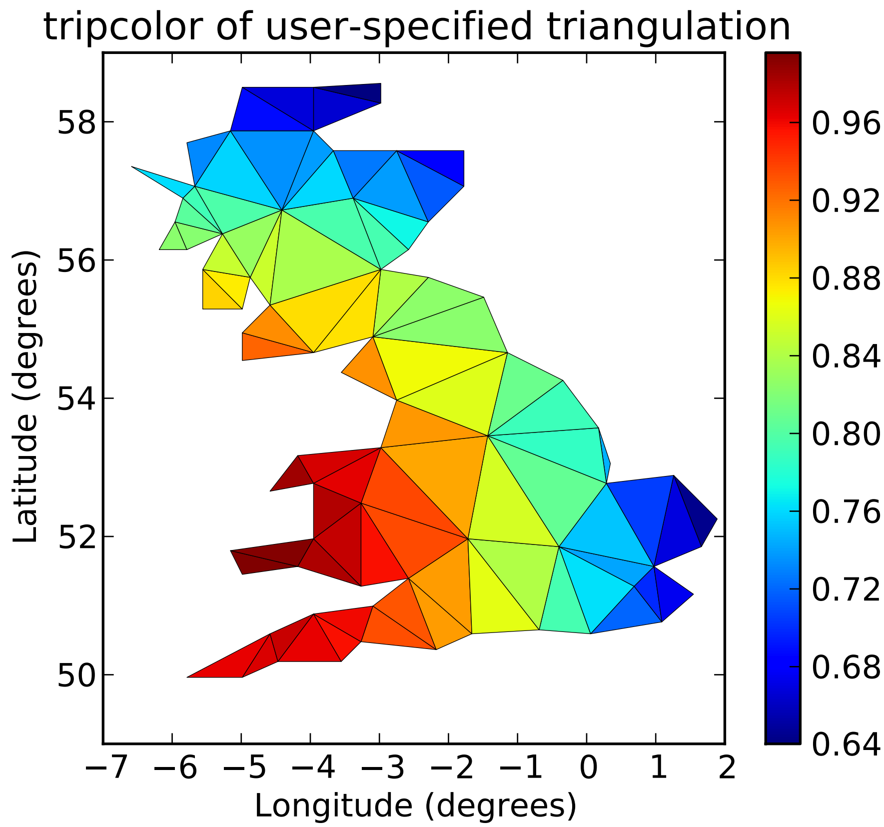
create a twin of Axes for generating a plot with a shared y-axis but independent x axis. The x-axis of self will have ticks on bottom and the returned axes will have ticks on the top

update_datalim(*xys, 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', linestyles='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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance

Continued on next page

Table 35.29 – continued from previous page

clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
segments	unknown
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
verts	unknown
visible	[True | False]
zorder	any number

xaxis_date(*tz=None*)

Sets up x-axis ticks and labels that treat the x data as dates.

tz is the time zone to use in labeling dates. Defaults to rc value.

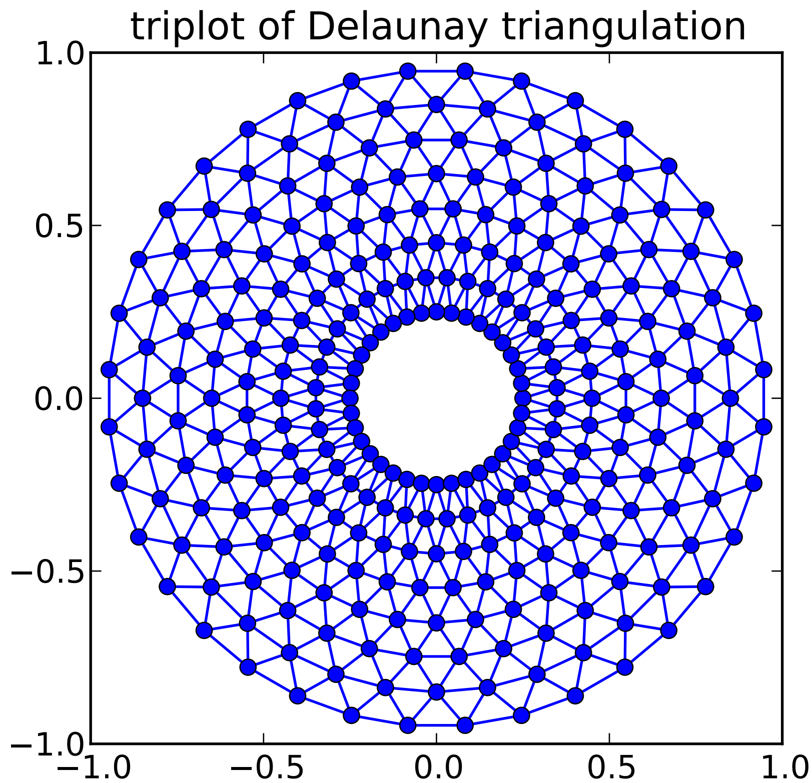
xaxis_inverted()

Returns True if the x-axis is inverted.

xcorr(*x, y, normed=True, detrend=<function detrend_none at 0x3cc2e60>, 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:

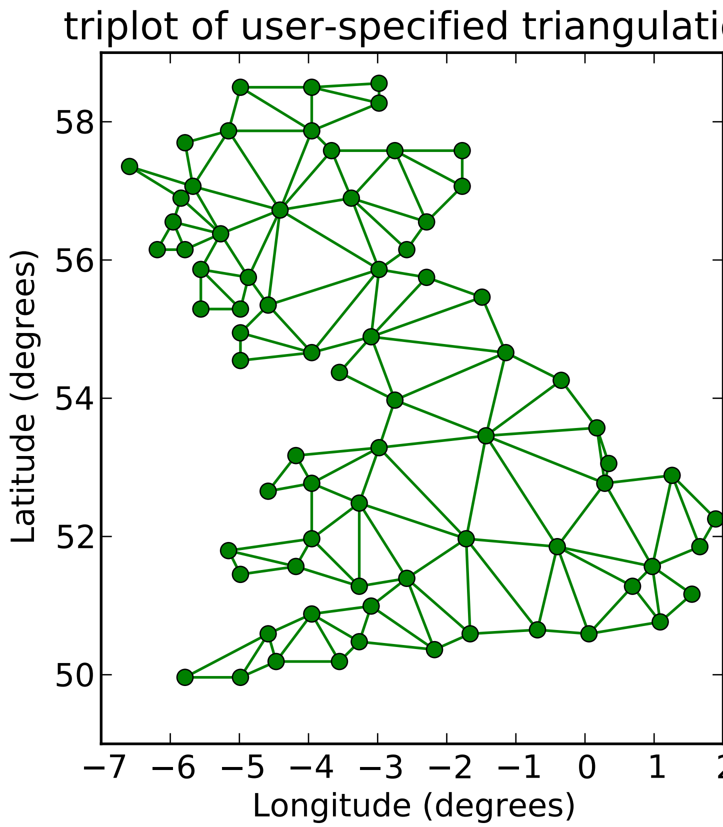
- *lags* are a length `2*maxlags+1` lag vector
- *c* is the `2*maxlags+1` auto correlation vector
- ***line* is a `Line2D` instance** returned by `plot()`.

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*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 the time zone to use in labeling dates. Defaults to rc value.

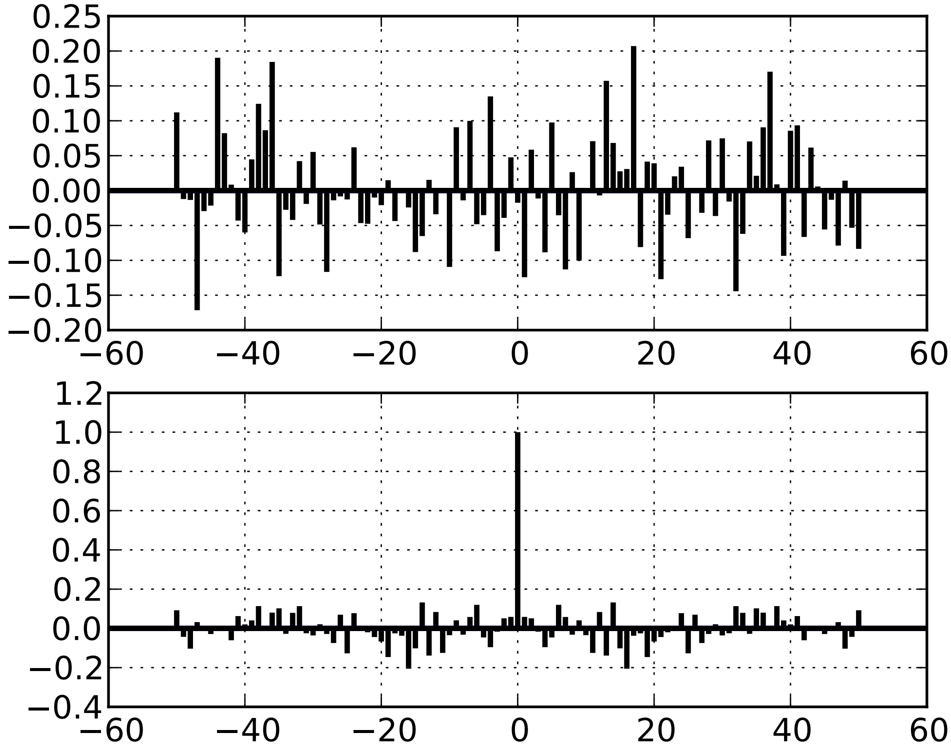
yaxis_inverted()
Returns True if the y-axis is inverted.

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.subplotpars

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*)

CHAPTER

THIRTYSIX

MATPLOTLIB AXIS

36.1 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()

Sets up x-axis ticks and labels that treat the x data as dates.

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_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 coodinate 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* is *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, labelsize=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 occured 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

set_view_interval(*vmin, vmax, ignore=False*)

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 occured 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.

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_data_interval()
return the Interval instance for this axis data limits

get_minpos()

get_view_interval()
return the Interval instance for this axis view limits

set_view_interval(*vmin, vmax, ignore=False*)

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.

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_data_interval()
return the Interval instance for this axis data limits

get_minpos()

get_view_interval()
return the Interval instance for this axis view limits

set_view_interval(*vmin, vmax, ignore=False*)

update_position(*loc*)
Set the location of tick in data coords with scalar loc

CHAPTER

THIRTYSEVEN

MATPLOTLIB CBOOK

37.1 matplotlib.cbook

A collection of utility functions and classes. Many (but not all) from the Python Cookbook – hence the name cbook

class **Bunch**(***kwds*)

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**(*signals*)

Handle registering and disconnecting for a set of signals and callbacks:

```
signals = 'eat', 'drink', 'be merry'

def oneat(x):
    print 'eat', x

def ondrink(x):
    print 'drink', x

callbacks = CallbackRegistry(signals)

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.

signals is a sequence of valid signals

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.

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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 retreived 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 **ViewVCCachedServer**(*cache_dir, baseurl*)
Bases: `urllib2.BaseHandler`

Urllib2 handler that takes care of caching files. The file cache.pck holds the directory of files that have been cached.

cache_file(*url, data, headers*)
Store a received file in the cache directory.

get_sample_data(*fname, asfileobj=True*)
Check the cachedirectory for a sample_data file. If it does not exist, fetch it with urllib from the svn repo 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.

http_error_304(*req, fp, code, msg, hdrs*)
Read the file from the cache since the server has no newer version.

http_request(*req*)
Make the request conditional if we have a cached file.

http_response(*req, response*)
Update the cache with the returned file.

in_cache_dir(*fn*)

read_cache()
Read the cache file from the cache directory.

remove_stale_files()
Remove files from the cache directory that are not listed in cache.pck.

write_cache()
Write the cache data structure into the cache directory.

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 0x30e0ed8>*)
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 svn repo

> http://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk/sample_data/

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 svn:

```
svn co https://matplotlib.svn.sourceforge.net/svnroot/matplotlib/trunk/sample_data
```

and svn add the data file you want to support. This is primarily intended for use in mpl examples that need custom data

`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 contrain size, just setitem, so use with caution

mkdirs(*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*. It *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 0x7fede617f150>, 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

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*

CHAPTER

THIRTYEIGHT

MATPLOTLIB CM

38.1 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*.

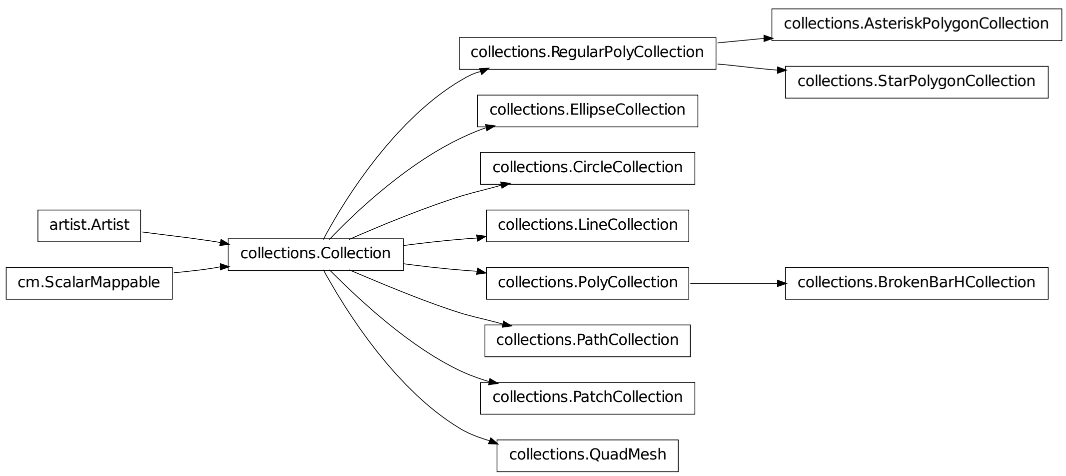
In the second case, the three arguments are passed to the `colors.LinearSegmentedColormap` initializer, and the resulting colormap is registered.

revcmap(*data*)

CHAPTER

THIRTYNINE

MATPLOTLIB COLLECTIONS



39.1 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 segemnts)

class `AsteriskPolygonCollection`(*numsides, rotation=0, sizes=(1,), **kwargs*)

Bases: `matplotlib.collections.RegularPolyCollection`

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^2

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^2

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 ith 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 tranparencies 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(*pickradius*)

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 ith 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` 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 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, **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.

set_paths(*paths*)

class **PolyCollection**(*verts, sizes=None, closed=True, **kwargs*)

Bases: `matplotlib.collections.Collection`

verts is a sequence of (*verts0*, *verts1*, ...) where *verts_i* 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_i*. 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_i* specify a unit square, then *sizes_i* is the area of that square in points^2. 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 <= m <= *meshWidth* and 0 <= n <= *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^2

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^2

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,
    )
```

CHAPTER

FORTY

MATPLOTLIB COLORBAR

40.1 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
orientation	vertical or horizontal
fraction	0.15; fraction of original axes to use for colorbar
pad	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
shrink	1.0; fraction by which to shrink the colorbar
aspect	20; ratio of long to short dimensions

All but the first of these are stripped from the input kw set.

Returns (cax, kw), the child axes and the reduced kw dictionary.

CHAPTER

FORTYONE

MATPLOTLIB COLORS

41.1 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 = '#eeefff'
```

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 len(boundaries)-2, j goes from 0 to ncolors-1.

Out-of-range values are mapped to -1 if low and 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*nx*3) adjust their color values to given the impression of a shaded relief map with a specified light source using the elevation (ny*nx). A new RGB array ((ny*nx*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 < len(colors)
```

the list will be truncated at *N*. If:

```
N > len(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*)

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`

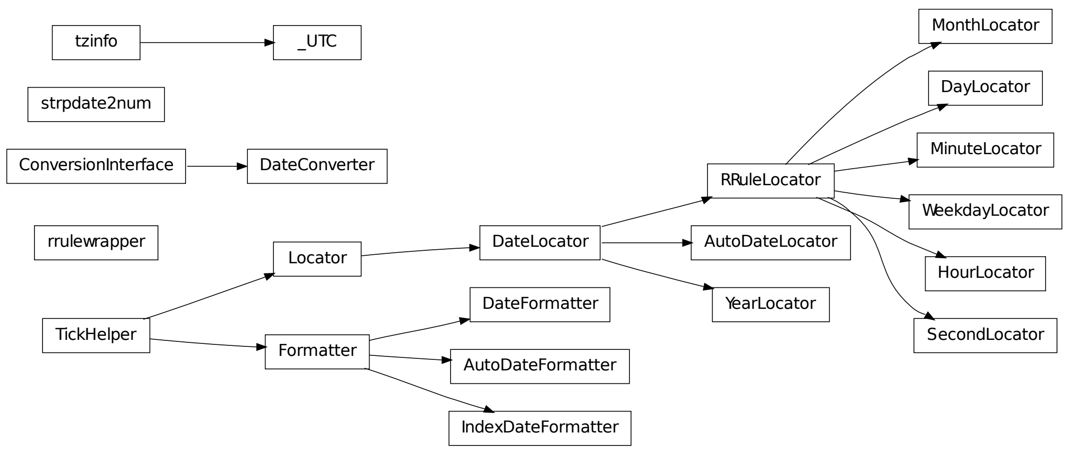
rgb2hex(*rgb*)
Given an rgb or rgba sequence of 0-1 floats, return the hex string

rgb_to_hsv(*arr*)
convert rgb values in a numpy array to hsv values input and output arrays should have shape (M,N,3)

CHAPTER

FORTYTWO

MATPLOTLIB DATES



42.1 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.

42.1.1 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 rrule 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 specifed 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.

42.1.2 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 >= 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 occurances 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 occurance.

class **WeekdayLocator**(*byweekday=1, interval=1, tz=None*)
Bases: `matplotlib.dates.RRuleLocator`

Make ticks on occurances 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 occurances 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 occurances 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 occurances 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 occurances 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 excelent 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 Nth 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.

CHAPTER

FORTYTHREE

MATPLOTLIB FIGURE

43.1 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 `Figure`(*figsize=None, dpi=None, facecolor=None, edgecolor=None, linewidth=1.0, 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.

The figure patch is drawn by a the attribute

patch 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 a axes with axes 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()`:

```
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)   # add an Axes instance
```

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, eg. 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')
```

The Axes instance will be returned.

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 Axes instance
axes_locator	unknown
axis_bgcolor	any matplotlib color - see colors()
axis_off	unknown
axis_on	unknown
axisbelow	[*True* | *False*]
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color_cycle	unknown
contains	a callable function
cursor_props	a (*float*, *color*) tuple

Continued on next page

Table 43.1 – continued from previous page

figure	unknown
frame_on	[*True* | *False*]
gid	an id string
label	any string
lod	[True | False]
navigate	[True | False]
navigate_mode	unknown
picker	[None|float|boolean|callable]
position	unknown
rasterization_zorder	unknown
rasterized	[True | False | None]
snap	unknown
title	str
transform	Transform instance
url	a url string
visible	[True | False]
xbound	unknown
xlabel	str
xlim	len(2) sequence of floats
xmargin	unknown
xscale	['linear' | 'log' | 'symlog']
xticklabels	sequence of strings
xticks	sequence of floats
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 general 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 `Axes` instance
`axes_locator`	unknown
`axis_bgcolor`	any matplotlib color - see `colors()`
`axis_off`	unknown
`axis_on`	unknown
`axisbelow`	[*True* | *False*]
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color_cycle`	unknown
`contains`	a callable function
`cursor_props`	a (*float*, *color*) tuple
`figure`	unknown
`frame_on`	[*True* | *False*]
`gid`	an id string
`label`	any string
`lod`	[True | False]
`navigate`	[True | False]
`navigate_mode`	unknown
`picker`	[None|float|boolean|callable]
`position`	unknown
`rasterization_zorder`	unknown
`rasterized`	[True | False | None]
`snap`	unknown
`title`	str
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]

Continued on next page

Table 43.2 – continued from previous page

xbound	unknown
xlabel	str
xlim	len(2) sequence of floats
xmargin	unknown
xscale	['linear' | 'log' | 'symlog']
xticklabels	sequence of strings
xticks	sequence of floats
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

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

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

Additional keyword arguments are of two kinds:

axes properties:

Property	Description
orientation	vertical or horizontal
fraction	0.15; fraction of original axes to use for colorbar
pad	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
shrink	1.0; fraction by which to shrink the colorbar
aspect	20; ratio of long to short dimensions

colorbar properties:

Property	Description
extend	['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 set_under and set_over metho
spacing	['uniform' | 'proportional'] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.
ticks	[None | list of ticks | Locator object] If None, ticks are determined automatically from the input.
format	[None | format string | Formatter object] If None, the `ScalarFormatter` is used. If a forma string is given, e.g. '%.3f', that is used. An alternative `Formatter` object may be given instead.
drawedges	[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
boundaries	None or a sequence
values	None or a sequence which must be of length 1 less than the sequence of *boundaries*. For eac region delimited by adjacent entries in *boundaries*, the color mapped to the corresponding value in values 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:

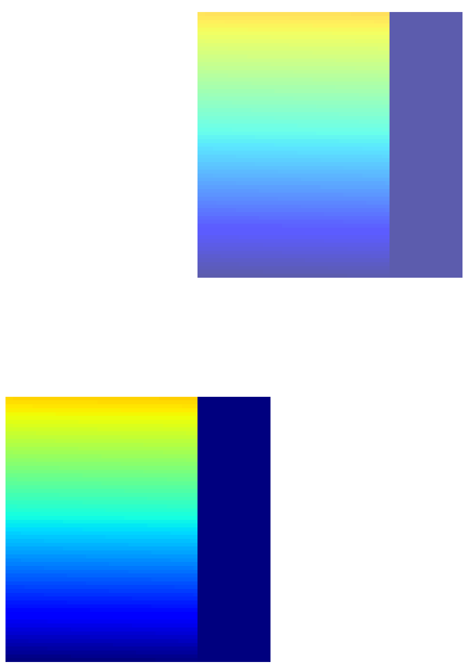
- If *X* is MxN, assume luminance (grayscale)
- If *X* is MxNx3, assume RGB
- If *X* is MxNx4, assume RGBA

Optional keyword arguments:

Keyword	Description
xo or yo	An integer, the *x* and *y* image offset in pixels
cmap	a `matplotlib.cm.ColorMap` instance, eg cm.jet. If None, default to the rc `image.cmap` value
norm	a `matplotlib.colors.Normalize` instance. The default is normalization(). 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 norm instance, the settings for *vmin* and *vmax* 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 rc image.origin 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
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 Axes instance
axes_locator	unknown
axis_bgcolor	any matplotlib color - see colors()
axis_off	unknown
axis_on	unknown
axisbelow	[*True* | *False*]
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color_cycle	unknown
contains	a callable function
cursor_props	a (*float*, *color*) tuple
figure	unknown
frame_on	[*True* | *False*]
gid	an id string
label	any string
lod	[True | False]
navigate	[True | False]
navigate_mode	unknown
picker	[None|float|boolean|callable]
position	unknown
rasterization_zorder	unknown
rasterized	[True | False | None]
snap	unknown
title	str
transform	Transform instance
url	a url string
visible	[True | False]
xbound	unknown
xlabel	str
xlim	len(2) sequence of floats
xmargin	unknown
xscale	['linear' | 'log' | 'symlog']

Continued on next page

Table 43.3 – continued from previous page

xticklabels	sequence of strings
xticks	sequence of floats
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

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 overriden 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

Example:

savefig(**args, **kwargs*)

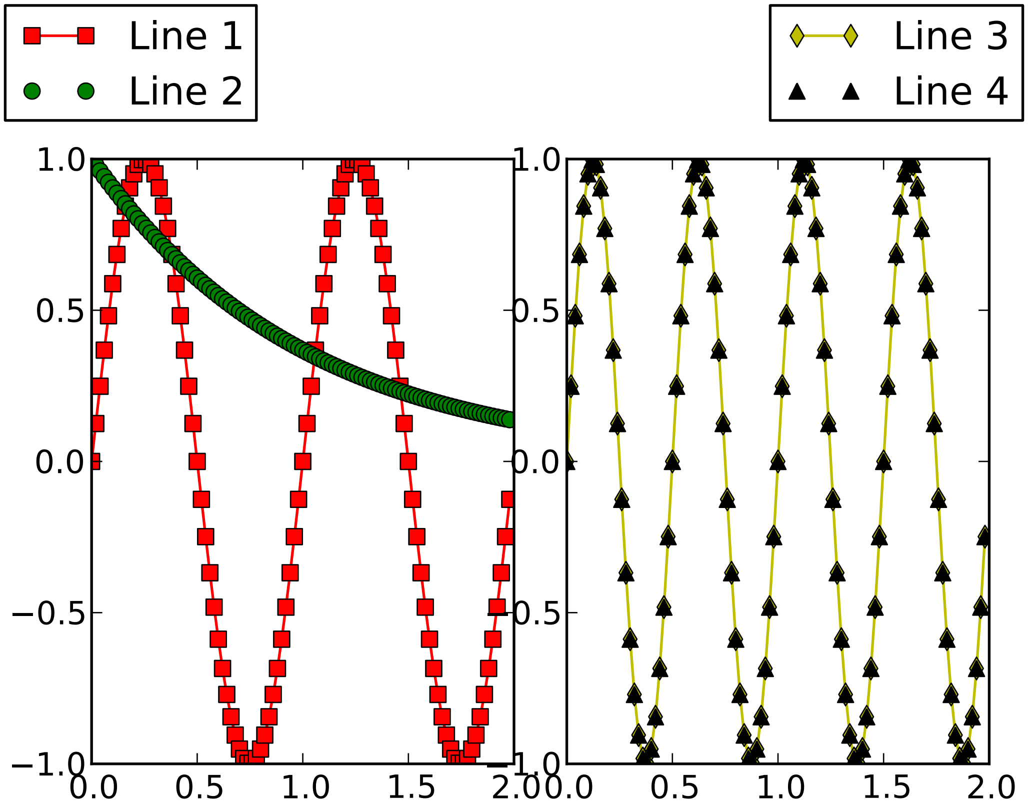
call signature:

```
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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
backgroundcolor	any matplotlib color
bbox	rectangle prop dict
clip_box	a matplotlib.transforms.Bbox instance

Table 43.4 – continued fror

clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	any matplotlib color
contains	a callable function
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	any number

waitforbuttonpress(*timeout=-1*)

call signature:

```
waitforbuttonpress(self, timeout=-1)
```

Blocking call to interact with the figure.

This will return True is 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 with 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

CHAPTER

FORTYFOUR

MATPLOTLIB FONT_MANAGER

44.1 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*)

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, is 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'

OSXFontDirectory()
Return the system font directories for OS X. This is done by starting at the list of hardcoded paths in `OSXFontDirectories` and returning all nested directories within them.

OSXInstalledFonts(*directory=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_fontext_synonyms(*fontext*)
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.

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, fontext='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 *fontext* == 'afm'.

x11FontDirectory()
Return the system font directories for X11. This is done by starting at the list of hardcoded paths in `X11FontDirectories` and returning all nested directories within them.

44.2 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.

CHAPTER

FORTYFIVE

MATPLOTLIB GRIDSPEC

45.1 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.

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 ros 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 SuplotSpec 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 inheirted. 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.

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 stars from 0.

get_geometry()
get the subplot geometry, eg 2,2,3. Unlike SuplorParams, index is 0-based

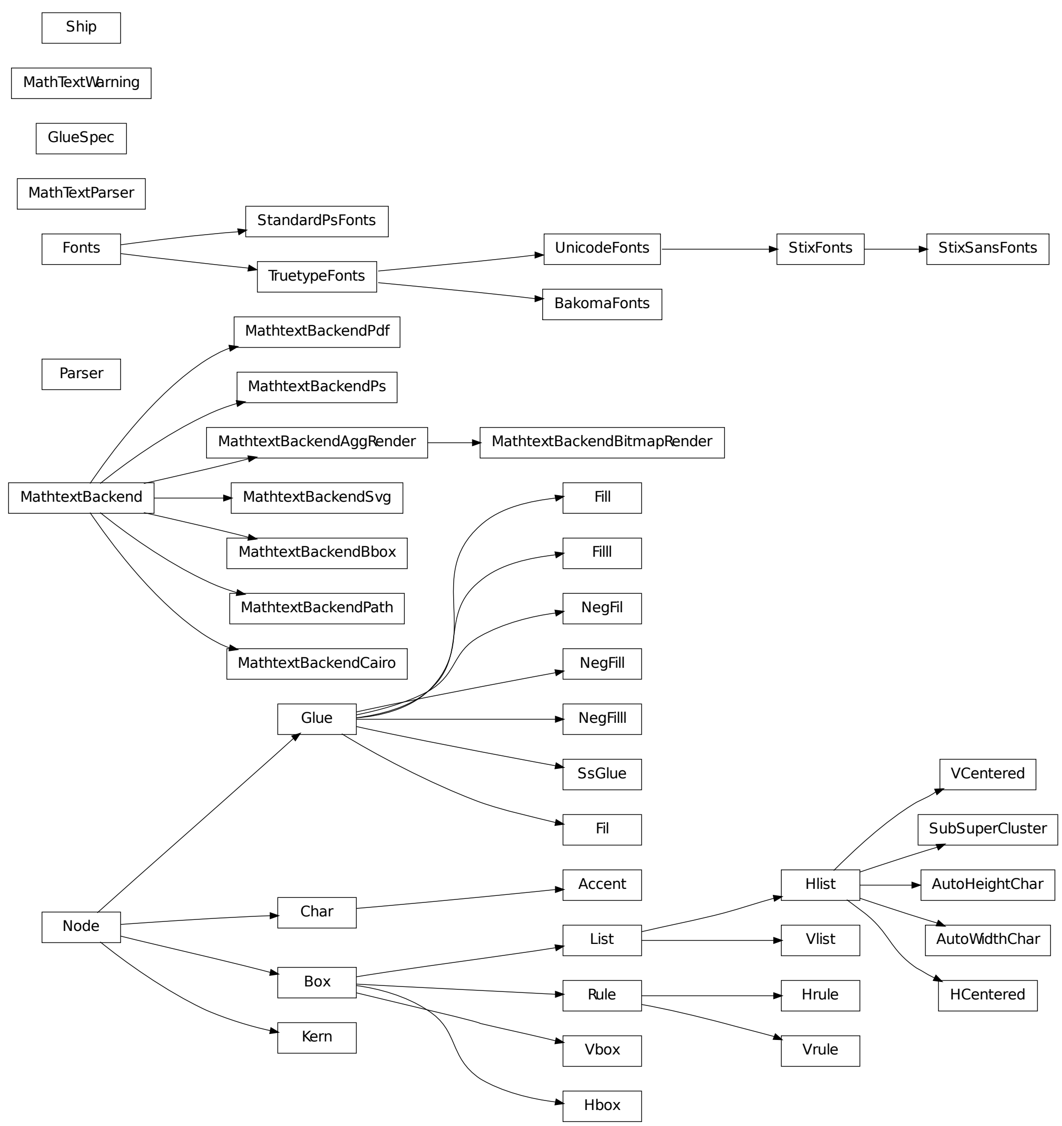
get_gridspec()

get_position(*fig, return_all=False*)
update the subplot position from fig.subplotpars

CHAPTER

FORTYSIX

MATPLOTLIB MATHTEXT



46.1 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, 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 Cairo backend.

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_dropsub(*nucleus*)

is_overunder(*nucleus*)

is_slanted(*nucleus*)

math(*s, loc, toks*)

non_math(*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').

`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.

CHAPTER

FORTYSEVEN

MATPLOTLIB MLAB

47.1 matplotlib.mlab

Numerical python functions written for compatability with MATLAB commands with the same names.

47.1.1 MATLAB compatible functions

`cohere()` Coherence (normalized cross spectral density)

`csd()` Cross spectral density uing 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 uing 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)

47.1.2 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

47.1.3 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 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()
```

47.1.4 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 freqeuently 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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, noverlap=0, pad_to=None, sides='default', scale_by_freq=None*)
The coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \tag{47.1}$$

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.

***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 is it 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 Hz^-1. This allows for integration over the returned frequency values. The default is True for MATLAB compatibility.

The return value is the tuple (Cxy, f), where f are the frequencies of the coherence vector. For cohere, 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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, noverlap=0, preferSpeedOverMemory=True, progressCallback=<function donothing_callback at 0x3cc5cf8>, 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 performace gains over calling `cohere()` for each pair, and will use subtantially 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 -> coherence vector for that pair. I.e., `Cxy[(i,j) = cohere(X[:,i], X[:,j])`. Number of dictionary keys is `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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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 *Pxy*, with a scaling to correct for power loss due to windowing.

If len(*x*) < *NFFT* or 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.

***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 is it 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 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%20o

`distances_along_curve`(*X*)
Computes the distance between a set of successive points in *N* dimensions.

Where X is an M x 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*.

$$\sum p_i \log_2(p_i) \tag{47.2}$$

where p_i is the probability of observing y in the i^{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(200000)
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 0x3cc2e60>, window=<function window_none at 0x3cc2140>*)

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 *xfin* <= *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_tookits.natgrid`) has been created that provides a more robust algorithm fof 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_tookits.natgrid` only provides natural neighbor interpolation.

The natgrid matplotlib toolkit can be downloaded from 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:

```
                    /  1  if i0=i1=...=iR,
id[i0,i1,...,iR] = -|
                    \  0  otherwise.
```

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*)
: Returm 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 seperate 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=0.693147180559945*29)
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 ith 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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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.

***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 is it 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 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 or 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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, noverlap=128, pad_to=None, sides='default', scale_by_freq=None*)

Compute a spectrogram of data in *x*. Data are split into *NFFT* length segements 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 frequencie 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.

***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 is it 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 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 Meteorolocial Office, March 2006 halldor at vedur.is

Completely reworked and optimized for Python by Norbert Nemec, Institute of Theoretical Physics, University or 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

CHAPTER

FORTYEIGHT

MATPLOTLIB PATH

48.1 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*)
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.

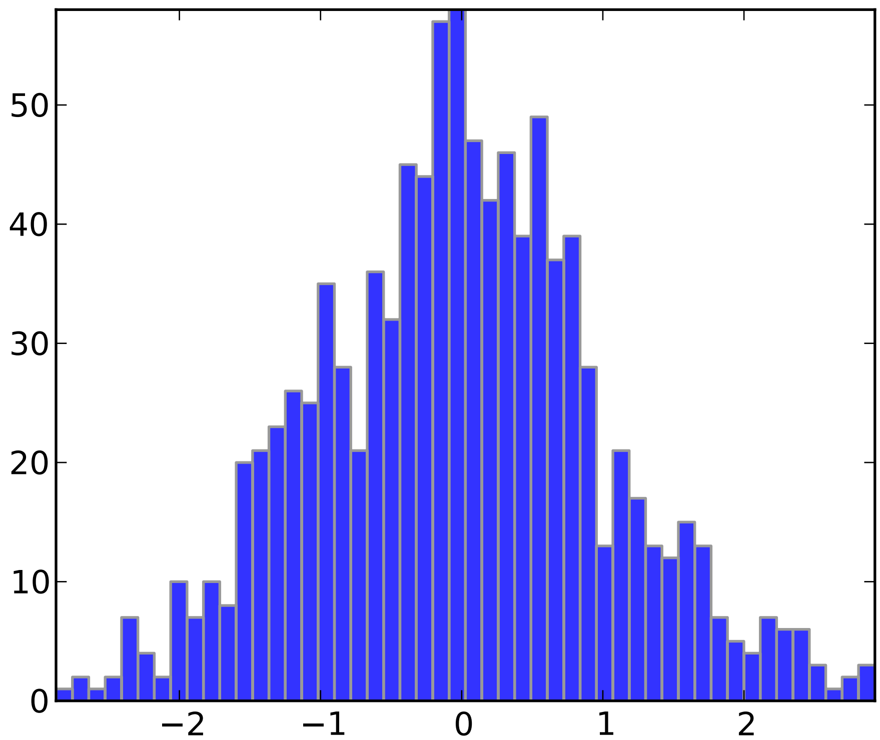
class `make_compound_path_from_polys`(*XY*)
(static method) Make a compound path object to draw a number of polygons with equal numbers of sides XY is a (numpolys x numsides x 2) numpy array of vertices. Return object is a `Path`

`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.TransformedPath 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)

CHAPTER

FORTYNINE

MATPLOTLIB PYPLOT

49.1 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*maxlags+1 lag vector
- *c* is the 2*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 $2imes\text{len}(x) - 1$ lags.

The return value is a tuple (*lags*, *c*, *linecol*, *b*) where

- *linecol* is the LineCollection
- *b* is the *x*-axis.

See Also:

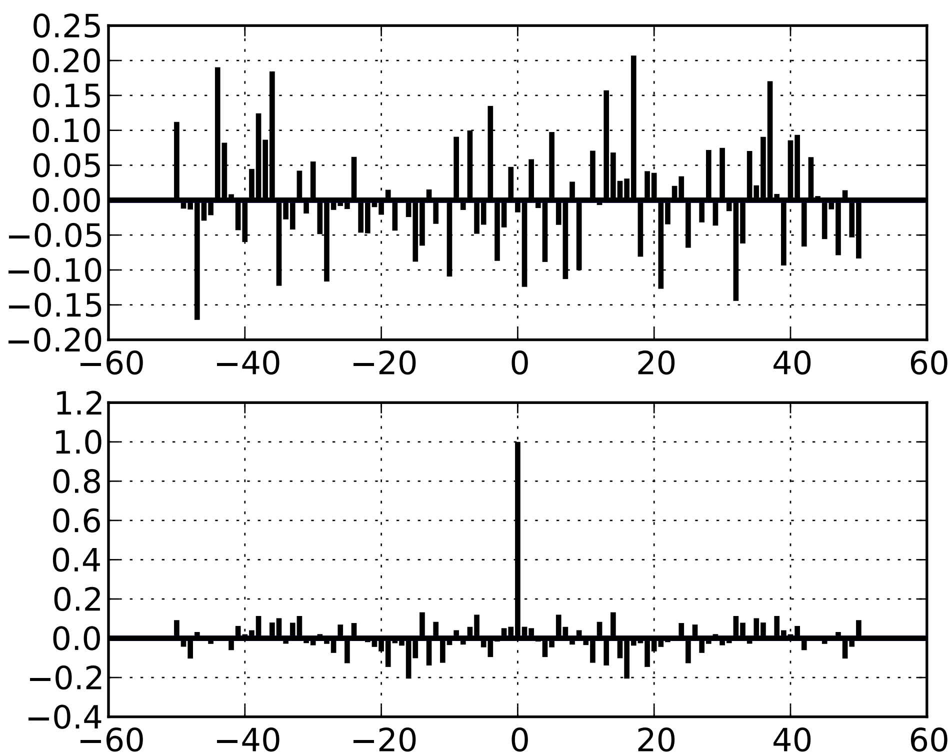
plot() or vlines()

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 shink percent of the distance *d* away from the endpoints. ie, `shrink=0.05 is 5%`
?	any key for `matplotlib.patches.polygon`

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 `matplotlib.patches.PathPatch`

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 *xy* value
'polar'	you can specify *theta*, *r* 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 contols 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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function

Table 49.1 – continued fro

family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a matplotlib.figure.Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	any number

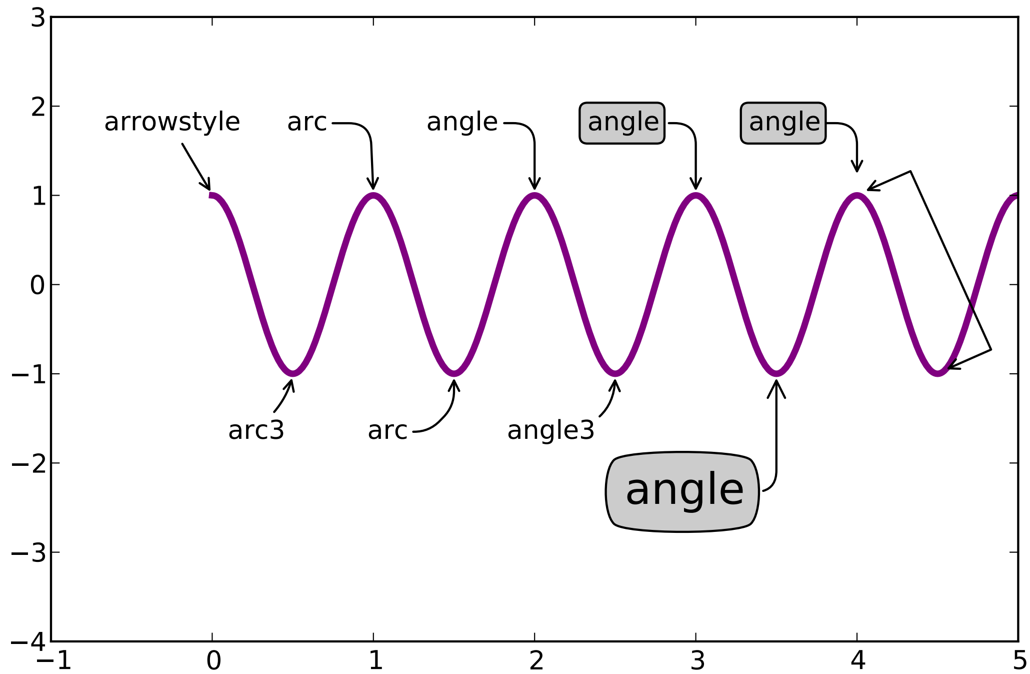
arrow(*x, y, dx, dy, hold=None, **kwargs*)

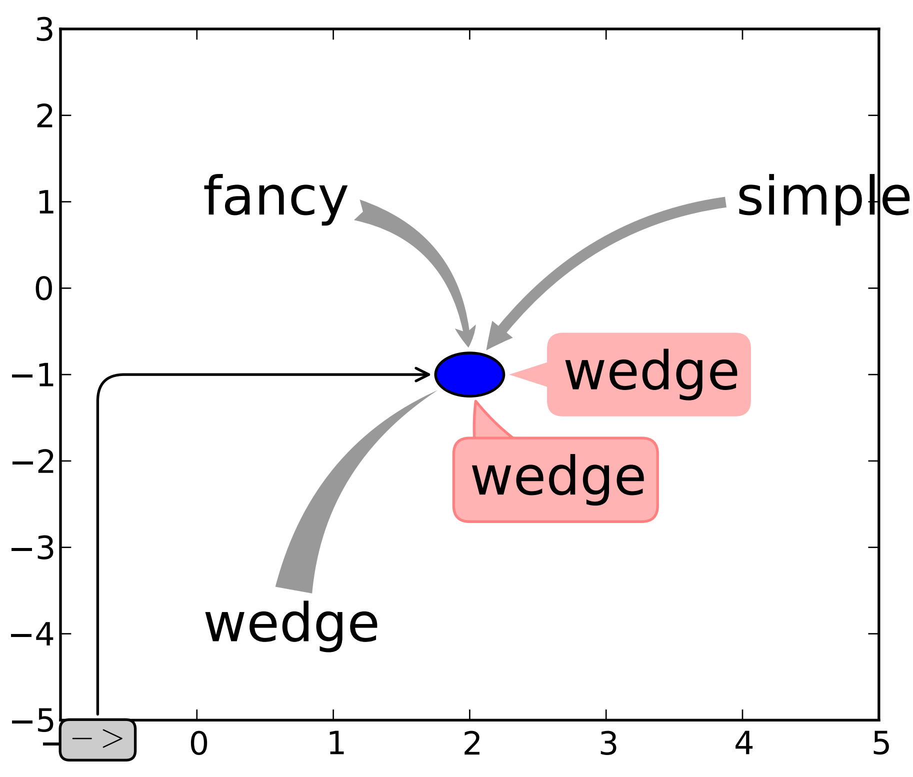
call signature:

```
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:


arrowstyle
arc
angle
angle
angle
arc3
arc
angle3
angle


fancy
simple
wedge
wedge
wedge
->

Property	Description
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

Example:

Exception occurred rendering plot.

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	Desctiption
axisbg	color	the axes background color
frameon	[True|False]	display the frame?
sharex	otherax	current axes shares xaxis attribute with otherax
sharey	otherax	current axes shares yaxis attribute with otherax
polar	[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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	any number

Example:

Additional kwargs: hold = [True|False] overrides default hold state

axis(*v, **kwargs*)

Set/Get the axis properties:

```
>>> axis()
```

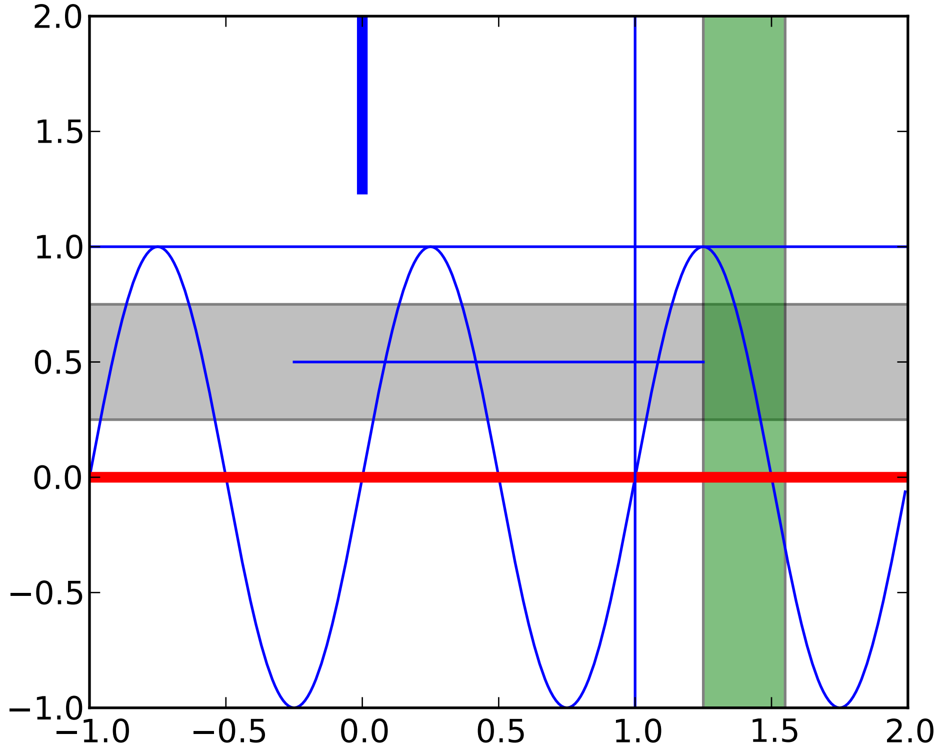
returns the current axes limits `[xmin, xmax, ymin, ymax]`.

```
>>> 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 (*xmax* - *xmin*) or (*ymax* - *ymin*). 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 *xmin*, *xmax*, *ymin*, *ymax* as kwargs selectively to alter just those limits without changing the others.

The xmin, xmax, ymin, ymax tuple is returned

See Also:

xlim(), ylim() For setting the x- and y-limits individually.

axvline(*x=0, ymin=0, ymax=1, hold=None, **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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance

clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	any number

See Also:

`axhspan()` for example plot and source code

Additional kwargs: hold = [True|False] overrides default hold state

bar(*left, height, width=0.8000000000000004, 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
left	the x coordinates of the left sides of the bars
height	the heights of the bars

Optional keyword arguments:

Keyword	Description
width	the widths of the bars
bottom	the y coordinates of the bottom edges of the bars
color	the colors of the bars
edgecolor	the colors of the bar edges
linewidth	width of bar edges; None means use default linewidth; 0 means don't draw edges.
xerr	if not None, will be used to generate errorbars on the bar chart
yerr	if not None, will be used to generate errorbars on the bar chart
ecolor	specifies the color of any errorbar
capsize	(default 3) determines the length in points of the error bar caps
error_kw	dictionary of kwargs to be passed to errorbar method. *ecolor* and *capsize* may be specified here rather than as independent kwargs.
align	'edge' (default) | 'center'
orientation	'vertical' | 'horizontal'
log	[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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or aa	[True | False] or None for default
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	matplotlib color spec
`contains`	a callable function
`edgecolor` or ec	mpl color spec, or None for default, or 'none' for no color
`facecolor` or fc	mpl color spec, or None for default, or 'none' for no color
`figure`	a `matplotlib.figure.Figure` instance
`fill`	[True | False]
`gid`	an id string
`hatch`	['/' | '\\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
`label`	any string
`linestyle` or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
`linewidth` or lw	float or None for default
`lod`	[True | False]
`path_effects`	unknown
`picker`	[None|float|boolean|callable]
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`visible`	[True | False]
`zorder`	any number

Example: A stacked bar chart.

Additional kwargs: hold = [True|False] overrides default hold state

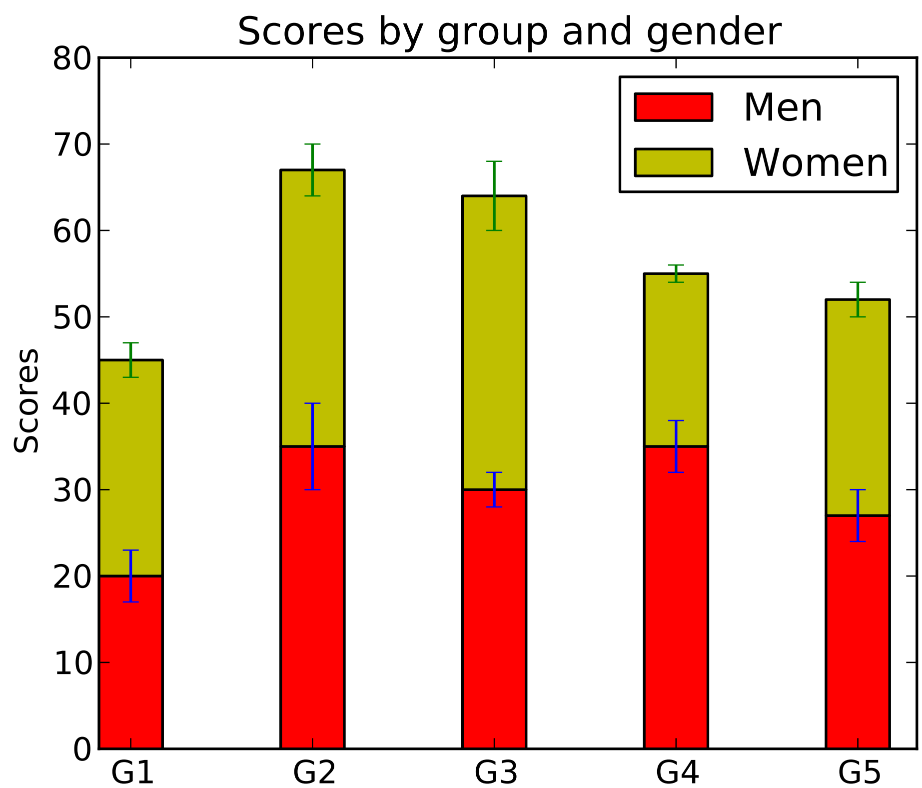
barbs(**args, **kw*)

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:

```
:     /\    \
:    /  \    \
:   /    \    \    \
:  /      \    \    \
: ------------------------------
```

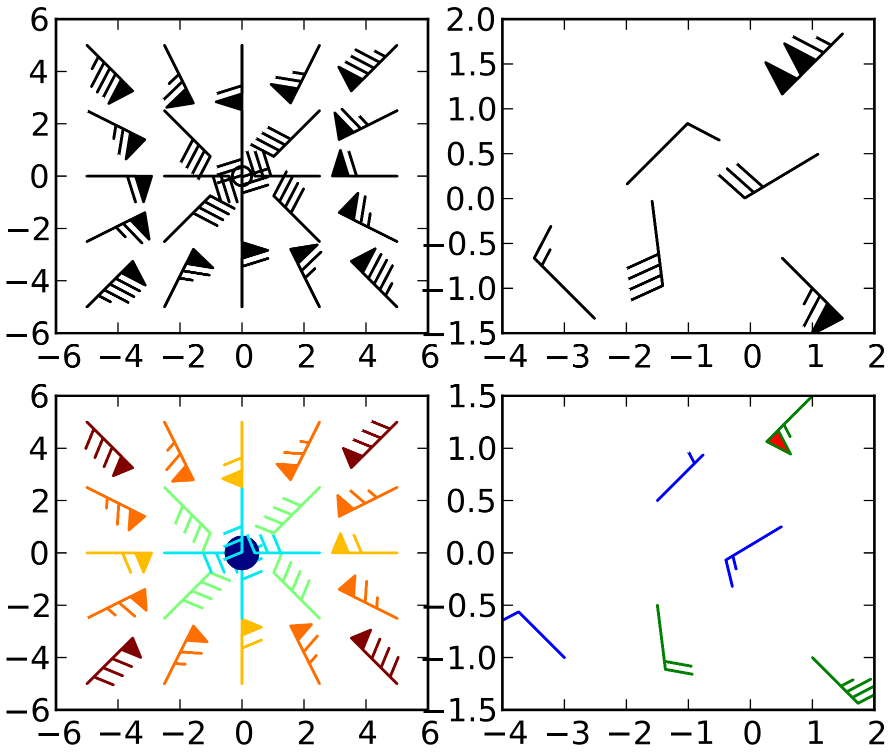
The largest increment is given by a triangle (or "flag"). After those come full lines (barbs). The smallest increment is a half line. There is only, of course, ever at most 1 half line. If the magnitude is small and only needs a single half-line and no full lines or triangles, the half-line is offset 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]
`pickradius`	unknown
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string
`urls`	unknown
`visible`	[True | False]
`zorder`	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)

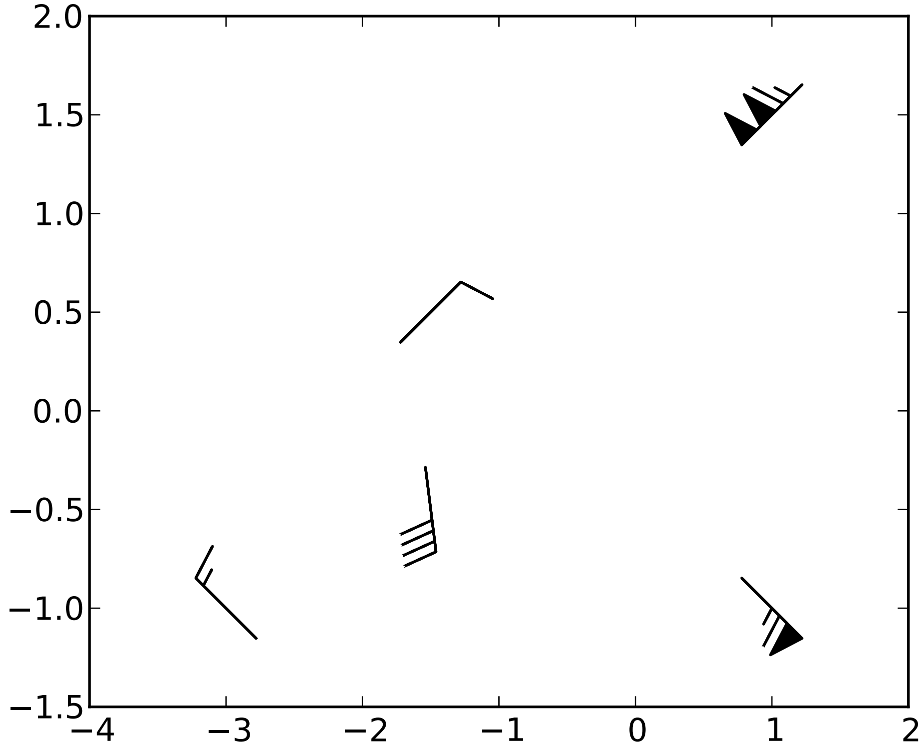
bottom, *width*, *height*, and *left* can be either scalars or sequences

Return value is a list of `matplotlib.patches.Rectangle` instances.

Required arguments:

Argument	Description
bottom	the vertical positions of the bottom edges of the bars
width	the lengths of the bars

Optional keyword arguments:



Keyword	Description
height	the heights (thicknesses) of the bars
left	the x coordinates of the left edges of the bars
color	the colors of the bars
edgecolor	the colors of the bar edges
linewidth	width of bar edges; None means use default linewidth; 0 means don't draw edges.
xerr	if not None, will be used to generate errorbars on the bar chart
yerr	if not None, will be used to generate errorbars on the bar chart
ecolor	specifies the color of any errorbar
capsize	(default 3) determines the length in points of the error bar caps
align	'edge' (default) | 'center'
log	[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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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 it's 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:

Additional kwargs: hold = [True|False] overrides default hold state

broken_barh(*xranges, yrange, hold=None, **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
xranges	sequence of (*xmin*, *xwidth*)
yrange	sequence of (*ymin*, *ywidth*)

kwargs are `matplotlib.collections.BrokenBarHCollection` properties:

Property	Description
	Continued on next page

Table 49.5 – continued from previous page

agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	any number

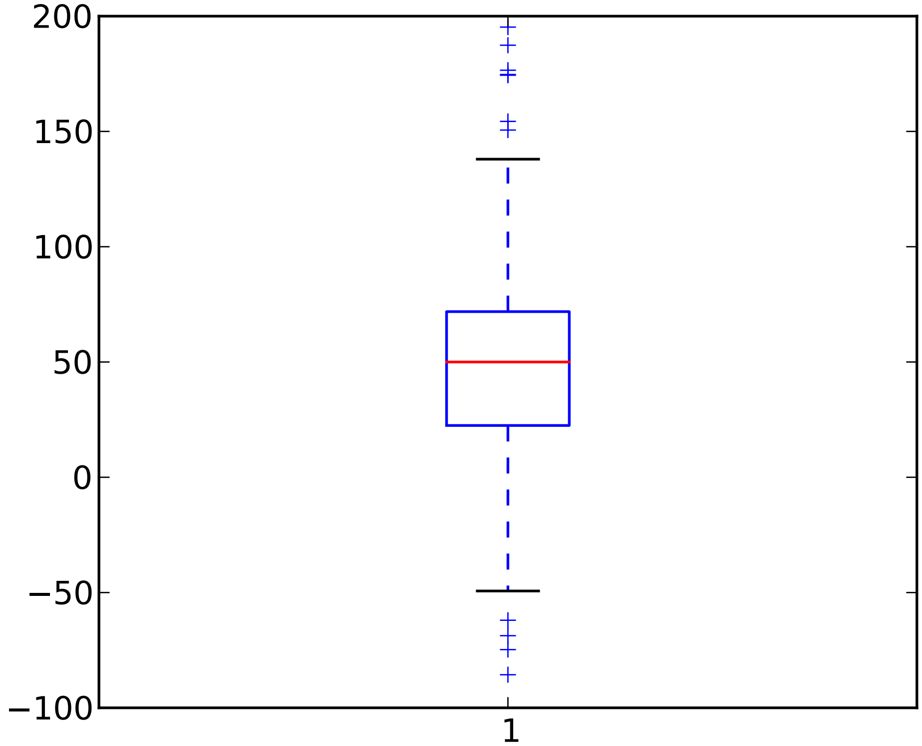
these can either be a single argument, ie:

```
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)
```

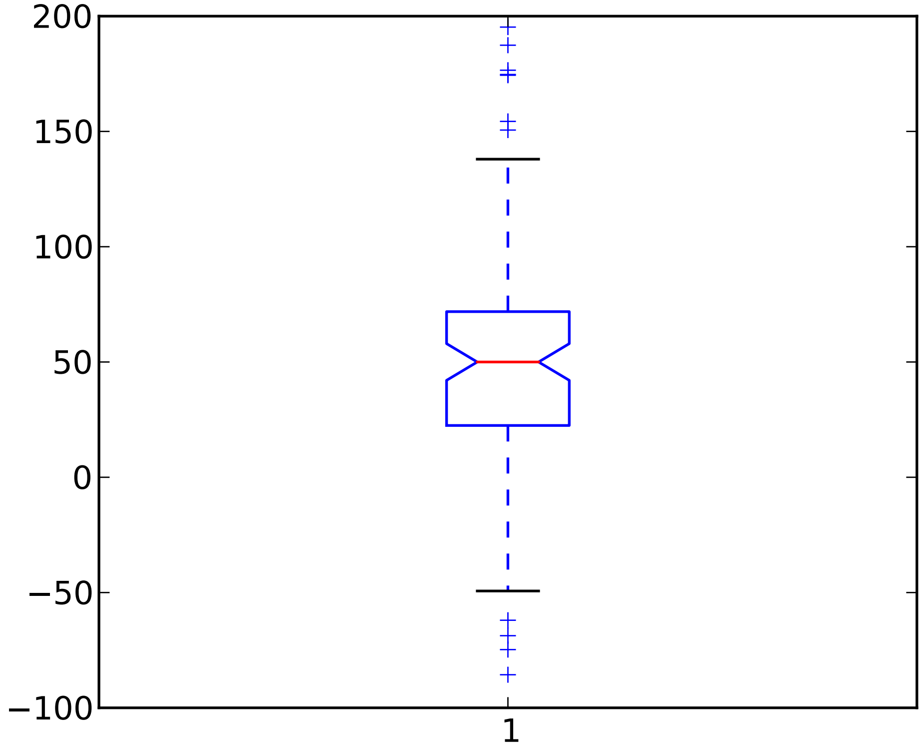
only labels contours listed in *v*.

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*.

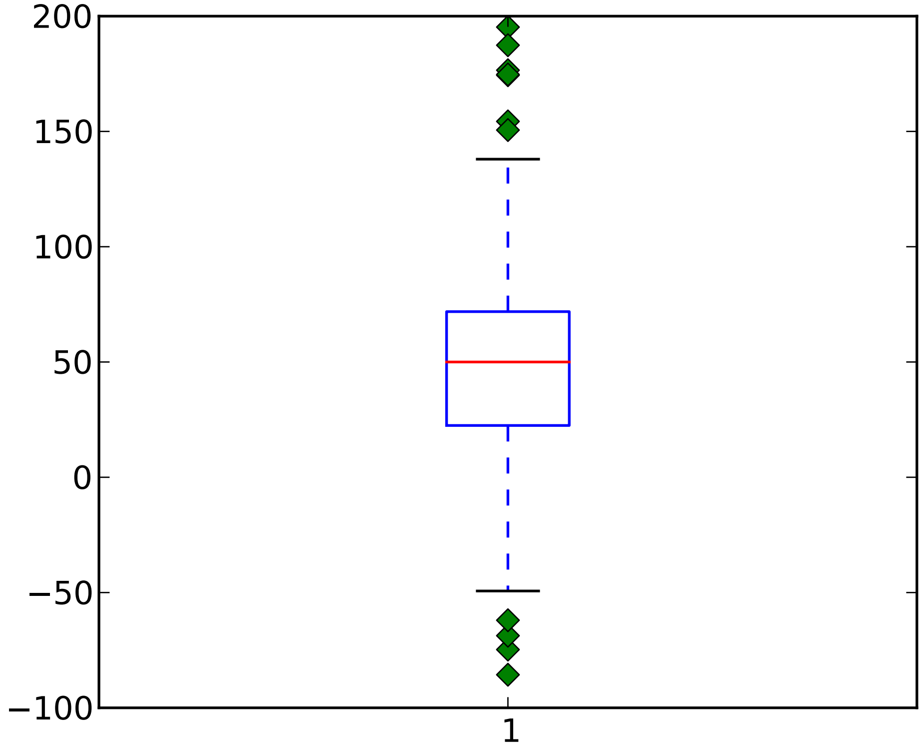
***inline_spacing*:** space in pixels to leave on each side of label when placing inline. Defaults to 5. This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

***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)

***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 draw-



ing 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.

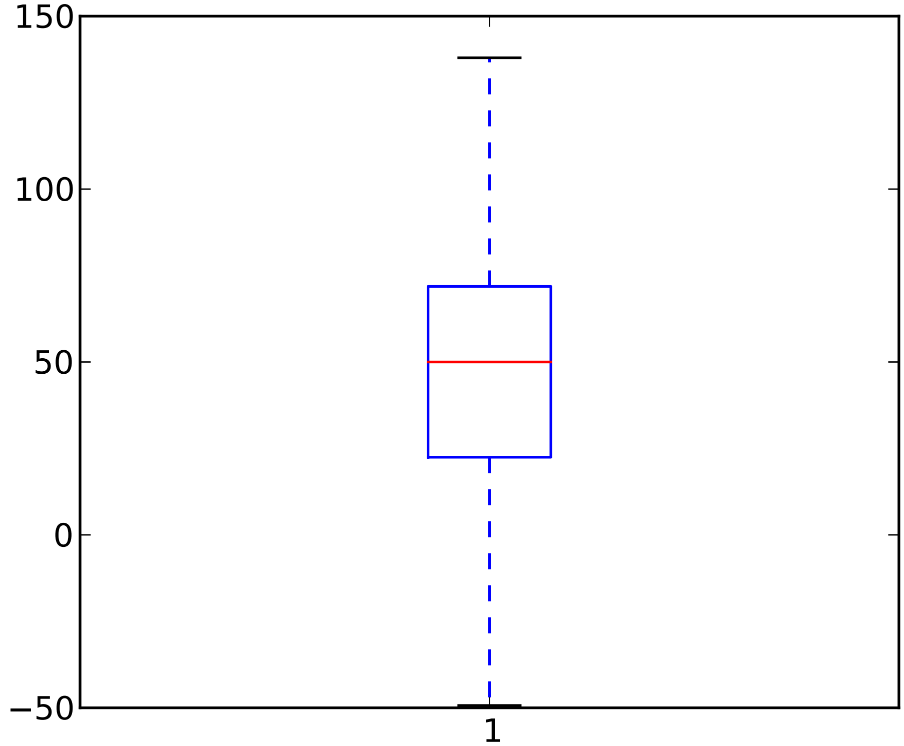
If you want to set the clim of multiple images, use, for example:

```
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(num)` closes figure number *num*

`close(h)` where *h* is a `Figure` instance, closes that figure

`close('all')` closes all the figure windows

cohere(*x, y, NFFT=256, Fs=2, Fc=0, detrend=<function detrend_none at 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, noverlap=0, pad_to=None, sides='default', scale_by_freq=None, hold=None, **kwargs*)

call signature:

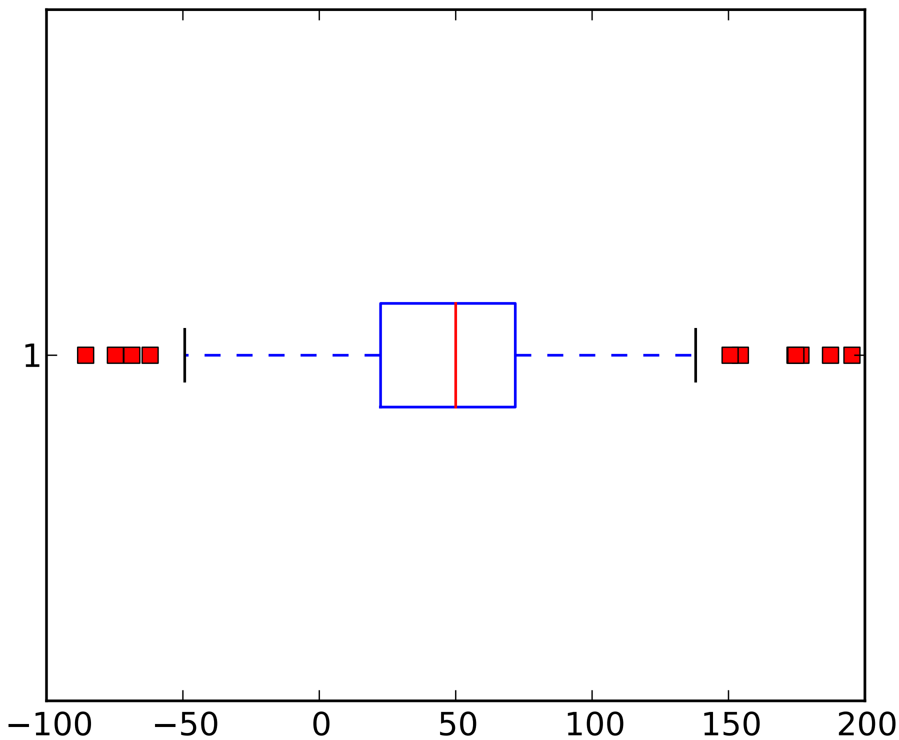
```
cohere(x, y, NFFT=256, Fs=2, Fc=0, detrend = mlab.detrend_none,
       window = mlab.window_hanning, noverlap=0, pad_to=None,
       sides='default', scale_by_freq=None, **kwargs)
```

`cohere()` the coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \tag{49.1}$$

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.



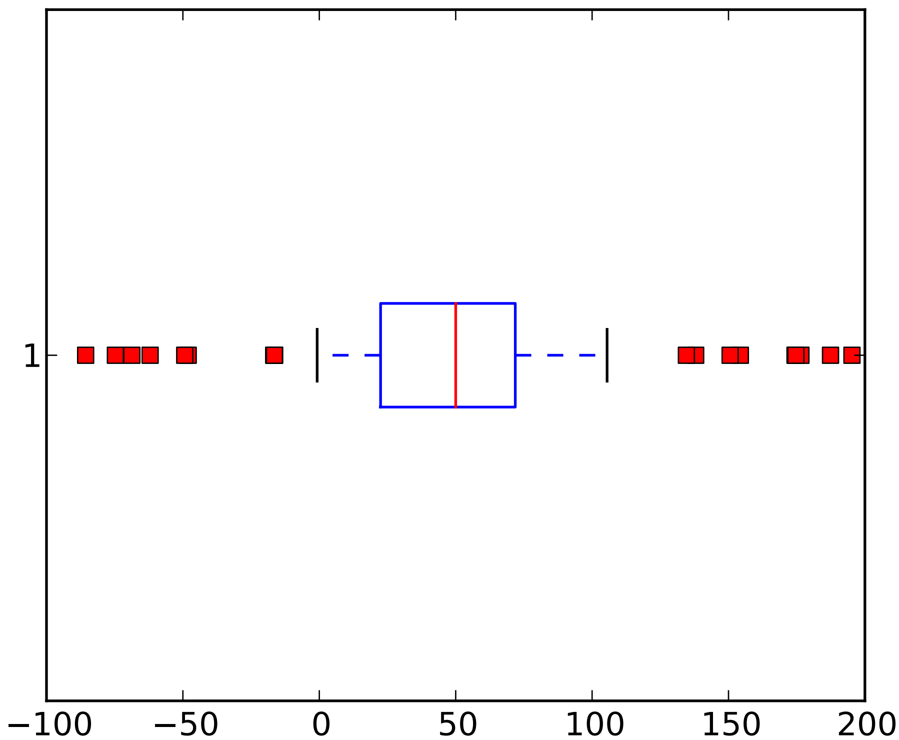
***Fs*: scalar** The sampling frequency (samples per time unit). It is used to calculate the Fourier frequencies, freqs, in cycles per time unit. The default value is 2.

***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 is it 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 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.

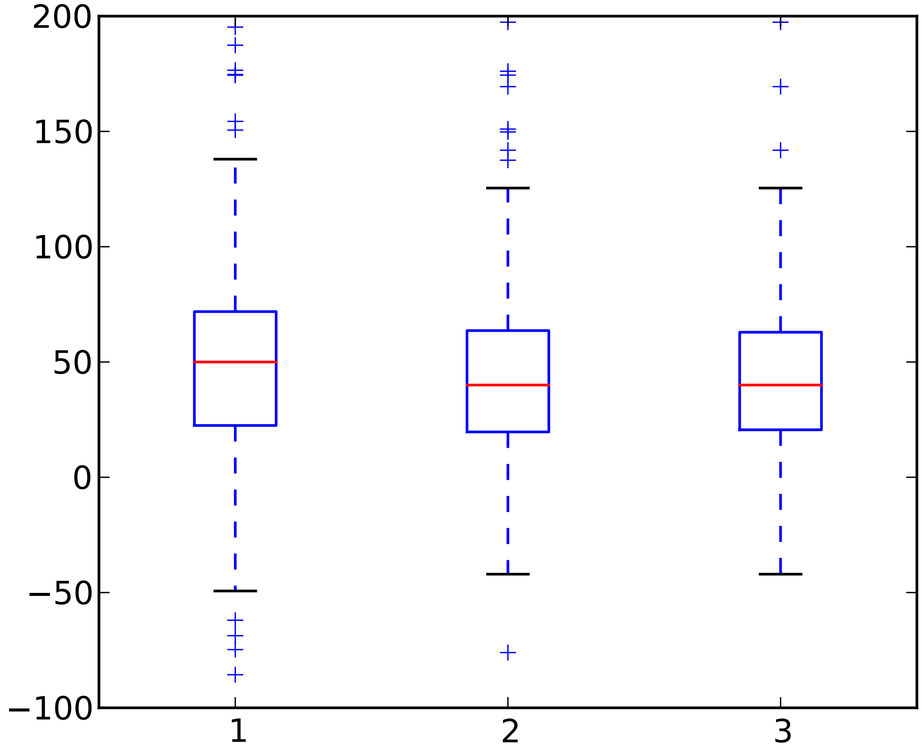
The return value is a tuple (Cxy, f), where f are the frequencies of the coherence vector.

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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string

linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a `matplotlib.transforms.Transform` instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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:

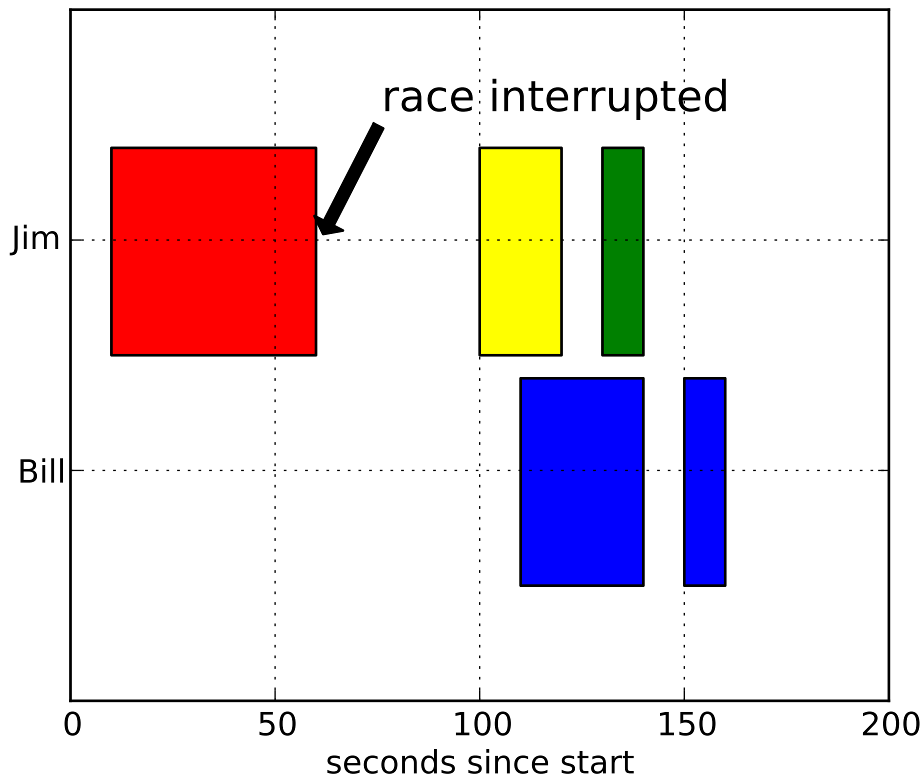
```
colorbar(**kwargs)
colorbar(mappable, **kwargs)
colorbar(mappable, cax=cax, **kwargs)
colorbar(mappable, ax=ax, **kwargs)
```

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



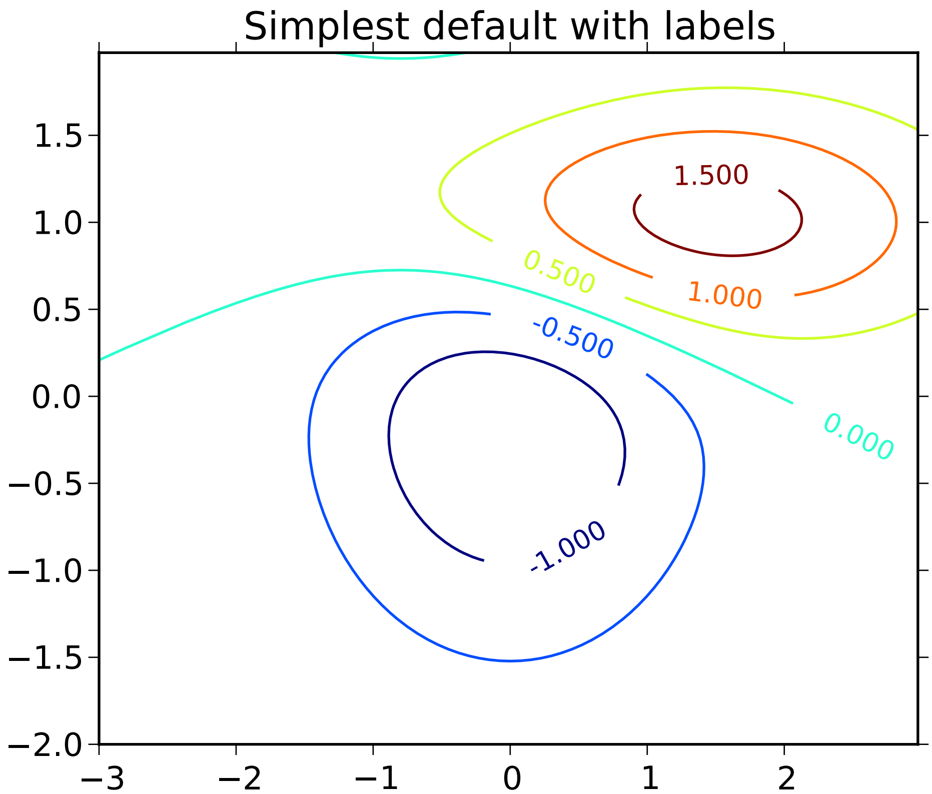
ax None | parent axes object from which space for a new colorbar axes will be stolen

Additional keyword arguments are of two kinds:

axes properties:

Property	Description
orientation	vertical or horizontal
fraction	0.15; fraction of original axes to use for colorbar
pad	0.05 if vertical, 0.15 if horizontal; fraction of original axes between colorbar and new image axes
shrink	1.0; fraction by which to shrink the colorbar
aspect	20; ratio of long to short dimensions

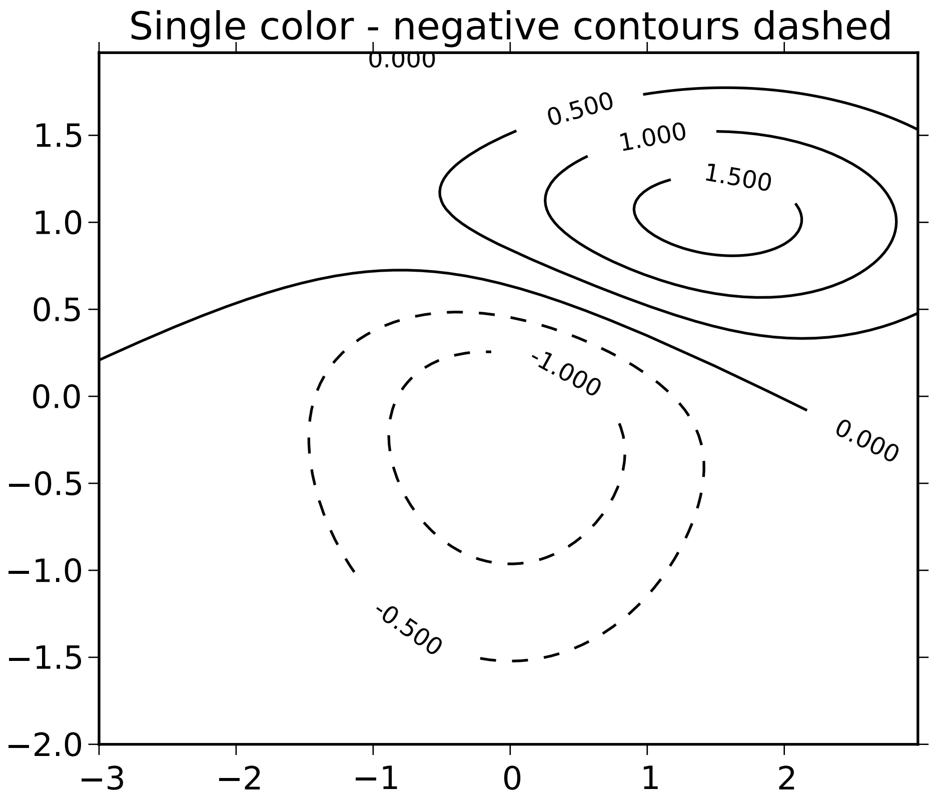
colorbar properties:



Property	Description
extend	['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 set_under and set_over methods.
spacing	['uniform' | 'proportional'] Uniform spacing gives each discrete color the same space; proportional makes the space proportional to the data interval.
ticks	[None | list of ticks | Locator object] If None, ticks are determined automatically from the input.
format	[None | format string | Formatter object] If None, the `ScalarFormatter` is used. If a format string is given, e.g. '%.3f', that is used. An alternative `Formatter` object may be given instead.
drawedges	[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
boundaries	None or a sequence
values	None or a sequence which must be of length 1 less than the sequence of *boundaries*. For each region delimited by adjacent entries in *boundaries*, the color mapped to the corresponding value in values 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*.

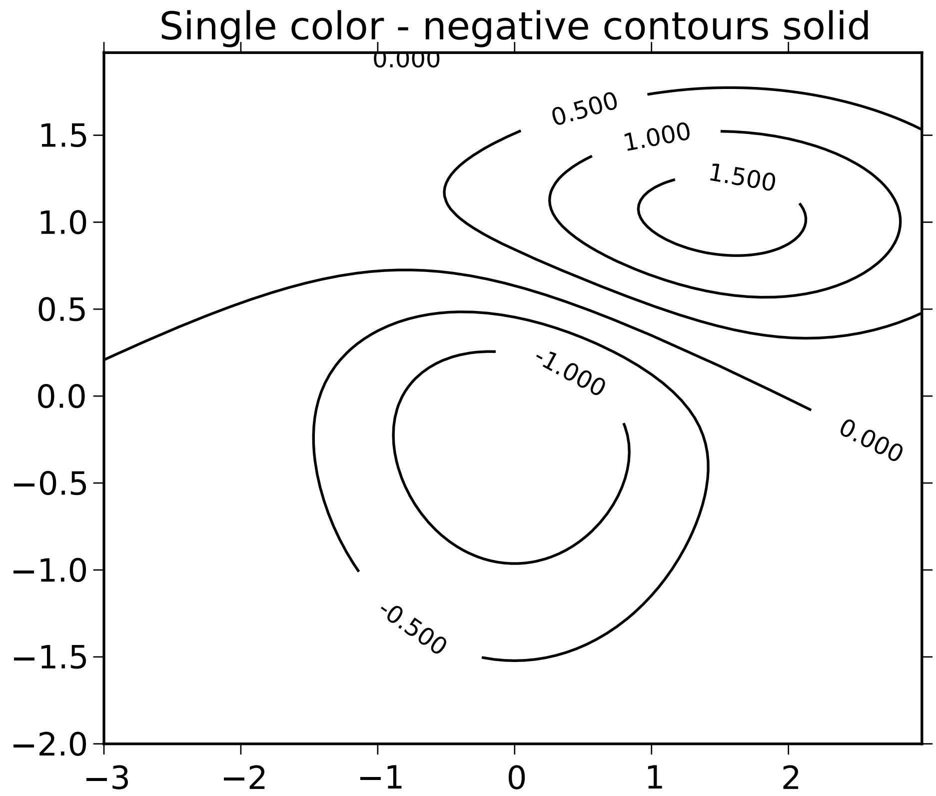
For more precise control, you can manually specify the positions of the axes objects in which the mappable and the colorbar are drawn. In this case, do not use any of the axes properties kwargs.

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



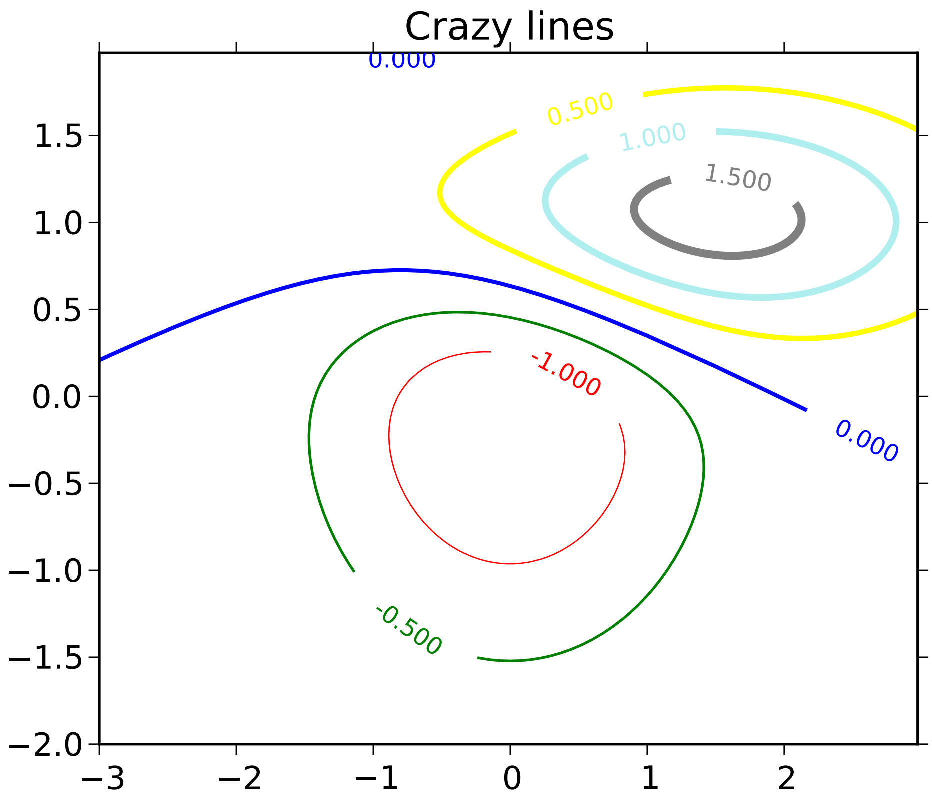
- hot
- hsv
- jet
- pink
- prism
- spring
- summer
- winter
- spectral

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()

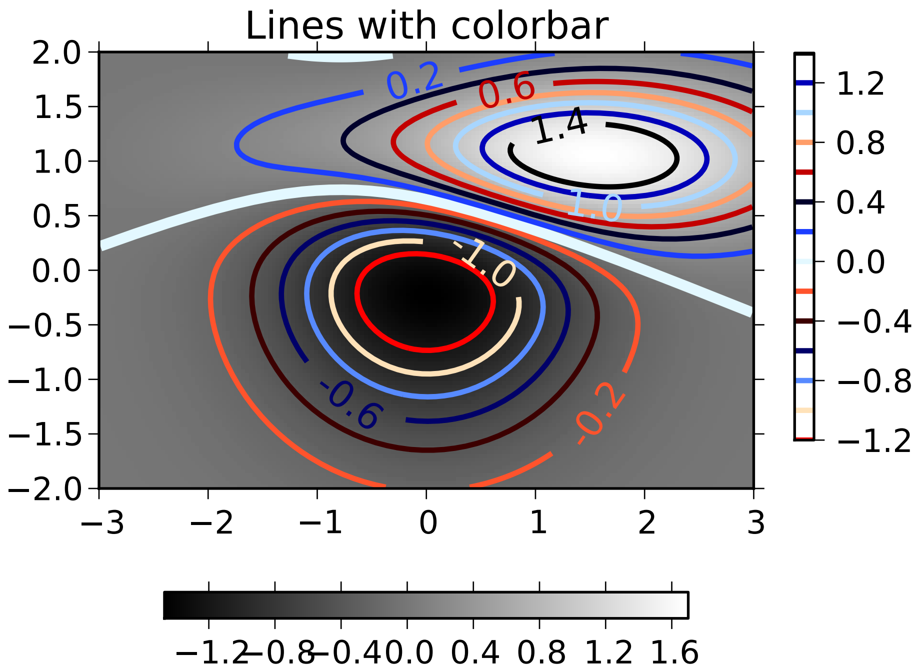
This is a do-nothing function to provide you with help on how matplotlib handles colors.

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 = '#eeefff'
```



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 turqoise title:

```
title('Is this the best color?', color='#afeeee')
```

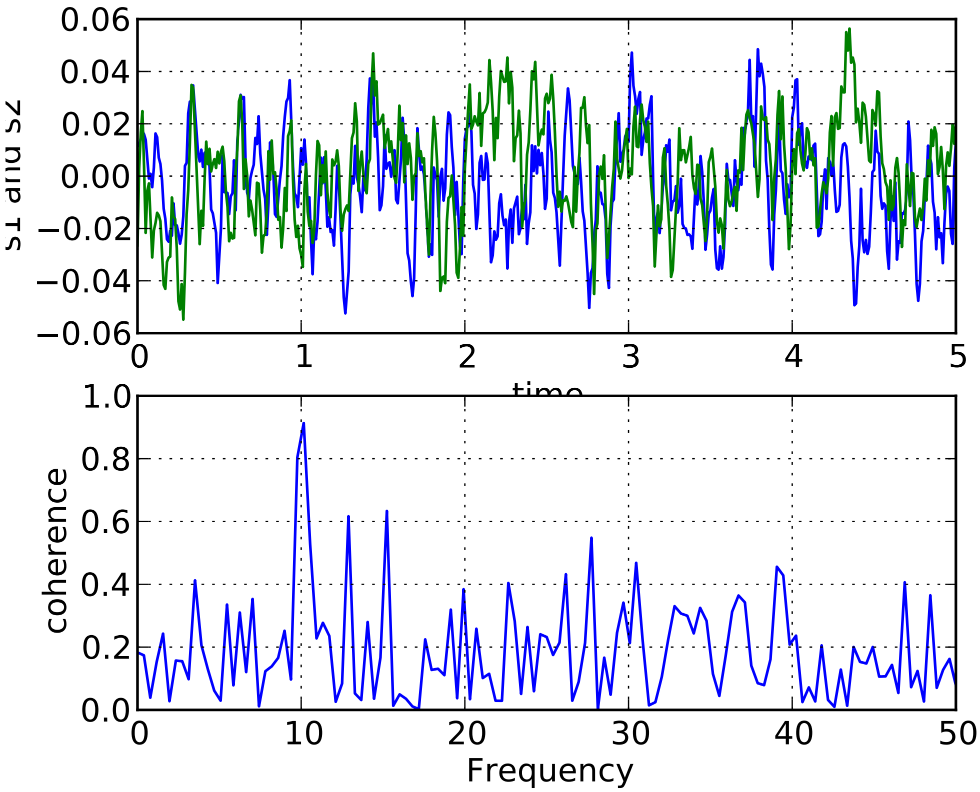
connect(*s, func*)

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, *Y*, and *Z* must be arrays with the same dimensions.

Z may be a masked array, but filled contouring may not handle internal masked regions correctly.

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`.

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:

***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: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

```
z1 < z <= 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()`.

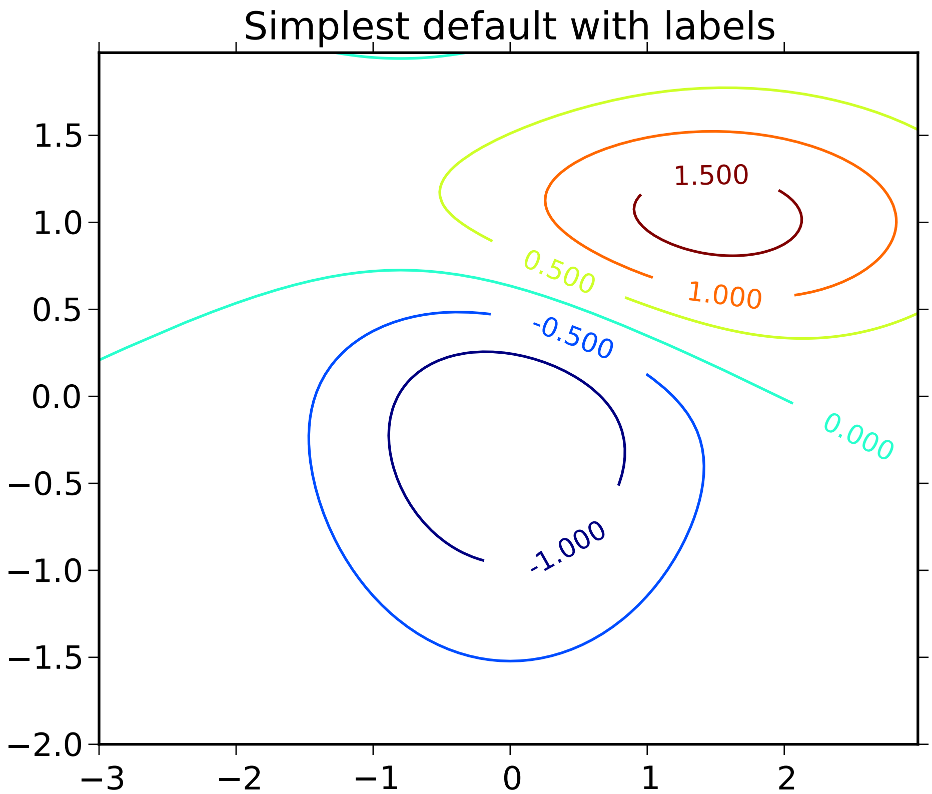
call signatures:

```
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 (len(*V*)-1) regions between the values in *V*

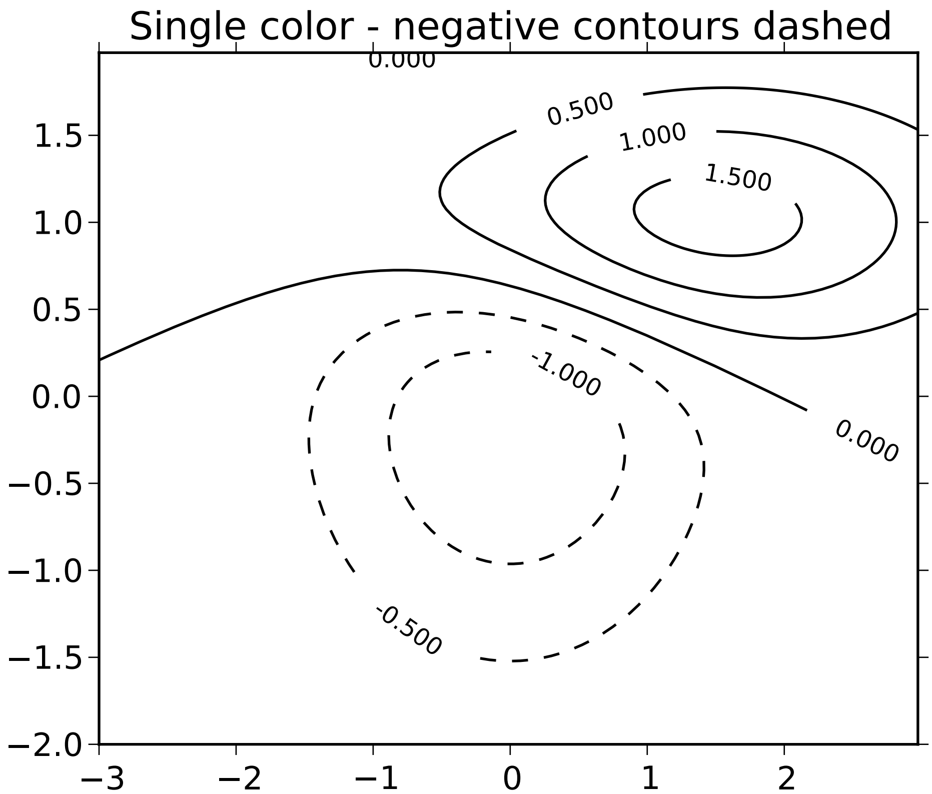
```
contour(Z, **kwargs)
```

Use keyword args to control colors, linewidth, origin, cmap ... see below for more details.

X, *Y*, and *Z* must be arrays with the same dimensions.

Z may be a masked array, but filled contouring may not handle internal masked regions correctly.

`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

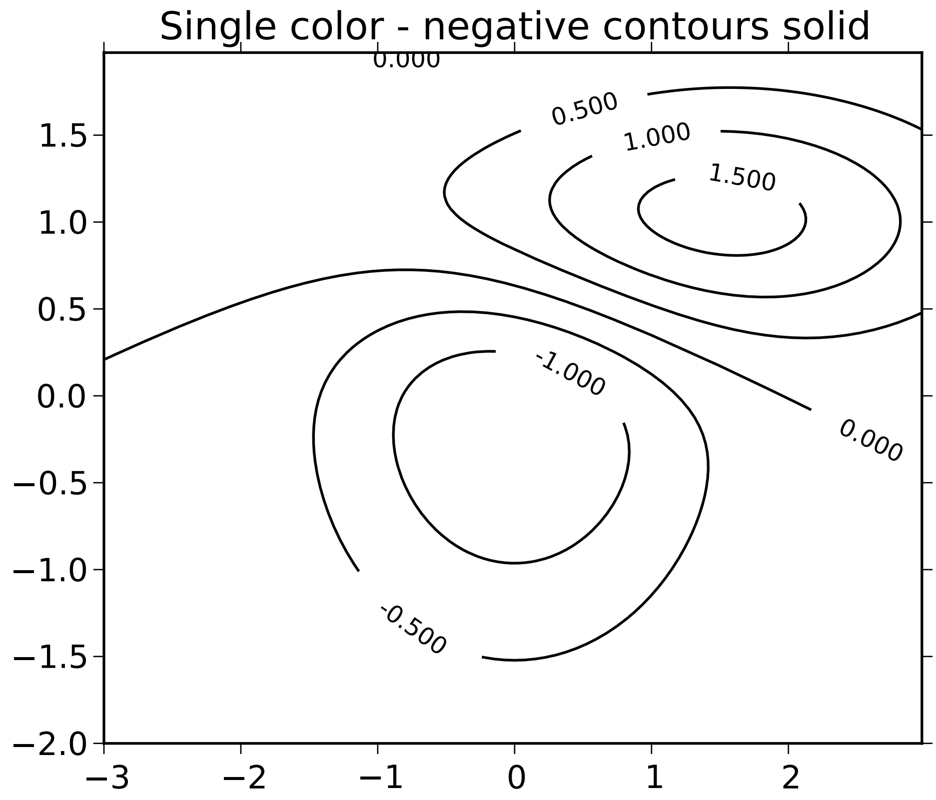
***cmap*: [None | Colormap]** A cm `Colormap` instance or *None*. If *cmap* is *None* and *colors* is *None*, a default Colormap is used.

***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)]

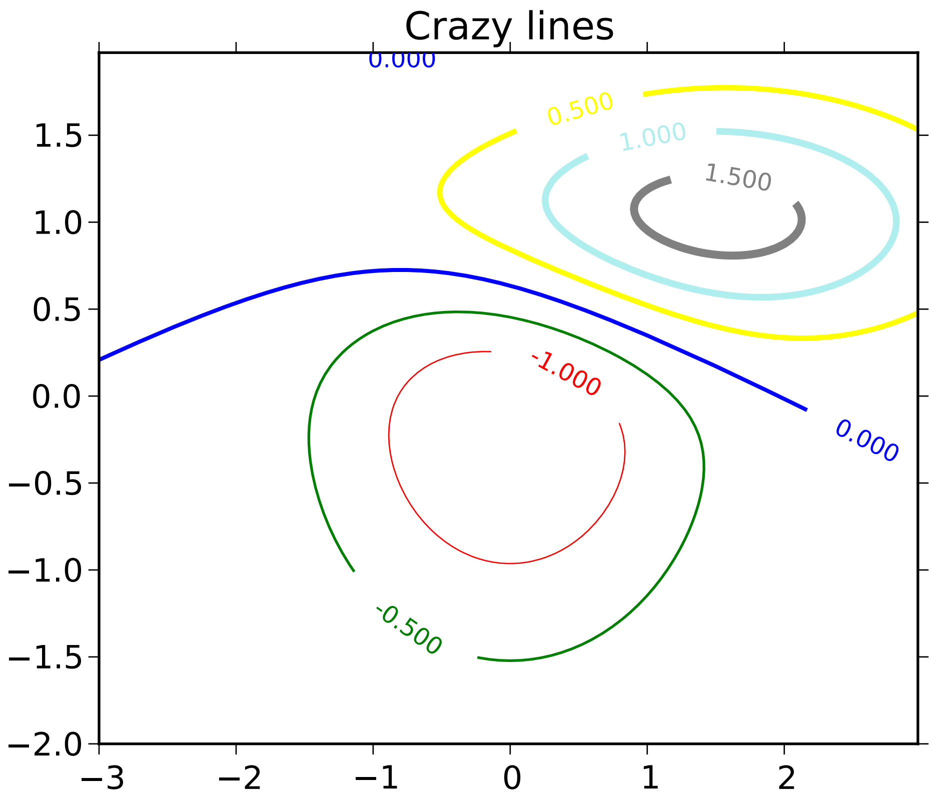
If *origin* is not *None*, then *extent* is interpreted as in `matplotlib.pyplot.imshow()`: it gives the outer pixel boundaries. In this case, the position of Z[0,0] is the center of the pixel, not a corner. If *origin* is *None*, then (*x0*, *y0*) is the position of Z[0,0], and (*x1*, *y1*) is the position 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`.



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.

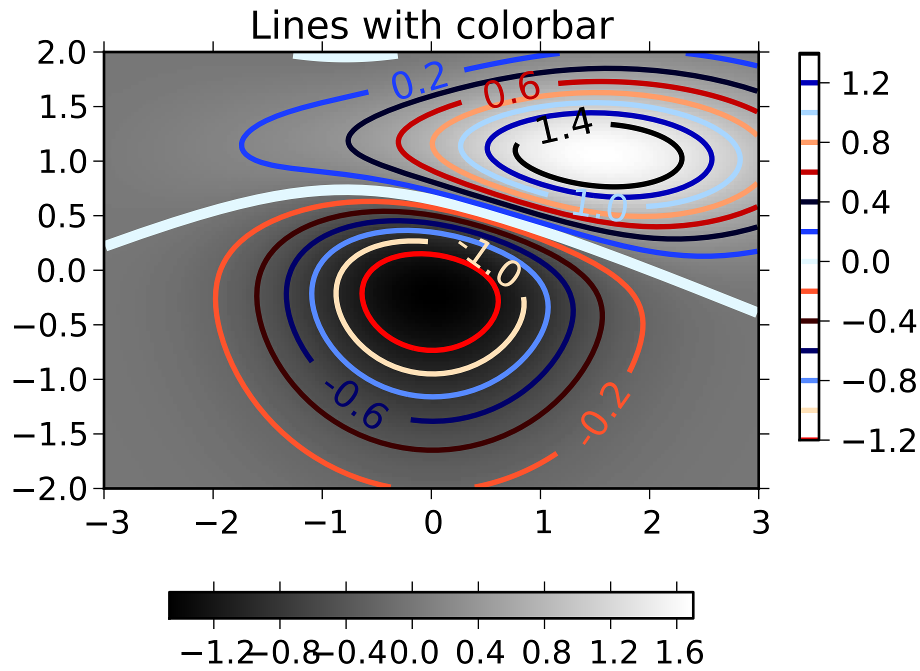
linestyles can also be an iterable of the above strings specifying a set of linestyles to be used. If this iterable is shorter than the number of contour levels it will be repeated as necessary.

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:

***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: contourf fills intervals that are closed at the top; that is, for boundaries *z1* and *z2*, the filled region is:

```
z1 < z <= 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.

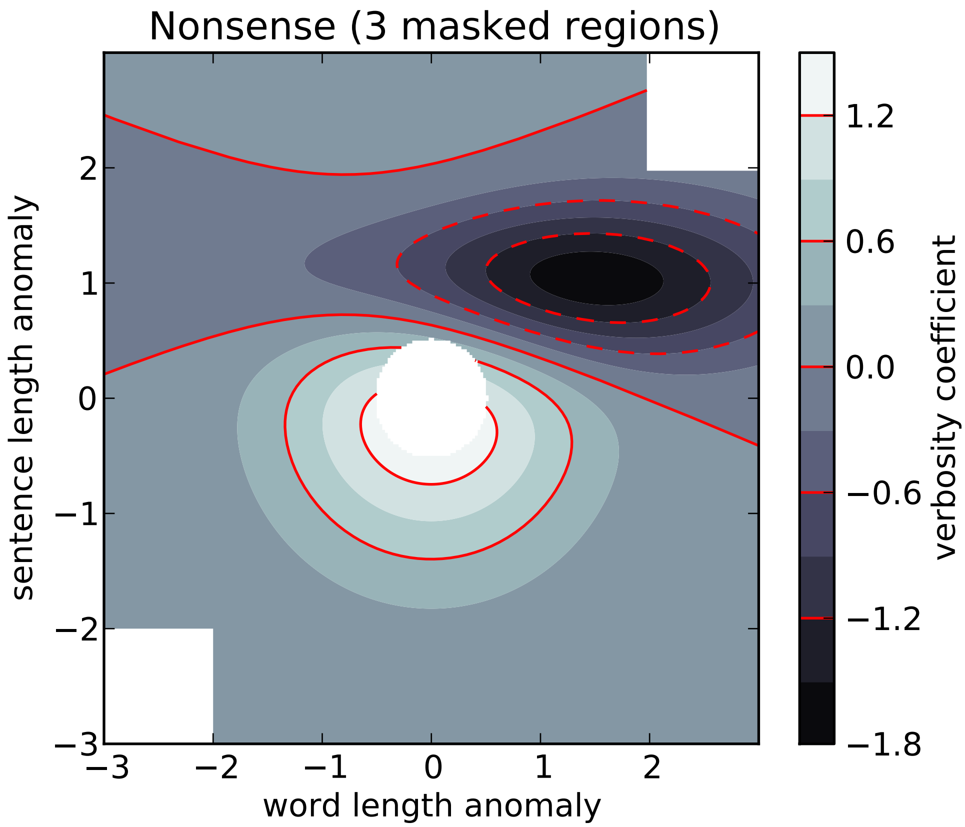
Examples:

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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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.

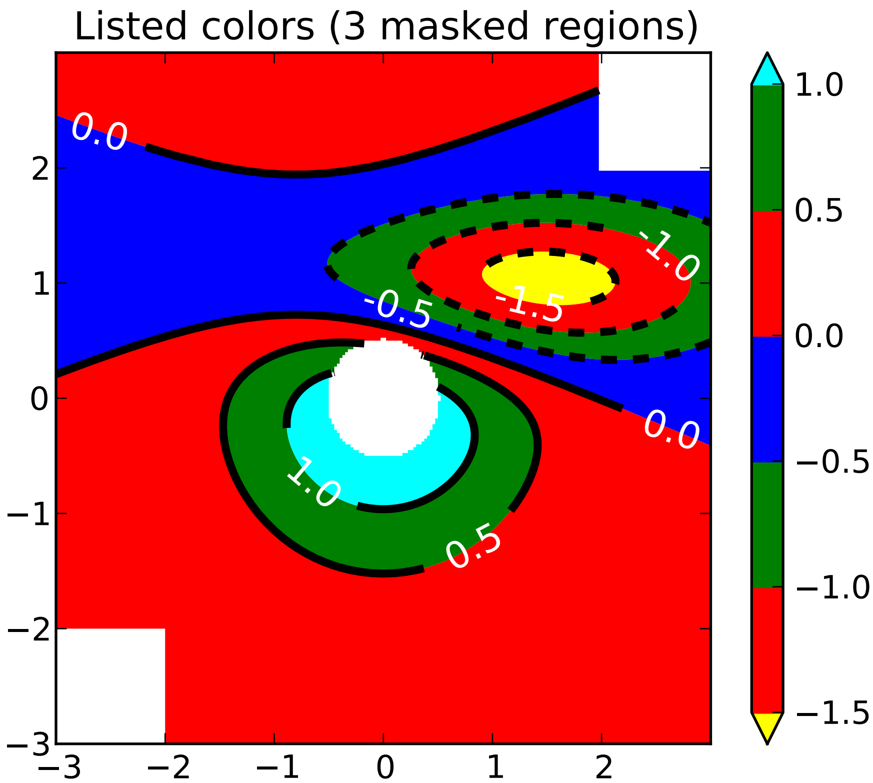
Returns the tuple $(Pxy, freqs)$. P is the cross spectrum (complex valued), and $10\log_{10}|P_{xy}|$ is plotted.

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.

***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 is it a function. The `pylab` module defines `detrend_none()`,



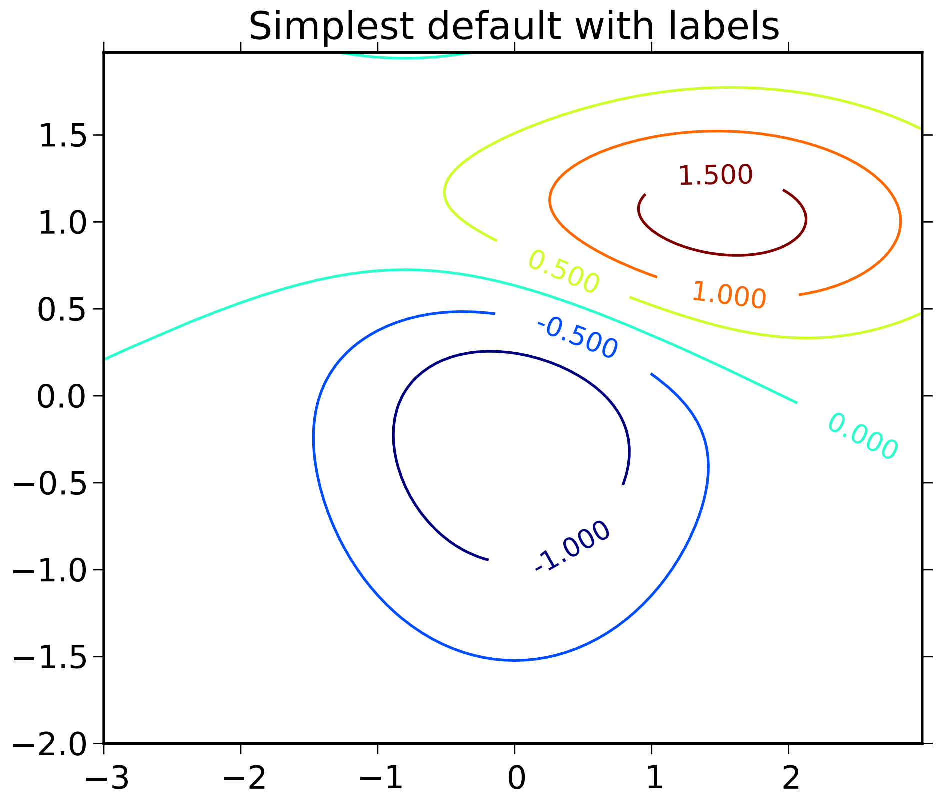
detrend_mean(), and detrend_linear(), but you can use a custom function as well.

***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 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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]

<table>
<tr><td>clip_path</td><td>[(Path, Transform) | Patch | None]</td></tr>
<tr><td>color or c</td><td>any matplotlib color</td></tr>
<tr><td>contains</td><td>a callable function</td></tr>
<tr><td>dash_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>dash_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>dashes</td><td>sequence of on/off ink in points</td></tr>
<tr><td>data</td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td>drawstyle</td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td>figure</td><td>a matplotlib.figure.Figure instance</td></tr>
<tr><td>fillstyle</td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td>gid</td><td>an id string</td></tr>
<tr><td>label</td><td>any string</td></tr>
<tr><td>linestyle or ls</td><td>['-' | '--' | '-.' | ':' | 'None' | ' ' | ''] and any drawstyle in combination with a</td></tr>
<tr><td>linewidth or lw</td><td>float value in points</td></tr>
<tr><td>lod</td><td>[True | False]</td></tr>
<tr><td>marker</td><td>['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |</td></tr>
<tr><td>markeredgecolor or mec</td><td>any matplotlib color</td></tr>
<tr><td>markeredgewidth or mew</td><td>float value in points</td></tr>
<tr><td>markerfacecolor or mfc</td><td>any matplotlib color</td></tr>
<tr><td>markerfacecoloralt or mfcalt</td><td>any matplotlib color</td></tr>
<tr><td>markersize or ms</td><td>float</td></tr>
<tr><td>markevery</td><td>None | integer | (startind, stride)</td></tr>
<tr><td>picker</td><td>float distance in points or callable pick function fn(artist, event)</td></tr>
<tr><td>pickradius</td><td>float distance in points</td></tr>
<tr><td>rasterized</td><td>[True | False | None]</td></tr>
<tr><td>snap</td><td>unknown</td></tr>
<tr><td>solid_capstyle</td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td>solid_joinstyle</td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td>transform</td><td>a matplotlib.transforms.Transform instance</td></tr>
<tr><td>url</td><td>a url string</td></tr>
<tr><td>visible</td><td>[True | False]</td></tr>
<tr><td>xdata</td><td>1D array</td></tr>
<tr><td>ydata</td><td>1D array</td></tr>
<tr><td>zorder</td><td>any number</td></tr>
</table>

Example:

Additional kwargs: hold = [True|False] overrides default hold state

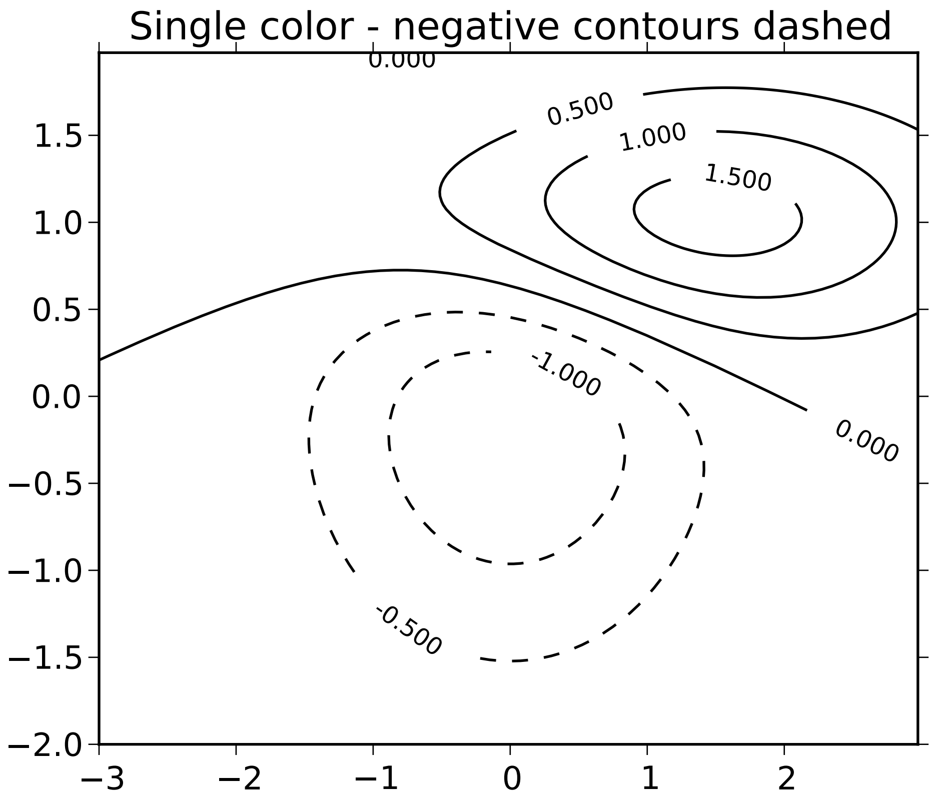
delaxes(**args*)

`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

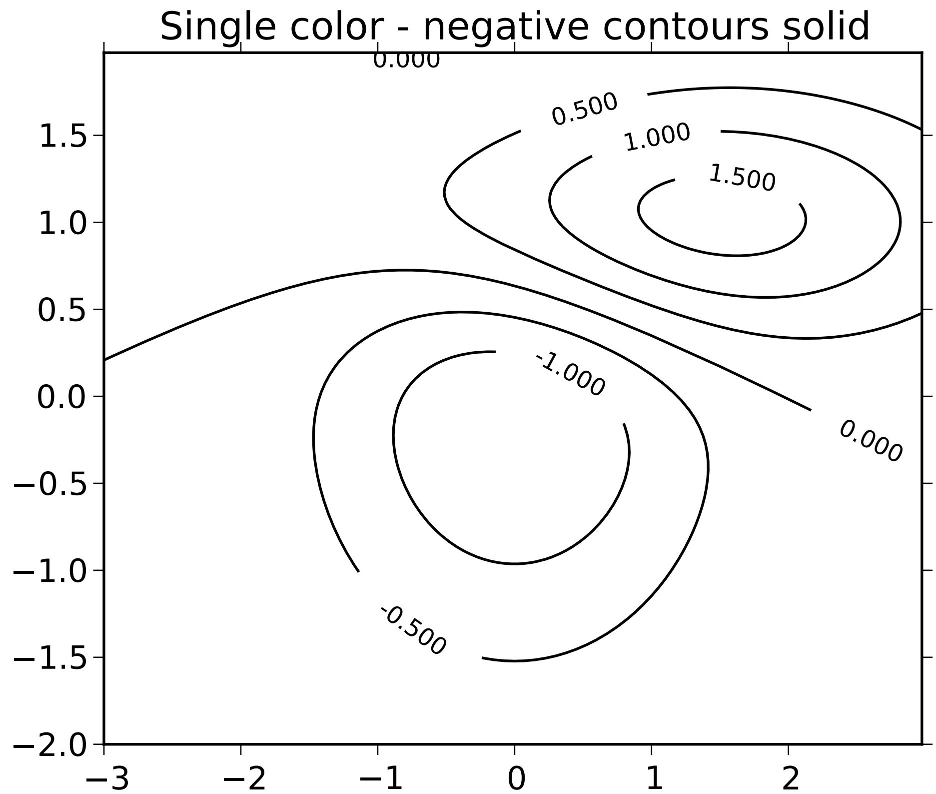
errorbar(*x*, *y*, *yerr=None*, *xerr=None*, *fmt='-'*, *ecolor=None*, *elinewidth=None*, *capsize=3*, *barsabove=False*, *lolims=False*, *uplims=False*, *xlolims=False*, *xuplims=False*, *hold=None*, ***kwargs*)
call signature:

```
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.

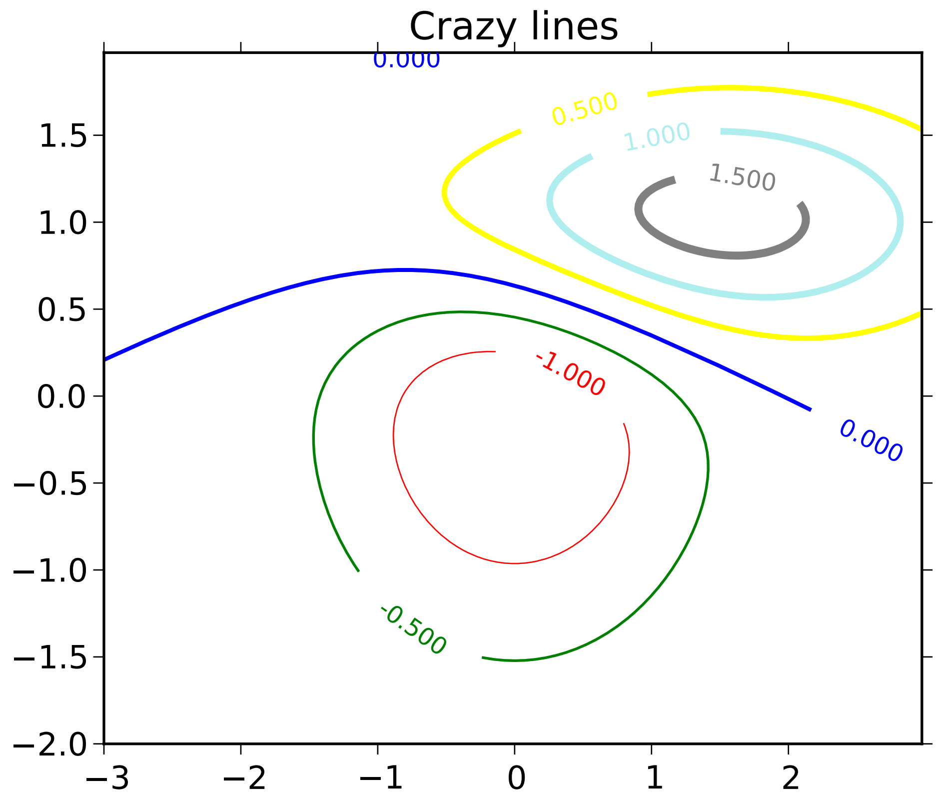
***elinewidth*: scalar** the linewidth of the errorbar lines. If *None*, use the linewidth.

***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*, *markeredgecolor*, *markersize* and *markeredgewith*.

valid kwargs for the marker properties are

Property	Description
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color` or c	any matplotlib color
`contains`	a callable function
`dash_capstyle`	['butt' | 'round' | 'projecting']

dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	any number

Returns (*plotline*, *caplines*, *barlinecols*):

***plotline*: Line2D instance** *x*, *y* plot markers and/or line

***caplines*: list of error bar cap** Line2D instances

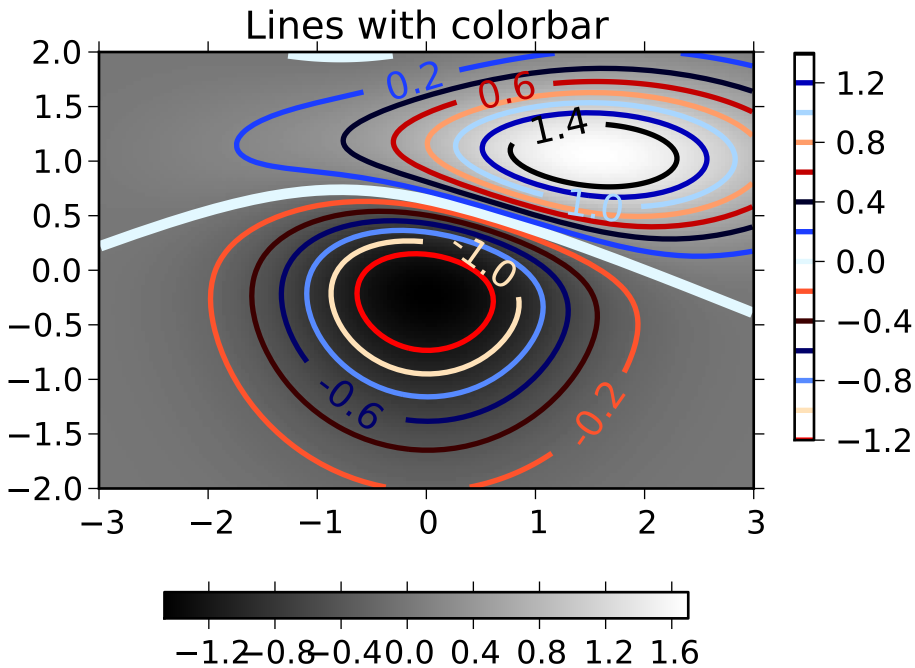
***barlinecols*: list of** LineCollection instances for the horizontal and vertical error ranges.

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.

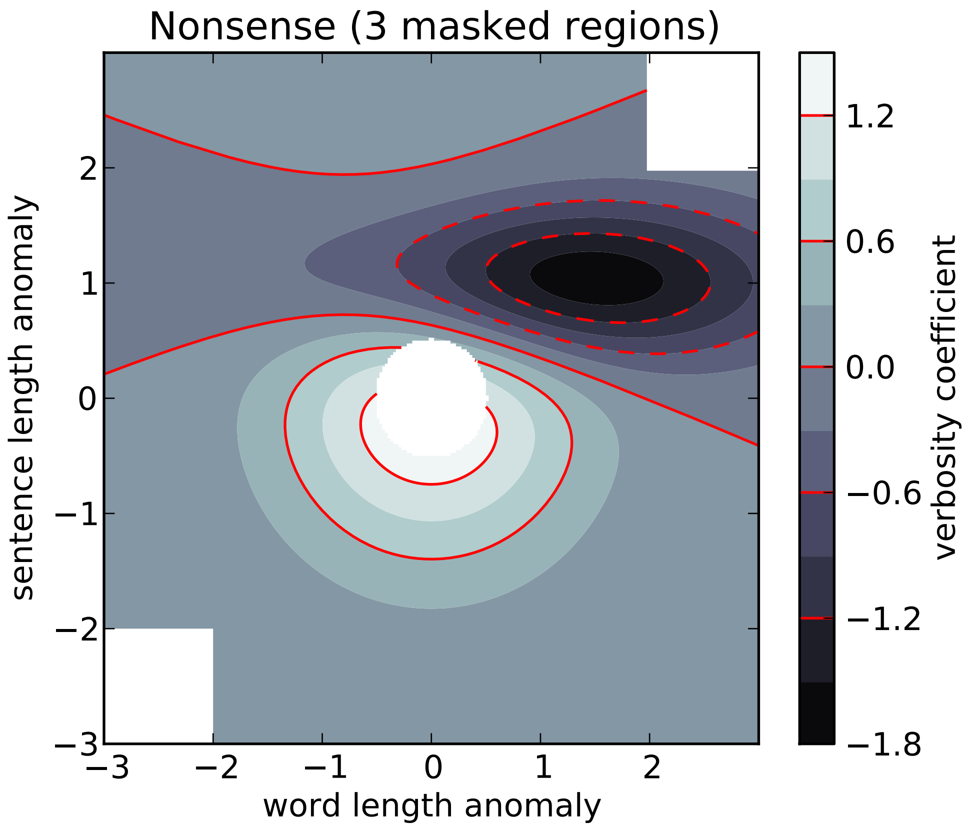
`figimage(X, xo, yo)`

with pixel offsets *xo*, *yo*,

X must be a float array:

- If *X* is MxN, assume luminance (grayscale)
- If *X* is MxNx3, assume RGB
- If *X* is MxNx4, assume RGBA

Optional keyword arguments:



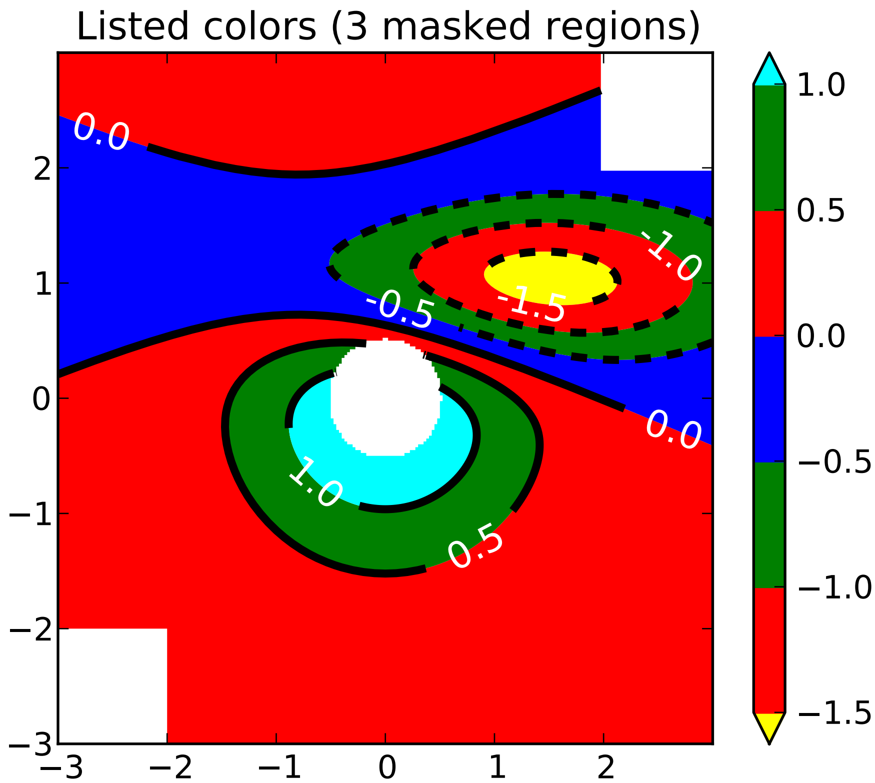
Keyword	Description
xo or yo	An integer, the *x* and *y* image offset in pixels
cmap	a `matplotlib.cm.ColorMap` instance, eg cm.jet. If None, default to the rc `image.cmap` value
norm	a `matplotlib.colors.Normalize` instance. The default is normalization(). This scales luminance -> 0-1
vmin|vmax	are 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 norm instance, the settings for *vmin* and *vmax* 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 rc image.origin 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'Addition 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' )
```

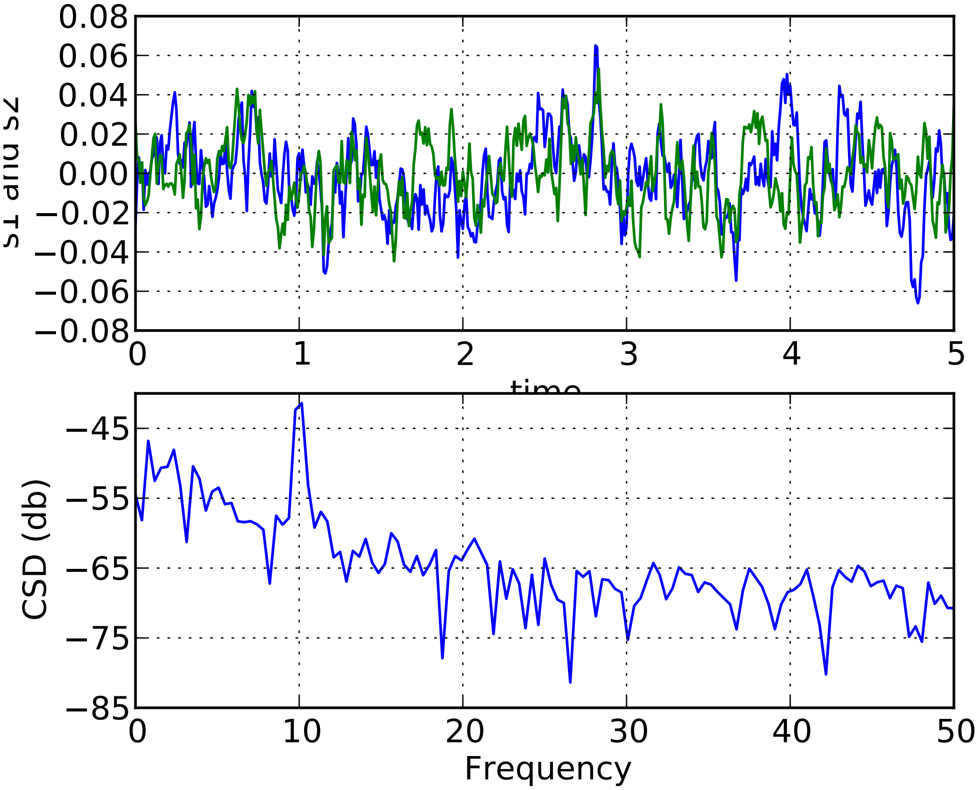
See Also:

`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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function
`family` or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
`figure`	a `matplotlib.figure.Figure` instance
`fontproperties` or font_properties	a `matplotlib.font_manager.FontProperties` instance
`gid`	an id string
`horizontalalignment` or ha	['center' | 'right' | 'left']

Table 49.9 – continued fro

label	any string
linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | '
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	any number

figure(*num=None, figsize=None, dpi=None, facecolor=None, edgecolor=None, frameon=True, FigureClass=<class 'matplotlib.figure.Figure'>, **kwargs*)

call signature:

```
figure(num=None, figsize=(8, 6), dpi=80, facecolor='w', edgecolor='k')
```

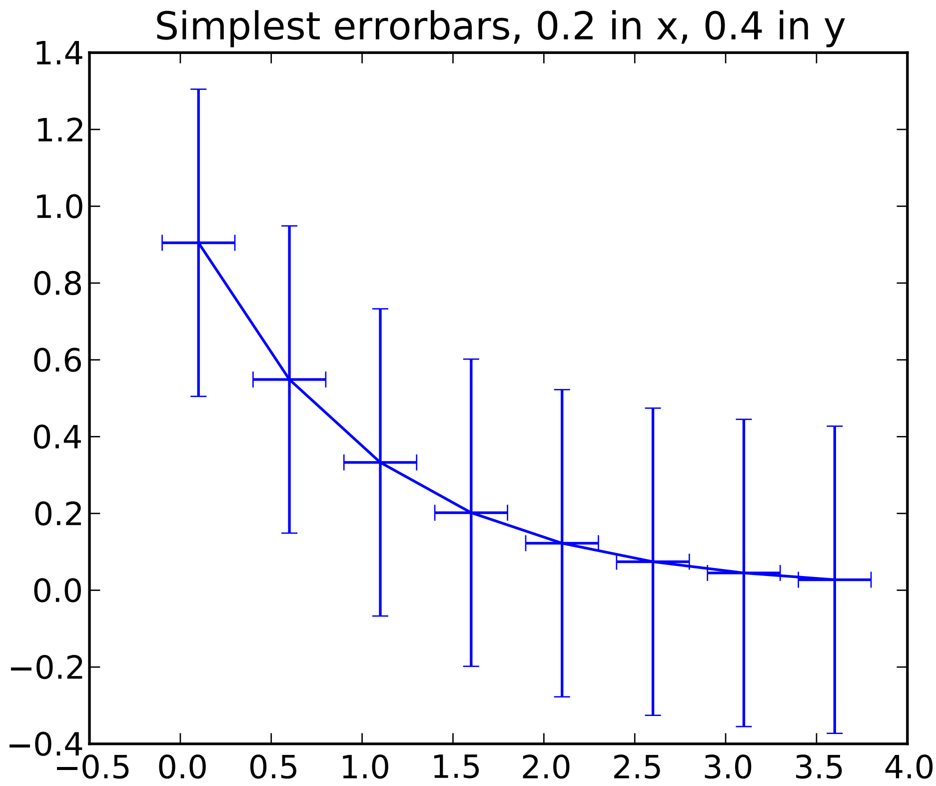
Create a new figure and return a `matplotlib.figure.Figure` instance. If *num* = *None*, the figure number will be incremented and a new figure will be created. The returned figure objects have a *number* attribute holding this number.

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)
```

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*)

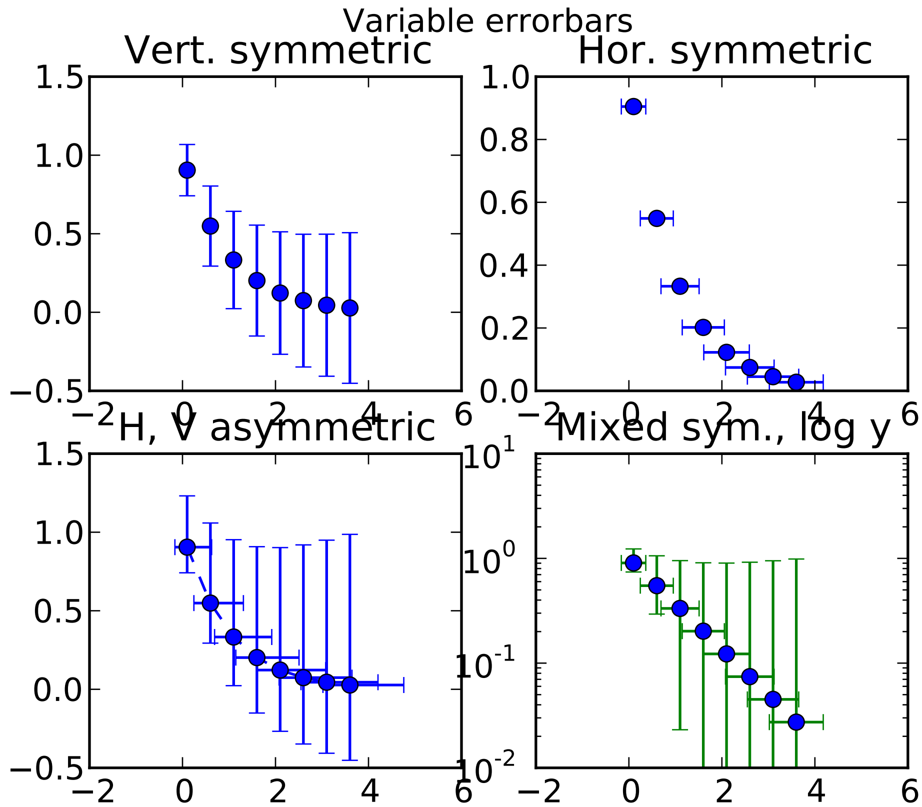
call signature:

```
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')
```

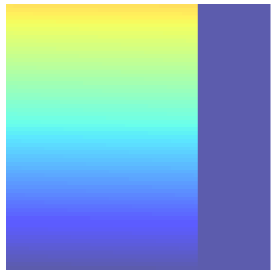
Return value is a list of `Patch` instances that were added.

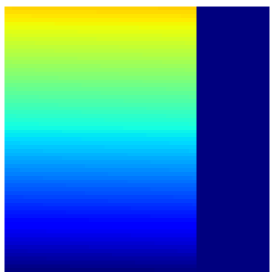
The same color strings that `plot()` supports are supported by the fill format string.

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).

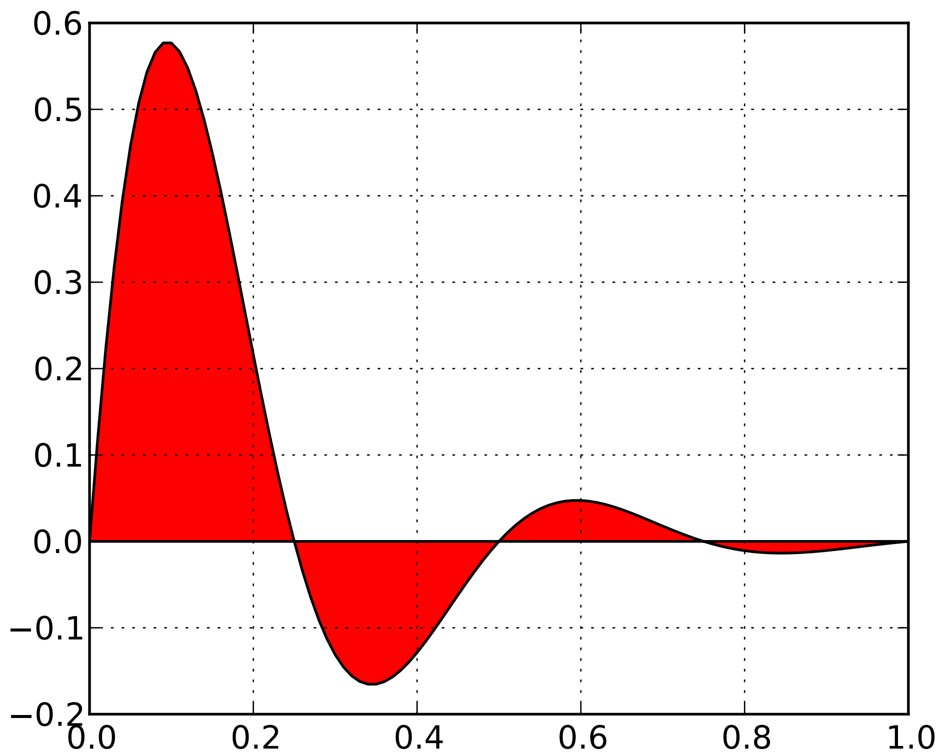
kwargs control the Polygon properties:





Property	Description
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]

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 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:

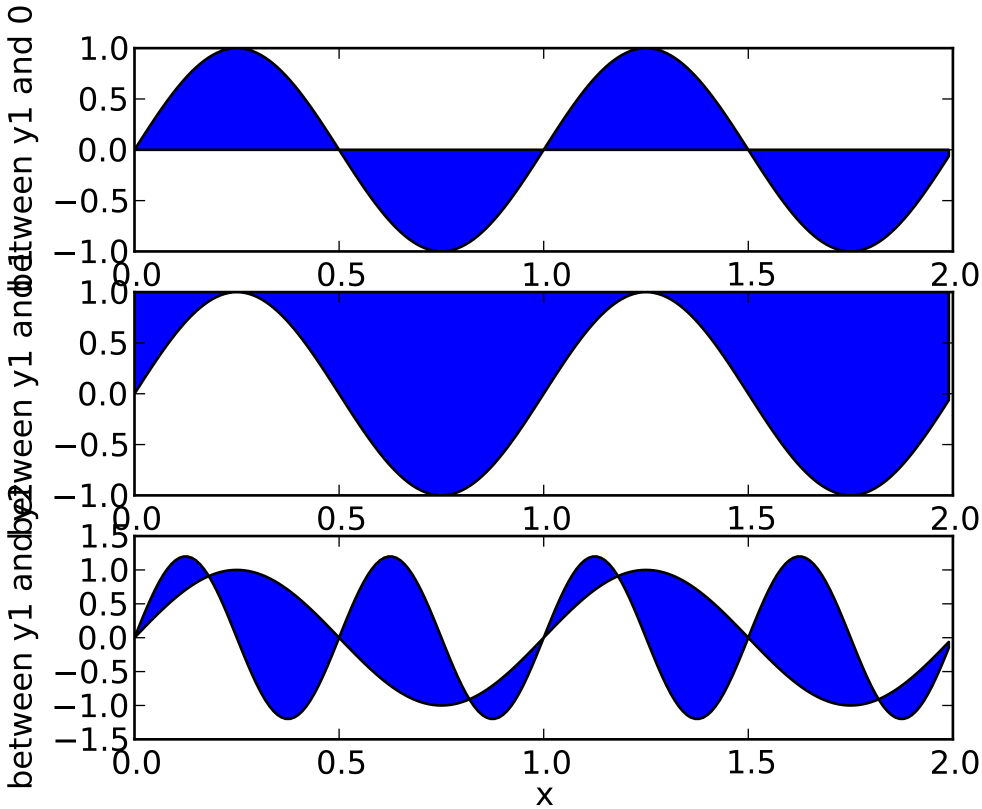
Property	Description
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance

Continued on next page

Table 49.11 – continued from previous page

clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	any number

See Also:

fill_between() for filling between two sets of y-values

Additional kwargs: hold = [True|False] overrides default hold state

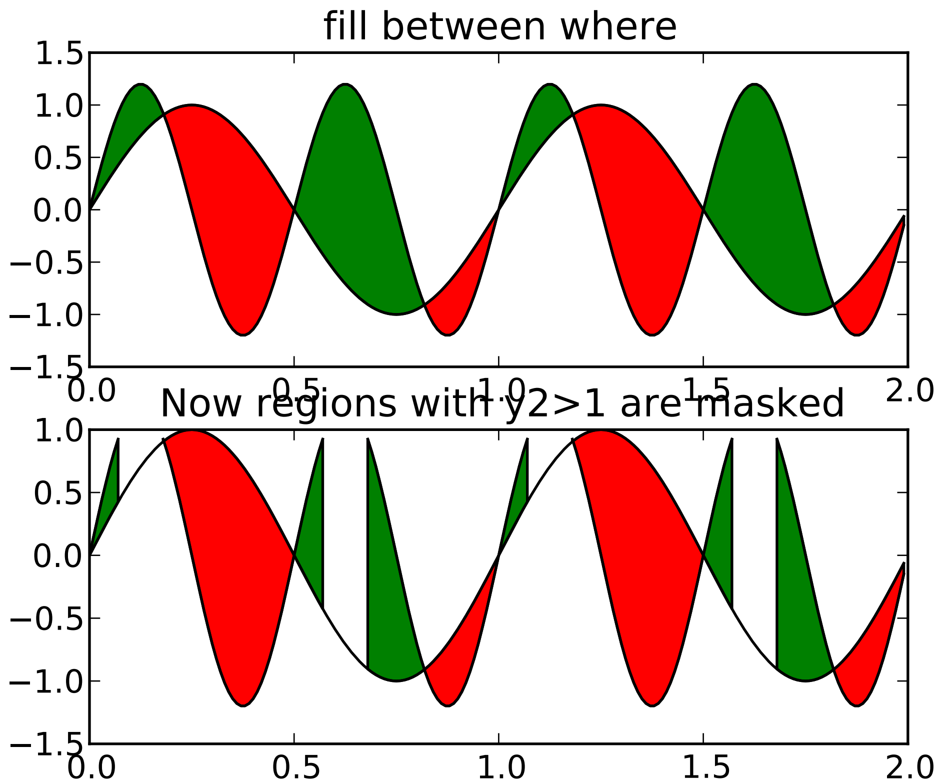
findobj(*o=None, match=None*)

pyplot signature: findobj(o=gcf(), match=None)

Recursively find all :class:matplotlib.artist.Artist instances contained in self.

match can be

- None: return all objects contained in artist (including artist)
- function with signature `boolean = match(artist)` used to filter matches
- class instance: eg Line2D. Only return artists of class type



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:

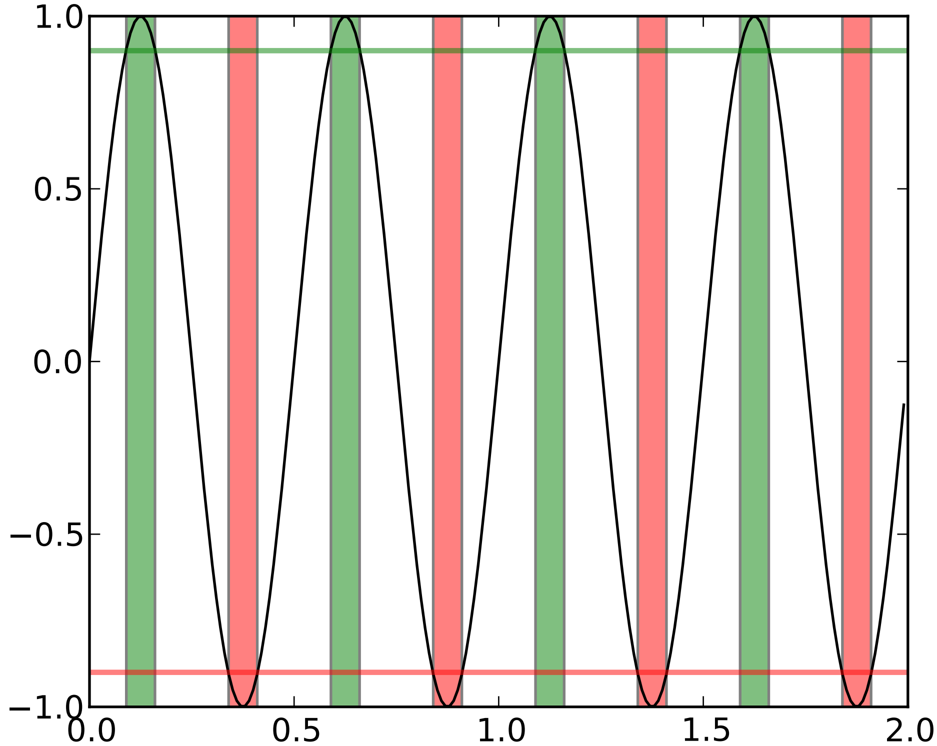
```
plot(t,s)
a = gca()
a.set_xlim([0,10])
```

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_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)
```

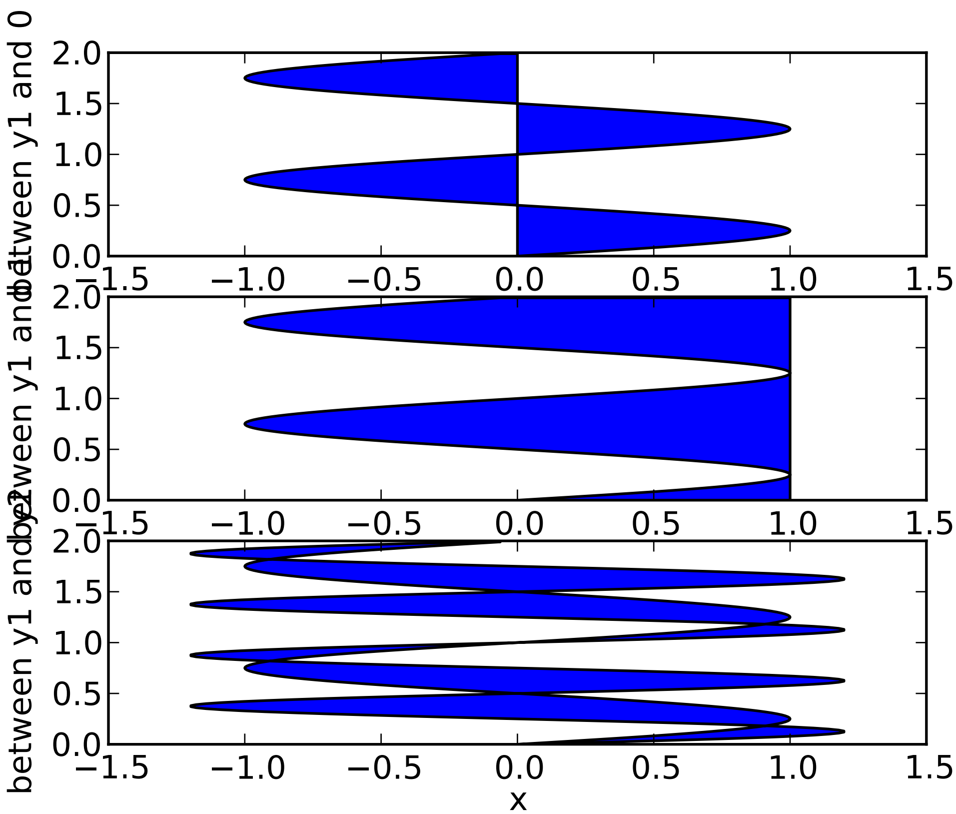
Blocking call to interact with the figure.

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 overriden 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', **kwargs*)

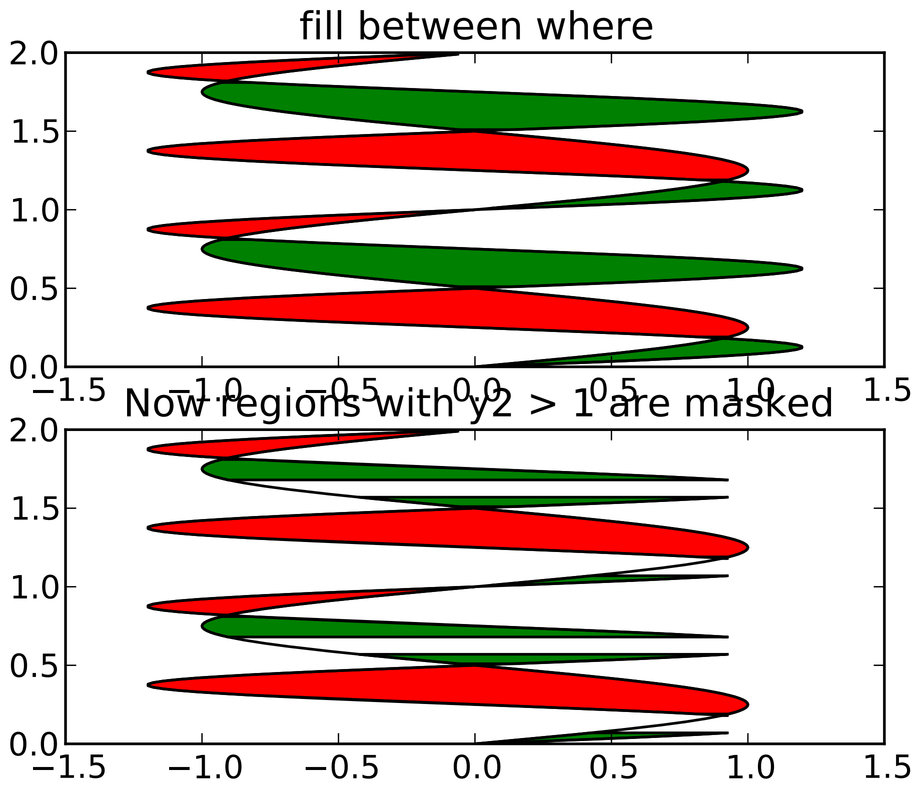
call signature:

```
grid(self, b=None, which='major', **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.



kawrgs are used to set the grid line properties, eg:

```
ax.grid(color='r', linestyle='-', linewidth=2)
```

Valid Line2D kwargs are

Property	Description
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']

figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	any number

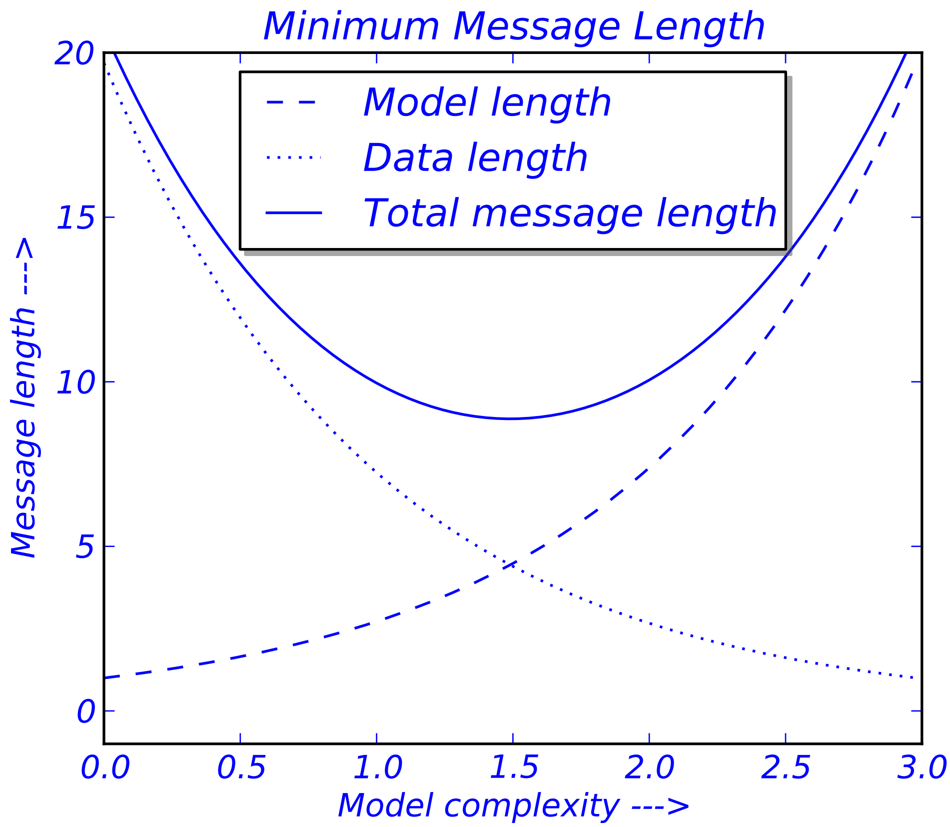
hexbin(*x, y, C=None, gridsize=100, bins=None, xscale='linear', yscale='linear', extent=None, cmap=None, norm=None, vmin=None, vmax=None, alpha=None, linewidths=None, edgecolors='none', reduce_C_function=<function mean at 0x2d3a578>, mincnt=None, marginals=False, hold=None, **kwargs*)

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 occurences 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.

***scale*: ['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 rectagles 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples

Continued on next page

Table 49.13 – continued from previous page

facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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:

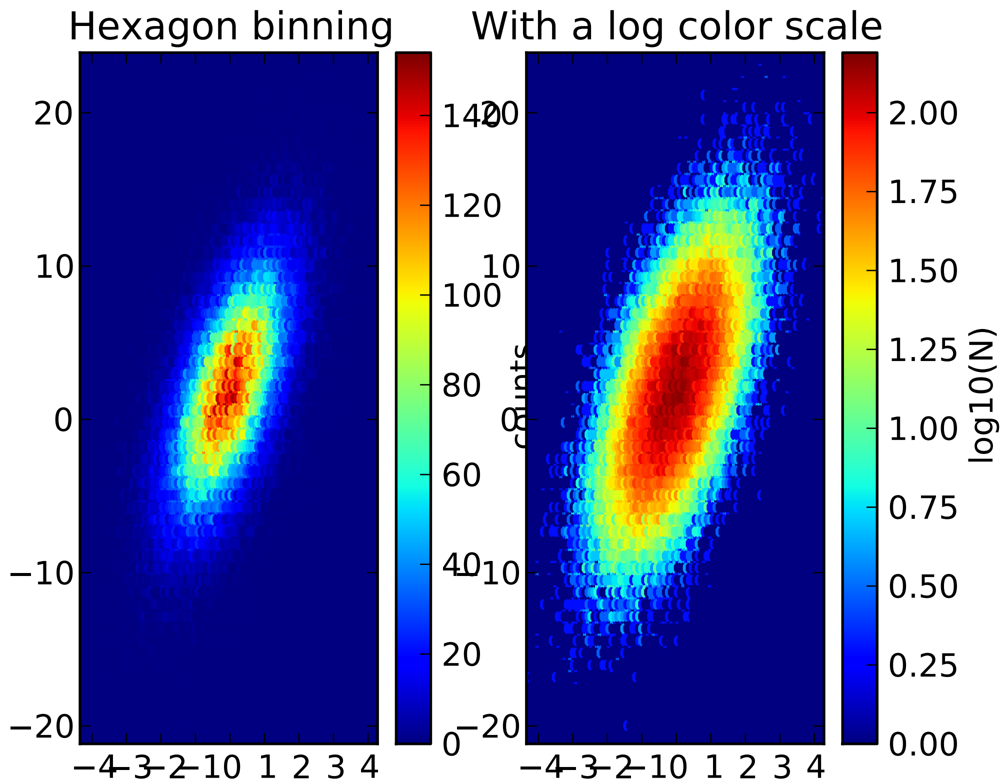
```
hist(x, bins=10, range=None, normed=False, cumulative=False,
     bottom=None, histtype='bar', align='mid',
     orientation='vertical', rwidth=None, log=False, **kwargs)
```

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 >= 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/(len(x)*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))
```

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 aranged 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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*.

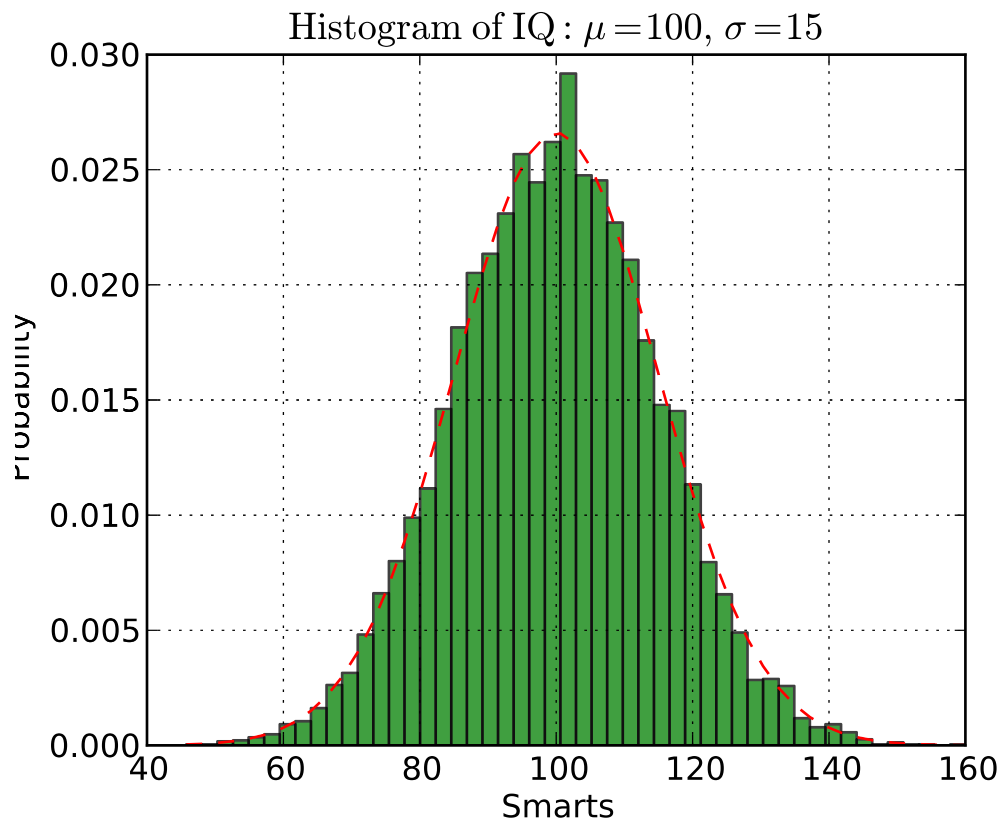
Returns the LineCollection that was added.

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
```

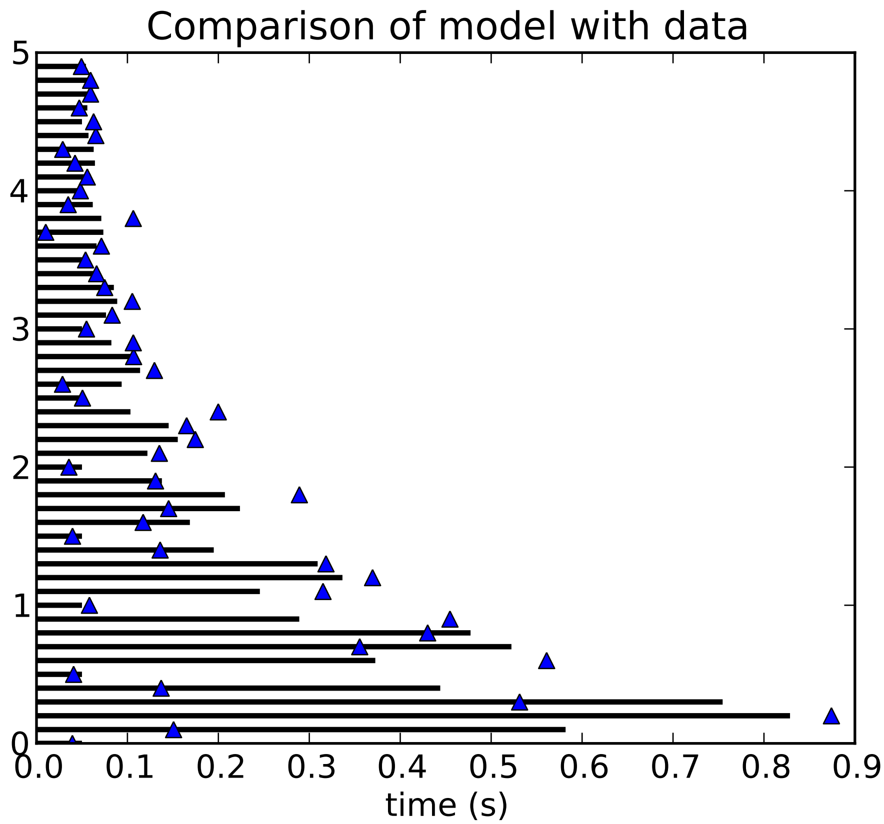
When *hold* is *True*, subsequent plot commands will be added to the current axes. When *hold* is *False*, the current axes and figure will be cleared on the next plot command.

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 MxN. For RGB images, the return value is MxNx3. For RGBA images the return value is MxNx4.

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:

- MxN – luminance (grayscale, float array only)
- MxNx3 – RGB (float or uint8 array)
- MxNx4 – RGBA (float or uint8 array)

The value for each component of MxNx3 and MxNx4 float arrays should be in the range 0.0 to 1.0; MxN 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*, '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 *filternorm* and *filterrad* parameters

***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

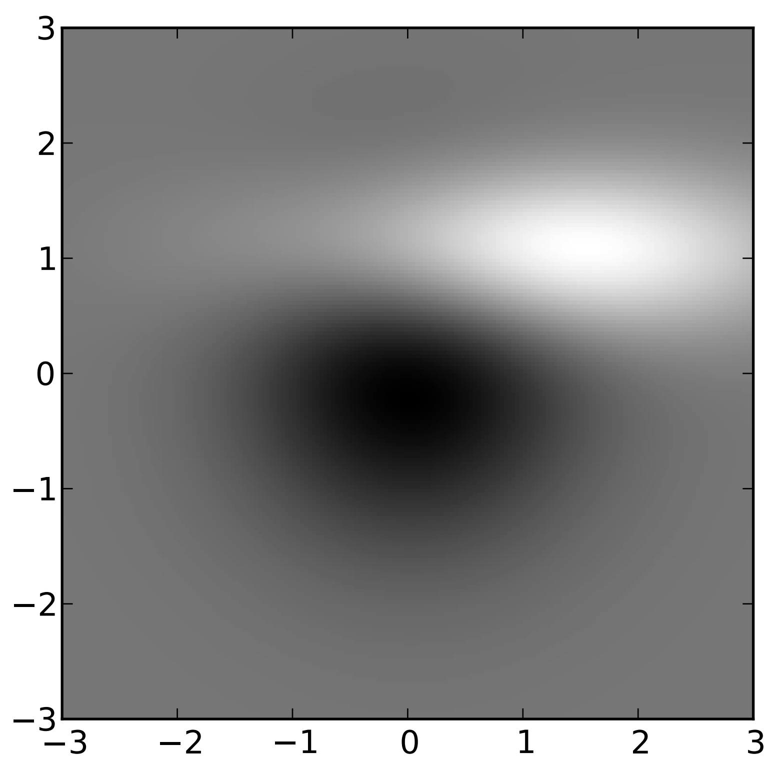
***filternorm*:** A parameter for the antigrain image resize filter. From the antigrain documentation, if *filternorm* = 1, the filter normalizes integer values and corrects the rounding errors. It doesn't do anything with the source floating point values, it corrects only integers according to the rule 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
contains	a callable function
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
lod	[True | False]
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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 the interactive status

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 itslef 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. Default is True

***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

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:

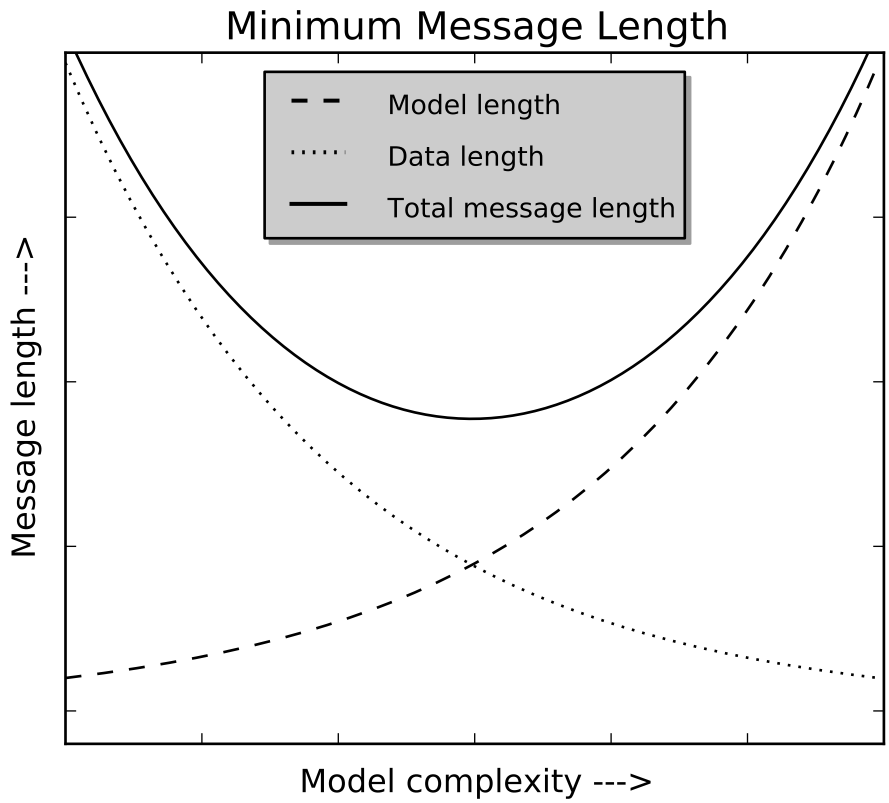
```
ax.locator_params(tight=True, nbins=4)
```

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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)

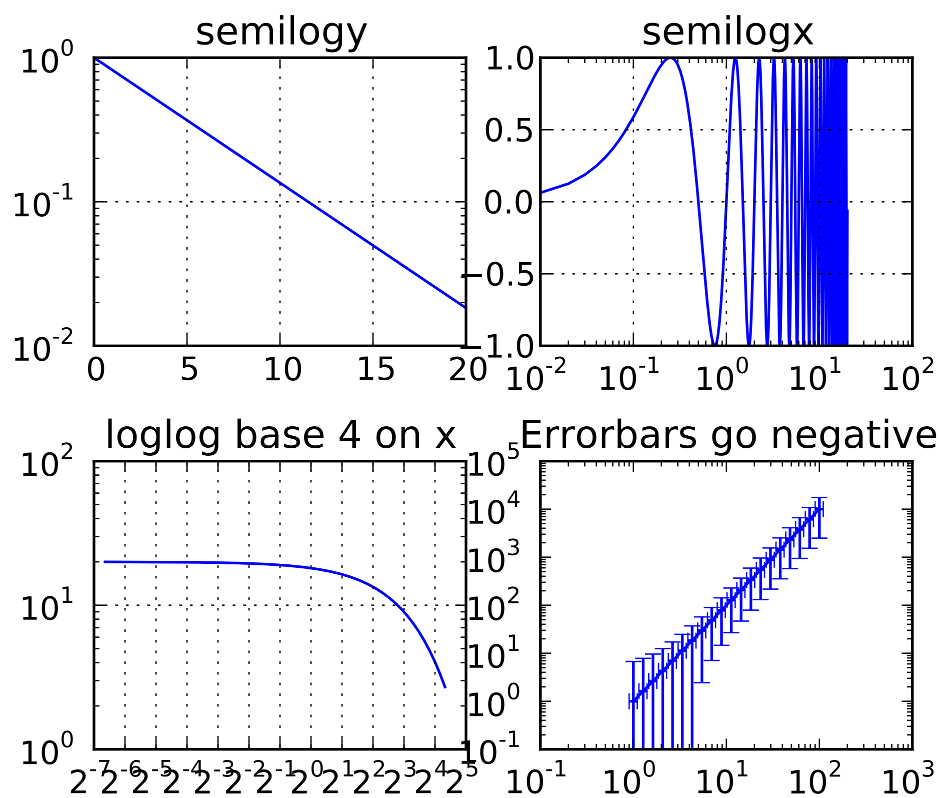
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | ''] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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()`.

***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.

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 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance
`gid`	an id string
`label`	any string
`linestyle` or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
`linewidth` or lw or linewidths	float or sequence of floats
`lod`	[True | False]
`norm`	unknown
`offsets`	float or sequence of floats
`paths`	unknown
`picker`	[None|float|boolean|callable]
`pickradius`	unknown
`rasterized`	[True | False | None]
`snap`	unknown
`transform`	`Transform` instance
`url`	a url string

Continued on next page

Table 49.15 – continued from previous page

urls	unknown
visible	[True | False]
zorder	any number

Note: the default *antialiaseds* is taken from rcParams['patch.antialiased'], which defaults to *True*. In some cases, particularly if *alpha* is 1, you may be able to reduce rendering artifacts (light or dark patch boundaries) by setting it to *False*. An alternative it to set *edgecolors* to 'face'. Unfortunately, there seems to be no single combination of parameters that eliminates artifacts under all conditions.

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 <= 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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, anitialising, 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, antialised=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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]

`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color` or c	any matplotlib color
`contains`	a callable function
`dash_capstyle`	['butt' | 'round' | 'projecting']
`dash_joinstyle`	['miter' | 'round' | 'bevel']
`dashes`	sequence of on/off ink in points
`data`	2D array (rows are x, y) or two 1D arrays
`drawstyle`	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
`figure`	a `matplotlib.figure.Figure` instance
`fillstyle`	['full' | 'left' | 'right' | 'bottom' | 'top']
`gid`	an id string
`label`	any string
`linestyle` or ls	[`'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | "] and any drawstyle in combination with a
`linewidth` or lw	float value in points
`lod`	[True | False]
`marker`	[`'+'` | `'*'` | `','` | `'.'` | `'1'` | `'2'` | `'3'` | `'4'` | `'<'` | `'>'` | `'D'` | `'H'` | `'^'` | `'_'` | `'d'` |
`markeredgecolor` or mec	any matplotlib color
`markeredgewidth` or mew	float value in points
`markerfacecolor` or mfc	any matplotlib color
`markerfacecoloralt` or mfcalt	any matplotlib color
`markersize` or ms	float
`markevery`	None | integer | (startind, stride)
`picker`	float distance in points or callable pick function `fn(artist, event)`
`pickradius`	float distance in points
`rasterized`	[True | False | None]
`snap`	unknown
`solid_capstyle`	['butt' | 'round' | 'projecting']
`solid_joinstyle`	['miter' | 'round' | 'bevel']
`transform`	a `matplotlib.transforms.Transform` instance
`url`	a url string
`visible`	[True | False]
`xdata`	1D array
`ydata`	1D array
`zorder`	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]** 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:

<table>
<tr><th>Property</th><th>Description</th></tr>
<tr><td><code>agg_filter</code></td><td>unknown</td></tr>
<tr><td><code>alpha</code></td><td>float (0.0 transparent through 1.0 opaque)</td></tr>
<tr><td><code>animated</code></td><td>[True | False]</td></tr>
<tr><td><code>antialiased</code> or aa</td><td>[True | False]</td></tr>
<tr><td><code>axes</code></td><td>an <code>Axes</code> instance</td></tr>
<tr><td><code>clip_box</code></td><td>a <code>matplotlib.transforms.Bbox</code> instance</td></tr>
<tr><td><code>clip_on</code></td><td>[True | False]</td></tr>
<tr><td><code>clip_path</code></td><td>[(<code>Path</code>, <code>Transform</code>) | <code>Patch</code> | None]</td></tr>
<tr><td><code>color</code> or c</td><td>any matplotlib color</td></tr>
<tr><td><code>contains</code></td><td>a callable function</td></tr>
<tr><td><code>dash_capstyle</code></td><td>['butt' | 'round' | 'projecting']</td></tr>
<tr><td><code>dash_joinstyle</code></td><td>['miter' | 'round' | 'bevel']</td></tr>
<tr><td><code>dashes</code></td><td>sequence of on/off ink in points</td></tr>
<tr><td><code>data</code></td><td>2D array (rows are x, y) or two 1D arrays</td></tr>
<tr><td><code>drawstyle</code></td><td>['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']</td></tr>
<tr><td><code>figure</code></td><td>a <code>matplotlib.figure.Figure</code> instance</td></tr>
<tr><td><code>fillstyle</code></td><td>['full' | 'left' | 'right' | 'bottom' | 'top']</td></tr>
<tr><td><code>gid</code></td><td>an id string</td></tr>
<tr><td><code>label</code></td><td>any string</td></tr>
<tr><td><code>linestyle</code> or ls</td><td>[<code>'-'</code> | <code>'--'</code> | <code>'-.'</code> | <code>':'</code> | <code>'None'</code> | <code>' '</code> | "] and any drawstyle in combination with a</td></tr>
<tr><td><code>linewidth</code> or lw</td><td>float value in points</td></tr>
<tr><td><code>lod</code></td><td>[True | False]</td></tr>
<tr><td><code>marker</code></td><td>[<code>'+'</code> | <code>'*'</code> | <code>','</code> | <code>'.'</code> | <code>'1'</code> | <code>'2'</code> | <code>'3'</code> | <code>'4'</code> | <code>'<'</code> | <code>'>'</code> | <code>'D'</code> | <code>'H'</code> | <code>'^'</code> | <code>'_'</code> | <code>'d'</code> |</td></tr>
<tr><td><code>markeredgecolor</code> or mec</td><td>any matplotlib color</td></tr>
<tr><td><code>markeredgewidth</code> or mew</td><td>float value in points</td></tr>
</table>

markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a `matplotlib.transforms.Transform` instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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.pylab.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
axes	Create a new axes
axis	Set or return the current axis limits
bar	make a bar chart
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

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Table 49.19 – continued from previous page

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	show the figures
specgram	a spectrogram plot
stem	make a stem plot
subplot	make a subplot (numrows, numcols, axesnum)
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 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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 $|\mathrm{fft}(i)|^2$ 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.

***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 is it 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 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 (*Pxx*, *freqs*).

For plotting, the power is plotted as $10\log_{10}(P_{xx})$ for decibels, though *Pxx* itself is returned.

References: Bendat & Piersol – Random Data: Analysis and Measurement Procedures, John Wiley & Sons (1986)

kwargs control the Line2D properties:

Property	Description
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']

dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	any number

Example:

Additional kwargs: hold = [True|False] overrides default hold state

quiver(**args*, ***kw*)

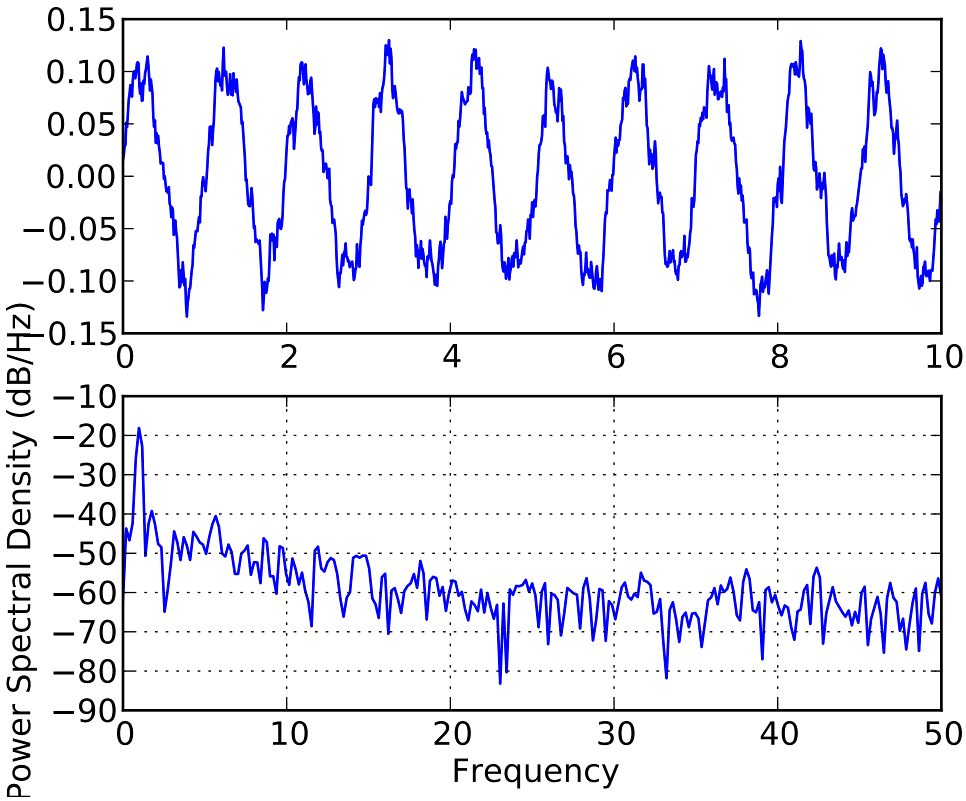
Plot a 2-D field of arrows.

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 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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or antialiaseds	Boolean or sequence of booleans
array	unknown
axes	an Axes instance
clim	a length 2 sequence of floats
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
colorbar	unknown
contains	a callable function
edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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 - the ones that were created at matplotlib load time.

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^2. 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:

Value	Description
's'	square
'o'	circle
'^'	triangle up
'>'	triangle right
'v'	triangle down
'<'	triangle left
'd'	diamond
'p'	pentagon
'h'	hexagon
'8'	octagon
'+'	plus
'x'	cross

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 (*numsides* and *angle* is ignored)

***angle*:** the angle of rotation of the symbol

Finally, *marker* can be (*verts*, 0): *verts* is a sequence of (*x*, *y*) vertices for a custom scatter symbol. Alternatively, use the kwarg combination *marker* = *None*, *verts* =

verts.

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 <= scalar <= 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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function
`edgecolor` or edgecolors	matplotlib color arg or sequence of rgba tuples
`facecolor` or facecolors	matplotlib color arg or sequence of rgba tuples
`figure`	a `matplotlib.figure.Figure` instance

Continued on next page

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gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
visible	[True | False]
zorder	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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
antialiased or aa	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
data	2D array (rows are x, y) or two 1D arrays
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a matplotlib.figure.Figure instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top']
gid	an id string
label	any string
linestyle or ls	['-' | '--' | '-.' | ':' | 'None' | ' ' | "] and any drawstyle in combination with a
linewidth or lw	float value in points
lod	[True | False]
marker	['+' | '*' | ',' | '.' | '1' | '2' | '3' | '4' | '<' | '>' | 'D' | 'H' | '^' | '_' | 'd' |
markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function fn(artist, event)
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`antialiased` or aa	[True | False]
`axes`	an `Axes` instance
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color` or c	any matplotlib color
`contains`	a callable function
`dash_capstyle`	['butt' | 'round' | 'projecting']
`dash_joinstyle`	['miter' | 'round' | 'bevel']
`dashes`	sequence of on/off ink in points
`data`	2D array (rows are x, y) or two 1D arrays
`drawstyle`	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
`figure`	a `matplotlib.figure.Figure` instance
`fillstyle`	['full' | 'left' | 'right' | 'bottom' | 'top']
`gid`	an id string
`label`	any string
`linestyle` or ls	[`'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | "] and any drawstyle in combination with a
`linewidth` or lw	float value in points
`lod`	[True | False]
`marker`	[`'+'` | `'*'` | `','` | `'.'` | `'1'` | `'2'` | `'3'` | `'4'` | `'<'` | `'>'` | `'D'` | `'H'` | `'^'` | `'_'` | `'d'` |

markeredgecolor or mec	any matplotlib color
markeredgewidth or mew	float value in points
markerfacecolor or mfc	any matplotlib color
markerfacecoloralt or mfcalt	any matplotlib color
markersize or ms	float
markevery	None | integer | (startind, stride)
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	[True | False | None]
snap	unknown
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a matplotlib.transforms.Transform instance
url	a url string
visible	[True | False]
xdata	1D array
ydata	1D array
zorder	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
```

specgram(*x, NFFT=256, Fs=2, Fc=0, detrend=<function detrend_none at 0x3cc2e60>, window=<function window_hanning at 0x3cc20c8>, 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.

***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 is it 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 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:

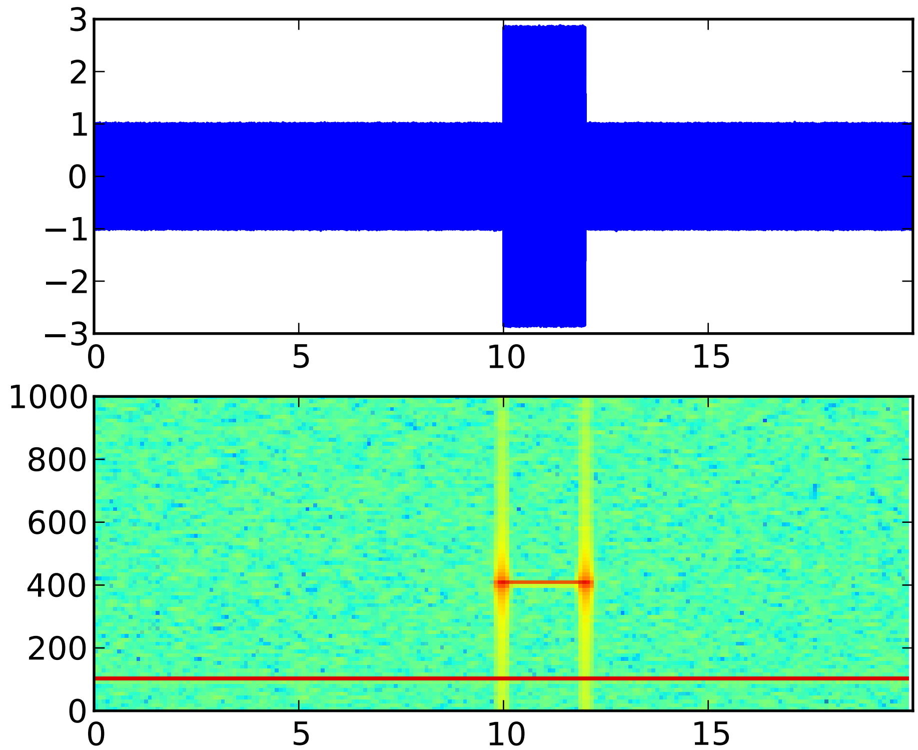
Additional kwargs are passed on to imshow which makes the specgram image

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 is plotted using *basefmt*.

Return value is a tuple (*markerline*, *stemlines*, *baseline*).

See Also:

this document for details

`examples/pylab_examples/stem_plot.py` for a demo

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(*plotNum*) == *numRows* * *numCols*

You can leave out the commas if *numRows* <= *numCols* <= *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.

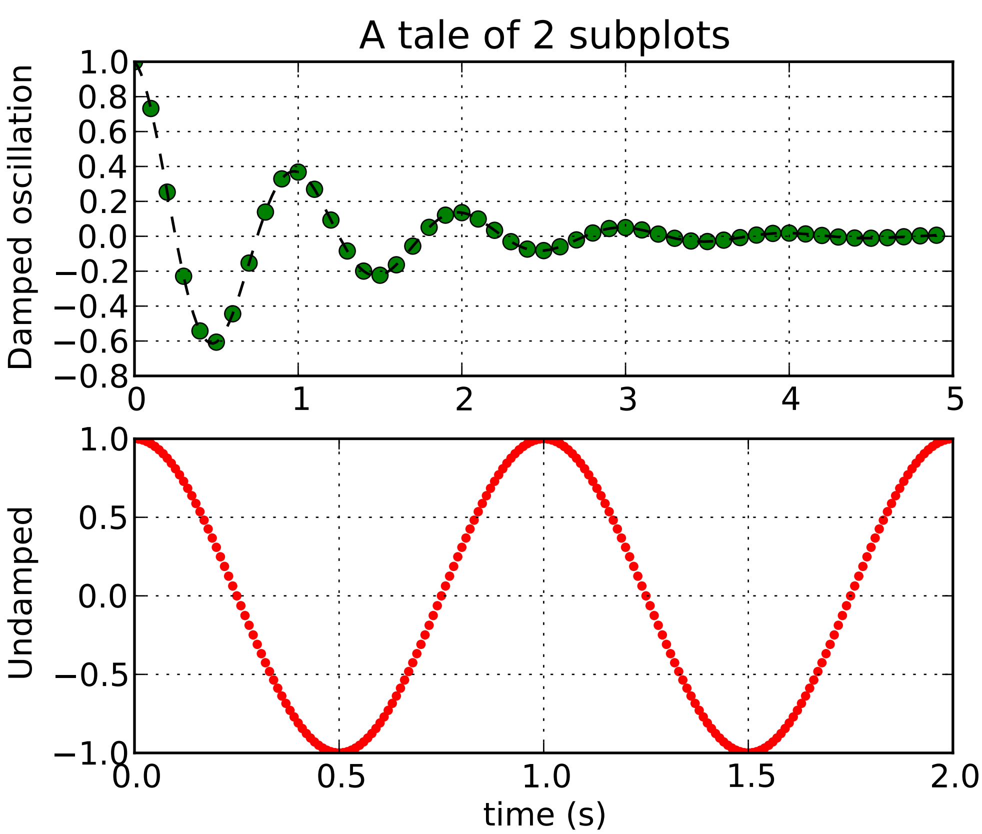
projection: A string giving the name of a custom projection to be used for the subplot. This projection must have been previously registered. See `matplotlib.projections.register_projection()`

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.

sharex [bool] If True, the Y axis will be shared amongst all subplots.

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 contaning 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 supblot 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
agg_filter	unknown
alpha	float (0.0 transparent through 1.0 opaque)
animated	[True | False]
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
contains	a callable function
figure	a matplotlib.figure.Figure instance
fontsize	a float in points
gid	an id string
label	any string
lod	[True | False]
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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
`agg_filter`	unknown
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	[True | False]
`axes`	an `Axes` instance
`backgroundcolor`	any matplotlib color
`bbox`	rectangle prop dict
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`color`	any matplotlib color
`contains`	a callable function
`family` or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
`figure`	a `matplotlib.figure.Figure` instance
`fontproperties` or font_properties	a `matplotlib.font_manager.FontProperties` instance
`gid`	an id string
`horizontalalignment` or ha	['center' | 'right' | 'left']
`label`	any string

Table 49.25 – continued fro

linespacing	float (multiple of font size)
lod	[True | False]
multialignment	['left' | 'right' | 'center']
path_effects	unknown
picker	[None|float|boolean|callable]
position	(x,y)
rasterized	[True | False | None]
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	unknown
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large
snap	unknown
stretch or fontstretch	[a numeric value in range 0-1000 | 'ultra-condensed' | 'extra-condensed' | 'c
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion.
transform	Transform instance
url	a url string
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va or ma	['center' | 'top' | 'bottom' | 'baseline']
visible	[True | False]
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
x	float
y	float
zorder	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:

Keyword	Description
style	['sci' (or 'scientific') | 'plain'] plain turns off scientific notation
scilimits	(m, n), pair of integers; if *style* is 'sci', scientific notation will be used for numbers outside the range 10'-m':sup: to 10'n':sup:. Use (0,0) to include all numbers.
useOffset	[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.
axis	['x' | 'y' | 'both']

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.

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, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, 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 (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

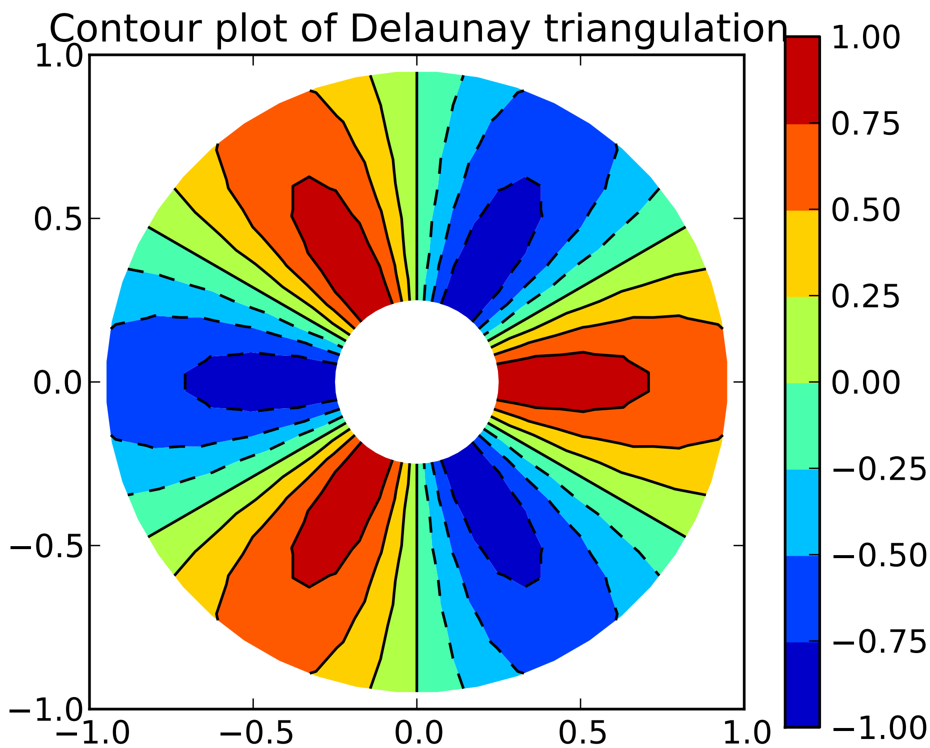
***nchunk*: [0 | integer]** If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of roughly *nchunk* by *nchunk* points. This may never actually be advantageous, so this option may be removed. Chunking introduces artifacts at the chunk boundaries unless *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 <= 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*)

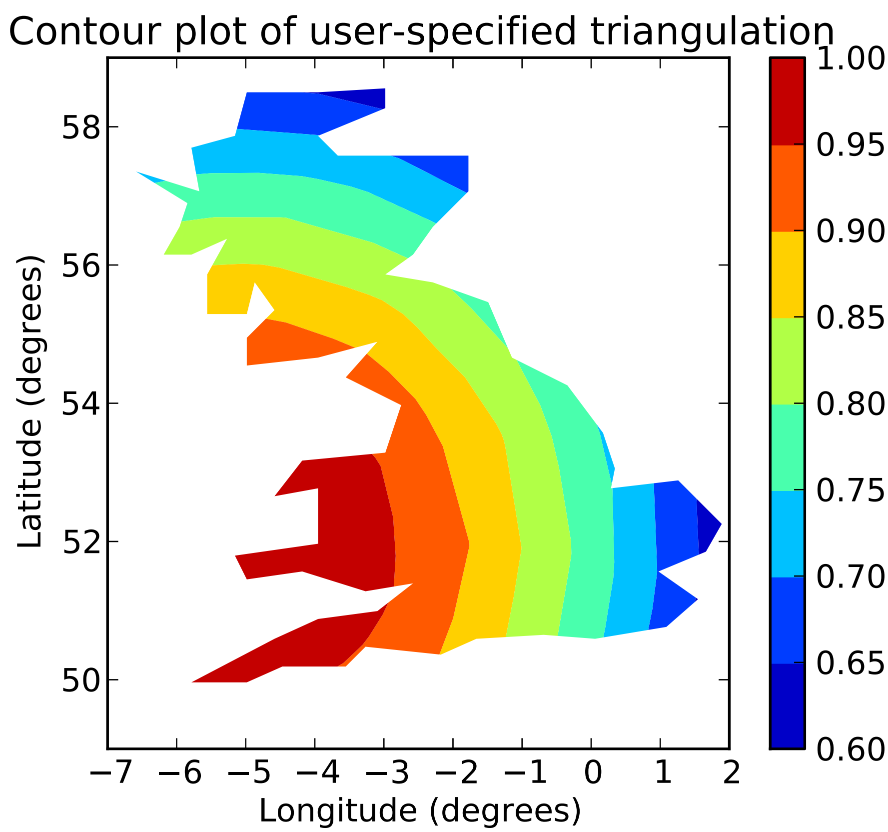
`tricontour()` and `tricontourf()` draw contour lines and filled contours, respectively, on an unstructured triangular grid. Except as noted, function signatures and return values are the same for both versions.

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, ...)
tricontour(x, y, mask=mask, ...)
tricontour(x, y, triangles, 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 (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 <= 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.

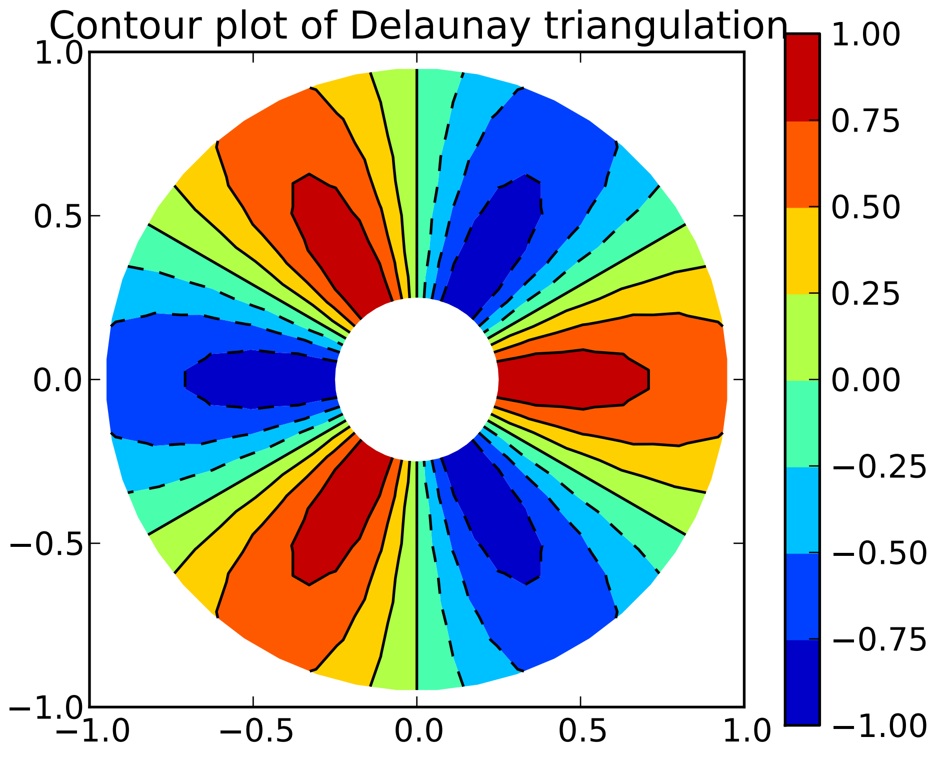
Examples:

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, ...)
tripcolor(x, y, mask=mask, ...)
tripcolor(x, y, triangles, mask, ...)
tripcolor(x, y, triangles, mask=mask, ...)
```

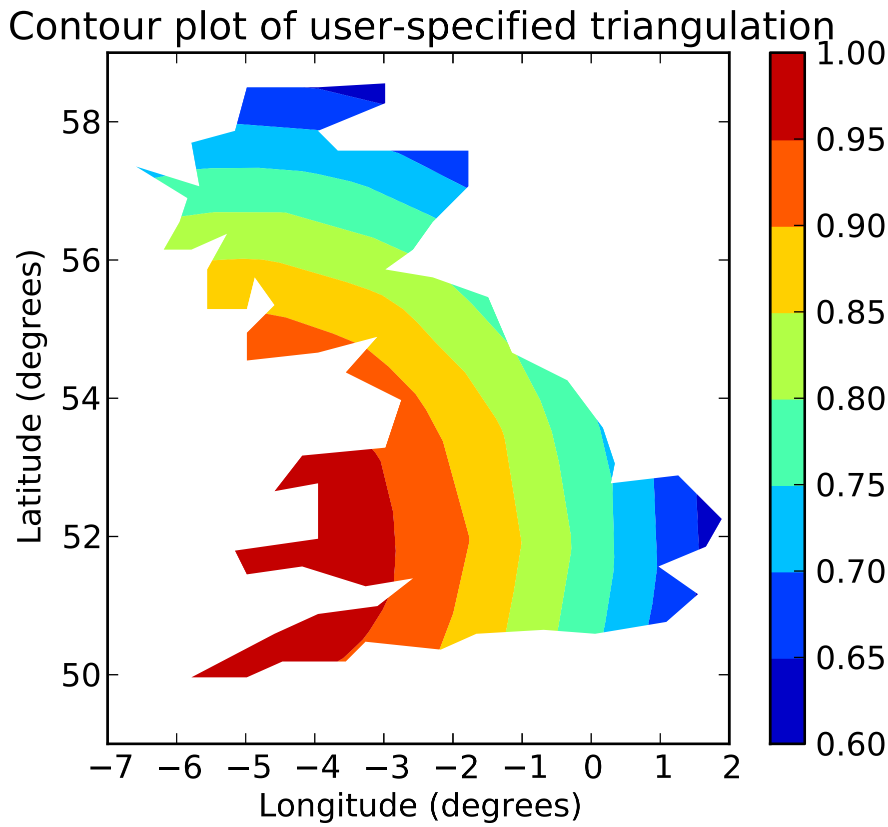
in which case a Triangulation object will be created. See `Triangulation` for a explanation of these possibilities.

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, ...)
```

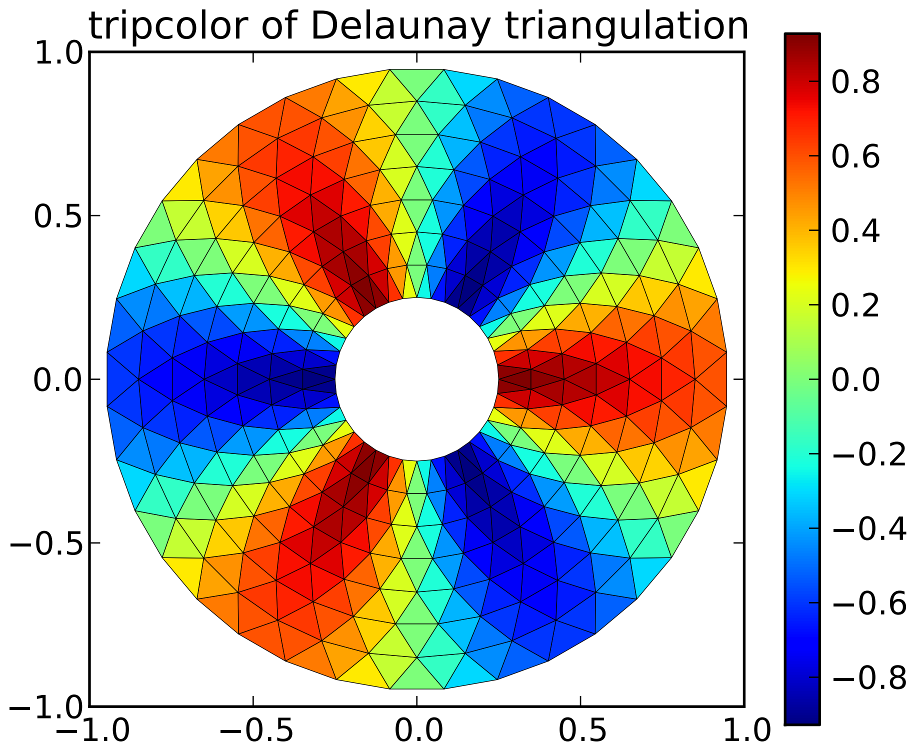
where triangulation is a `Triangulation` object, or

```
triplot(x, y, ...)
triplot(x, y, triangles, ...)
triplot(x, y, triangles=triangles, ...)
triplot(x, y, mask, ...)
triplot(x, y, mask=mask, ...)
triplot(x, y, triangles, 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.

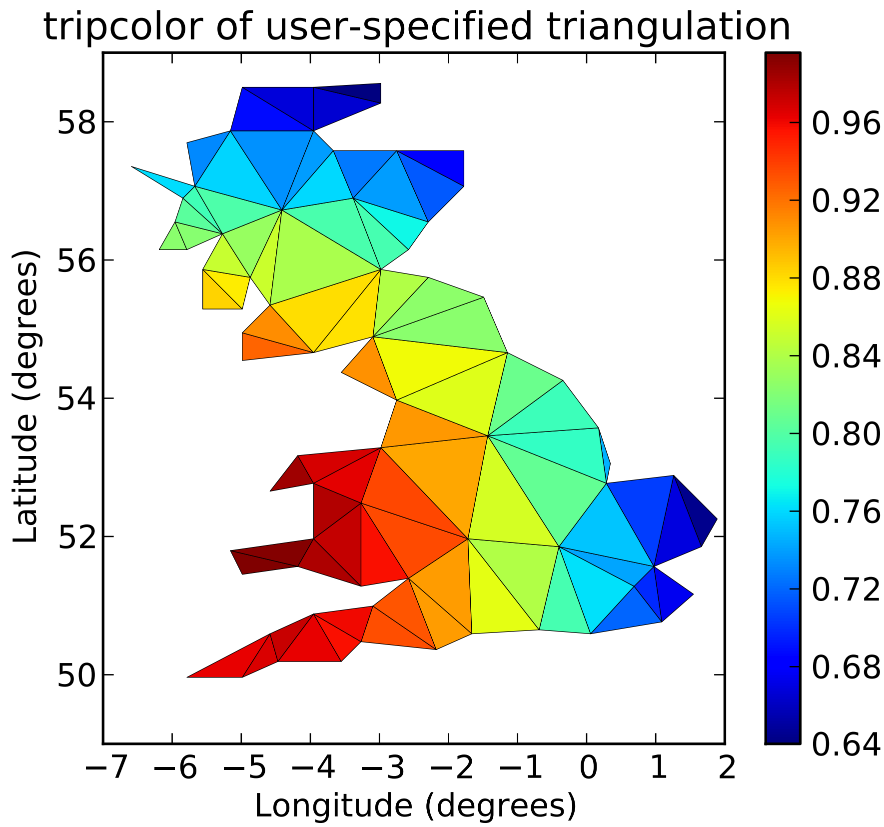
vlines(*x, ymin, ymax, colors='k', linestyles='solid', label='', hold=None, **kwargs*)

call signature:

```
vlines(x, ymin, ymax, color='k', linestyles='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
`agg_filter`	unknown
`alpha`	float or None
`animated`	[True | False]
`antialiased` or antialiaseds	Boolean or sequence of booleans
`array`	unknown
`axes`	an `Axes` instance
`clim`	a length 2 sequence of floats
`clip_box`	a `matplotlib.transforms.Bbox` instance
`clip_on`	[True | False]
`clip_path`	[(`Path`, `Transform`) | `Patch` | None]
`cmap`	a colormap or registered colormap name
`color`	matplotlib color arg or sequence of rgba tuples
`colorbar`	unknown
`contains`	a callable function

Continued on next page

Table 49.26 – continued from previous page

edgecolor or edgecolors	matplotlib color arg or sequence of rgba tuples
facecolor or facecolors	matplotlib color arg or sequence of rgba tuples
figure	a matplotlib.figure.Figure instance
gid	an id string
label	any string
linestyle or linestyles or dashes	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq)]
linewidth or lw or linewidths	float or sequence of floats
lod	[True | False]
norm	unknown
offsets	float or sequence of floats
paths	unknown
picker	[None|float|boolean|callable]
pickradius	unknown
rasterized	[True | False | None]
segments	unknown
snap	unknown
transform	Transform instance
url	a url string
urls	unknown
verts	unknown
visible	[True | False]
zorder	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 is 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.

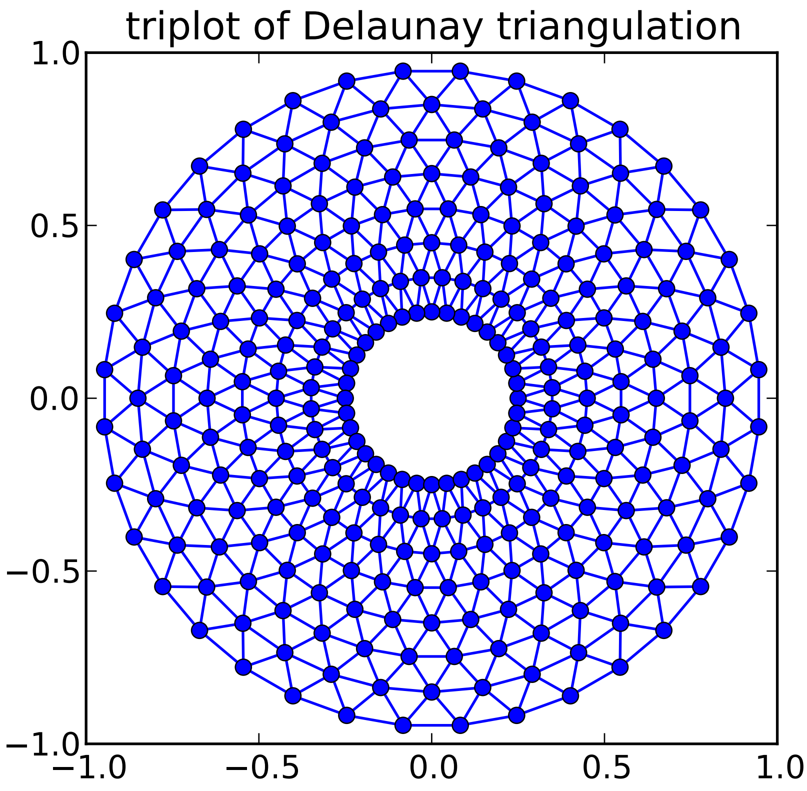
winter()

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 0x3cc2e60>, 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:

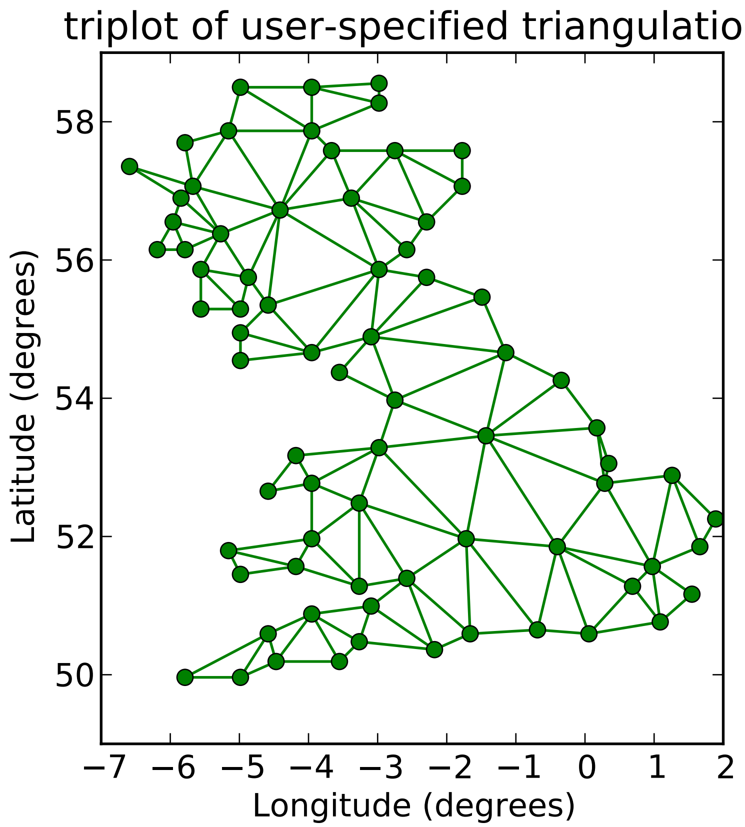
- *lags* are a length `2*maxlags+1` lag vector
- *c* is the `2*maxlags+1` auto correlation vector
- ***line* is a `Line2D` instance** returned by `plot()`.

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*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:

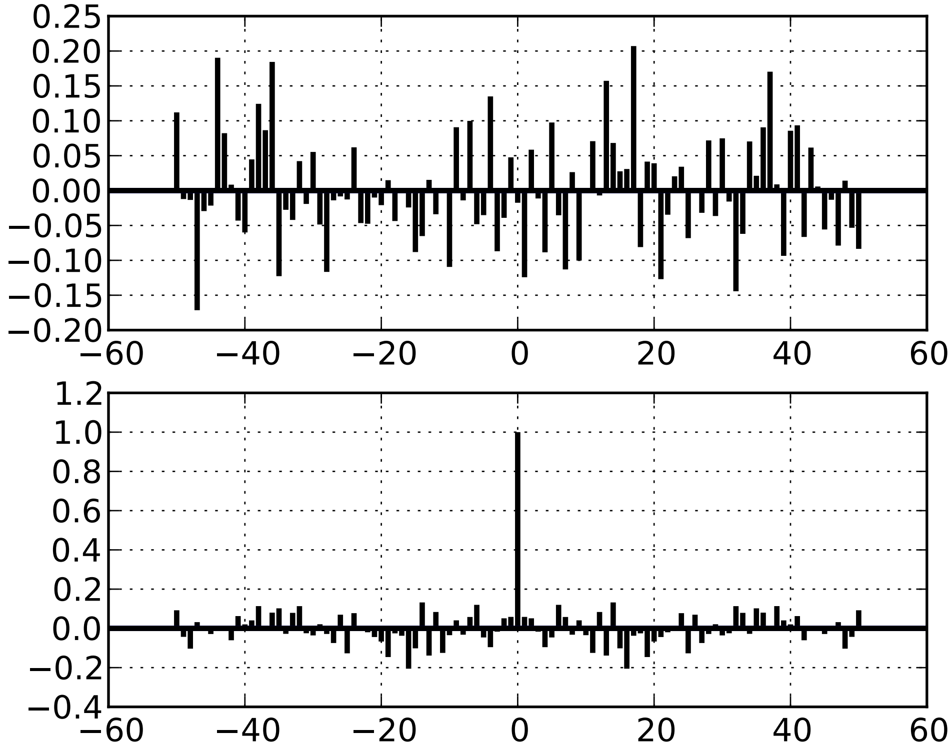
```
override = {
    'fontsize'            : 'small',
    'verticalalignment'   : 'top',
    'horizontalalignment' : 'center'
    }
```

See Also:

`text()` For information on how override and the optional args work

xlim(*args, **kwargs*)

Set/Get the xlimits 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
```

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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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
```

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'

***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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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: `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`

will place 10 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 )
```

CHAPTER

FIFTY

MATPLOTLIB NXUTILS

50.1 matplotlib.nxutils

general purpose numerical utilities, eg for computational geometry, that are not available in numpy

CHAPTER

FIFTYONE

MATPLOTLIB SPINE

51.1 matplotlib.spine

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
agg_filter	unknown
alpha	float or None
animated	[True | False]
antialiased or aa	[True | False] or None for default
axes	an Axes instance
clip_box	a matplotlib.transforms.Bbox instance
clip_on	[True | False]
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, or None for default, or 'none' for no color
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a matplotlib.figure.Figure instance
fill	[True | False]
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
label	any string
linestyle or ls	['solid' | 'dashed' | 'dashdot' | 'dotted']
linewidth or lw	float or None for default
lod	[True | False]
path_effects	unknown
picker	[None|float|boolean|callable]
rasterized	[True | False | None]
snap	unknown
transform	Transform instance
url	a url string
visible	[True | False]
zorder	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

CHAPTER

FIFTYTWO

MATPLOTLIB TICKER

52.1 matplotlib.ticker

52.1.1 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 = range(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 dyamically 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.

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 an 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()

set_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 interative 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**(*fmt*)
Bases: `matplotlib.ticker.Formatter`

Use a format string to format the tick

class **ScalarFormatter**(*useOffset=True, useMathText=False*)
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 >= 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_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_useOffset(*val*)

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

is_decade(*x*)

label_minor(*labelOnlyBase*)
switch on/off minor ticks labeling

nearest_long(*x*)

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 interger)

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*)

CHAPTER

FIFTYTHREE

MATPLOTLIB UNITS

53.1 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 converter themselves to arrays. It also supoprts 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 support 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 ouput 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

CHAPTER

FIFTYFOUR

MATPLOTLIB BACKENDS

54.1 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 backend 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 suh 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*)

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 overrride

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_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*)

`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 <=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 attibutes:

canvas A `FigureCanvasBase` instance

num The figure nuamber

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 floats from 0-1. color can be a MATLAB format string, a html hex color string, or a rgb tuple

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 unit tuple, or a float between 0 and 1. In the latter case, grayscale is used.

The `GraphicsContextBase` converts colors to rgb internally. If you know the color is rgb already, you can set `isRGB=True` to avoid the performace hit of the conversion

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').

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*)

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 whenver 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 trianglex.

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, linestyles, antialiaseds, urls*)

Draws a collection of paths selecting drawing properties from the lists *facecolors*, *edgecolors*, *linewidths*, *linestyles* 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, facecolors, 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.TexManager` 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:

```
points to pixels = points * pixels_per_inch/72.0 * 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*)

54.2 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.

54.3 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

54.4 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

54.5 matplotlib.backends.backend_pdf

A PDF matplotlib backend (not yet complete) Author: Jouni K Seppänen <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.

54.6 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.boxes:
        ...
```

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.boxes, 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.

54.7 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.

Part V

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 developerd by adobe systems and is starting to show its age: for example is 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 packages as 'python-gtk2'

pyqt pyqt provides python wrappers for the *Qt* widgets library and is requied 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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