Matplotlib

Release 2.2.3

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Part I

User's Guide

CHAPTER

ONE

HISTORY

Note: The following introductory text was written in 2008 by John D. Hunter (1968-2012), the original author of Matplotlib.

Matplotlib is a library for making 2D plots of arrays in Python. Although it has its origins in emulating the MATLAB graphics commands, it is independent of MATLAB, and can be used in a Pythonic, object oriented way. Although Matplotlib is written primarily in pure Python, it makes heavy use of NumPy and other extension code to provide good performance even for large arrays.

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

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

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

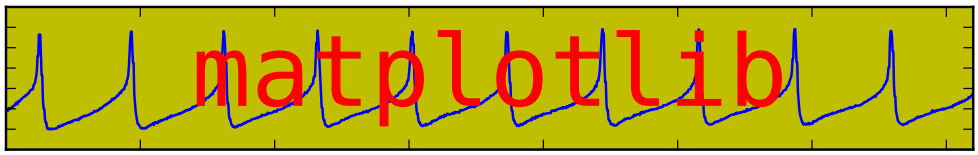
- Plots should look great - publication quality. One important requirement for me is that the text looks good (antialiased, etc.)
- Postscript output for inclusion with TeX documents
- Embeddable in a graphical user interface for application development
- Code should be easy enough that I can understand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

Finding no package that suited me just right, I did what any self-respecting Python programmer would do: rolled up my sleeves and dived in. Not having any real experience with computer graphics, I decided to emulate MATLAB's plotting capabilities because that is something MATLAB does very well. This had the added advantage that many people have a lot of MATLAB experience, and thus they can quickly get up to 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.

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 in 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.

Matplotlib's original logo (2003 – 2008).



CHAPTER

TWO

INSTALLING

Note: If you wish to contribute to the project, it's recommended you *install the latest development version*.

Contents

- *Installing*
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    - *macOS*
    - *Linux*
    - *Test Data*
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    - *Scientific Python Distributions*
    - *Linux : using your package manager*
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    - *Dependencies*
    - *Building on Linux*
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    - *Building on Windows*
      - *Wheel builds using conda packages*
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2.1 Installing an official release

Matplotlib and most of its dependencies are all available as wheel packages for macOS, Windows and Linux distributions:

```
python -mpip install -U pip
python -mpip install -U matplotlib
```

Note: The following backends work out of the box: Agg, ps, pdf, svg and TkAgg.

For support of other GUI frameworks, LaTeX rendering, saving animations and a larger selection of file formats, you may need to install *additional dependencies*.

Although not required, we suggest also installing `IPython` for interactive use. To easily install a complete Scientific Python stack, see *Scientific Python Distributions* below.

2.1.1 Windows

In case Python 2.7 or 3.4 are not installed for all users, the Microsoft Visual C++ 2008 (64 bit or 32 bit for Python 2.7) or Microsoft Visual C++ 2010 (64 bit or 32 bit for Python 3.4) redistributable packages need to be installed.

2.1.2 macOS

If you are using Python 2.7 on a Mac you may need to do:

```
xcode-select --install
```

so that *subprocess32*, a dependency, may be compiled.

To use the native OSX backend you will need *a framework build* build of Python.

2.1.3 Linux

On extremely old versions of Linux and Python 2.7 you may need to install the master version of *subprocess32* (see comments).

2.1.4 Test Data

The wheels (`*.whl`) on the PyPI download page do not contain test data or example code. If you want to try the many demos that come in the Matplotlib source distribution, download the `*.tar.gz` file and look in the `examples` subdirectory. To run the test suite:

- extract the `lib\matplotlib\tests` or `lib\mpl_toolkits\tests` directories from the source distribution;

- install test dependencies: pytest, mock, Pillow, MiKTeX, GhostScript, ffmpeg, avconv, ImageMagick, and Inkscape;
- run `py.test path\to\tests\directory`.

2.2 Third-party distributions of Matplotlib

2.2.1 Scientific Python Distributions

Anaconda and Canopy and ActiveState are excellent choices that "just work" out of the box for Windows, macOS and common Linux platforms. WinPython is an option for windows users. All of these distributions include Matplotlib and *lots* of other useful (data) science tools.

2.2.2 Linux : using your package manager

If you are on Linux, you might prefer to use your package manager. Matplotlib is packaged for almost every major Linux distribution.

- Debian / Ubuntu: `sudo apt-get install python3-matplotlib`
- Fedora: `sudo dnf install python3-matplotlib`
- Red Hat: `sudo yum install python3-matplotlib`
- Arch: `sudo pacman -S python-matplotlib`

2.3 Installing from source

If you are interested in contributing to Matplotlib development, running the latest source code, or just like to build everything yourself, it is not difficult to build Matplotlib from source. Grab the latest *tar.gz* release file from the PyPI files page, or if you want to develop Matplotlib or just need the latest bugfixed version, grab the latest git version *Install from source*.

The standard environment variables `CC`, `CXX`, `PKG_CONFIG` are respected. This means you can set them if your toolchain is prefixed. This may be used for cross compiling.

```
export CC=x86_64-pc-linux-gnu-gcc
export CXX=x86_64-pc-linux-gnu-g++
export PKG_CONFIG=x86_64-pc-linux-gnu-pkg-config
```

Once you have satisfied the requirements detailed below (mainly Python, NumPy, libpng and FreeType), you can build Matplotlib.

```
cd matplotlib
python -mpip install .
```

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

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

2.3.1 Dependencies

Matplotlib requires a large number of dependencies:

- Python (>= 2.7 or >= 3.4)
- NumPy (>= 1.7.1)
- setuptools
- dateutil (>= 2.1)
- pyparsing
- libpng (>= 1.2)
- pytz
- FreeType (>= 2.3)
- cycler (>= 0.10.0)
- six
- backports.functools_lru_cache (for Python 2.7 only)
- subprocess32 (for Python 2.7 only, on Linux and macOS only)
- kiwisolver (>= 1.0.0)

Optionally, you can also install a number of packages to enable better user interface toolkits. See *What is a backend?* for more details on the optional Matplotlib backends and the capabilities they provide.

- *tk* (>= 8.3, != 8.6.0 or 8.6.1): for the Tk-based backends;
- PyQt4 (>= 4.6) or PySide: for the Qt4-based backend;
- PyQt5: for the Qt5-based backend;
- *pygtk* (>= 2.4): for the GTK and the GTKAgg backend;
- *wxpython* (>= 2.9 or later): for the WX or WXAgg backend;
- cairocffi (>= v0.8): for cairo based backends;
- pycairo: for GTK3Cairo;
- Tornado: for the WebAgg backend;

For better support of animation output format and image file formats, LaTeX, etc., you can install the following:

- ffmpeg/avconv: for saving movies;
- ImageMagick: for saving animated gifs;
- Pillow (>=2.0): for a larger selection of image file formats: JPEG, BMP, and TIFF image files;
- LaTeX and GhostScript (for rendering text with LaTeX).

Note: Matplotlib depends on a large number of non-Python libraries. pkg-config can be used to find required non-Python libraries and thus make the install go more smoothly if the libraries and headers are not in the expected locations.

Note: The following libraries are shipped with Matplotlib:

- `Agg`: the Anti-Grain Geometry C++ rendering engine;
- `qhull`: to compute Delaunay triangulation;
- `ttconv`: a true type font utility.

2.3.2 Building on Linux

It is easiest to use your system package manager to install the dependencies.

If you are on Debian/Ubuntu, you can get all the dependencies required to build Matplotlib with:

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

If you are on Fedora, you can get all the dependencies required to build Matplotlib with:

```
sudo dnf builddep python-matplotlib
```

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

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

These commands do not build Matplotlib, but instead get and install the build dependencies, which will make building from source easier.

2.3.3 Building on macOS

The build situation on macOS is complicated by the various places one can get the libpng and FreeType requirements (MacPorts, Fink, /usr/X11R6), the different architectures (e.g., x86, ppc, universal), and the different macOS versions (e.g., 10.4 and 10.5). We recommend that you build the way we do for the macOS

release: get the source from the tarball or the git repository and install the required dependencies through a third-party package manager. Two widely used package managers are Homebrew, and MacPorts. The following example illustrates how to install libpng and FreeType using `brew`:

```
brew install libpng freetype pkg-config
```

If you are using MacPorts, execute the following instead:

```
port install libpng freetype pkgconfig
```

After installing the above requirements, install Matplotlib from source by executing:

```
python -mpip install .
```

Note that your environment is somewhat important. Some conda users have found that, to run the tests, their PYTHONPATH must include /path/to/anaconda/.../site-packages and their DYLD_FALLBACK_LIBRARY_PATH must include /path/to/anaconda/lib.

2.3.4 Building on Windows

The Python shipped from https://www.python.org is compiled with Visual Studio 2008 for versions before 3.3, Visual Studio 2010 for 3.3 and 3.4, and Visual Studio 2015 for 3.5 and 3.6. Python extensions are recommended to be compiled with the same compiler.

Since there is no canonical Windows package manager, the methods for building FreeType, zlib, and libpng from source code are documented as a build script at matplotlib-winbuild.

There are a few possibilities to build Matplotlib on Windows:

- Wheels via matplotlib-winbuild
- Wheels by using conda packages
- Conda packages

Wheel builds using conda packages

This is a wheel build, but we use conda packages to get all the requirements. The binary requirements (png, FreeType,...) are statically linked and therefore not needed during the wheel install.

The commands below assume that you can compile a native Python lib for the Python version of your choice. See this howto for how to install and setup such environments. If in doubt: use Python >= 3.5 as it mostly works without fiddling with environment variables:

```
# create a new environment with the required packages
conda create  -n "matplotlib_build" python=3.5 numpy python-dateutil pyparsing pytz␣
↪tornado "cycler>=0.10" tk libpng zlib freetype
activate matplotlib_build
# if you want a qt backend, you also have to install pyqt (be aware that pyqt doesn't mix␣
↪well if
# you have created the environment with conda-forge already activated...)
```

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```
conda install pyqt
# this package is only available in the conda-forge channel
conda install -c conda-forge msinttypes
# for Python 2.7
conda install -c conda-forge backports.functools_lru_cache

# copy the libs which have "wrong" names
set LIBRARY_LIB=%CONDA_PREFIX%\Library\lib
mkdir lib || cmd /c "exit /b 0"
copy %LIBRARY_LIB%\zlibstatic.lib lib\z.lib
copy %LIBRARY_LIB%\libpng_static.lib lib\png.lib

# Make the header files and the rest of the static libs available during the build
# CONDA_DEFAULT_ENV is a env variable which is set to the currently active environment␣
↪path
set MPLBASEDIRLIST=%CONDA_PREFIX%\Library\;.

# build the wheel
python setup.py bdist_wheel
```

The `build_alllocal.cmd` script in the root folder automates these steps if you have already created and activated the conda environment.

Conda packages

This needs a working installed C compiler for the version of Python you are compiling the package for but you don't need to setup the environment variables:

```
# only the first time...
conda install conda-build

# the Python version you want a package for...
set CONDA_PY=3.5

# builds the package, using a clean build environment
conda build ci\conda_recipe

# install the new package
conda install --use-local matplotlib
```

CHAPTER

THREE

TUTORIALS

This page contains more in-depth guides for using Matplotlib. It is broken up into beginner, intermediate, and advanced sections, as well as sections covering specific topics.

For shorter examples, see our examples page. You can also find external resources and a FAQ in our user guide.

3.1 Introductory

These tutorials cover the basics of creating visualizations with Matplotlib, as well as some best-practices in using the package effectively.

Note: Click *here* to download the full example code

3.1.1 Sample plots in Matplotlib

Here you'll find a host of example plots with the code that generated them.

Line Plot

Here's how to create a line plot with text labels using `plot()`.

Multiple subplots in one figure

Multiple axes (i.e. subplots) are created with the `subplot()` function:

Images

Matplotlib can display images (assuming equally spaced horizontal dimensions) using the `imshow()` function.

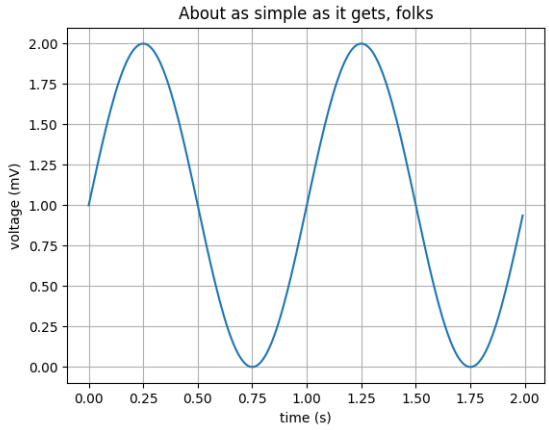


Fig. 1: Simple Plot

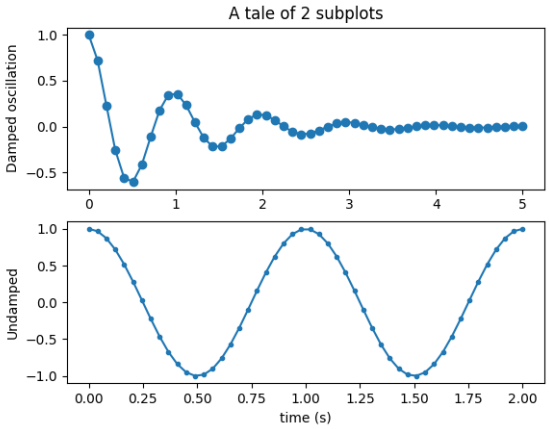


Fig. 2: Subplot

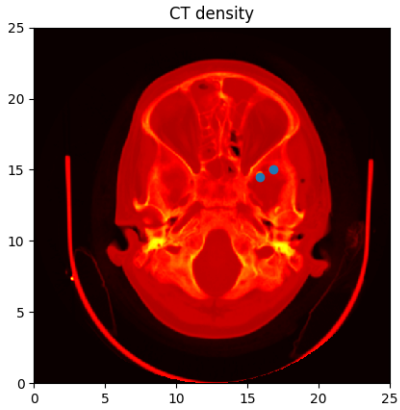


Fig. 3: Example of using *imshow()* to display a CT scan

Contouring and pseudocolor

The *pcolormesh()* function can make a colored representation of a two-dimensional array, even if the horizontal dimensions are unevenly spaced. The *contour()* function is another way to represent the same data:

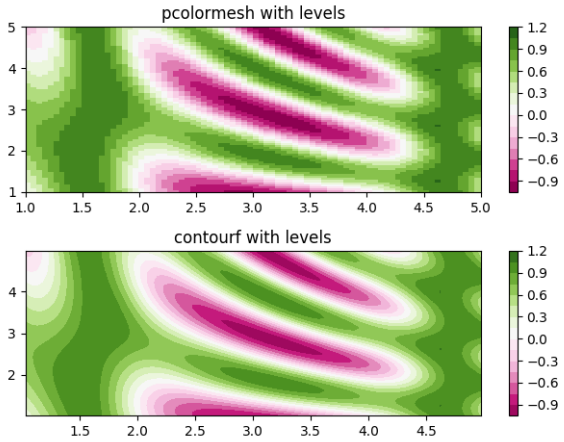


Fig. 4: Example comparing *pcolormesh()* and *contour()* for plotting two-dimensional data

Histograms

The *hist()* function automatically generates histograms and returns the bin counts or probabilities:

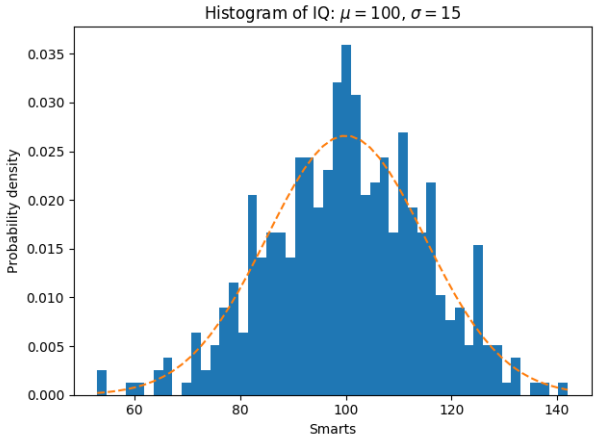


Fig. 5: Histogram Features

Paths

You can add arbitrary paths in Matplotlib using the *matplotlib.path* module:

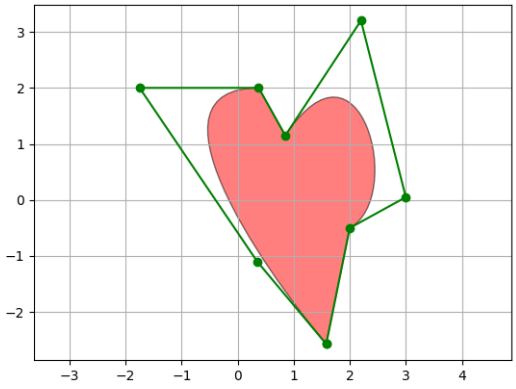


Fig. 6: Path Patch

Three-dimensional plotting

The mplot3d toolkit (see *Getting started* and mplot3d-examples-index) has support for simple 3d graphs including surface, wireframe, scatter, and bar charts.

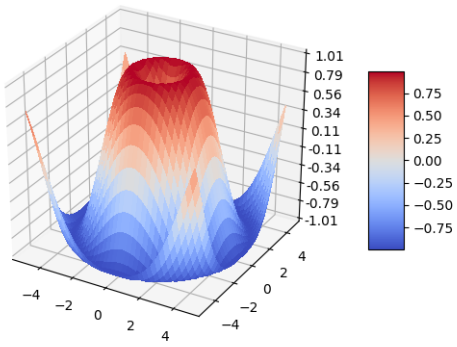


Fig. 7: Surface3d

Thanks to John Porter, Jonathon Taylor, Reinier Heeres, and Ben Root for the `mplot3d` toolkit. This toolkit is included with all standard Matplotlib installs.

Streamplot

The *`streamplot()`* function plots the streamlines of a vector field. In addition to simply plotting the streamlines, it allows you to map the colors and/or line widths of streamlines to a separate parameter, such as the speed or local intensity of the vector field.

This feature complements the *`quiver()`* function for plotting vector fields. Thanks to Tom Flannaghan and Tony Yu for adding the streamplot function.

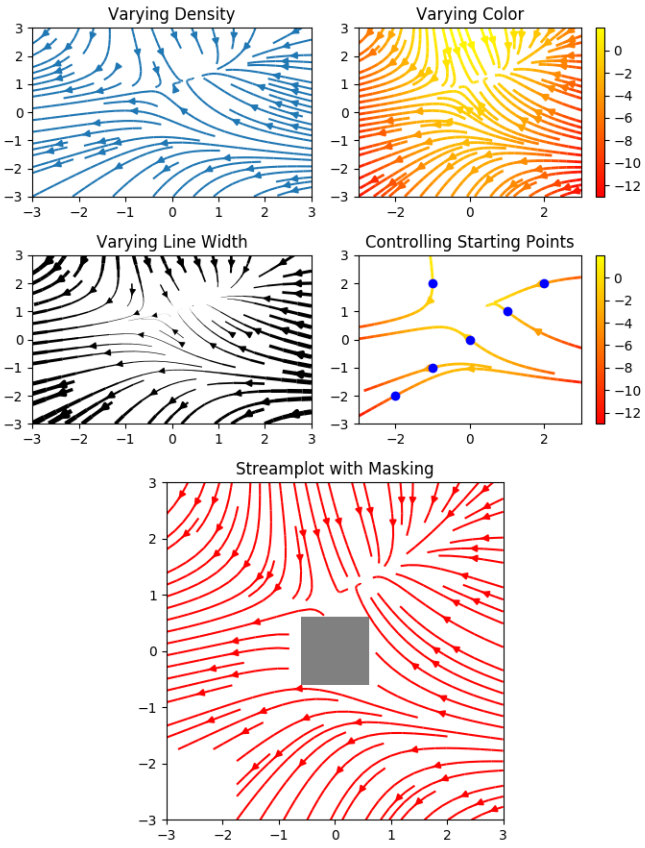


Fig. 8: Streamplot with various plotting options.

Ellipses

In support of the Phoenix mission to Mars (which used Matplotlib to display ground tracking of spacecraft), Michael Droettboom built on work by Charlie Moad to provide an extremely accurate 8-spline approximation to elliptical arcs (see `Arc`), which are insensitive to zoom level.

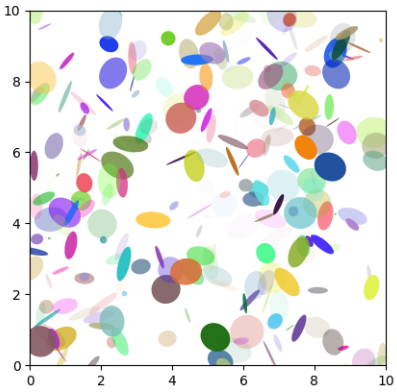


Fig. 9: Ellipse Demo

Bar charts

Use the `bar()` function to make bar charts, which includes customizations such as error bars:

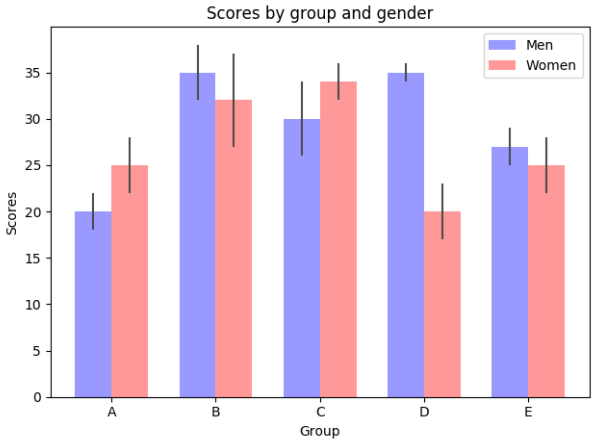


Fig. 10: Barchart Demo

You can also create stacked bars (bar_stacked.py), or horizontal bar charts (barh.py).

Pie charts

The `pie()` function allows you to create pie charts. Optional features include auto-labeling the percentage of area, exploding one or more wedges from the center of the pie, and a shadow effect. Take a close look at

the attached code, which generates this figure in just a few lines of code.

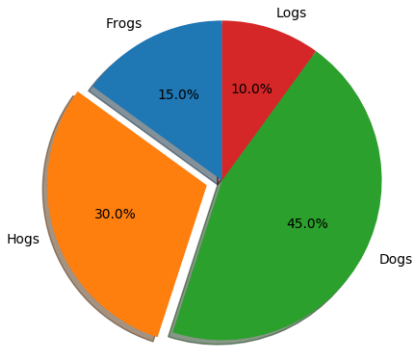


Fig. 11: Pie Features

Tables

The `table()` function adds a text table to an axes.

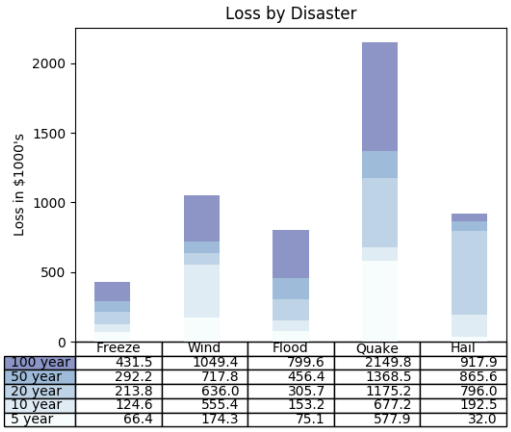


Fig. 12: Table Demo

Scatter plots

The `scatter()` function makes a scatter plot with (optional) size and color arguments. This example plots changes in Google's stock price, with marker sizes reflecting the trading volume and colors varying with time. Here, the alpha attribute is used to make semitransparent circle markers.

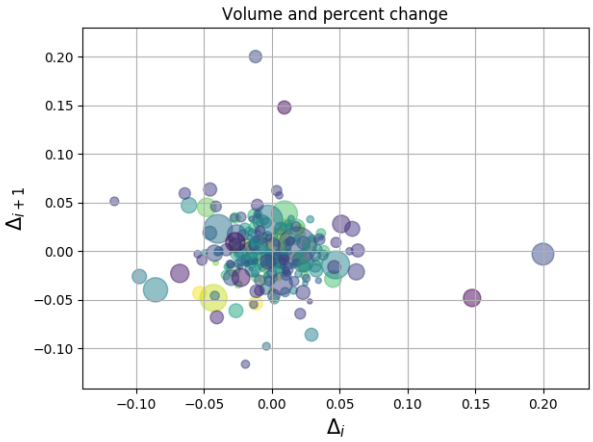


Fig. 13: Scatter Demo2

GUI widgets

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.

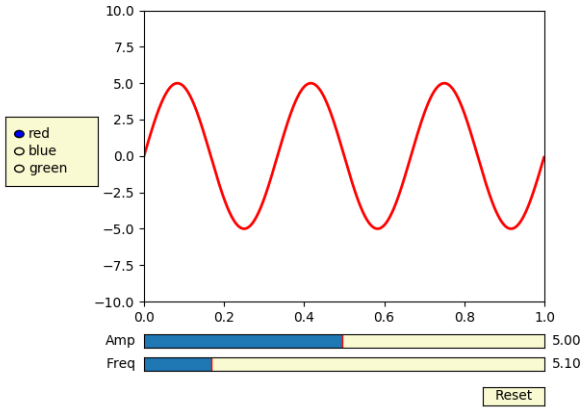


Fig. 14: Slider and radio-button GUI.

Filled curves

The *fill()* function lets you plot filled curves and polygons:

Thanks to Andrew Straw for adding this function.

Date handling

You can plot timeseries data with major and minor ticks and custom tick formatters for both.

See *matplotlib.ticker* and *matplotlib.dates* for details and usage.

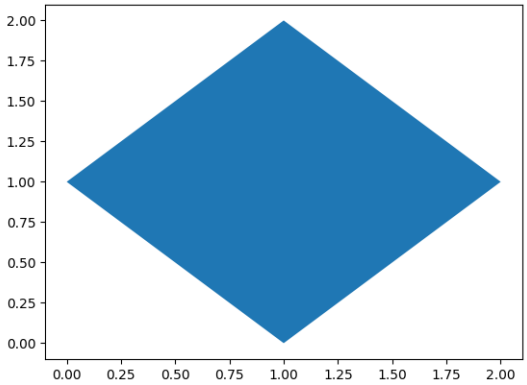


Fig. 15: Fill

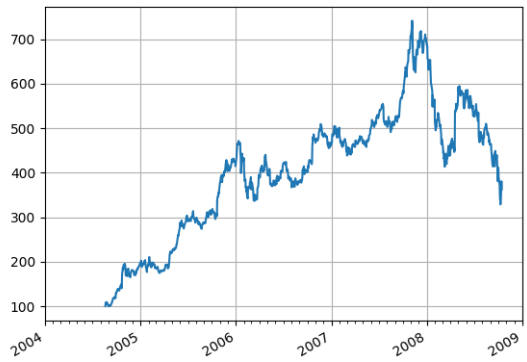


Fig. 16: Date

Log plots

The *semilogx()*, *semilogy()* and *loglog()* functions simplify the creation of logarithmic plots.

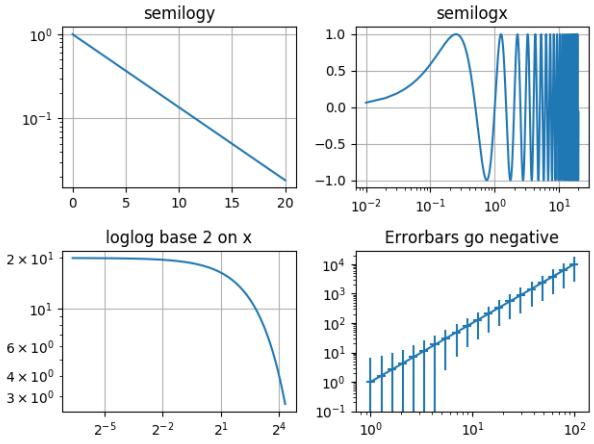


Fig. 17: Log Demo

Thanks to Andrew Straw, Darren Dale and Gregory Lielens for contributions log-scaling infrastructure.

Polar plots

The *polar()* function generates polar plots.

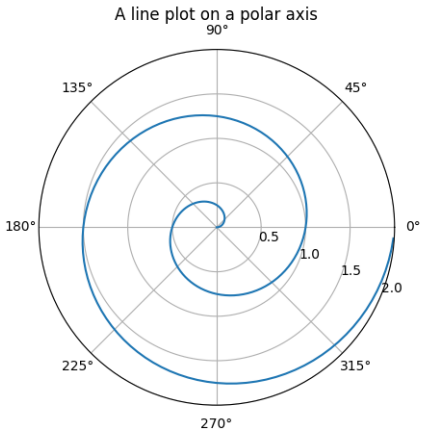


Fig. 18: Polar Demo

Legends

The *legend()* function automatically generates figure legends, with MATLAB-compatible legend-placement functions.

Thanks to Charles Twardy for input on the legend function.

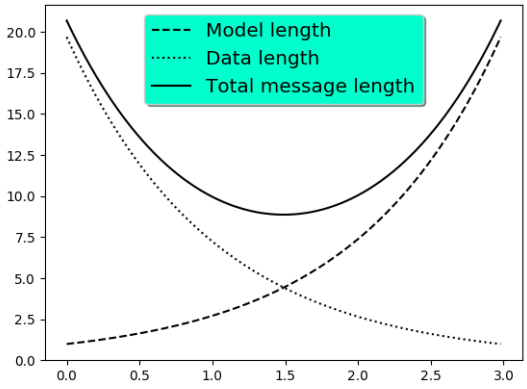


Fig. 19: Legend

TeX-notation for text objects

Below is a sampling of the many TeX expressions now supported by Matplotlib's internal mathtext engine. The mathtext module provides TeX style mathematical expressions using FreeType and the DejaVu, BaKoMa computer modern, or STIX fonts. See the `matplotlib.mathtext` module for additional details.

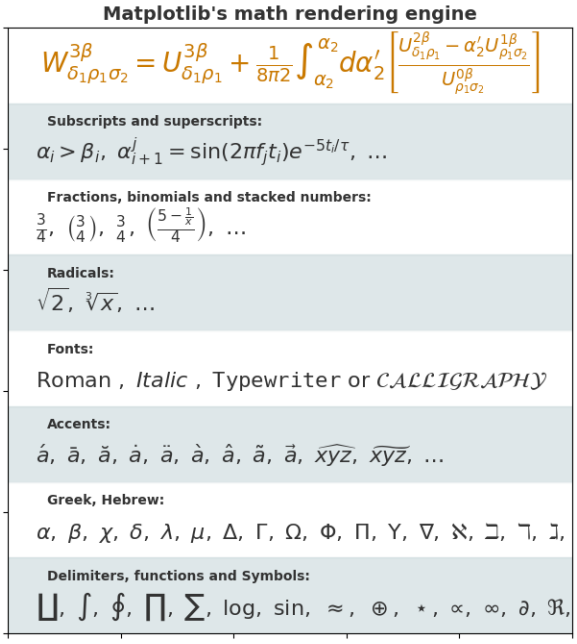


Fig. 20: Mathtext Examples

Matplotlib's mathtext infrastructure is an independent implementation and does not require TeX or any external packages installed on your computer. See the tutorial at *Writing mathematical expressions*.

Native TeX rendering

Although Matplotlib's internal math rendering engine is quite powerful, sometimes you need TeX. Matplotlib supports external TeX rendering of strings with the *usetex* option.

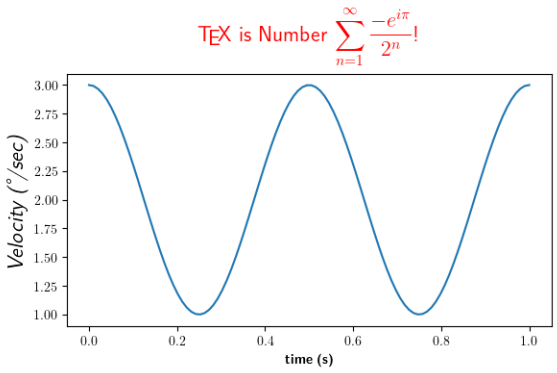
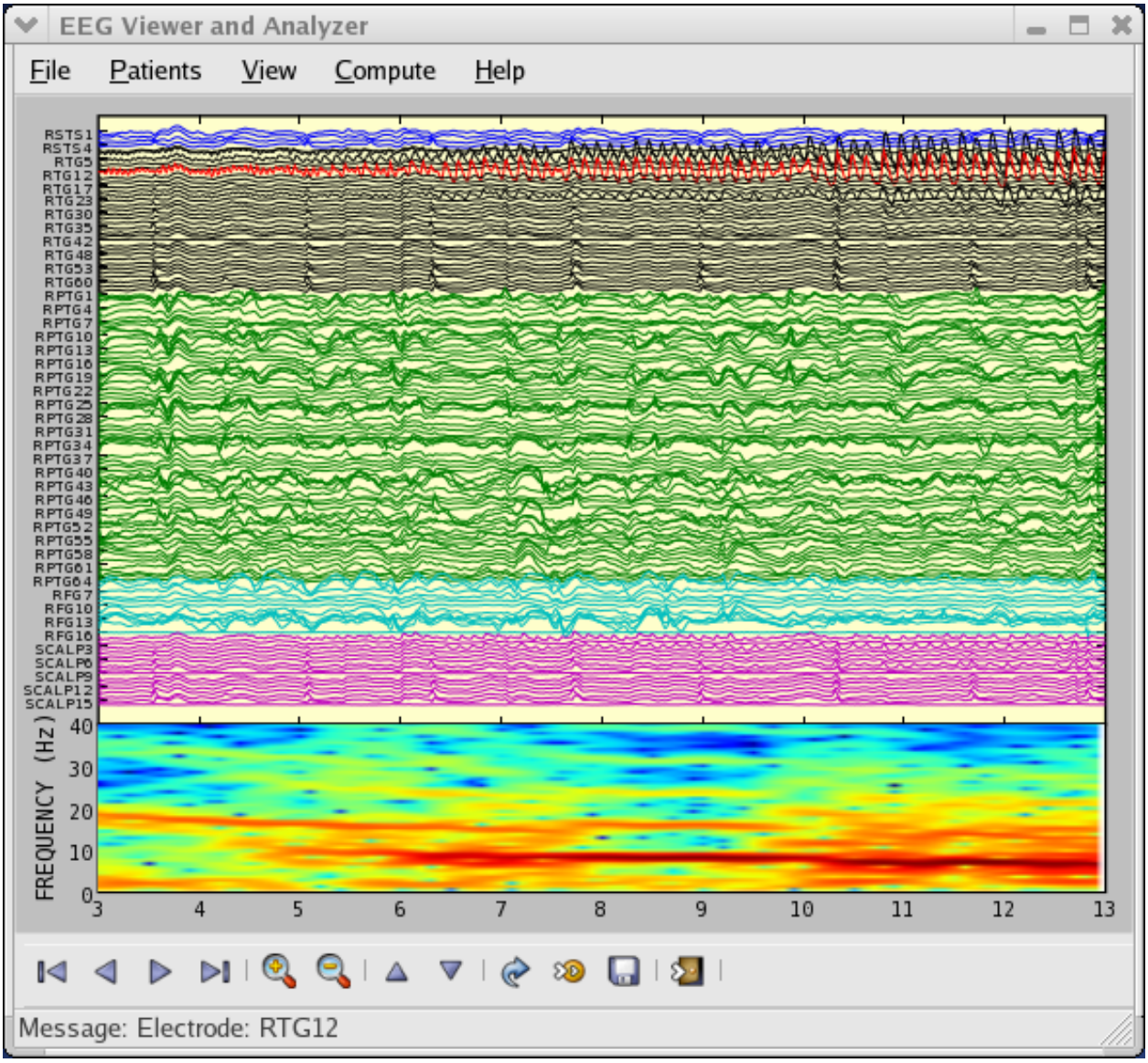


Fig. 21: Tex Demo

EEG GUI

You can embed Matplotlib into pygtk, wx, Tk, or Qt applications. Here is a screenshot of an EEG viewer called pbrain.



The lower axes uses *specgram()* to plot the spectrogram of one of the EEG channels.

For examples of how to embed Matplotlib in different toolkits, see:

- /gallery/user_interfaces/embedding_in_gtk2_sgskip
- /gallery/user_interfaces/embedding_in_wx2_sgskip
- /gallery/user_interfaces/mpl_with_glade_sgskip
- /gallery/user_interfaces/embedding_in_qt_sgskip
- /gallery/user_interfaces/embedding_in_tk_sgskip

XKCD-style sketch plots

Just for fun, Matplotlib supports plotting in the style of `xkcd`.

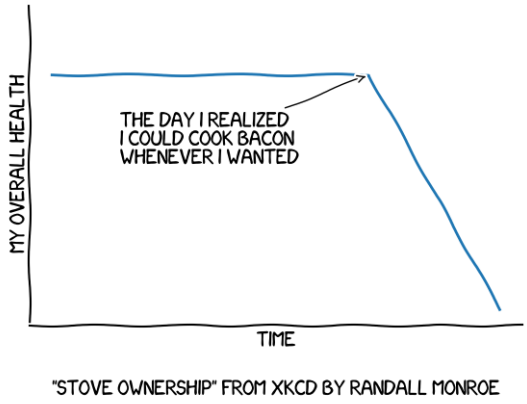


Fig. 22: Xkcd

Subplot example

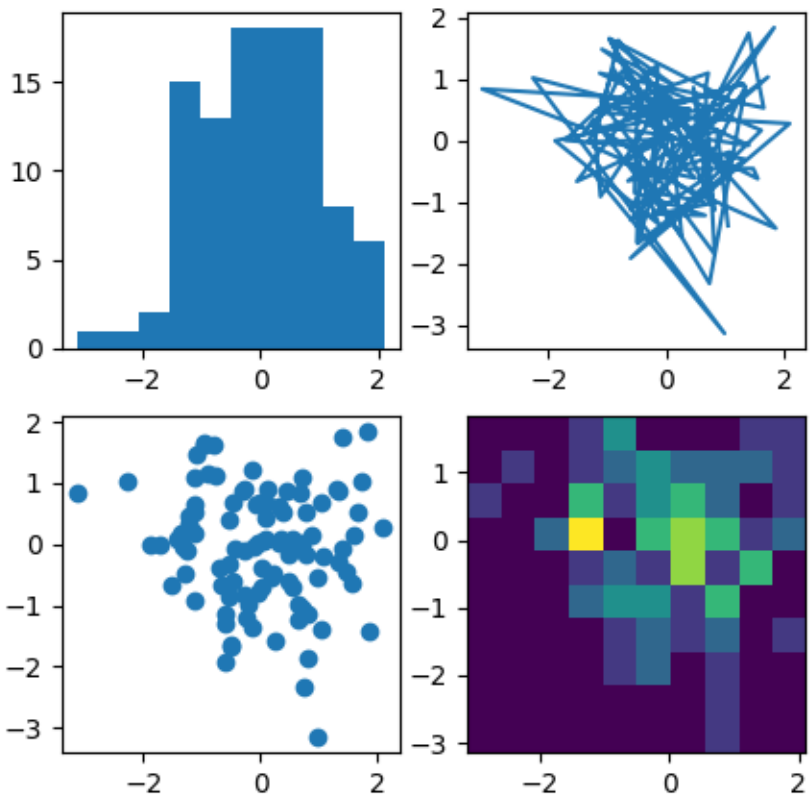
Many plot types can be combined in one figure to create powerful and flexible representations of data.

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

np.random.seed(19680801)
data = np.random.randn(2, 100)

fig, axs = plt.subplots(2, 2, figsize=(5, 5))
axs[0, 0].hist(data[0])
axs[1, 0].scatter(data[0], data[1])
axs[0, 1].plot(data[0], data[1])
axs[1, 1].hist2d(data[0], data[1])

plt.show()
```



Note: Click *here* to download the full example code

3.1.2 Customizing Matplotlib with style sheets and rcParams

Tips for customizing the properties and default styles of Matplotlib.

Using style sheets

The `style` package adds support for easy-to-switch plotting "styles" with the same parameters as a matplotlibrc file (which is read at startup to configure matplotlib).

There are a number of pre-defined styles provided by Matplotlib. For example, there's a pre-defined style called "ggplot", which emulates the aesthetics of ggplot (a popular plotting package for R). To use this style, just add:

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

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```
import matplotlib as mpl
plt.style.use('ggplot')
data = np.random.randn(50)
```

To list all available styles, use:

```
print(plt.style.available)
```

Out:

```
['tableau-colorblind10', 'seaborn', 'seaborn-whitegrid', 'seaborn-white', 'seaborn-ticks
↪', 'seaborn-talk', 'seaborn-poster', 'seaborn-pastel', 'seaborn-paper', 'seaborn-
↪notebook', 'seaborn-muted', 'seaborn-deep', 'seaborn-darkgrid', 'seaborn-dark',
↪'seaborn-dark-palette', 'seaborn-colorblind', 'seaborn-bright', 'grayscale', 'ggplot',
↪'fivethirtyeight', 'fast', 'dark_background', 'classic', 'bmh', '_classic_test',
↪'Solarize_Light2']
```

Defining your own style

You can create custom styles and use them by calling `style.use` with the path or URL to the style sheet. Additionally, if you add your `<style-name>.mplstyle` file to `mpl_configdir/stylelib`, you can reuse your custom style sheet with a call to `style.use(<style-name>)`. By default `mpl_configdir` should be `~/.config/matplotlib`, but you can check where yours is with `matplotlib.get_configdir()`; you may need to create this directory. You also can change the directory where matplotlib looks for the stylelib/ folder by setting the MPLCONFIGDIR environment variable, see *matplotlib configuration and cache directory locations*.

Note that a custom style sheet in `mpl_configdir/stylelib` will override a style sheet defined by matplotlib if the styles have the same name.

For example, you might want to create `mpl_configdir/stylelib/presentation.mplstyle` with the following:

```
axes.titlesize : 24
axes.labelsize : 20
lines.linewidth : 3
lines.markersize : 10
xtick.labelsize : 16
ytick.labelsize : 16
```

Then, when you want to adapt a plot designed for a paper to one that looks good in a presentation, you can just add:

```
>>> import matplotlib.pyplot as plt
>>> plt.style.use('presentation')
```

Composing styles

Style sheets are designed to be composed together. So you can have a style sheet that customizes colors and a separate style sheet that alters element sizes for presentations. These styles can easily be combined by passing a list of styles:

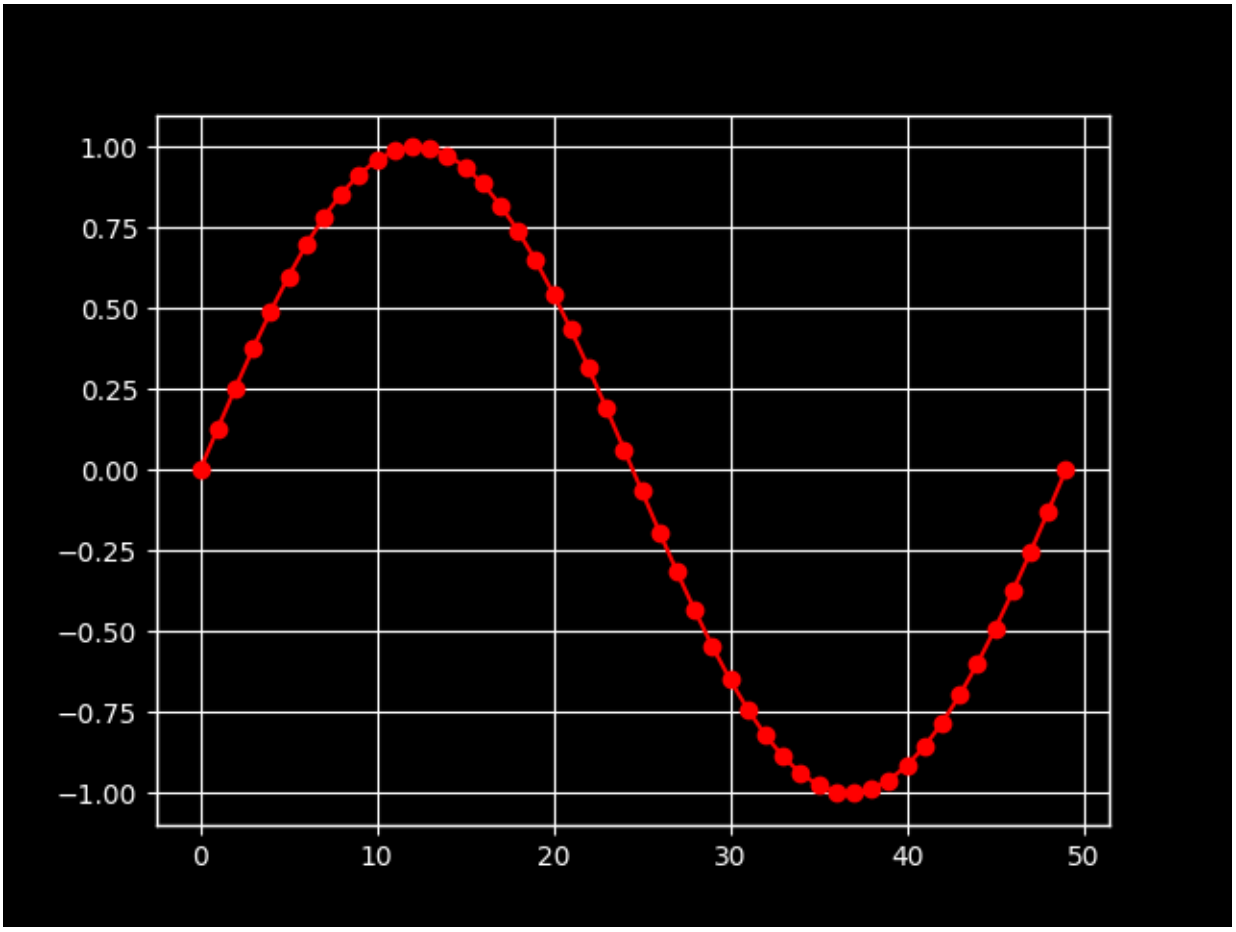
```
>>> import matplotlib.pyplot as plt
>>> plt.style.use(['dark_background', 'presentation'])
```

Note that styles further to the right will overwrite values that are already defined by styles on the left.

Temporary styling

If you only want to use a style for a specific block of code but don't want to change the global styling, the style package provides a context manager for limiting your changes to a specific scope. To isolate your styling changes, you can write something like the following:

```
with plt.style.context(('dark_background')):
    plt.plot(np.sin(np.linspace(0, 2 * np.pi)), 'r-o')
plt.show()
```

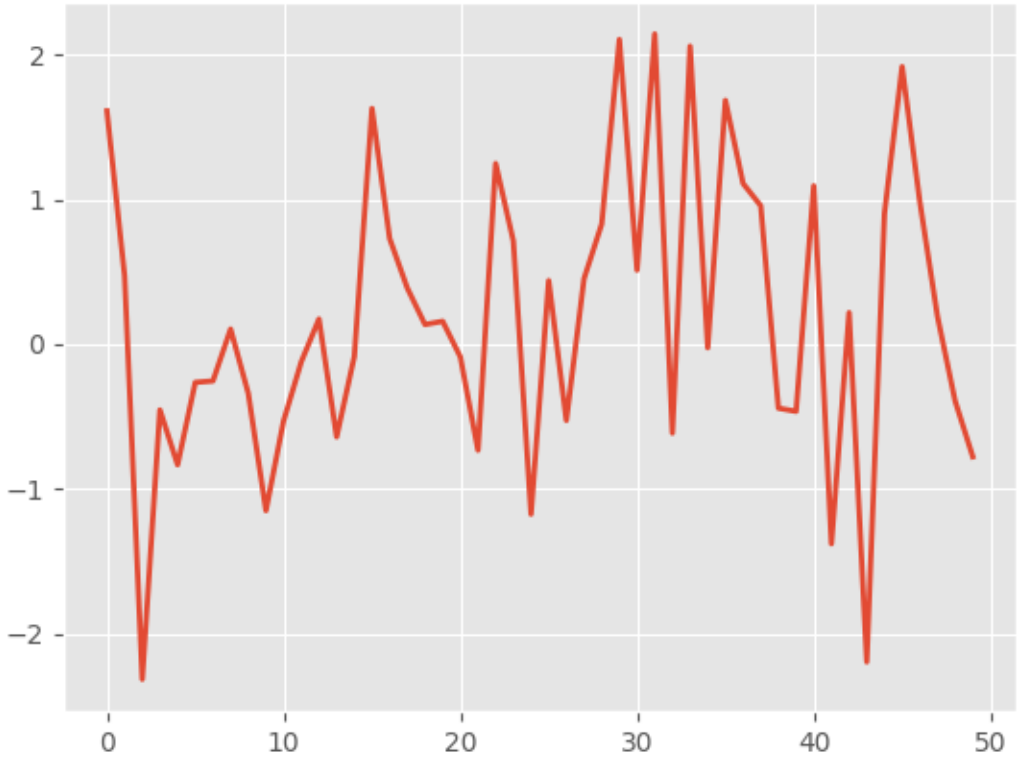


3.1.3 matplotlib rcParams

Dynamic rc settings

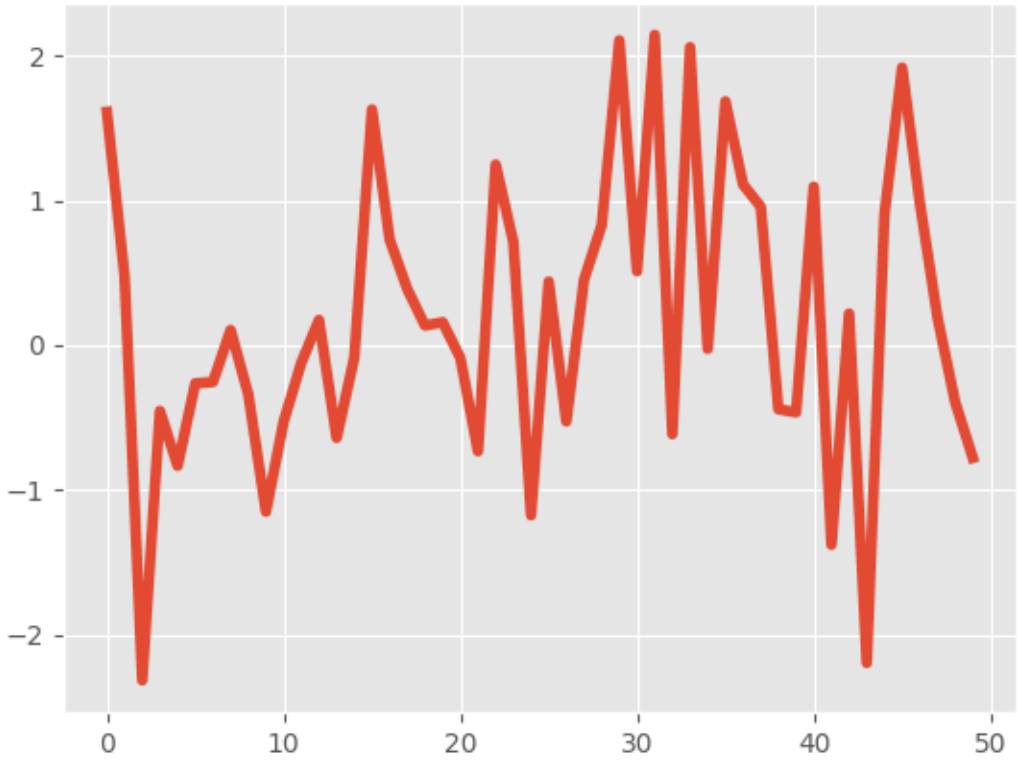
You can also dynamically change the default rc settings in a python script or interactively from the python shell. All of the rc settings are stored in a dictionary-like variable called *matplotlib.rcParams*, which is global to the matplotlib package. rcParams can be modified directly, for example:

```
mpl.rcParams['lines.linewidth'] = 2
mpl.rcParams['lines.color'] = 'r'
plt.plot(data)
```



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:

```
mpl.rc('lines', linewidth=4, color='g')
plt.plot(data)
```



The *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.

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 four 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. `$MATPLOTLIBRC` if it is a file, else `$MATPLOTLIBRC/matplotlibrc`.
3. It next looks in a user-specific place, depending on your platform:
   - On Linux and FreeBSD, it looks in `.config/matplotlib/matplotlibrc` (or `$XDG_CONFIG_HOME/matplotlib/matplotlibrc`) if you've customized your environment.
   - On other platforms, it looks in `.matplotlib/matplotlibrc`.

See *matplotlib configuration and cache directory locations*.

4. *INSTALL*/matplotlib/mpl-data/matplotlibrc, where *INSTALL* is something like /usr/lib/python3.5/site-packages on Linux, and maybe C:\Python35\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 your user-specific matplotlib directory.

Once a matplotlibrc file has been found, it will *not* search any of the other paths.

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

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

See below for a sample *matplotlibrc file*. Although all parameters are optional, you should almost always set the backend or else matplotlib will choose Agg, a *non-interactive* backend. This can lead to unexpected behavior, since if you do not have a matplotlibrc file, it would normally fall back to *INSTALL*/matplotlib/mpl-data/matplotlibrc, which is often set to an interactive backend by the package maintainer.

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 overwritten in your next install.
## If you want to keep a permanent local copy that will not be
## overwritten, place it in the following location:
## unix/linux:
##      $HOME/.config/matplotlib/matplotlibrc or
##      $XDG_CONFIG_HOME/matplotlib/matplotlibrc (if $XDG_CONFIG_HOME is set)
## other platforms:
##      $HOME/.matplotlib/matplotlibrc
##
## See http://matplotlib.org/users/customizing.html#the-matplotlibrc-file for
## more details on the paths which are checked for the configuration file.
##
## 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 - a scalar
## grayscale intensity such as 0.75 - a legal html color name, e.g., red,
## blue, darkslategray
```

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```
##### CONFIGURATION BEGINS HERE

## The default backend; one of GTK GTKAgg GTKCairo GTK3Agg GTK3Cairo
## MacOSX Qt4Agg Qt5Agg 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'.
##
## If you omit this parameter, it will always default to "Agg", which is a
## non-interactive backend.
backend      : $TEMPLATE_BACKEND

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

## The port to use for the web server in the WebAgg backend.
#webagg.port : 8988

## The address on which the WebAgg web server should be reachable
#webagg.address : 127.0.0.1

## If webagg.port is unavailable, a number of other random ports will
## be tried until one that is available is found.
#webagg.port_retries : 50

## When True, open the webbrowser to the plot that is shown
#webagg.open_in_browser : True

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

#interactive  : False
#toolbar      : toolbar2   ## None | toolbar2  ("classic" is deprecated)
#timezone     : UTC        ## a pytz timezone string, e.g., 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.org/api/artist_api.html#module-matplotlib.lines for more
## information on line properties.
#lines.linewidth   : 1.5     ## line width in points
#lines.linestyle   : -       ## solid line
#lines.color       : C0      ## has no affect on plot(); see axes.prop_cycle
```

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```
#lines.marker      : None    ## the default marker
#lines.markeredgewidth  : 1.0     ## the line width around the marker symbol
#lines.markersize  : 6            ## markersize, in points
#lines.dash_joinstyle : round        ## miter|round|bevel
#lines.dash_capstyle : butt          ## butt|round|projecting
#lines.solid_joinstyle : round       ## miter|round|bevel
#lines.solid_capstyle : projecting   ## butt|round|projecting
#lines.antialiased : True         ## render lines in antialiased (no jaggies)

## The three standard dash patterns.  These are scaled by the linewidth.
#lines.dashed_pattern : 3.7, 1.6
#lines.dashdot_pattern : 6.4, 1.6, 1, 1.6
#lines.dotted_pattern : 1, 1.65
#lines.scale_dashes : True

#markers.fillstyle: full ## full|left|right|bottom|top|none

#### PATCHES
## Patches are graphical objects that fill 2D space, like polygons or
## circles.  See
## http://matplotlib.org/api/artist_api.html#module-matplotlib.patches
## information on patch properties
#patch.linewidth        : 1        ## edge width in points.
#patch.facecolor        : C0
#patch.edgecolor        : k       ## if forced, or patch is not filled
#patch.force_edgecolor  : False   ## True to always use edgecolor
#patch.antialiased      : True    ## render patches in antialiased (no jaggies)

#### HATCHES
#hatch.color     : k
#hatch.linewidth : 1.0

#### Boxplot
#boxplot.notch       : False
#boxplot.vertical    : True
#boxplot.whiskers    : 1.5
#boxplot.bootstrap   : None
#boxplot.patchartist : False
#boxplot.showmeans   : False
#boxplot.showcaps    : True
#boxplot.showbox     : True
#boxplot.showfliers  : True
#boxplot.meanline    : False

#boxplot.flierprops.color           : k
#boxplot.flierprops.marker          : o
#boxplot.flierprops.markerfacecolor : none
#boxplot.flierprops.markeredgecolor : k
#boxplot.flierprops.markersize      : 6
#boxplot.flierprops.linestyle       : none
#boxplot.flierprops.linewidth       : 1.0
```

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```
#boxplot.boxprops.color     : k
#boxplot.boxprops.linewidth : 1.0
#boxplot.boxprops.linestyle : -

#boxplot.whiskerprops.color     : k
#boxplot.whiskerprops.linewidth : 1.0
#boxplot.whiskerprops.linestyle : -

#boxplot.capprops.color     : k
#boxplot.capprops.linewidth : 1.0
#boxplot.capprops.linestyle : -

#boxplot.medianprops.color     : C1
#boxplot.medianprops.linewidth : 1.0
#boxplot.medianprops.linestyle : -

#boxplot.meanprops.color           : C2
#boxplot.meanprops.marker          : ^
#boxplot.meanprops.markerfacecolor : C2
#boxplot.meanprops.markeredgecolor : C2
#boxplot.meanprops.markersize      :  6
#boxplot.meanprops.linestyle       : --
#boxplot.meanprops.linewidth       : 1.0


#### FONT

## font properties used by text.Text.  See
## http://matplotlib.org/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.  When text.usetex is False,
## font.family may also be one or more concrete font names.
##
## 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.
```

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```
##
## 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.
## 10 pt is the standard value.

#font.family         : sans-serif
#font.style          : normal
#font.variant        : normal
#font.weight         : normal
#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           : 10.0
#font.serif          : DejaVu Serif, Bitstream Vera Serif, Computer Modern Roman, New␣
 ↪Century Schoolbook, Century Schoolbook L, Utopia, ITC Bookman, Bookman, Nimbus Roman␣
 ↪No9 L, Times New Roman, Times, Palatino, Charter, serif
#font.sans-serif     : DejaVu Sans, Bitstream Vera Sans, Computer Modern Sans Serif,␣
 ↪Lucida Grande, Verdana, Geneva, Lucid, Arial, Helvetica, Avant Garde, sans-serif
#font.cursive        : Apple Chancery, Textile, Zapf Chancery, Sand, Script MT, Felipa,␣
 ↪cursive
#font.fantasy        : Comic Sans MS, Chicago, Charcoal, ImpactWestern, Humor Sans, xkcd,
 ↪ fantasy
#font.monospace      : DejaVu Sans Mono, Bitstream Vera Sans Mono, Computer Modern␣
 ↪Typewriter, Andale Mono, Nimbus Mono L, Courier New, Courier, Fixed, Terminal,␣
 ↪monospace

#### TEXT
## text properties used by text.Text.  See
## http://matplotlib.org/api/artist_api.html#module-matplotlib.text for more
## information on text properties
#text.color          : k

#### LaTeX customizations. See http://wiki.scipy.org/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
```

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```
                            ## 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.latex.preview : False

#text.hinting : auto   ## May be one of the following:
                       ##   none: Perform no hinting
                       ##   auto: Use FreeType's autohinter
                       ##   native: Use the hinting information in the
                       #              font file, if available, and if your
                       #              FreeType library supports it
                       ##   either: Use the native hinting information,
                       #              or the autohinter if none is available.
                       ## For backward compatibility, this value may also be
                       ## True === 'auto' or False === 'none'.
#text.hinting_factor : 8 ## Specifies the amount of softness for hinting in the
                         ## horizontal direction.  A value of 1 will hint to full
                         ## pixels.  A value of 2 will hint to half pixels etc.
#text.antialiased : True ## If True (default), the text will be antialiased.
                         ## 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  : sans
#mathtext.tt  : monospace
#mathtext.it  : sans:italic
#mathtext.bf  : sans:bold
#mathtext.sf  : sans
#mathtext.fontset : dejavusans ## Should be 'dejavusans' (default),
                               ## 'dejavuserif', '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,
```

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```
## default fontsizes for ticklabels, and so on.  See
## http://matplotlib.org/api/axes_api.html#module-matplotlib.axes
#axes.facecolor      : w       ## axes background color
#axes.edgecolor      : k       ## axes edge color
#axes.linewidth      : 0.8     ## edge linewidth
#axes.grid           : False   ## display grid or not
#axes.grid.axis      : both    ## which axis the grid should apply to
#axes.grid.which     : major   ## gridlines at major, minor or both ticks
#axes.titlesize      : large   ## fontsize of the axes title
#axes.titleweight    : normal  ## font weight of title
#axes.titlepad       : 6.0     ## pad between axes and title in points
#axes.labelsize      : medium  ## fontsize of the x any y labels
#axes.labelpad       : 4.0     ## space between label and axis
#axes.labelweight    : normal  ## weight of the x and y labels
#axes.labelcolor     : k
#axes.axisbelow      : line    ## draw axis gridlines and ticks below
                               ## patches (True); above patches but below
                               ## lines ('line'); or above all (False)
#axes.formatter.limits : -7, 7 ## use scientific notation if log10
                               ## of the axis range is smaller than the
                               ## first or larger than the second
#axes.formatter.use_locale : False ## When True, format tick labels
                                   ## according to the user's locale.
                                   ## For example, use ',' as a decimal
                                   ## separator in the fr_FR locale.
#axes.formatter.use_mathtext : False ## When True, use mathtext for scientific
                                     ## notation.
#axes.formatter.min_exponent: 0 ## minimum exponent to format in scientific notation
#axes.formatter.useoffset      : True    ## If True, the tick label formatter
                                        ## will default to labeling ticks relative
                                        ## to an offset when the data range is
                                        ## small compared to the minimum absolute
                                        ## value of the data.
#axes.formatter.offset_threshold : 4     ## When useoffset is True, the offset
                                        ## will be used when it can remove
                                        ## at least this number of significant
                                        ## digits from tick labels.
#axes.spines.left   : True   ## display axis spines
#axes.spines.bottom : True
#axes.spines.top    : True
#axes.spines.right  : True
#axes.unicode_minus  : True    ## use unicode for the minus symbol
                               ## rather than hyphen.  See
                               ## http://en.wikipedia.org/wiki/Plus_and_minus_signs
↪#Character_codes
#axes.prop_cycle    : cycler('color', ['1f77b4', 'ff7f0e', '2ca02c', 'd62728', '9467bd',
↪'8c564b', 'e377c2', '7f7f7f', 'bcbd22', '17becf'])
                      ## color cycle for plot lines  as list of string
                      ## colorspecs: single letter, long name, or web-style hex
                                     ## Note the use of string escapes here ('1f77b4
↪', instead of 1f77b4)
                      ## as opposed to the rest of this file.
↪
```

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```
#axes.autolimit_mode : data ## How to scale axes limits to the data.
                            ## Use "data" to use data limits, plus some margin
                            ## Use "round_number" move to the nearest "round" number
#axes.xmargin        : .05  ## x margin.  See `axes.Axes.margins`
#axes.ymargin        : .05  ## y margin See `axes.Axes.margins`
#polaraxes.grid      : True    ## display grid on polar axes
#axes3d.grid         : True    ## display grid on 3d axes

#### DATES
## These control the default format strings used in AutoDateFormatter.
## Any valid format datetime format string can be used (see the python
## `datetime` for details).  For example using '%%x' will use the locale date␣
 ↪representation
## '%%X' will use the locale time representation and '%%c' will use the full locale␣
 ↪datetime
## representation.
## These values map to the scales:
##     {'year': 365, 'month': 30, 'day': 1, 'hour': 1/24, 'minute': 1 / (24 * 60)}

#date.autoformatter.year     : %Y
#date.autoformatter.month    : %Y-%m
#date.autoformatter.day      : %Y-%m-%d
#date.autoformatter.hour     : %m-%d %H
#date.autoformatter.minute   : %d %H:%M
#date.autoformatter.second   : %H:%M:%S
#date.autoformatter.microsecond   : %M:%S.%f

#### TICKS
## see http://matplotlib.org/api/axis_api.html#matplotlib.axis.Tick
#xtick.top            : False  ## draw ticks on the top side
#xtick.bottom         : True   ## draw ticks on the bottom side
#xtick.labeltop       : False  ## draw label on the top
#xtick.labelbottom    : True   ## draw label on the bottom
#xtick.major.size     : 3.5    ## major tick size in points
#xtick.minor.size     : 2      ## minor tick size in points
#xtick.major.width    : 0.8    ## major tick width in points
#xtick.minor.width    : 0.6    ## minor tick width in points
#xtick.major.pad      : 3.5    ## distance to major tick label in points
#xtick.minor.pad      : 3.4    ## 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      : out    ## direction: in, out, or inout
#xtick.minor.visible  : False  ## visibility of minor ticks on x-axis
#xtick.major.top      : True   ## draw x axis top major ticks
#xtick.major.bottom   : True   ## draw x axis bottom major ticks
#xtick.minor.top      : True   ## draw x axis top minor ticks
#xtick.minor.bottom   : True   ## draw x axis bottom minor ticks
#xtick.alignment      : center ## alignment of xticks

#ytick.left           : True   ## draw ticks on the left side
#ytick.right          : False  ## draw ticks on the right side
#ytick.labelleft      : True   ## draw tick labels on the left side
```

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```
#ytick.labelright     : False  ## draw tick labels on the right side
#ytick.major.size     : 3.5    ## major tick size in points
#ytick.minor.size     : 2      ## minor tick size in points
#ytick.major.width    : 0.8    ## major tick width in points
#ytick.minor.width    : 0.6    ## minor tick width in points
#ytick.major.pad      : 3.5    ## distance to major tick label in points
#ytick.minor.pad      : 3.4    ## 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      : out    ## direction: in, out, or inout
#ytick.minor.visible  : False  ## visibility of minor ticks on y-axis
#ytick.major.left     : True   ## draw y axis left major ticks
#ytick.major.right    : True   ## draw y axis right major ticks
#ytick.minor.left     : True   ## draw y axis left minor ticks
#ytick.minor.right    : True   ## draw y axis right minor ticks
#ytick.alignment      : center_baseline ## alignment of yticks

#### GRIDS
#grid.color       :   b0b0b0    ## grid color
#grid.linestyle   :   -         ## solid
#grid.linewidth   :   0.8       ## in points
#grid.alpha       :   1.0       ## transparency, between 0.0 and 1.0

#### Legend
#legend.loc           : best
#legend.frameon       : True     ## if True, draw the legend on a background patch
#legend.framealpha    : 0.8      ## legend patch transparency
#legend.facecolor     : inherit  ## inherit from axes.facecolor; or color spec
#legend.edgecolor     : 0.8      ## background patch boundary color
#legend.fancybox      : True     ## if True, use a rounded box for the
                                 ## legend background, else a rectangle
#legend.shadow        : False    ## if True, give background a shadow effect
#legend.numpoints     : 1        ## the number of marker points in the legend line
#legend.scatterpoints : 1        ## number of scatter points
#legend.markerscale   : 1.0      ## the relative size of legend markers vs. original
#legend.fontsize      : medium
## Dimensions as fraction of fontsize:
#legend.borderpad     : 0.4      ## border whitespace
#legend.labelspacing  : 0.5      ## the vertical space between the legend entries
#legend.handlelength  : 2.0      ## the length of the legend lines
#legend.handleheight  : 0.7      ## the height of the legend handle
#legend.handletextpad : 0.8      ## the space between the legend line and legend text
#legend.borderaxespad : 0.5      ## the border between the axes and legend edge
#legend.columnspacing : 2.0      ## column separation

#### FIGURE
## See http://matplotlib.org/api/figure_api.html#matplotlib.figure.Figure
#figure.titlesize : large      ## size of the figure title (Figure.suptitle())
#figure.titleweight : normal   ## weight of the figure title
#figure.figsize   : 6.4, 4.8   ## figure size in inches
#figure.dpi       : 100        ## figure dots per inch
#figure.facecolor : w      ## figure facecolor; 0.75 is scalar gray
```

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```
#figure.edgecolor : w      ## figure edgecolor
#figure.frameon : True          ## enable figure frame
#figure.max_open_warning : 20  ## The maximum number of figures to open through
                               ## the pyplot interface before emitting a warning.
                               ## If less than one this feature is disabled.
## The figure subplot parameters.  All dimensions are a fraction of the
#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  : 0.11   ## the bottom of the subplots of the figure
#figure.subplot.top     : 0.88   ## the top of the subplots of the figure
#figure.subplot.wspace  : 0.2    ## the amount of width reserved for space between␣
↪subplots,
                               ## expressed as a fraction of the average axis width
#figure.subplot.hspace  : 0.2    ## the amount of height reserved for space between␣
↪subplots,
                               ## expressed as a fraction of the average axis height

## Figure layout
#figure.autolayout : False     ## When True, automatically adjust subplot
                               ## parameters to make the plot fit the figure
                               ## using `tight_layout`
#figure.constrained_layout.use: False ## When True, automatically make plot
                                     ## elements fit on the figure. (Not compatible
                                     ## with `autolayout`, above).
#figure.constrained_layout.h_pad : 0.04167 ## Padding around axes objects. Float␣
↪representing
#figure.constrained_layout.w_pad : 0.04167 ##  inches. Default is 3./72. inches (3 pts)
#figure.constrained_layout.hspace : 0.02   ## Space between subplot groups. Float␣
↪representing
#figure.constrained_layout.wspace : 0.02   ##  a fraction of the subplot widths being␣
↪separated.

#### IMAGES
#image.aspect : equal             ## equal | auto | a number
#image.interpolation  : nearest   ## see help(imshow) for options
#image.cmap   : viridis           ## A colormap name, gray etc...
#image.lut    : 256               ## the size of the colormap lookup table
#image.origin : upper             ## lower | upper
#image.resample  : True
#image.composite_image : True     ## When True, all the images on a set of axes are
                                  ## combined into a single composite image before
                                  ## saving a figure as a vector graphics file,
                                  ## such as a PDF.

#### CONTOUR PLOTS
#contour.negative_linestyle : dashed ## string or on-off ink sequence
#contour.corner_mask        : True   ## True | False | legacy

#### ERRORBAR PLOTS
#errorbar.capsize : 0             ## length of end cap on error bars in pixels

#### HISTOGRAM PLOTS
```

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```
#hist.bins : 10                   ## The default number of histogram bins.
                                  ## If Numpy 1.11 or later is
                                  ## installed, may also be `auto`

#### SCATTER PLOTS
#scatter.marker : o               ## The default marker type for scatter plots.

#### 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.
#### PATHS
#path.simplify : True   ## When True, simplify paths by removing "invisible"
                        ## points to reduce file size and increase rendering
                        ## speed
#path.simplify_threshold : 0.111111111111  ## 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.
#path.sketch : None ## May be none, or a 3-tuple of the form (scale, length,
                    ## randomness).
                    ## *scale* is the amplitude of the wiggle
                    ## perpendicular to the line (in pixels).  *length*
                    ## is the length of the wiggle along the line (in
                    ## pixels).  *randomness* is the factor by which
                    ## the length is randomly scaled.
#path.effects : []  ##

#### SAVING FIGURES
## the default savefig params can be different from the display params
## e.g., you may want a higher resolution, or to make the figure
## background white
#savefig.dpi         : figure   ## figure dots per inch or 'figure'
#savefig.facecolor   : w        ## figure facecolor when saving
#savefig.edgecolor   : w        ## figure edgecolor when saving
#savefig.format      : png      ## png, ps, pdf, svg
#savefig.bbox        : standard ## 'tight' or 'standard'.
                               ## 'tight' is incompatible with pipe-based animation
                               ## backends but will workd with temporary file based␣
↪ones:
                               ## e.g. setting animation.writer to ffmpeg will not work,
                               ## use ffmpeg_file instead
#savefig.pad_inches  : 0.1      ## Padding to be used when bbox is set to 'tight'
#savefig.jpeg_quality: 95       ## when a jpeg is saved, the default quality parameter.
```

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```
#savefig.directory   : ~        ## default directory in savefig dialog box,
                                ## leave empty to always use current working directory
#savefig.transparent : False    ## setting that controls whether figures are saved with a
                                ## transparent background by default
#savefig.frameon : True                         ## enable frame of figure when saving
#savefig.orientation : portrait        ## Orientation of saved␣
↪figure

### 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)
#pdf.use14corefonts : False
#pdf.inheritcolor : False

### svg backend params
#svg.image_inline : True       ## write raster image data directly into the svg file
#svg.fonttype :   path         ## How to handle SVG fonts:
   ##     none: Assume fonts are installed on the machine where the SVG will be viewed.
   ##     path: Embed characters as paths -- supported by most SVG renderers
   ##     svgfont: Embed characters as SVG fonts -- supported only by Chrome,
   ##                Opera and Safari
#svg.hashsalt : None           ## if not None, use this string as hash salt
                               ## instead of uuid4
### pgf parameter
#pgf.rcfonts : True
#pgf.preamble :
#pgf.texsystem : xelatex
#pgf.debug : False

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

## 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, ctrl+f       ## toggling
#keymap.home : h, r, home            ## home or reset mnemonic
```

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```
#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, ctrl+s             ## saving current figure
#keymap.quit : ctrl+w, cmd+w, q      ## close the current figure
#keymap.quit_all : W, cmd+W, Q       ## close all figures
#keymap.grid : g                     ## switching on/off major grids in current axes
#keymap.grid_minor : G               ## switching on/off minor grids in current axes
#keymap.yscale : l                   ## toggle scaling of y-axes ('log'/'linear')
#keymap.xscale : k, L                ## toggle scaling of x-axes ('log'/'linear')
#keymap.all_axes : a                 ## enable all axes

## Control location of examples data files
#examples.directory :              ## directory to look in for custom installation

###ANIMATION settings
#animation.html :  none            ## How to display the animation as HTML in
                                   ## the IPython notebook. 'html5' uses
                                   ## HTML5 video tag; 'jshtml' creates a
                                   ## Javascript animation
#animation.writer : ffmpeg         ## MovieWriter 'backend' to use
#animation.codec : h264            ## Codec to use for writing movie
#animation.bitrate: -1             ## Controls size/quality tradeoff for movie.
                                   ## -1 implies let utility auto-determine
#animation.frame_format:  png      ## Controls frame format used by temp files
#animation.html_args:              ## Additional arguments to pass to html writer
#animation.ffmpeg_path:  ffmpeg    ## Path to ffmpeg binary. Without full path
                                   ## $PATH is searched
#animation.ffmpeg_args:            ## Additional arguments to pass to ffmpeg
#animation.avconv_path:  avconv    ## Path to avconv binary. Without full path
                                   ## $PATH is searched
#animation.avconv_args:            ## Additional arguments to pass to avconv
#animation.convert_path:  convert  ## Path to ImageMagick's convert binary.
                                   ## On Windows use the full path since convert
                                   ## is also the name of a system tool.
#animation.convert_args:           ## Additional arguments to pass to convert
#animation.embed_limit : 20.0
```

Note: Click *here* to download the full example code

3.1.4 Image tutorial

A short tutorial on plotting images with Matplotlib.

Startup commands

First, let's start IPython. It is a most excellent enhancement to the standard Python prompt, and it ties in especially well with Matplotlib. Start IPython either at a shell, or the IPython Notebook now.

With IPython started, we now need to connect to a GUI event loop. This tells IPython where (and how) to display plots. To connect to a GUI loop, execute the **%matplotlib** magic at your IPython prompt. There's more detail on exactly what this does at IPython's documentation on GUI event loops.

If you're using IPython Notebook, the same commands are available, but people commonly use a specific argument to the %matplotlib magic:

```
In [1]: %matplotlib inline
```

This turns on inline plotting, where plot graphics will appear in your notebook. This has important implications for interactivity. For inline plotting, commands in cells below the cell that outputs a plot will not affect the plot. For example, changing the color map is not possible from cells below the cell that creates a plot. However, for other backends, such as Qt5, that open a separate window, cells below those that create the plot will change the plot - it is a live object in memory.

This tutorial will use matplotlib's imperative-style plotting interface, pyplot. This interface maintains global state, and is very useful for quickly and easily experimenting with various plot settings. The alternative is the object-oriented interface, which is also very powerful, and generally more suitable for large application development. If you'd like to learn about the object-oriented interface, a great place to start is our FAQ on usage. For now, let's get on with the imperative-style approach:

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

Importing image data into Numpy arrays

Loading image data is supported by the Pillow library. Natively, Matplotlib only supports PNG images. The commands shown below fall back on Pillow if the native read fails.

The image used in this example is a PNG file, but keep that Pillow 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...

```
img = mpimg.imread('../../doc/_static/stinkbug.png')
print(img)
```

Out:

```
[[[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]]

 [[0.4117647  0.4117647  0.4117647 ]
  [0.4117647  0.4117647  0.4117647 ]
  [0.4117647  0.4117647  0.4117647 ]
```

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```
 ...
 [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]]

...

[[0.4392157  0.4392157  0.4392157 ]
 [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]
 [0.4392157  0.4392157  0.4392157 ]
 ...
 [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]]]
```

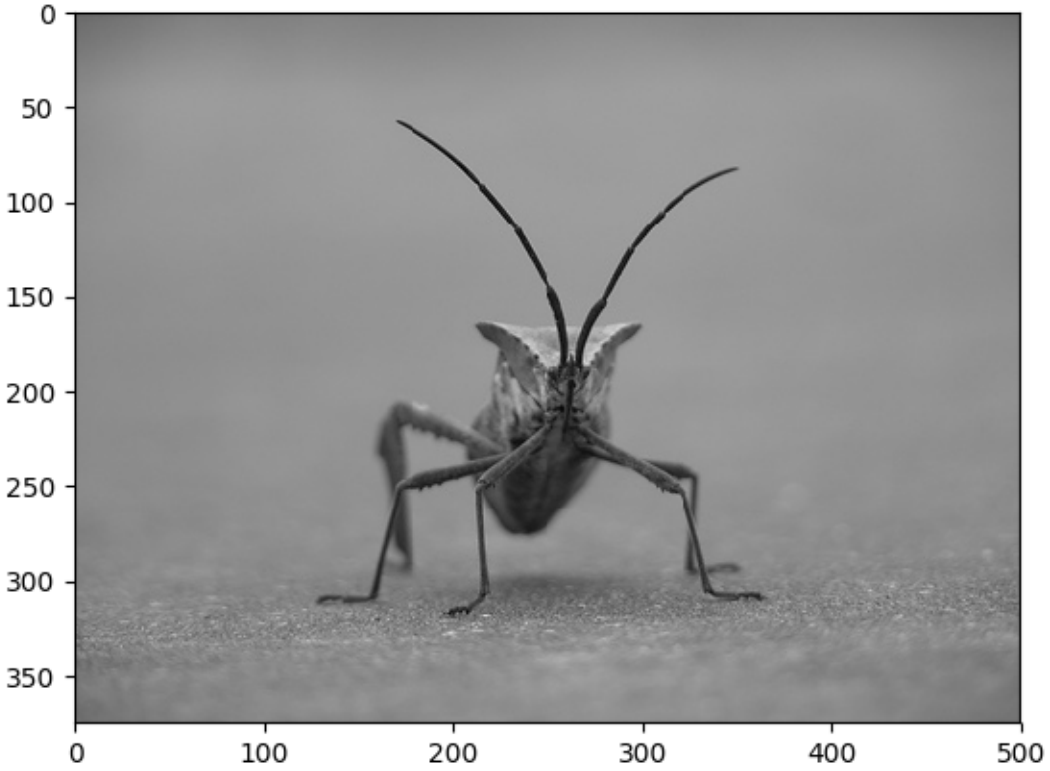
Note the dtype there - float32. Matplotlib has rescaled the 8 bit data from each channel to floating point data between 0.0 and 1.0. As a side note, the only datatype that Pillow can work with is uint8. Matplotlib plotting can handle float32 and uint8, but image reading/writing for any format other than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

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.

```
imgplot = plt.imshow(img)
```



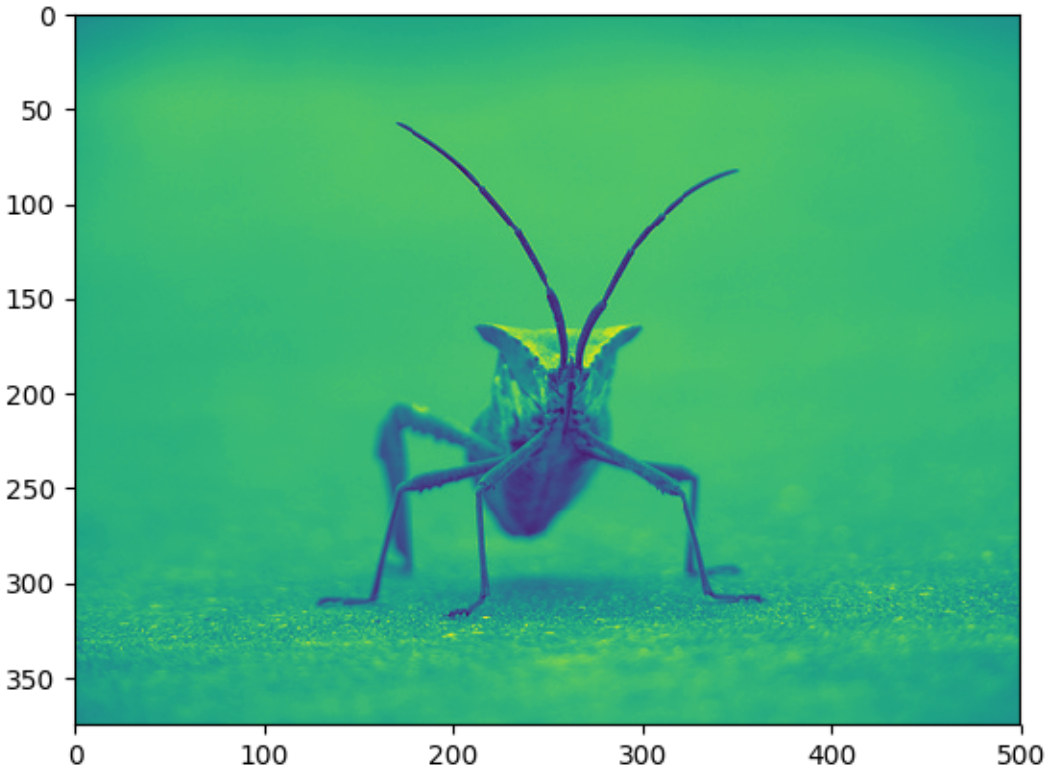
You can also plot any numpy array.

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.

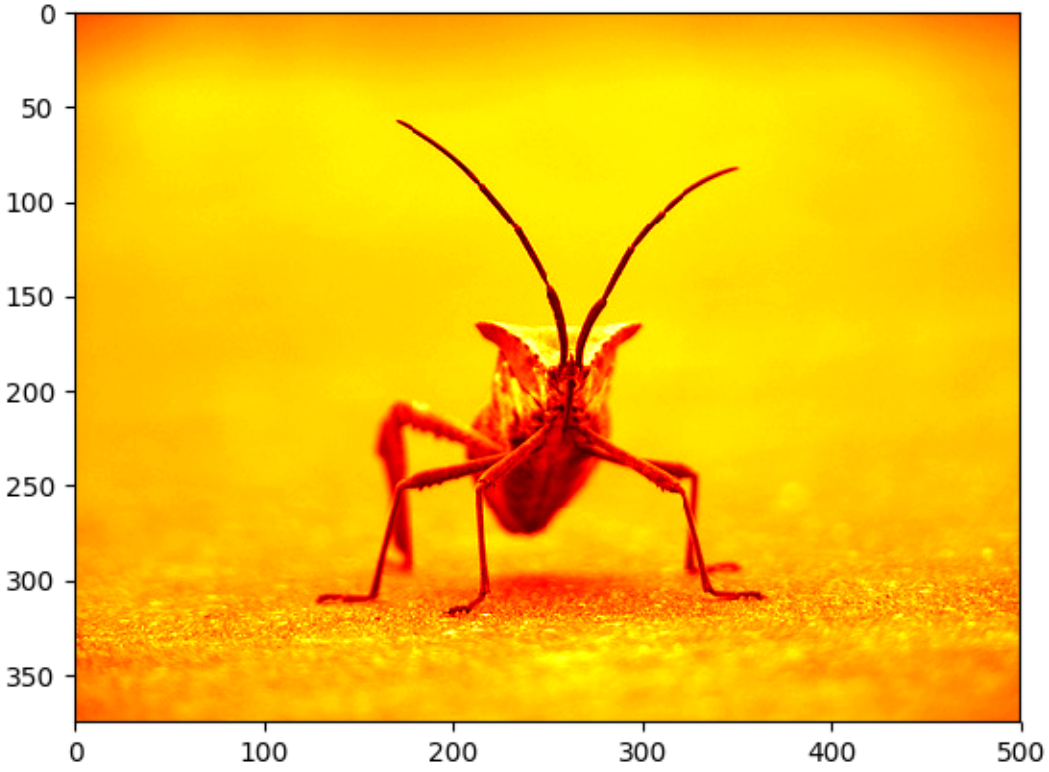
Pseudocolor is only relevant to single-channel, grayscale, luminosity images. We currently have an RGB image. Since R, G, and B are all similar (see for yourself above or in your data), we can just pick one channel of our data:

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

# This is array slicing.  You can read more in the `Numpy tutorial
# <https://docs.scipy.org/doc/numpy/user/quickstart.html>`_.

plt.imshow(lum_img)
```



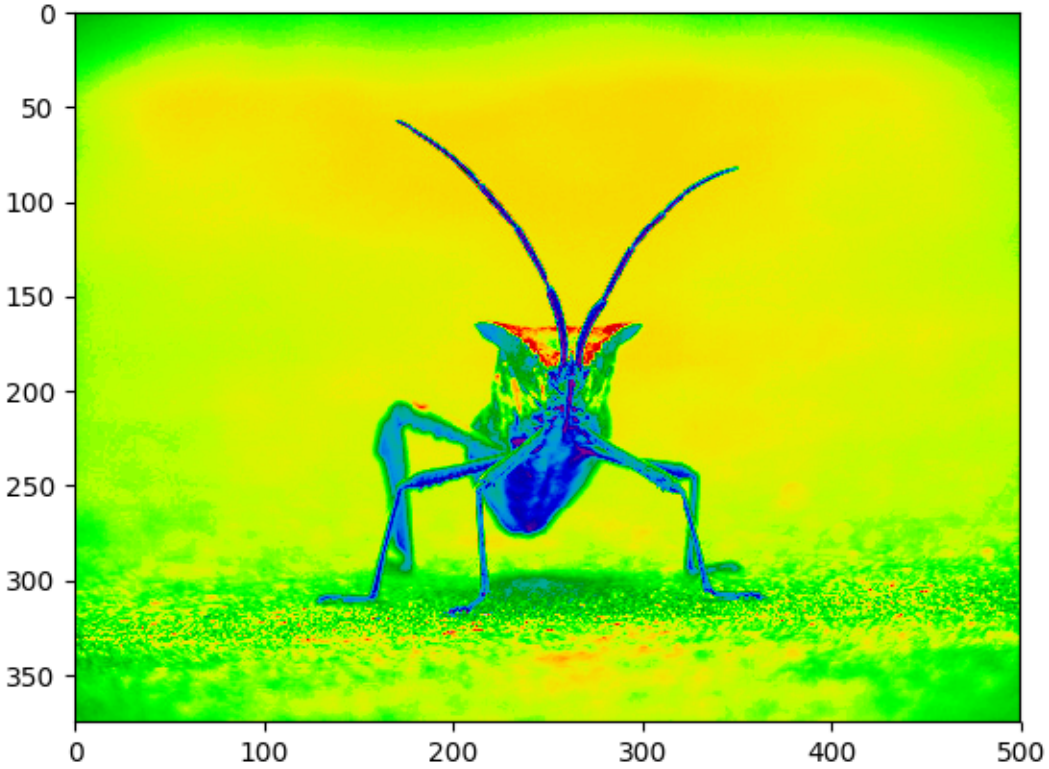
Now, with a luminosity (2D, no color) image, the default colormap (aka lookup table, LUT), is applied. The default is called viridis. There are plenty of others to choose from.

```
plt.imshow(lum_img, cmap="hot")
```



Note that you can also change colormaps on existing plot objects using the `set_cmap()` method:

```
imgplot = plt.imshow(lum_img)
imgplot.set_cmap('nipy_spectral')
```



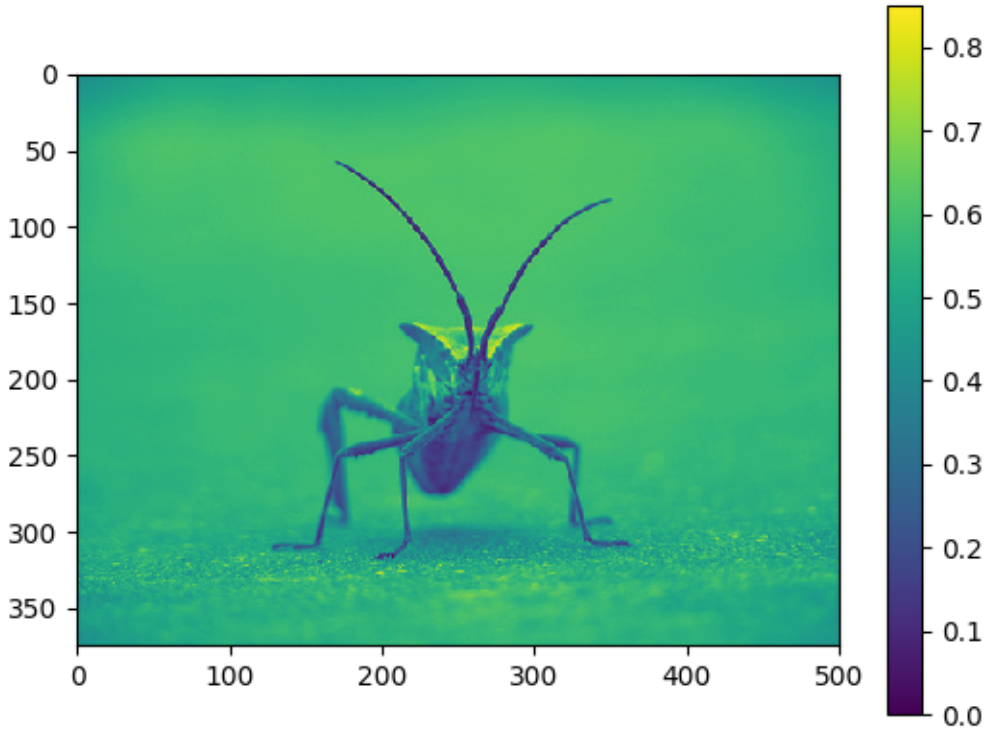
Note: However, remember that in the IPython notebook with the inline backend, you can't make changes to plots that have already been rendered. If you create imgplot here in one cell, you cannot call set_cmap() on it in a later cell and expect the earlier plot to change. Make sure that you enter these commands together in one cell. plt commands will not change plots from earlier cells.

There are many other colormap schemes available. See the list and images of the colormaps.

Color scale reference

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

```
imgplot = plt.imshow(lum_img)
plt.colorbar()
```

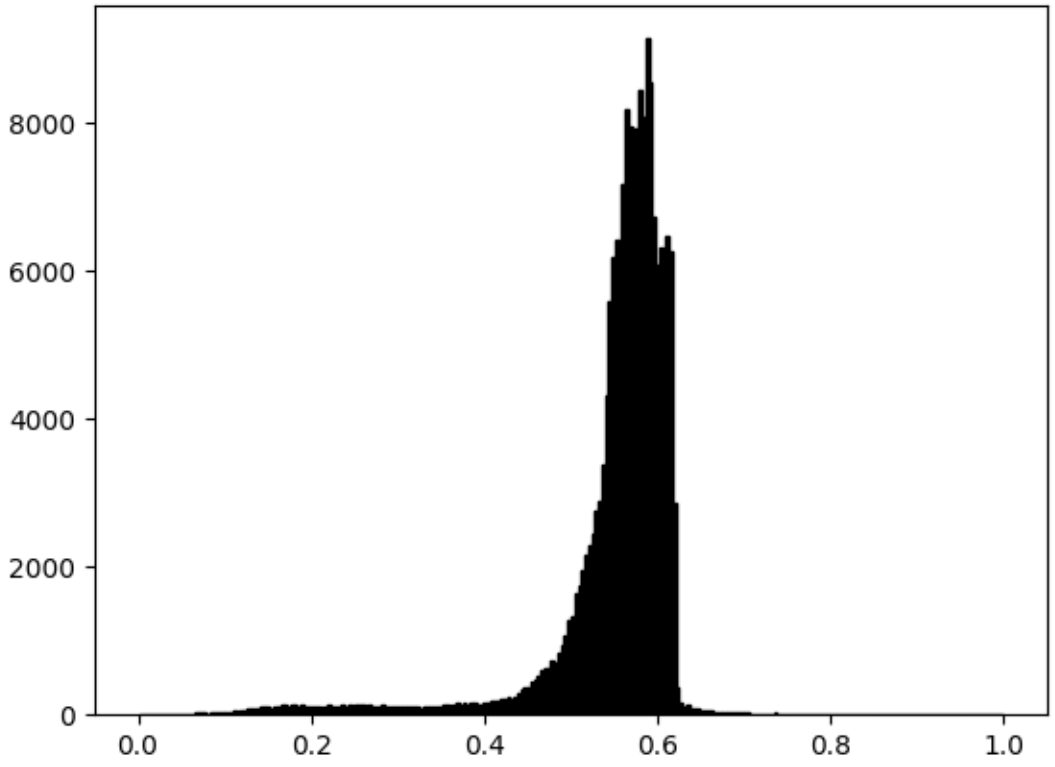


This adds a colorbar to your existing figure. This won't automatically change if you change you switch to a different colormap - you have to re-create your plot, and add in the colorbar again.

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.

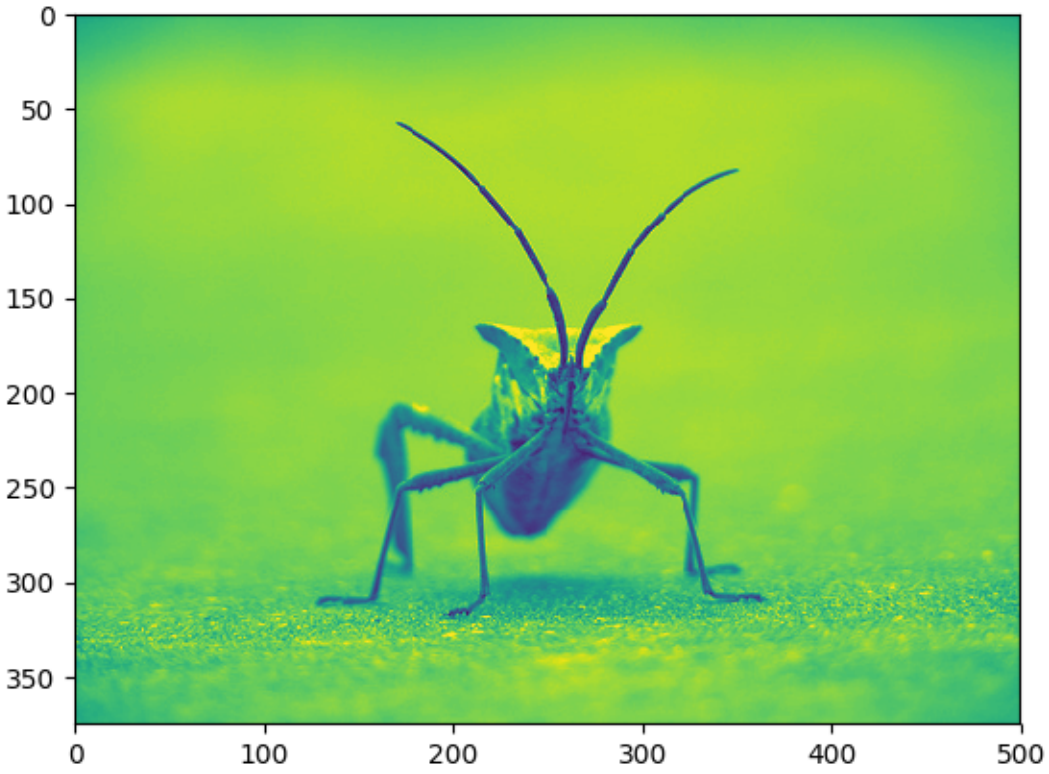
```
plt.hist(lum_img.ravel(), bins=256, range=(0.0, 1.0), fc='k', ec='k')
```



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 passing the clim argument to imshow. You could also do this by calling the `set_clim()` method of the image plot object, but make sure that you do so in the same cell as your plot command when working with the IPython Notebook - it will not change plots from earlier cells.

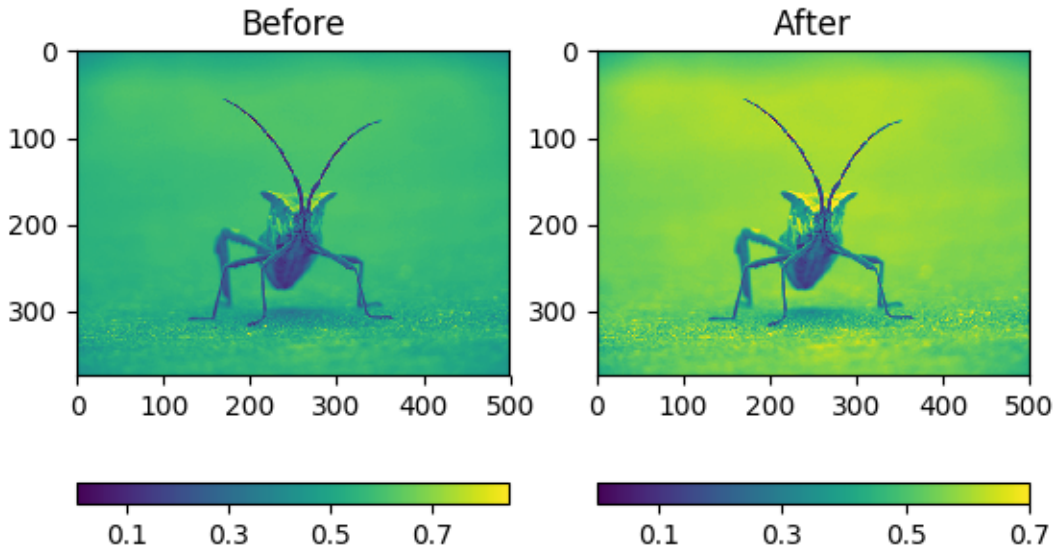
You can specify the clim in the call to `plot`.

```
imgplot = plt.imshow(lum_img, clim=(0.0, 0.7))
```



You can also specify the clim using the returned object

```
fig = plt.figure()
a = fig.add_subplot(1, 2, 1)
imgplot = plt.imshow(lum_img)
a.set_title('Before')
plt.colorbar(ticks=[0.1, 0.3, 0.5, 0.7], orientation='horizontal')
a = fig.add_subplot(1, 2, 2)
imgplot = plt.imshow(lum_img)
imgplot.set_clim(0.0, 0.7)
a.set_title('After')
plt.colorbar(ticks=[0.1, 0.3, 0.5, 0.7], orientation='horizontal')
```

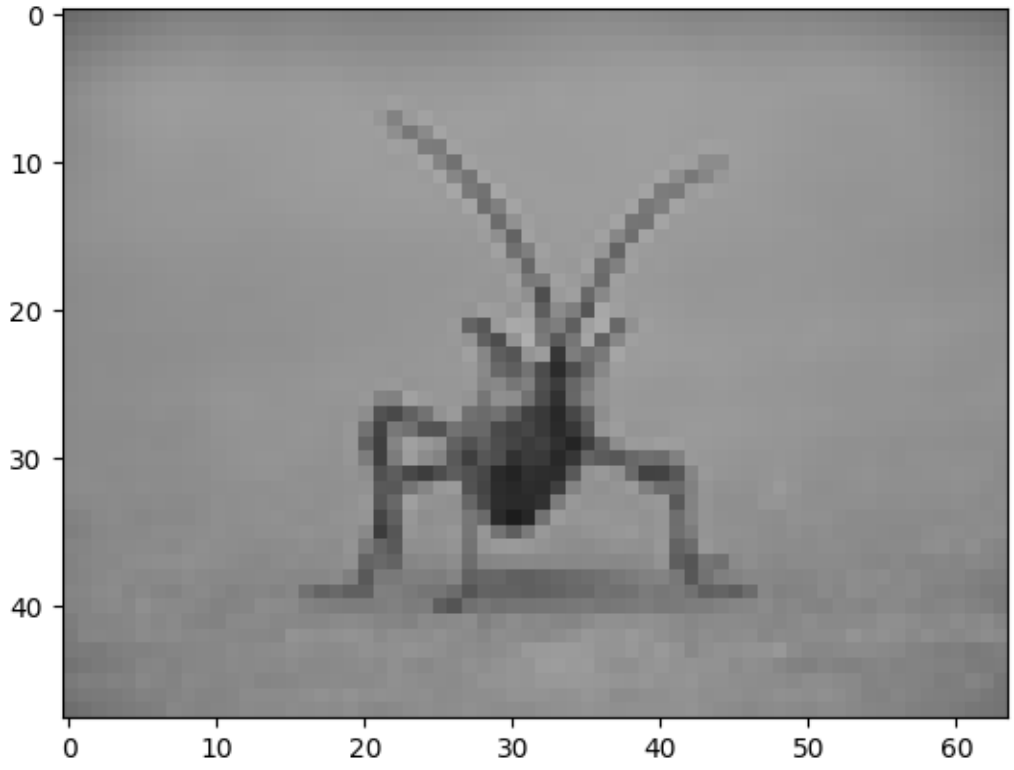


Array Interpolation schemes

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.

We'll use the Pillow library that we used to load the image also to resize the image.

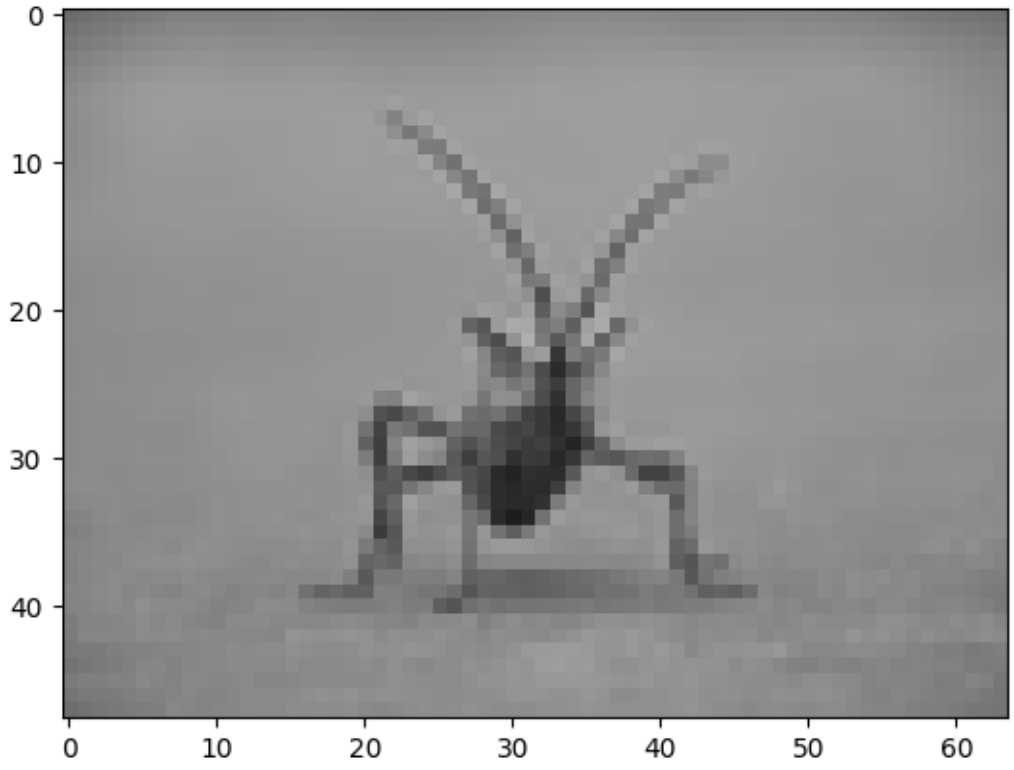
```
from PIL import Image

img = Image.open('../../doc/_static/stinkbug.png')
img.thumbnail((64, 64), Image.ANTIALIAS)  # resizes image in-place
imgplot = plt.imshow(img)
```



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

Let's try some others. Here's "nearest", which does no interpolation.

```
imgplot = plt.imshow(img, interpolation="nearest")
```



and bicubic:

```
imgplot = plt.imshow(img, interpolation="bicubic")
```

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

Note: Click *here* to download the full example code

3.1.5 Usage Guide

This tutorial covers some basic usage patterns and best-practices to help you get started with Matplotlib.

General Concepts

`matplotlib` has an extensive codebase that can be daunting to many new users. However, most of matplotlib can be understood with a fairly simple conceptual framework and knowledge of a few important points.

Plotting requires action on a range of levels, from the most general (e.g., 'contour this 2-D array') to the most specific (e.g., 'color this screen pixel red'). The purpose of a plotting package is to assist you in visualizing your data as easily as possible, with all the necessary control – that is, by using relatively high-level commands most of the time, and still have the ability to use the low-level commands when needed.

Therefore, everything in matplotlib is organized in a hierarchy. At the top of the hierarchy is the matplotlib "state-machine environment" which is provided by the *matplotlib.pyplot* module. At this level, simple functions are used to add plot elements (lines, images, text, etc.) to the current axes in the current figure.

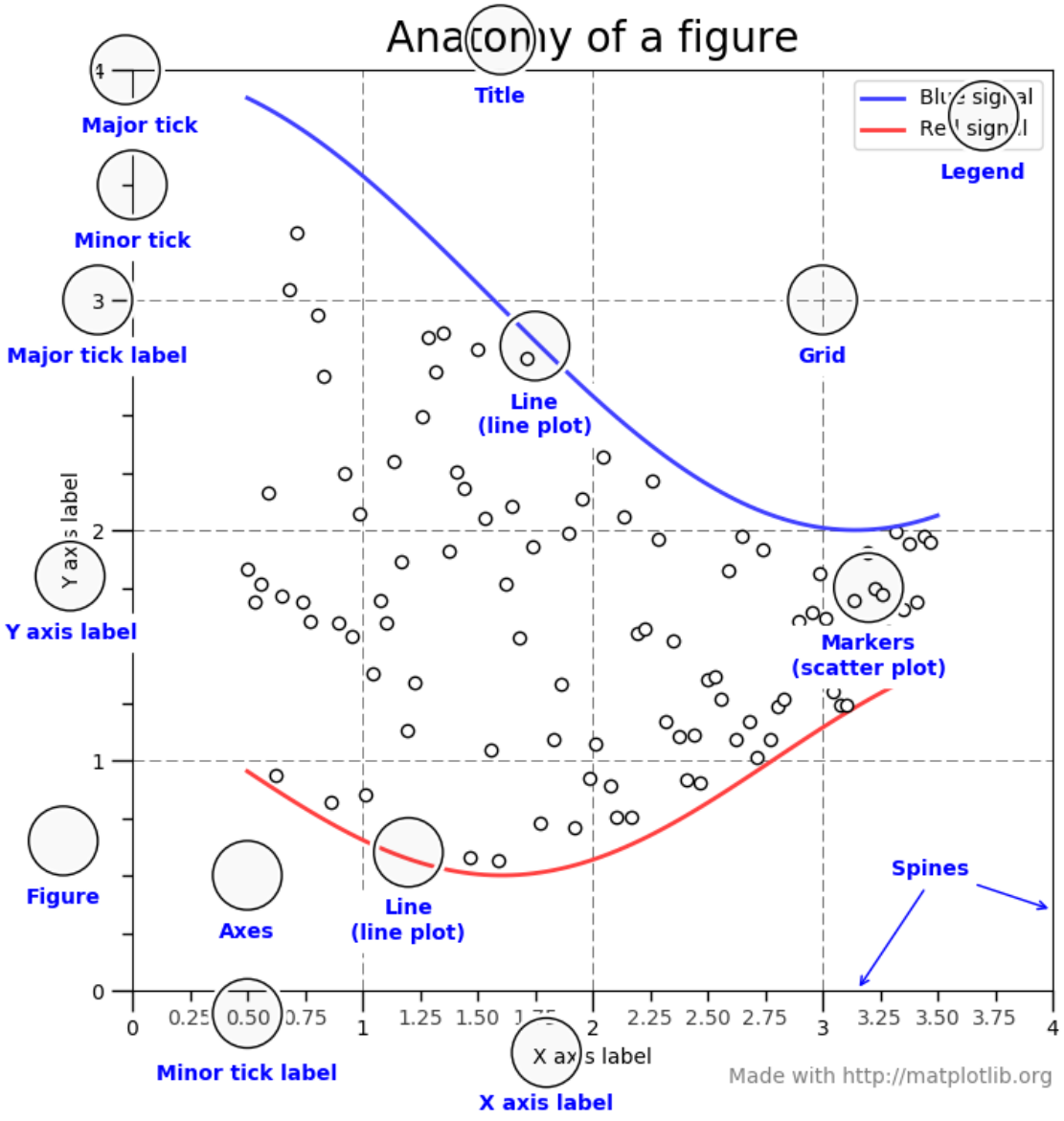
Note: Pyplot's state-machine environment behaves similarly to MATLAB and should be most familiar to users with MATLAB experience.

The next level down in the hierarchy is the first level of the object-oriented interface, in which pyplot is used only for a few functions such as figure creation, and the user explicitly creates and keeps track of the figure and axes objects. At this level, the user uses pyplot to create figures, and through those figures, one or more axes objects can be created. These axes objects are then used for most plotting actions.

For even more control – which is essential for things like embedding matplotlib plots in GUI applications – the pyplot level may be dropped completely, leaving a purely object-oriented approach.

```
# sphinx_gallery_thumbnail_number = 3
import matplotlib.pyplot as plt
import numpy as np
```

Parts of a Figure

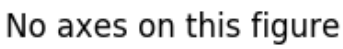


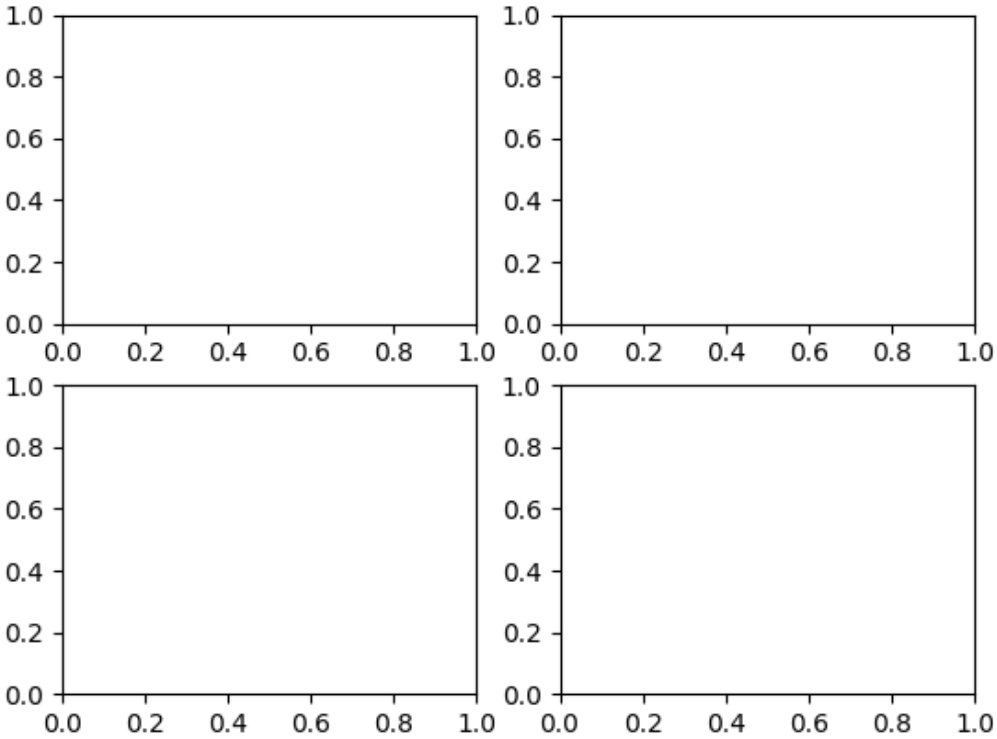
Figure

The **whole** figure. The figure keeps track of all the child `Axes`, a smattering of 'special' artists (titles, figure legends, etc), and the **canvas**. (Don't worry too much about the canvas, it is crucial as it is the object that actually does the drawing to get you your plot, but as the user it is more-or-less invisible to you). A figure can have any number of `Axes`, but to be useful should have at least one.

The easiest way to create a new figure is with pyplot:

```
fig = plt.figure()  # an empty figure with no axes
fig.suptitle('No axes on this figure')  # Add a title so we know which it is

fig, ax_lst = plt.subplots(2, 2)  # a figure with a 2x2 grid of Axes
```





-

Axes

This is what you think of as 'a plot', it is the region of the image with the data space. A given figure can contain many Axes, but a given *Axes* object can only be in one *Figure*. The Axes contains two (or three in the case of 3D) *Axis* objects (be aware of the difference between **Axes** and **Axis**) which take care of the data limits (the data limits can also be controlled via set via the *set_xlim()* and *set_ylim()* `Axes` methods). Each `Axes` has a title (set via *set_title()*), an x-label (set via *set_xlabel()*), and a y-label set via *set_ylabel()*).

The `Axes` class and it's member functions are the primary entry point to working with the OO interface.

Axis

These are the number-line-like objects. They take care of setting the graph limits and generating the ticks (the marks on the axis) and ticklabels (strings labeling the ticks). The location of the ticks is determined by a *Locator* object and the ticklabel strings are formatted by a *Formatter*. The combination of the correct `Locator` and `Formatter` gives very fine control over the tick locations and labels.

Artist

Basically everything you can see on the figure is an artist (even the `Figure`, `Axes`, and `Axis` objects). This includes `Text` objects, `Line2D` objects, `collection` objects, `Patch` objects ... (you get the idea). When the figure is rendered, all of the artists are drawn to the **canvas**. Most Artists are tied to an Axes; such an Artist cannot be shared by multiple Axes, or moved from one to another.

Types of inputs to plotting functions

All of plotting functions expect `np.array` or `np.ma.masked_array` as input. Classes that are 'array-like' such as `pandas` data objects and `np.matrix` may or may not work as intended. It is best to convert these to `np.array` objects prior to plotting.

For example, to convert a `pandas.DataFrame`

```
a = pandas.DataFrame(np.random.rand(4,5), columns = list('abcde'))
a_asndarray = a.values
```

and to covert a `np.matrix`

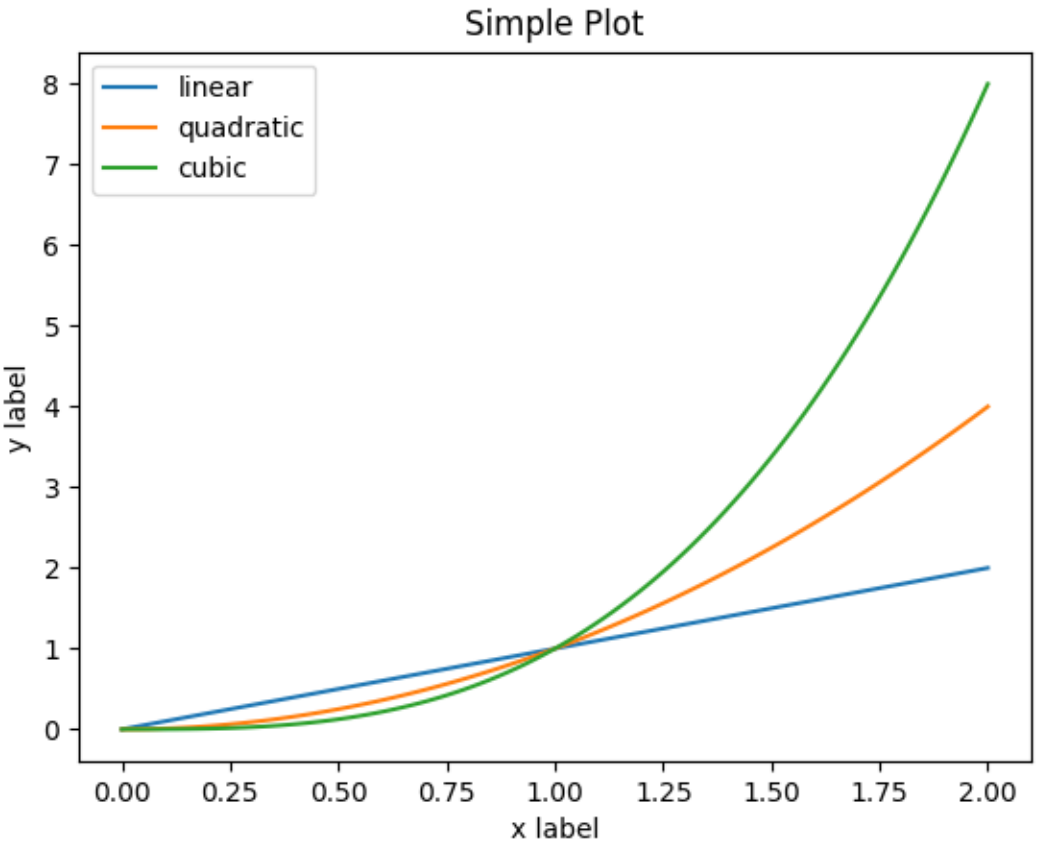
```
b = np.matrix([[1,2],[3,4]])
b_asarray = np.asarray(b)
```

Matplotlib, pyplot and pylab: how are they related?

Matplotlib is the whole package; *`matplotlib.pyplot`* is a module in matplotlib; and `pylab` is a module that gets installed alongside `matplotlib`.

Pyplot provides the state-machine interface to the underlying object-oriented plotting library. The state-machine implicitly and automatically creates figures and axes to achieve the desired plot. For example:

```
x = np.linspace(0, 2, 100)

plt.plot(x, x, label='linear')
plt.plot(x, x**2, label='quadratic')
plt.plot(x, x**3, label='cubic')

plt.xlabel('x label')
plt.ylabel('y label')

plt.title("Simple Plot")

plt.legend()

plt.show()
```



The first call to `plt.plot` will automatically create the necessary figure and axes to achieve the desired plot. Subsequent calls to `plt.plot` re-use the current axes and each add another line. Setting the title, legend, and axis labels also automatically use the current axes and set the title, create the legend, and label the axis respectively.

`pylab` is a convenience module that bulk imports *`matplotlib.pyplot`* (for plotting) and `numpy` (for mathematics and working with arrays) in a single name space. Although many examples use `pylab`, it is no longer recommended.

For non-interactive plotting it is suggested to use pyplot to create the figures and then the OO interface for plotting.

Coding Styles

When viewing this documentation and examples, you will find different coding styles and usage patterns. These styles are perfectly valid and have their pros and cons. Just about all of the examples can be converted into another style and achieve the same results. The only caveat is to avoid mixing the coding styles for your own code.

Note: Developers for matplotlib have to follow a specific style and guidelines. See *The Matplotlib Devel-*

opers' Guide.

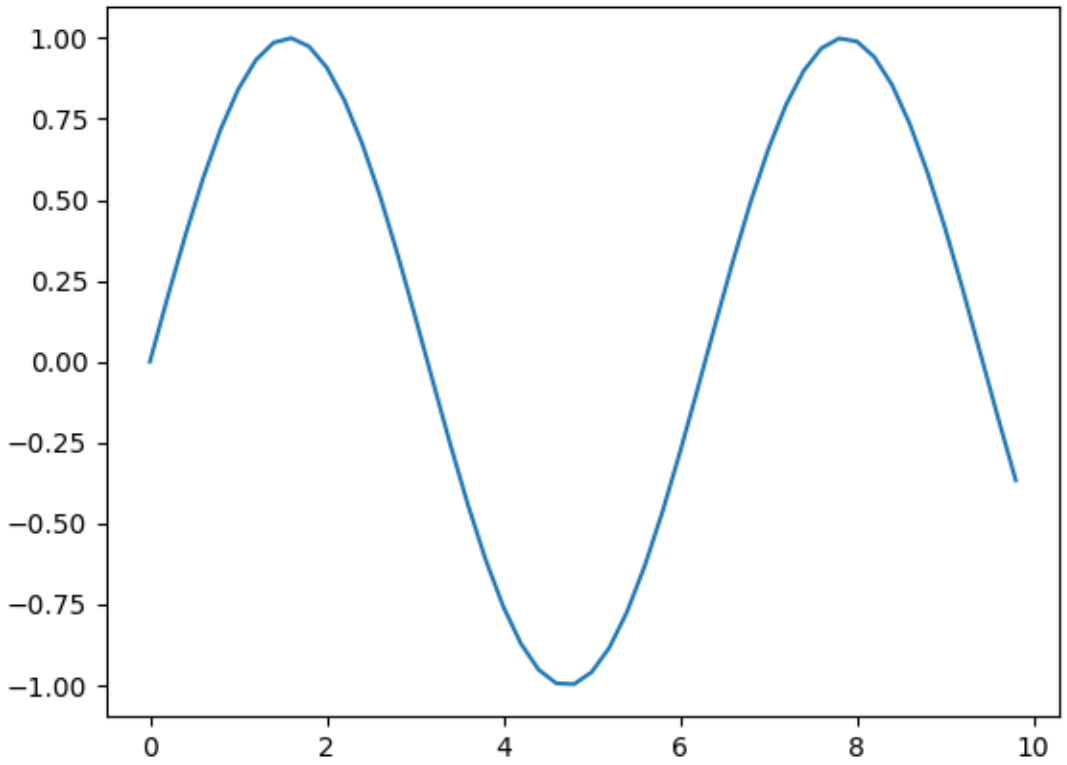
Of the different styles, there are two that are officially supported. Therefore, these are the preferred ways to use matplotlib.

For the pyplot style, the imports at the top of your scripts will typically be:

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

Then one calls, for example, np.arange, np.zeros, np.pi, plt.figure, plt.plot, plt.show, etc. Use the pyplot interface for creating figures, and then use the object methods for the rest:

```
x = np.arange(0, 10, 0.2)
y = np.sin(x)
fig, ax = plt.subplots()
ax.plot(x, y)
plt.show()
```

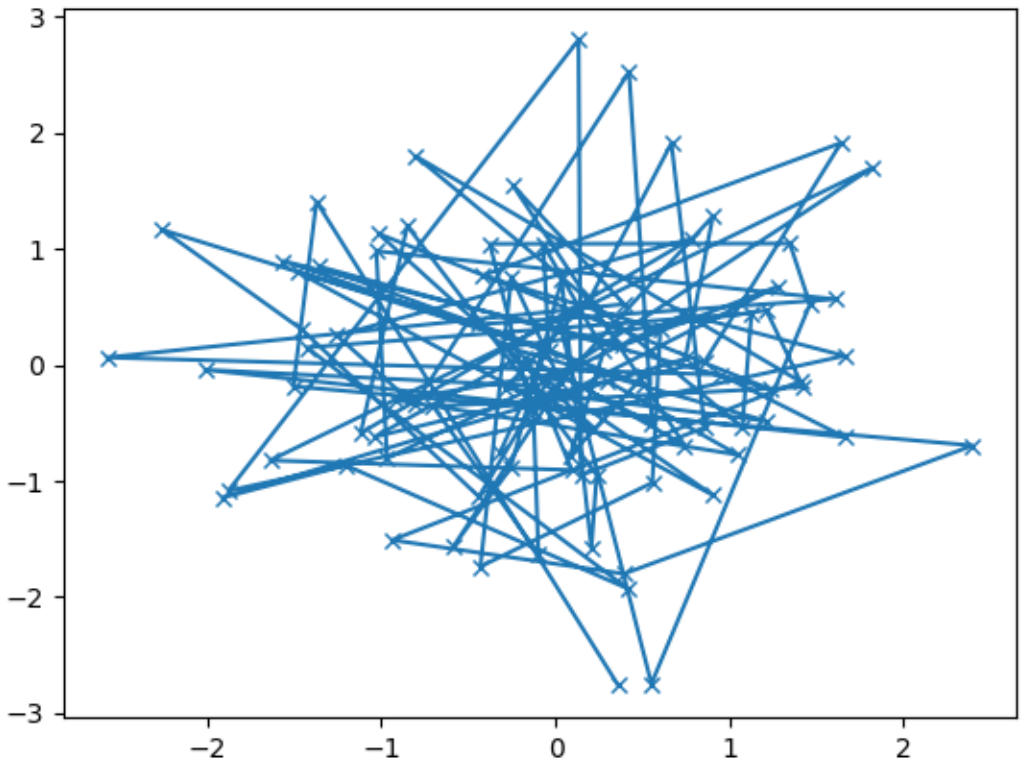


So, why all the extra typing instead of the MATLAB-style (which relies on global state and a flat namespace)? For very simple things like this example, the only advantage is academic: the wordier styles are more explicit, more clear as to where things come from and what is going on. For more complicated applications, this explicitness and clarity becomes increasingly valuable, and the richer and more complete

object-oriented interface will likely make the program easier to write and maintain.

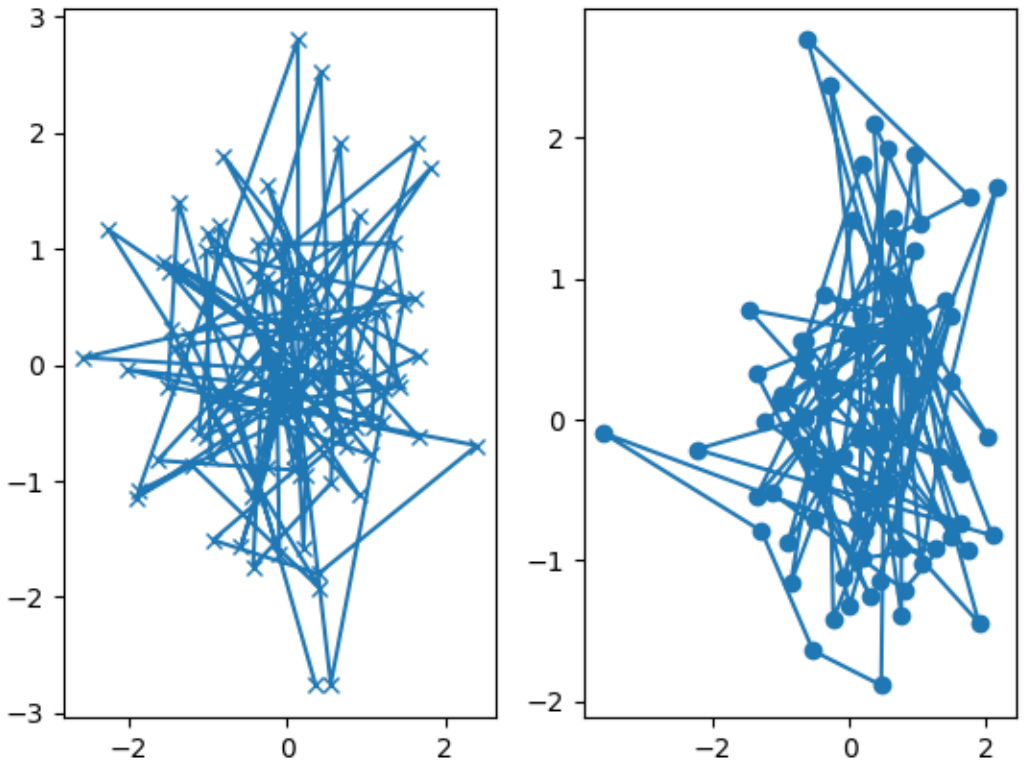
Typically one finds oneself making the same plots over and over again, but with different data sets, which leads to needing to write specialized functions to do the plotting. The recommended function signature is something like:

```
def my_plotter(ax, data1, data2, param_dict):
    """
    A helper function to make a graph

    Parameters
    ----------
    ax : Axes
        The axes to draw to

    data1 : array
       The x data

    data2 : array
       The y data

    param_dict : dict
       Dictionary of kwargs to pass to ax.plot

    Returns
    -------
    out : list
        list of artists added
    """
    out = ax.plot(data1, data2, **param_dict)
    return out

# which you would then use as:

data1, data2, data3, data4 = np.random.randn(4, 100)
fig, ax = plt.subplots(1, 1)
my_plotter(ax, data1, data2, {'marker': 'x'})
```



or if you wanted to have 2 sub-plots:

```
fig, (ax1, ax2) = plt.subplots(1, 2)
my_plotter(ax1, data1, data2, {'marker': 'x'})
my_plotter(ax2, data3, data4, {'marker': 'o'})
```



Again, for these simple examples this style seems like overkill, however once the graphs get slightly more complex it pays off.

Backends

What is a backend?

A lot of documentation on the website and in the mailing lists refers to the "backend" and many new users are confused by this term. matplotlib targets many different use cases and output formats. Some people use matplotlib interactively from the python shell and have plotting windows pop up when they type commands. Some people embed matplotlib into graphical user interfaces like wxpython or pygtk to build rich applications. Others use matplotlib in batch scripts to generate postscript images from some numerical simulations, and still others in web application servers to dynamically serve up graphs.

To support all of these use cases, matplotlib can target different outputs, and each of these capabilities is called a backend; the "frontend" is the user facing code, i.e., the plotting code, whereas the "backend" does all the hard work behind-the-scenes to make the figure. There are two types of backends: user interface backends (for use in pygtk, wxpython, tkinter, qt4, or macosx; also referred to as "interactive backends") and hardcopy backends to make image files (PNG, SVG, PDF, PS; also referred to as "non-interactive backends").

There are four ways to configure your backend. If they conflict each other, the method mentioned last in the following list will be used, e.g. calling *use()* will override the setting in your matplotlibrc.

1. The backend parameter in your matplotlibrc file (see *Customizing Matplotlib with style sheets and rcParams*):

```
backend : WXAgg   # use wxpython with antigrain (agg) rendering
```

2. Setting the *MPLBACKEND* environment variable, either for your current shell or for a single script. On Unix:

```
> export MPLBACKEND=module://my_backend
> python simple_plot.py

> MPLBACKEND="module://my_backend" python simple_plot.py
```

   On Windows, only the former is possible:

```
> set MPLBACKEND=module://my_backend
> python simple_plot.py
```

   Setting this environment variable will override the backend parameter in *any* matplotlibrc, even if there is a matplotlibrc in your current working directory. Therefore setting *MPLBACKEND* globally, e.g. in your .bashrc or .profile, is discouraged as it might lead to counter-intuitive behavior.

3. If your script depends on a specific backend you can use the *use()* function:

```
import matplotlib
matplotlib.use('PS')   # generate postscript output by default
```

   If you use the *use()* function, this must be done before importing *matplotlib.pyplot*. Calling *use()* after pyplot has been imported will have no effect. Using *use()* will require changes in your code if users want to use a different backend. Therefore, you should avoid explicitly calling *use()* unless absolutely necessary.

Note: Backend name specifications are not case-sensitive; e.g., 'GTKAgg' and 'gtkagg' are equivalent.

With a typical installation of matplotlib, such as from a binary installer or a linux distribution package, a good default backend will already be set, allowing both interactive work and plotting from scripts, with output to the screen and/or to a file, so at least initially you will not need to use any of the methods given above.

If, however, you want to write graphical user interfaces, or a web application server (*Matplotlib in a web application server*), or need a better understanding of what is going on, read on. To make things a little more customizable for graphical user interfaces, matplotlib separates the concept of the renderer (the thing that actually does the drawing) from the canvas (the place where the drawing goes). The canonical renderer for user interfaces is Agg which uses the Anti-Grain Geometry C++ library to make a raster (pixel) image of the figure. All of the user interfaces except macosx can be used with agg rendering, e.g., WXAgg, GTKAgg, QT4Agg, QT5Agg, TkAgg. In addition, some of the user interfaces support other rendering engines. For

example, with GTK, you can also select GDK rendering (backend `GTK` deprecated in 2.0) or Cairo rendering (backend `GTKCairo`).

For the rendering engines, one can also distinguish between vector or raster renderers. Vector graphics languages issue drawing commands like "draw a line from this point to this point" and hence are scale free, and raster backends generate a pixel representation of the line whose accuracy depends on a DPI setting.

Here is a summary of the matplotlib renderers (there is an eponymous backed for each; these are *non-interactive backends*, capable of writing to a file):

Renderer	Filetypes	Description
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*	*raster graphics* and *vector graphics* – using the Cairo graphics library

And here are the user interfaces and renderer combinations supported; these are *interactive backends*, capable of displaying to the screen and of using appropriate renderers from the table above to write to a file:

Backend	Description
Qt5Agg	Agg rendering in a *Qt5* canvas (requires PyQt5). This backend can be activated in IPython with `%matplotlib qt5`.
ipympl	Agg rendering embedded in a Jupyter widget. (requires ipympl). This backend can be enabled in a Jupyter notebook with `%matplotlib ipympl`.
GTK3Agg	Agg rendering to a *GTK* 3.x canvas (requires PyGObject, and pycairo or cairocffi). This backend can be activated in IPython with `%matplotlib gtk3`.
macosx	Agg rendering into a Cocoa canvas in OSX. This backend can be activated in IPython with `%matplotlib osx`.
TkAgg	Agg rendering to a *Tk* canvas (requires TkInter). This backend can be activated in IPython with `%matplotlib tk`.
nbAgg	Embed an interactive figure in a Jupyter classic notebook. This backend can be enabled in Jupyter notebooks via `%matplotlib notebook`.
WebAgg	On `show()` will start a tornado server with an interactive figure.
GTK3Cairo	Cairo rendering to a *GTK* 3.x canvas (requires PyGObject, and pycairo or cairocffi).
Qt4Agg	Agg rendering to a *Qt4* canvas (requires PyQt4 or `pyside`). This backend can be activated in IPython with `%matplotlib qt4`.
GTKAgg	Agg rendering to a *GTK* 2.x canvas (requires PyGTK, and pycairo or cairocffi; Python2 only). This backend can be activated in IPython with `%matplotlib gtk`.
GTKCairo	Cairo rendering to a *GTK* 2.x canvas (requires PyGTK, and pycairo or cairocffi; Python2 only).
WXAgg	Agg rendering to a *wxWidgets* canvas (requires wxPython; v4.0 (in beta) is required for Python3). This backend can be activated in IPython with `%matplotlib wx.#`

ipympl

The Jupyter widget ecosystem is moving too fast to support directly in Matplotlib. To install ipympl

```
pip install ipympl
jupyter nbextension enable --py --sys-prefix ipympl
```

or

```
conda install ipympl -c conda-forge
```

See jupyter-matplotlib for more details.

GTK and Cairo

Both `GTK2` and `GTK3` have implicit dependencies on PyCairo regardless of the specific Matplotlib backend used. Unfortunately the latest release of PyCairo for Python3 does not implement the Python wrappers needed for the `GTK3Agg` backend. `Cairocffi` can be used as a replacement which implements the correct wrapper.

How do I select PyQt4 or PySide?

The `QT_API` environment variable can be set to either `pyqt` or `pyside` to use `PyQt4` or `PySide`, respectively.

Since the default value for the bindings to be used is `PyQt4`, `matplotlib` first tries to import it, if the import fails, it tries to import `PySide`.

What is interactive mode?

Use of an interactive backend (see *What is a backend?*) permits–but does not by itself require or ensure–plotting to the screen. Whether and when plotting to the screen occurs, and whether a script or shell session continues after a plot is drawn on the screen, depends on the functions and methods that are called, and on a state variable that determines whether matplotlib is in "interactive mode". The default Boolean value is set by the `matplotlibrc` file, and may be customized like any other configuration parameter (see *Customizing Matplotlib with style sheets and rcParams*). It may also be set via *matplotlib.interactive()*, and its value may be queried via *matplotlib.is_interactive()*. Turning interactive mode on and off in the middle of a stream of plotting commands, whether in a script or in a shell, is rarely needed and potentially confusing, so in the following we will assume all plotting is done with interactive mode either on or off.

Note: Major changes related to interactivity, and in particular the role and behavior of *show()*, were made in the transition to matplotlib version 1.0, and bugs were fixed in 1.0.1. Here we describe the version 1.0.1 behavior for the primary interactive backends, with the partial exception of *macosx*.

Interactive mode may also be turned on via *matplotlib.pyplot.ion()*, and turned off via *matplotlib.pyplot.ioff()*.

Note: Interactive mode works with suitable backends in ipython and in the ordinary python shell, but it does *not* work in the IDLE IDE. If the default backend does not support interactivity, an interactive backend can be explicitly activated using any of the methods discussed in *What is a backend?*.

Interactive example

From an ordinary python prompt, or after invoking ipython with no options, try this:

```
import matplotlib.pyplot as plt
plt.ion()
plt.plot([1.6, 2.7])
```

Assuming you are running version 1.0.1 or higher, and you have an interactive backend installed and selected by default, you should see a plot, and your terminal prompt should also be active; you can type additional commands such as:

```
plt.title("interactive test")
plt.xlabel("index")
```

and you will see the plot being updated after each line. Since version 1.5, modifying the plot by other means *should* also automatically update the display on most backends. Get a reference to the `Axes` instance, and call a method of that instance:

```
ax = plt.gca()
ax.plot([3.1, 2.2])
```

If you are using certain backends (like `macosx`), or an older version of matplotlib, you may not see the new line added to the plot immediately. In this case, you need to explicitly call `draw()` in order to update the plot:

```
plt.draw()
```

Non-interactive example

Start a fresh session as in the previous example, but now turn interactive mode off:

```
import matplotlib.pyplot as plt
plt.ioff()
plt.plot([1.6, 2.7])
```

Nothing happened–or at least nothing has shown up on the screen (unless you are using *macosx* backend, which is anomalous). To make the plot appear, you need to do this:

```
plt.show()
```

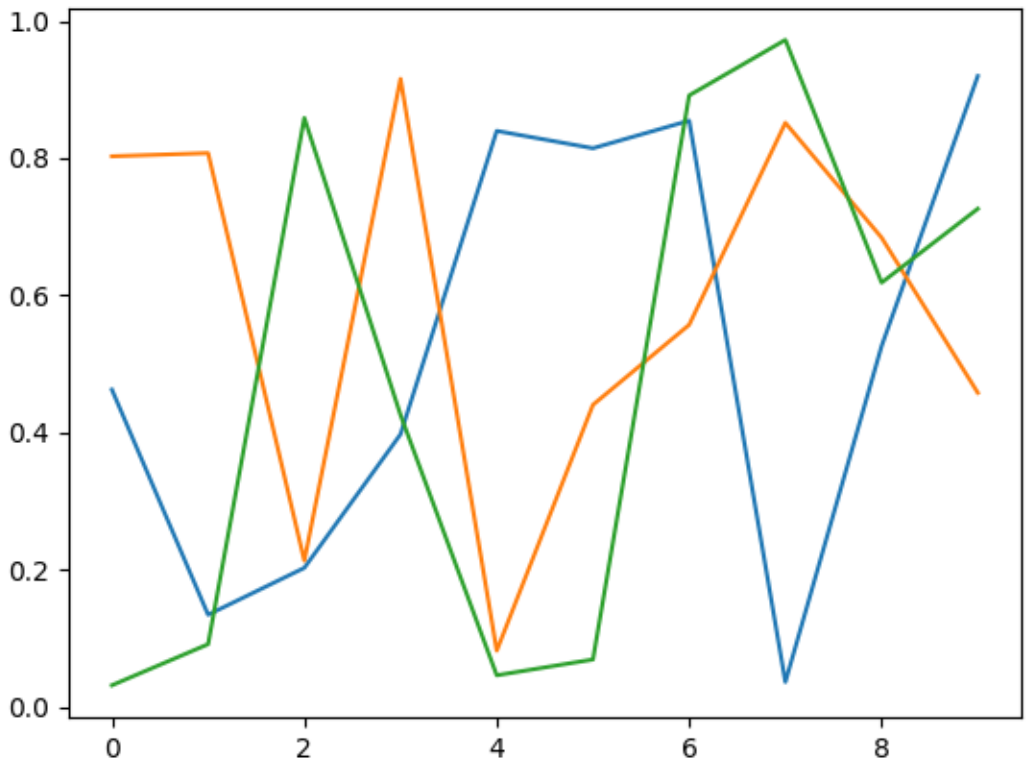
Now you see the plot, but your terminal command line is unresponsive; the `show()` command *blocks* the input of additional commands until you manually kill the plot window.

What good is this–being forced to use a blocking function? Suppose you need a script that plots the contents of a file to the screen. You want to look at that plot, and then end the script. Without some blocking command such as show(), the script would flash up the plot and then end immediately, leaving nothing on the screen.

In addition, non-interactive mode delays all drawing until show() is called; this is more efficient than redrawing the plot each time a line in the script adds a new feature.

Prior to version 1.0, show() generally could not be called more than once in a single script (although sometimes one could get away with it); for version 1.0.1 and above, this restriction is lifted, so one can write a script like this:

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

plt.ioff()
for i in range(3):
    plt.plot(np.random.rand(10))
    plt.show()
```



which makes three plots, one at a time.

Summary

In interactive mode, pyplot functions automatically draw to the screen.

When plotting interactively, if using object method calls in addition to pyplot functions, then call *draw()* whenever you want to refresh the plot.

Use non-interactive mode in scripts in which you want to generate one or more figures and display them before ending or generating a new set of figures. In that case, use *show()* to display the figure(s) and to block execution until you have manually destroyed them.

Performance

Whether exploring data in interactive mode or programmatically saving lots of plots, rendering performance can be a painful bottleneck in your pipeline. Matplotlib provides a couple ways to greatly reduce rendering time at the cost of a slight change (to a settable tolerance) in your plot's appearance. The methods available to reduce rendering time depend on the type of plot that is being created.

Line segment simplification

For plots that have line segments (e.g. typical line plots, outlines of polygons, etc.), rendering performance can be controlled by the `path.simplify` and `path.simplify_threshold` parameters in your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams* for more information about the `matplotlibrc` file). The `path.simplify` parameter is a boolean indicating whether or not line segments are simplified at all. The `path.simplify_threshold` parameter controls how much line segments are simplified; higher thresholds result in quicker rendering.

The following script will first display the data without any simplification, and then display the same data with simplification. Try interacting with both of them:

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

# Setup, and create the data to plot
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1, np.log10(50000), 400).astype(int)] = -1
mpl.rcParams['path.simplify'] = True

mpl.rcParams['path.simplify_threshold'] = 0.0
plt.plot(y)
plt.show()

mpl.rcParams['path.simplify_threshold'] = 1.0
plt.plot(y)
plt.show()
```

Matplotlib currently defaults to a conservative simplification threshold of `1/9`. If you want to change your default settings to use a different value, you can change your `matplotlibrc` file. Alternatively, you could

create a new style for interactive plotting (with maximal simplification) and another style for publication quality plotting (with minimal simplification) and activate them as necessary. See *Customizing Matplotlib with style sheets and rcParams* for instructions on how to perform these actions.

The simplification works by iteratively merging line segments into a single vector until the next line segment's perpendicular distance to the vector (measured in display-coordinate space) is greater than the `path.simplify_threshold` parameter.

Note: Changes related to how line segments are simplified were made in version 2.1. Rendering time will still be improved by these parameters prior to 2.1, but rendering time for some kinds of data will be vastly improved in versions 2.1 and greater.

Marker simplification

Markers can also be simplified, albeit less robustly than line segments. Marker simplification is only available to *Line2D* objects (through the `markevery` property). Wherever *Line2D* construction parameter are passed through, such as *matplotlib.pyplot.plot()* and *matplotlib.axes.Axes.plot()*, the `markevery` parameter can be used:

```
plt.plot(x, y, markevery=10)
```

The markevery argument allows for naive subsampling, or an attempt at evenly spaced (along the *x* axis) sampling. See the /gallery/lines_bars_and_markers/markevery_demo for more information.

Splitting lines into smaller chunks

If you are using the Agg backend (see *What is a backend?*), then you can make use of the `agg.path.chunksize` rc parameter. This allows you to specify a chunk size, and any lines with greater than that many vertices will be split into multiple lines, each of which have no more than `agg.path.chunksize` many vertices. (Unless `agg.path.chunksize` is zero, in which case there is no chunking.) For some kind of data, chunking the line up into reasonable sizes can greatly decrease rendering time.

The following script will first display the data without any chunk size restriction, and then display the same data with a chunk size of 10,000. The difference can best be seen when the figures are large, try maximizing the GUI and then interacting with them:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
mpl.rcParams['path.simplify_threshold'] = 1.0

# Setup, and create the data to plot
y = np.random.rand(100000)
y[50000:] *= 2
y[np.logspace(1,np.log10(50000), 400).astype(int)] = -1
mpl.rcParams['path.simplify'] = True
```

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```
mpl.rcParams['agg.path.chunksize'] = 0
plt.plot(y)
plt.show()

mpl.rcParams['agg.path.chunksize'] = 10000
plt.plot(y)
plt.show()
```

Using the *fast* style

The *fast* style can be used to automatically set simplification and chunking parameters to reasonable settings to speed up plotting large amounts of data. It can be used simply by running:

```
import matplotlib.style as mplstyle
mplstyle.use('fast')
```

It is very light weight, so it plays nicely with other styles, just make sure the fast style is applied last so that other styles do not overwrite the settings:

```
mplstyle.use(['dark_background', 'ggplot', 'fast'])
```

Note: Click *here* to download the full example code

3.1.6 Pyplot tutorial

An introduction to the pyplot interface.

Intro to pyplot

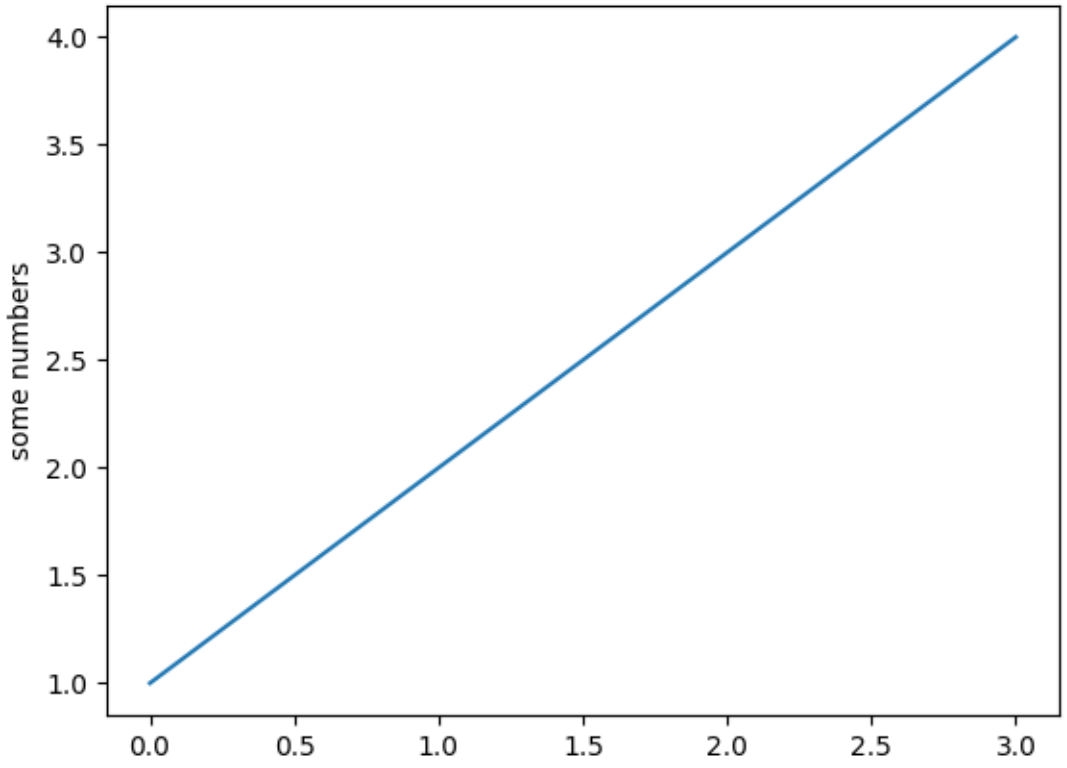
matplotlib.pyplot is a collection of command style functions that make matplotlib work like MATLAB. Each `pyplot` function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc.

In *matplotlib.pyplot* various states are preserved across function calls, so that it keeps track of things like the current figure and plotting area, and the plotting functions are directed to the current axes (please note that "axes" here and in most places in the documentation refers to the *axes* part of a figure and not the strict mathematical term for more than one axis).

Note: the pyplot API is generally less-flexible than the object-oriented API. Most of the function calls you see here can also be called as methods from an `Axes` object. We recommend browsing the tutorials and examples to see how this works.

Generating visualizations with pyplot is very quick:

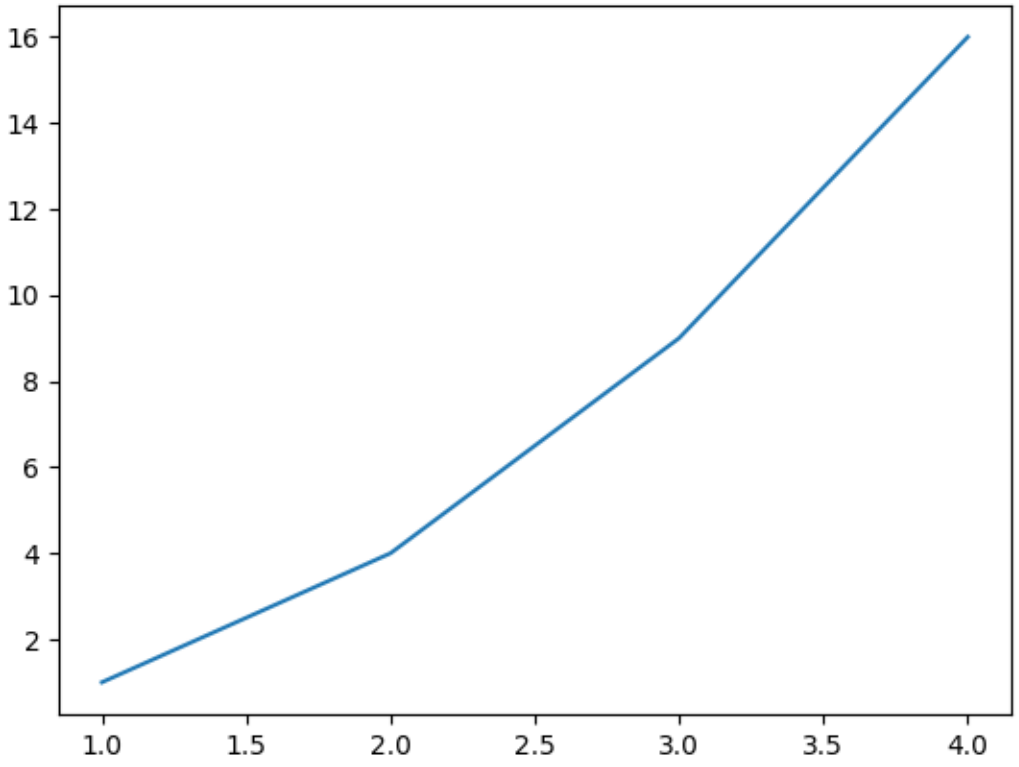
```
import matplotlib.pyplot as plt
plt.plot([1, 2, 3, 4])
plt.ylabel('some numbers')
plt.show()
```



You may be wondering why the x-axis ranges from 0-3 and the y-axis from 1-4. 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 `[0,1,2,3]`.

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:

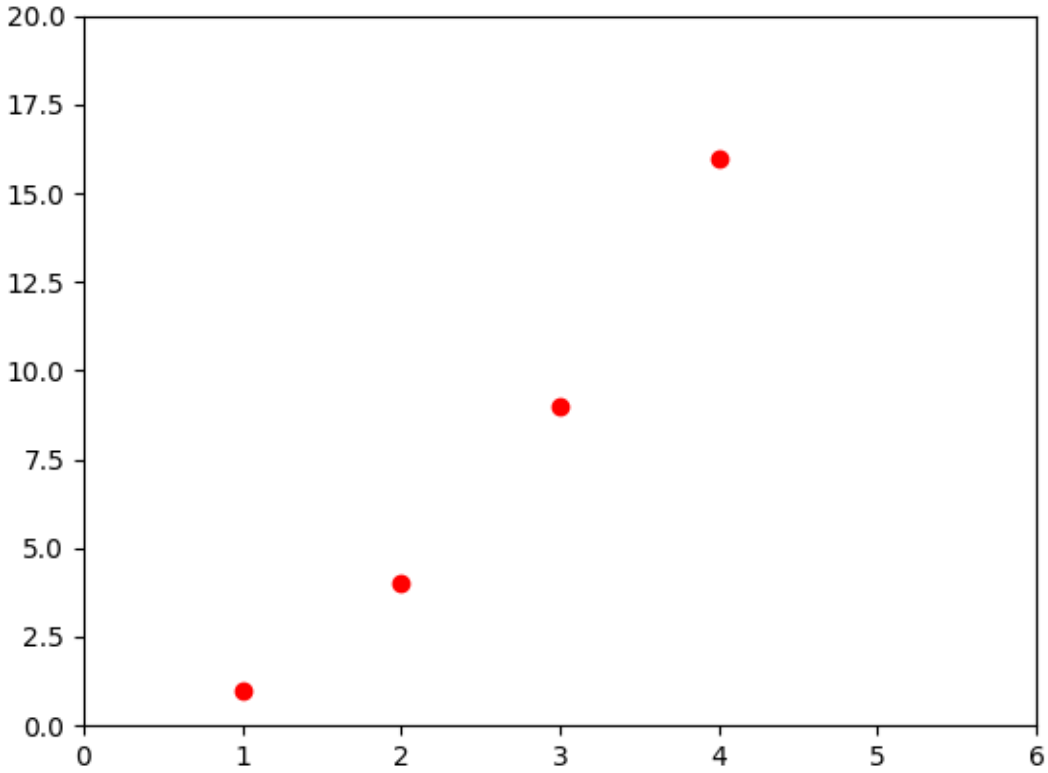
```
plt.plot([1, 2, 3, 4], [1, 4, 9, 16])
```



Formatting the style of your plot

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

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



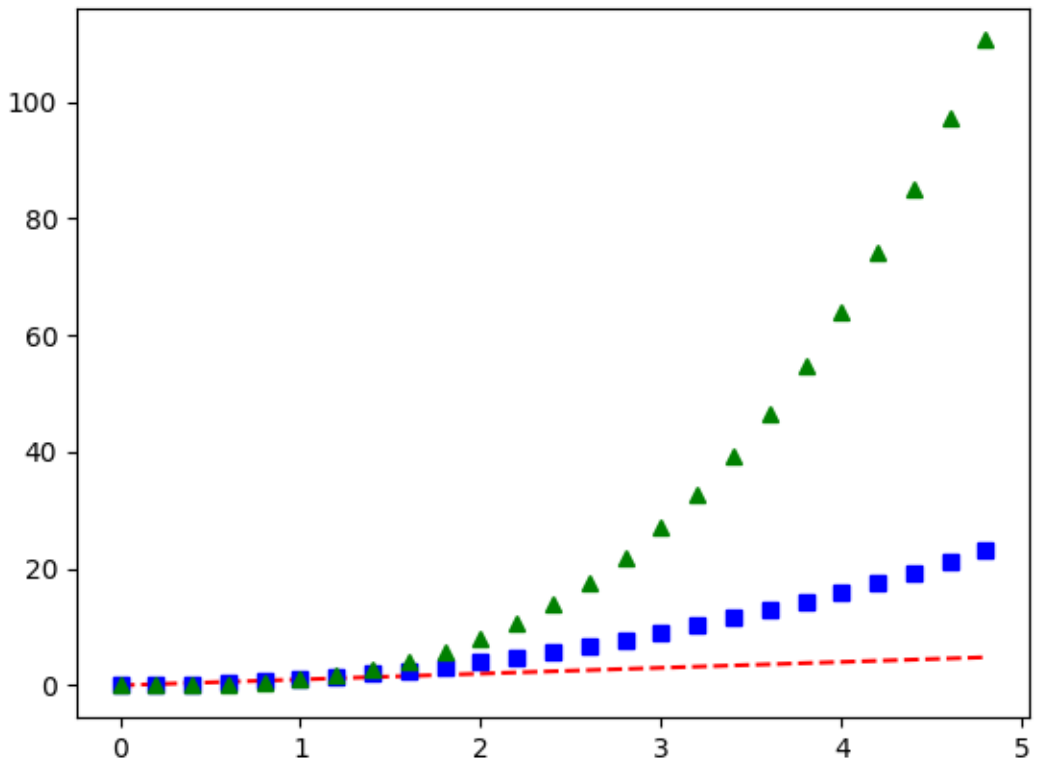
See the *plot()* documentation for a complete list of line styles and format strings. The *axis()* command in the example above takes a list of `[xmin, xmax, ymin, ymax]` and specifies the viewport of the axes.

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

# 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^')
plt.show()
```



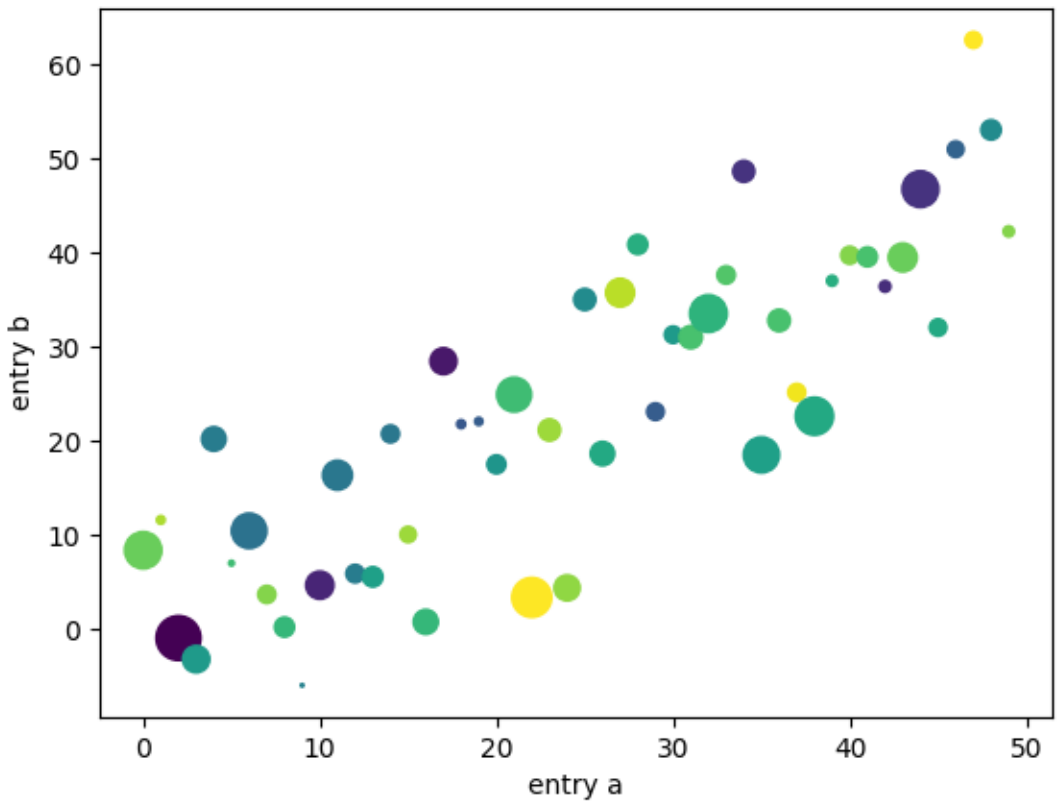
Plotting with keyword strings

There are some instances where you have data in a format that lets you access particular variables with strings. For example, with `numpy.recarray` or `pandas.DataFrame`.

Matplotlib allows you provide such an object with the `data` keyword argument. If provided, then you may generate plots with the strings corresponding to these variables.

```
data = {'a': np.arange(50),
        'c': np.random.randint(0, 50, 50),
        'd': np.random.randn(50)}
data['b'] = data['a'] + 10 * np.random.randn(50)
data['d'] = np.abs(data['d']) * 100

plt.scatter('a', 'b', c='c', s='d', data=data)
plt.xlabel('entry a')
plt.ylabel('entry b')
plt.show()
```



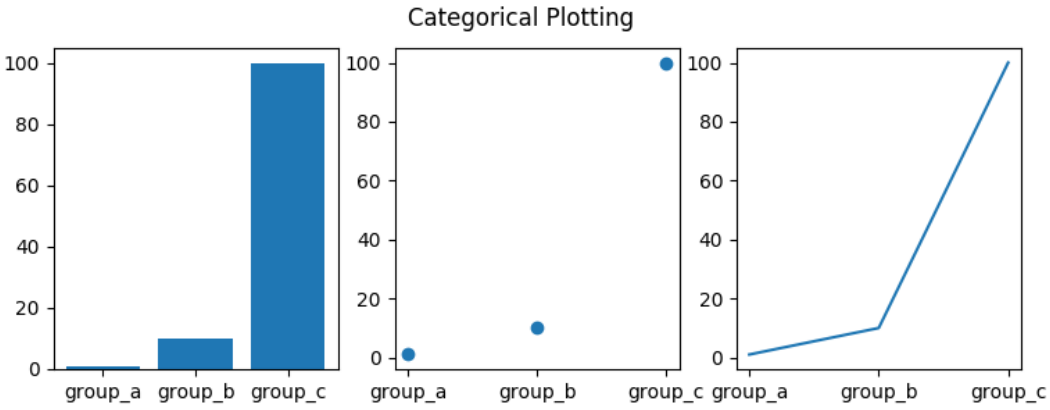
Plotting with categorical variables

It is also possible to create a plot using categorical variables. Matplotlib allows you to pass categorical variables directly to many plotting functions. For example:

```
names = ['group_a', 'group_b', 'group_c']
values = [1, 10, 100]

plt.figure(1, figsize=(9, 3))

plt.subplot(131)
plt.bar(names, values)
plt.subplot(132)
plt.scatter(names, values)
plt.subplot(133)
plt.plot(names, values)
plt.suptitle('Categorical Plotting')
plt.show()
```



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 a `Line2D` instance. `plot` returns a list of `Line2D` objects; e.g., `line1, line2 = plot(x1, y1, x2, y2)`. In the code below we will suppose that we have only one line so that the list returned is of length 1. We use tuple unpacking with `line,` to get the first element of that 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.

Property	Value Type
alpha	float
animated	[True | False]
antialiased or aa	[True | False]
clip_box	a matplotlib.transform.Bbox instance
clip_on	[True | False]

Continued on next page

Table 1 – continued from previous page

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

Working with multiple figures and axes

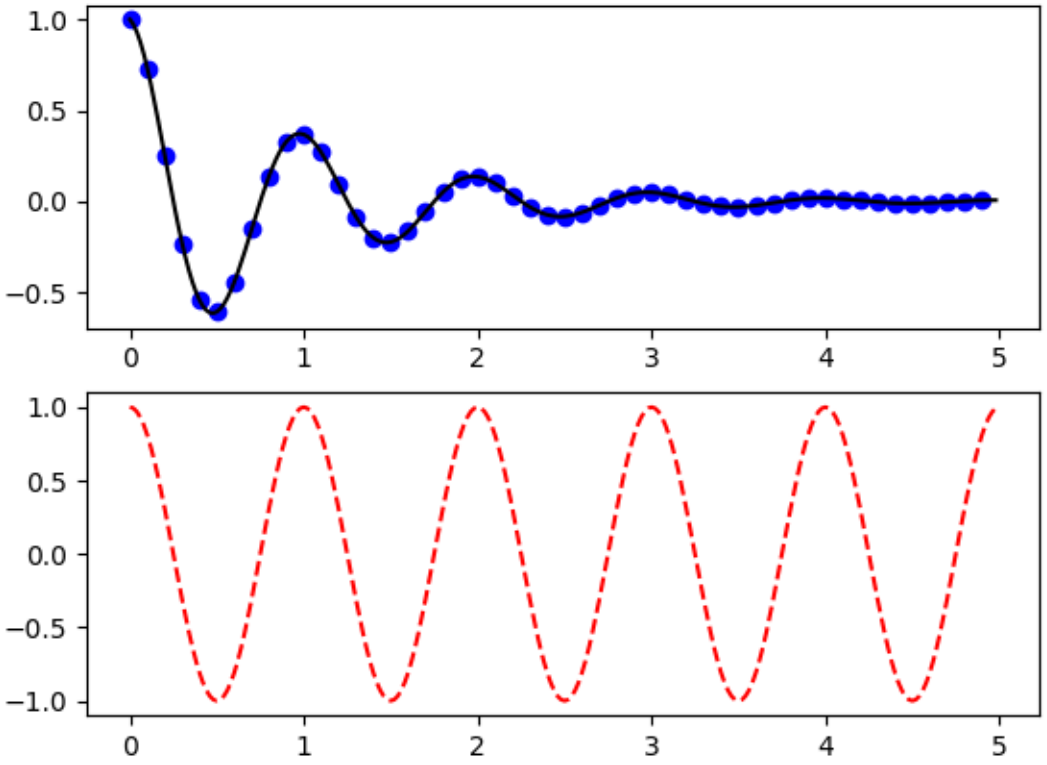
MATLAB, and *pyplot*, have the concept of the current figure and the current axes. All plotting commands apply to the current axes. The function *gca()* returns the current axes (a *matplotlib.axes.Axes* instance), and *gcf()* returns the current figure (*matplotlib.figure.Figure* instance). Normally, 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.

```
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--')
plt.show()
```



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 any axes. The *subplot()* command specifies `numrows, numcols, plot_number` where `plot_number` 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, i.e., 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) coordi-

nates. See /gallery/subplots_axes_and_figures/axes_demo for an example of placing axes manually and /gallery/subplots_axes_and_figures/subplot_demo for an example with lots of 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 it annoying that states (specifically the current image, figure and axes) are being maintained for you behind the scenes, 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 lots 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.

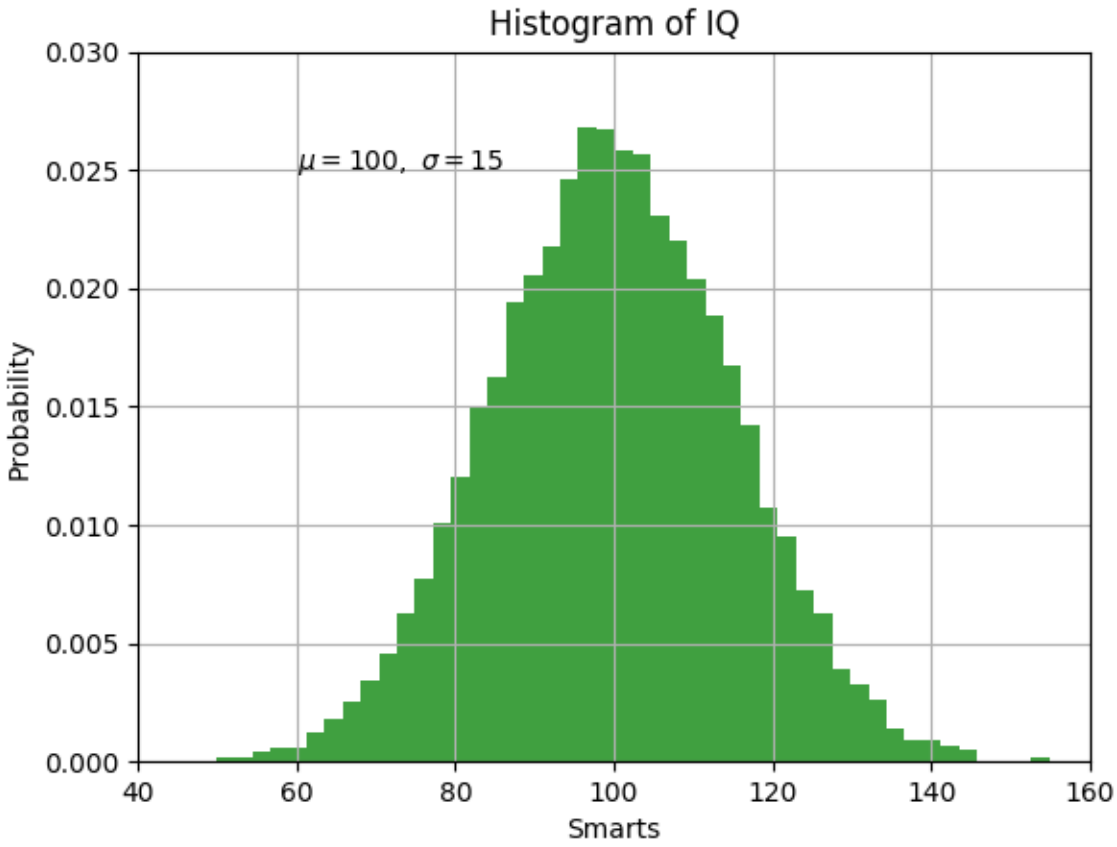
Working with text

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 in Matplotlib Plots* for a more detailed example)

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

# the histogram of the data
n, bins, patches = plt.hist(x, 50, density=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)
plt.show()
```



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*.

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` preceding the title string is important – it signifies that the string is a *raw* string and not to treat backslashes as 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*.

Annotating text

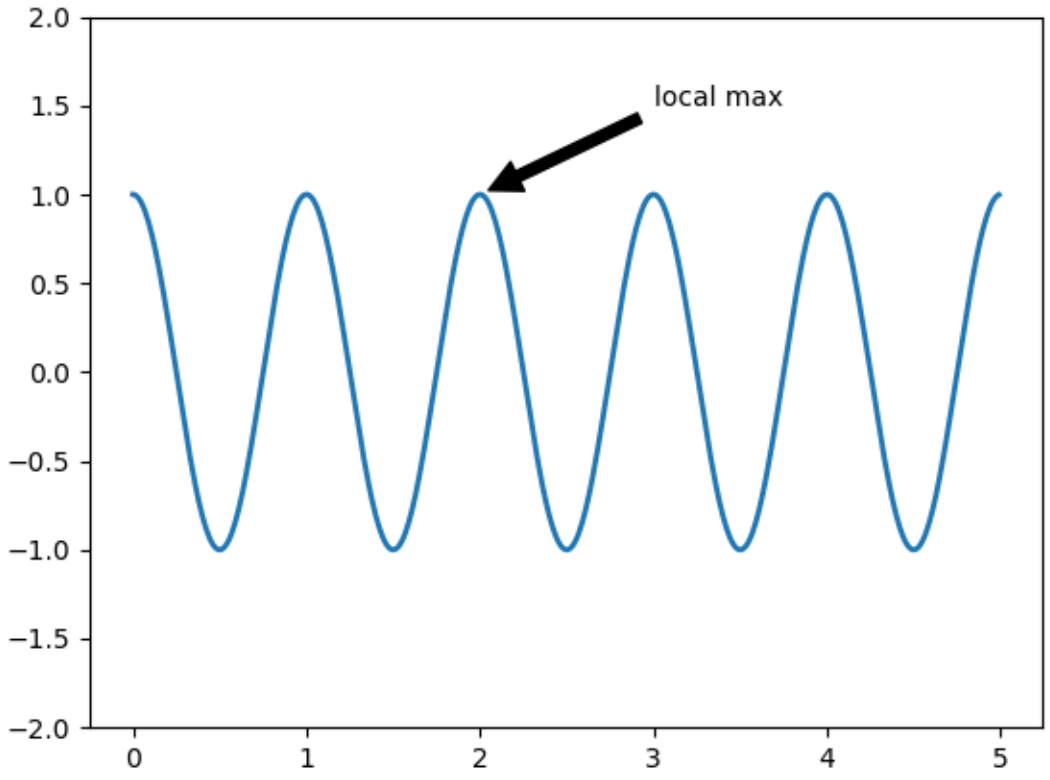
The uses of the basic *text()* command above place text at an arbitrary position on the Axes. A common use for text is to annotate some feature of the plot, and the *annotate()* method provides helper functionality to make annotations easy. In an annotation, there are two points to consider: the location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

```
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 *Basic annotation* and *Advanced Anno-*

tation for details. More examples can be found in /gallery/text_labels_and_annotations/annotation_demo.

Logarithmic and other nonlinear axes

matplotlib.pyplot supports not only linear axis scales, but also logarithmic and logit scales. This is commonly used if data spans many orders of magnitude. Changing the scale of an axis is easy:

plt.xscale('log')

An example of four plots with the same data and different scales for the y axis is shown below.

```
from matplotlib.ticker import NullFormatter  # useful for `logit` scale

# Fixing random state for reproducibility
np.random.seed(19680801)

# make up some data in the interval ]0, 1[
y = np.random.normal(loc=0.5, scale=0.4, size=1000)
y = y[(y > 0) & (y < 1)]
y.sort()
x = np.arange(len(y))

# plot with various axes scales
plt.figure(1)

# linear
plt.subplot(221)
plt.plot(x, y)
plt.yscale('linear')
plt.title('linear')
plt.grid(True)


# log
plt.subplot(222)
plt.plot(x, y)
plt.yscale('log')
plt.title('log')
plt.grid(True)


# symmetric log
plt.subplot(223)
plt.plot(x, y - y.mean())
plt.yscale('symlog', linthreshy=0.01)
plt.title('symlog')
plt.grid(True)

# logit
plt.subplot(224)
plt.plot(x, y)
plt.yscale('logit')
```

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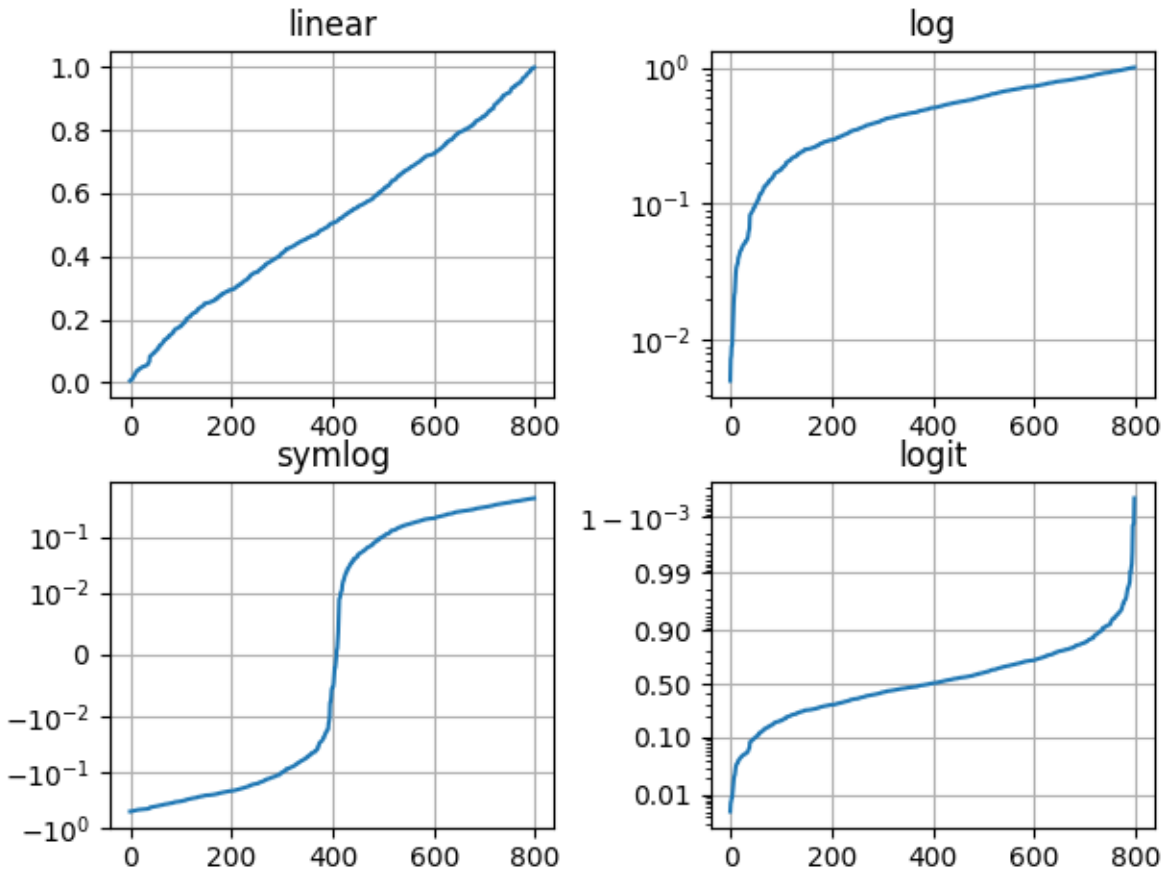
```
plt.title('logit')
plt.grid(True)
# Format the minor tick labels of the y-axis into empty strings with
# `NullFormatter`, to avoid cumbering the axis with too many labels.
plt.gca().yaxis.set_minor_formatter(NullFormatter())
# Adjust the subplot layout, because the logit one may take more space
# than usual, due to y-tick labels like "1 - 10^{-3}"
plt.subplots_adjust(top=0.92, bottom=0.08, left=0.10, right=0.95, hspace=0.25,
                    wspace=0.35)

plt.show()
```



It is also possible to add your own scale, see *Developer's guide for creating scales and transformations* for details.

Note: Click *here* to download the full example code

3.1.7 The Lifecycle of a Plot

This tutorial aims to show the beginning, middle, and end of a single visualization using Matplotlib. We'll begin with some raw data and end by saving a figure of a customized visualization. Along the way we'll try to highlight some neat features and best-practices using Matplotlib.

Note: This tutorial is based off of this excellent blog post by Chris Moffitt. It was transformed into this tutorial by Chris Holdgraf.

A note on the Object-Oriented API vs Pyplot

Matplotlib has two interfaces. The first is an object-oriented (OO) interface. In this case, we utilize an instance of *axes.Axes* in order to render visualizations on an instance of *figure.Figure*.

The second is based on MATLAB and uses a state-based interface. This is encapsulated in the `pyplot` module. See the *pyplot tutorials* for a more in-depth look at the pyplot interface.

Most of the terms are straightforward but the main thing to remember is that:

- The Figure is the final image that may contain 1 or more Axes.
- The Axes represent an individual plot (don't confuse this with the word "axis", which refers to the x/y axis of a plot).

We call methods that do the plotting directly from the Axes, which gives us much more flexibility and power in customizing our plot. See the object-oriented examples for many examples of how this approach is used.

Note: In general, try to use the object-oriented interface over the pyplot interface.

Our data

We'll use the data from the post from which this tutorial was derived. It contains sales information for a number of companies.

```
# sphinx_gallery_thumbnail_number = 10
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter

data = {'Barton LLC': 109438.50,
        'Frami, Hills and Schmidt': 103569.59,
        'Fritsch, Russel and Anderson': 112214.71,
        'Jerde-Hilpert': 112591.43,
        'Keeling LLC': 100934.30,
        'Koepp Ltd': 103660.54,
        'Kulas Inc': 137351.96,
        'Trantow-Barrows': 123381.38,
```

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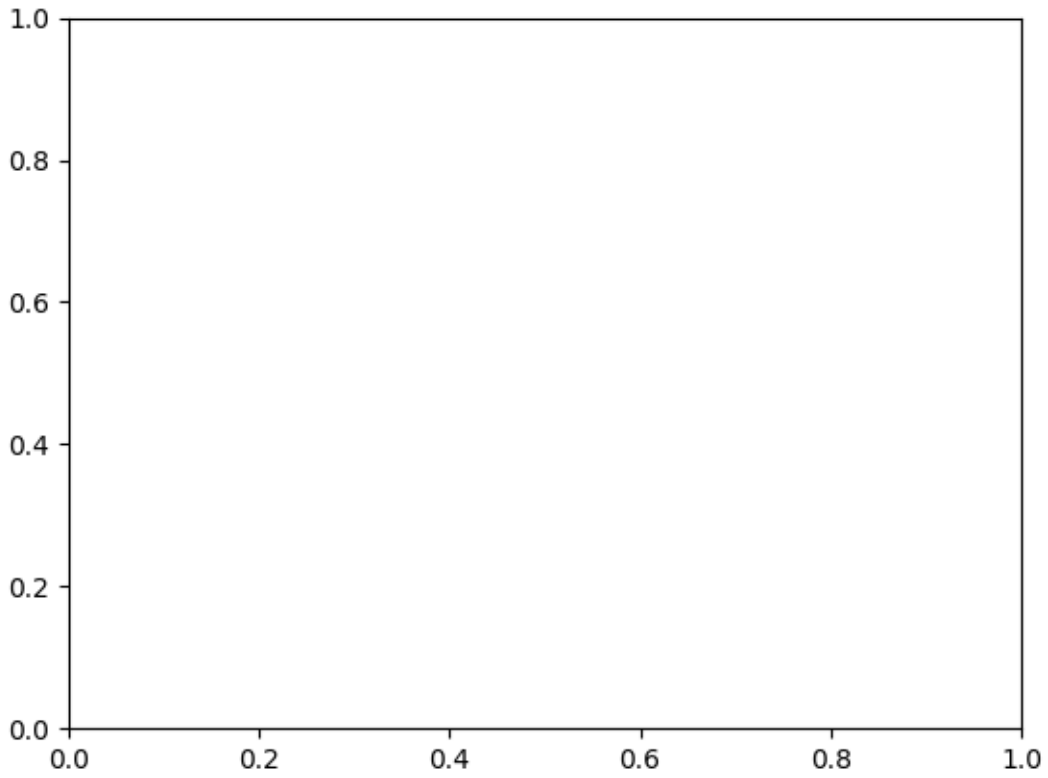
```
        'White-Trantow': 135841.99,
        'Will LLC': 104437.60}
group_data = list(data.values())
group_names = list(data.keys())
group_mean = np.mean(group_data)
```

Getting started

This data is naturally visualized as a barplot, with one bar per group. To do this with the object-oriented approach, we'll first generate an instance of *figure.Figure* and *axes.Axes*. The Figure is like a canvas, and the Axes is a part of that canvas on which we will make a particular visualization.

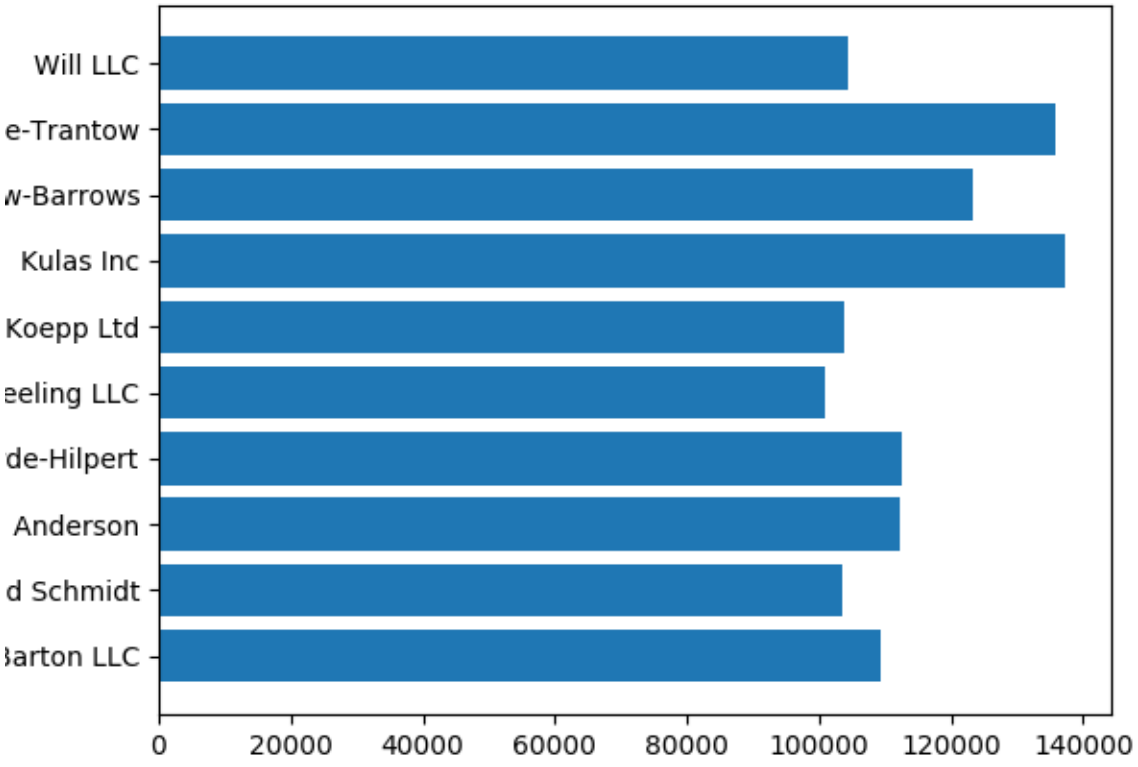
Note: Figures can have multiple axes on them. For information on how to do this, see the *Tight Layout tutorial*.

```
fig, ax = plt.subplots()
```



Now that we have an Axes instance, we can plot on top of it.

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
```



Controlling the style

There are many styles available in Matplotlib in order to let you tailor your visualization to your needs. To see a list of styles, we can use `pyplot.style`.

```
print(plt.style.available)
```

Out:

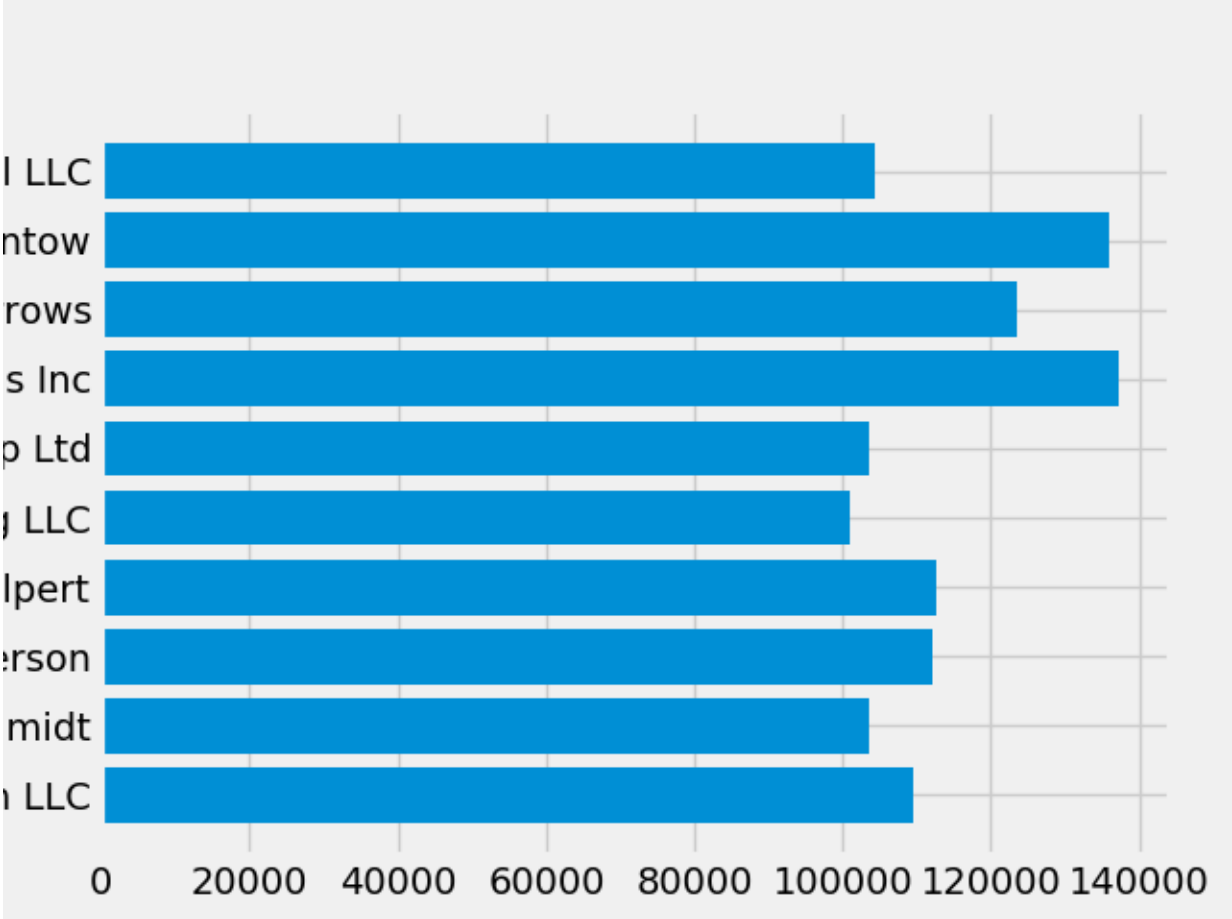
```
['tableau-colorblind10', 'seaborn', 'seaborn-whitegrid', 'seaborn-white', 'seaborn-ticks
↪', 'seaborn-talk', 'seaborn-poster', 'seaborn-pastel', 'seaborn-paper', 'seaborn-
↪notebook', 'seaborn-muted', 'seaborn-deep', 'seaborn-darkgrid', 'seaborn-dark',
↪'seaborn-dark-palette', 'seaborn-colorblind', 'seaborn-bright', 'grayscale', 'ggplot',
↪'fivethirtyeight', 'fast', 'dark_background', 'classic', 'bmh', '_classic_test',
↪'Solarize_Light2']
```

You can activate a style with the following:

```
plt.style.use('fivethirtyeight')
```

Now let's remake the above plot to see how it looks:

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
```

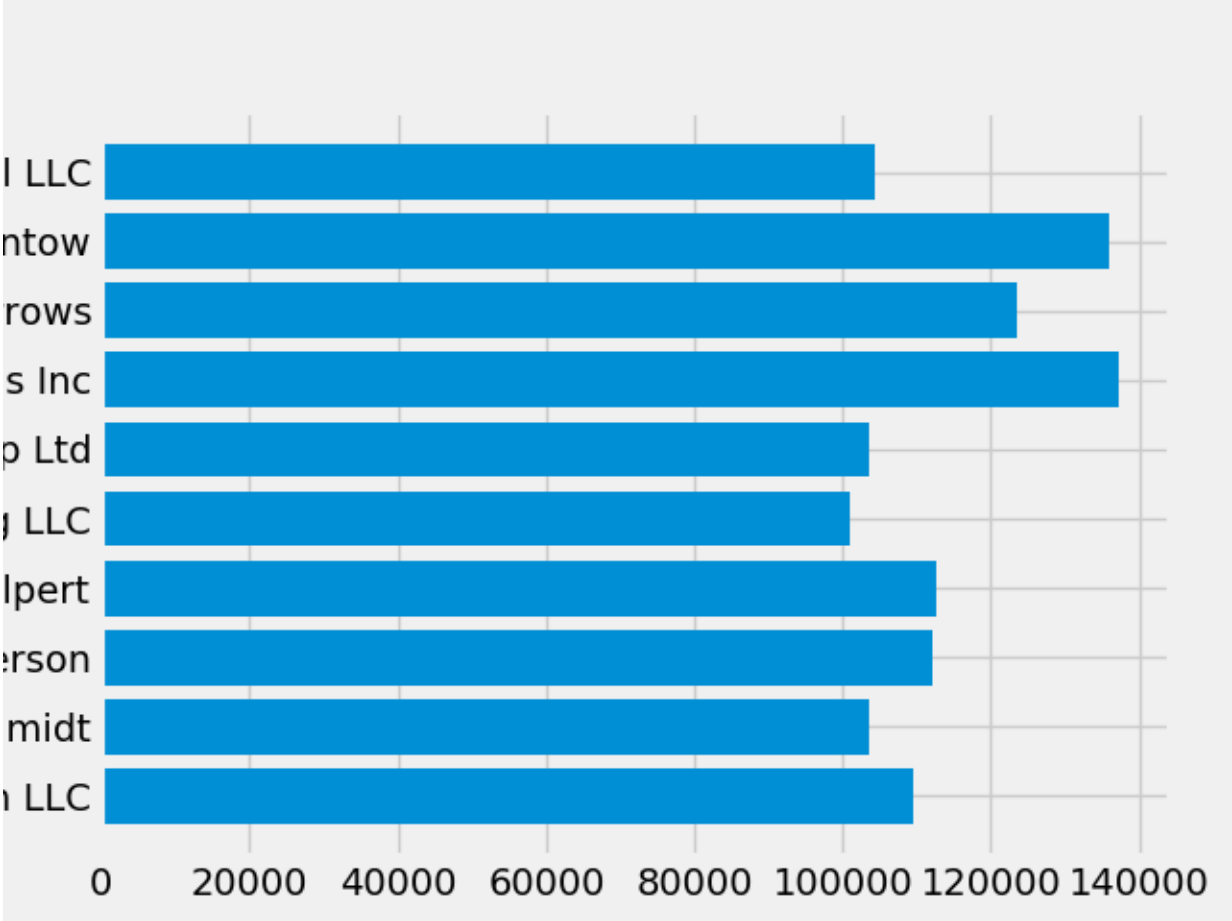


The style controls many things, such as color, linewidths, backgrounds, etc.

Customizing the plot

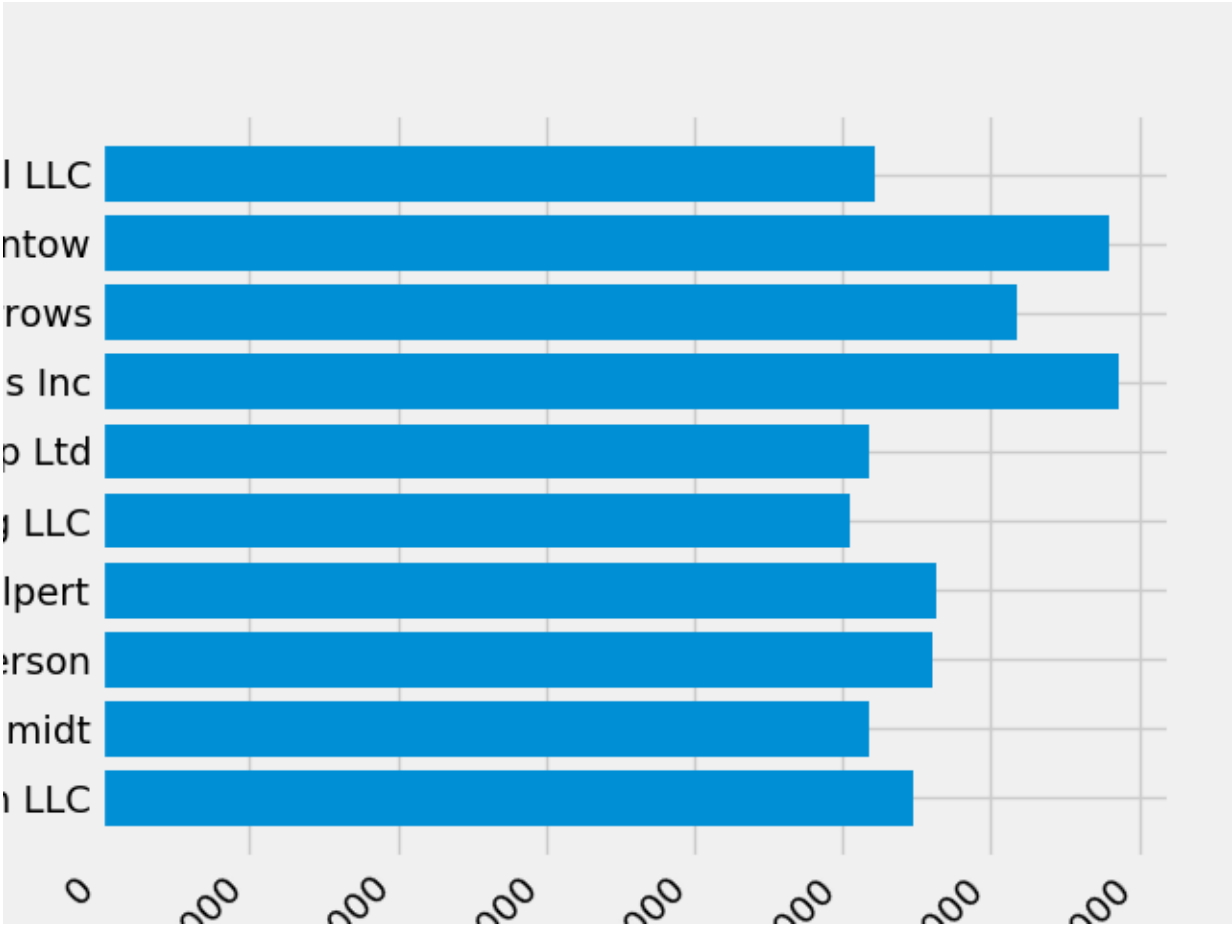
Now we've got a plot with the general look that we want, so let's fine-tune it so that it's ready for print. First let's rotate the labels on the x-axis so that they show up more clearly. We can gain access to these labels with the *axes.Axes.get_xticklabels()* method:

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
```



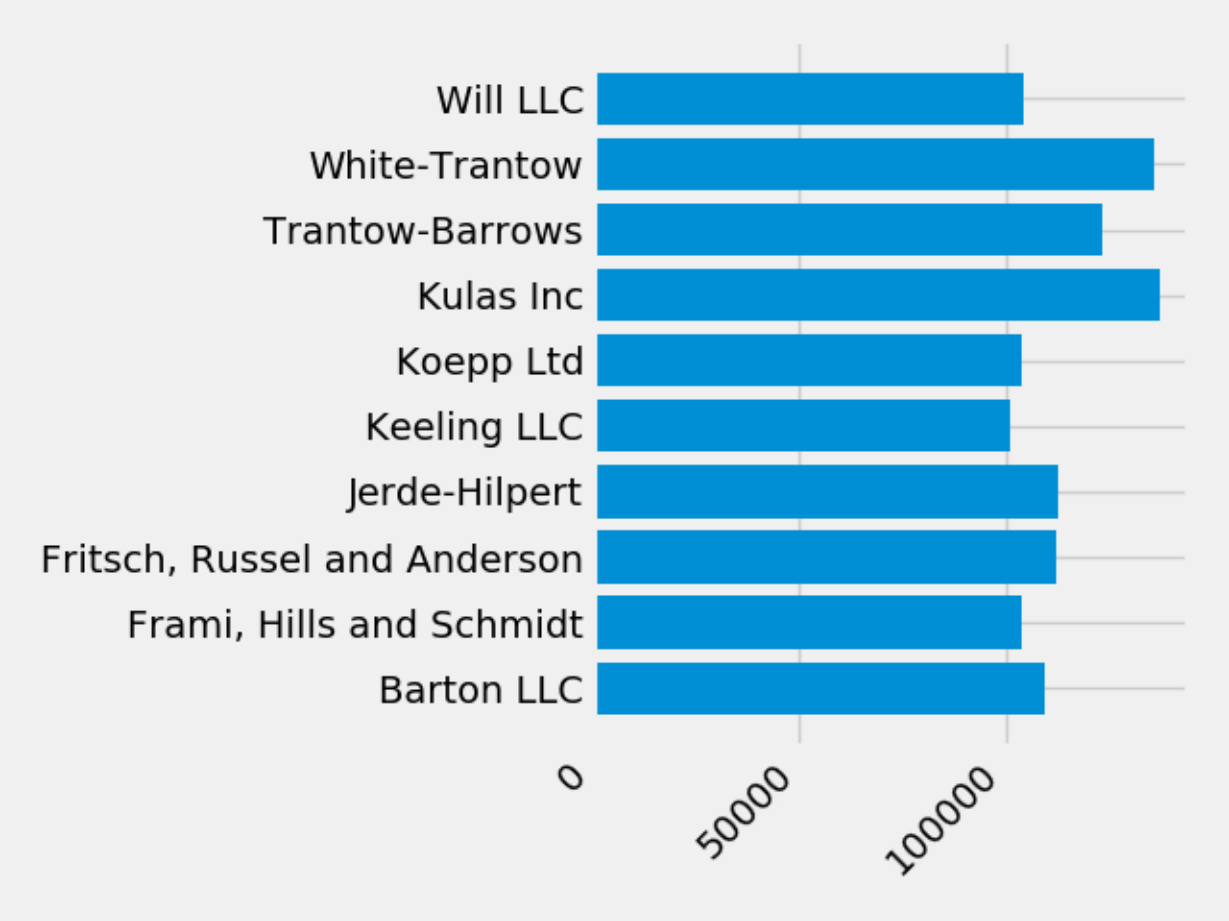
If we'd like to set the property of many items at once, it's useful to use the *pyplot.setp()* function. This will take a list (or many lists) of Matplotlib objects, and attempt to set some style element of each one.

```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
```



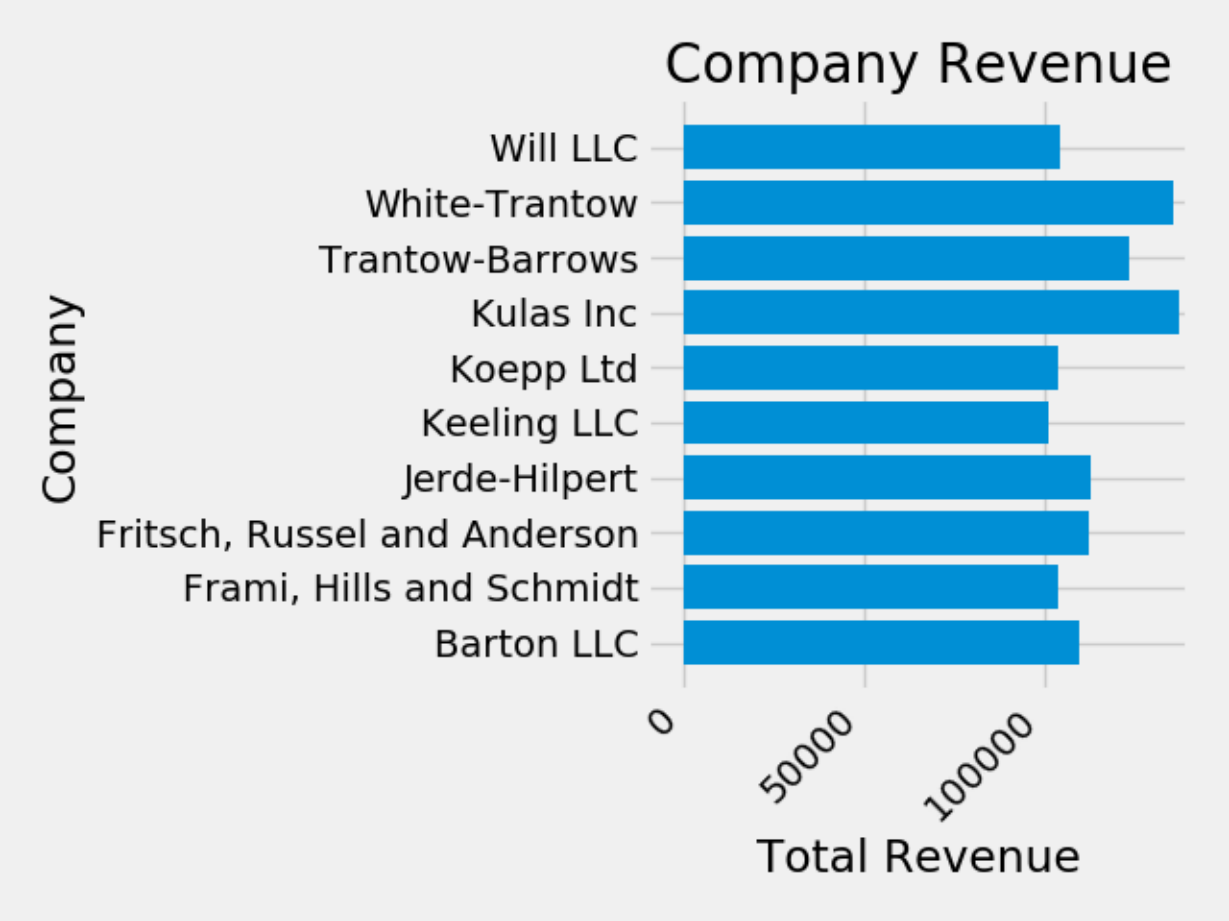
It looks like this cut off some of the labels on the bottom. We can tell Matplotlib to automatically make room for elements in the figures that we create. To do this we'll set the `autolayout` value of our rcParams. For more information on controlling the style, layout, and other features of plots with rcParams, see *Customizing Matplotlib with style sheets and rcParams*.

```
plt.rcParams.update({'figure.autolayout': True})

fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
```



Next, we'll add labels to the plot. To do this with the OO interface, we can use the *axes.Axes.set()* method to set properties of this Axes object.

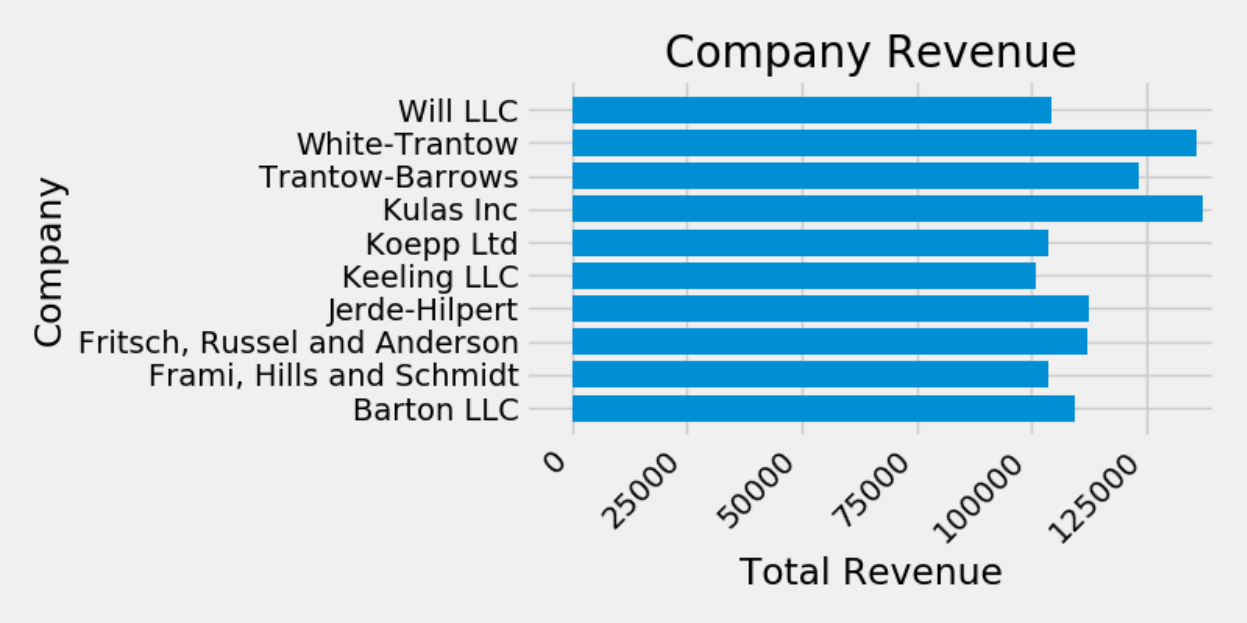
```
fig, ax = plt.subplots()
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
```



We can also adjust the size of this plot using the *pyplot.subplots()* function. We can do this with the `figsize` kwarg.

Note: While indexing in NumPy follows the form (row, column), the figsize kwarg follows the form (width, height). This follows conventions in visualization, which unfortunately are different from those of linear algebra.

```
fig, ax = plt.subplots(figsize=(8, 4))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')
ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
```

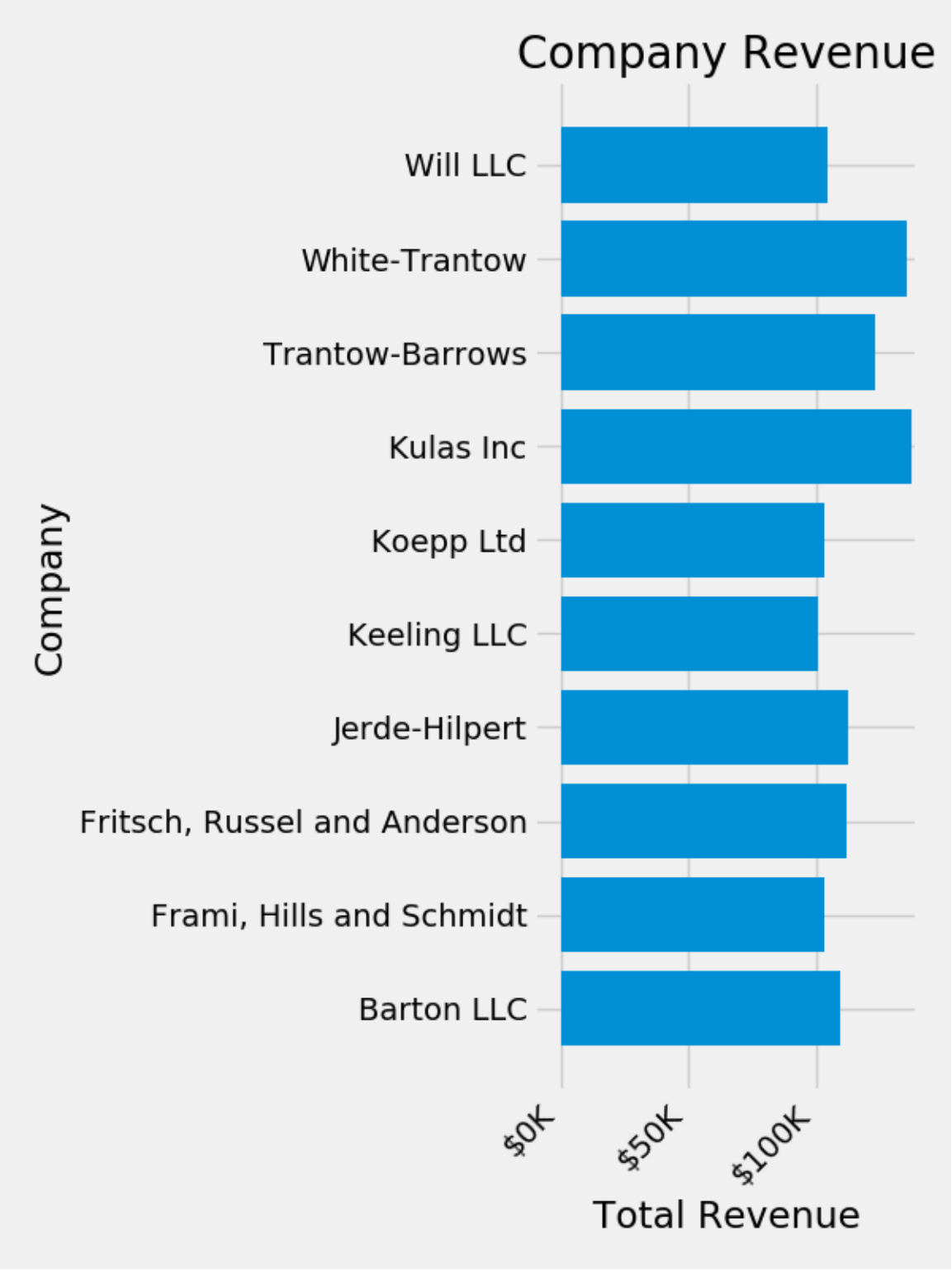


For labels, we can specify custom formatting guidelines in the form of functions by using the *ticker.FuncFormatter* class. Below we'll define a function that takes an integer as input, and returns a string as an output.

```
def currency(x, pos):
    """The two args are the value and tick position"""
    if x >= 1e6:
        s = '${:1.1f}M'.format(x*1e-6)
    else:
        s = '${:1.0f}K'.format(x*1e-3)
    return s

formatter = FuncFormatter(currency)
```

We can then apply this formatter to the labels on our plot. To do this, we'll use the `xaxis` attribute of our axis. This lets you perform actions on a specific axis on our plot.

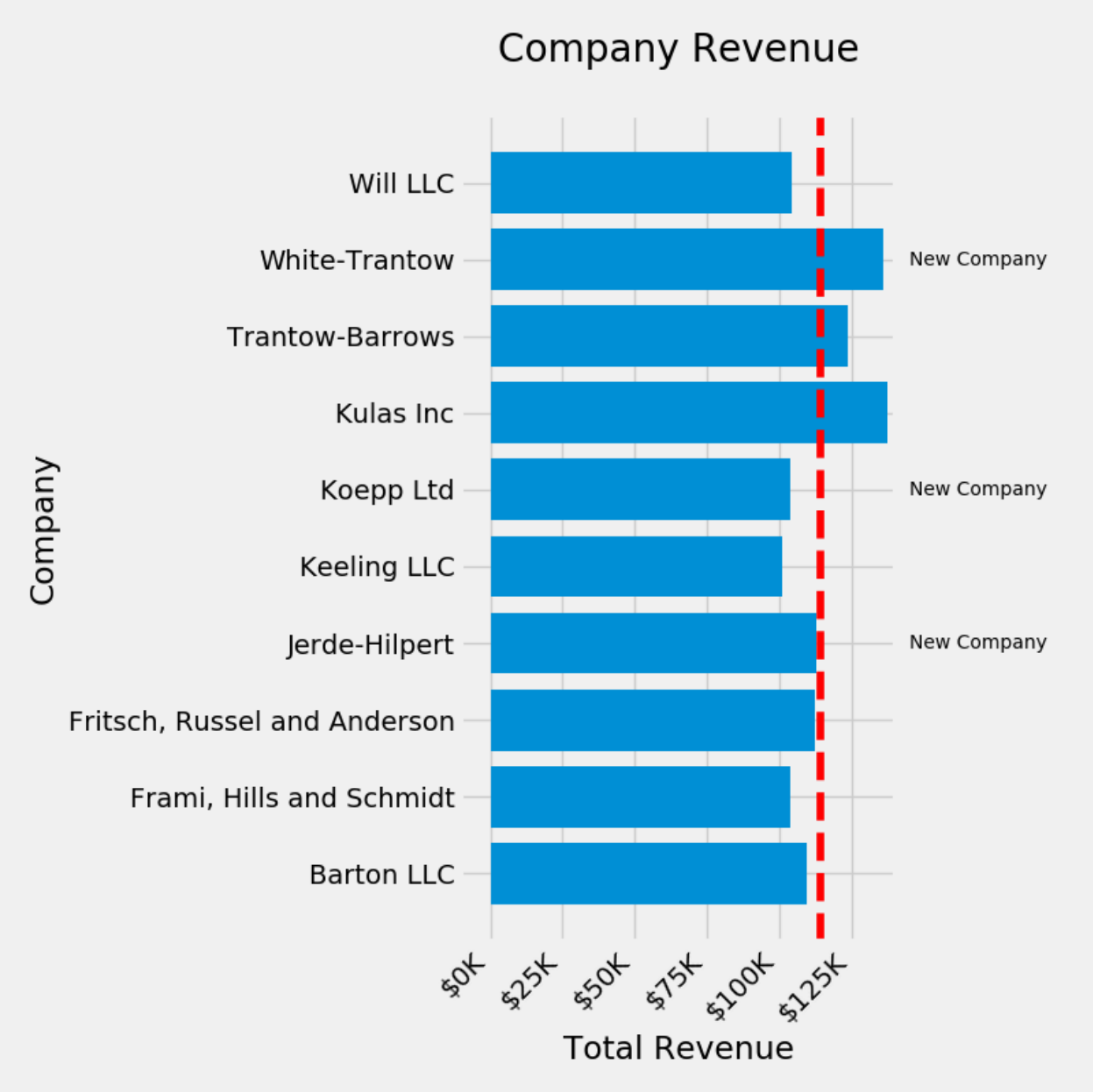
```
fig, ax = plt.subplots(figsize=(6, 8))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')

ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
ax.xaxis.set_major_formatter(formatter)
```


Company Revenue
Will LLC
White-Trantow
Trantow-Barrows
Kulas Inc
Koepp Ltd
Keeling LLC
Jerde-Hilpert
Fritsch, Russel and Anderson
Frami, Hills and Schmidt
Barton LLC
Company
$0K
$50K
$100K
Total Revenue

Combining multiple visualizations

It is possible to draw multiple plot elements on the same instance of *axes.Axes*. To do this we simply need to call another one of the plot methods on that axes object.

```
fig, ax = plt.subplots(figsize=(8, 8))
ax.barh(group_names, group_data)
labels = ax.get_xticklabels()
plt.setp(labels, rotation=45, horizontalalignment='right')

# Add a vertical line, here we set the style in the function call
ax.axvline(group_mean, ls='--', color='r')

# Annotate new companies
for group in [3, 5, 8]:
    ax.text(145000, group, "New Company", fontsize=10,
            verticalalignment="center")

# Now we'll move our title up since it's getting a little cramped
ax.title.set(y=1.05)

ax.set(xlim=[-10000, 140000], xlabel='Total Revenue', ylabel='Company',
       title='Company Revenue')
ax.xaxis.set_major_formatter(formatter)
ax.set_xticks([0, 25e3, 50e3, 75e3, 100e3, 125e3])
fig.subplots_adjust(right=.1)

plt.show()
```



Saving our plot

Now that we're happy with the outcome of our plot, we want to save it to disk. There are many file formats we can save to in Matplotlib. To see a list of available options, use:

```
print(fig.canvas.get_supported_filetypes())
```

Out:

```
{'ps': 'Postscript', 'eps': 'Encapsulated Postscript', 'pdf': 'Portable Document Format',
 ↪ 'pgf': 'PGF code for LaTeX', 'png': 'Portable Network Graphics', 'raw': 'Raw RGBA␣
↪bitmap', 'rgba': 'Raw RGBA bitmap', 'svg': 'Scalable Vector Graphics', 'svgz':
↪'Scalable Vector Graphics', 'jpg': 'Joint Photographic Experts Group', 'jpeg': 'Joint␣
↪Photographic Experts Group', 'tif': 'Tagged Image File Format', 'tiff': 'Tagged Image␣
↪File Format'}
```

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We can then use the *figure.Figure.savefig()* in order to save the figure to disk. Note that there are several useful flags we'll show below:

- `transparent=True` makes the background of the saved figure transparent if the format supports it.
- `dpi=80` controls the resolution (dots per square inch) of the output.
- `bbox_inches="tight"` fits the bounds of the figure to our plot.

```
# Uncomment this line to save the figure.
# fig.savefig('sales.png', transparent=False, dpi=80, bbox_inches="tight")
```

3.2 Intermediate

These tutorials cover some of the more complicated classes and functions in Matplotlib. They can be useful for particular custom and complex visualizations.

Note: Click *here* to download the full example code

3.2.1 Styling with cycler

Demo of custom property-cycle settings to control colors and other style properties for multi-line plots.

Note: More complete documentation of the `cycler` API can be found here.

This example demonstrates two different APIs:

1. Setting the default rc parameter specifying the property cycle. This affects all subsequent axes (but not axes already created).
2. Setting the property cycle for a single pair of axes.

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

First we'll generate some sample data, in this case, four offset sine curves.

```
x = np.linspace(0, 2 * np.pi, 50)
offsets = np.linspace(0, 2 * np.pi, 4, endpoint=False)
yy = np.transpose([np.sin(x + phi) for phi in offsets])
```

Now `yy` has shape

```
print(yy.shape)
```

Out:

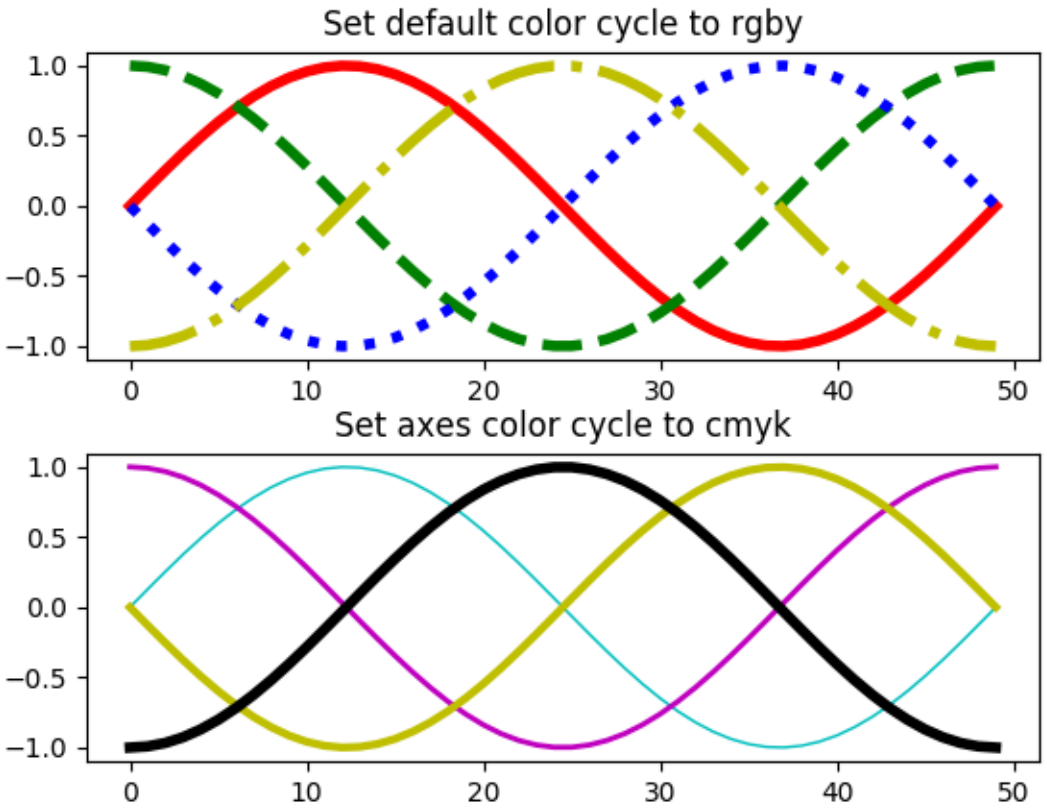
```
(50, 4)
```

So `yy[:, i]` will give you the `i`-th offset sine curve. Let's set the default prop_cycle using *matplotlib.pyplot.rc()*. We'll combine a color cycler and a linestyle cycler by adding (+) two `cycler`'s together. See the bottom of this tutorial for more information about combining different cyclers.

```
default_cycler = (cycler(color=['r', 'g', 'b', 'y']) +
                  cycler(linestyle=['-', '--', ':', '-.']))

plt.rc('lines', linewidth=4)
plt.rc('axes', prop_cycle=default_cycler)
```

Now we'll generate a figure with two axes, one on top of the other. On the first axis, we'll plot with the default cycler. On the second axis, we'll set the prop_cycler using *matplotlib.axes.Axes.set_prop_cycle()* which will only set the `prop_cycle` for this *matplotlib.axes.Axes* instance. We'll use a second `cycler` that combines a color cycler and a linewidth cycler.

```
custom_cycler = (cycler(color=['c', 'm', 'y', 'k']) +
                 cycler(lw=[1, 2, 3, 4]))

fig, (ax0, ax1) = plt.subplots(nrows=2)
ax0.plot(yy)
ax0.set_title('Set default color cycle to rgby')
ax1.set_prop_cycle(custom_cycler)
ax1.plot(yy)
ax1.set_title('Set axes color cycle to cmyk')

# Add a bit more space between the two plots.
fig.subplots_adjust(hspace=0.3)
plt.show()
```



Setting `prop_cycler` in the `matplotlibrc` file or style files

Remember, if you want to set a custom `prop_cycler` in your `.matplotlibrc` file or a style file (`style.mplstyle`), you can set the `axes.prop_cycle` property:

```
axes.prop_cycle    : cycler(color='bgrcmyk')
```

Cycling through multiple properties

You can add cyclers:

```
from cycler import cycler
cc = (cycler(color=list('rgb')) +
      cycler(linestyle=['-', '--', '-.']))
for d in cc:
    print(d)
```

Results in:

```
{'color': 'r', 'linestyle': '-'}
{'color': 'g', 'linestyle': '--'}
{'color': 'b', 'linestyle': '-.'}
```

You can multiply cyclers:

```
from cycler import cycler
cc = (cycler(color=list('rgb')) *
      cycler(linestyle=['-', '--', '-.']))
for d in cc:
    print(d)
```

Results in:

```
{'color': 'r', 'linestyle': '-'}
{'color': 'r', 'linestyle': '--'}
{'color': 'r', 'linestyle': '-.'}
{'color': 'g', 'linestyle': '-'}
{'color': 'g', 'linestyle': '--'}
{'color': 'g', 'linestyle': '-.'}
{'color': 'b', 'linestyle': '-'}
{'color': 'b', 'linestyle': '--'}
{'color': 'b', 'linestyle': '-.'}
```

Note: Click *here* to download the full example code

3.2.2 Legend guide

Generating legends flexibly in Matplotlib.

This legend guide is an extension of the documentation available at *legend()* - please ensure you are familiar with contents of that documentation before proceeding with this guide.

This guide makes use of some common terms, which are documented here for clarity:

legend entry A legend is made up of one or more legend entries. An entry is made up of exactly one key and one label.

legend key The colored/patterned marker to the left of each legend label.

legend label The text which describes the handle represented by the key.

legend handle The original object which is used to generate an appropriate entry in the legend.

Controlling the legend entries

Calling *legend()* with no arguments automatically fetches the legend handles and their associated labels. This functionality is equivalent to:

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

The *get_legend_handles_labels()* function returns a list of handles/artists which exist on the Axes which can be used to generate entries for the resulting legend - it is worth noting however that not all artists can be added to a legend, at which point a "proxy" will have to be created (see *Creating artists specifically for adding to the legend (aka. Proxy artists)* for further details).

For full control of what is being added to the legend, it is common to pass the appropriate handles directly to *legend()*:

```
line_up, = plt.plot([1,2,3], label='Line 2')
line_down, = plt.plot([3,2,1], label='Line 1')
plt.legend(handles=[line_up, line_down])
```

In some cases, it is not possible to set the label of the handle, so it is possible to pass through the list of labels to *legend()*:

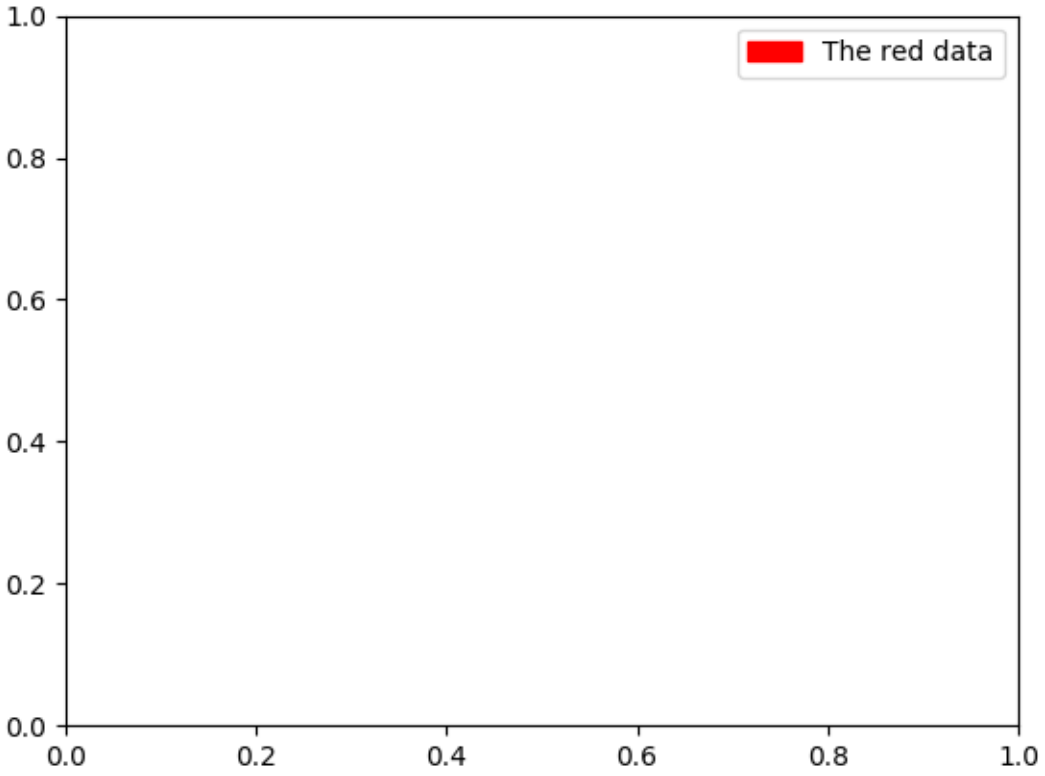
```
line_up, = plt.plot([1,2,3], label='Line 2')
line_down, = plt.plot([3,2,1], label='Line 1')
plt.legend([line_up, line_down], ['Line Up', 'Line Down'])
```

Creating artists specifically for adding to the legend (aka. Proxy artists)

Not all handles can be turned into legend entries automatically, so it is often necessary to create an artist which *can*. Legend handles don't have to exists on the Figure or Axes in order to be used.

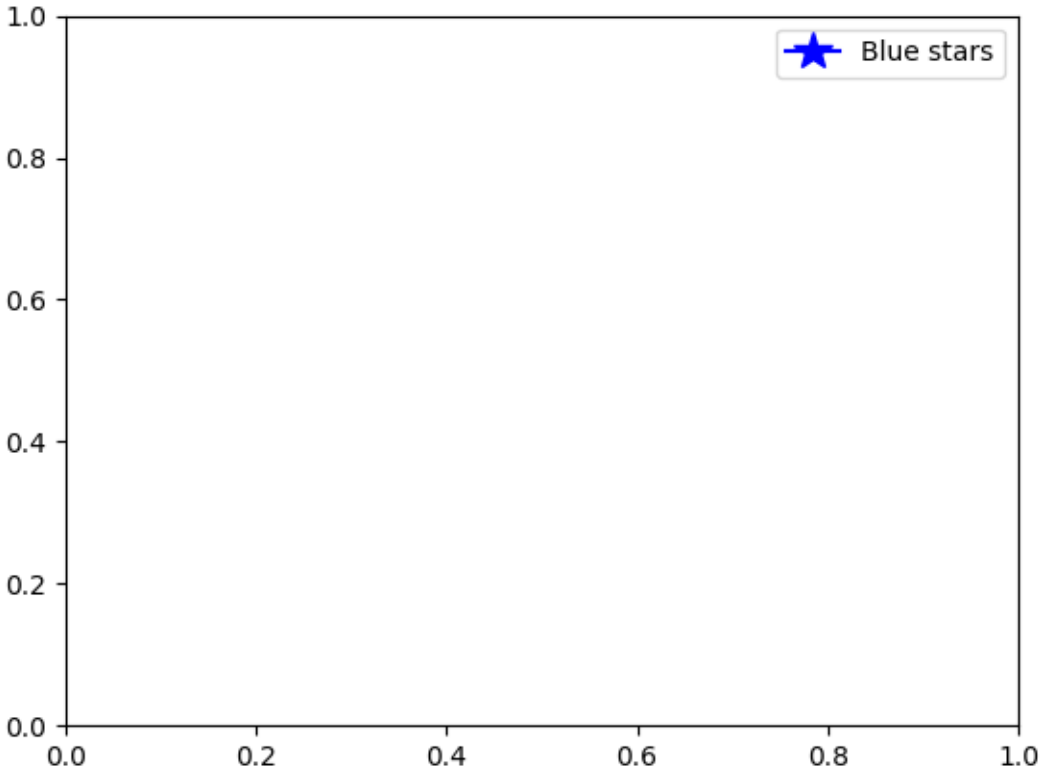
Suppose we wanted to create a legend which has an entry for some data which is represented by a red color:

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

red_patch = mpatches.Patch(color='red', label='The red data')
plt.legend(handles=[red_patch])

plt.show()
```



There are many supported legend handles, instead of creating a patch of color we could have created a line with a marker:

```
import matplotlib.lines as mlines

blue_line = mlines.Line2D([], [], color='blue', marker='*',
                          markersize=15, label='Blue stars')
plt.legend(handles=[blue_line])

plt.show()
```



Legend location

The location of the legend can be specified by the keyword argument *loc*. Please see the documentation at *legend()* for more details.

The bbox_to_anchor keyword gives a great degree of control for manual legend placement. For example, if you want your axes legend located at the figure's top right-hand corner instead of the axes' corner, simply specify the corner's location, and the coordinate system of that location:

```
plt.legend(bbox_to_anchor=(1, 1),
           bbox_transform=plt.gcf().transFigure)
```

More examples of custom legend placement:

```
plt.subplot(211)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")

# Place a legend above this subplot, expanding itself to
# fully use the given bounding box.
plt.legend(bbox_to_anchor=(0., 1.02, 1., .102), loc=3,
           ncol=2, mode="expand", borderaxespad=0.)
```

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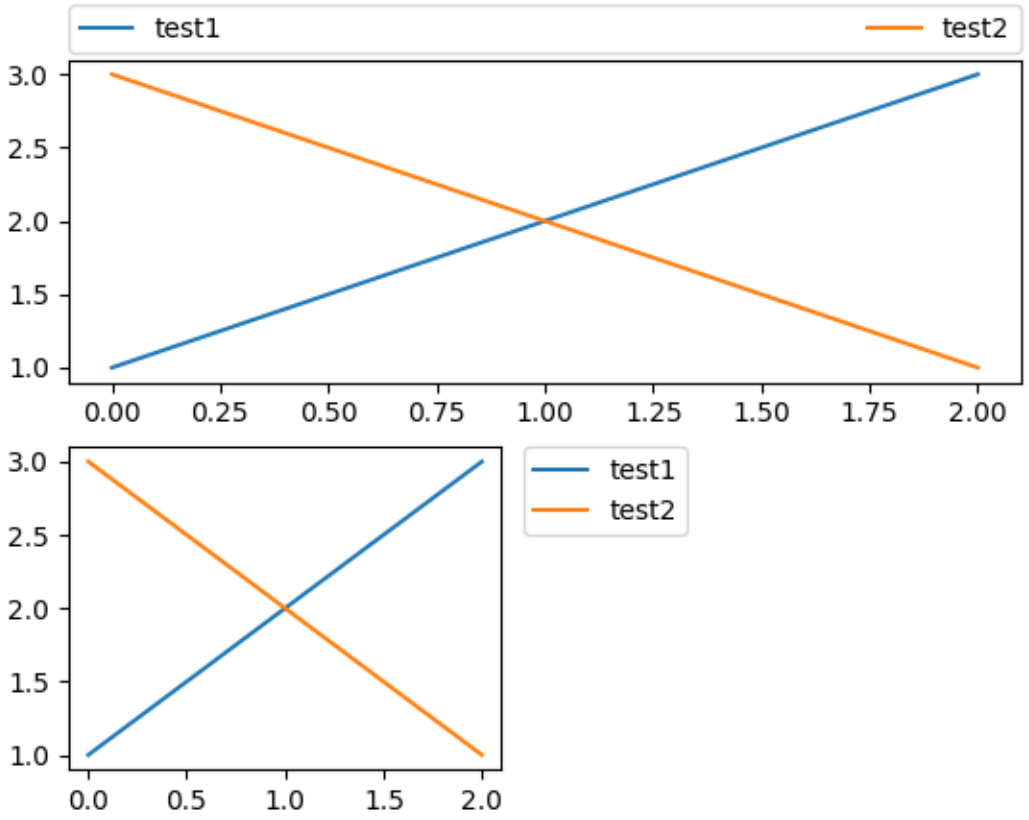
```
plt.subplot(223)
plt.plot([1, 2, 3], label="test1")
plt.plot([3, 2, 1], label="test2")
# Place a legend to the right of this smaller subplot.
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.show()
```



Multiple legends on the same Axes

Sometimes it is more clear to split legend entries across multiple legends. Whilst the instinctive approach to doing this might be to call the *legend()* function multiple times, you will find that only one legend ever exists on the Axes. This has been done so that it is possible to call *legend()* repeatedly to update the legend to the latest handles on the Axes, so to persist old legend instances, we must add them manually to the Axes:

```
line1, = plt.plot([1, 2, 3], label="Line 1", linestyle='--')
line2, = plt.plot([3, 2, 1], label="Line 2", linewidth=4)

# Create a legend for the first line.
```

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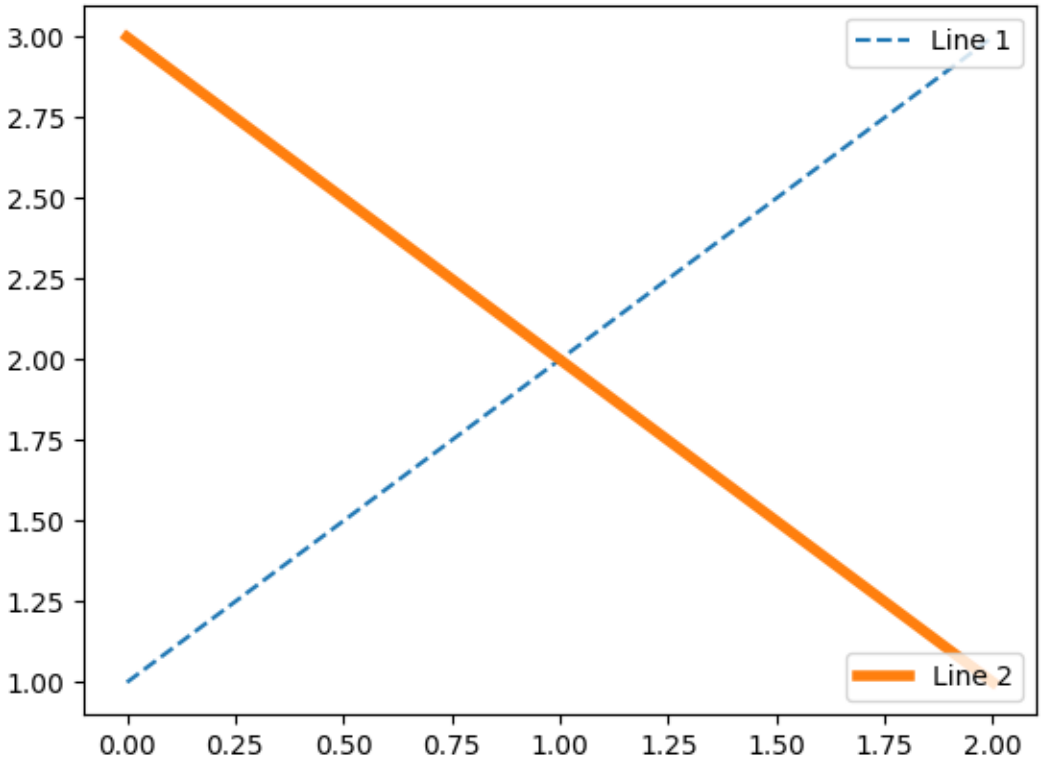
```
first_legend = plt.legend(handles=[line1], loc=1)

# Add the legend manually to the current Axes.
ax = plt.gca().add_artist(first_legend)

# Create another legend for the second line.
plt.legend(handles=[line2], loc=4)

plt.show()
```



Legend Handlers

In order to create legend entries, handles are given as an argument to an appropriate *HandlerBase* subclass. The choice of handler subclass is determined by the following rules:

1. Update *get_legend_handler_map()* with the value in the `handler_map` keyword.
2. Check if the `handle` is in the newly created `handler_map`.
3. Check if the type of `handle` is in the newly created `handler_map`.
4. Check if any of the types in the `handle`'s mro is in the newly created `handler_map`.

For completeness, this logic is mostly implemented in *get_legend_handler()*.

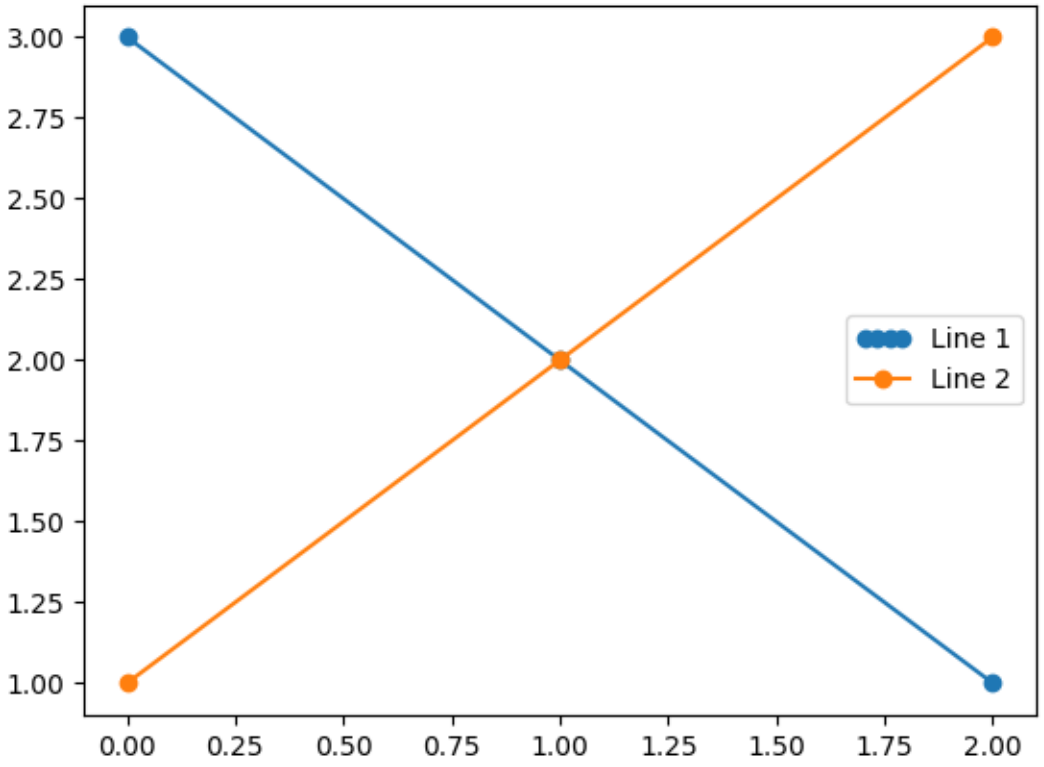
All of this flexibility means that we have the necessary hooks to implement custom handlers for our own type of legend key.

The simplest example of using custom handlers is to instantiate one of the existing *HandlerBase* subclasses. For the sake of simplicity, let's choose *matplotlib.legend_handler.HandlerLine2D* which accepts a `numpoints` argument (note numpoints is a keyword on the *legend()* function for convenience). We can then pass the mapping of instance to Handler as a keyword to legend.

```
from matplotlib.legend_handler import HandlerLine2D

line1, = plt.plot([3, 2, 1], marker='o', label='Line 1')
line2, = plt.plot([1, 2, 3], marker='o', label='Line 2')

plt.legend(handler_map={line1: HandlerLine2D(numpoints=4)})
```



As you can see, "Line 1" now has 4 marker points, where "Line 2" has 2 (the default). Try the above code, only change the map's key from `line1` to `type(line1)`. Notice how now both *Line2D* instances get 4 markers.

Along with handlers for complex plot types such as errorbars, stem plots and histograms, the default `handler_map` has a special `tuple` handler (*HandlerTuple*) which simply plots the handles on top of one another for each item in the given tuple. The following example demonstrates combining two legend

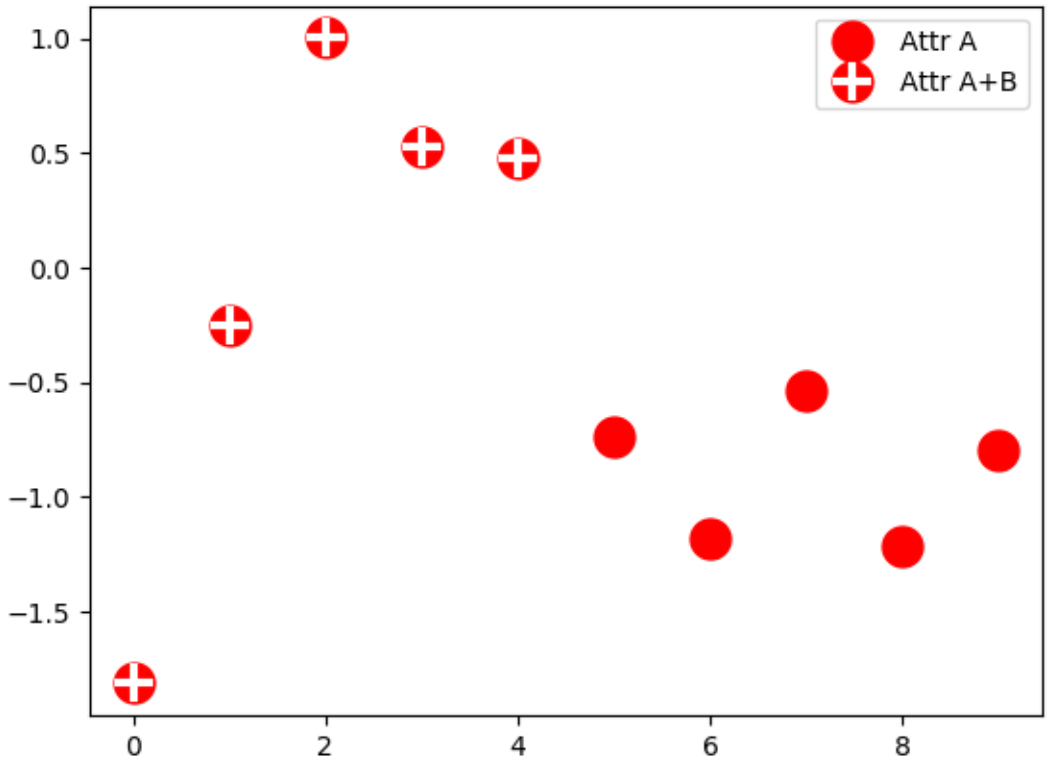
keys on top of one another:

```
from numpy.random import randn

z = randn(10)

red_dot, = plt.plot(z, "ro", markersize=15)
# Put a white cross over some of the data.
white_cross, = plt.plot(z[:5], "w+", markeredgewidth=3, markersize=15)

plt.legend([red_dot, (red_dot, white_cross)], ["Attr A", "Attr A+B"])
```

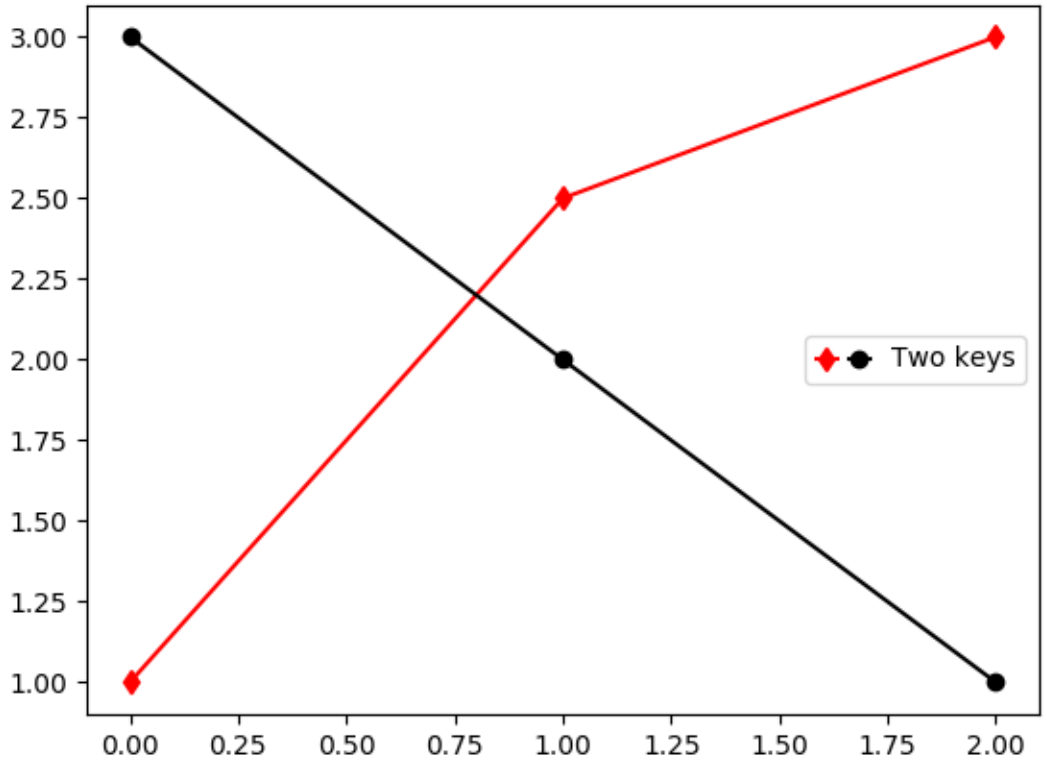


The *HandlerTuple* class can also be used to assign several legend keys to the same entry:

```
from matplotlib.legend_handler import HandlerLine2D, HandlerTuple

p1, = plt.plot([1, 2.5, 3], 'r-d')
p2, = plt.plot([3, 2, 1], 'k-o')

l = plt.legend([(p1, p2)], ['Two keys'], numpoints=1,
               handler_map={tuple: HandlerTuple(ndivide=None)})
```



Implementing a custom legend handler

A custom handler can be implemented to turn any handle into a legend key (handles don't necessarily need to be matplotlib artists). The handler must implement a "legend_artist" method which returns a single artist for the legend to use. Signature details about the "legend_artist" are documented at *legend_artist()*.

```
import matplotlib.patches as mpatches


class AnyObject(object):
    pass


class AnyObjectHandler(object):
    def legend_artist(self, legend, orig_handle, fontsize, handlebox):
        x0, y0 = handlebox.xdescent, handlebox.ydescent
        width, height = handlebox.width, handlebox.height
        patch = mpatches.Rectangle([x0, y0], width, height, facecolor='red',
                                   edgecolor='black', hatch='xx', lw=3,
                                   transform=handlebox.get_transform())
        handlebox.add_artist(patch)
```

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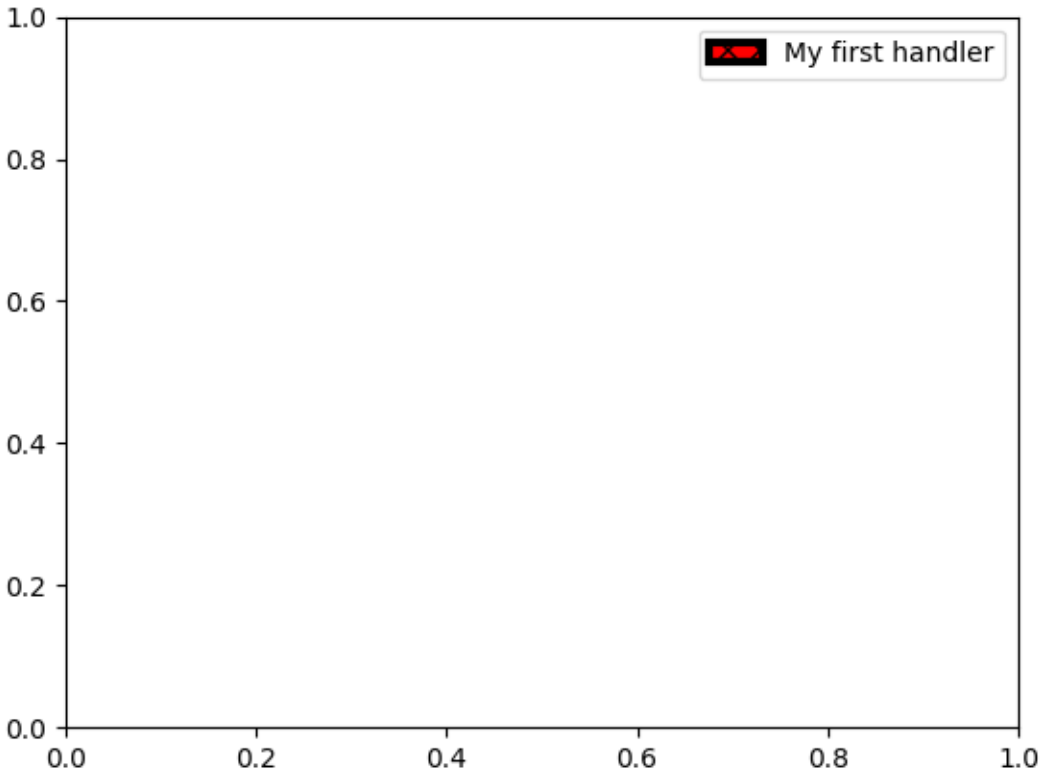
```
        return patch


plt.legend([AnyObject()], ['My first handler'],
           handler_map={AnyObject: AnyObjectHandler()})
```



Alternatively, had we wanted to globally accept `AnyObject` instances without needing to manually set the `handler_map` keyword all the time, we could have registered the new handler with:

```
from matplotlib.legend import Legend
Legend.update_default_handler_map({AnyObject: AnyObjectHandler()})
```

Whilst the power here is clear, remember that there are already many handlers implemented and what you want to achieve may already be easily possible with existing classes. For example, to produce elliptical legend keys, rather than rectangular ones:

```
from matplotlib.legend_handler import HandlerPatch


class HandlerEllipse(HandlerPatch):
    def create_artists(self, legend, orig_handle,
```

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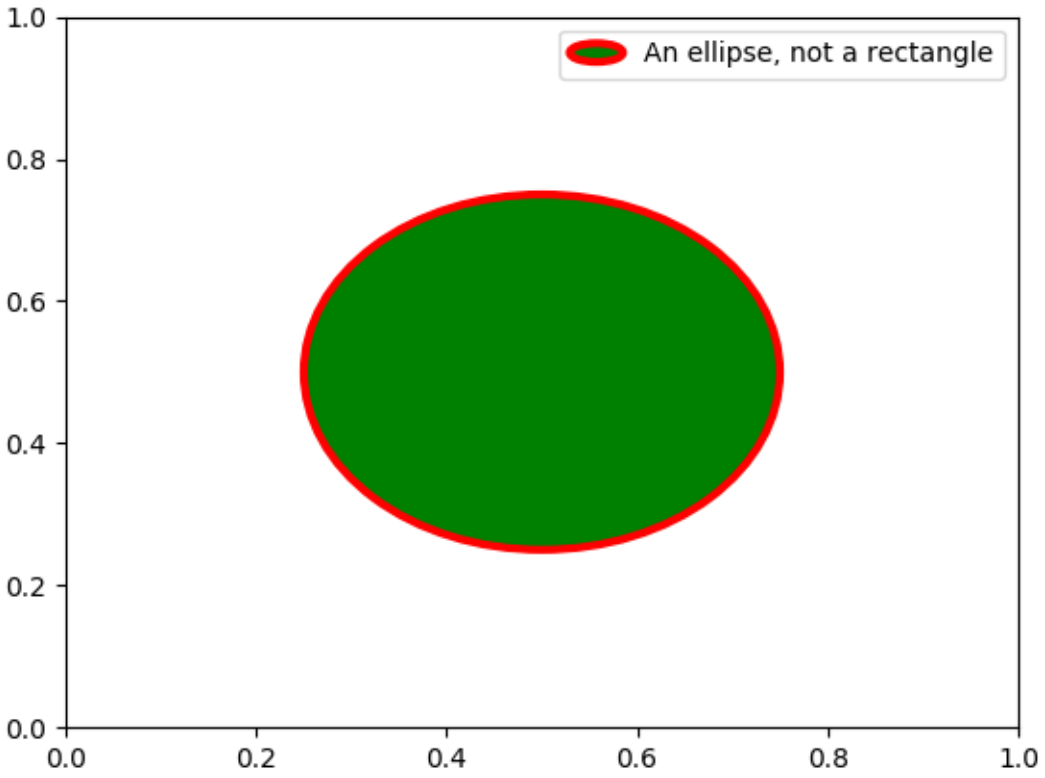
```
                        xdescent, ydescent, width, height, fontsize, trans):
        center = 0.5 * width - 0.5 * xdescent, 0.5 * height - 0.5 * ydescent
        p = mpatches.Ellipse(xy=center, width=width + xdescent,
                             height=height + ydescent)
        self.update_prop(p, orig_handle, legend)
        p.set_transform(trans)
        return [p]


c = mpatches.Circle((0.5, 0.5), 0.25, facecolor="green",
                    edgecolor="red", linewidth=3)
plt.gca().add_patch(c)

plt.legend([c], ["An ellipse, not a rectangle"],
           handler_map={mpatches.Circle: HandlerEllipse()})
```



Note: Click *here* to download the full example code

3.2.3 Artist tutorial

Using Artist objects to render on the canvas.

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 their 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 (e.g., `numpy` arrays and strings) and create primitive `Artist` instances as needed (e.g., `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)
```

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```
s = np.sin(2*np.pi*t)
line, = ax.plot(t, s, color='blue', lw=2)
```

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

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

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

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

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

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

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

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

Try creating the figure below.

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

fig = plt.figure()
fig.subplots_adjust(top=0.8)
ax1 = fig.add_subplot(211)
ax1.set_ylabel('volts')
ax1.set_title('a sine wave')

t = np.arange(0.0, 1.0, 0.01)
s = np.sin(2*np.pi*t)
line, = ax1.plot(t, s, color='blue', lw=2)

# Fixing random state for reproducibility
np.random.seed(19680801)

ax2 = fig.add_axes([0.15, 0.1, 0.7, 0.3])
```

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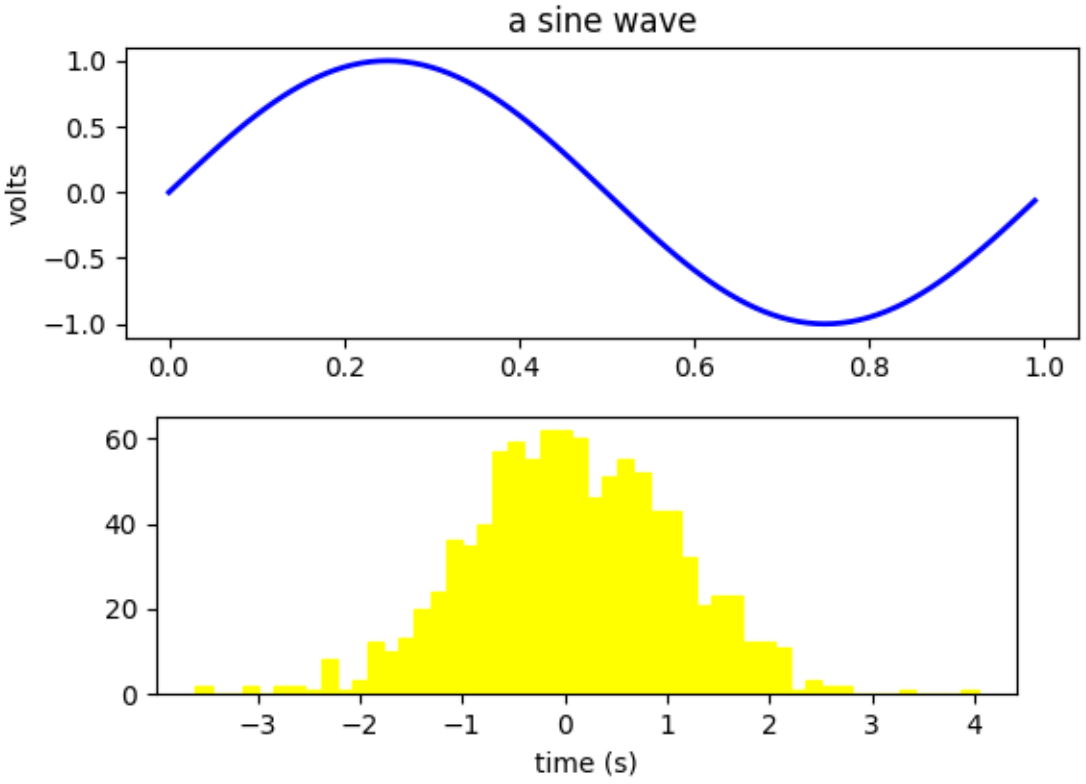
```
n, bins, patches = ax2.hist(np.random.randn(1000), 50,
                            facecolor='yellow', edgecolor='yellow')
ax2.set_xlabel('time (s)')

plt.show()
```



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, e.g., 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 (e.g., 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
rasterized	Boolean; Turns vectors into rastergraphics: (for compression & eps transparency)

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, e.g., `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
```

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```
    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 *artist Module* for a listing of properties for a given object.

Object containers

Now that we know how to inspect and set the properties of a given object we want to configure, we need to know 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.

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.

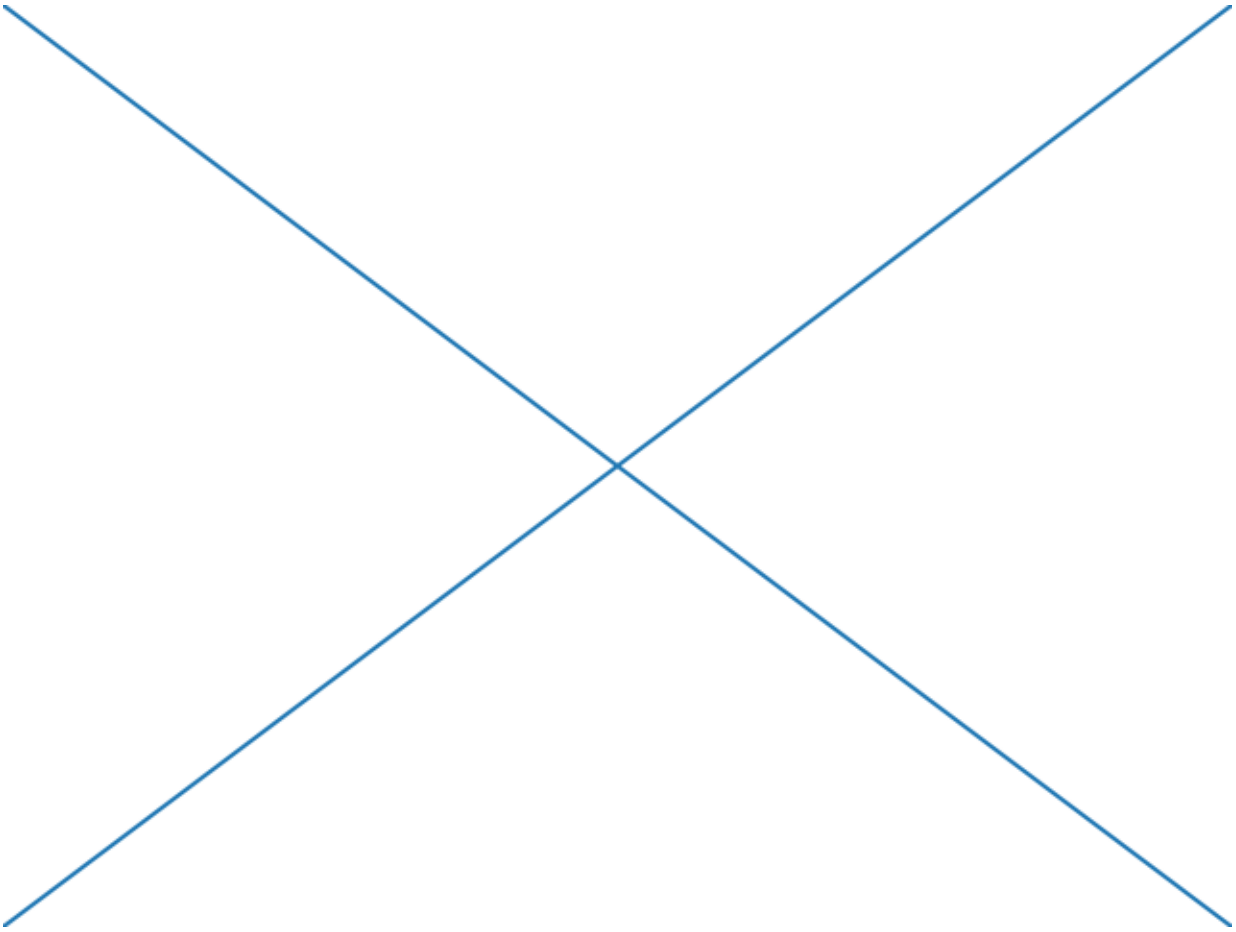
More useful is "figure coordinates" where (0, 0) is the bottom-left of the figure and (1, 1) is the top-right of the figure which you can obtain by setting the `Artist` transform to `fig.transFigure`:

```
import matplotlib.lines as lines

fig = plt.figure()

l1 = lines.Line2D([0, 1], [0, 1], transform=fig.transFigure, figure=fig)
l2 = lines.Line2D([0, 1], [1, 0], transform=fig.transFigure, figure=fig)
fig.lines.extend([l1, l2])

plt.show()
```



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

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, e.g., 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 [262]: fig, ax = plt.subplots()

# 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 respec-

tive 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 color 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

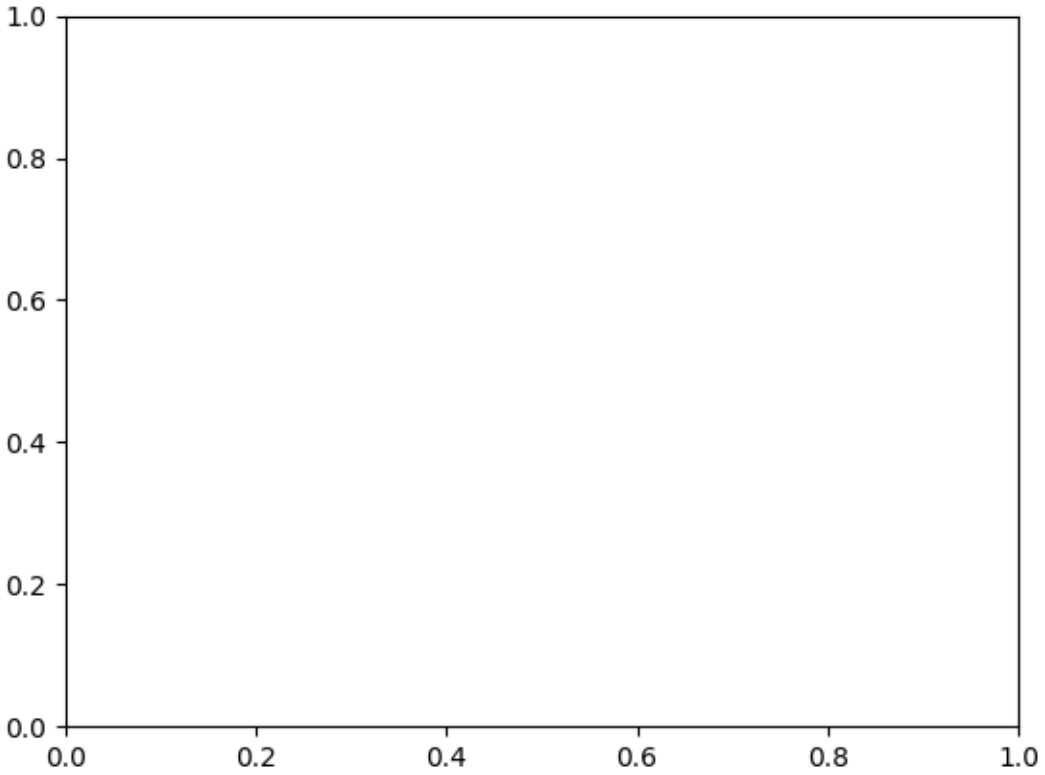
Axes attribute	Description
artists	A list of Artist instances
patch	Rectangle instance for Axes background
collections	A list of Collection instances
images	A list of AxesImage
legends	A list of Legend instances
lines	A list of Line2D instances
patches	A list of Patch instances
texts	A list of Text instances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

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 (e.g., 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, `Axis` instances have accessor methods that return the tick lines, tick labels, tick locations etc.:

```
fig, ax = plt.subplots()
axis = ax.xaxis
axis.get_ticklocs()
```




```
axis.get_ticklabels()
```

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

```
axis.get_ticklines()
```

by default you get the major ticks back

```
axis.get_ticklines()
```

but you can also ask for the minor ticks

```
axis.get_ticklines(minor=True)

# 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, e.g., '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

# 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')
```

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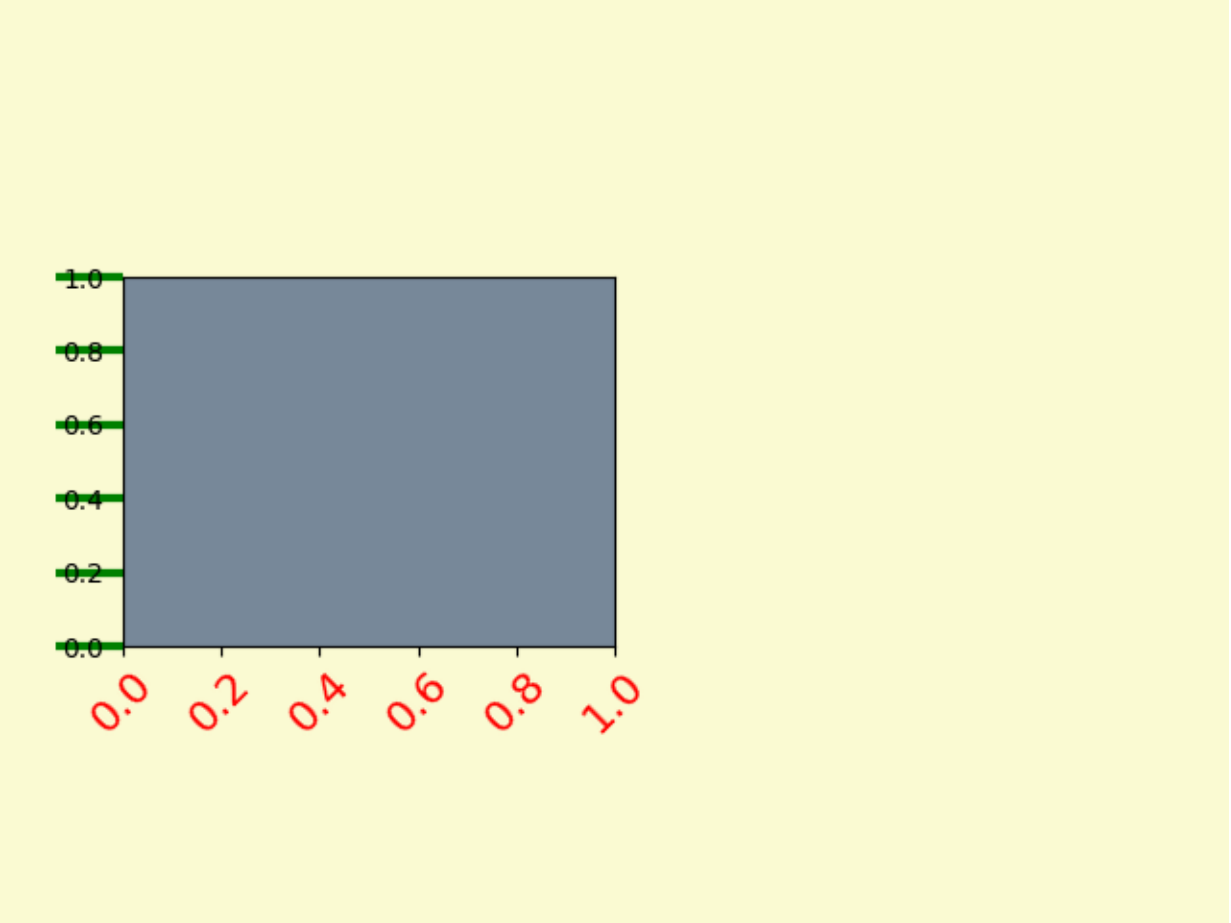
```
    line.set_markersize(25)
    line.set_markeredgewidth(3)

plt.show()
```



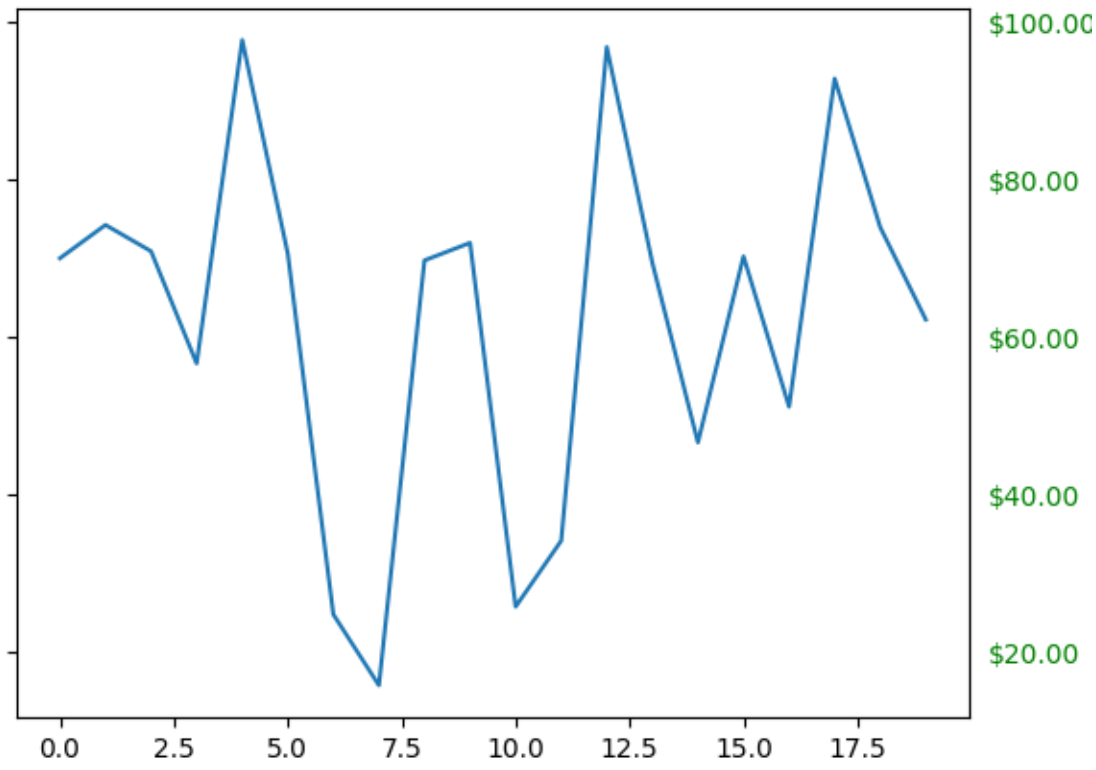
Tick containers

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 gridline
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 the 1st tick label
label2On	boolean which determines whether to draw the 2nd 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 matplotlib.ticker as ticker

# Fixing random state for reproducibility
np.random.seed(19680801)

fig, ax = plt.subplots()
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')

plt.show()
```



Note: Click *here* to download the full example code

3.2.4 Customizing Figure Layouts Using GridSpec and Other Functions

How to create grid-shaped combinations of axes.

subplots() Perhaps the primary function used to create figures and axes. It's also similar to *subplot()*, but creates and places all axes on the figure at once.

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 *subplot()*, but uses 0-based indexing and let subplot to occupy multiple cells. This function is not covered in this tutorial.

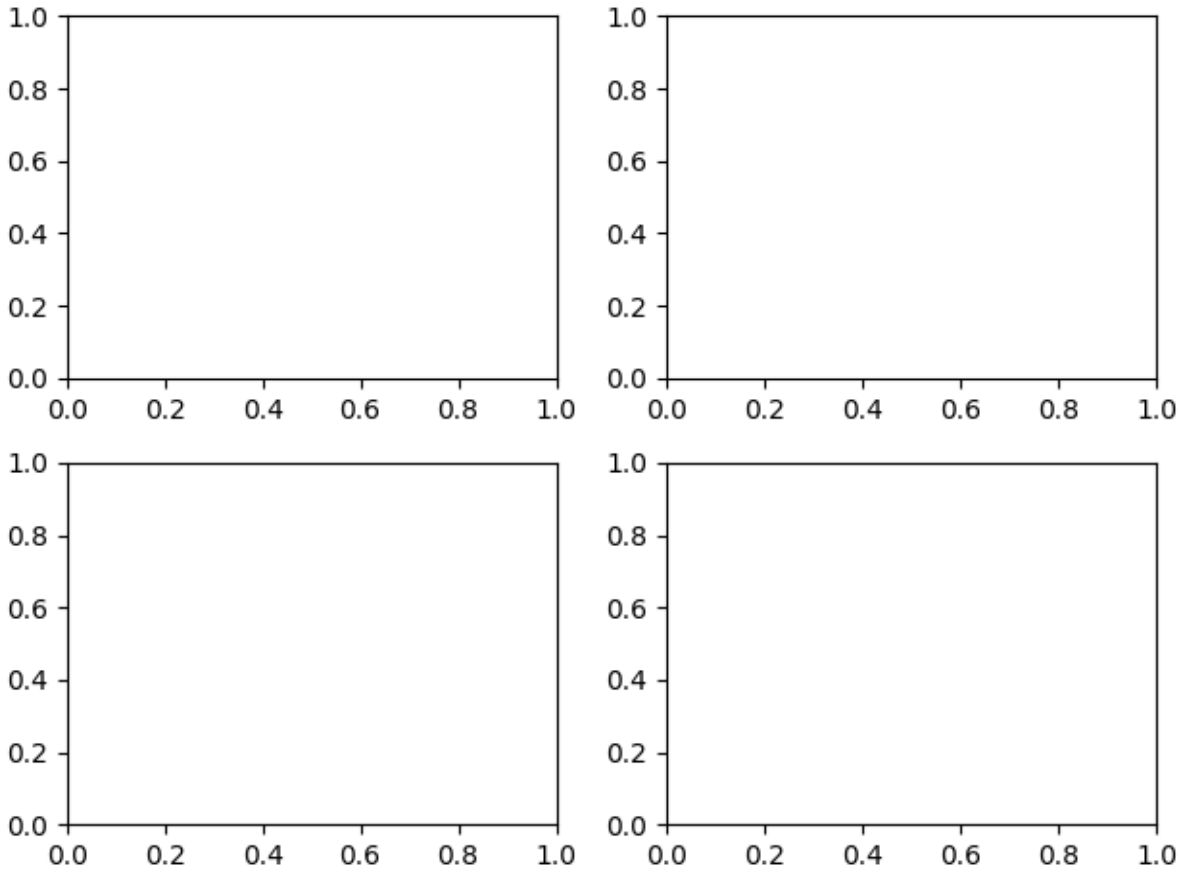
```
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
```

Basic Quickstart Guide

These first two examples show how to create a basic 4-by-4 grid using both *subplots()* and *gridspec*.

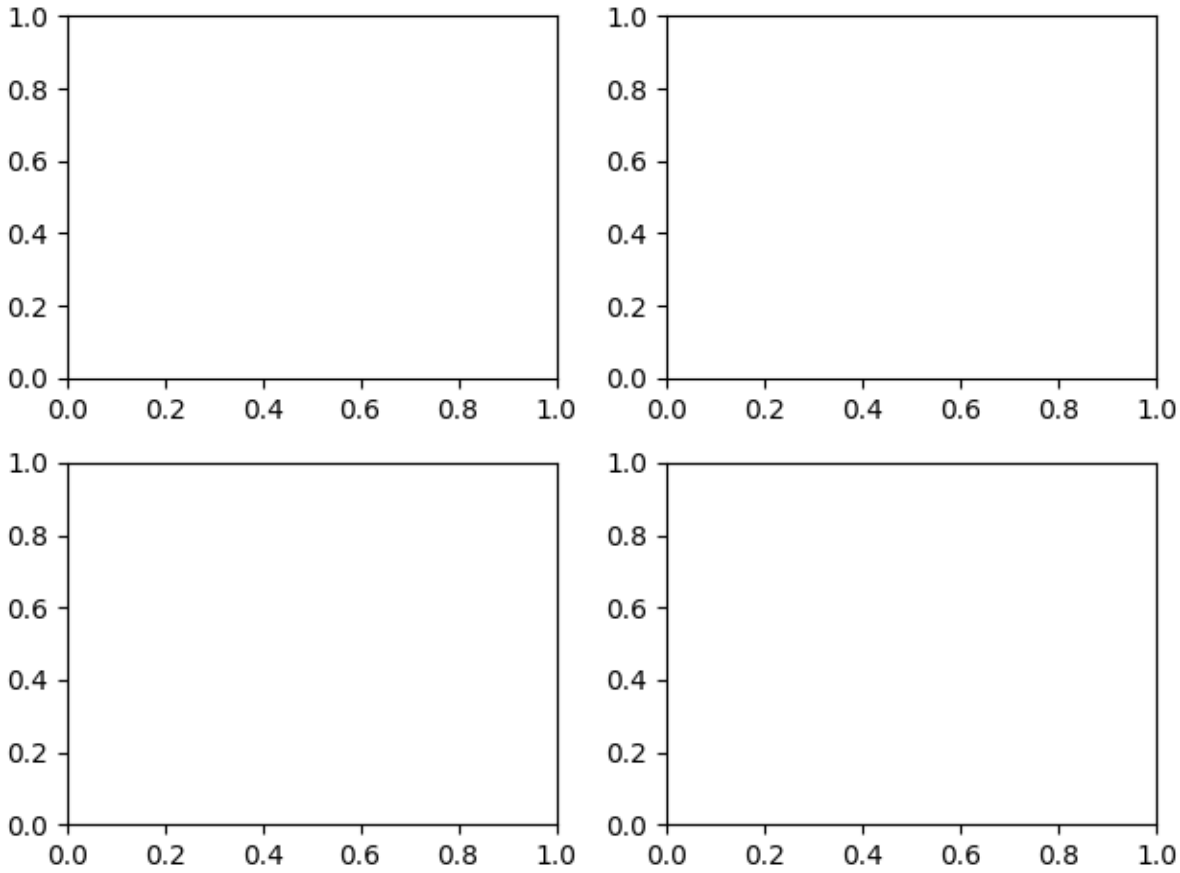
Using *subplots()* is quite simple. It returns a *Figure* instance and an array of *Axes* objects.

```
fig1, f1_axes = plt.subplots(ncols=2, nrows=2)
fig1.tight_layout()
```



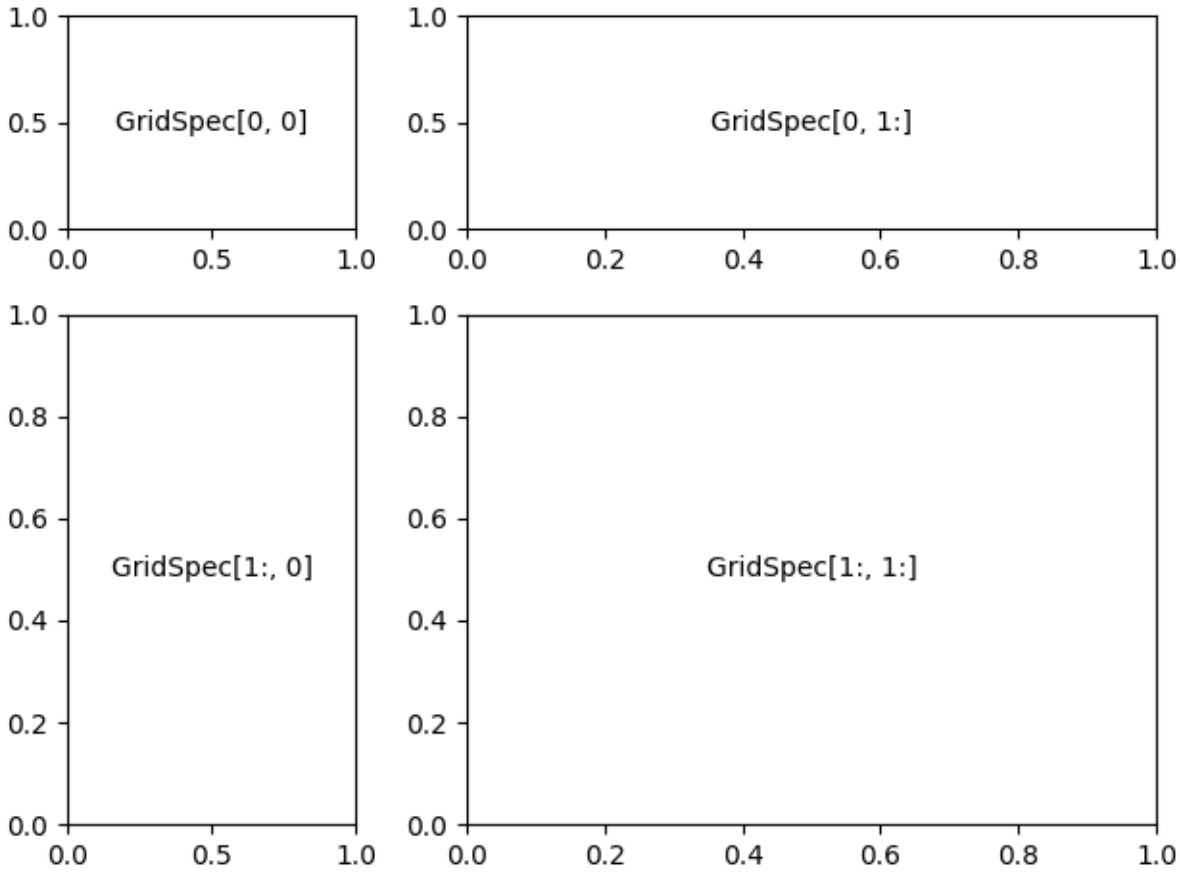
For a simple use case such as this, *gridspec* is perhaps overly verbose. You have to create the figure and *GridSpec* instance separately, then pass elements of gridspec instance to the *add_subplot()* method to create the axes objects. The elements of the gridspec are accessed in generally the same manner as numpy arrays.

```
fig2 = plt.figure()
spec2 = gridspec.GridSpec(ncols=2, nrows=2)
f2_ax1 = fig2.add_subplot(spec2[0, 0])
f2_ax2 = fig2.add_subplot(spec2[0, 1])
f2_ax3 = fig2.add_subplot(spec2[1, 0])
f2_ax4 = fig2.add_subplot(spec2[1, 1])
fig2.tight_layout()
```



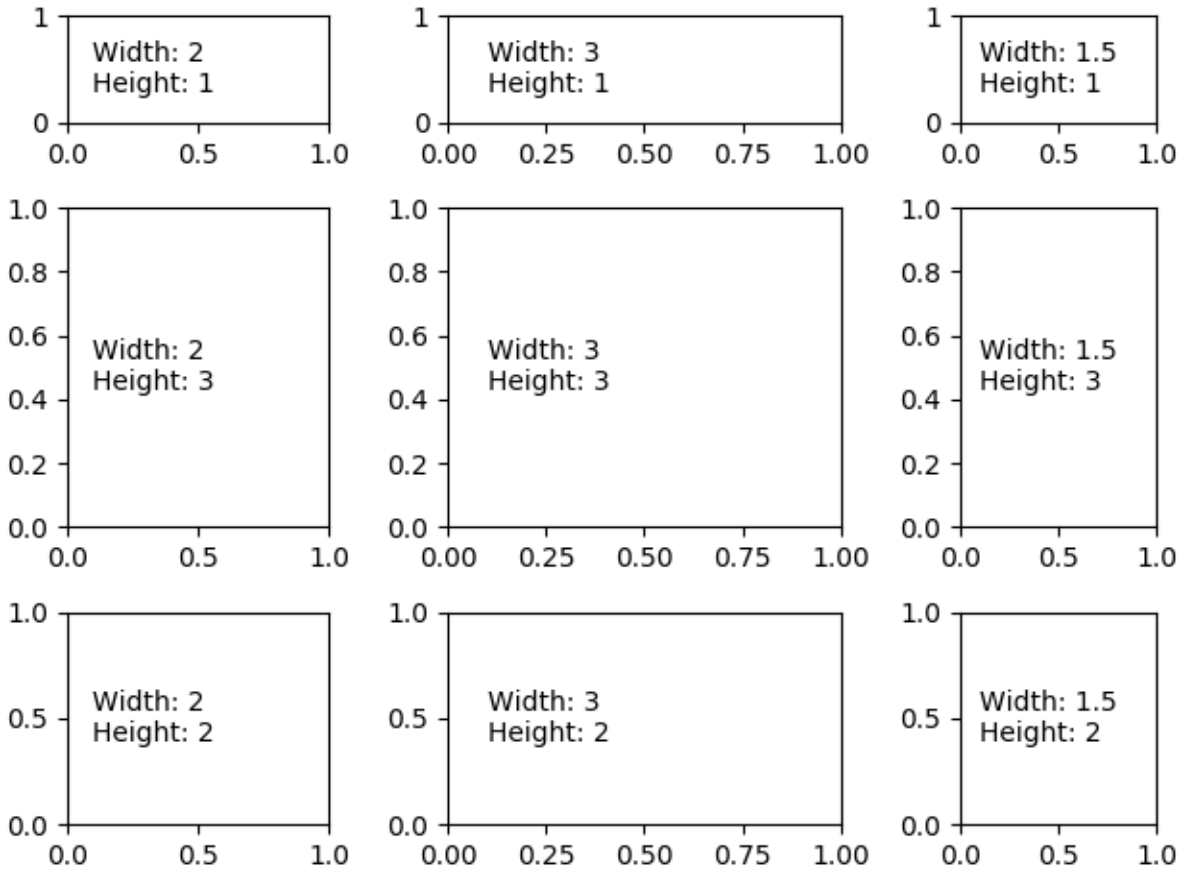
When you want to have subplots of different sizes, however, *gridspec* becomes indispensable and provides a couple of options. The method shown here initializes a uniform grid specification, and then uses typical numpy indexing and slices to allocate multiple "cells" for a given subplot.

```
fig3 = plt.figure()
spec3 = gridspec.GridSpec(ncols=3, nrows=3)
anno_opts = dict(xy=(0.5, 0.5), xycoords='axes fraction',
                 va='center', ha='center')

fig3.add_subplot(spec3[0, 0]).annotate('GridSpec[0, 0]', **anno_opts)
fig3.add_subplot(spec3[0, 1:]).annotate('GridSpec[0, 1:]', **anno_opts)
fig3.add_subplot(spec3[1:, 0]).annotate('GridSpec[1:, 0]', **anno_opts)
fig3.add_subplot(spec3[1:, 1:]).annotate('GridSpec[1:, 1:]', **anno_opts)

fig3.tight_layout()
```



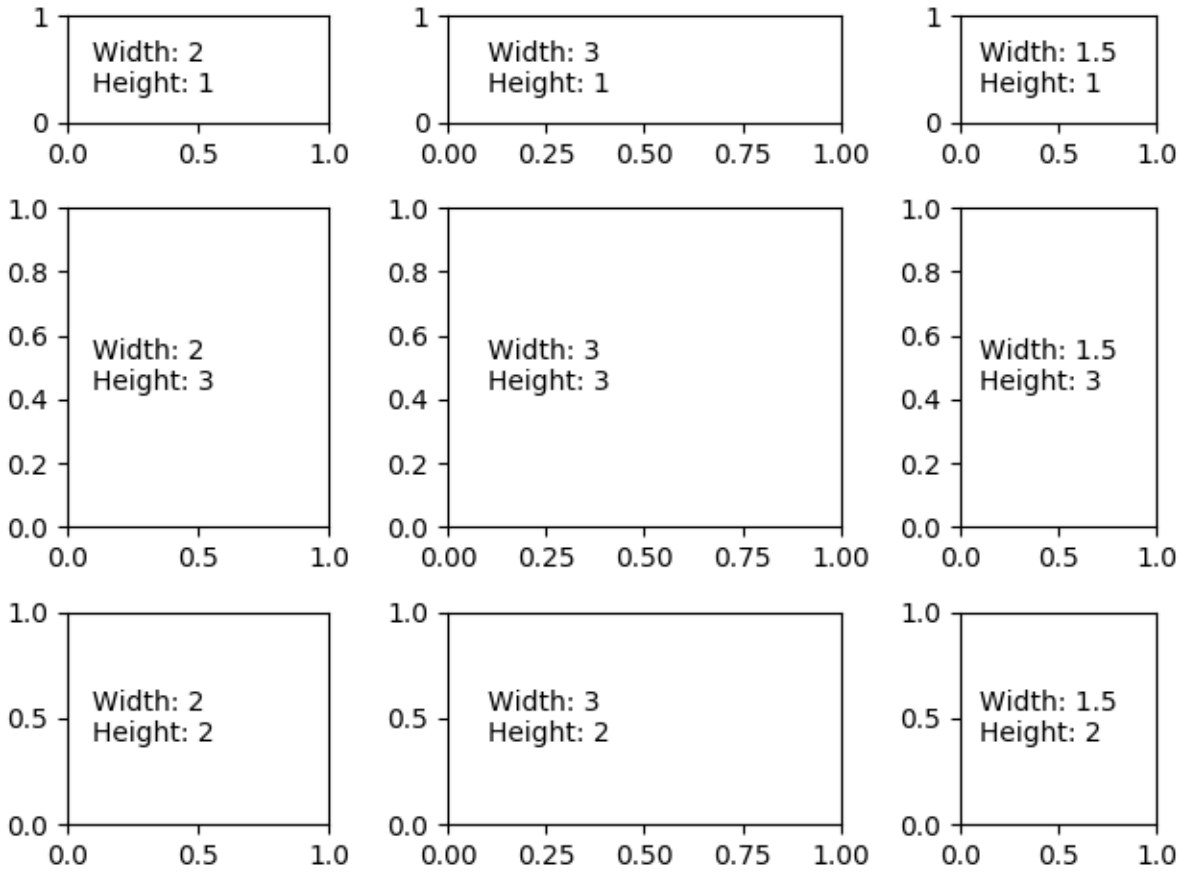
Other option is to use the `width_ratios` and `height_ratios` parameters. These keyword arguments are lists of numbers. Note that absolute values are meaningless, only their relative ratios matter. That means that `width_ratios=[2, 4, 8]` is equivalent to `width_ratios=[1, 2, 4]` within equally wide figures. For the sake of demonstration, we'll blindly create the axes within `for` loops since we won't need them later.

```
fig4 = plt.figure()
widths = [2, 3, 1.5]
heights = [1, 3, 2]
spec4 = gridspec.GridSpec(ncols=3, nrows=3, width_ratios=widths,
                          height_ratios=heights)
for row in range(3):
    for col in range(3):
        ax = fig4.add_subplot(spec4[row, col])
        label = 'Width: {}\nHeight: {}'.format(widths[col], heights[row])
        ax.annotate(label, (0.1, 0.5), xycoords='axes fraction', va='center')

fig4.tight_layout()
```



Learning to use `width_ratios` and `height_ratios` is particularly useful since the top-level function *subplots()* accepts them within the `gridspec_kw` parameter. For that matter, any parameter accepted by *GridSpec* can be passed to *subplots()* via the `gridspec_kw` parameter. This example recreates the previous figure without directly using a gridspec instance.

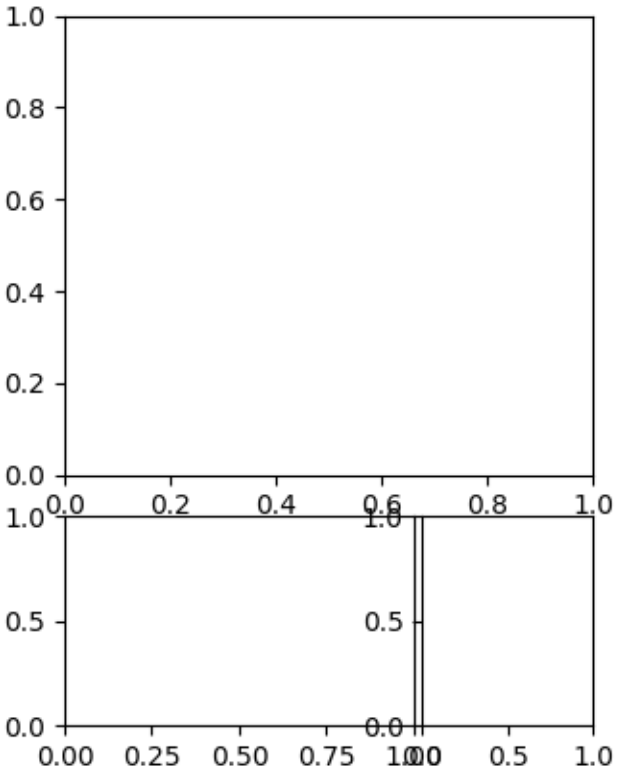
```
gs_kw = dict(width_ratios=widths, height_ratios=heights)
fig5, f5_axes = plt.subplots(ncols=3, nrows=3, gridspec_kw=gs_kw)
for r, row in enumerate(f5_axes):
    for c, ax in enumerate(row):
        label = 'Width: {}\nHeight: {}'.format(widths[c], heights[r])
        ax.annotate(label, (0.1, 0.5), xycoords='axes fraction', va='center')

fig5.tight_layout()
```



Fine Adjustments to a Gridspec Layout

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

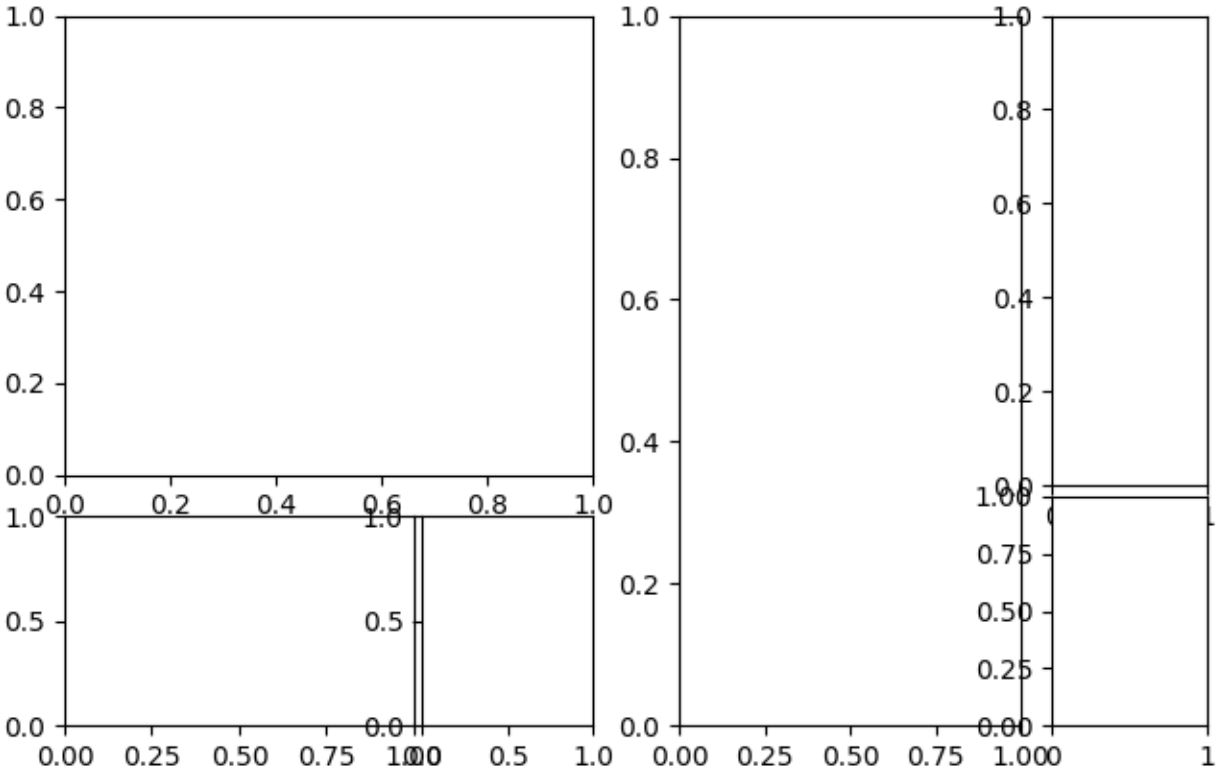
```
fig = plt.figure()
gs1 = gridspec.GridSpec(nrows=3, ncols=3, left=0.05, right=0.48, wspace=0.05)
ax1 = fig.add_subplot(gs1[:-1, :])
ax2 = fig.add_subplot(gs1[-1, :-1])
ax3 = fig.add_subplot(gs1[-1, -1])
```



This is similar to *subplots_adjust()*, but it only affects the subplots that are created from the given GridSpec.

For example, compare the left and right sides of this figure:

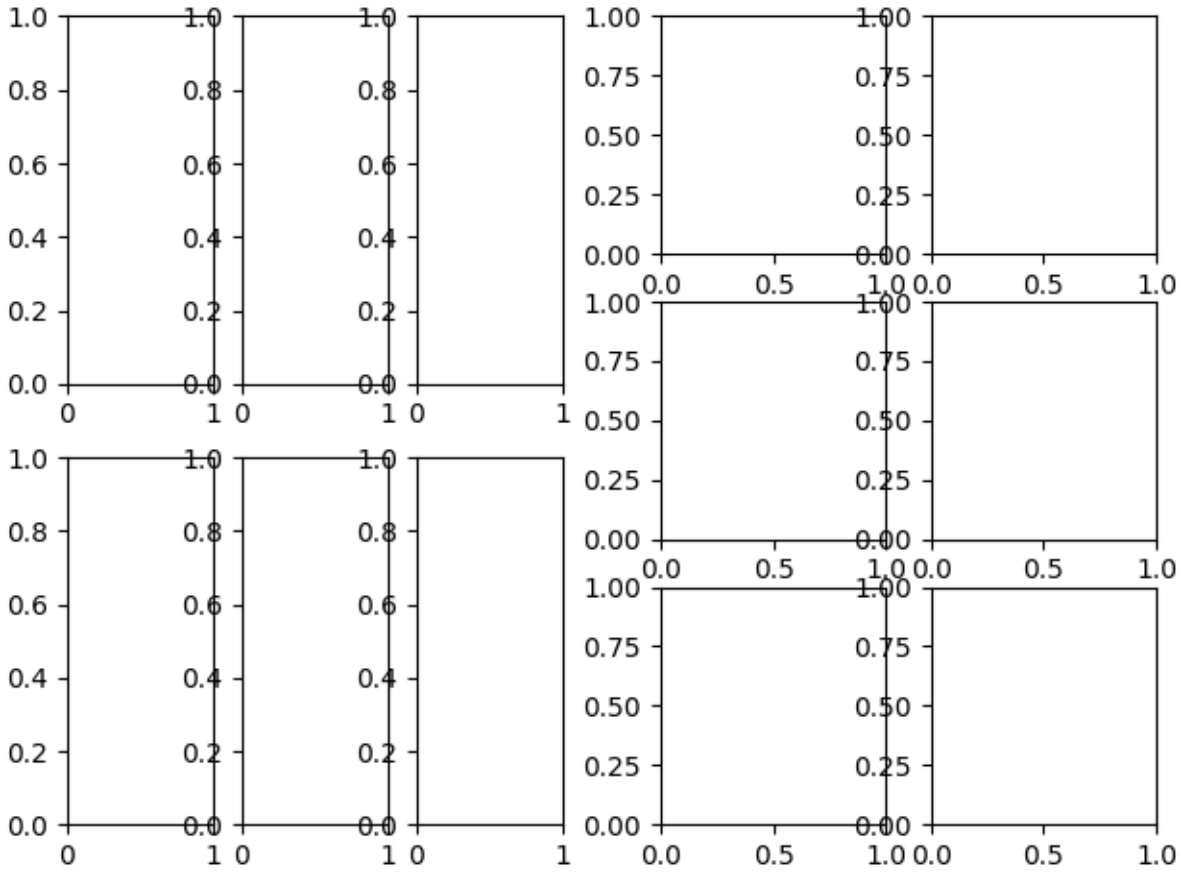
```
fig = plt.figure()
gs1 = gridspec.GridSpec(nrows=3, ncols=3, left=0.05, right=0.48,
                        wspace=0.05)
ax1 = fig.add_subplot(gs1[:-1, :])
ax2 = fig.add_subplot(gs1[-1, :-1])
ax3 = fig.add_subplot(gs1[-1, -1])


gs2 = gridspec.GridSpec(nrows=3, ncols=3, left=0.55, right=0.98,
                        hspace=0.05)
ax4 = fig.add_subplot(gs2[:, :-1])
ax5 = fig.add_subplot(gs2[:-1, -1])
ax6 = fig.add_subplot(gs2[-1, -1])
```



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.

```
fig = plt.figure()
gs0 = gridspec.GridSpec(1, 2)

gs00 = gridspec.GridSpecFromSubplotSpec(2, 3, subplot_spec=gs0[0])
gs01 = gridspec.GridSpecFromSubplotSpec(3, 2, subplot_spec=gs0[1])

for a in range(2):
    for b in range(3):
        fig.add_subplot(gs00[a, b])
        fig.add_subplot(gs01[b, a])

fig.tight_layout()
```



A Complex Nested GridSpec using SubplotSpec

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

```
import numpy as np
from itertools import product


def squiggle_xy(a, b, c, d, i=np.arange(0.0, 2*np.pi, 0.05)):
    return np.sin(i*a)*np.cos(i*b), np.sin(i*c)*np.cos(i*d)

fig = plt.figure(figsize=(8, 8))

# gridspec inside gridspec
outer_grid = gridspec.GridSpec(4, 4, wspace=0.0, hspace=0.0)

for i in range(16):
    inner_grid = gridspec.GridSpecFromSubplotSpec(
      3, 3, subplot_spec=outer_grid[i], wspace=0.0, hspace=0.0)
    a, b = int(i/4)+1, i % 4+1
    for j, (c, d) in enumerate(product(range(1, 4), repeat=2)):
```

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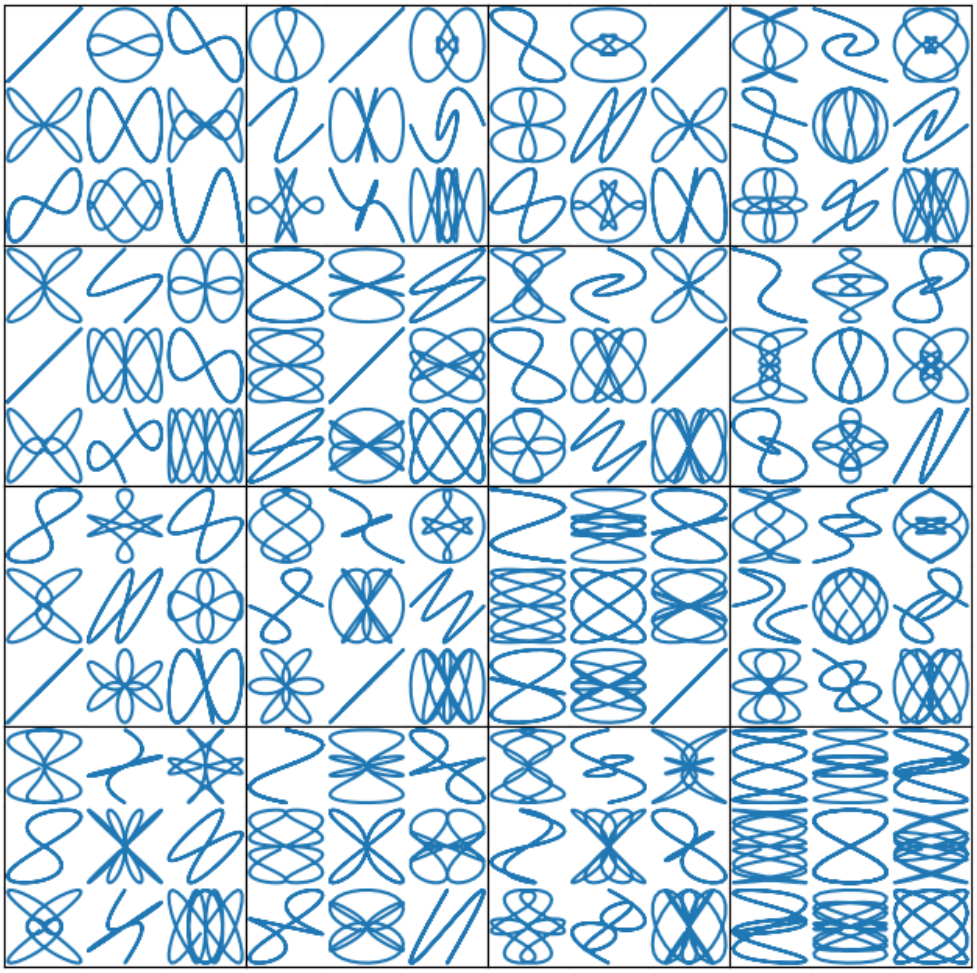
```
        ax = plt.Subplot(fig, inner_grid[j])
        ax.plot(*squiggle_xy(a, b, c, d))
        ax.set_xticks([])
        ax.set_yticks([])
        fig.add_subplot(ax)

all_axes = fig.get_axes()

# show only the outside spines
for ax in all_axes:
    for sp in ax.spines.values():
        sp.set_visible(False)
    if ax.is_first_row():
        ax.spines['top'].set_visible(True)
    if ax.is_last_row():
        ax.spines['bottom'].set_visible(True)
    if ax.is_first_col():
        ax.spines['left'].set_visible(True)
    if ax.is_last_col():
        ax.spines['right'].set_visible(True)

plt.show()
```



Total running time of the script: (0 minutes 1.877 seconds)

Note: Click *here* to download the full example code

3.2.5 Tight Layout guide

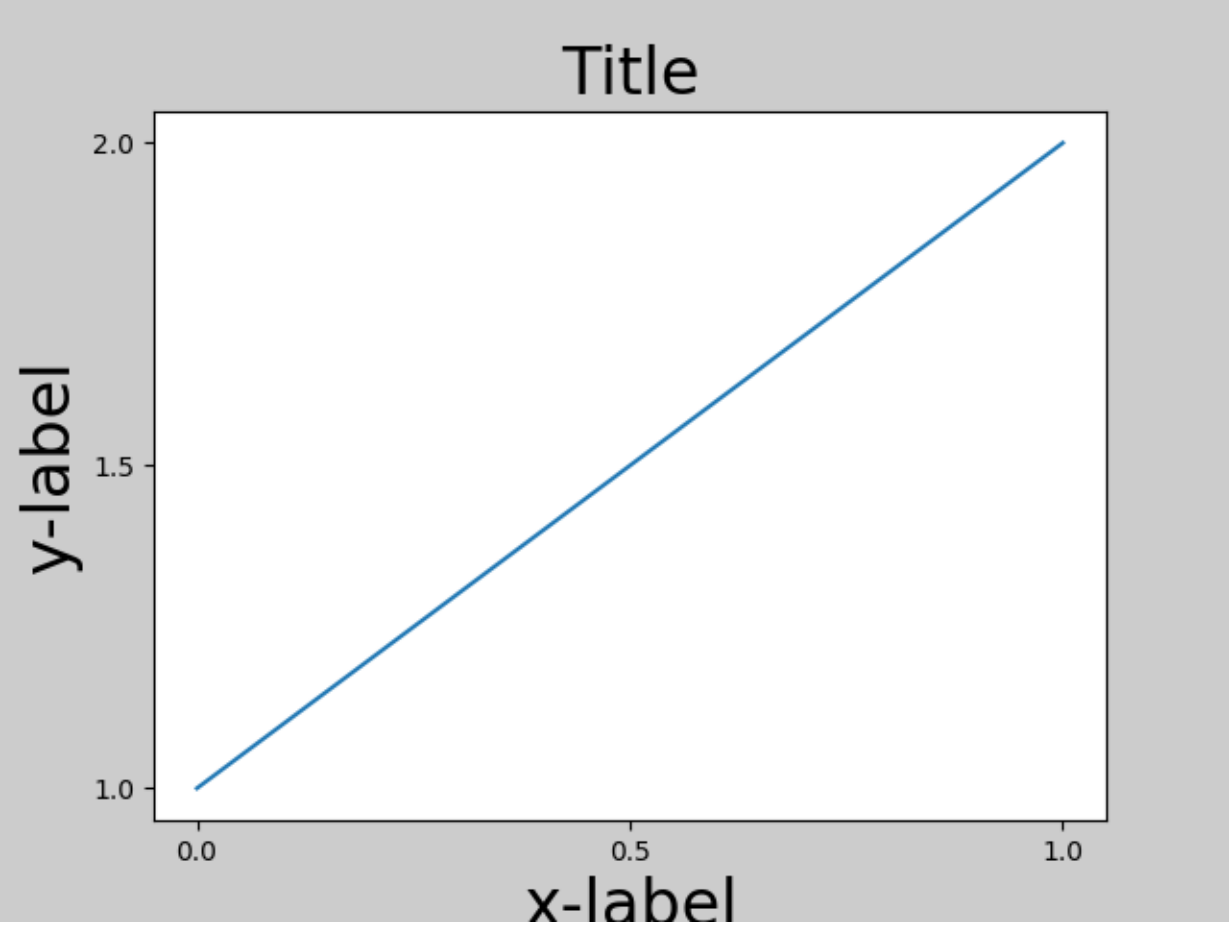
How to use tight-layout to fit plots within your figure cleanly.

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

Simple Example

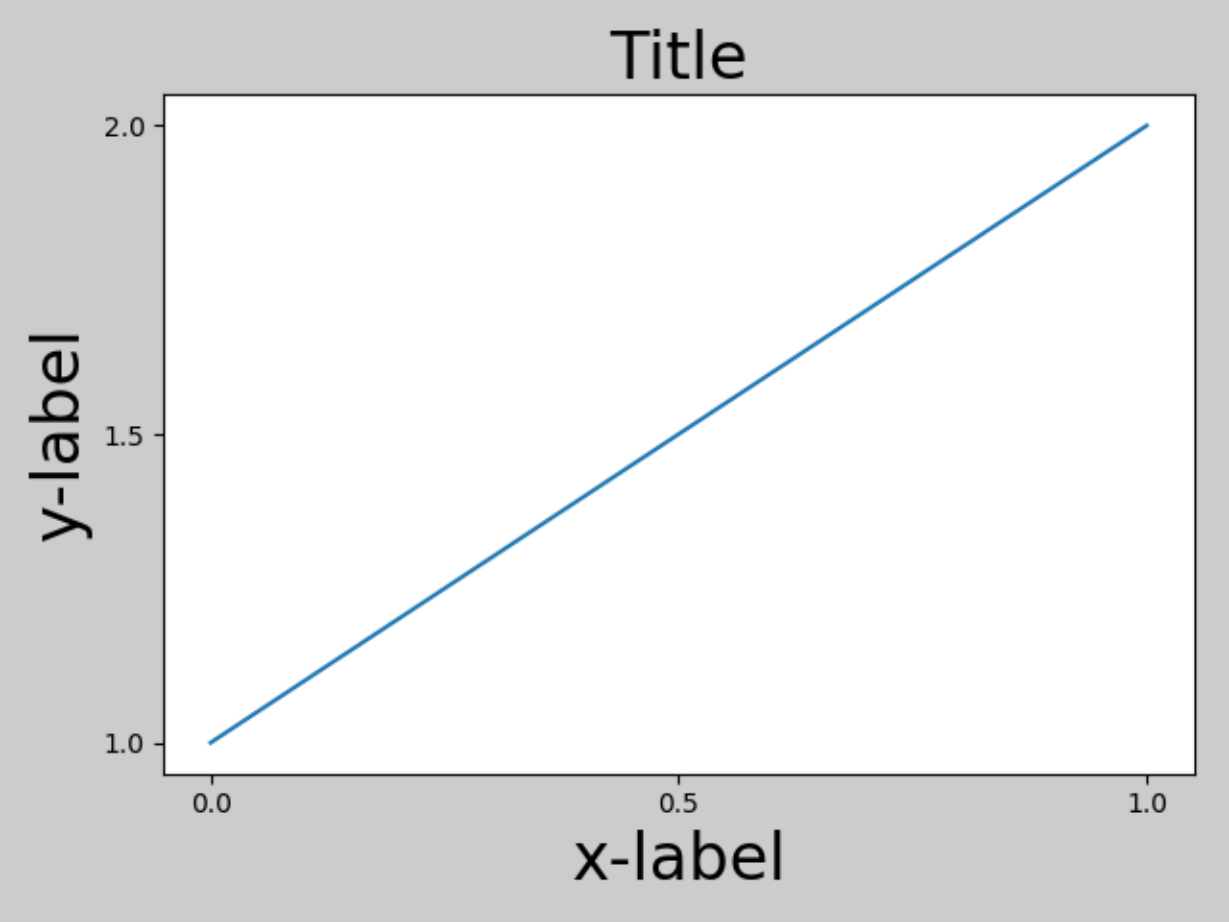
In matplotlib, the location of axes (including subplots) are specified in normalized figure coordinates. It can happen that your axis labels or titles (or sometimes even ticklabels) go outside the figure area, and are thus clipped.

```
# sphinx_gallery_thumbnail_number = 7

import matplotlib.pyplot as plt
import numpy as np

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


def example_plot(ax, fontsize=12):
    ax.plot([1, 2])

    ax.locator_params(nbins=3)
    ax.set_xlabel('x-label', fontsize=fontsize)
    ax.set_ylabel('y-label', fontsize=fontsize)
    ax.set_title('Title', fontsize=fontsize)

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



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

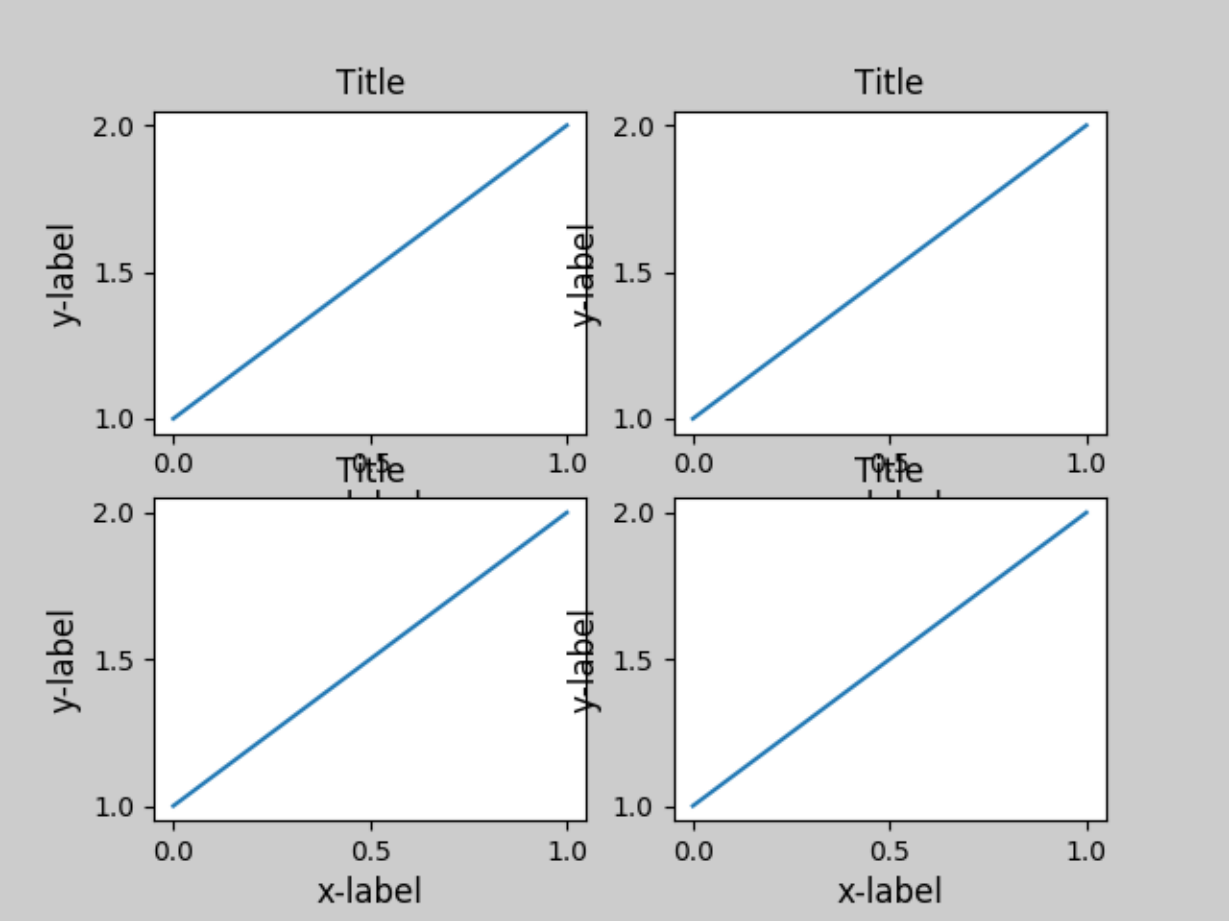
```
fig, ax = plt.subplots()
example_plot(ax, fontsize=24)
plt.tight_layout()
```



Note that *matplotlib.pyplot.tight_layout()* will only adjust the subplot params when it is called. In order to perform this adjustment each time the figure is redrawn, you can call `fig.set_tight_layout(True)`, or, equivalently, set the `figure.autolayout` rcParam to `True`.

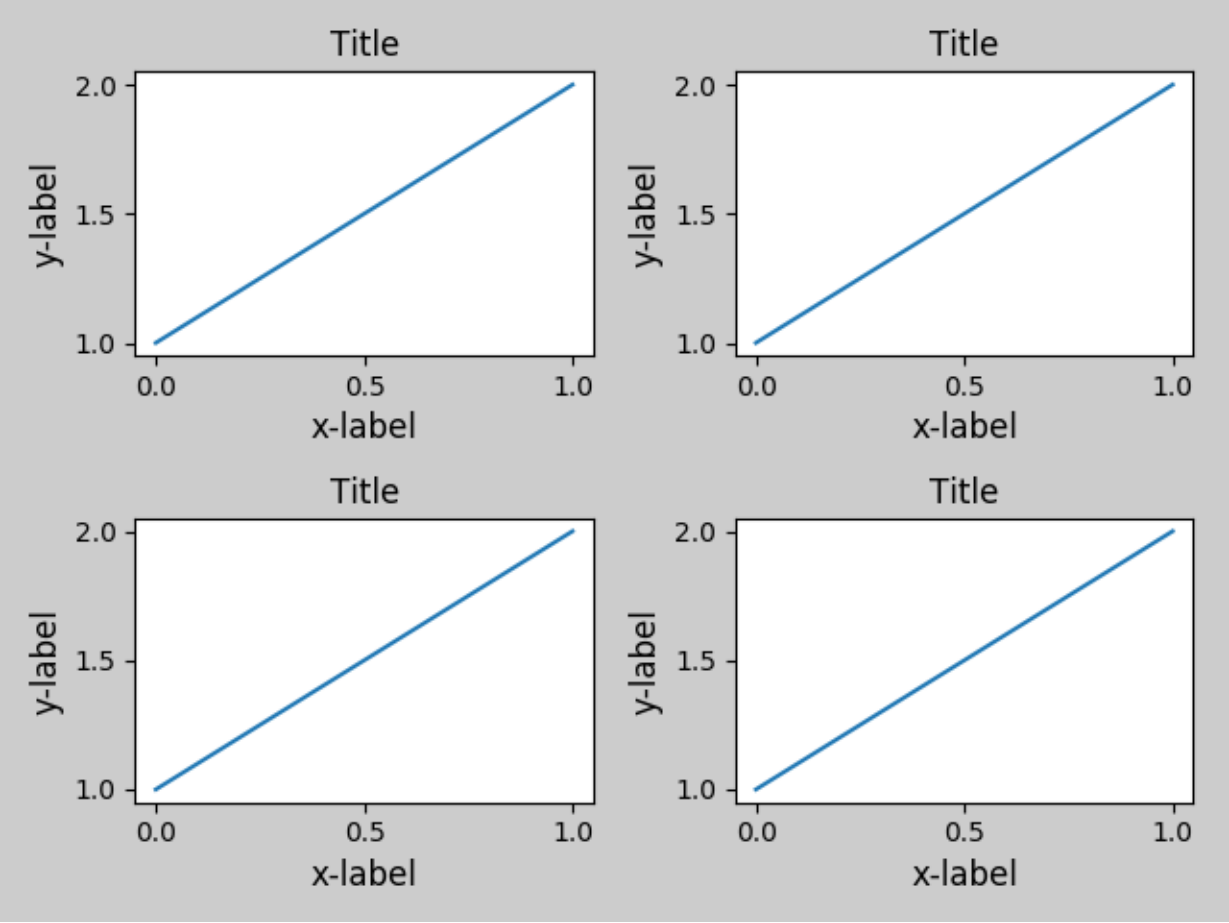
When you have multiple subplots, often you see labels of different axes overlapping each other.

```
plt.close('all')

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



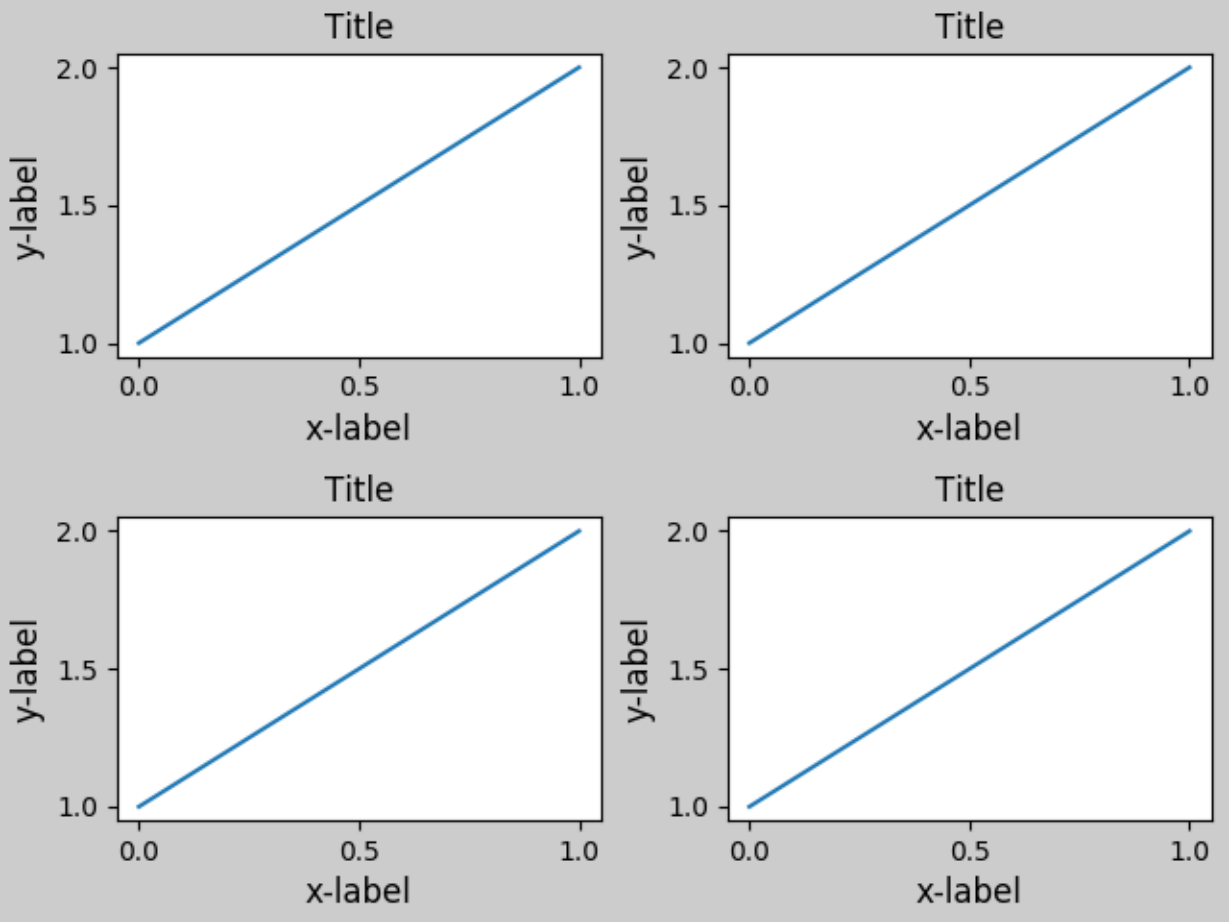
tight_layout() will also adjust spacing between subplots to minimize the overlaps.

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



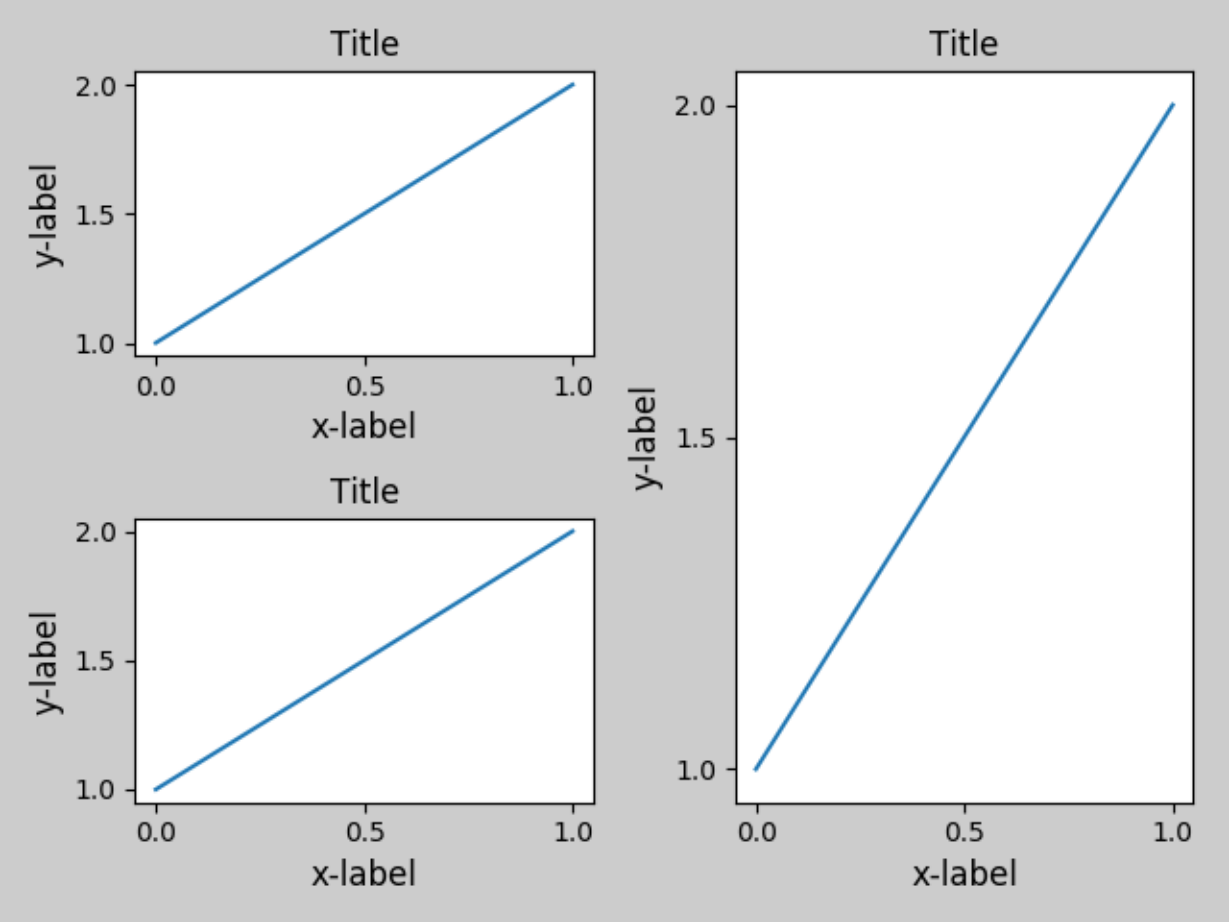
tight_layout() can take keyword arguments of *pad*, *w_pad* and *h_pad*. These control the extra padding around the figure border and between subplots. The pads are specified in fraction of fontsize.

```
fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(nrows=2, ncols=2)
example_plot(ax1)
example_plot(ax2)
example_plot(ax3)
example_plot(ax4)
plt.tight_layout(pad=0.4, w_pad=0.5, h_pad=1.0)
```



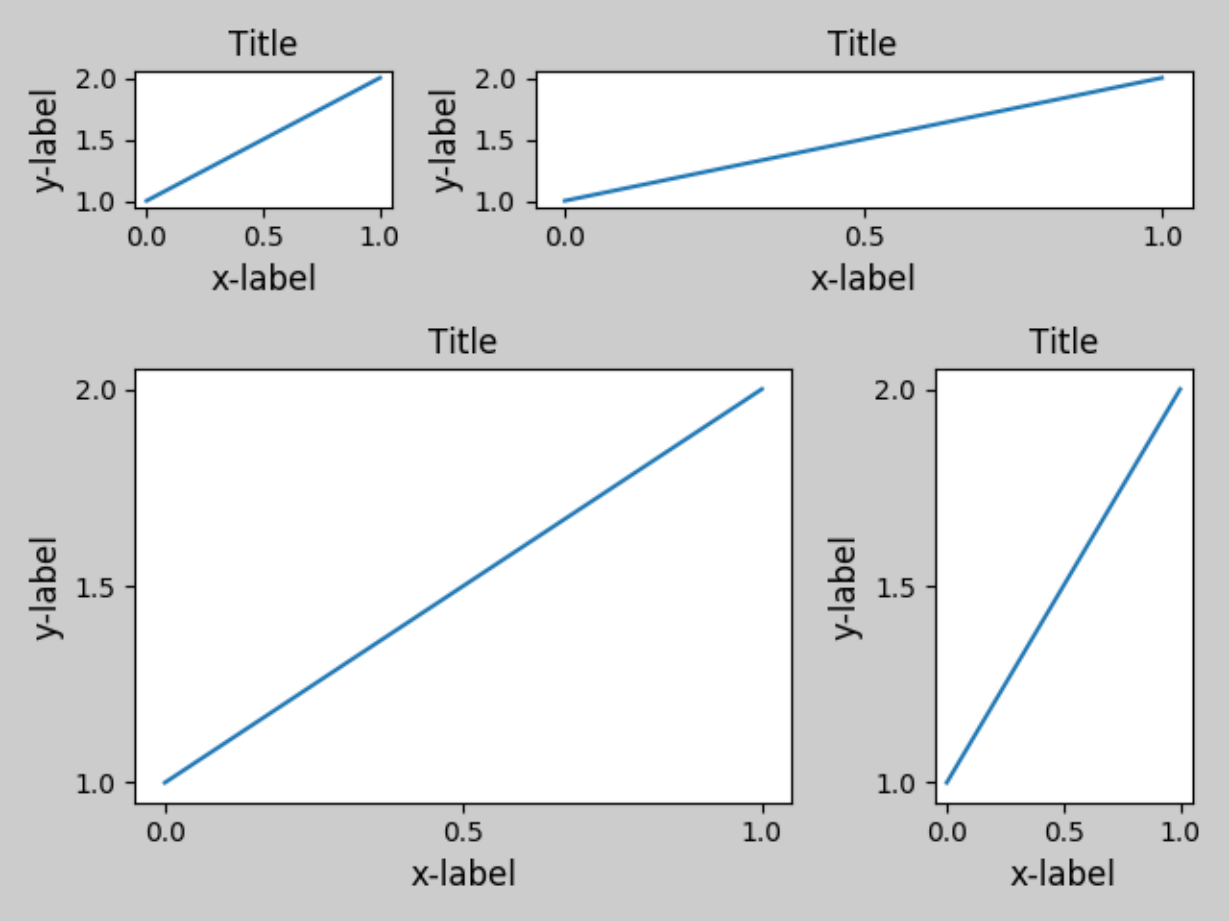
tight_layout() will work even if the sizes of subplots are different as far as their grid specification is compatible. In the example below, *ax1* and *ax2* are subplots of a 2x2 grid, while *ax3* is of a 1x2 grid.

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

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

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

plt.tight_layout()
```



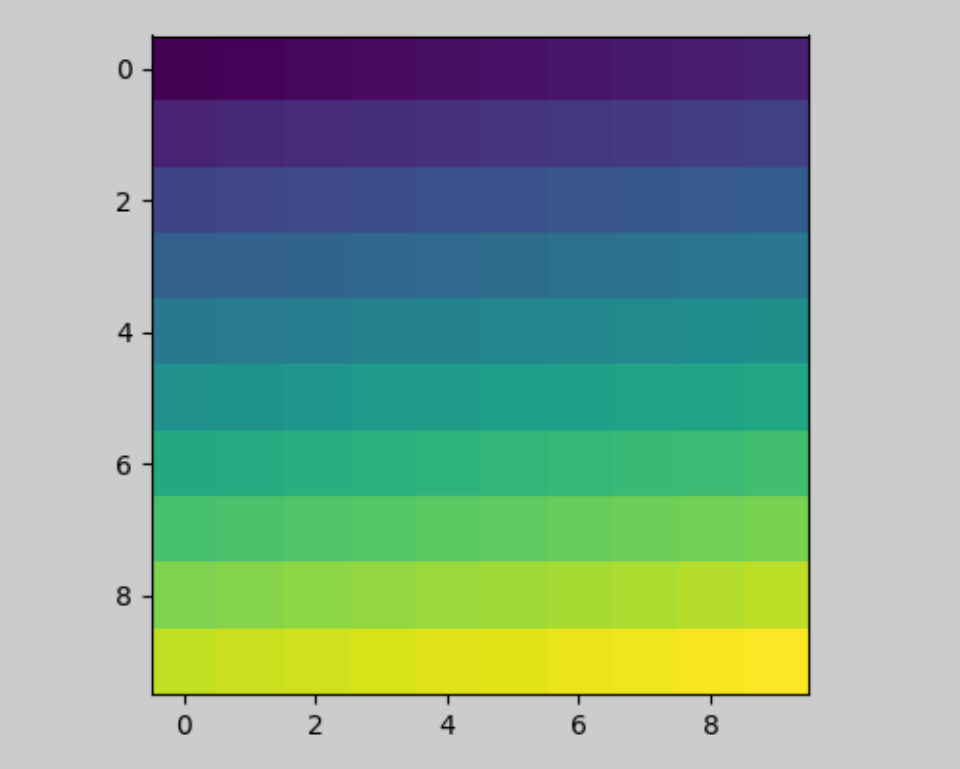
It works with subplots created with *subplot2grid()*. In general, subplots created from the gridspec (*Customizing Figure Layouts Using GridSpec and Other Functions*) will work.

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

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

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

plt.tight_layout()
```



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

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

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

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

plt.tight_layout()
```



Caveats

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

Use with GridSpec

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

```
import matplotlib.gridspec as gridspec

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

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

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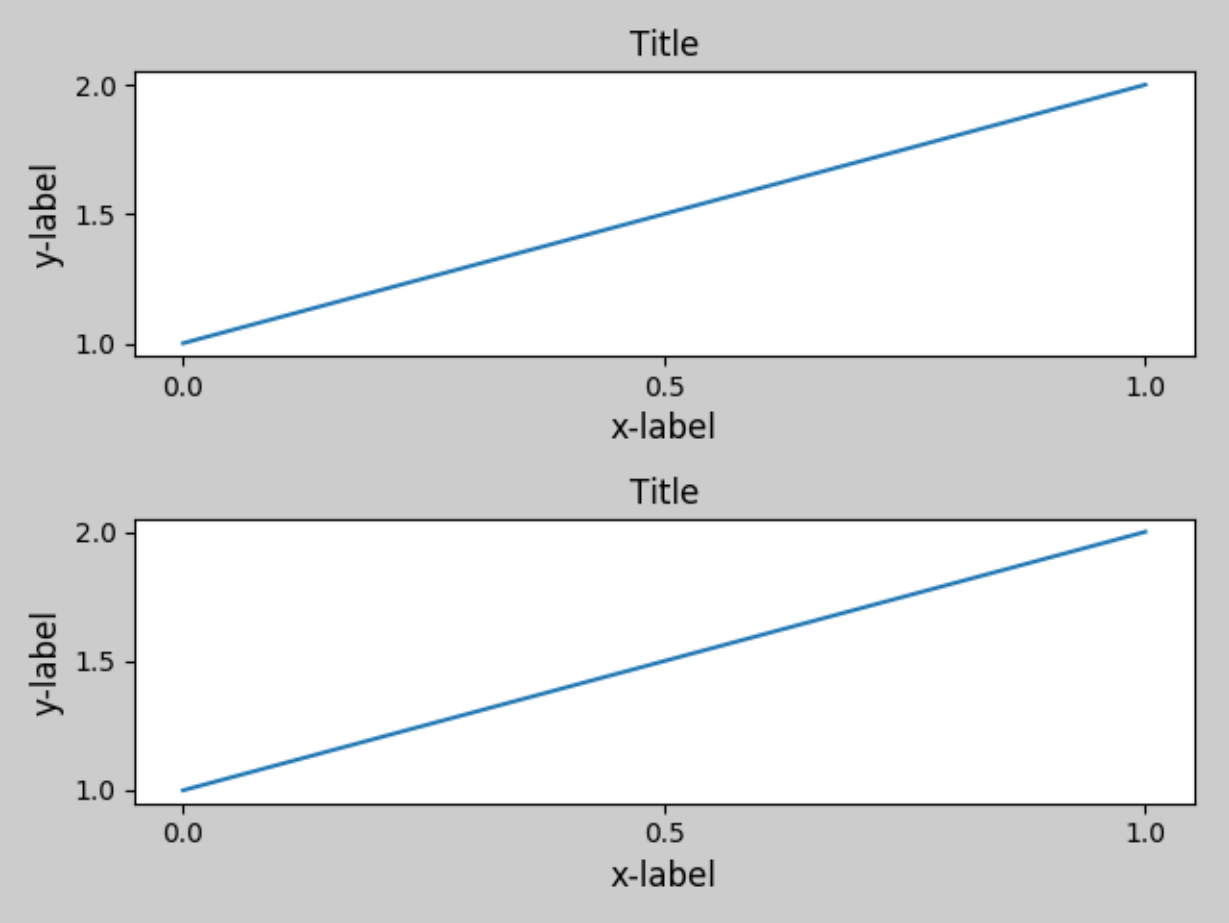
```
example_plot(ax1)
example_plot(ax2)

gs1.tight_layout(fig)
```



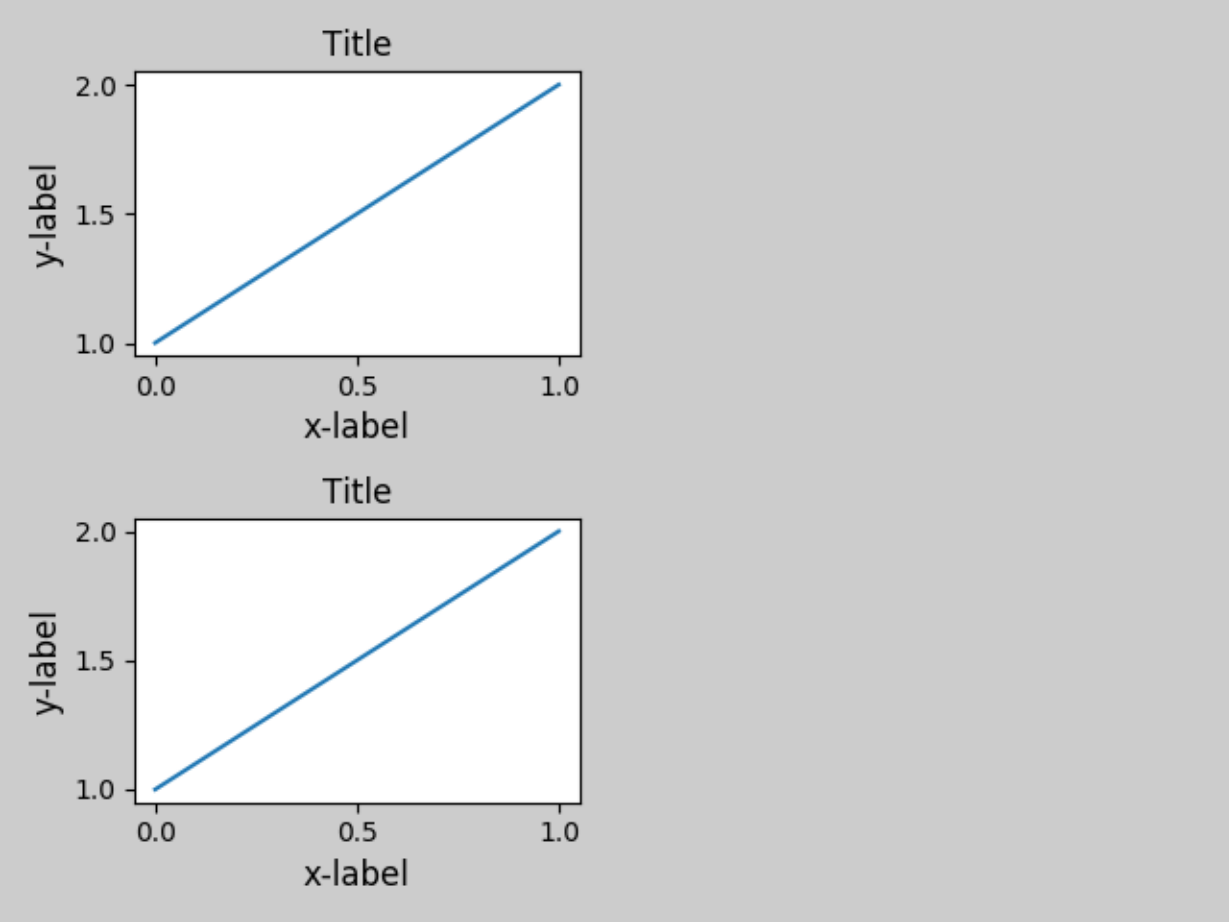
You may provide an optional *rect* parameter, which specifies the bounding box that the subplots will be fit inside. The coordinates must be in normalized figure coordinates and the default is (0, 0, 1, 1).

```
fig = plt.figure()

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

example_plot(ax1)
example_plot(ax2)

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



For example, this can be used for a figure with multiple gridspecs.

```
fig = plt.figure()

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

example_plot(ax1)
example_plot(ax2)

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

gs2 = gridspec.GridSpec(3, 1)

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

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

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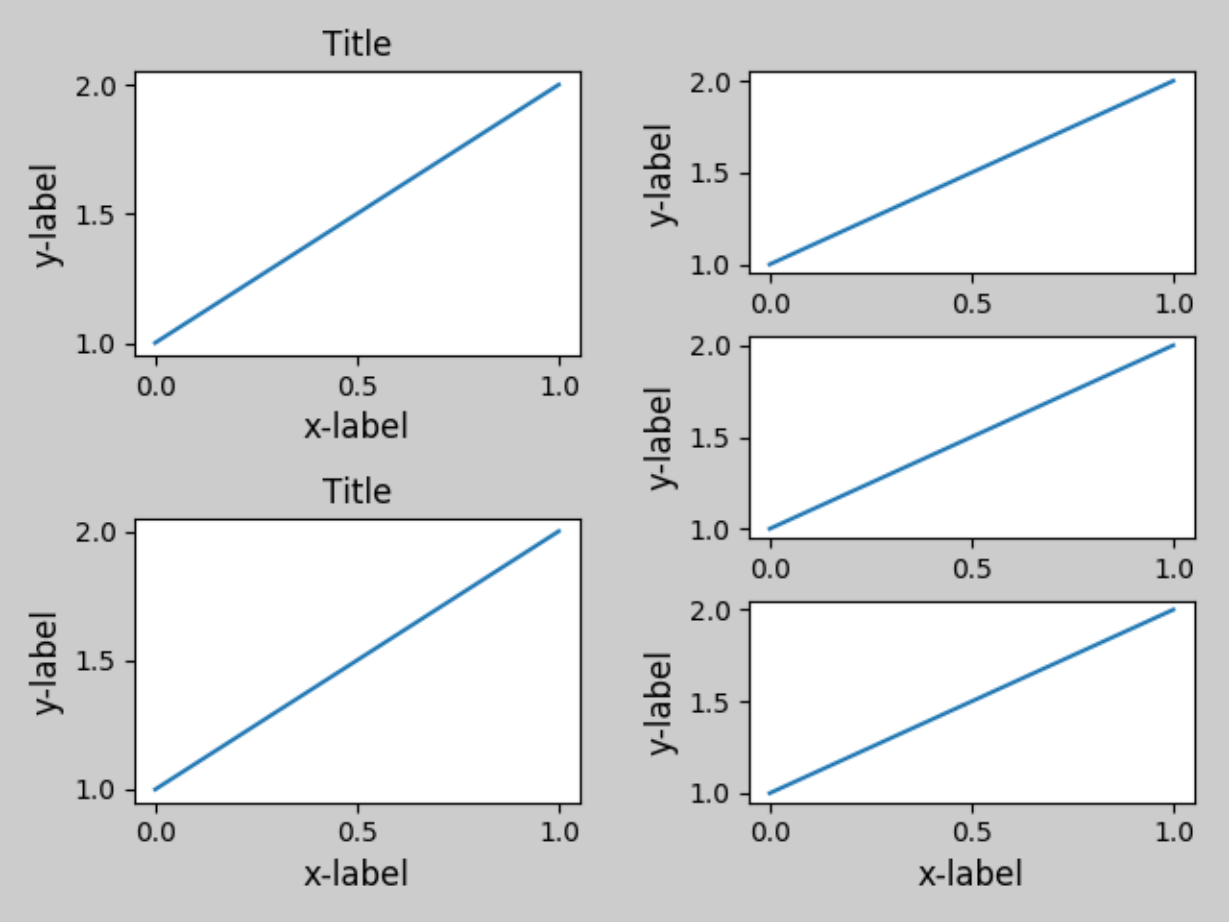
```
gs2.tight_layout(fig, rect=[0.5, 0, 1, 1], h_pad=0.5)

# We may try to match the top and bottom of two grids ::
top = min(gs1.top, gs2.top)
bottom = max(gs1.bottom, gs2.bottom)

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



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

```
fig = plt.gcf()

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

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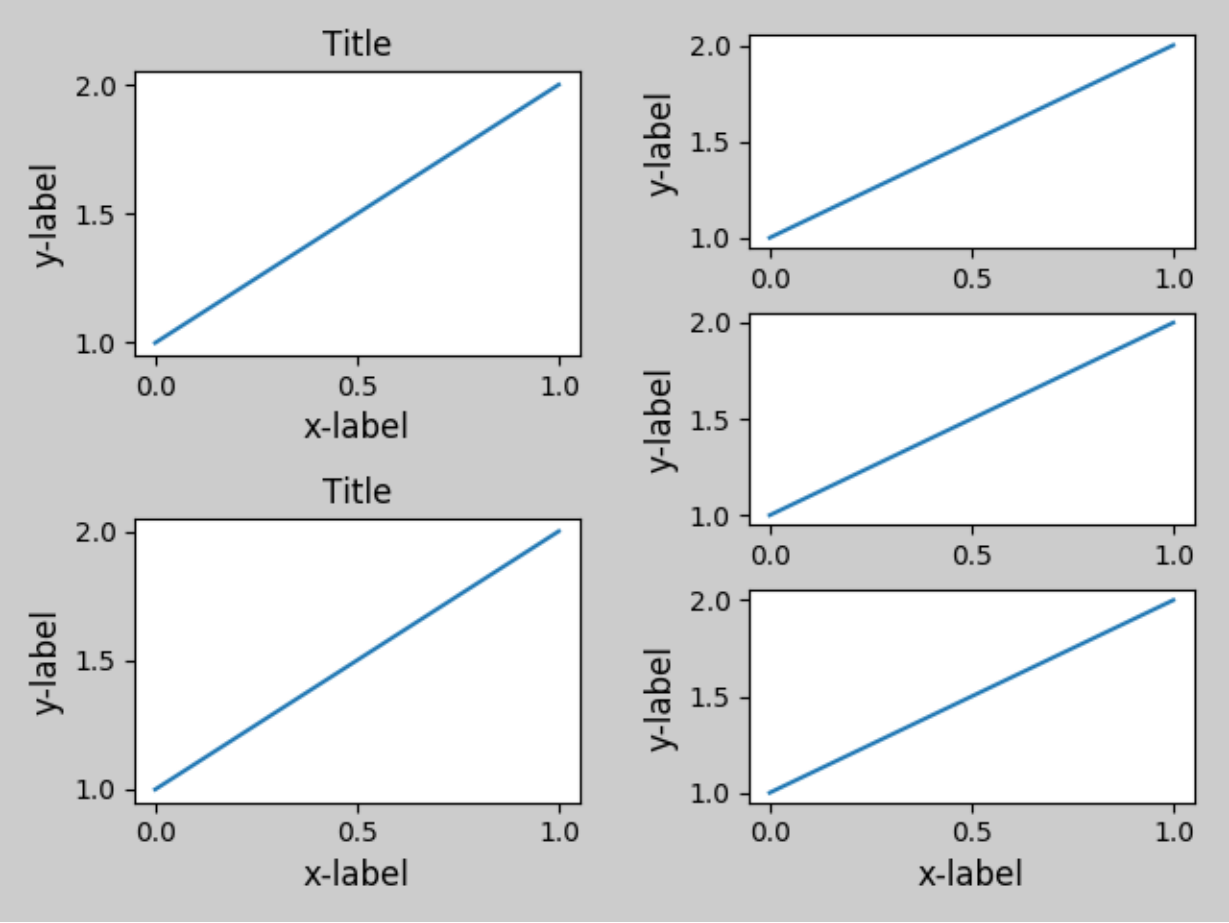
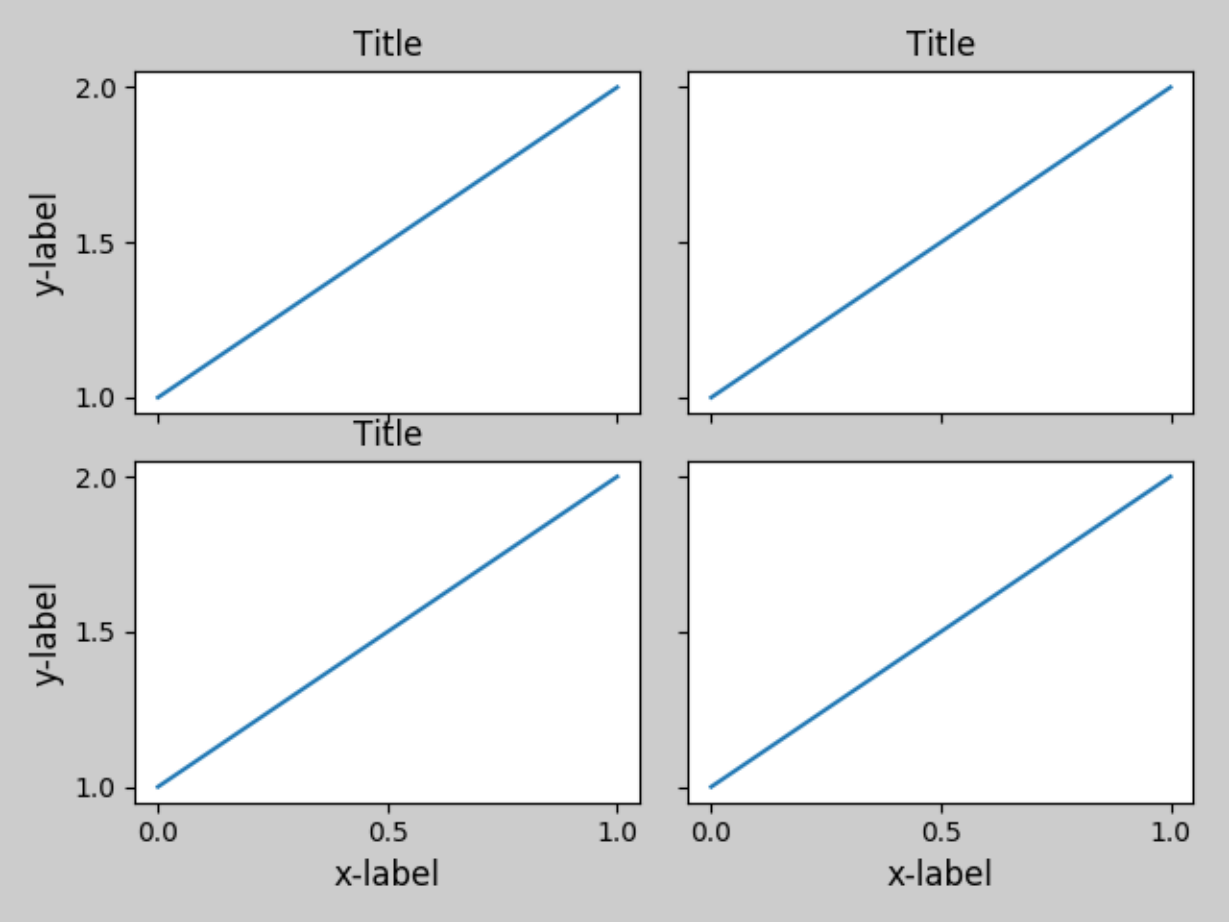
```
example_plot(ax1)
example_plot(ax2)

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

gs2 = gridspec.GridSpec(3, 1)

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

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

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

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

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

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

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



Use with AxesGrid1

While limited, the axes_grid1 toolkit is also supported.

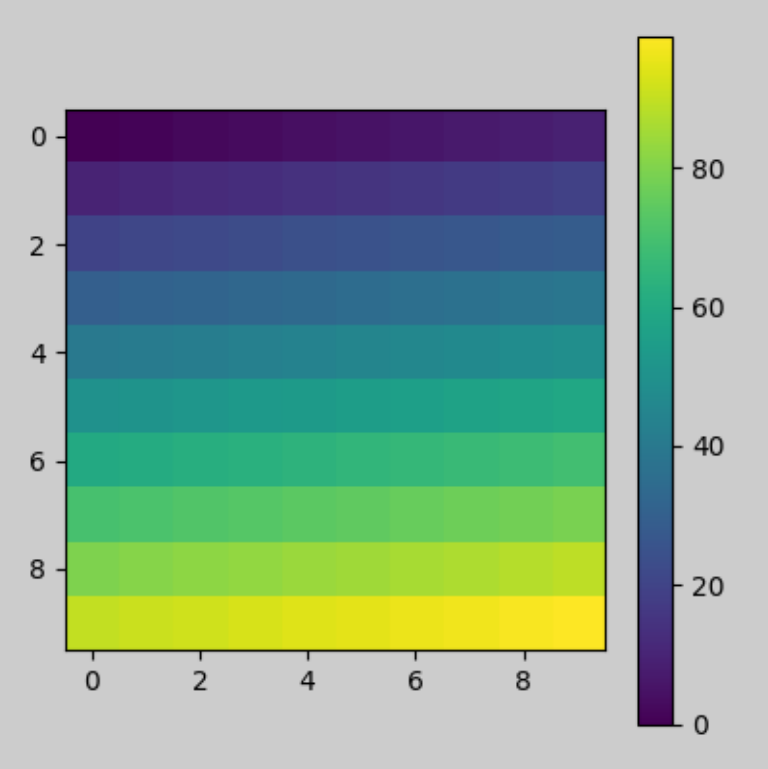
```
from mpl_toolkits.axes_grid1 import Grid

plt.close('all')
fig = plt.figure()
grid = Grid(fig, rect=111, nrows_ncols=(2, 2),
            axes_pad=0.25, label_mode='L',
            )

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

plt.tight_layout()
```



Colorbar

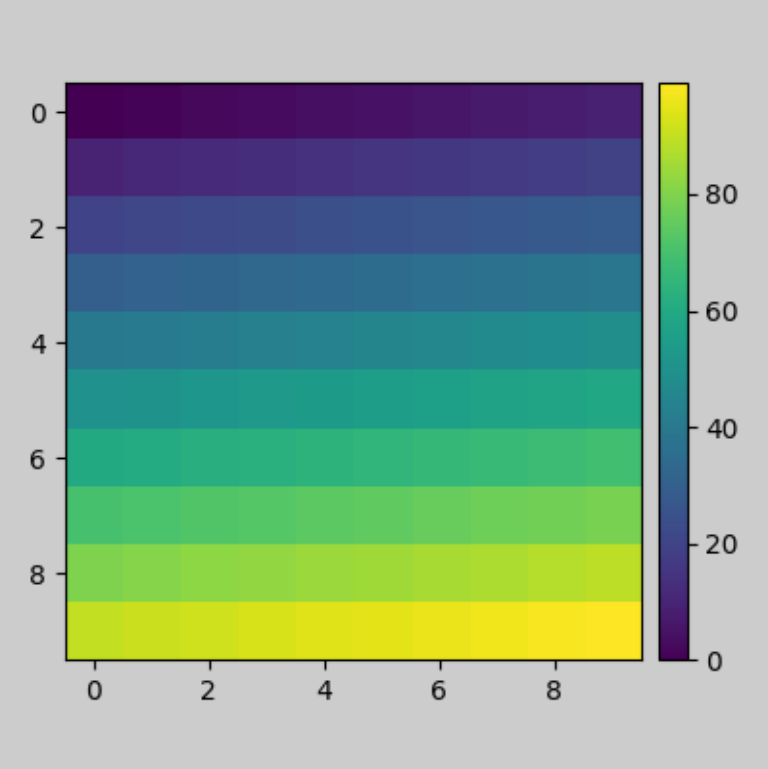
If you create a colorbar with the *colorbar()* command, the created colorbar is an instance of Axes, *not* Subplot, so tight_layout does not work. With Matplotlib v1.1, you may create a colorbar as a subplot using the gridspec.

```
plt.close('all')
arr = np.arange(100).reshape((10, 10))
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

plt.colorbar(im, use_gridspec=True)

plt.tight_layout()
```



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

```
from mpl_toolkits.axes_grid1 import make_axes_locatable

plt.close('all')
arr = np.arange(100).reshape((10, 10))
fig = plt.figure(figsize=(4, 4))
im = plt.imshow(arr, interpolation="none")

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

plt.tight_layout()
```



Note: Click *here* to download the full example code

3.2.6 *origin* and *extent* in `imshow`

`imshow()` allows you to render an image (either a 2D array which will be color-mapped (based on *norm* and *cmap*) or and 3D RGB(A) array which will be used as-is) to a rectangular region in dataspace. The orientation of the image in the final rendering is controlled by the *origin* and *extent* kwargs (and attributes on the resulting `AxesImage` instance) and the data limits of the axes.

The *extent* kwarg controls the bounding box in data coordinates that the image will fill specified as `(left, right, bottom, top)` in **data coordinates**, the *origin* kwarg controls how the image fills that bounding box, and the orientation in the final rendered image is also affected by the axes limits.

Hint: Most of the code below is used for adding labels and informative text to the plots. The described effects of *origin* and *extent* can be seen in the plots without the need to follow all code details.

For a quick understanding, you may want to skip the code details below and directly continue with the discussion of the results.

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.gridspec import GridSpec
```

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```
def index_to_coordinate(index, extent, origin):
    """Return the pixel center of an index."""
    left, right, bottom, top = extent

    hshift = 0.5 * np.sign(right - left)
    left, right = left + hshift, right - hshift
    vshift = 0.5 * np.sign(top - bottom)
    bottom, top = bottom + vshift, top - vshift

    if origin == 'upper':
        bottom, top = top, bottom

    return {
        "[0, 0]": (left, bottom),
        "[M', 0]": (left, top),
        "[0, N']": (right, bottom),
        "[M', N']": (right, top),
    }[index]


def get_index_label_pos(index, extent, origin, inverted_xindex):
    """
    Return the desired position and horizontal alignment of an index label.
    """
    if extent is None:
        extent = lookup_extent(origin)
    left, right, bottom, top = extent
    x, y = index_to_coordinate(index, extent, origin)

    is_x0 = index[-2:] == "0]"
    halign = 'left' if is_x0 ^ inverted_xindex else 'right'
    hshift = 0.5 * np.sign(left - right)
    x += hshift * (1 if is_x0 else -1)
    return x, y, halign


def get_color(index, data, cmap):
    """Return the data color of an index."""
    val = {
        "[0, 0]": data[0, 0],
        "[0, N']": data[0, -1],
        "[M', 0]": data[-1, 0],
        "[M', N']": data[-1, -1],
    }[index]
    return cmap(val / data.max())


def lookup_extent(origin):
    """Return extent for label positioning when not given explicitly."""
    if origin == 'lower':
```

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```
        return (-0.5, 6.5, -0.5, 5.5)
    else:
        return (-0.5, 6.5, 5.5, -0.5)


def set_extent_None_text(ax):
    ax.text(3, 2.5, 'equals\nextent=None', size='large',
            ha='center', va='center', color='w')


def plot_imshow_with_labels(ax, data, extent, origin, xlim, ylim):
    """Actually run ``imshow()`` and add extent and index labels."""
    im = ax.imshow(data, origin=origin, extent=extent)

    # extent labels (left, right, bottom, top)
    left, right, bottom, top = im.get_extent()
    if xlim is None or top > bottom:
        upper_string, lower_string = 'top', 'bottom'
    else:
        upper_string, lower_string = 'bottom', 'top'
    if ylim is None or left < right:
        port_string, starboard_string = 'left', 'right'
        inverted_xindex = False
    else:
        port_string, starboard_string = 'right', 'left'
        inverted_xindex = True
    bbox_kwargs = {'fc': 'w', 'alpha': .75, 'boxstyle': "round4"}
    ann_kwargs = {'xycoords': 'axes fraction',
                  'textcoords': 'offset points',
                  'bbox': bbox_kwargs}
    ax.annotate(upper_string, xy=(.5, 1), xytext=(0, -1),
                ha='center', va='top', **ann_kwargs)
    ax.annotate(lower_string, xy=(.5, 0), xytext=(0, 1),
                ha='center', va='bottom', **ann_kwargs)
    ax.annotate(port_string, xy=(0, .5), xytext=(1, 0),
                ha='left', va='center', rotation=90,
                **ann_kwargs)
    ax.annotate(starboard_string, xy=(1, .5), xytext=(-1, 0),
                ha='right', va='center', rotation=-90,
                **ann_kwargs)
    ax.set_title('origin: {origin}'.format(origin=origin))

    # index labels
    for index in ["[0, 0]", "[0, N']", "[M', 0]", "[M', N']"]:
        tx, ty, halign = get_index_label_pos(index, extent, origin,
                                             inverted_xindex)
        facecolor = get_color(index, data, im.get_cmap())
        ax.text(tx, ty, index, color='white', ha=halign, va='center',
                bbox={'boxstyle': 'square', 'facecolor': facecolor})
    if xlim:
        ax.set_xlim(*xlim)
    if ylim:
```

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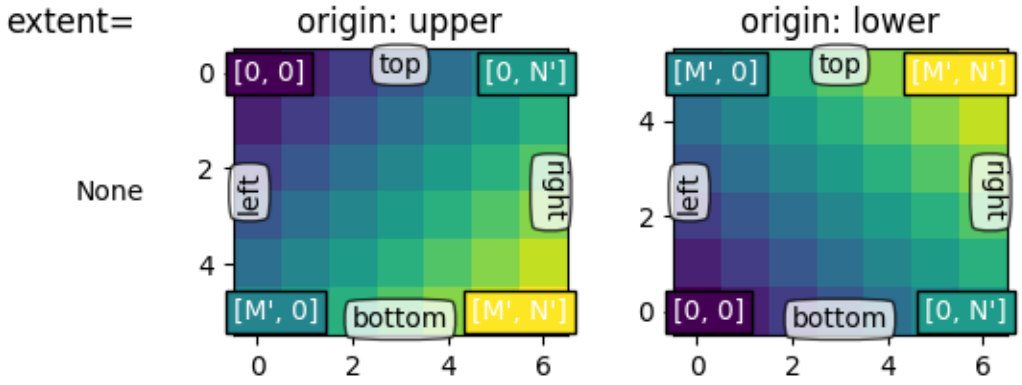
```
        ax.set_ylim(*ylim)


def generate_imshow_demo_grid(extents, xlim=None, ylim=None):
    N = len(extents)
    fig = plt.figure(tight_layout=True)
    fig.set_size_inches(6, N * (11.25) / 5)
    gs = GridSpec(N, 5, figure=fig)

    columns = {'label': [fig.add_subplot(gs[j, 0]) for j in range(N)],
               'upper': [fig.add_subplot(gs[j, 1:3]) for j in range(N)],
               'lower': [fig.add_subplot(gs[j, 3:5]) for j in range(N)]}
    x, y = np.ogrid[0:6, 0:7]
    data = x + y

    for origin in ['upper', 'lower']:
        for ax, extent in zip(columns[origin], extents):
            plot_imshow_with_labels(ax, data, extent, origin, xlim, ylim)

    for ax, extent in zip(columns['label'], extents):
        text_kwargs = {'ha': 'right',
                       'va': 'center',
                       'xycoords': 'axes fraction',
                       'xy': (1, .5)}
        if extent is None:
            ax.annotate('None', **text_kwargs)
            ax.set_title('extent=')
        else:
            left, right, bottom, top = extent
            text = ('left: {left:0.1f}\nright: {right:0.1f}\n' +
                    'bottom: {bottom:0.1f}\ntop: {top:0.1f}\n').format(
                        left=left, right=right, bottom=bottom, top=top)

            ax.annotate(text, **text_kwargs)
        ax.axis('off')
    return columns
```

Default extent

First, let's have a look at the default `extent=None`

```
generate_imshow_demo_grid(extents=[None])
```



Generally, for an array of shape (M, N), the first index runs along the vertical, the second index runs along the horizontal. The pixel centers are at integer positions ranging from 0 to `N' = N - 1` horizontally and from 0 to `M' = M - 1` vertically. *origin* determines how to the data is filled in the bounding box.

For `origin='lower'`:

- [0, 0] is at (left, bottom)
- [M', 0] is at (left, top)
- [0, N'] is at (right, bottom)
- [M', N'] is at (right, top)

`origin='upper'` reverses the vertical axes direction and filling:

- [0, 0] is at (left, top)
- [M', 0] is at (left, bottom)
- [0, N'] is at (right, top)
- [M', N'] is at (right, bottom)

In summary, the position of the [0, 0] index as well as the extent are influenced by *origin*:

origin	[0, 0] position	extent
upper	top left	`(-0.5, numcols-0.5, numrows-0.5, -0.5)`
lower	bottom left	`(-0.5, numcols-0.5, -0.5, numrows-0.5)`

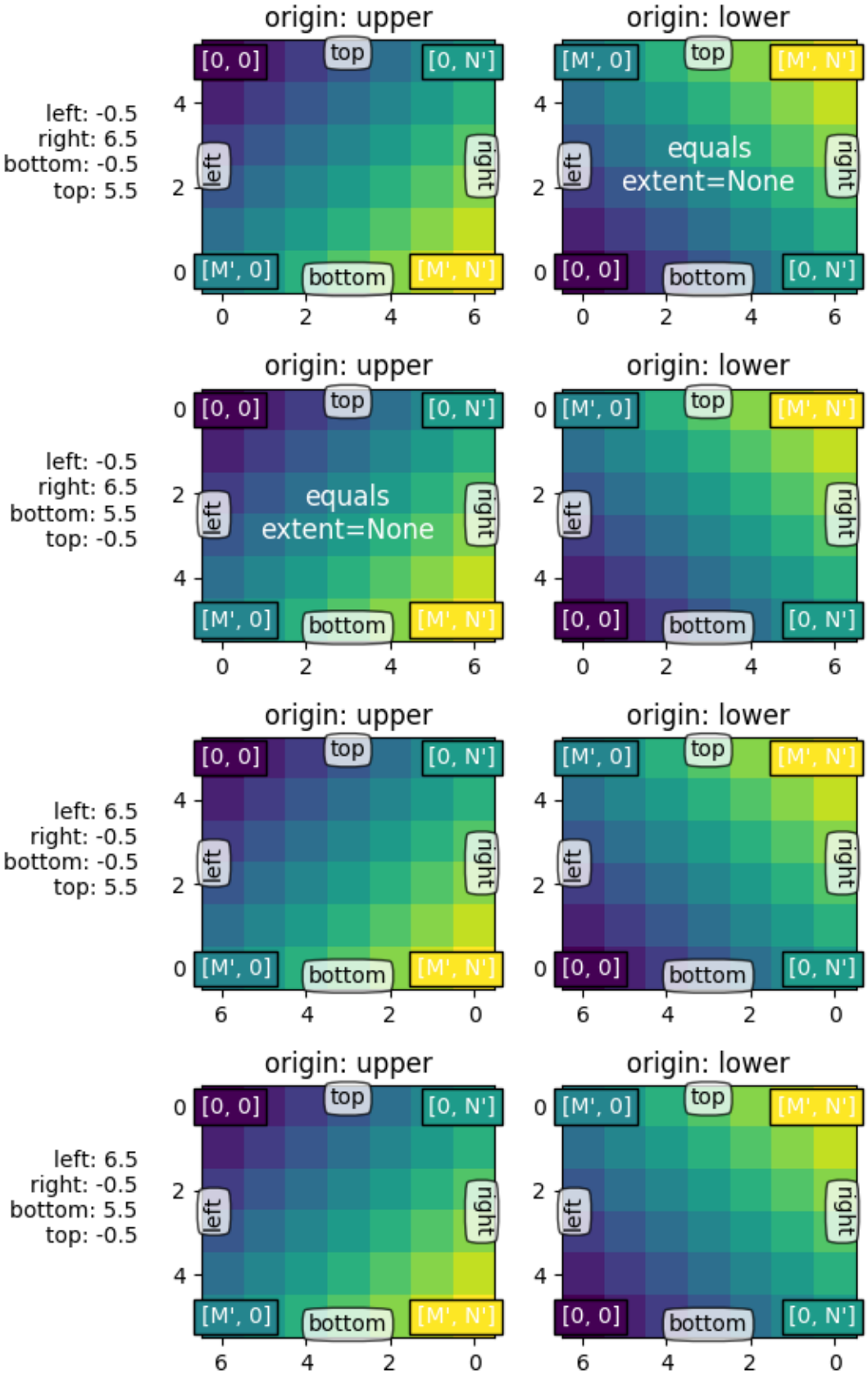
The default value of *origin* is set by `rcParams["image.origin"]` which defaults to `'upper'` to match the matrix indexing conventions in math and computer graphics image indexing conventions.

Explicit extent

By setting *extent* we define the coordinates of the image area. The underlying image data is interpolated/resampled to fill that area.

If the axes is set to autoscale, then the view limits of the axes are set to match the *extent* which ensures that the coordinate set by `(left, bottom)` is at the bottom left of the axes! However, this may invert the axis so they do not increase in the 'natural' direction.

```
extents = [(-0.5, 6.5, -0.5, 5.5),
           (-0.5, 6.5, 5.5, -0.5),
           (6.5, -0.5, -0.5, 5.5),
           (6.5, -0.5, 5.5, -0.5)]

columns = generate_imshow_demo_grid(extents)
set_extent_None_text(columns['upper'][1])
set_extent_None_text(columns['lower'][0])
```


origin: upper
origin: lower
left: -0.5
right: 6.5
bottom: -0.5
top: 5.5
left: -0.5
right: 6.5
bottom: 5.5
top: -0.5
left: 6.5
right: -0.5
bottom: -0.5
top: 5.5
left: 6.5
right: -0.5
bottom: 5.5
top: -0.5
[0, 0]
[0, N']
[M', 0]
[M', N']
top
bottom
left
right
equals
extent=None

Explicit extent and axes limits

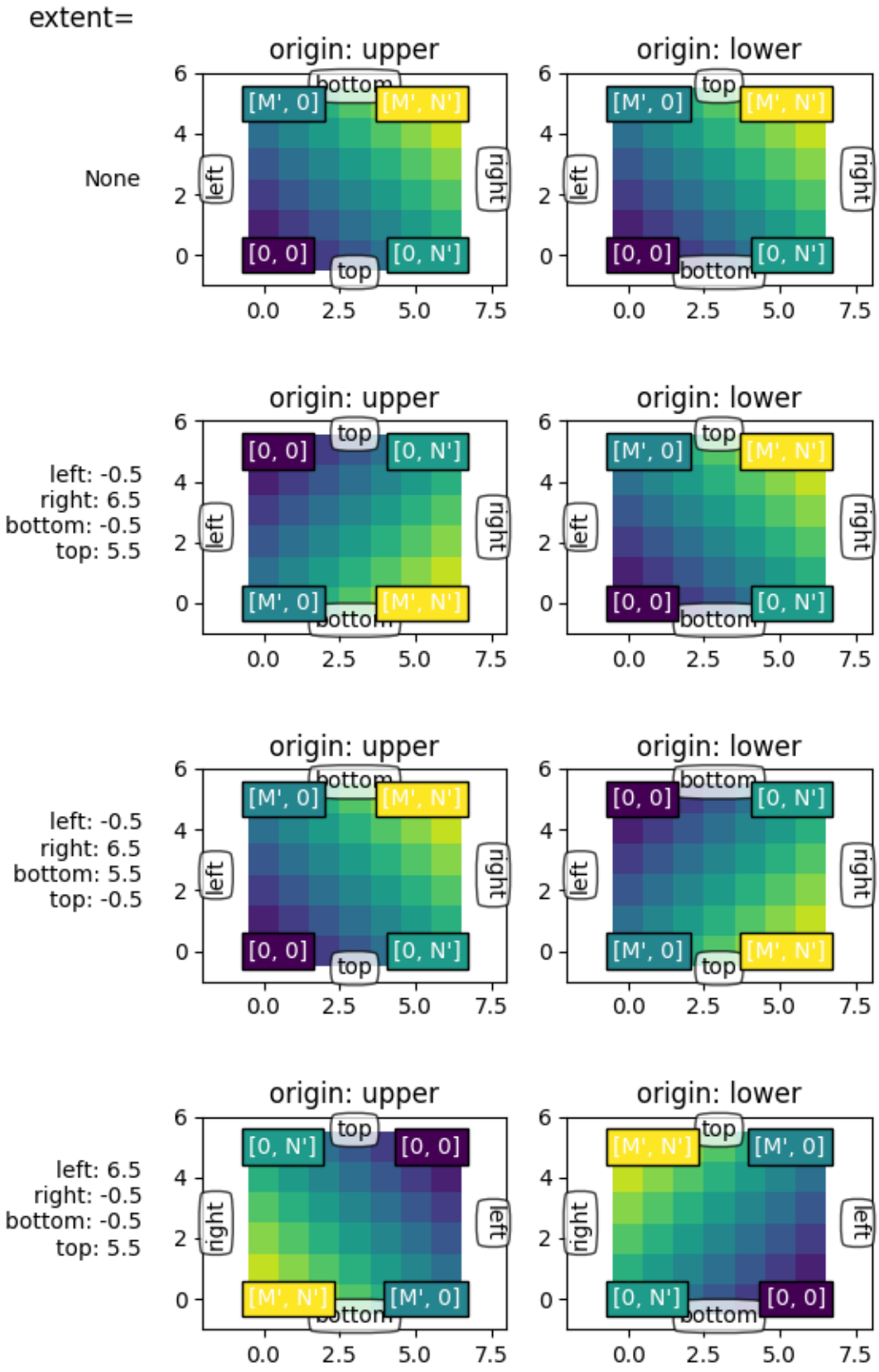
If we fix the axes limits by explicity setting `set_xlim` / `set_ylim`, we force a certain size and orientation of the axes. This can decouple the 'left-right' and 'top-bottom' sense of the image from the orientation on the screen.

In the example below we have chosen the limits slightly larger than the extent (note the white areas within the Axes).

While we keep the extents as in the examples before, the coordinate (0, 0) is now explicitly put at the bottom left and values increase to up and to the right (from the viewer point of view). We can see that:

- The coordinate `(left, bottom)` anchors the image which then fills the box going towards the `(right, top)` point in data space.
- The first column is always closest to the 'left'.
- *origin* controls if the first row is closest to 'top' or 'bottom'.
- The image may be inverted along either direction.
- The 'left-right' and 'top-bottom' sense of the image may be uncoupled from the orientation on the screen.

```
generate_imshow_demo_grid(extents=[None] + extents,
                          xlim=(-2, 8), ylim=(-1, 6))
```


extent=
origin: upper
origin: lower
None
left: -0.5
right: 6.5
bottom: -0.5
top: 5.5
left: -0.5
right: 6.5
bottom: 5.5
top: -0.5
left: 6.5
right: -0.5
bottom: -0.5
top: 5.5
left: 6.5
right: -0.5
[M', 0]
[M', N']
[0, 0]
[0, N']
bottom
top
left
right
0.0
2.5
5.0
7.5
0
2
4
6

Note: Click *here* to download the full example code

3.2.7 Constrained Layout Guide

How to use constrained-layout to fit plots within your figure cleanly.

constrained_layout automatically adjusts subplots and decorations like legends and colorbars so that they fit in the figure window while still preserving, as best they can, the logical layout requested by the user.

constrained_layout is similar to *tight_layout*, but uses a constraint solver to determine the size of axes that allows them to fit.

Warning: As of Matplotlib 2.2, Constrained Layout is **experimental**. The behaviour and API are subject to change, or the whole functionality may be removed without a deprecation period. If you *require* your plots to be absolutely reproducible, get the Axes positions after running Constrained Layout and use `ax.set_position()` in your code with `constrained_layout=False`.

Simple Example

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

```
# sphinx_gallery_thumbnail_number = 18

#import matplotlib
#matplotlib.use('Qt5Agg')

import warnings

import matplotlib.pyplot as plt
import numpy as np
import matplotlib.colors as mcolors
import matplotlib.gridspec as gridspec

import matplotlib._layoutbox as layoutbox

plt.rcParams['savefig.facecolor'] = "0.8"
plt.rcParams['figure.figsize'] = 4.5, 4.


def example_plot(ax, fontsize=12, nodec=False):
    ax.plot([1, 2])

    ax.locator_params(nbins=3)
    if not nodec:
```

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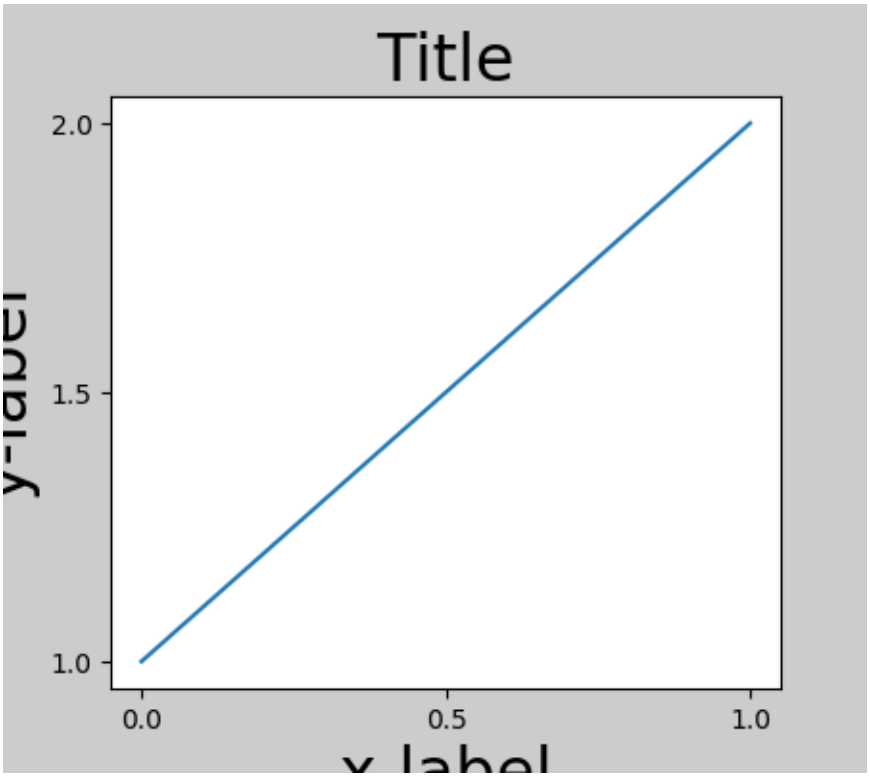
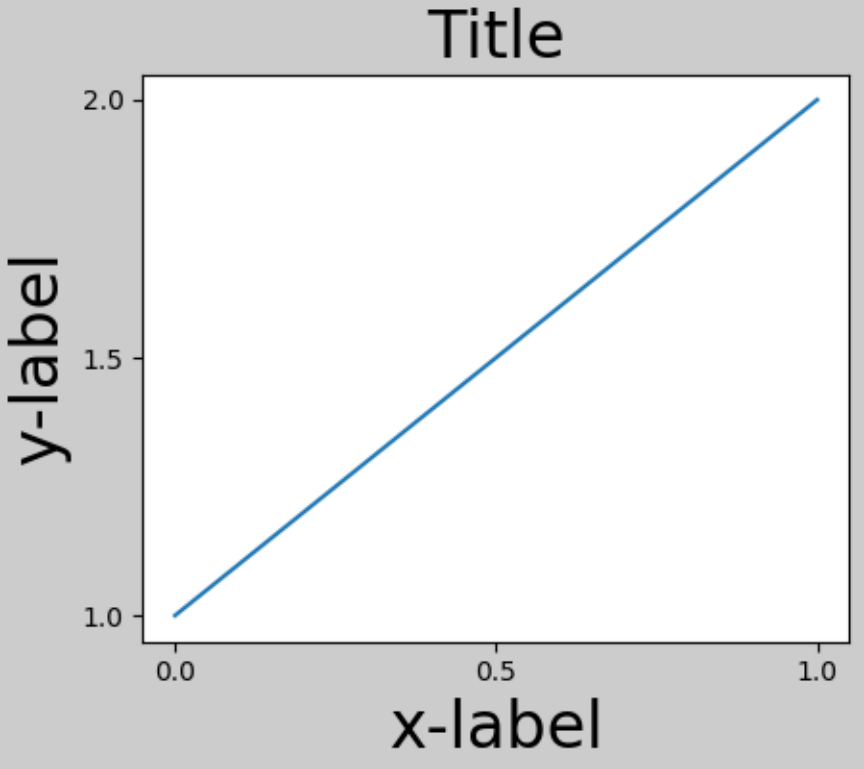
```
        ax.set_xlabel('x-label', fontsize=fontsize)
        ax.set_ylabel('y-label', fontsize=fontsize)
        ax.set_title('Title', fontsize=fontsize)
    else:
        ax.set_xticklabels('')
        ax.set_yticklabels('')


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



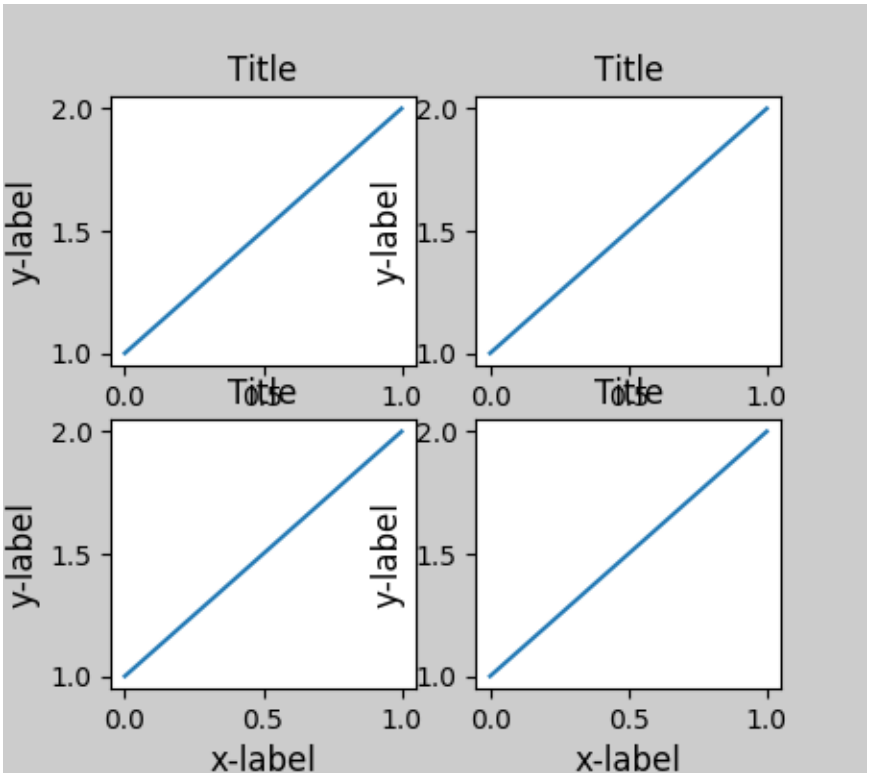
To prevent this, the location of axes needs to be adjusted. For subplots, this can be done by adjusting the subplot params (*Move the edge of an axes to make room for tick labels*). However, specifying your figure with the `constrained_layout=True` kwarg will do the adjusting automatically.

```
fig, ax = plt.subplots(constrained_layout=True)
example_plot(ax, fontsize=24)
```



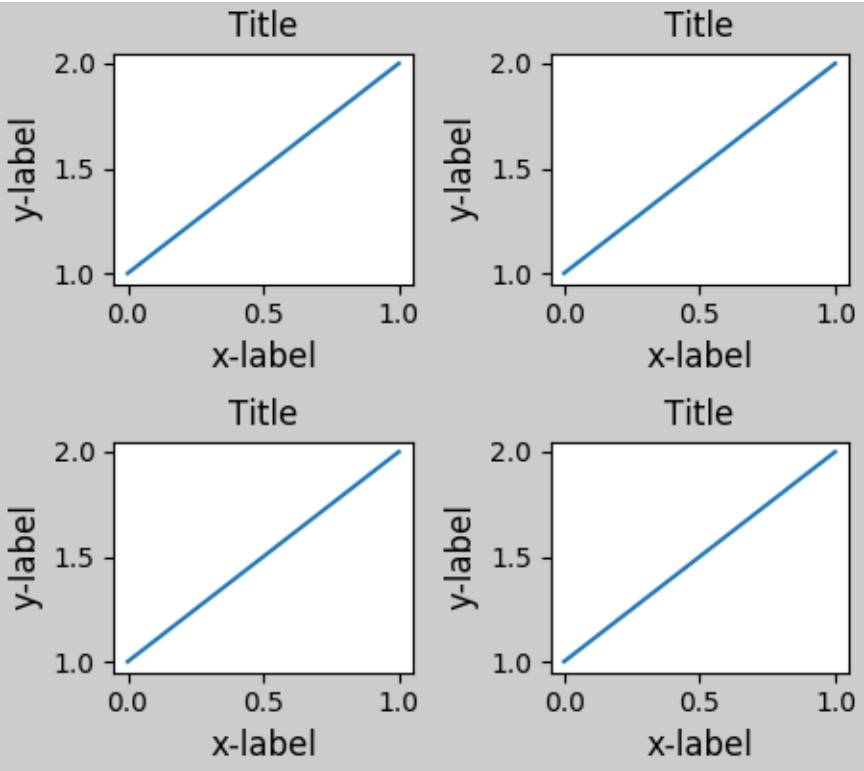
When you have multiple subplots, often you see labels of different axes overlapping each other.

```
fig, axs = plt.subplots(2, 2, constrained_layout=False)
for ax in axs.flatten():
    example_plot(ax)
```



Specifying `constrained_layout=True` in the call to `plt.subplots` causes the layout to be properly constrained.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    example_plot(ax)
```

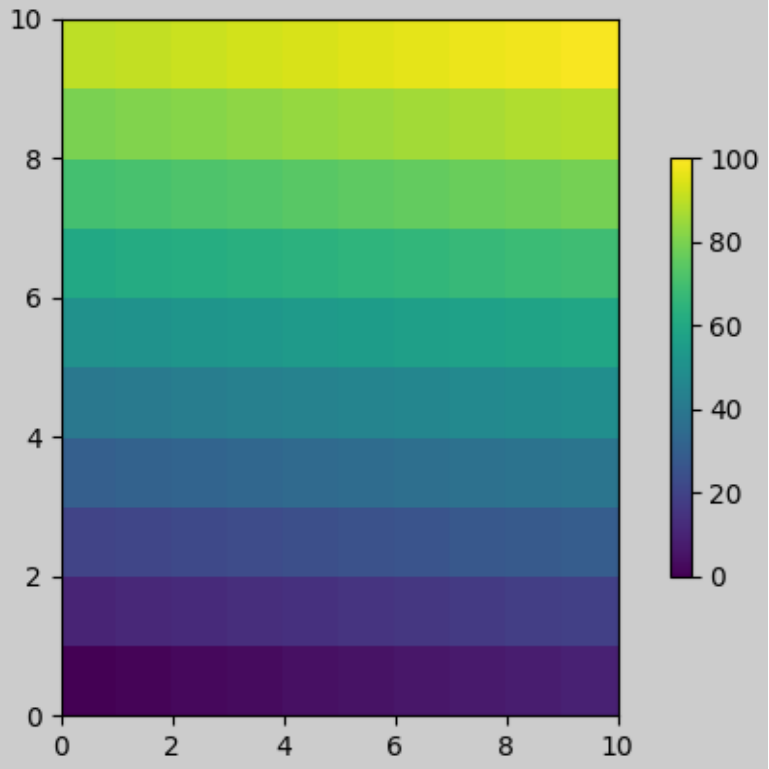


Colorbars

If you create a colorbar with the *colorbar()* command you need to make room for it. `constrained_layout` does this automatically. Note that if you specify `use_gridspec=True` it will be ignored because this option is made for improving the layout via `tight_layout`.

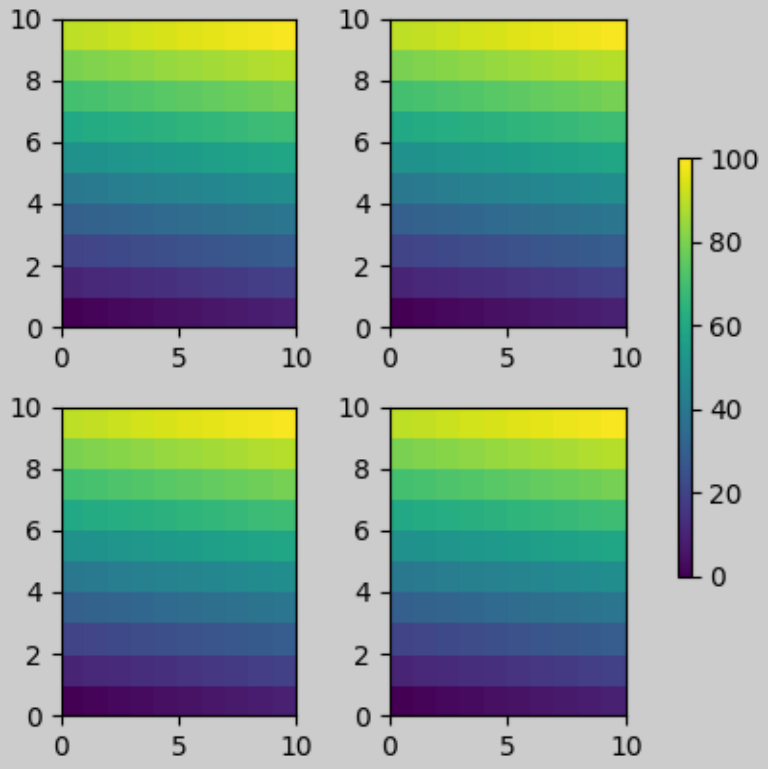
Note: For the `pcolormesh` kwargs (`pc_kwargs`) we use a dictionary. Below we will assign one colorbar to a number of axes each containing a `ScalarMappable`; specifying the norm and colormap ensures the colorbar is accurate for all the axes.

```
arr = np.arange(100).reshape((10, 10))
norm = mcolors.Normalize(vmin=0., vmax=100.)
# see note above: this makes all pcolormesh calls consistent:
pc_kwargs = {'rasterized':True, 'cmap':'viridis', 'norm':norm}
fig, ax = plt.subplots(figsize=(4, 4), constrained_layout=True)
im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=ax, shrink=0.6)
```



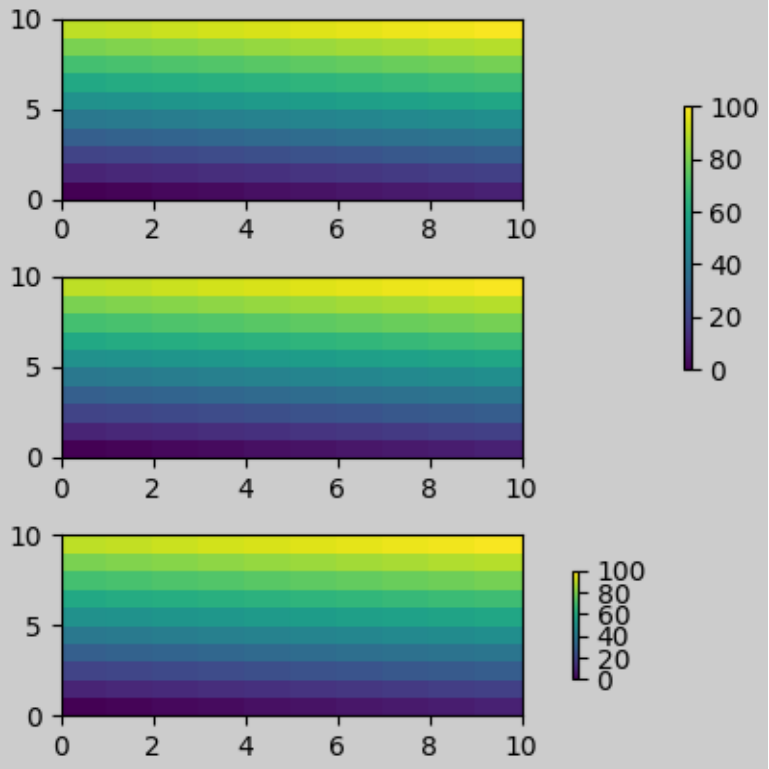
If you specify a list of axes (or other iterable container) to the `ax` argument of `colorbar`, constrained_layout will take space from all # axes that share the same gridspec.

```
fig, axs = plt.subplots(2, 2, figsize=(4, 4), constrained_layout=True)
for ax in axs.flatten():
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs, shrink=0.6)
```



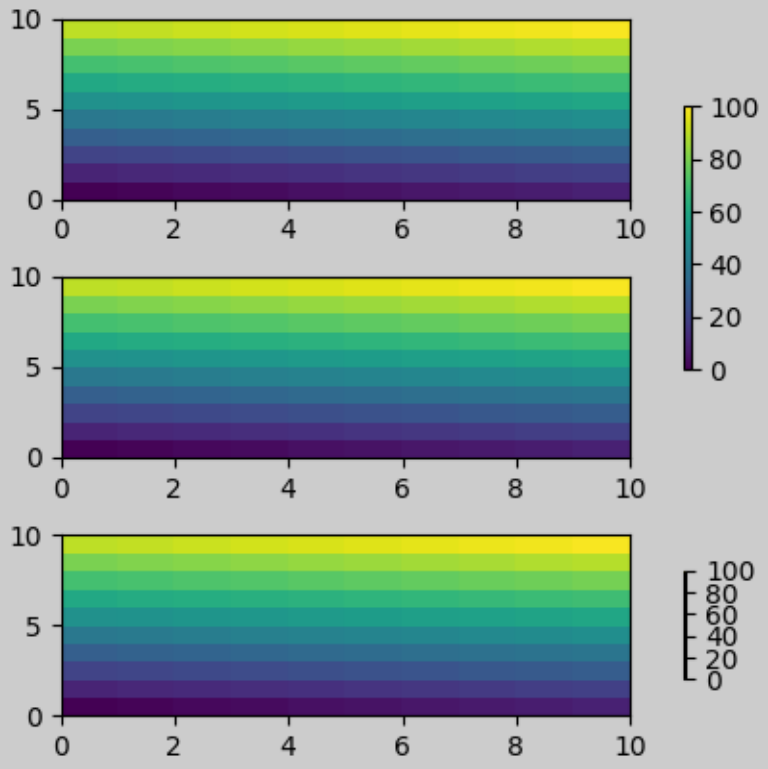
Note that there is a bit of a subtlety when specifying a single axes as the parent. In the following, it might be desirable and expected for the colorbars to line up, but they don't because the colorbar paired with the bottom axes is tied to the subplotspec of the axes, and hence shrinks when the gridspec-level colorbar is added.

```
fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[2], shrink=0.6)
```



The API to make a single-axes behave like a list of axes is to specify it as a list (or other iterable container), as below:

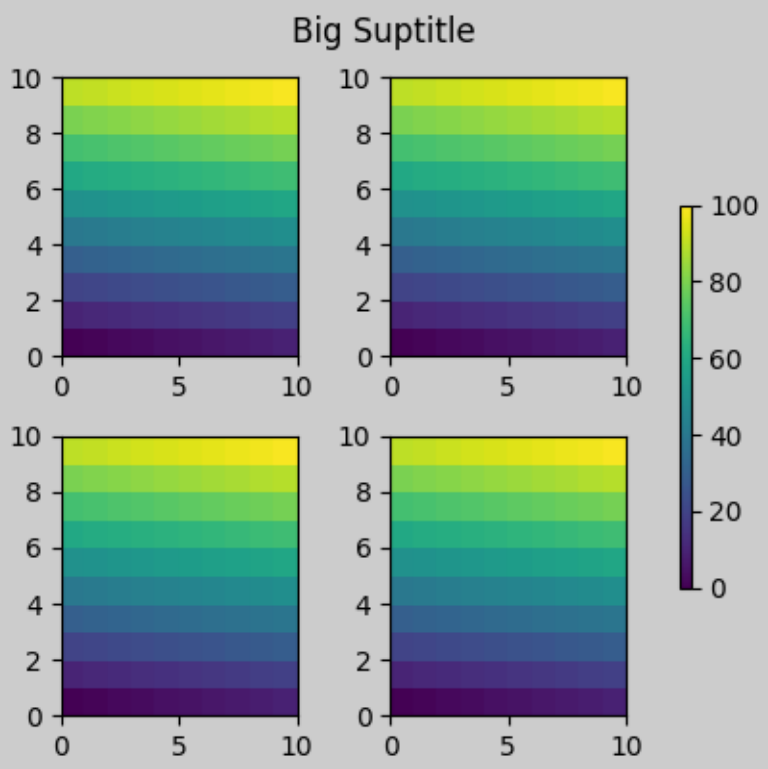
```
fig, axs = plt.subplots(3, 1, figsize=(4, 4), constrained_layout=True)
for ax in axs[:2]:
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs[:2], shrink=0.6)
im = axs[2].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=[axs[2]], shrink=0.6)
```



Suptitle

`constrained_layout` can also make room for `suptitle`.

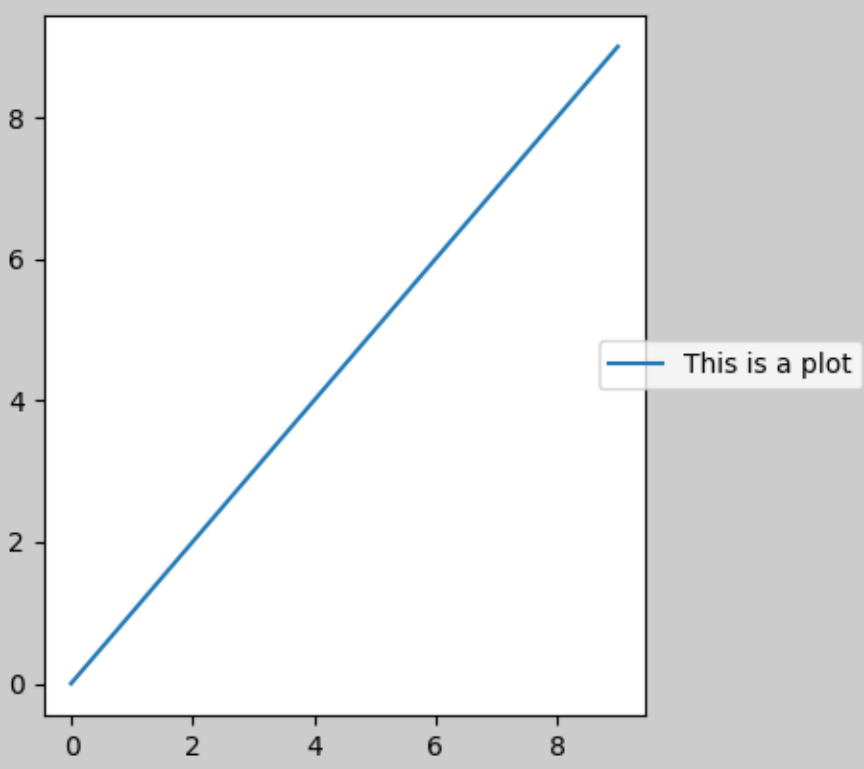
```
fig, axs = plt.subplots(2, 2, figsize=(4, 4), constrained_layout=True)
for ax in axs.flatten():
    im = ax.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=axs, shrink=0.6)
fig.suptitle('Big Suptitle')
```



Legends

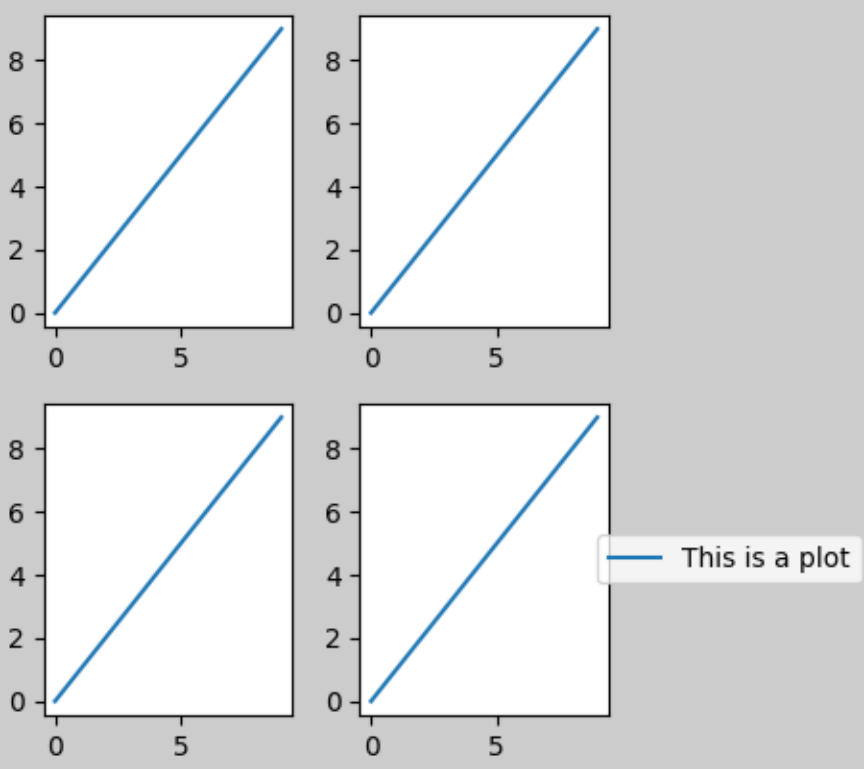
Legends can be placed outside of their parent axis. Constrained-layout is designed to handle this. However, constrained-layout does *not* handle legends being created via `fig.legend()` (yet).

```
fig, ax = plt.subplots(constrained_layout=True)
ax.plot(np.arange(10), label='This is a plot')
ax.legend(loc='center left', bbox_to_anchor=(0.9, 0.5))
```



However, this will steal space from a subplot layout:

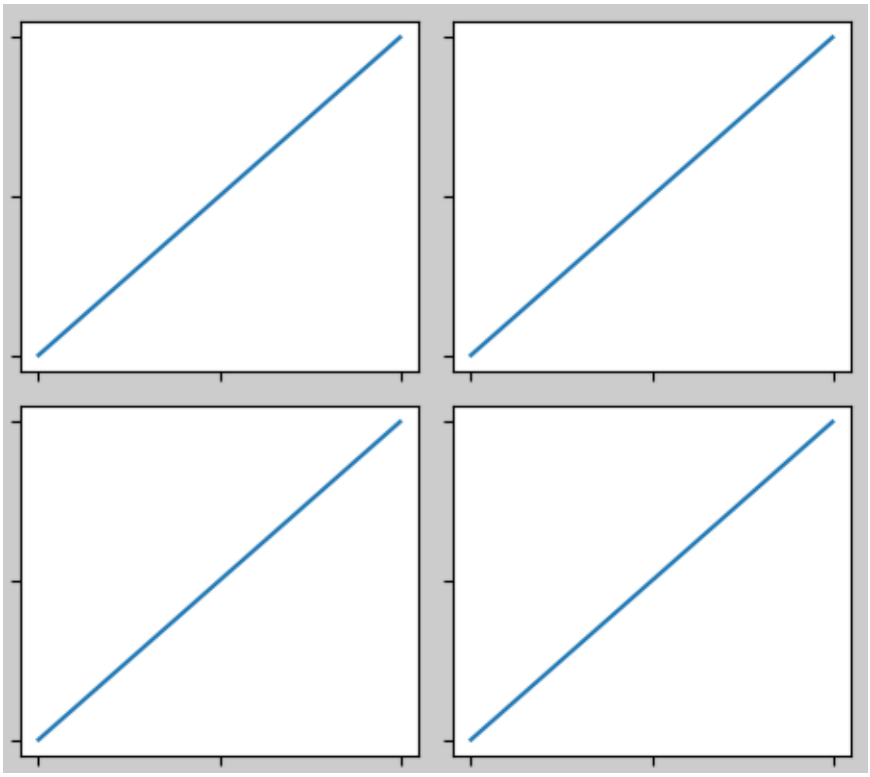
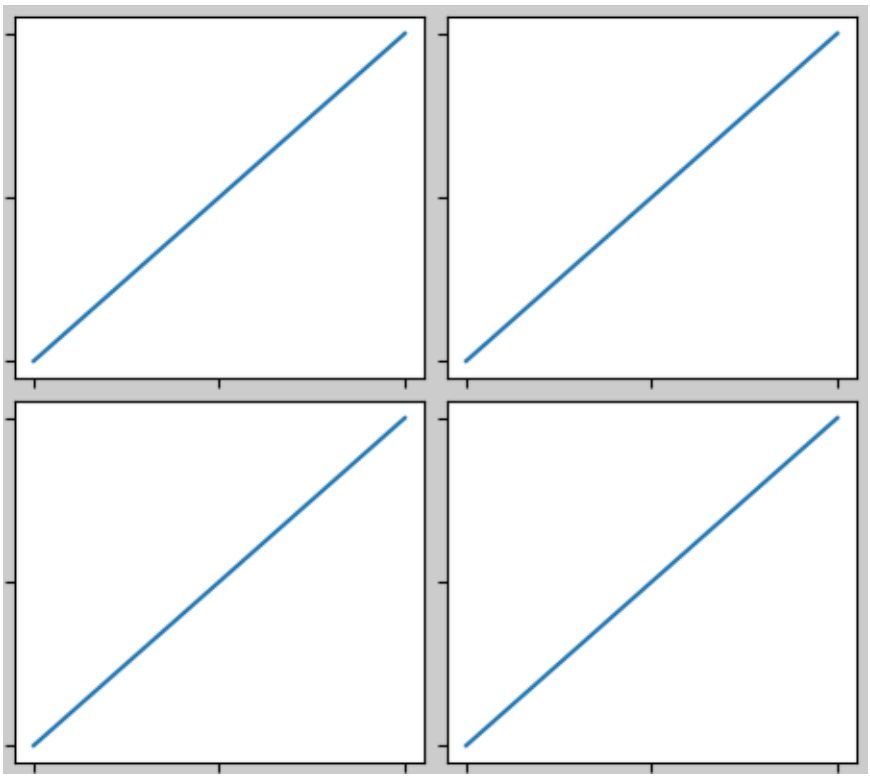
```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten()[:-1]:
    ax.plot(np.arange(10))
axs[1, 1].plot(np.arange(10), label='This is a plot')
axs[1, 1].legend(loc='center left', bbox_to_anchor=(0.9, 0.5))
```



Padding and Spacing

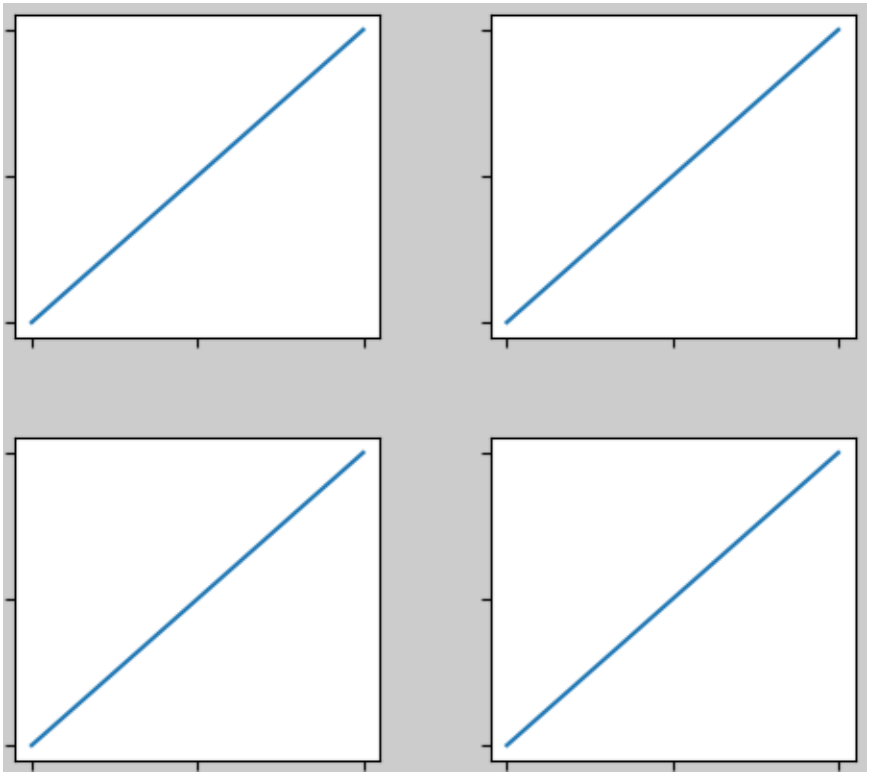
For constrained_layout, we have implemented a padding around the edge of each axes. This padding sets the distance from the edge of the plot, and the minimum distance between adjacent plots. It is specified in inches by the keyword arguments `w_pad` and `h_pad` to the function `fig.set_constrained_layout_pads`:

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=4./72., h_pad=4./72.,
        hspace=0., wspace=0.)

fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
        hspace=0., wspace=0.)
```

- 
- 

Spacing between subplots is set by `wspace` and `hspace`. There are specified as a fraction of the size of the subplot group as a whole. If the size of the figure is changed, then these spaces change in proportion. Note in the blow how the space at the edges doesn't change from the above, but the space between subplots does.

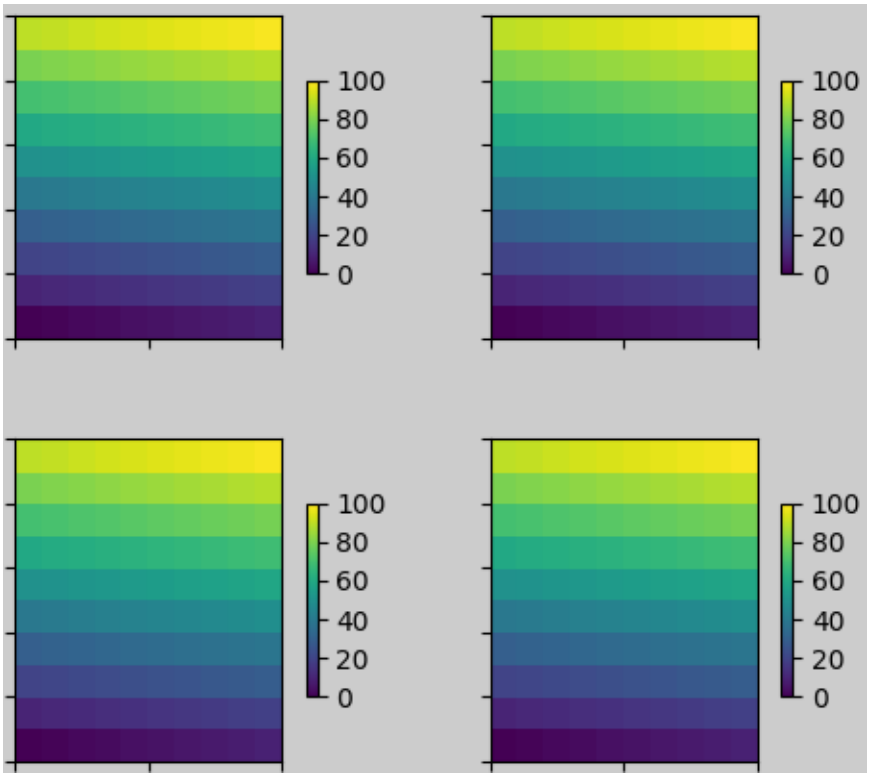
```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    example_plot(ax, nodec=True)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
        hspace=0.2, wspace=0.2)
```



Spacing with colorbars

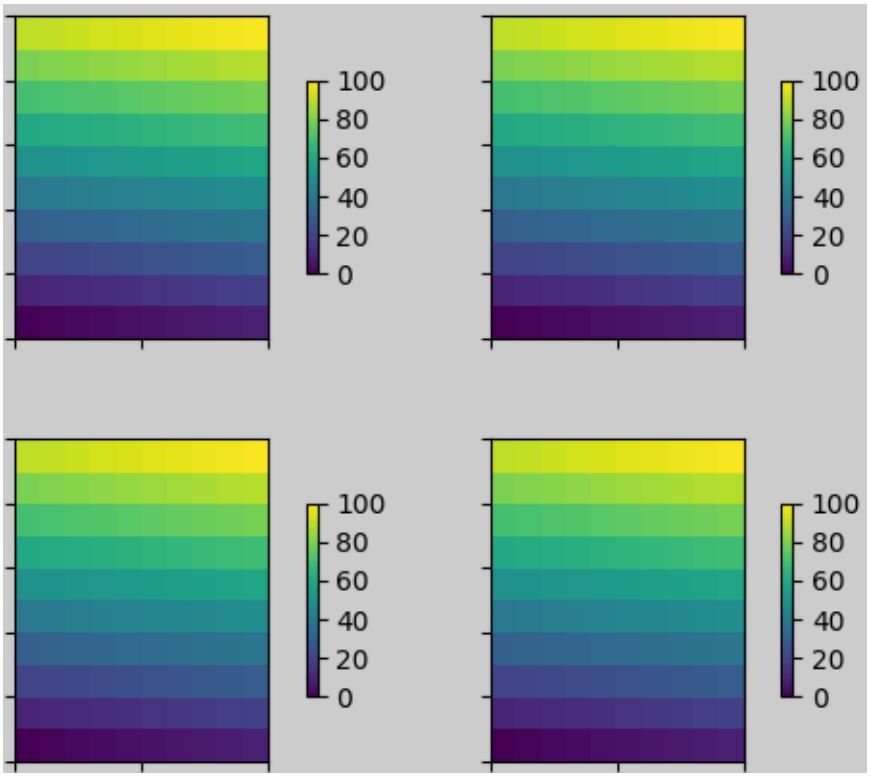
Colorbars still respect the `w_pad` and `h_pad` values. However they will be `wspace` and `hsapce` apart from other subplots. Note the use of a `pad` kwarg here in the `colorbar` call. It defaults to 0.02 of the size of the axis it is attached to.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    pc = ax.pcolormesh(arr, **pc_kwargs)
    fig.colorbar(im, ax=ax, shrink=0.6, pad=0)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
        hspace=0.2, wspace=0.2)
```



In the above example, the colorbar will not ever be closer than 2 pts to the plot, but if we want it a bit further away, we can specify its value for pad to be non-zero.

```
fig, axs = plt.subplots(2, 2, constrained_layout=True)
for ax in axs.flatten():
    pc = ax.pcolormesh(arr, **pc_kwargs)
    fig.colorbar(im, ax=ax, shrink=0.6, pad=0.05)
    ax.set_xticklabels('')
    ax.set_yticklabels('')
fig.set_constrained_layout_pads(w_pad=2./72., h_pad=2./72.,
        hspace=0.2, wspace=0.2)
```

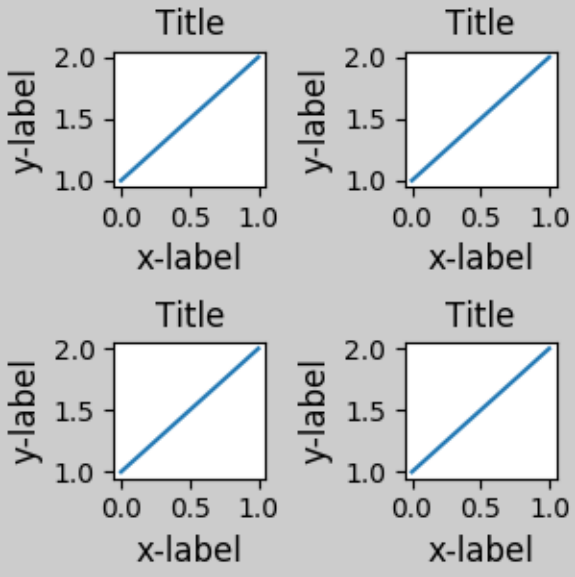


rcParams

There are five `rcParams` that can be set, either in a script or in the `matplotlibrc` file. They all have the prefix `figure.constrained_layout`:

- `use`: Whether to use constrained_layout. Default is False
- **`w_pad`, `h_pad` Padding around axes objects.** Float representing inches. Default is 3./72. inches (3 pts)
- **`wspace`, `hspace` Space between subplot groups.** Float representing a fraction of the subplot widths being separated. Default is 0.02.

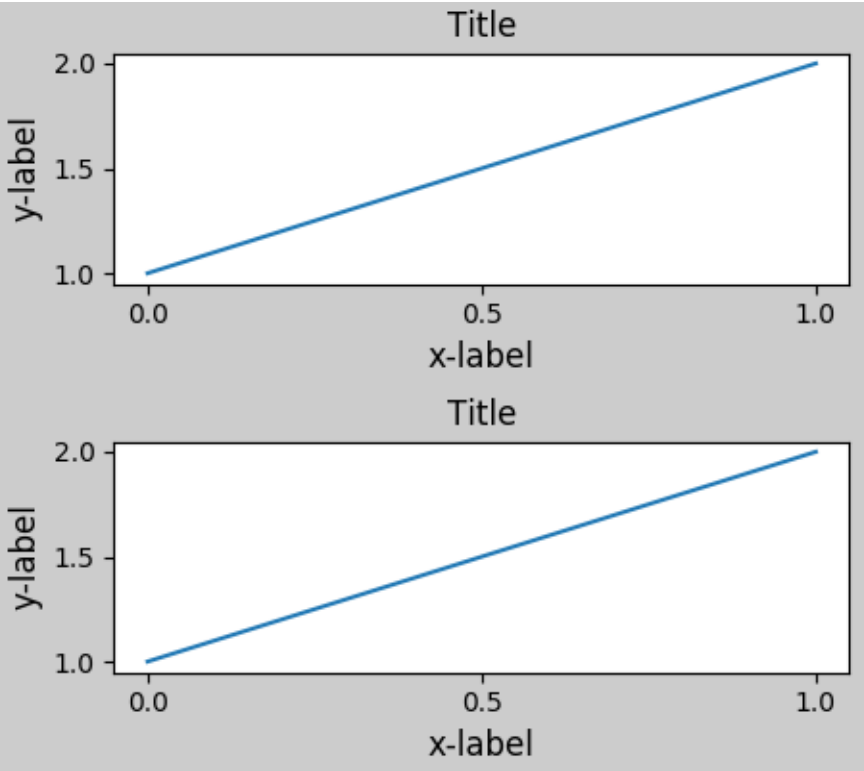
```
plt.rcParams['figure.constrained_layout.use'] = True
fig, axs = plt.subplots(2, 2, figsize=(3, 3))
for ax in axs.flatten():
    example_plot(ax)
```



Use with GridSpec

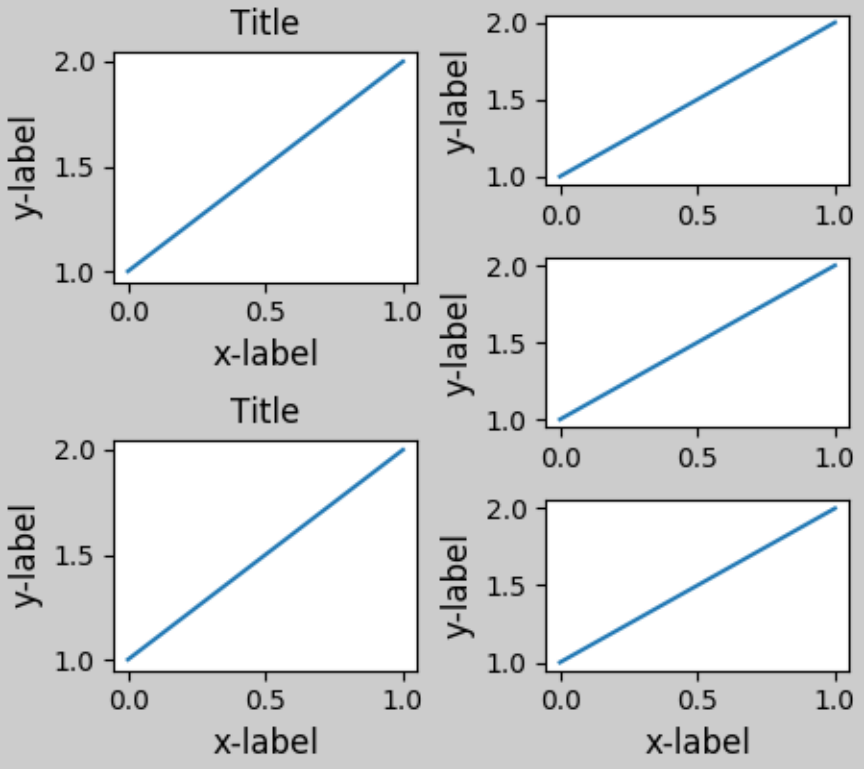
constrained_layout is meant to be used with *subplots()* or *GridSpec()* and *add_subplot()*.

```
fig = plt.figure(constrained_layout=True)

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

example_plot(ax1)
example_plot(ax2)
```



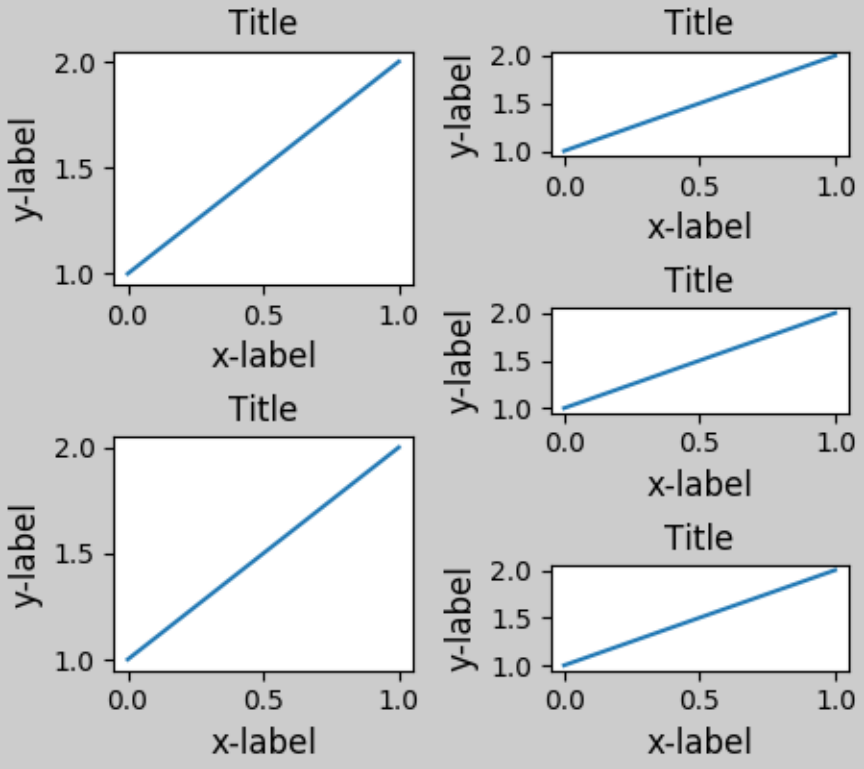
More complicated gridspec layouts are possible...

```
fig = plt.figure(constrained_layout=True)

gs0 = gridspec.GridSpec(1, 2, figure=fig)

gs1 = gridspec.GridSpecFromSubplotSpec(2, 1, gs0[0])
ax1 = fig.add_subplot(gs1[0])
ax2 = fig.add_subplot(gs1[1])

example_plot(ax1)
example_plot(ax2)

gs2 = gridspec.GridSpecFromSubplotSpec(3, 1, gs0[1])

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

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



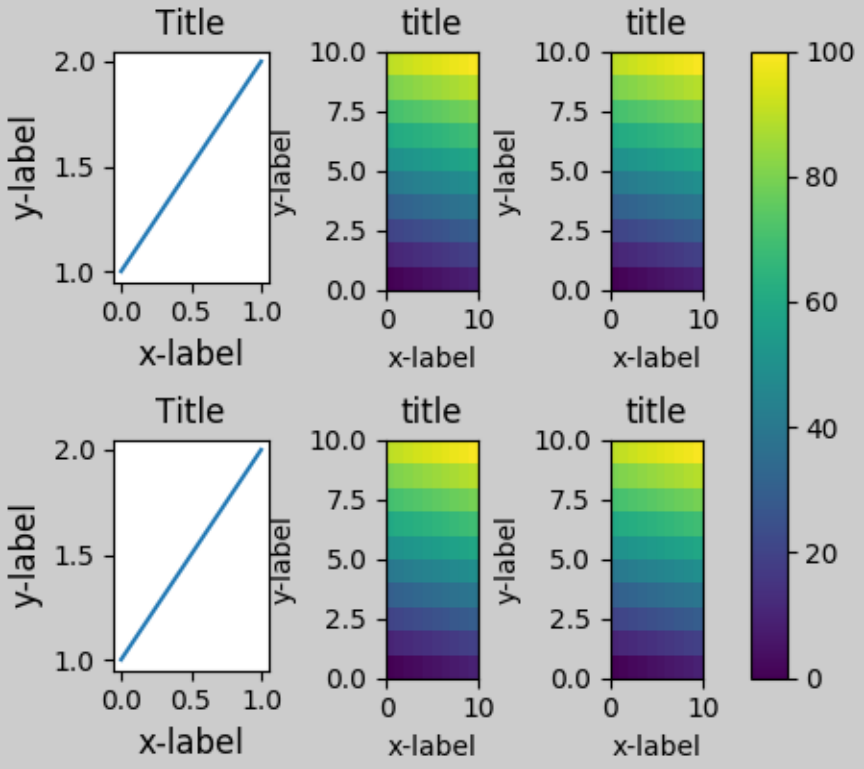
Note that in the above the left and columns don't have the same vertical extent. If we want the top and bottom of the two grids to line up then they need to be in the same gridspec:

```
fig = plt.figure(constrained_layout=True)

gs0 = gridspec.GridSpec(6, 2, figure=fig)

ax1 = fig.add_subplot(gs0[:3, 0])
ax2 = fig.add_subplot(gs0[3:, 0])

example_plot(ax1)
example_plot(ax2)

ax = fig.add_subplot(gs0[0:2, 1])
example_plot(ax)
ax = fig.add_subplot(gs0[2:4, 1])
example_plot(ax)
ax = fig.add_subplot(gs0[4:, 1])
example_plot(ax)
```



This example uses two gridspecs to have the colorbar only pertain to one set of pcolors. Note how the left column is wider than the two right-hand columns because of this. Of course, if you wanted the subplots to be the same size you only needed one gridspec.

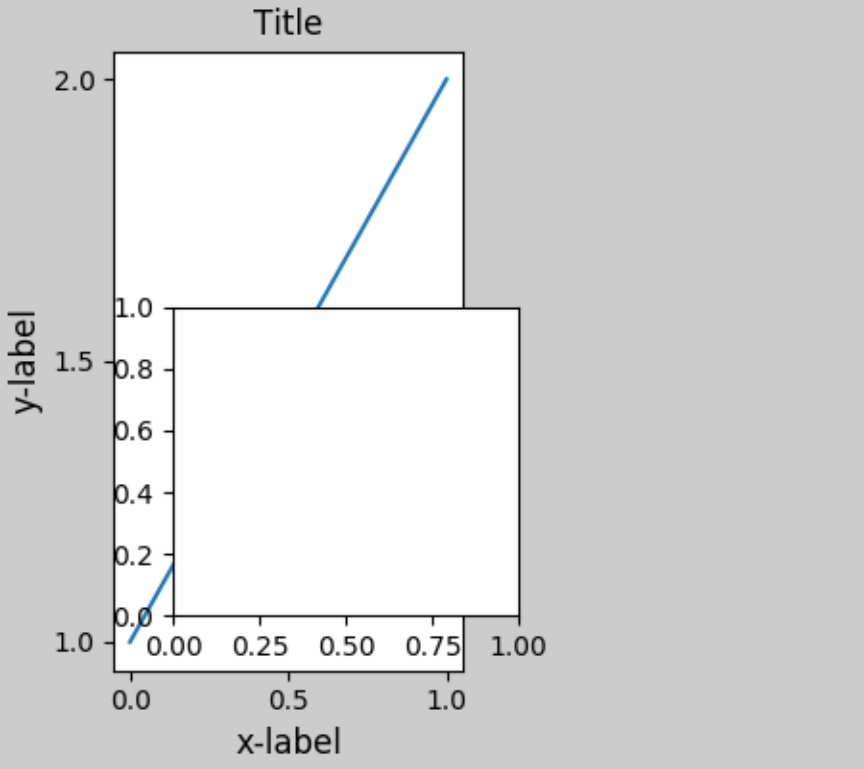
```
def docomplicated(suptitle=None):
    fig = plt.figure(constrained_layout=True)
    gs0 = gridspec.GridSpec(1, 2, figure=fig, width_ratios=[1., 2.])
    gsl = gridspec.GridSpecFromSubplotSpec(2, 1, gs0[0])
    gsr = gridspec.GridSpecFromSubplotSpec(2, 2, gs0[1])

    for gs in gsl:
        ax = fig.add_subplot(gs)
        example_plot(ax)
    axs = []
    for gs in gsr:
        ax = fig.add_subplot(gs)
        pcm = ax.pcolormesh(arr, **pc_kwargs)
        ax.set_xlabel('x-label')
        ax.set_ylabel('y-label')
        ax.set_title('title')

        axs += [ax]
    fig.colorbar(pcm, ax=axs)
    if suptitle is not None:
        fig.suptitle(suptitle)

docomplicated()
```



Manually setting axes positions

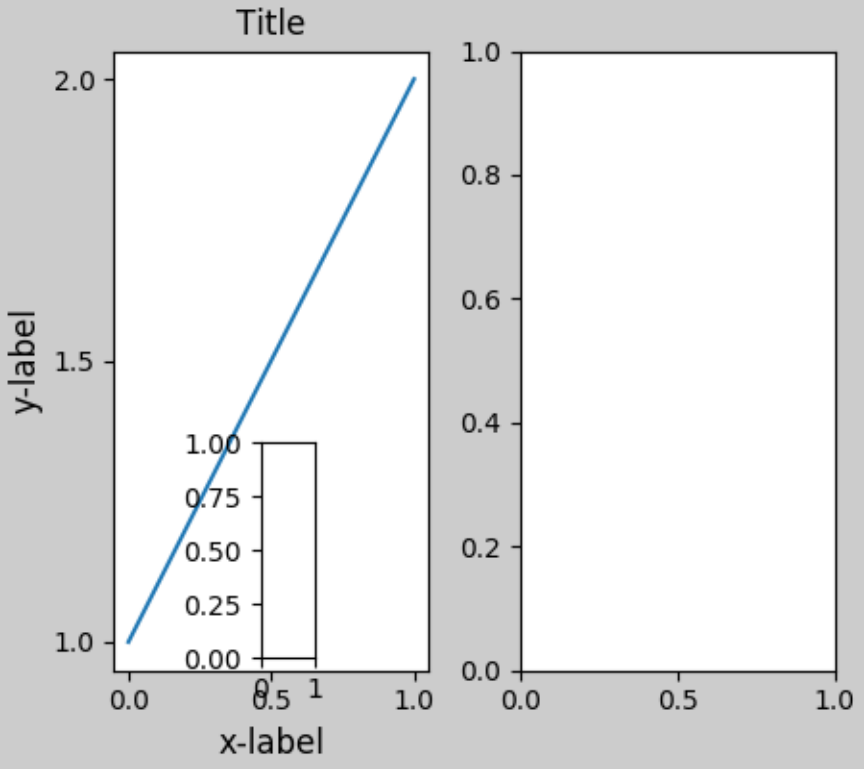
There can be good reasons to manually set an axes position. A manual call to `ax.set_position()` will set the axes so constrained_layout has no effect on it anymore. (Note that constrained_layout still leaves the space for the axes that is moved).

```
fig, axs = plt.subplots(1, 2, constrained_layout=True)
example_plot(axs[0], fontsize=12)
axs[1].set_position([0.2, 0.2, 0.4, 0.4])
```



If you want an inset axes in data-space, you need to manually execute the layout using `fig.execute_constrained_layout()` call. The inset figure will then be properly positioned. However, it will not be properly positioned if the size of the figure is subsequently changed. Similarly, if the figure is printed to another backend, there may be slight changes of location due to small differences in how the backends render fonts.

```
from matplotlib.transforms import Bbox

fig, axs = plt.subplots(1, 2, constrained_layout=True)
example_plot(axs[0], fontsize=12)
fig.execute_constrained_layout()
# put into data-space:
bb_data_ax2 = Bbox.from_bounds(0.5, 1., 0.2, 0.4)
disp_coords = axs[0].transData.transform(bb_data_ax2)
fig_coords_ax2 = fig.transFigure.inverted().transform(disp_coords)
bb_ax2 = Bbox(fig_coords_ax2)
ax2 = fig.add_axes(bb_ax2)
```

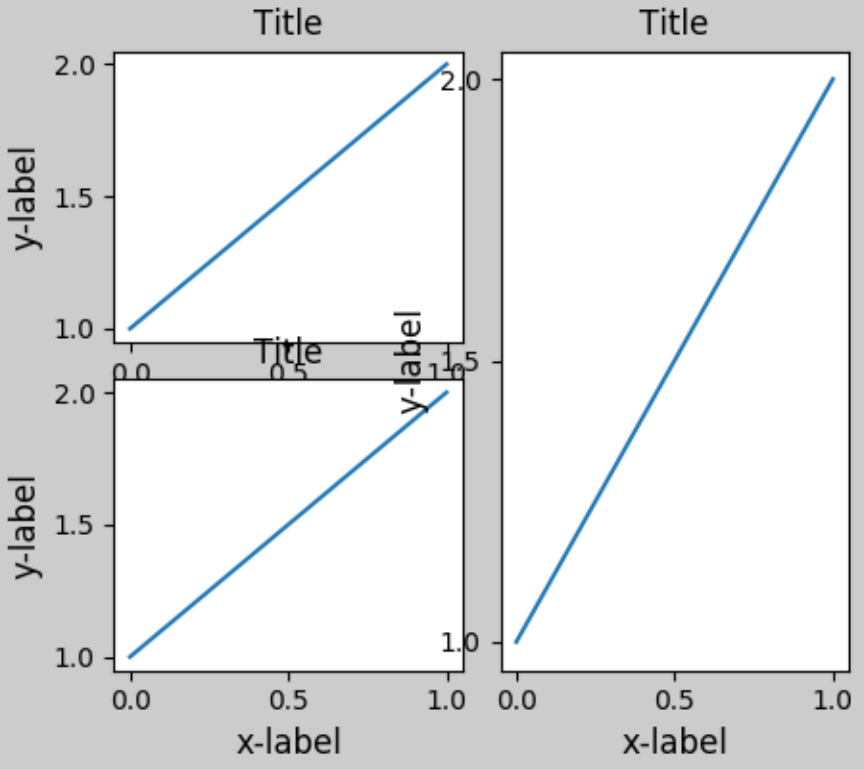


Limitations

Incompatible functions

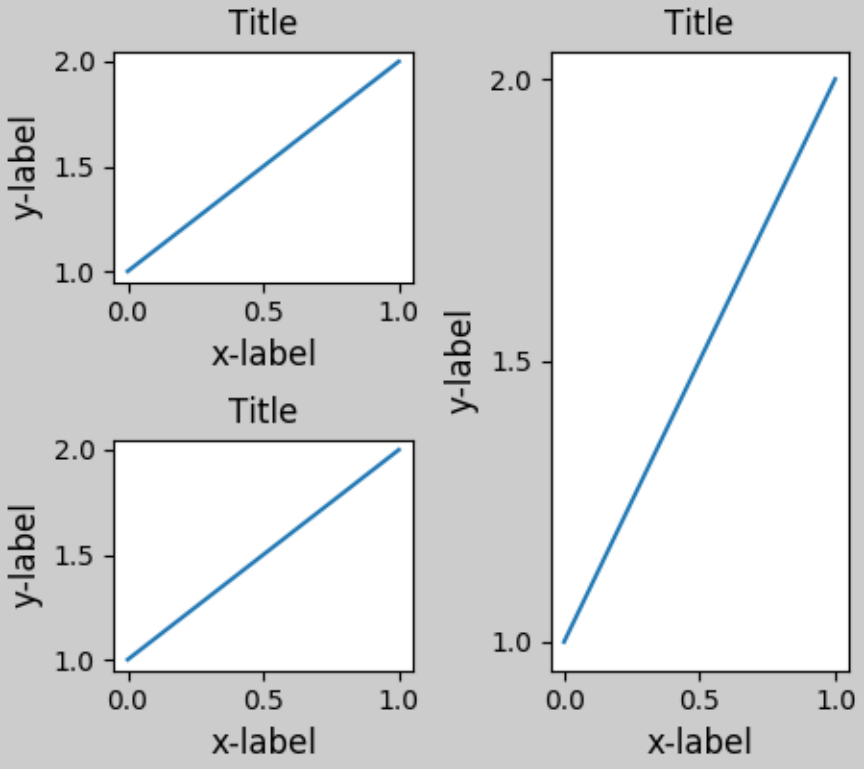
`constrained_layout` will not work on subplots created via the `subplot` command. The reason is that each of these commands creates a separate `GridSpec` instance and `constrained_layout` uses (nested) gridspecs to carry out the layout. So the following fails to yield a nice layout:

```
fig = plt.figure(constrained_layout=True)

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

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



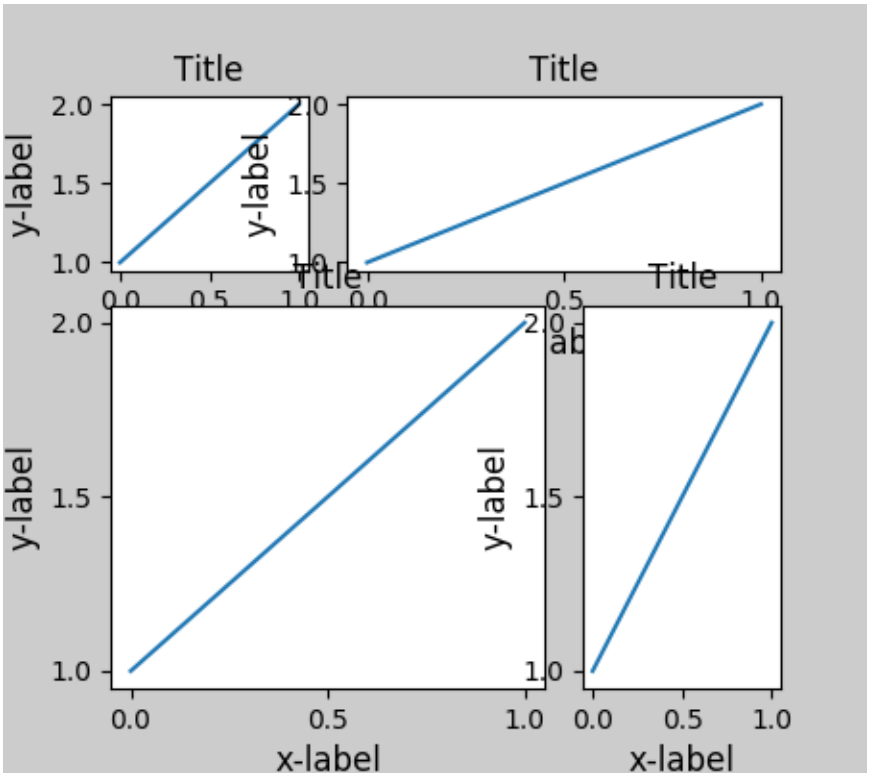
Of course that layout is possible using a gridspec:

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(2, 2, figure=fig)

ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[1, 0])
ax3 = fig.add_subplot(gs[:, 1])

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



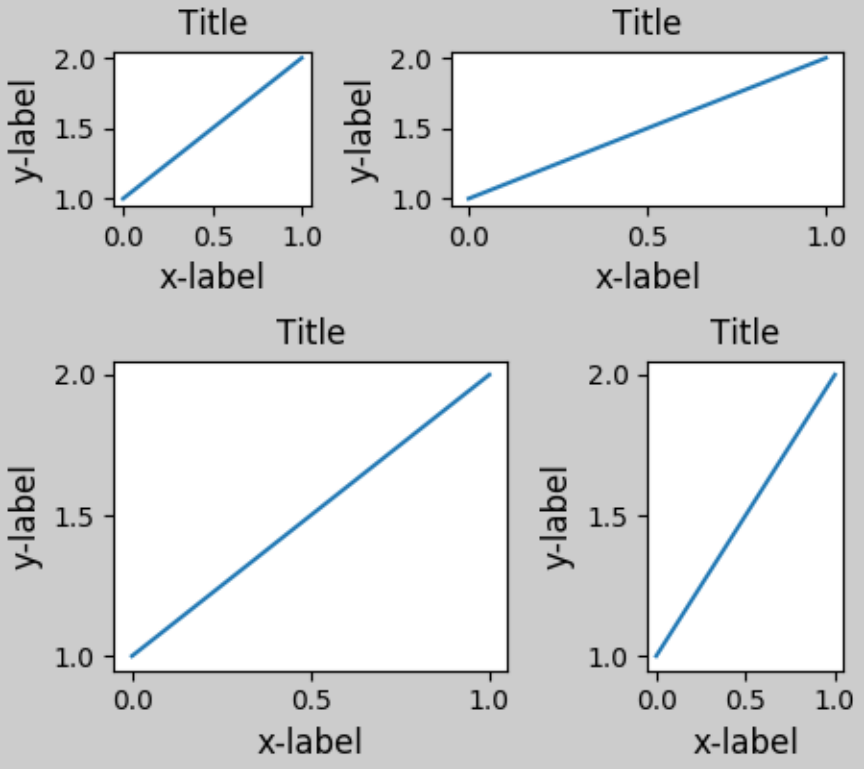
Similarly, *subplot2grid()* doesn't work for the same reason: each call creates a different parent gridspec.

```
fig = plt.figure(constrained_layout=True)

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

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



The way to make this plot compatible with `constrained_layout` is again to use `gridspec` directly

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(3, 3, figure=fig)

ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[0, 1:])
ax3 = fig.add_subplot(gs[1:, 0:2])
ax4 = fig.add_subplot(gs[1:, -1])

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



Other Caveats

- `constrained_layout` only considers ticklabels, axis labels, titles, and legends. Thus, other artists may be clipped and also may overlap.
- It assumes that the extra space needed for ticklabels, axis labels, and titles is independent of original location of axes. This is often true, but there are rare cases where it is not.
- There are small differences in how the backends handle rendering fonts, so the results will not be pixel-identical.

Debugging

Constrained-layout can fail in somewhat unexpected ways. Because it uses a constraint solver the solver can find solutions that are mathematically correct, but that aren't at all what the user wants. The usual failure mode is for all sizes to collapse to their smallest allowable value. If this happens, it is for one of two reasons:

1. There was not enough room for the elements you were requesting to draw.
2. There is a bug - in which case open an issue at https://github.com/matplotlib/matplotlib/issues.

If there is a bug, please report with a self-contained example that does not require outside data or dependencies (other than numpy).

Notes on the algorithm

The algorithm for the constraint is relatively straightforward, but has some complexity due to the complex ways we can layout a figure.

Figure layout

Figures are laid out in a hierarchy:

1. Figure: `fig = plt.figure()`

1. Gridspec `gs0 = gridspec.GridSpec(1, 2, figure=fig)`

    (a) Subplotspec: `ss = gs[0, 0]`

        i. Axes: `ax0 = fig.add_subplot(ss)`

    (b) Subplotspec: `ss = gs[0, 1]`

    (a) Gridspec: `gsR = gridspec.GridSpecFromSubplotSpec(2, 1, ss)`

    - Subplotspec: ss = gsR[0, 0]

      – Axes: `axR0 = fig.add_subplot(ss)`

    - Subplotspec: ss = gsR[1, 0]

      – Axes: `axR1 = fig.add_subplot(ss)`

Each item has a layoutbox associated with it. The nesting of gridspecs created with *GridSpecFromSubplotSpec* can be arbitrarily deep.

Each ~matplotlib.axes.Axes` has *two* layoutboxes. The first one, ``ax._layoutbox represents the outside of the Axes and all its decorations (i.e. ticklabels,axis labels, etc.). The second layoutbox corresponds to the Axes' `ax.position`, which sets where in the figure the spines are placed.

Why so many stacked containers? Ideally, all that would be needed are the Axes layout boxes. For the Gridspec case, a container is needed if the Gridspec is nested via *GridSpecFromSubplotSpec*. At the top level, it is desirable for symmetry, but it also makes room for *suptitle*.

For the Subplotspec/Axes case, Axes often have colorbars or other annotations that need to be packaged inside the Subplotspec, hence the need for the outer layer.

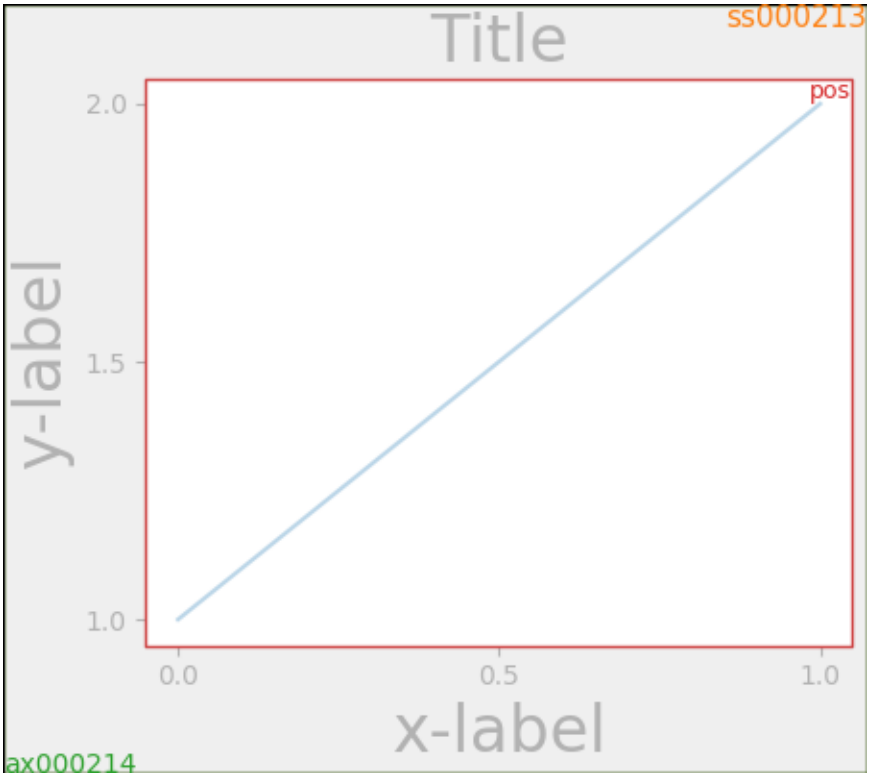
Simple case: one Axes

For a single Axes the layout is straight forward. The Figure and outer Gridspec layoutboxes coincide. The Subplotspec and Axes boxes also coincide because the Axes has no colorbar. Note the difference between the red `pos` box and the green `ax` box is set by the size of the decorations around the Axes.

In the code, this is accomplished by the entries in `do_constrained_layout` like:

```
ax._poslayoutbox.edit_left_margin_min(-bbox.x0 + pos.x0 + w_padt)
```

```
from matplotlib._layoutbox import plot_children

fig, ax = plt.subplots(constrained_layout=True)
example_plot(ax, fontsize=24)
plot_children(fig, fig._layoutbox, printit=False)
```



Simple case: two Axes

For this case, the Axes layoutboxes and the Subplotspec boxes still co-incide. However, because the decorations in the right-hand plot are so much smaller than the left-hand, so the right-hand layoutboxes are smaller.

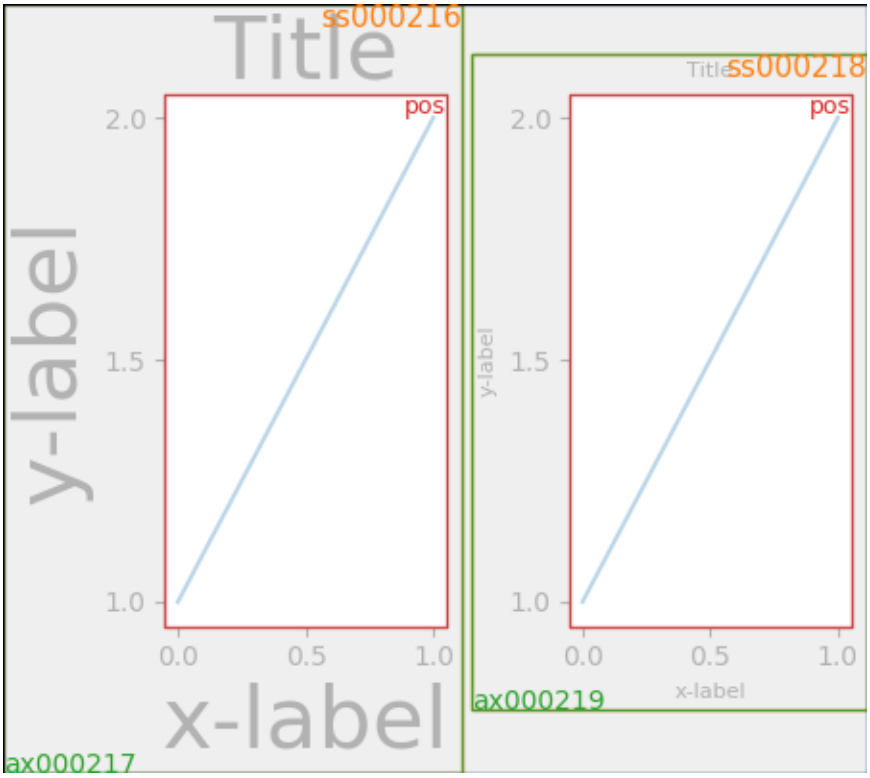
The Subplotspec boxes are laid out in the code in the subroutine `arange_subplotspecs`, which simply checks the subplotspecs in the code against one another and stacks them appropriately.

The two `pos` axes are lined up. Because they have the same minimum row, they are lined up at the top. Because they have the same maximum row they are lined up at the bottom. In the code this is accomplished via the calls to `layoutbox.align`. If there was more than one row, then the same horizontal alignment would occur between the rows.

The two `pos` axes are given the same width because the subplotspecs occupy the same number of columns. This is accomplished in the code where `dcols0` is compared to `dcolsC`. If they are equal, then their widths are constrained to be equal.

While it is a bit subtle in this case, note that the division between the Subplotspecs is *not* centered, but has been moved to the right to make space for the larger labels on the left-hand plot.

```
fig, ax = plt.subplots(1, 2, constrained_layout=True)
example_plot(ax[0], fontsize=32)
example_plot(ax[1], fontsize=8)
plot_children(fig, fig._layoutbox, printit=False)
```



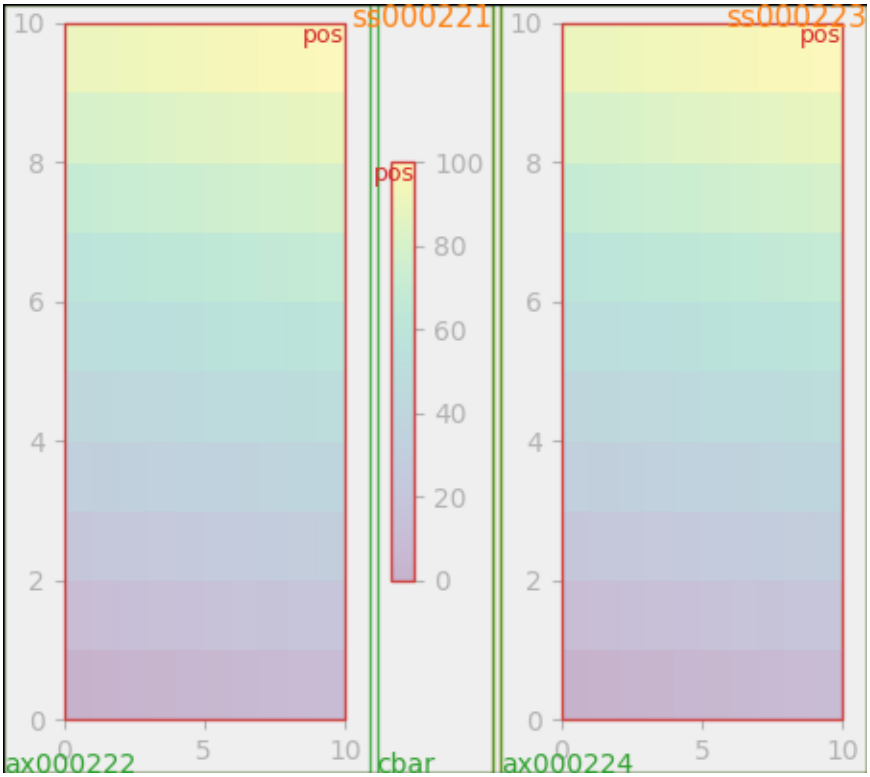
Two Axes and colorbar

Adding a colorbar makes it clear why the Subplotspec layoutboxes must be different from the axes layoutboxes. Here we see the left-hand subplotspec has more room to accommodate the *colorbar*, and that there are two green `ax` boxes inside the `ss` box.

Note that the width of the `pos` boxes is still the same because of the constraint on their widths because their subplotspecs occupy the same number of columns (one in this example).

The colorbar layout logic is contained in *make_axes* which calls `_constrained_layout.layoutcolorbarsingle` for cbars attached to a single axes, and `_constrained_layout.layoutcolorbargridspec` if the colorbar is associated with a gridspec.

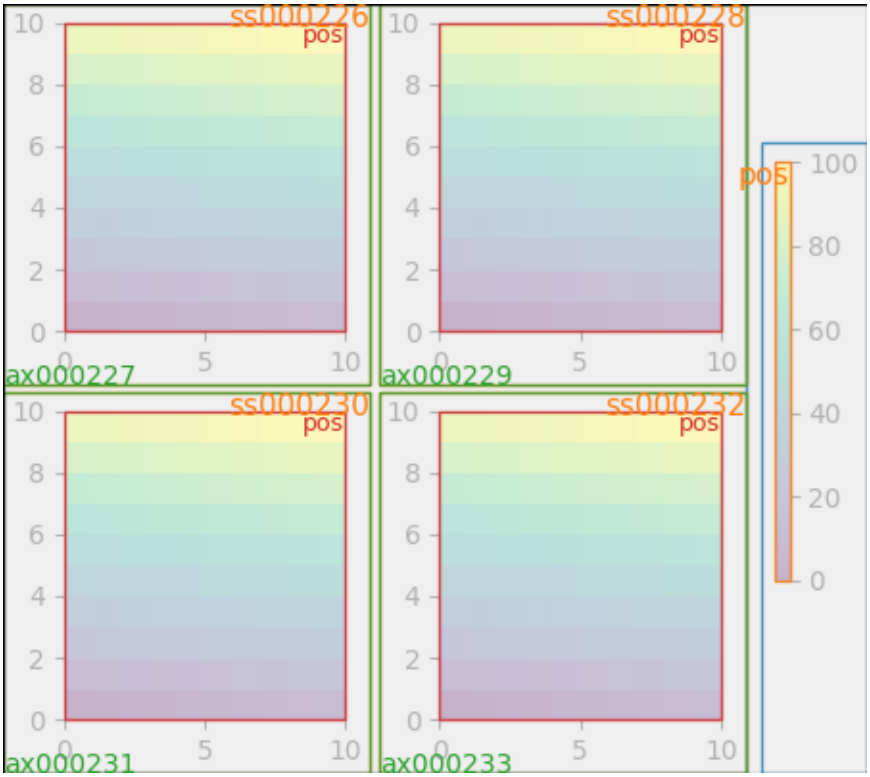
```
fig, ax = plt.subplots(1, 2, constrained_layout=True)
im = ax[0].pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=ax[0], shrink=0.6)
im = ax[1].pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```



Colorbar associated with a Gridspec

This example shows the Subplotspec layoutboxes being made smaller by a colorbar layoutbox. The size of the colorbar layoutbox is set to be *shrink* smaller than the vertical extent of the `pos` layoutboxes in the gridspec, and it is made to be centered between those two points.

```
fig, ax = plt.subplots(2, 2, constrained_layout=True)
for a in ax.flatten():
    im = a.pcolormesh(arr, **pc_kwargs)
fig.colorbar(im, ax=ax, shrink=0.6)
plot_children(fig, fig._layoutbox, printit=False)
```



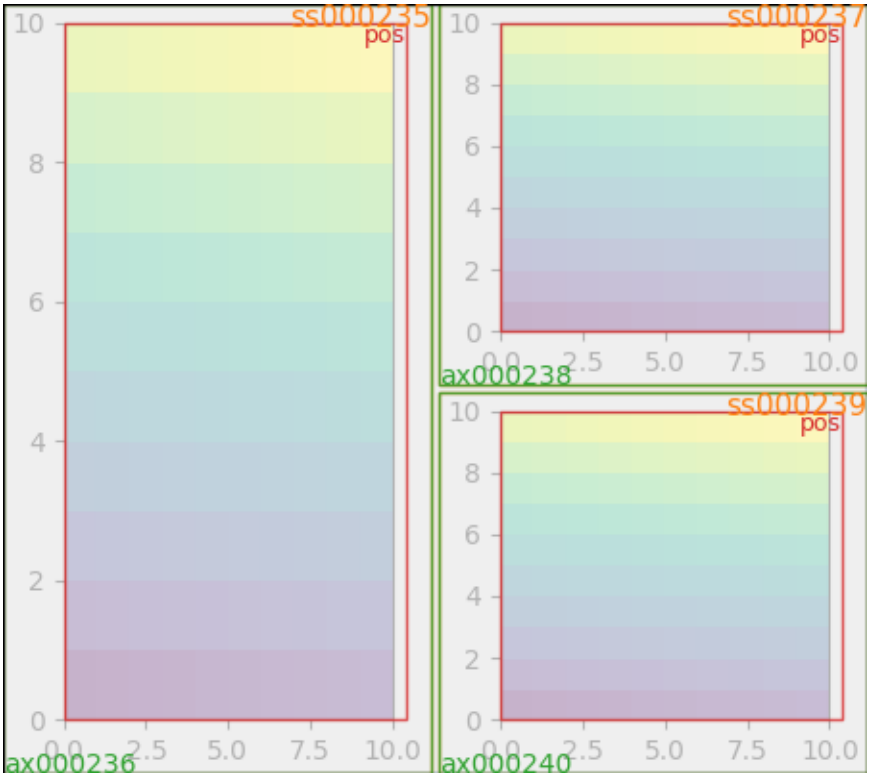
Uneven sized Axes

There are two ways to make axes have an uneven size in a Gridspec layout, either by specifying them to cross Gridspecs rows or columns, or by specifying width and height ratios.

The first method is used here. The constraint that makes the heights be correct is in the code where `drowsC < drows0` which in this case would be 1 is less than 2. So we constrain the height of the 1-row Axes to be less than half the height of the 2-row Axes.

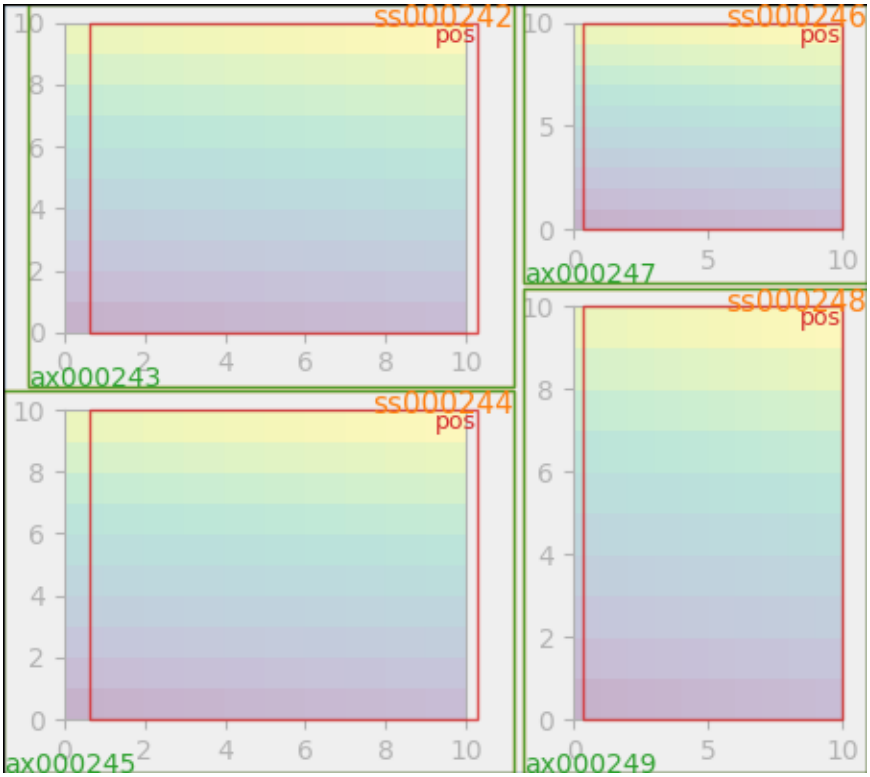
Note: This algorithm can be wrong if the decorations attached to the smaller axes are very large, so there is an unaccounted-for edge case.

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(2, 2, figure=fig)
ax = fig.add_subplot(gs[:, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[0, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[1, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```



Height and width ratios are accommodated with the same part of the code with the smaller axes always constrained to be less in size than the larger.

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(3, 2, figure=fig,
    height_ratios=[1., 0.5, 1.5],
    width_ratios=[1.2, 0.8])
ax = fig.add_subplot(gs[:2, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[2, 0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[0, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[1:, 1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
```

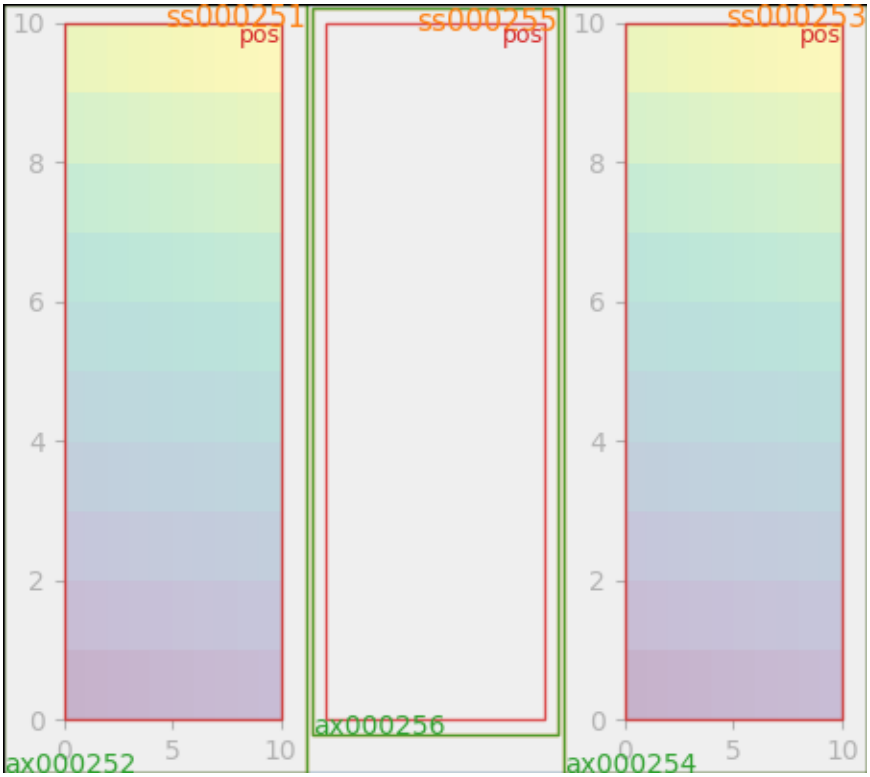


Empty gridspec slots

The final piece of the code that has not been explained is what happens if there is an empty gridspec opening. In that case a fake invisible axes is added and we proceed as before. The empty gridspec has no decorations, but the axes position in made the same size as the occupied Axes positions.

This is done at the start of `do_constrained_layout` (`hassubplotspec`).

```
fig = plt.figure(constrained_layout=True)
gs = gridspec.GridSpec(1, 3, figure=fig)
ax = fig.add_subplot(gs[0])
im = ax.pcolormesh(arr, **pc_kwargs)
ax = fig.add_subplot(gs[-1])
im = ax.pcolormesh(arr, **pc_kwargs)
plot_children(fig, fig._layoutbox, printit=False)
plt.show()
```



Other notes

The layout is called only once. This is OK if the original layout was pretty close (which it should be in most cases). However, if the layout changes a lot from the default layout then the decorators can change size. In particular the x and ytick labels can change. If this happens, then we should probably call the whole routine twice.

Total running time of the script: (0 minutes 1.924 seconds)

3.3 Advanced

These tutorials cover advanced topics for experienced Matplotlib users and developers.

Note: Click *here* to download the full example code

3.3.1 Path effects guide

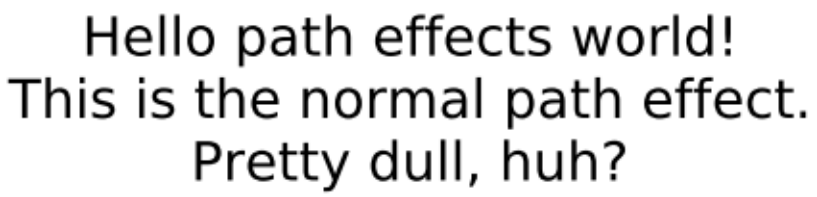
Defining paths that objects follow on a canvas.

Matplotlib's `patheffects` module provides functionality to apply a multiple draw stage to any Artist which can be rendered via a `Path`.

Artists which can have a path effect applied to them include *Patch*, *Line2D*, *Collection* and even *Text*. Each artist's path effects can be controlled via the `set_path_effects` method (*set_path_effects*), which takes an iterable of *AbstractPathEffect* instances.

The simplest path effect is the *Normal* effect, which simply draws the artist without any effect:

```
import matplotlib.pyplot as plt
import matplotlib.patheffects as path_effects

fig = plt.figure(figsize=(5, 1.5))
text = fig.text(0.5, 0.5, 'Hello path effects world!\nThis is the normal '
                          'path effect.\nPretty dull, huh?',
                ha='center', va='center', size=20)
text.set_path_effects([path_effects.Normal()])
plt.show()
```

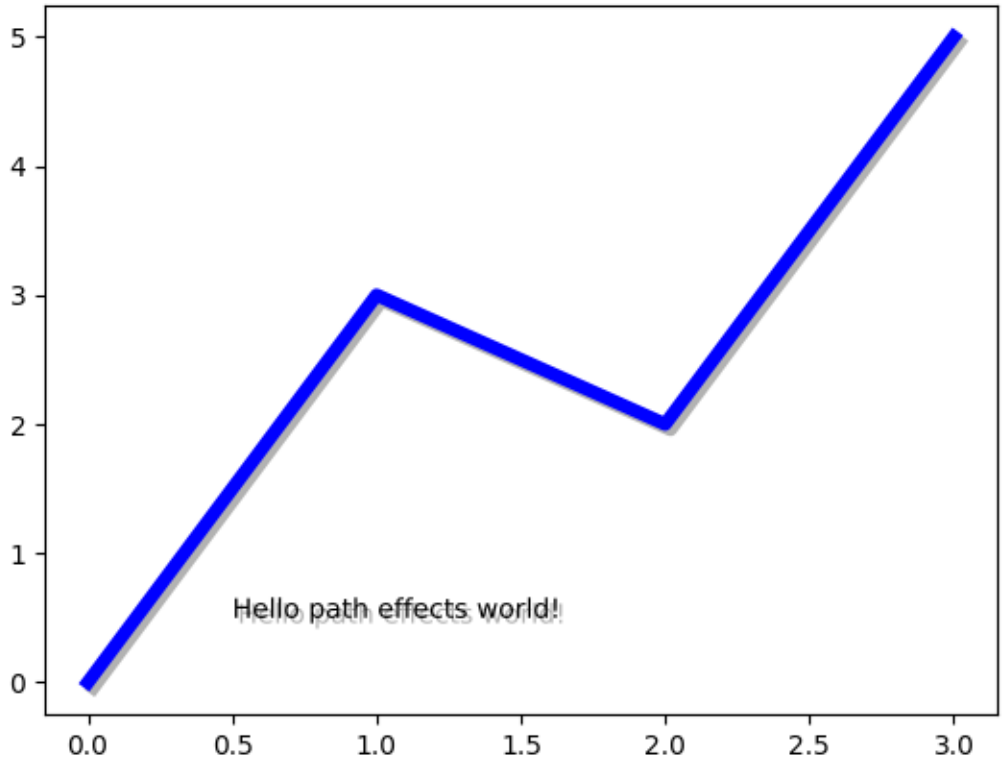


Whilst the plot doesn't look any different to what you would expect without any path effects, the drawing of the text now been changed to use the path effects framework, opening up the possibilities for more interesting examples.

Adding a shadow

A far more interesting path effect than *Normal* is the drop-shadow, which we can apply to any of our path based artists. The classes *SimplePatchShadow* and *SimpleLineShadow* do precisely this by drawing either a filled patch or a line patch below the original artist:

```
import matplotlib.patheffects as path_effects

text = plt.text(0.5, 0.5, 'Hello path effects world!',
                path_effects=[path_effects.withSimplePatchShadow()])

plt.plot([0, 3, 2, 5], linewidth=5, color='blue',
         path_effects=[path_effects.SimpleLineShadow(),
                       path_effects.Normal()])
plt.show()
```



Notice the two approaches to setting the path effects in this example. The first uses the `with*` classes to include the desired functionality automatically followed with the "normal" effect, whereas the latter explicitly defines the two path effects to draw.

Making an artist stand out

One nice way of making artists visually stand out is to draw an outline in a bold color below the actual artist. The *Stroke* path effect makes this a relatively simple task:

```
fig = plt.figure(figsize=(7, 1))
text = fig.text(0.5, 0.5, 'This text stands out because of\n'
                          'its black border.', color='white',
                          ha='center', va='center', size=30)
text.set_path_effects([path_effects.Stroke(linewidth=3, foreground='black'),
                       path_effects.Normal()])
plt.show()
```

It is important to note that this effect only works because we have drawn the text path twice; once with a thick black line, and then once with the original text path on top.

You may have noticed that the keywords to *Stroke* and *SimplePatchShadow* and *SimpleLineShadow* are not the usual Artist keywords (such as `facecolor` and `edgecolor` etc.). This is because with these path effects we are operating at lower level of matplotlib. In fact, the keywords which are accepted are those for a *matplotlib.backend_bases.GraphicsContextBase* instance, which have been designed for making it easy to create new backends - and not for its user interface.

Greater control of the path effect artist

As already mentioned, some of the path effects operate at a lower level than most users will be used to, meaning that setting keywords such as `facecolor` and `edgecolor` raise an AttributeError. Luckily there is a generic *PathPatchEffect* path effect which creates a *PathPatch* class with the original path. The keywords to this effect are identical to those of *PathPatch*:

```
fig = plt.figure(figsize=(8, 1))
t = fig.text(0.02, 0.5, 'Hatch shadow', fontsize=75, weight=1000, va='center')
t.set_path_effects([path_effects.PathPatchEffect(offset=(4, -4), hatch='xxxx',
                                                 facecolor='gray'),
                    path_effects.PathPatchEffect(edgecolor='white', linewidth=1.1,
                                                 facecolor='black')])
plt.show()
```

Note: Click *here* to download the full example code

3.3.2 Path Tutorial

Defining paths in your Matplotlib visualization.

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
```

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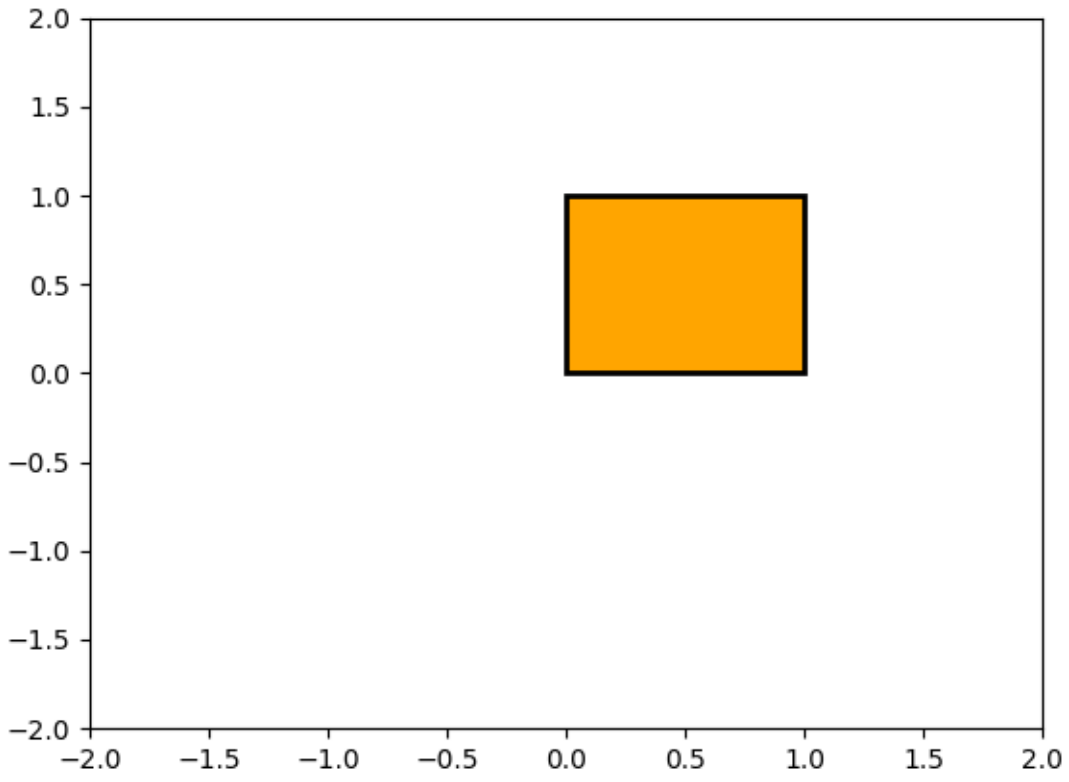
```
    (0., 1.),  # left, top
    (1., 1.),  # right, top
    (1., 0.),  # right, bottom
    (0., 0.),  # ignored
]

codes = [
    Path.MOVETO,
    Path.LINETO,
    Path.LINETO,
    Path.LINETO,
    Path.CLOSEPOLY,
]

path = Path(verts, codes)

fig, ax = plt.subplots()
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.

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

```
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, ax = plt.subplots()
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')
```

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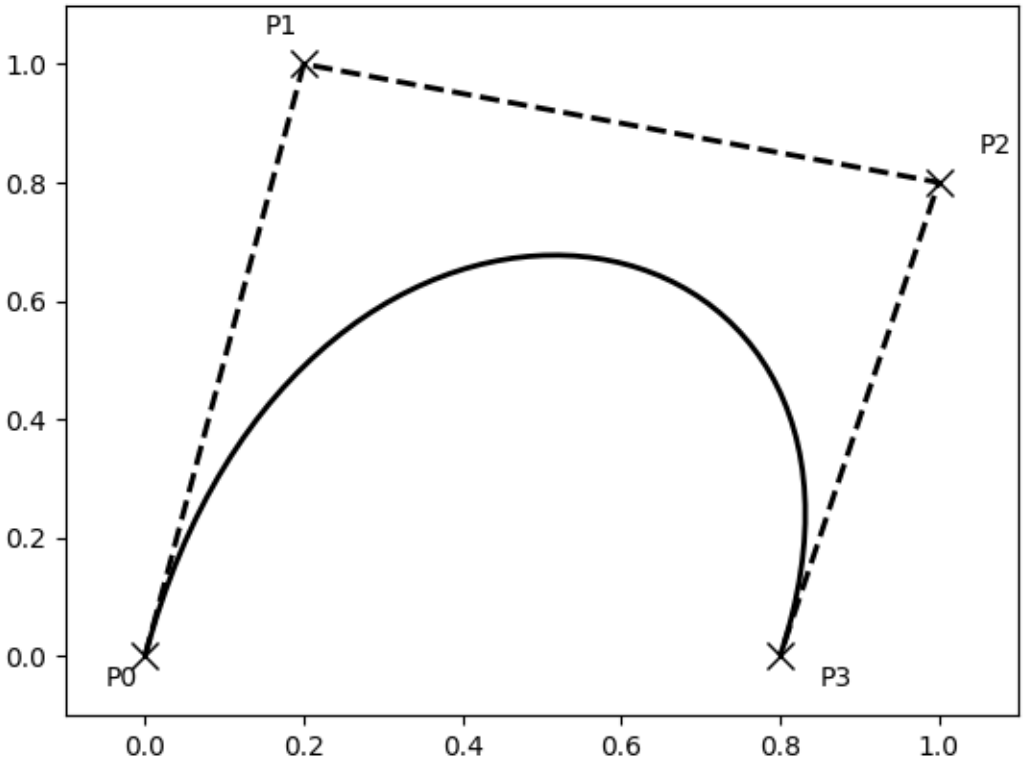
```
ax.set_xlim(-0.1, 1.1)
ax.set_ylim(-0.1, 1.1)
plt.show()
```



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, e.g., 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, e.g., 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)
```

```
import numpy as np
import matplotlib.patches as patches
import matplotlib.path as path

fig, ax = plt.subplots()
# Fixing random state for reproducibility
np.random.seed(19680801)

# histogram our data with numpy
data = np.random.randn(1000)
n, bins = np.histogram(data, 100)
```

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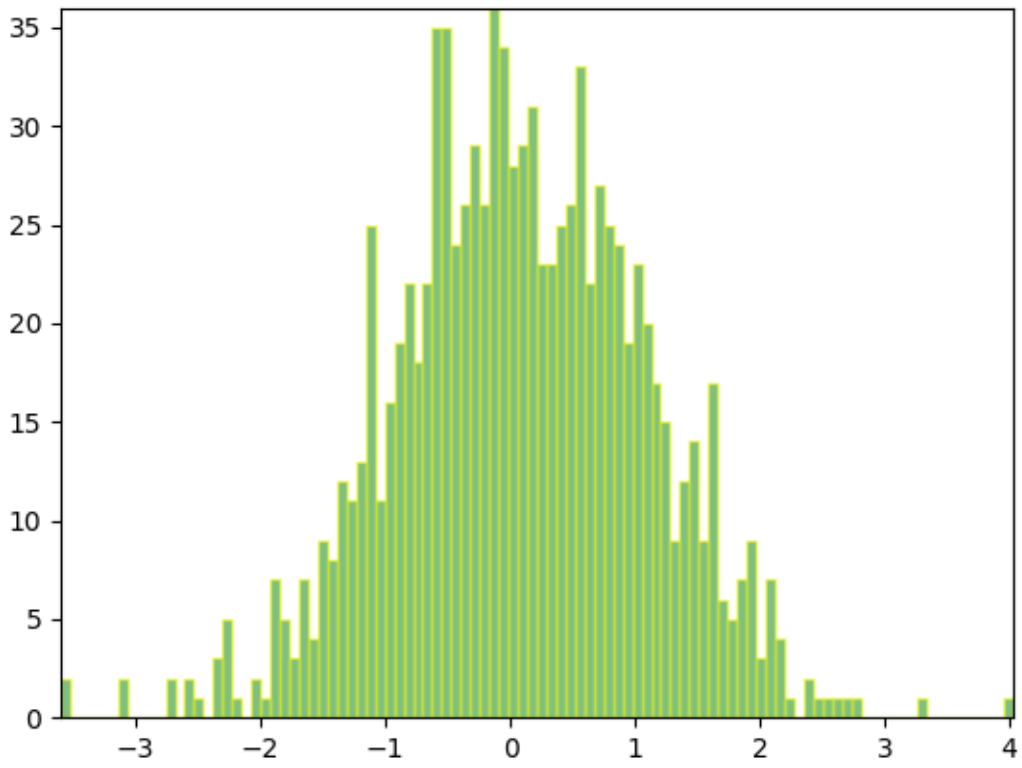
```
# get the corners of the rectangles for the histogram
left = np.array(bins[:-1])
right = np.array(bins[1:])
bottom = np.zeros(len(left))
top = bottom + n
nrects = len(left)

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

barpath = path.Path(verts, codes)
patch = patches.PathPatch(barpath, facecolor='green',
                          edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)

ax.set_xlim(left[0], right[-1])
ax.set_ylim(bottom.min(), top.max())

plt.show()
```



Note: Click *here* to download the full example code

3.3.3 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 some useful 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.

Coordinates	Transformation object	Description
"data"	`ax.transData`	The coordinate system for the data, controlled by 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`, or `IdentityTransform()`	The pixel coordinate system of the display; (0, 0) is bottom left of the display, and (width, height) is top right of the display in pixels.
"xaxis", "yaxis"	`ax.get_xaxis_transform()`, `ax.get_yaxis_transform()`	Blended coordinate systems; use data coordinates on one of the axis and axes coordinates on the other.

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.

Data coordinates

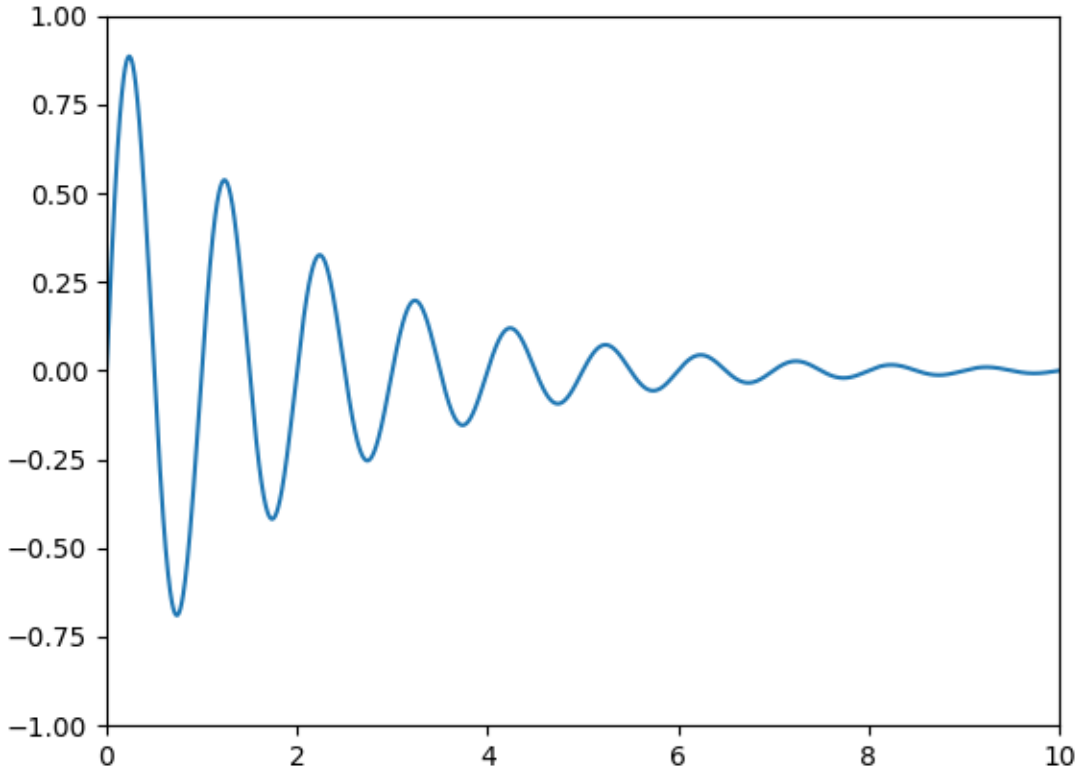
Let's start with the most commonly used coordinate, the `data` coordinate system. Whenever you add data to the axes, Matplotlib updates the datalimits, most commonly updated with the *set_xlim()* and *set_ylim()* methods. For example, in the figure below, the data limits stretch from 0 to 10 on the x-axis,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

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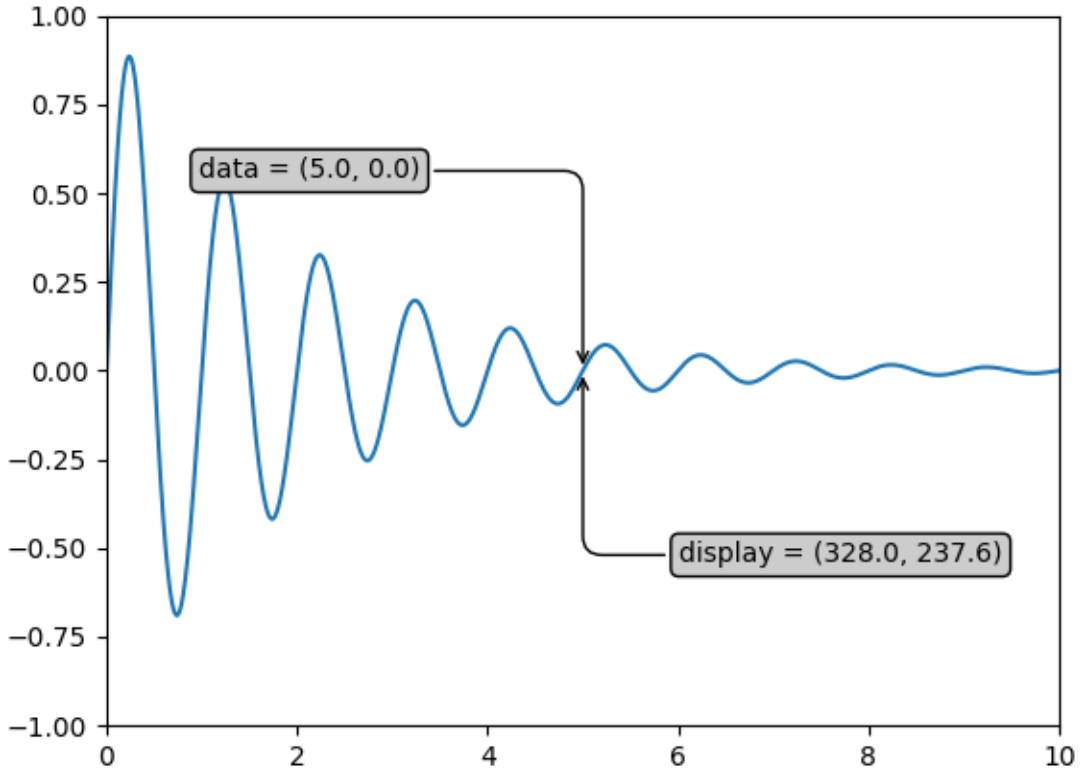
```
Out[43]: array([ 5.,  0.])
```

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.

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

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

xdata, ydata = 5, 0
xdisplay, ydisplay = ax.transData.transform_point((xdata, ydata))

bbox = dict(boxstyle="round", fc="0.8")
arrowprops = dict(
    arrowstyle="->",
    connectionstyle="angle,angleA=0,angleB=90,rad=10")

offset = 72
ax.annotate('data = (%.1f, %.1f)' % (xdata, ydata),
            (xdata, ydata), xytext=(-2*offset, offset), textcoords='offset points',
            bbox=bbox, arrowprops=arrowprops)


disp = ax.annotate('display = (%.1f, %.1f)' % (xdisplay, ydisplay),
                   (xdisplay, ydisplay), xytext=(0.5*offset, -offset),
                   xycoords='figure pixels',
                   textcoords='offset points',
                   bbox=bbox, arrowprops=arrowprops)


plt.show()
```



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])
```

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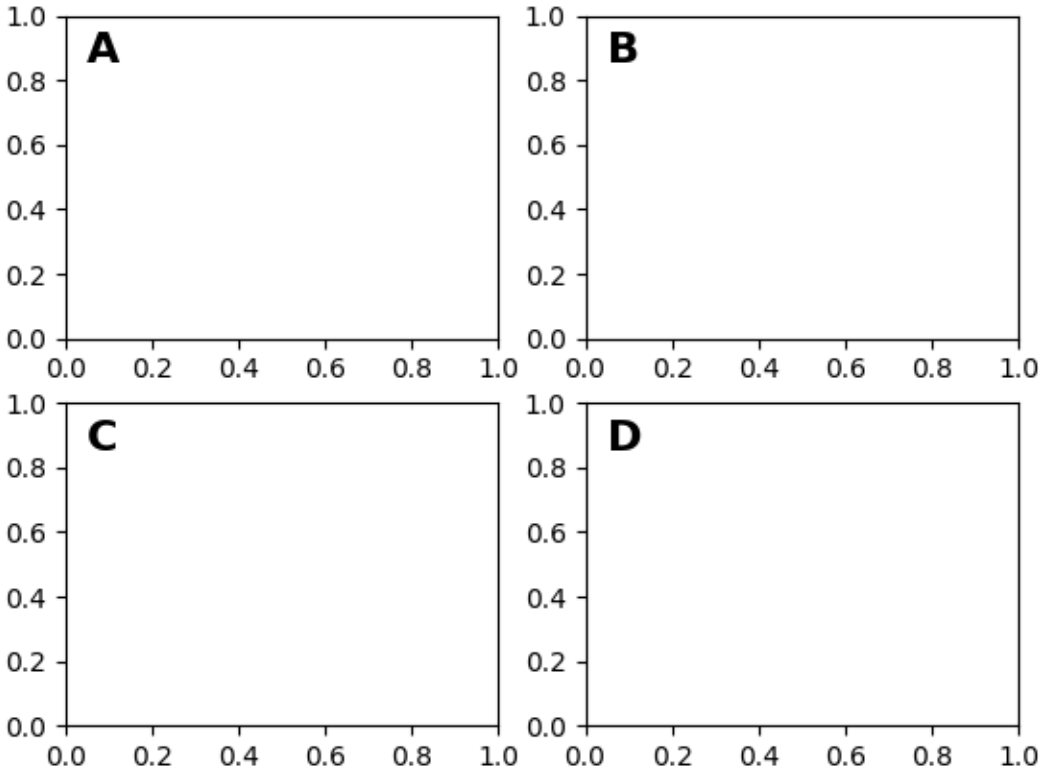
```
In [57]: ax.set_xlim(10, 20)
Out[57]: (10, 20)

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

Axes coordinates

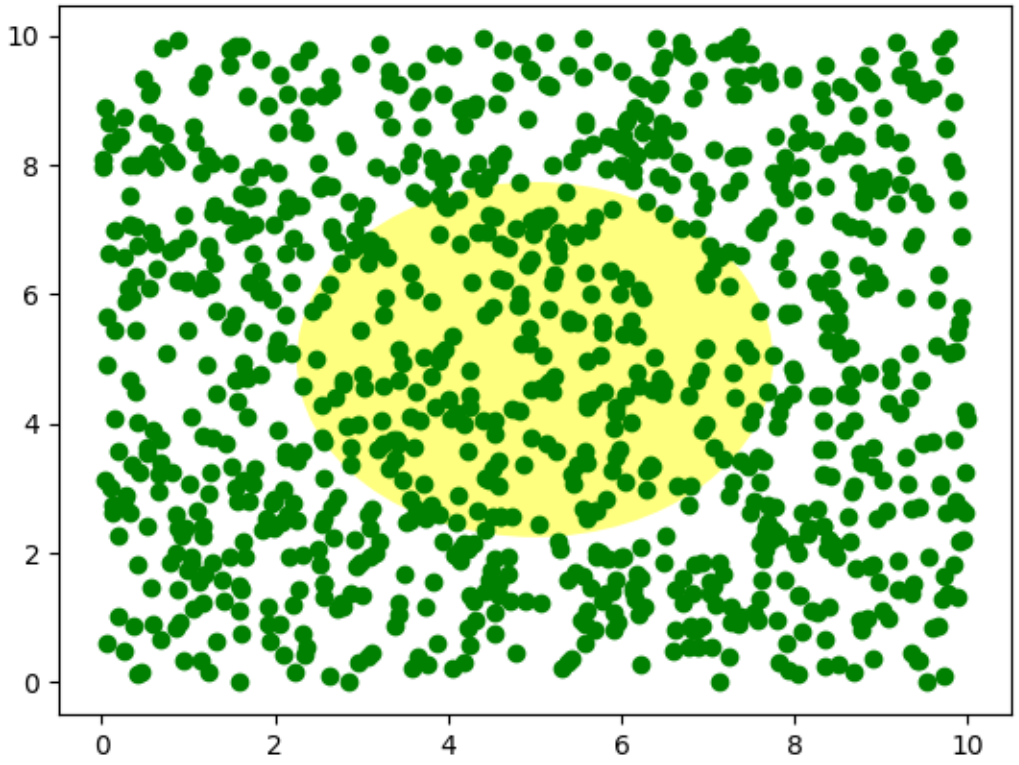
After the `data` coordinate system, `axes` is probably the second most useful coordinate system. Here the point (0, 0) is the bottom left of your axes or subplot, (0.5, 0.5) is the center, and (1.0, 1.0) is the top right. You can also refer to points outside the range, so (-0.1, 1.1) is to the left and 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, e.g., 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.

```
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 matplotlib.patches as patches

fig, ax = plt.subplots()

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()
```



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 matplotlib.transforms as transforms

fig, ax = plt.subplots()
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(
```

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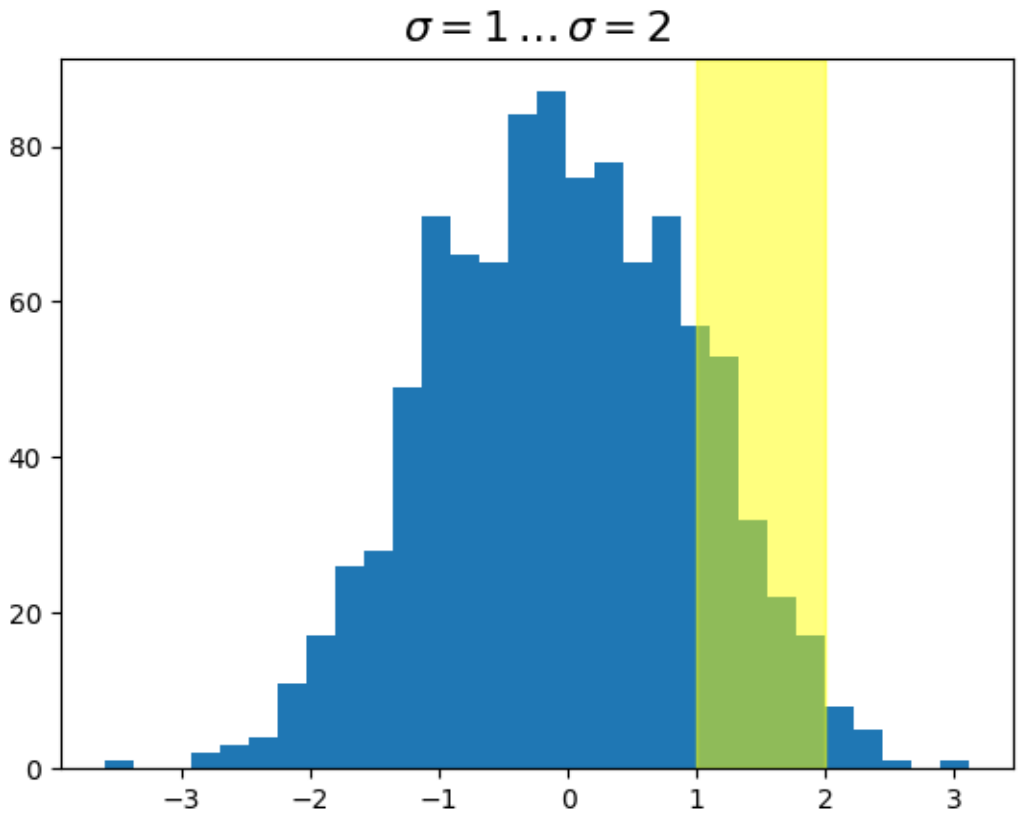
```
    ax.transData, ax.transAxes)

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

ax.add_patch(rect)

plt.show()
```



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

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

Using offset transforms to create a shadow effect

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

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

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

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

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

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

```
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')
```

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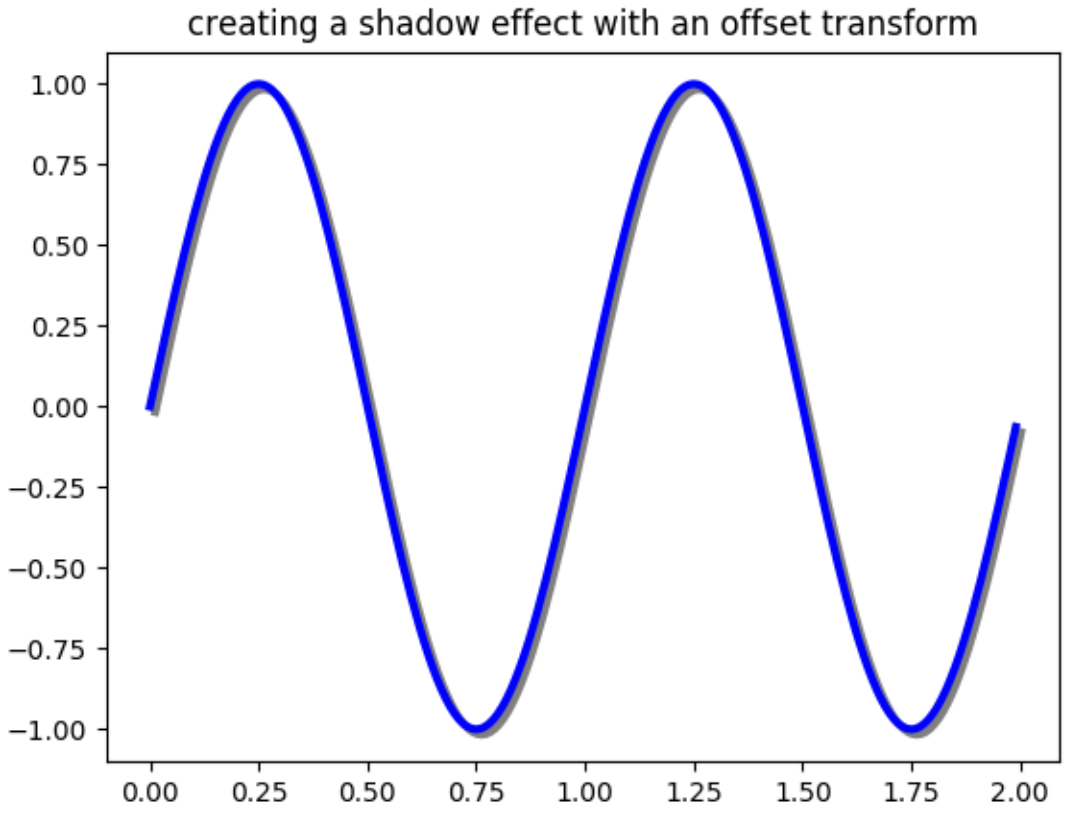
```
plt.show()
```



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, e.g., 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, e.g., 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 /gallery/misc/custom_projection.

3.4 Colors

Matplotlib has support for visualizing information with a wide array of colors and colormaps. These tutorials cover the basics of how these colormaps look, how you can create your own, and how you can customize colormaps for your use case.

For even more information see the examples page.

Note: Click *here* to download the full example code

3.4.1 Specifying Colors

Matplotlib recognizes the following formats to specify a color:

- an RGB or RGBA tuple of float values in `[0, 1]` (e.g., `(0.1, 0.2, 0.5)` or `(0.1, 0.2, 0.5, 0.3)`). RGBA is short for Red, Green, Blue, Alpha;
- a hex RGB or RGBA string (e.g., `'#0F0F0F'` or `'#0F0F0F0F'`);
- a string representation of a float value in `[0, 1]` inclusive for gray level (e.g., `'0.5'`);
- one of `{'b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'}`;
- a X11/CSS4 color name;
- a name from the xkcd color survey; prefixed with `'xkcd:'` (e.g., `'xkcd:sky blue'`);
- one of `{'tab:blue', 'tab:orange', 'tab:green', 'tab:red', 'tab:purple', 'tab:brown', 'tab:pink', 'tab:gray', 'tab:olive', 'tab:cyan'}` which are the Tableau Colors from the 'T10' categorical palette (which is the default color cycle);
- a "CN" color spec, i.e. `'C'` followed by a single digit, which is an index into the default property cycle (`matplotlib.rcParams['axes.prop_cycle']`); the indexing occurs at artist creation time and defaults to black if the cycle does not include color.

"Red", "Green" and "Blue", are the intensities of those colors, the combination of which span the colorspace.

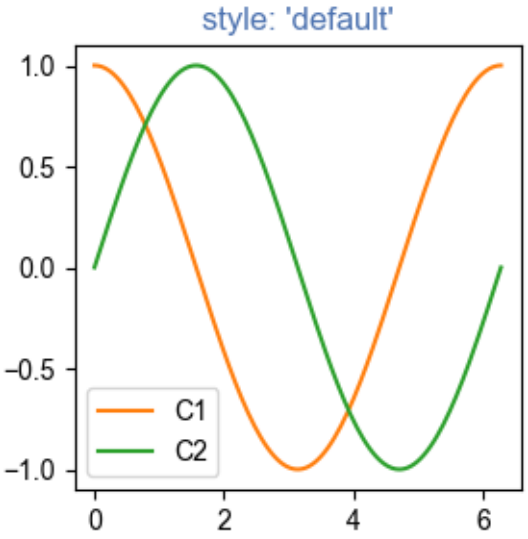
How "Alpha" behaves depends on the `zorder` of the Artist. Higher `zorder` Artists are drawn on top of lower Artists, and "Alpha" determines whether the lower artist is covered by the higher. If the old RGB of a pixel is `RGBold` and the RGB of the pixel of the Artist being added is `RGBnew` with Alpha `alpha`, then the RGB of the pixel is updated to: `RGB = RGBOld * (1 - Alpha) + RGBnew * Alpha`. Alpha of 1 means the old color is completely covered by the new Artist, Alpha of 0 means that pixel of the Artist is transparent.

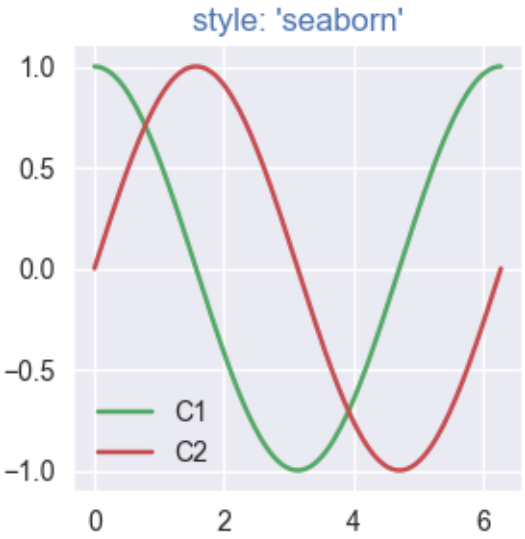
All string specifications of color, other than "CN", are case-insensitive.

"CN" color selection

"CN" colors are converted to RGBA as soon as the artist is created. For example,

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

th = np.linspace(0, 2*np.pi, 128)


def demo(sty):
    mpl.style.use(sty)
    fig, ax = plt.subplots(figsize=(3, 3))

    ax.set_title('style: {!r}'.format(sty), color='C0')

    ax.plot(th, np.cos(th), 'C1', label='C1')
    ax.plot(th, np.sin(th), 'C2', label='C2')
    ax.legend()

demo('default')
demo('seaborn')
```

- 



will use the first color for the title and then plot using the second and third colors of each style's `mpl.rcParams['axes.prop_cycle']`.

xkcd v X11/CSS4

The xkcd colors are derived from a user survey conducted by the webcomic xkcd. Details of the survey are available on the xkcd blog.

Out of 148 colors in the CSS color list, there are 95 name collisions between the X11/CSS4 names and the xkcd names, all but 3 of which have different hex values. For example `'blue'` maps to `'#0000FF'` where as `'xkcd:blue'` maps to `'#0343DF'`. Due to these name collisions all of the xkcd colors have `'xkcd:'` prefixed. As noted in the blog post, while it might be interesting to re-define the X11/CSS4 names based on such a survey, we do not do so unilaterally.

The name collisions are shown in the table below; the color names where the hex values agree are shown in bold.

```
import matplotlib._color_data as mcd
import matplotlib.patches as mpatch

overlap = {name for name in mcd.CSS4_COLORS
           if "xkcd:" + name in mcd.XKCD_COLORS}

fig = plt.figure(figsize=[4.8, 16])
ax = fig.add_axes([0, 0, 1, 1])

for j, n in enumerate(sorted(overlap, reverse=True)):
    weight = None
    cn = mcd.CSS4_COLORS[n]
    xkcd = mcd.XKCD_COLORS["xkcd:" + n].upper()
    if cn == xkcd:
        weight = 'bold'
```

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```
    r1 = mpatch.Rectangle((0, j), 1, 1, color=cn)
    r2 = mpatch.Rectangle((1, j), 1, 1, color=xkcd)
    txt = ax.text(2, j+.5, '  ' + n, va='center', fontsize=10,
                  weight=weight)
    ax.add_patch(r1)
    ax.add_patch(r2)
    ax.axhline(j, color='k')

ax.text(.5, j + 1.5, 'X11', ha='center', va='center')
ax.text(1.5, j + 1.5, 'xkcd', ha='center', va='center')
ax.set_xlim(0, 3)
ax.set_ylim(0, j + 2)
ax.axis('off')
```

X11
xkcd
aqua
aquamarine
azure
beige
black
blue
brown
chartreuse
chocolate
coral
crimson
cyan
darkblue
darkgreen
fuchsia
gold
goldenrod
green
grey
indigo
ivory
khaki
lavender
lightblue
lightgreen
lime
magenta
maroon
navy
olive

Note: Click *here* to download the full example code

3.4.2 Customized Colorbars Tutorial

This tutorial shows how to build colorbars without an attached plot.

Customized Colorbars

ColorbarBase derives from *ScalarMappable* and puts a colorbar in a specified axes, so it has everything needed for a standalone colorbar. It can be used as is to make a colorbar for a given colormap and does not need a mappable object like an image. In this tutorial we will explore what can be done with standalone colorbar.

Basic continuous colorbar

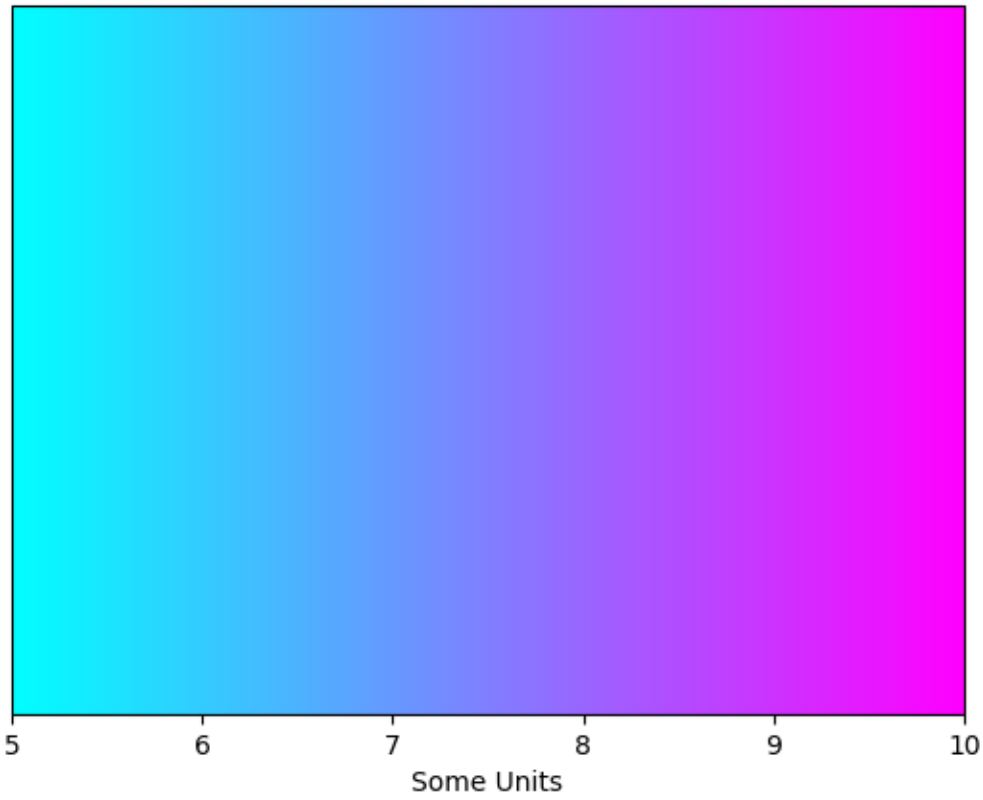
Set the colormap and norm to correspond to the data for which the colorbar will be used. Then create the colorbar by calling *ColorbarBase* and specify axis, colormap, norm and orientation as parameters. Here we create a basic continuous colorbar with ticks and labels. More information on colorbar api can be found here.

```
import matplotlib.pyplot as plt
import matplotlib as mpl

fig, ax = plt.subplots()

cmap = mpl.cm.cool
norm = mpl.colors.Normalize(vmin=5, vmax=10)

cb1 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                                norm=norm,
                                orientation='horizontal')
cb1.set_label('Some Units')
fig.show()
```



Discrete intervals colorbar

The second example illustrates the use of a *ListedColormap* which generates a colormap from a set of listed colors, `colors.BoundaryNorm()` which generates a colormap index based on discrete intervals and extended ends to show the "over" and "under" value colors. Over and under are used to display data outside of the normalized [0,1] range. Here we pass colors as gray shades as a string encoding a float in the 0-1 range.

If a *ListedColormap* is used, the length of the bounds array must be one greater than the length of the color list. The bounds must be monotonically increasing.

This time we pass some more arguments in addition to previous arguments to *ColorbarBase*. For the out-of-range values to display on the colorbar, we have to use the *extend* keyword argument. To use *extend*, you must specify two extra boundaries. Finally spacing argument ensures that intervals are shown on colorbar proportionally.

```
fig, ax = plt.subplots()

cmap = mpl.colors.ListedColormap(['red', 'green', 'blue', 'cyan'])
cmap.set_over('0.25')
cmap.set_under('0.75')
```

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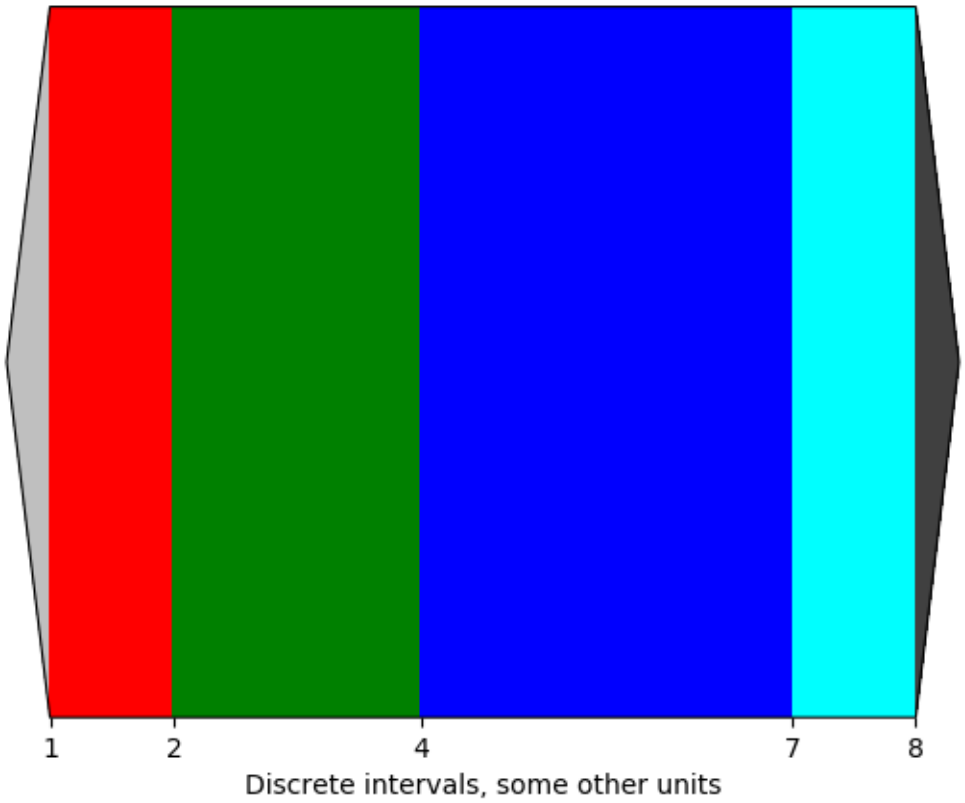
```
bounds = [1, 2, 4, 7, 8]
norm = mpl.colors.BoundaryNorm(bounds, cmap.N)
cb2 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                                norm=norm,
                                boundaries=[0] + bounds + [13],
                                extend='both',
                                ticks=bounds,
                                spacing='proportional',
                                orientation='horizontal')
cb2.set_label('Discrete intervals, some other units')
fig.show()
```



Colorbar with custom extension lengths

Here we illustrate the use of custom length colorbar extensions, used on a colorbar with discrete intervals. To make the length of each extension same as the length of the interior colors, use `extendfrac='auto'`.

```
fig, ax = plt.subplots()
```

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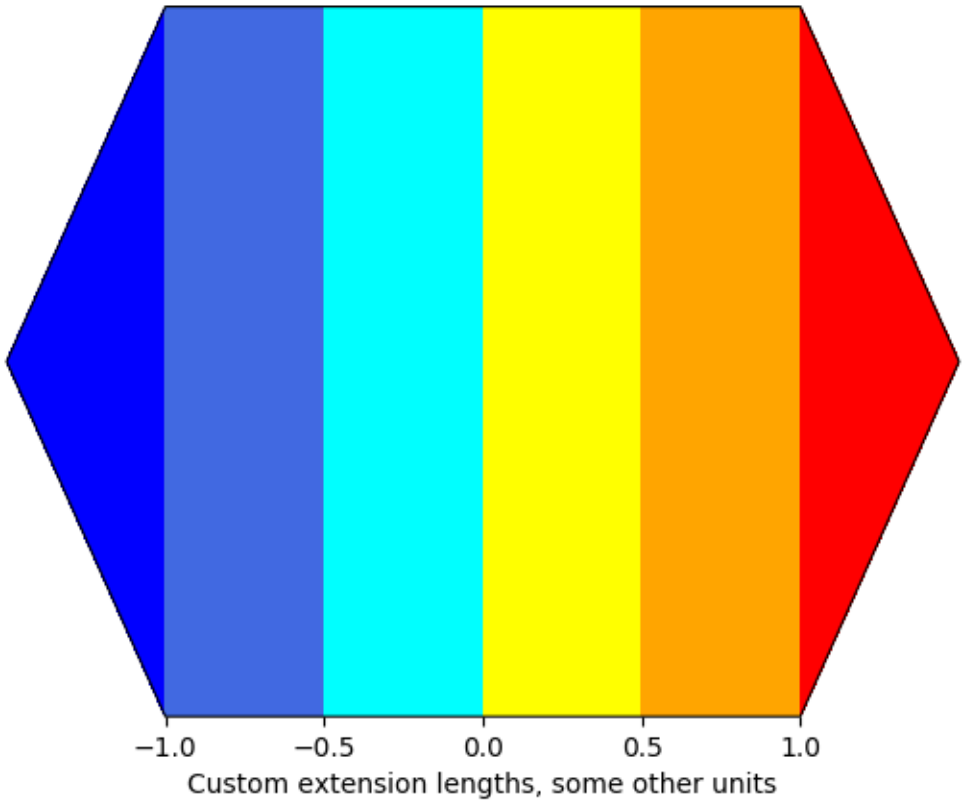
```
cmap = mpl.colors.ListedColormap(['royalblue', 'cyan',
                                  'yellow', 'orange'])
cmap.set_over('red')
cmap.set_under('blue')

bounds = [-1.0, -0.5, 0.0, 0.5, 1.0]
norm = mpl.colors.BoundaryNorm(bounds, cmap.N)
cb3 = mpl.colorbar.ColorbarBase(ax, cmap=cmap,
                                norm=norm,
                                boundaries=[-10] + bounds + [10],
                                extend='both',
                                extendfrac='auto',
                                ticks=bounds,
                                spacing='uniform',
                                orientation='horizontal')
cb3.set_label('Custom extension lengths, some other units')
fig.show()
```



Note: Click *here* to download the full example code

3.4.3 Colormap Normalization

Objects that use colormaps by default linearly map the colors in the colormap from data values *vmin* to *vmax*. For example:

```
pcm = ax.pcolormesh(x, y, Z, vmin=-1., vmax=1., cmap='RdBu_r')
```

will map the data in *Z* linearly from -1 to +1, so *Z=0* will give a color at the center of the colormap *RdBu_r* (white in this case).

Matplotlib does this mapping in two steps, with a normalization from [0,1] occurring first, and then mapping onto the indices in the colormap. Normalizations are classes defined in the *matplotlib.colors()* module. The default, linear normalization is *matplotlib.colors.Normalize()*.

Artists that map data to color pass the arguments *vmin* and *vmax* to construct a *matplotlib.colors.Normalize()* instance, then call it:

```
In [1]: import matplotlib as mpl

In [2]: norm = mpl.colors.Normalize(vmin=-1.,vmax=1.)

In [3]: norm(0.)
Out[3]: 0.5
```

However, there are sometimes cases where it is useful to map data to colormaps in a non-linear fashion.

Logarithmic

One of the most common transformations is to plot data by taking its logarithm (to the base-10). This transformation is useful to display changes across disparate scales. Using `colors.LogNorm()` normalizes the data via log_{10}. In the example below, there are two bumps, one much smaller than the other. Using `colors.LogNorm()`, the shape and location of each bump can clearly be seen:

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

N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]

# A low hump with a spike coming out of the top right.  Needs to have
# z/colour axis on a log scale so we see both hump and spike.  linear
# scale only shows the spike.
Z1 = np.exp(-(X)**2 - (Y)**2)
Z2 = np.exp(-(X * 10)**2 - (Y * 10)**2)
Z = Z1 + 50 * Z2

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolor(X, Y, Z,
                   norm=colors.LogNorm(vmin=Z.min(), vmax=Z.max()),
```

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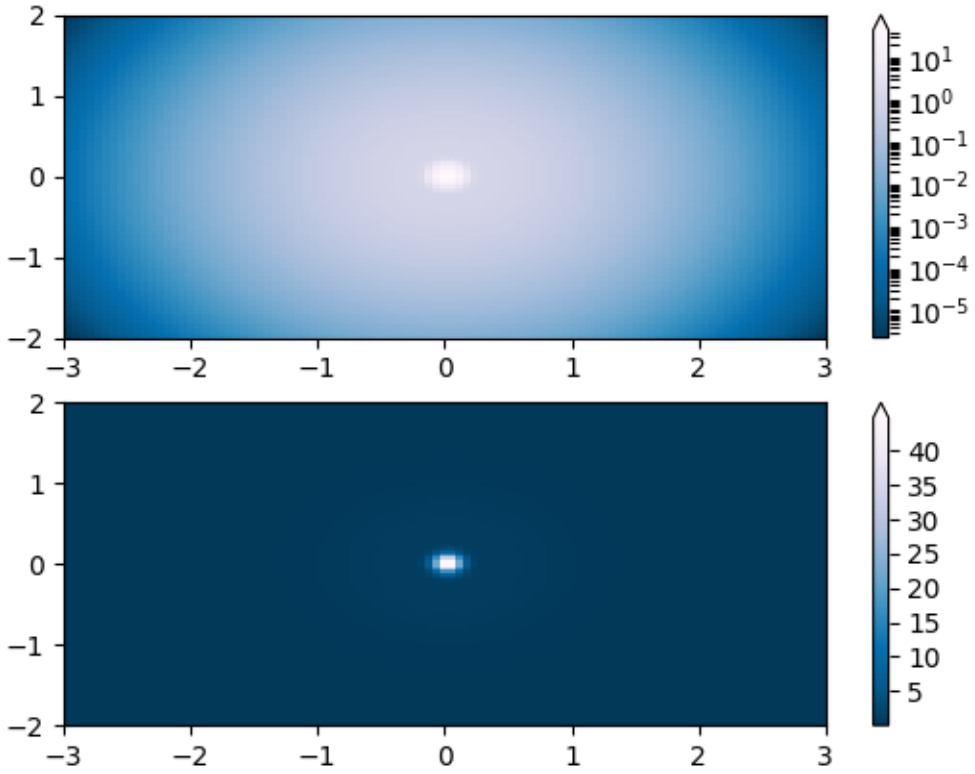
```
                    cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[0], extend='max')

pcm = ax[1].pcolor(X, Y, Z, cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[1], extend='max')
fig.show()
```

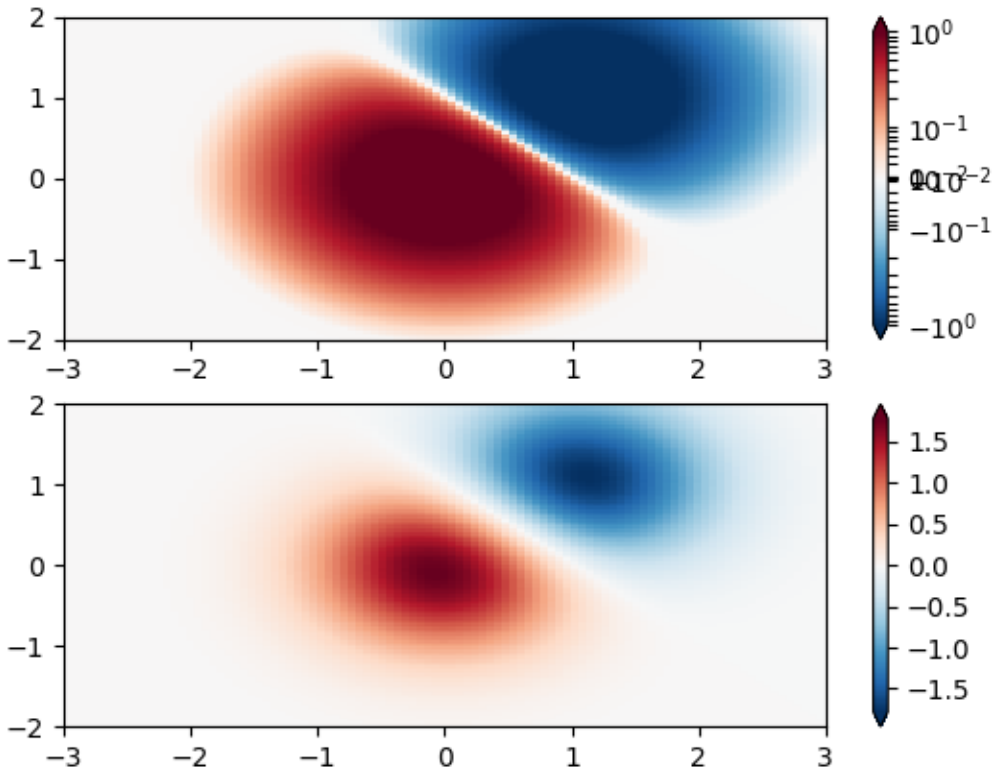


Symmetric logarithmic

Similarly, it sometimes happens that there is data that is positive and negative, but we would still like a logarithmic scaling applied to both. In this case, the negative numbers are also scaled logarithmically, and mapped to smaller numbers; e.g., if `vmin=-vmax`, then they the negative numbers are mapped from 0 to 0.5 and the positive from 0.5 to 1.

Since the logarithm of values close to zero tends toward infinity, a small range around zero needs to be mapped linearly. The parameter *linthresh* allows the user to specify the size of this range (*-linthresh*, *linthresh*). The size of this range in the colormap is set by *linscale*. When *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

```
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]
Z1 = np.exp(-X**2 - Y**2)
Z2 = np.exp(-(X - 1)**2 - (Y - 1)**2)
Z = (Z1 - Z2) * 2

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolormesh(X, Y, Z,
                       norm=colors.SymLogNorm(linthresh=0.03, linscale=0.03,
                                              vmin=-1.0, vmax=1.0),
                       cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[0], extend='both')

pcm = ax[1].pcolormesh(X, Y, Z, cmap='RdBu_r', vmin=-np.max(Z))
fig.colorbar(pcm, ax=ax[1], extend='both')
fig.show()
```



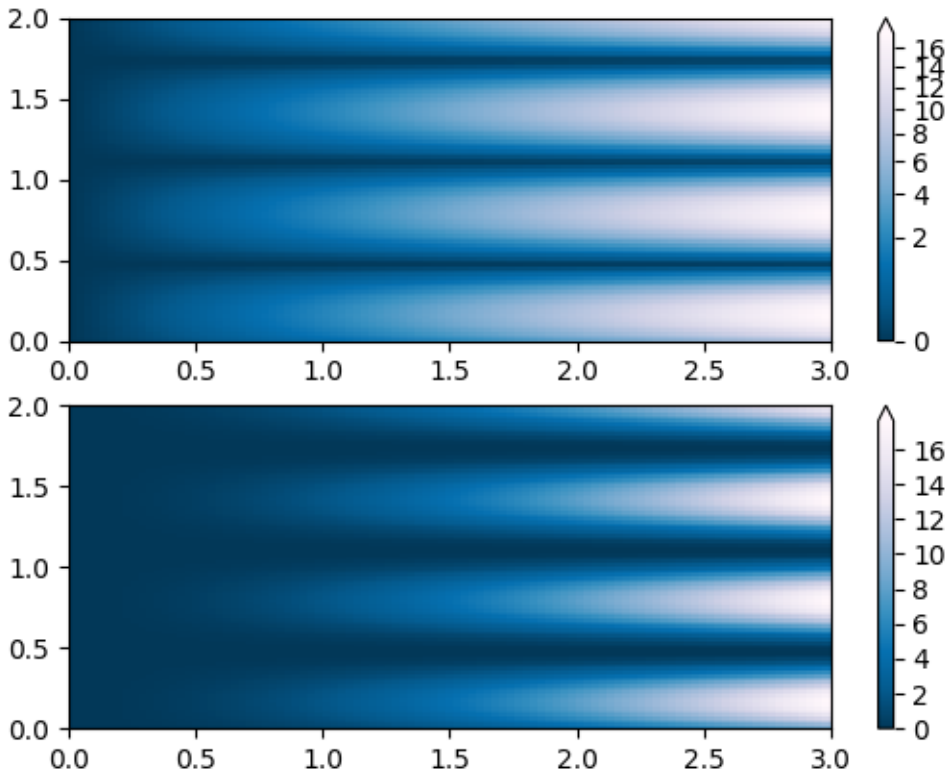
Power-law

Sometimes it is useful to remap the colors onto a power-law relationship (i.e. $y = x^{\gamma}$, where γ is the power). For this we use the `colors.PowerNorm()`. It takes as an argument *gamma* (*gamma* == 1.0 will just yield

the default linear normalization):

Note: There should probably be a good reason for plotting the data using this type of transformation. Technical viewers are used to linear and logarithmic axes and data transformations. Power laws are less common, and viewers should explicitly be made aware that they have been used.

```
N = 100
X, Y = np.mgrid[0:3:complex(0, N), 0:2:complex(0, N)]
Z1 = (1 + np.sin(Y * 10.)) * X**(2.)

fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolormesh(X, Y, Z1, norm=colors.PowerNorm(gamma=0.5),
                       cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[0], extend='max')

pcm = ax[1].pcolormesh(X, Y, Z1, cmap='PuBu_r')
fig.colorbar(pcm, ax=ax[1], extend='max')
fig.show()
```



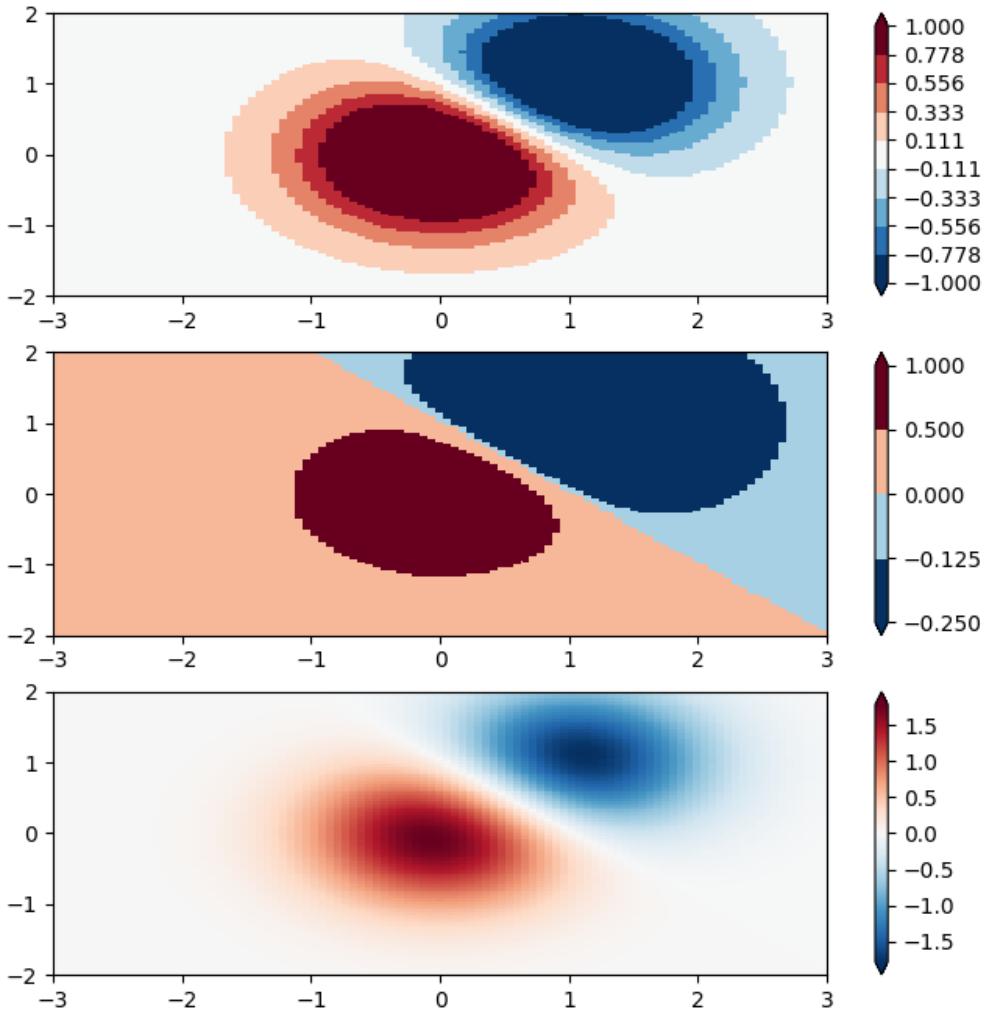
Discrete bounds

Another normaization that comes with matplolib is `colors.BoundaryNorm()`. In addition to *vmin* and *vmax*, this takes as arguments boundaries between which data is to be mapped. The colors are then linearly distributed between these "bounds". For instance:

```
In [4]: import matplotlib.colors as colors

In [5]: bounds = np.array([-0.25, -0.125, 0, 0.5, 1])

In [6]: norm = colors.BoundaryNorm(boundaries=bounds, ncolors=4)

In [7]: print(norm([-0.2,-0.15,-0.02, 0.3, 0.8, 0.99]))
[0 0 1 2 3 3]
```

Note unlike the other norms, this norm returns values from 0 to *ncolors*-1.

```
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]
Z1 = np.exp(-X**2 - Y**2)
Z2 = np.exp(-(X - 1)**2 - (Y - 1)**2)
Z = (Z1 - Z2) * 2

fig, ax = plt.subplots(3, 1, figsize=(8, 8))
ax = ax.flatten()
# even bounds gives a contour-like effect
bounds = np.linspace(-1, 1, 10)
norm = colors.BoundaryNorm(boundaries=bounds, ncolors=256)
pcm = ax[0].pcolormesh(X, Y, Z,
                       norm=norm,
                       cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[0], extend='both', orientation='vertical')

# uneven bounds changes the colormapping:
bounds = np.array([-0.25, -0.125, 0, 0.5, 1])
norm = colors.BoundaryNorm(boundaries=bounds, ncolors=256)
pcm = ax[1].pcolormesh(X, Y, Z, norm=norm, cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[1], extend='both', orientation='vertical')

pcm = ax[2].pcolormesh(X, Y, Z, cmap='RdBu_r', vmin=-np.max(Z))
fig.colorbar(pcm, ax=ax[2], extend='both', orientation='vertical')
fig.show()
```



Custom normalization: Two linear ranges

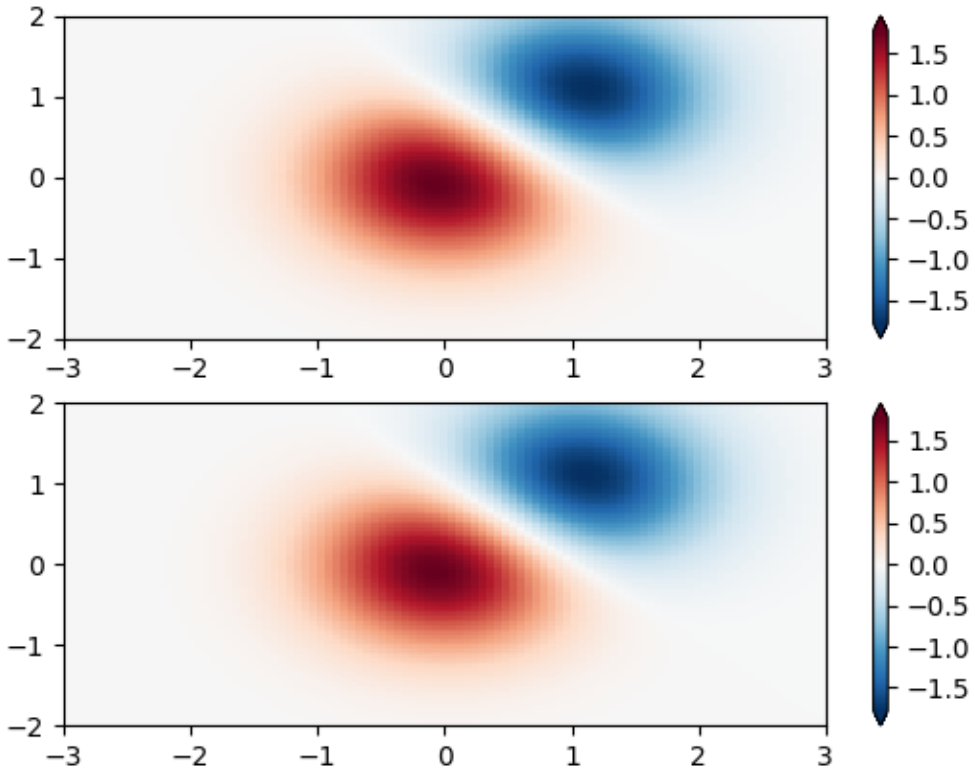
It is possible to define your own normalization. In the following example, we modify `colors:SymLogNorm()` to use different linear maps for the negative data values and the positive. (Note that this example is simple, and does not validate inputs or account for complex cases such as masked data)

Note: This may appear soon as `colors.OffsetNorm()`.

As above, non-symmetric mapping of data to color is non-standard practice for quantitative data, and should only be used advisedly. A practical example is having an ocean/land colormap where the land and ocean

data span different ranges.

```
N = 100
X, Y = np.mgrid[-3:3:complex(0, N), -2:2:complex(0, N)]
Z1 = np.exp(-X**2 - Y**2)
Z2 = np.exp(-(X - 1)**2 - (Y - 1)**2)
Z = (Z1 - Z2) * 2


class MidpointNormalize(colors.Normalize):
    def __init__(self, vmin=None, vmax=None, midpoint=None, clip=False):
        self.midpoint = midpoint
        colors.Normalize.__init__(self, vmin, vmax, clip)

    def __call__(self, value, clip=None):
        # I'm ignoring masked values and all kinds of edge cases to make a
        # simple example...
        x, y = [self.vmin, self.midpoint, self.vmax], [0, 0.5, 1]
        return np.ma.masked_array(np.interp(value, x, y))


fig, ax = plt.subplots(2, 1)

pcm = ax[0].pcolormesh(X, Y, Z,
                       norm=MidpointNormalize(midpoint=0.),
                       cmap='RdBu_r')
fig.colorbar(pcm, ax=ax[0], extend='both')

pcm = ax[1].pcolormesh(X, Y, Z, cmap='RdBu_r', vmin=-np.max(Z))
fig.colorbar(pcm, ax=ax[1], extend='both')
fig.show()
```



Note: Click *here* to download the full example code

3.4.4 Colormaps in Matplotlib

How (and why) to choose a particular colormap.

Overview

The idea behind choosing a good colormap is to find a good representation in 3D colorspace for your data set. The best colormap for any given data set depends on many things including:

- Whether representing form or metric data (*[Ware]*)
- Your knowledge of the data set (*e.g.*, is there a critical value from which the other values deviate?)
- If there is an intuitive color scheme for the parameter you are plotting
- If there is a standard in the field the audience may be expecting

For many applications, a perceptually uniform colormap is the best choice — one in which equal steps in data are perceived as equal steps in the color space. Researchers have found that the human brain perceives

changes in the lightness parameter as changes in the data much better than, for example, changes in hue. Therefore, colormaps which have monotonically increasing lightness through the colormap will be better interpreted by the viewer. A wonderful example of perceptually uniform colormaps is *[colorcet]*.

Color can be represented in 3D space in various ways. One way to represent color is using CIELAB. In CIELAB, color space is represented by lightness, L^*; red-green, a^*; and yellow-blue, b^*. The lightness parameter L^* can then be used to learn more about how the matplotlib colormaps will be perceived by viewers.

An excellent starting resource for learning about human perception of colormaps is from *[IBM]*.

Classes of colormaps

Colormaps are often split into several categories based on their function (see, *e.g.*, *[Moreland]*):

1. Sequential: change in lightness and often saturation of color incrementally, often using a single hue; should be used for representing information that has ordering.
2. Diverging: change in lightness and possibly saturation of two different colors that meet in the middle at an unsaturated color; should be used when the information being plotted has a critical middle value, such as topography or when the data deviates around zero.
3. Qualitative: often are miscellaneous colors; should be used to represent information which does not have ordering or relationships.

```
# sphinx_gallery_thumbnail_number = 2

import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt
from matplotlib import cm
from colorspacious import cspace_converter
from collections import OrderedDict

cmaps = OrderedDict()
```

Sequential

For the Sequential plots, the lightness value increases monotonically through the colormaps. This is good. Some of the L^* values in the colormaps span from 0 to 100 (binary and the other grayscale), and others start around $L^* = 20$. Those that have a smaller range of L^* will accordingly have a smaller perceptual range. Note also that the L^* function varies amongst the colormaps: some are approximately linear in L^* and others are more curved.

```
cmaps['Perceptually Uniform Sequential'] = [
            'viridis', 'plasma', 'inferno', 'magma', 'cividis']

cmaps['Sequential'] = [
            'Greys', 'Purples', 'Blues', 'Greens', 'Oranges', 'Reds',
```

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```
            'YlOrBr', 'YlOrRd', 'OrRd', 'PuRd', 'RdPu', 'BuPu',
            'GnBu', 'PuBu', 'YlGnBu', 'PuBuGn', 'BuGn', 'YlGn']
```

Sequential2

Many of the L^* values from the Sequential2 plots are monotonically increasing, but some (autumn, cool, spring, and winter) plateau or even go both up and down in L^* space. Others (afmhot, copper, gist_heat, and hot) have kinks in the L^* functions. Data that is being represented in a region of the colormap that is at a plateau or kink will lead to a perception of banding of the data in those values in the colormap (see *[mycarta-banding]* for an excellent example of this).

```
cmaps['Sequential (2)'] = [
            'binary', 'gist_yarg', 'gist_gray', 'gray', 'bone', 'pink',
            'spring', 'summer', 'autumn', 'winter', 'cool', 'Wistia',
            'hot', 'afmhot', 'gist_heat', 'copper']
```

Diverging

For the Diverging maps, we want to have monotonically increasing L^* values up to a maximum, which should be close to $L^* = 100$, followed by monotonically decreasing L^* values. We are looking for approximately equal minimum L^* values at opposite ends of the colormap. By these measures, BrBG and RdBu are good options. coolwarm is a good option, but it doesn't span a wide range of L^* values (see grayscale section below).

```
cmaps['Diverging'] = [
            'PiYG', 'PRGn', 'BrBG', 'PuOr', 'RdGy', 'RdBu',
            'RdYlBu', 'RdYlGn', 'Spectral', 'coolwarm', 'bwr', 'seismic']
```

Qualitative

Qualitative colormaps are not aimed at being perceptual maps, but looking at the lightness parameter can verify that for us. The L^* values move all over the place throughout the colormap, and are clearly not monotonically increasing. These would not be good options for use as perceptual colormaps.

```
cmaps['Qualitative'] = ['Pastel1', 'Pastel2', 'Paired', 'Accent',
                        'Dark2', 'Set1', 'Set2', 'Set3',
                        'tab10', 'tab20', 'tab20b', 'tab20c']
```

Miscellaneous

Some of the miscellaneous colormaps have particular uses for which they have been created. For example, gist_earth, ocean, and terrain all seem to be created for plotting topography (green/brown) and water depths (blue) together. We would expect to see a divergence in these colormaps, then, but multiple kinks may not

be ideal, such as in gist_earth and terrain. CMRmap was created to convert well to grayscale, though it does appear to have some small kinks in L^*. cubehelix was created to vary smoothly in both lightness and hue, but appears to have a small hump in the green hue area.

The often-used jet colormap is included in this set of colormaps. We can see that the L^* values vary widely throughout the colormap, making it a poor choice for representing data for viewers to see perceptually. See an extension on this idea at *[mycarta-jet]*.

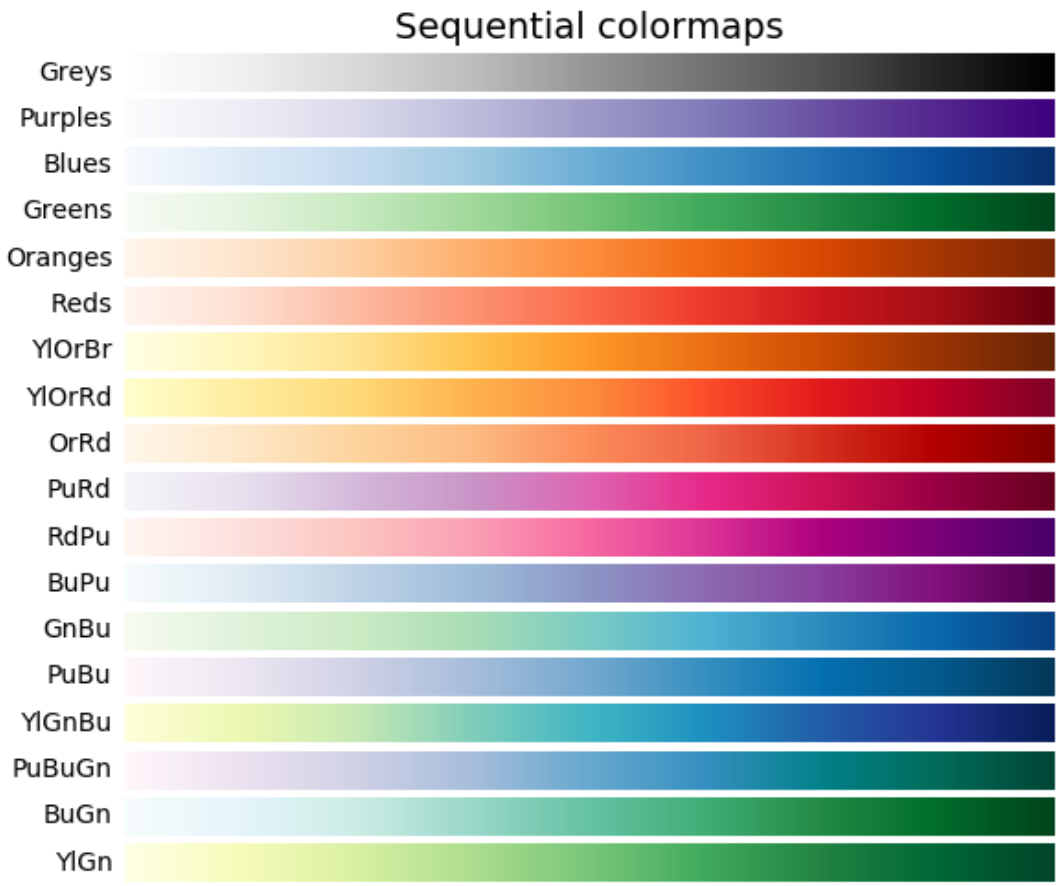
```
cmaps['Miscellaneous'] = [
            'flag', 'prism', 'ocean', 'gist_earth', 'terrain', 'gist_stern',
            'gnuplot', 'gnuplot2', 'CMRmap', 'cubehelix', 'brg', 'hsv',
            'gist_rainbow', 'rainbow', 'jet', 'nipy_spectral', 'gist_ncar']
```

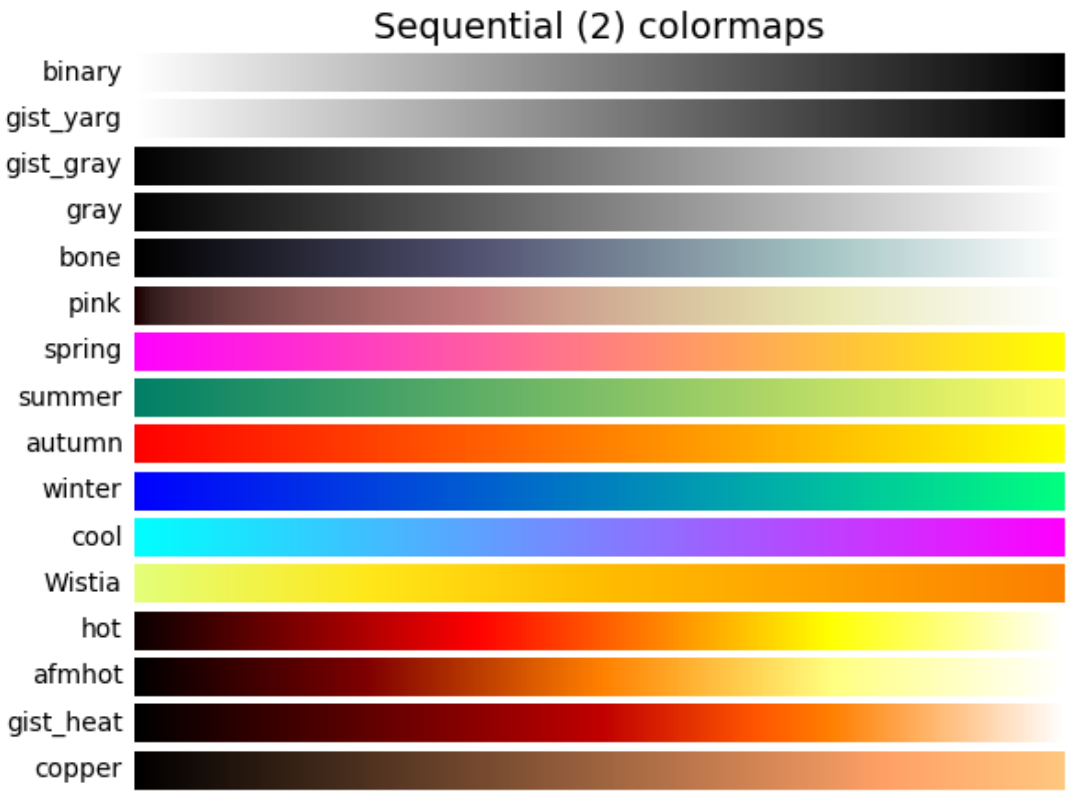
First, we'll show the range of each colormap. Note that some seem to change more "quickly" than others.

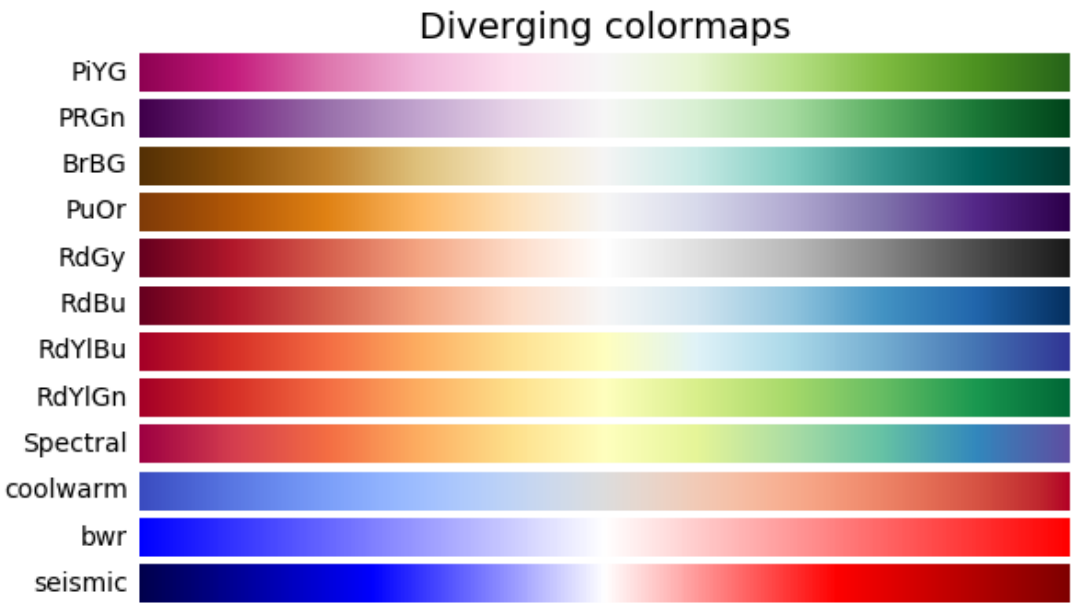
```
nrows = max(len(cmap_list) for cmap_category, cmap_list in cmaps.items())
gradient = np.linspace(0, 1, 256)
gradient = np.vstack((gradient, gradient))


def plot_color_gradients(cmap_category, cmap_list, nrows):
    fig, axes = plt.subplots(nrows=nrows)
    fig.subplots_adjust(top=0.95, bottom=0.01, left=0.2, right=0.99)
    axes[0].set_title(cmap_category + ' colormaps', fontsize=14)

    for ax, name in zip(axes, cmap_list):
        ax.imshow(gradient, aspect='auto', cmap=plt.get_cmap(name))
        pos = list(ax.get_position().bounds)
        x_text = pos[0] - 0.01
        y_text = pos[1] + pos[3]/2.
        fig.text(x_text, y_text, name, va='center', ha='right', fontsize=10)

    # Turn off *all* ticks & spines, not just the ones with colormaps.
    for ax in axes:
        ax.set_axis_off()


for cmap_category, cmap_list in cmaps.items():
    plot_color_gradients(cmap_category, cmap_list, nrows)

plt.show()
```

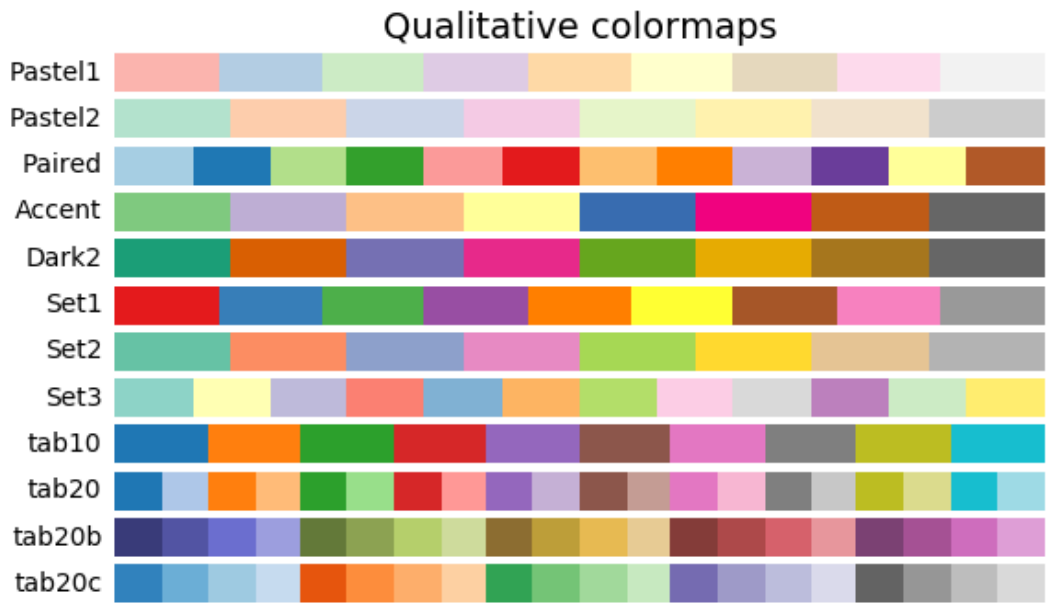
Perceptually Uniform Sequential colormaps
viridis
plasma
inferno
magma
cividis

-

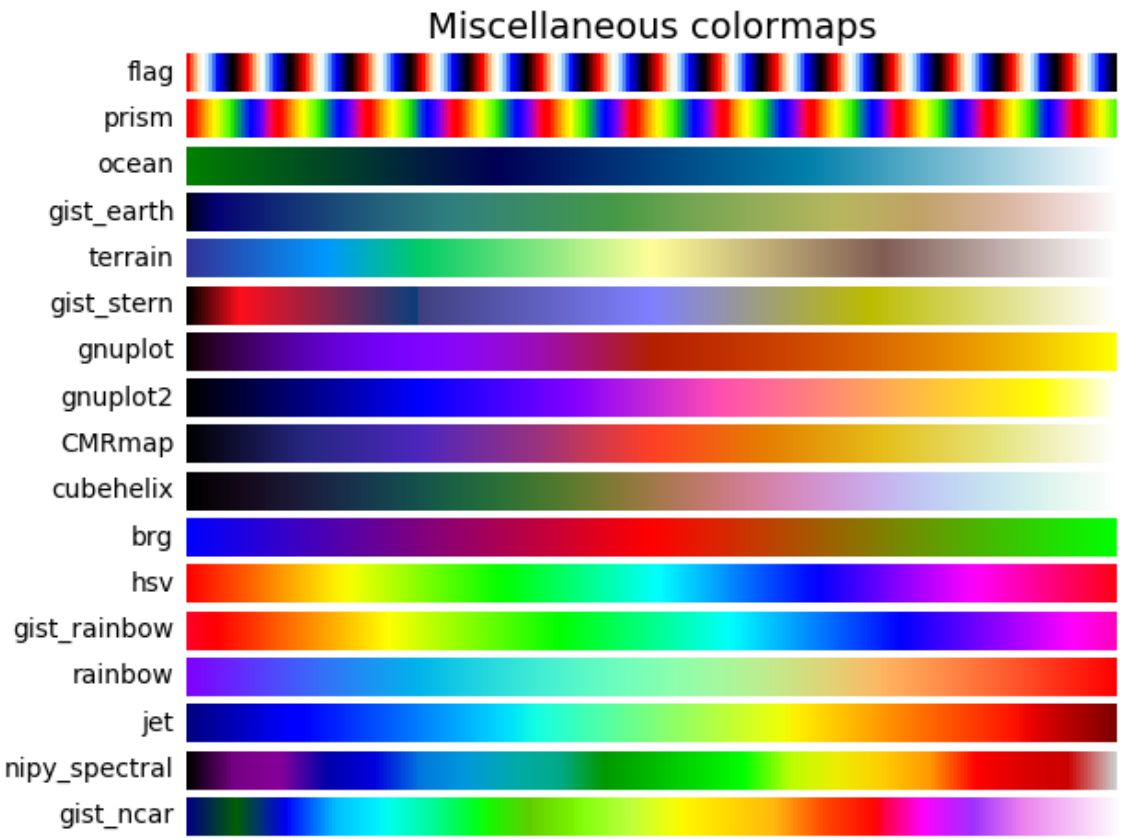

Sequential colormaps
Greys
Purples
Blues
Greens
Oranges
Reds
YlOrBr
YlOrRd
OrRd
PuRd
RdPu
BuPu
GnBu
PuBu
YlGnBu
PuBuGn
BuGn
YlGn


Sequential (2) colormaps
binary
gist_yarg
gist_gray
gray
bone
pink
spring
summer
autumn
winter
cool
Wistia
hot
afmhot
gist_heat
copper


Diverging colormaps
PiYG
PRGn
BrBG
PuOr
RdGy
RdBu
RdYlBu
RdYlGn
Spectral
coolwarm
bwr
seismic


Qualitative colormaps
Pastel1
Pastel2
Paired
Accent
Dark2
Set1
Set2
Set3
tab10
tab20
tab20b
tab20c

-



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Lightness of matplotlib colormaps

Here we examine the lightness values of the matplotlib colormaps. Note that some documentation on the colormaps is available (*[list-colormaps]*).

```
mpl.rcParams.update({'font.size': 12})

# Number of colormap per subplot for particular cmap categories
_DSUBS = {'Perceptually Uniform Sequential': 5, 'Sequential': 6,
          'Sequential (2)': 6, 'Diverging': 6, 'Qualitative': 4,
          'Miscellaneous': 6}

# Spacing between the colormaps of a subplot
_DC = {'Perceptually Uniform Sequential': 1.4, 'Sequential': 0.7,
       'Sequential (2)': 1.4, 'Diverging': 1.4, 'Qualitative': 1.4,
       'Miscellaneous': 1.4}

# Indices to step through colormap
x = np.linspace(0.0, 1.0, 100)

# Do plot
for cmap_category, cmap_list in cmaps.items():
```

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```
    # Do subplots so that colormaps have enough space.
    # Default is 6 colormaps per subplot.
    dsub = _DSUBS.get(cmap_category, 6)
    nsubplots = int(np.ceil(len(cmap_list) / dsub))

    # squeeze=False to handle similarly the case of a single subplot
    fig, axes = plt.subplots(nrows=nsubplots, squeeze=False,
                             figsize=(7, 2.6*nsubplots))

    for i, ax in enumerate(axes.flat):

        locs = []  # locations for text labels

        for j, cmap in enumerate(cmap_list[i*dsub:(i+1)*dsub]):

            # Get RGB values for colormap and convert the colormap in
            # CAM02-UCS colorspace.  lab[0, :, 0] is the lightness.
            rgb = cm.get_cmap(cmap)(x)[np.newaxis, :, :3]
            lab = cspace_converter("sRGB1", "CAM02-UCS")(rgb)

            # Plot colormap L values.  Do separately for each category
            # so each plot can be pretty.  To make scatter markers change
            # color along plot:
            # http://stackoverflow.com/questions/8202605/matplotlib-scatterplot-colour-
↪as-a-function-of-a-third-variable

            if cmap_category == 'Sequential':
                # These colormaps all start at high lightness but we want them
                # reversed to look nice in the plot, so reverse the order.
                y_ = lab[0, ::-1, 0]
                c_ = x[::-1]
            else:
                y_ = lab[0, :, 0]
                c_ = x

            dc = _DC.get(cmap_category, 1.4)  # cmaps horizontal spacing
            ax.scatter(x + j*dc, y_, c=c_, cmap=cmap, s=300, linewidths=0.0)

            # Store locations for colormap labels
            if cmap_category in ('Perceptually Uniform Sequential',
                                 'Sequential'):
                locs.append(x[-1] + j*dc)
            elif cmap_category in ('Diverging', 'Qualitative',
                                   'Miscellaneous', 'Sequential (2)'):
                locs.append(x[int(x.size/2.)] + j*dc)

        # Set up the axis limits:
        #   * the 1st subplot is used as a reference for the x-axis limits
        #   * lightness values goes from 0 to 100 (y-axis limits)
        ax.set_xlim(axes[0, 0].get_xlim())
        ax.set_ylim(0.0, 100.0)
```

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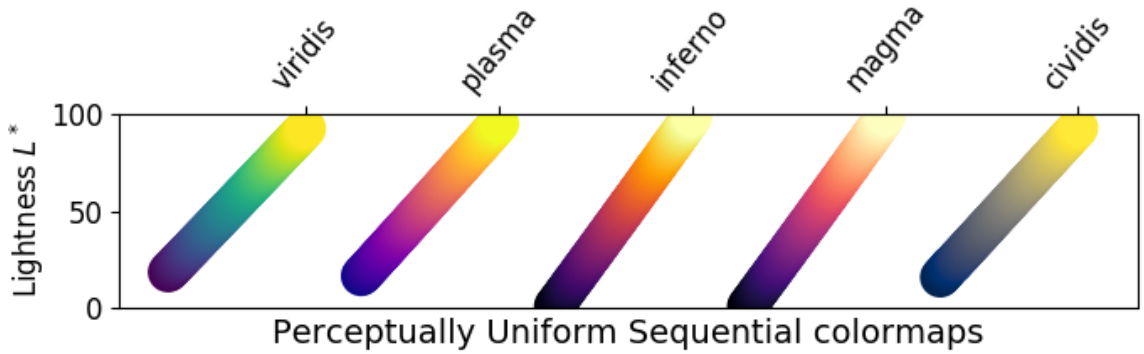
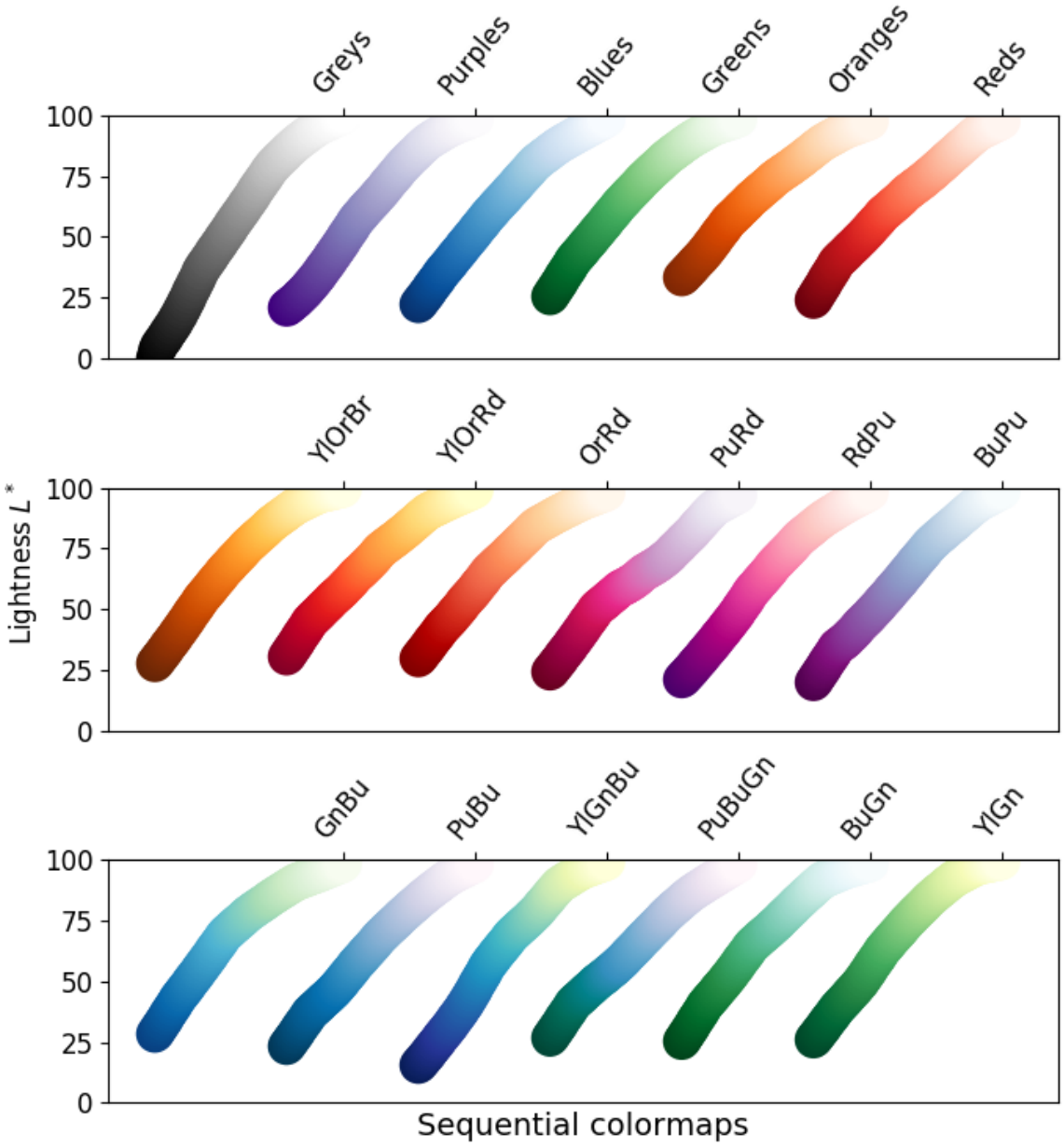
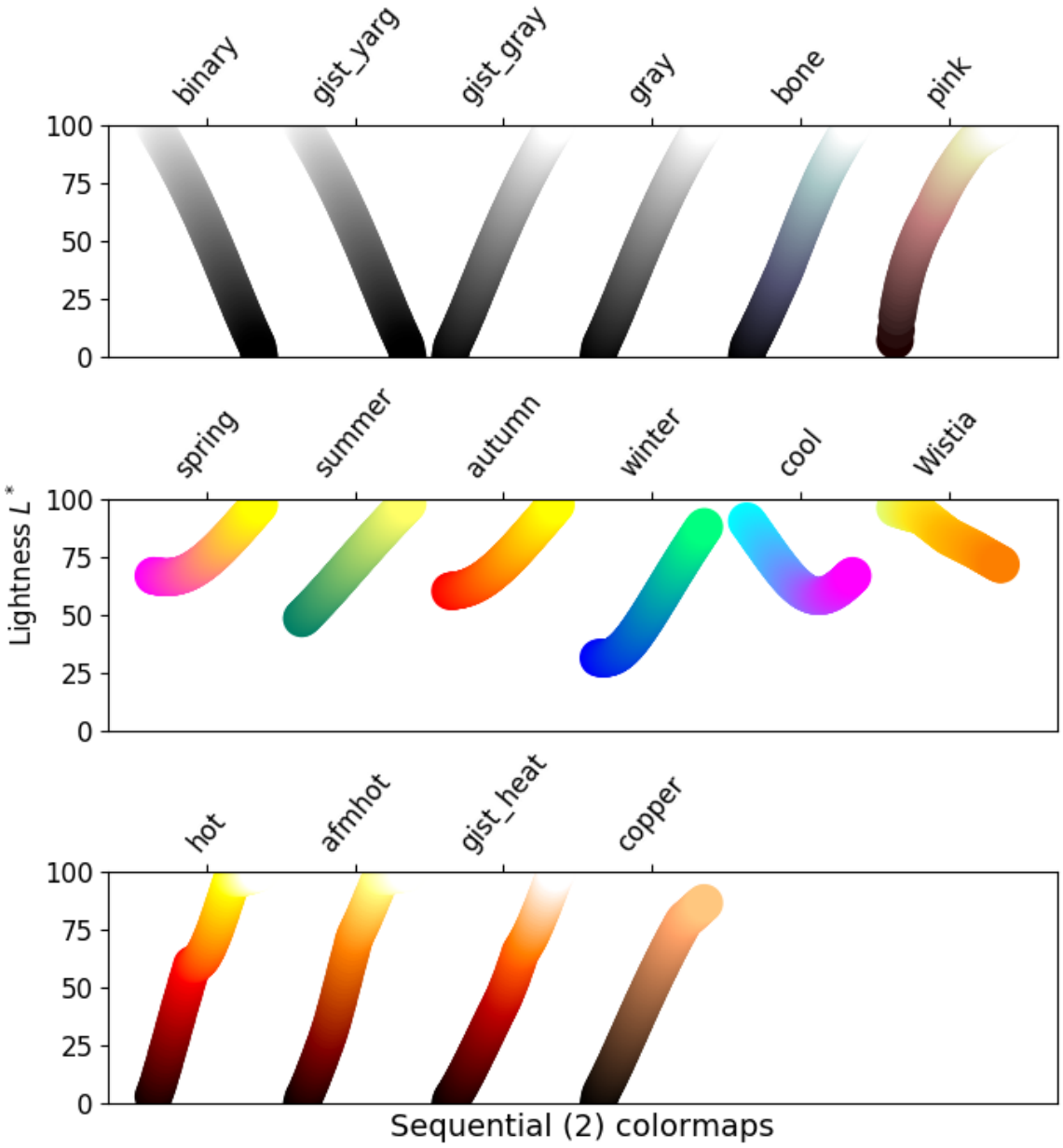
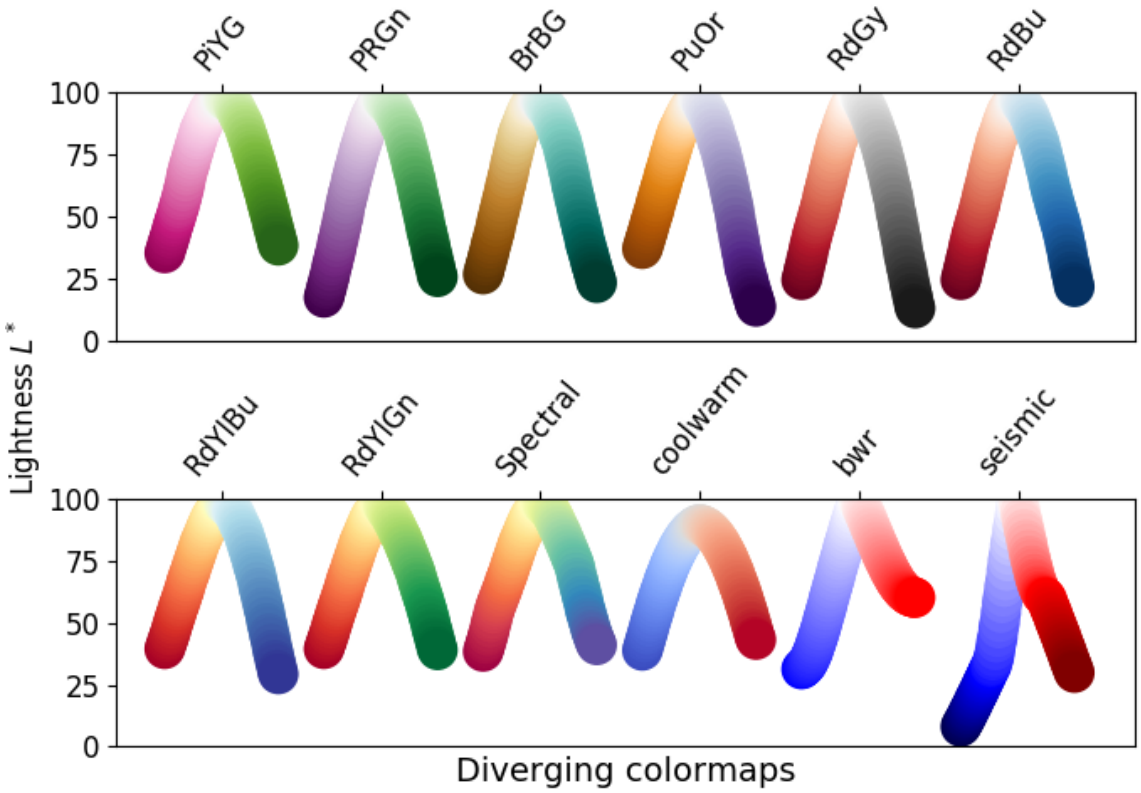
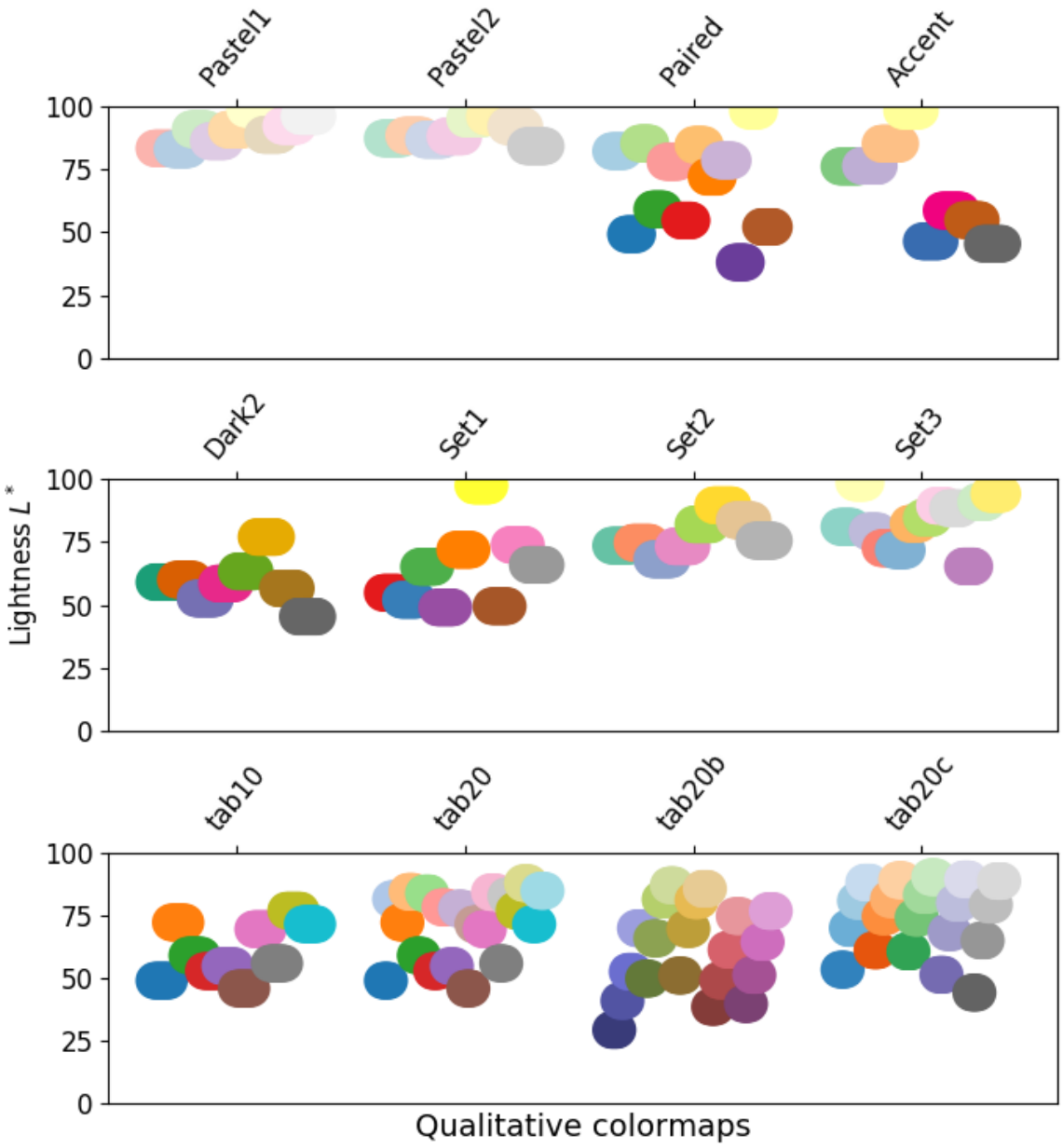
```
        # Set up labels for colormaps
        ax.xaxis.set_ticks_position('top')
        ticker = mpl.ticker.FixedLocator(locs)
        ax.xaxis.set_major_locator(ticker)
        formatter = mpl.ticker.FixedFormatter(cmap_list[i*dsub:(i+1)*dsub])
        ax.xaxis.set_major_formatter(formatter)
        ax.xaxis.set_tick_params(rotation=50)

    ax.set_xlabel(cmap_category + ' colormaps', fontsize=14)
    fig.text(0.0, 0.55, 'Lightness $L^*$', fontsize=12,
             transform=fig.transFigure, rotation=90)

    fig.tight_layout(h_pad=0.0, pad=1.5)
    plt.show()
```

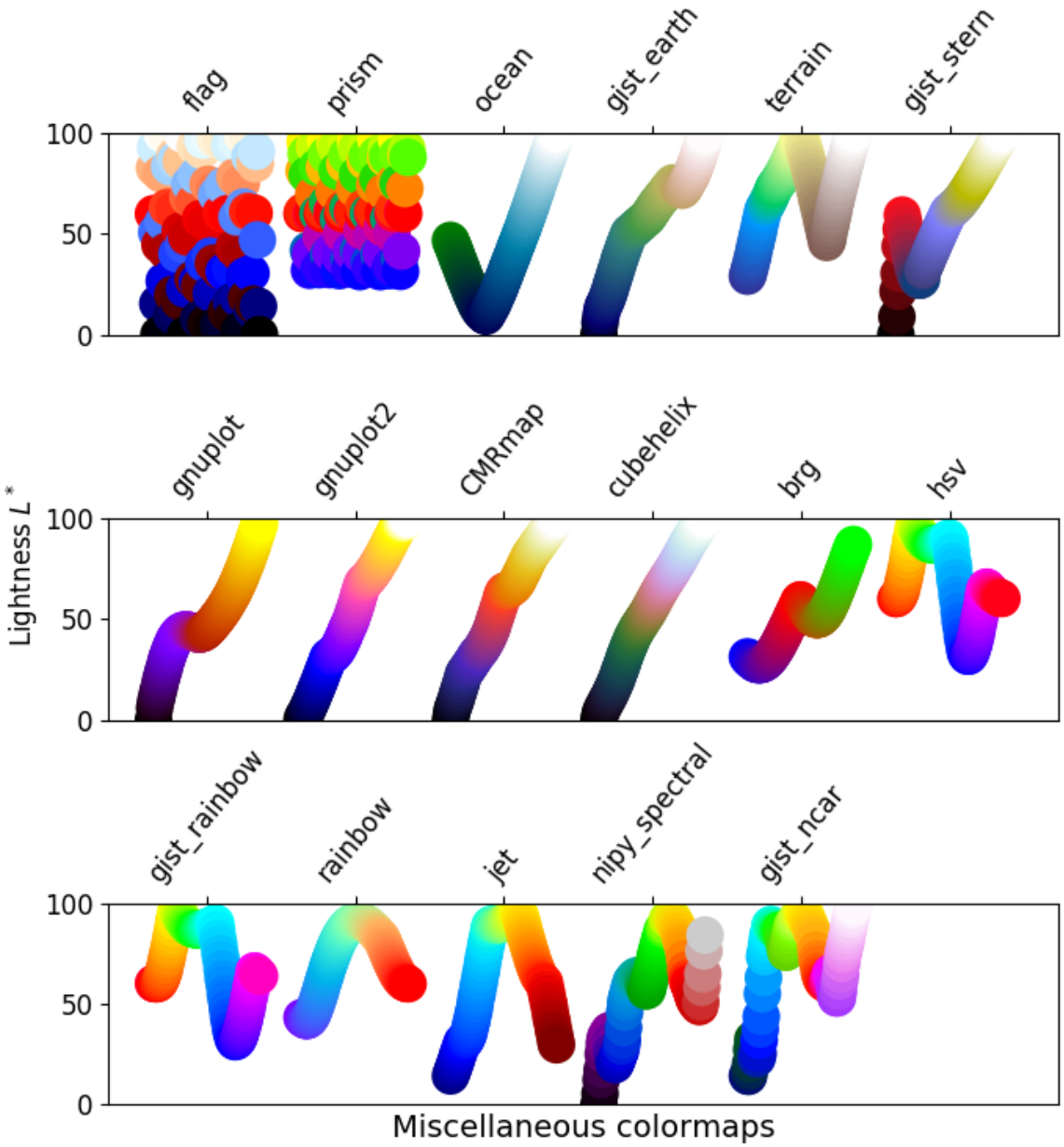



Greys
Purples
Blues
Greens
Oranges
Reds
YlOrBr
YlOrRd
OrRd
PuRd
RdPu
BuPu
GnBu
PuBu
YlGnBu
PuBuGn
BuGn
YlGn
100
75
50
25
0
Lightness L^*
Sequential colormaps


binary
gist_yarg
gist_gray
gray
bone
pink
spring
summer
autumn
winter
cool
Wistia
hot
afmhot
gist_heat
copper
Lightness L^*
100
75
50
25
0
Sequential (2) colormaps


PiYG
PRGn
BrBG
PuOr
RdGy
RdBu
RdYlBu
RdYlGn
Spectral
coolwarm
bwr
seismic
100
75
50
25
0
Lightness L^*
Diverging colormaps


Pastel1
Pastel2
Paired
Accent
Dark2
Set1
Set2
Set3
tab10
tab20
tab20b
tab20c
100
75
50
25
0
Lightness L^*
Qualitative colormaps



-

Grayscale conversion

It is important to pay attention to conversion to grayscale for color plots, since they may be printed on black and white printers. If not carefully considered, your readers may end up with indecipherable plots because the grayscale changes unpredictably through the colormap.

Conversion to grayscale is done in many different ways *[bw]*. Some of the better ones use a linear combination of the rgb values of a pixel, but weighted according to how we perceive color intensity. A nonlinear method of conversion to grayscale is to use the L^* values of the pixels. In general, similar principles apply for this question as they do for presenting one's information perceptually; that is, if a colormap is chosen

that is monotonically increasing in L^* values, it will print in a reasonable manner to grayscale.

With this in mind, we see that the Sequential colormaps have reasonable representations in grayscale. Some of the Sequential2 colormaps have decent enough grayscale representations, though some (autumn, spring, summer, winter) have very little grayscale change. If a colormap like this was used in a plot and then the plot was printed to grayscale, a lot of the information may map to the same gray values. The Diverging colormaps mostly vary from darker gray on the outer edges to white in the middle. Some (PuOr and seismic) have noticeably darker gray on one side than the other and therefore are not very symmetric. coolwarm has little range of gray scale and would print to a more uniform plot, losing a lot of detail. Note that overlaid, labeled contours could help differentiate between one side of the colormap vs. the other since color cannot be used once a plot is printed to grayscale. Many of the Qualitative and Miscellaneous colormaps, such as Accent, hsv, and jet, change from darker to lighter and back to darker gray throughout the colormap. This would make it impossible for a viewer to interpret the information in a plot once it is printed in grayscale.

```
mpl.rcParams.update({'font.size': 14})

# Indices to step through colormap.
x = np.linspace(0.0, 1.0, 100)

gradient = np.linspace(0, 1, 256)
gradient = np.vstack((gradient, gradient))


def plot_color_gradients(cmap_category, cmap_list):
    fig, axes = plt.subplots(nrows=len(cmap_list), ncols=2)
    fig.subplots_adjust(top=0.95, bottom=0.01, left=0.2, right=0.99,
                        wspace=0.05)
    fig.suptitle(cmap_category + ' colormaps', fontsize=14, y=1.0, x=0.6)

    for ax, name in zip(axes, cmap_list):

        # Get RGB values for colormap.
        rgb = cm.get_cmap(plt.get_cmap(name))(x)[np.newaxis, :, :3]

        # Get colormap in CAM02-UCS colorspace. We want the lightness.
        lab = cspace_converter("sRGB1", "CAM02-UCS")(rgb)
        L = lab[0, :, 0]
        L = np.float32(np.vstack((L, L, L)))

        ax[0].imshow(gradient, aspect='auto', cmap=plt.get_cmap(name))
        ax[1].imshow(L, aspect='auto', cmap='binary_r', vmin=0., vmax=100.)
        pos = list(ax[0].get_position().bounds)
        x_text = pos[0] - 0.01
        y_text = pos[1] + pos[3]/2.
        fig.text(x_text, y_text, name, va='center', ha='right', fontsize=10)

    # Turn off *all* ticks & spines, not just the ones with colormaps.
    for ax in axes.flat:
        ax.set_axis_off()

    plt.show()
```

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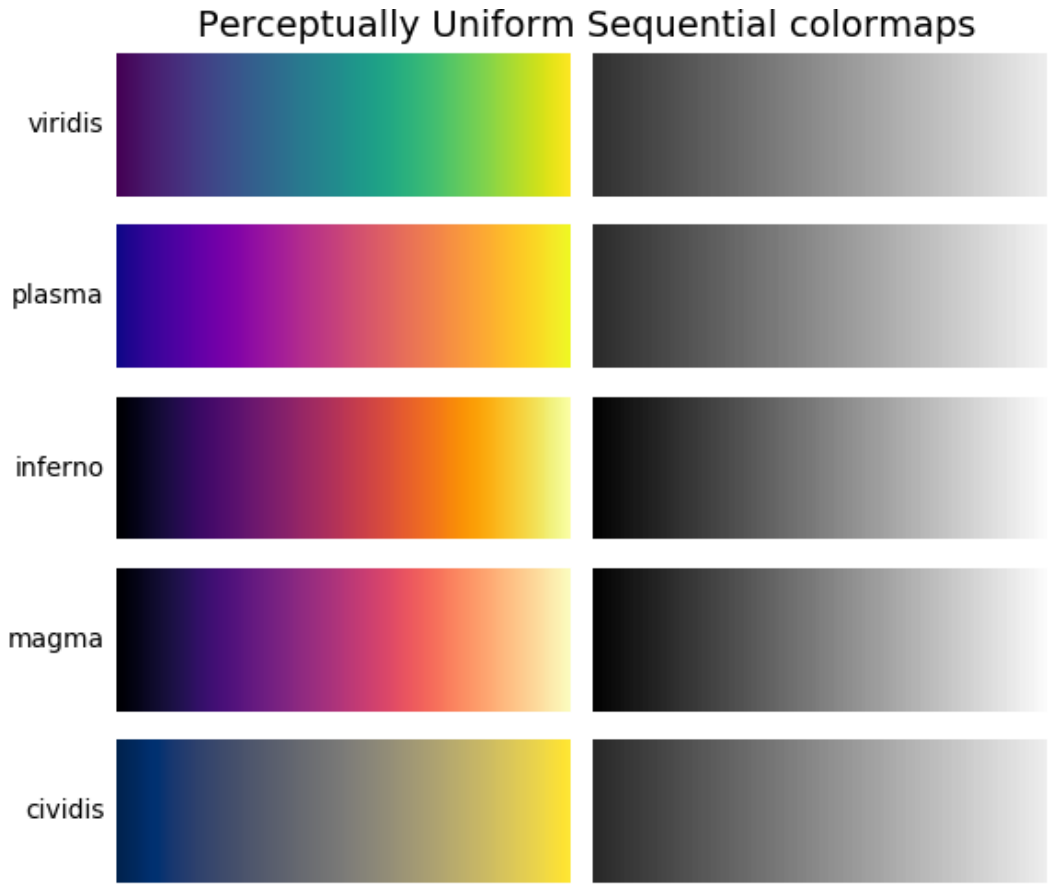
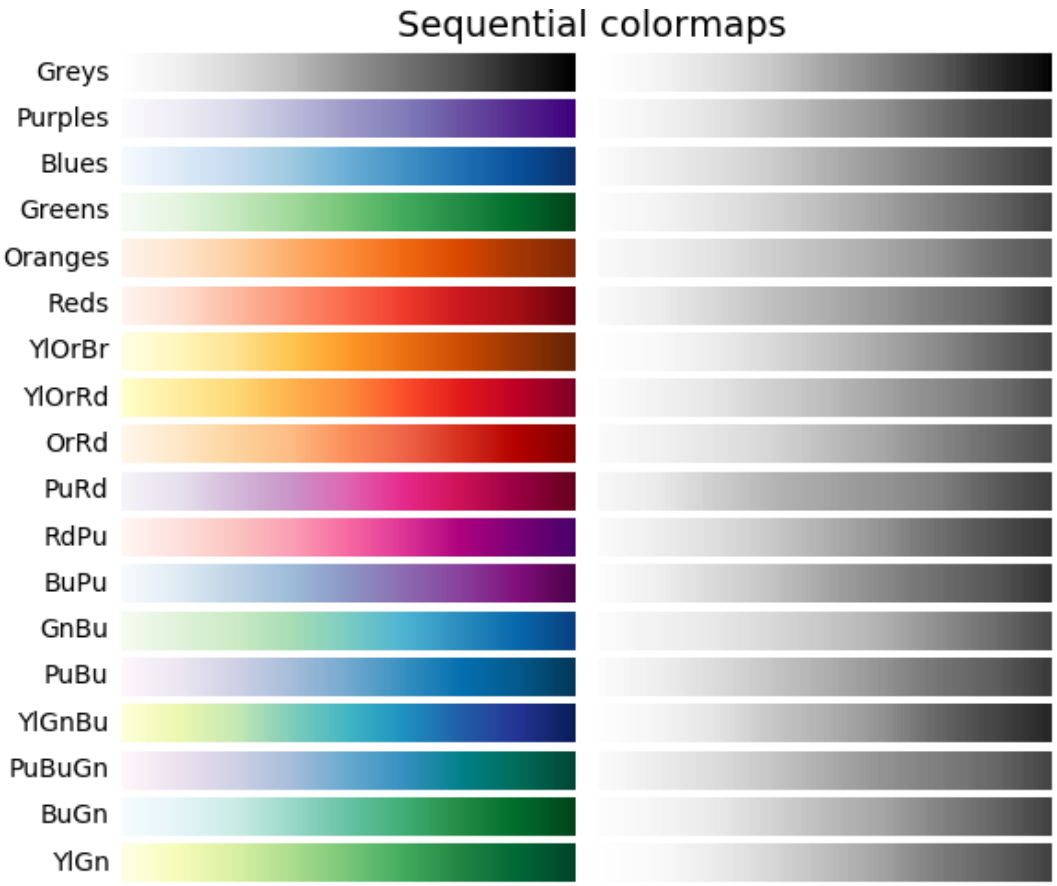
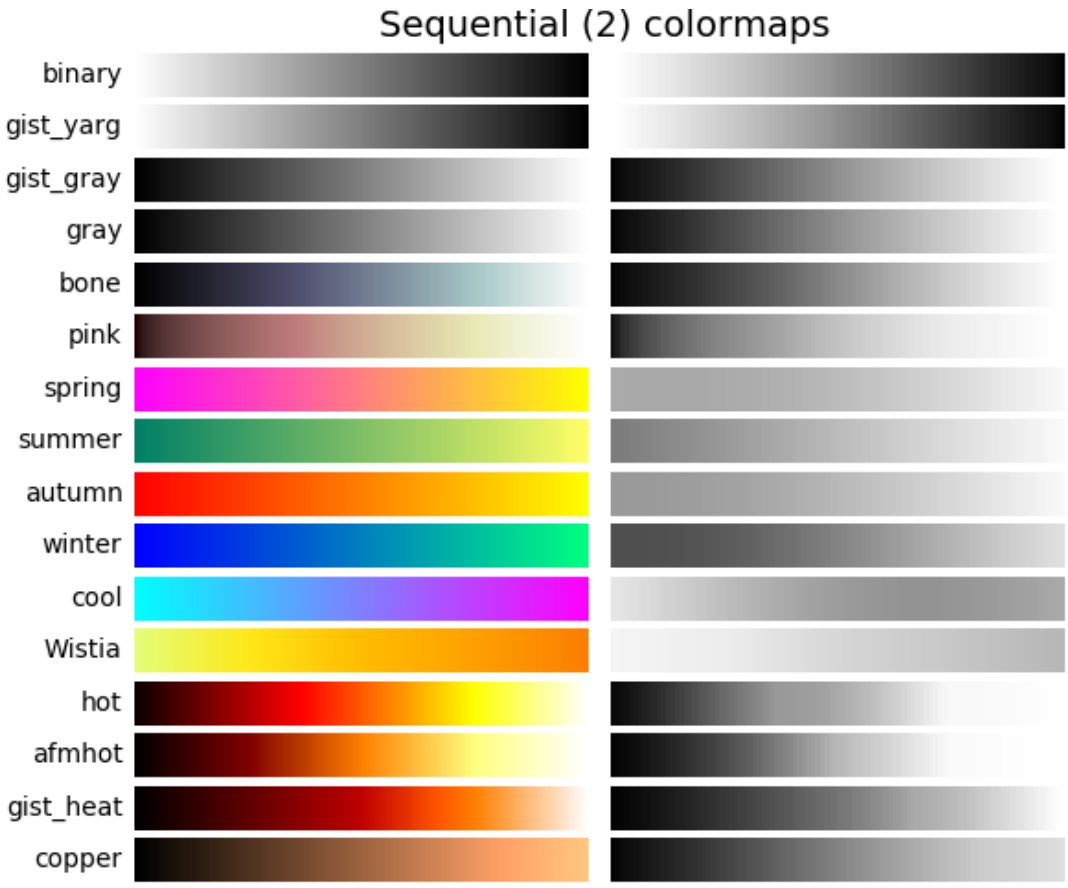
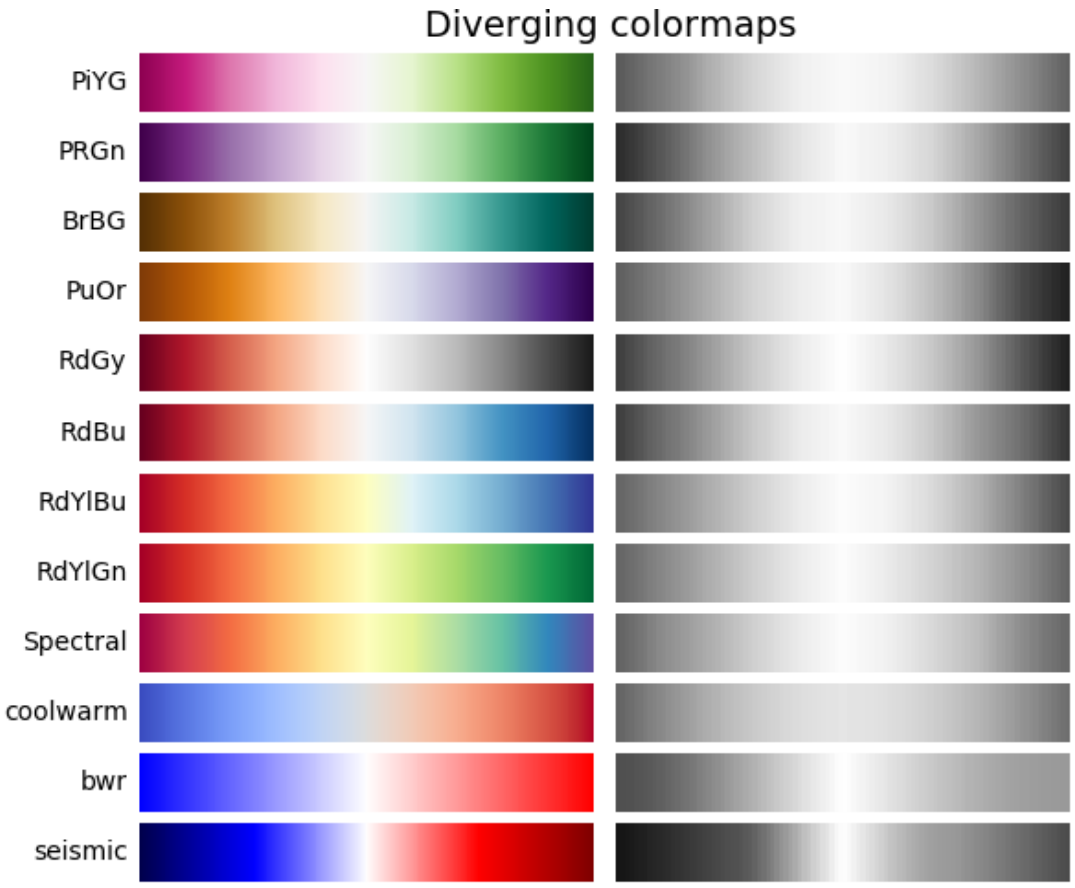
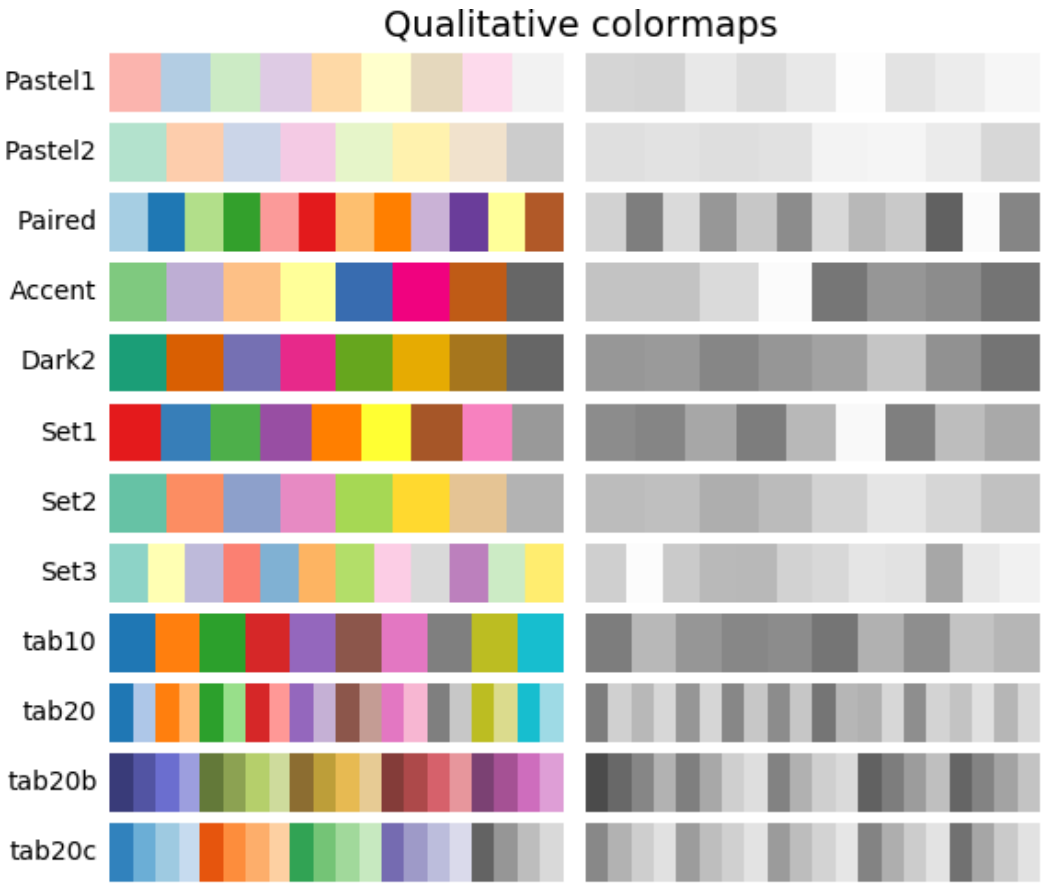
```
for cmap_category, cmap_list in cmaps.items():

    plot_color_gradients(cmap_category, cmap_list)
```

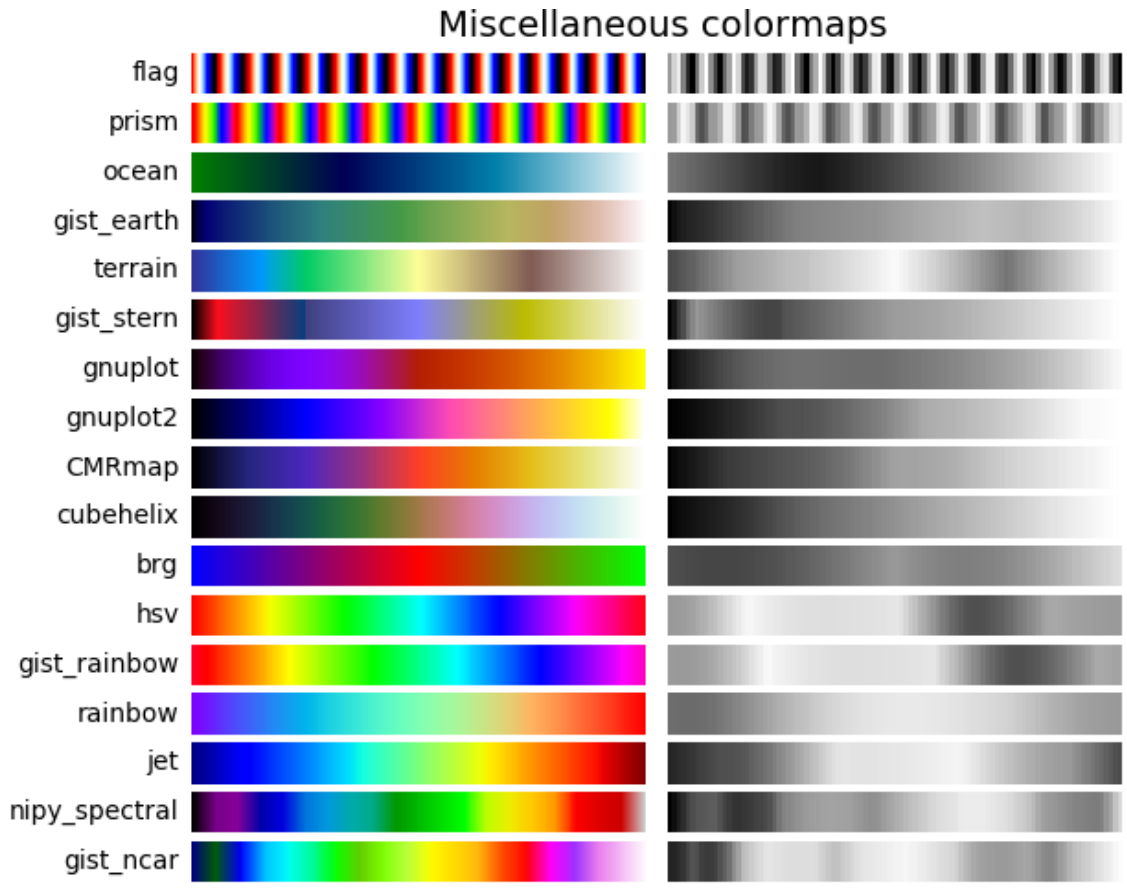



Sequential colormaps
Greys
Purples
Blues
Greens
Oranges
Reds
YlOrBr
YlOrRd
OrRd
PuRd
RdPu
BuPu
GnBu
PuBu
YlGnBu
PuBuGn
BuGn
YlGn


Sequential (2) colormaps
binary
gist_yarg
gist_gray
gray
bone
pink
spring
summer
autumn
winter
cool
Wistia
hot
afmhot
gist_heat
copper


Diverging colormaps
PiYG
PRGn
BrBG
PuOr
RdGy
RdBu
RdYlBu
RdYlGn
Spectral
coolwarm
bwr
seismic


Qualitative colormaps
Pastel1
Pastel2
Paired
Accent
Dark2
Set1
Set2
Set3
tab10
tab20
tab20b
tab20c



Color vision deficiencies

There is a lot of information available about color blindness (*e.g.*, *[colorblindness]*). Additionally, there are tools available to convert images to how they look for different types of color vision deficiencies (*e.g.*, *[vischeck]*).

The most common form of color vision deficiency involves differentiating between red and green. Thus, avoiding colormaps with both red and green will avoid many problems in general.

References

Total running time of the script: (0 minutes 2.559 seconds)

3.5 Text

matplotlib has extensive text support, including support for mathematical expressions, truetype support for raster and vector outputs, newline separated text with arbitrary rotations, and unicode support. These tutorials cover the basics of working with text in Matplotlib.

Note: Click *here* to download the full example code

3.5.1 Annotations

Annotating text with Matplotlib.

Table of Contents

- *Annotations*
- *Basic annotation*
- *Advanced Annotation*
  - *Annotating with Text with Box*
  - *Annotating with Arrow*
  - *Placing Artist at the anchored location of the Axes*
  - *Using Complex Coordinates with Annotations*
  - *Using ConnectionPatch*
    - *Advanced Topics*
  - *Zoom effect between Axes*
  - *Define Custom BoxStyle*

3.5.2 Basic annotation

The uses of the basic `text()` will 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.

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')

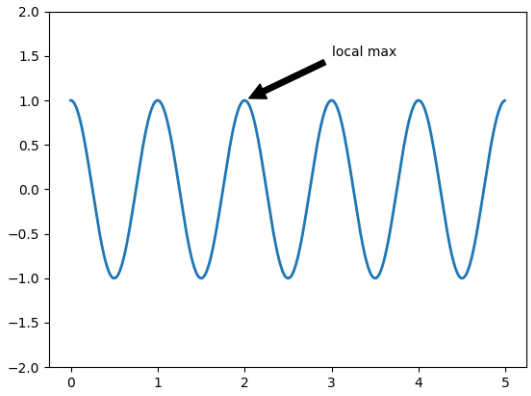


Fig. 23: Annotation Basic

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'	0,0 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.

Optionally, you can enable drawing of 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 `annotate` to the `Text` instance.

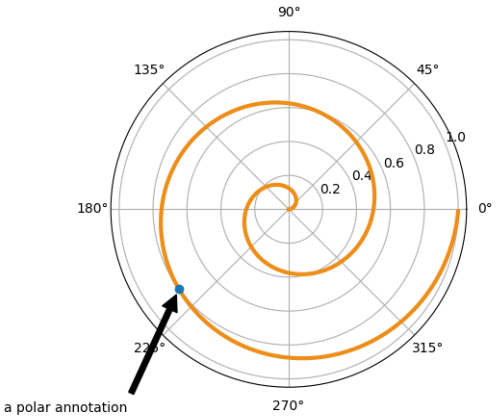


Fig. 24: Annotation Polar

For more on all the wild and wonderful things you can do with annotations, including fancy arrows, see *Advanced Annotation* and /gallery/text_labels_and_annotations/annotation_demo.

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

3.5.3 Advanced Annotation

Annotating with Text with Box

Let's start with a simple example.

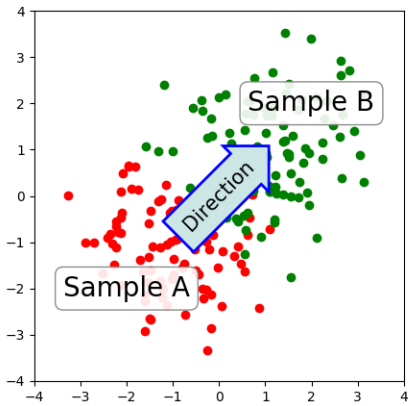


Fig. 25: Annotate Text Arrow

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 the *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
Circle	`circle`	pad=0.3
DArrow	`darrow`	pad=0.3
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 attribute 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")
```

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.

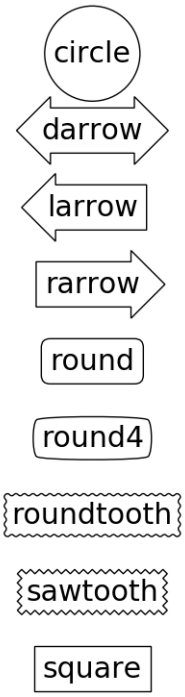


Fig. 26: Fancybox Demo

An arrow connecting two points (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"),
            )
```

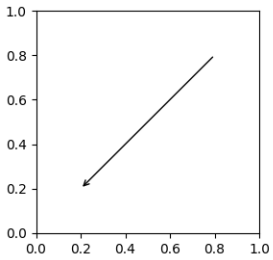


Fig. 27: Annotate Simple01

The arrow drawing takes a few steps.

1. a connecting path between two points are created. This is controlled by `connectionstyle` key value.
2. If patch object is given (*patchA* & *patchB*), the path is clipped to avoid the patch.

3. The path is further shrunk by given amount of pixels (*shrinkA* & *shrinkB*)
4. The path is transmuted to arrow patch, which is controlled by the `arrowstyle` key value.

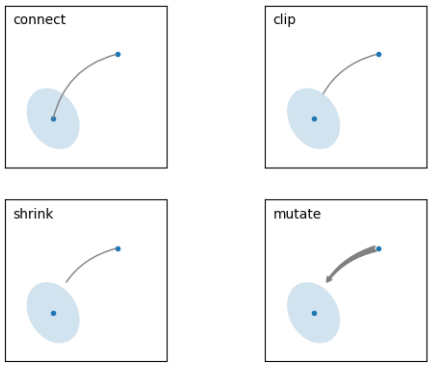


Fig. 28: Annotate Explain

The creation of the connecting path between two points is controlled by `connectionstyle` key and the 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 options can only 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`.

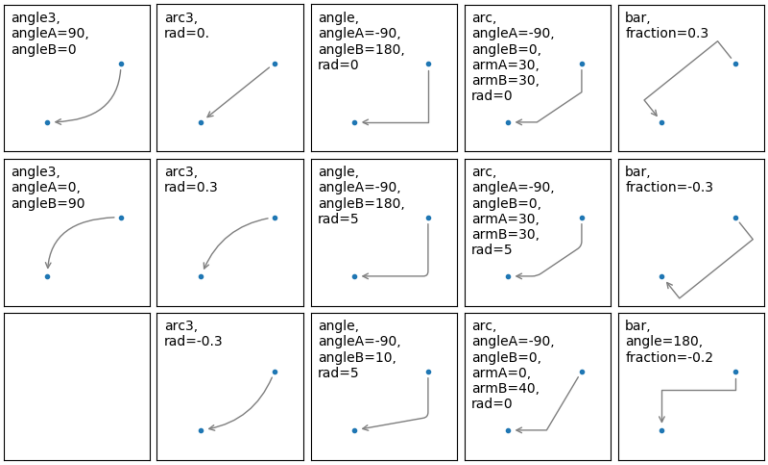


Fig. 29: Connectionstyle Demo

Name	Attrs
-	None
->	head_length=0.4,head_width=0.2
-[	widthB=1.0,lengthB=0.2,angleB=None
|-|	widthA=1.0,widthB=1.0
-|>	head_length=0.4,head_width=0.2
<-	head_length=0.4,head_width=0.2
<->	head_length=0.4,head_width=0.2
<|-	head_length=0.4,head_width=0.2
<|-|>	head_length=0.4,head_width=0.2
fancy	head_length=0.4,head_width=0.4,tail_width=0.4
simple	head_length=0.5,head_width=0.5,tail_width=0.2
wedge	tail_width=0.3,shrink_factor=0.5

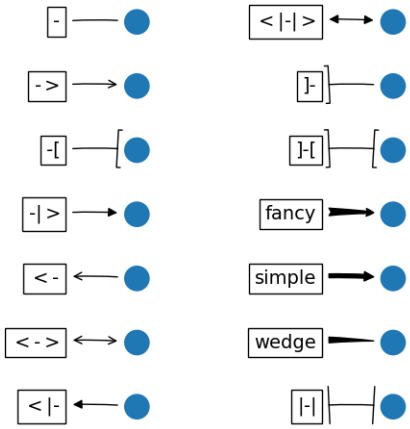


Fig. 30: Fancyarrow Demo

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

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

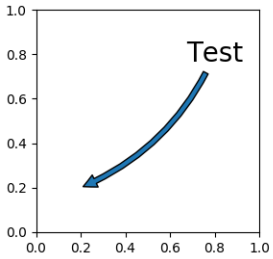


Fig. 31: Annotate Simple02

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

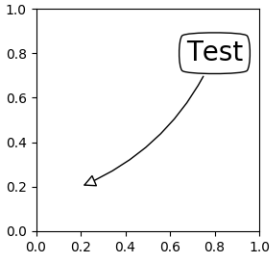


Fig. 32: Annotate Simple03

By default, the starting point is set to the center of the text extent. This can be adjusted with `relpos` key value. The values are normalized to the extent of the text. For example, (0,0) means lower-left corner and (1,1) means top-right.

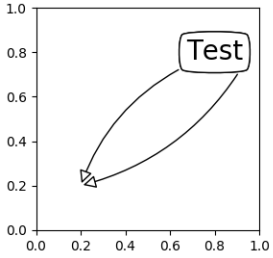


Fig. 33: Annotate Simple04

Placing Artist at the anchored location of the Axes

There are classes of artists that can be placed at an anchored location in the Axes. A common example is the legend. This type of artist can be created by using the OffsetBox class. A few predefined classes are available in `mpl_toolkits.axes_grid1.anchored_artists` others in `matplotlib.offsetbox`

```
from matplotlib.offsetbox 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)
```

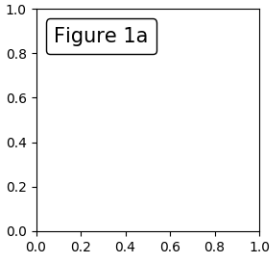


Fig. 34: Anchored Box01

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 pixels), and arbitrary artists can added to the drawing area. Note that the extents of the artists that are added to the drawing area are not related to the placement of the drawing area itself. Only the initial size matters.

```
from mpl_toolkits.axes_grid1.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 a transform set (it will be overridden) and the dimensions of those artists are interpreted as a pixel coordinate, i.e., the radius of the circles in above example are 10 pixels and 5 pixels, respectively.

Sometimes, you want your artists to scale with the data coordinate (or coordinates other than canvas pixels). 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_grid1.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 corresponding to 0.1 and 0.4 in data coordi-

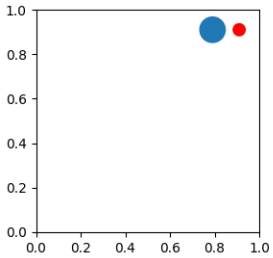


Fig. 35: Anchored Box02

nateing and will be automatically scaled when the view limits of the axes change.

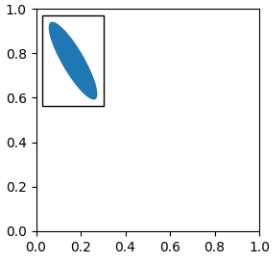


Fig. 36: Anchored Box03

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).

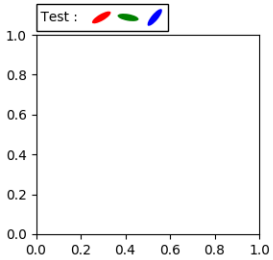


Fig. 37: Anchored Box04

Note that unlike the legend, the `bbox_transform` is set to IdentityTransform by default.

Using Complex Coordinates with Annotations

The Annotation in matplotlib supports several types of coordinates as described in *Basic annotation*. 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="->"))
```

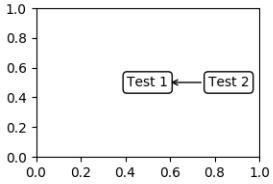


Fig. 38: Annotation with Simple Coordinates

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 the same as 1 and if a bbox is returned, it is the same as 2. The callable object should take a single argument of the renderer instance. For example, the 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 specifications. The first item is for the x-coordinate and the second is for the y-coordinate. For example,

```
annotate("Test", xy=(0.5, 1), xycoords=("data", "axes fraction"))
```

0.5 is in data coordinates, and 1 is in normalized axes coordinates. You may use an artist or transform as with a tuple. For example,

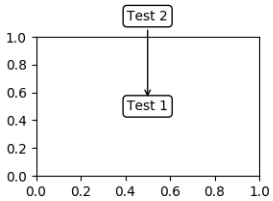


Fig. 39: Annotation with Simple Coordinates 2

5. Sometimes, you want your annotation with some "offset points", not from the annotated point but from some other point. *OffsetFrom* is a helper class for such cases.

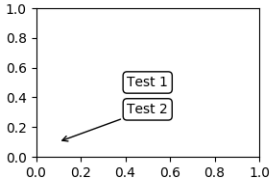


Fig. 40: Annotation with Simple Coordinates 3

You may take a look at this example /gallery/text_labels_and_annotations/annotation_demo.

Using ConnectionPatch

The ConnectionPatch is like an annotation without text. While the annotate function is recommended in most situations, the ConnectionPatch 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 the data coordinates of `ax1` to point xy in the data coordinates of `ax2`. Here is a simple example.

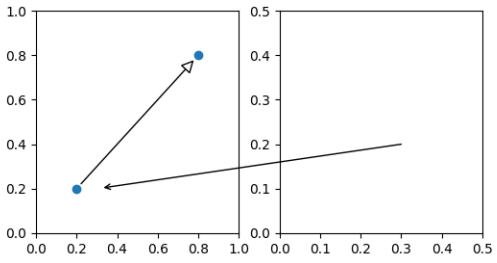


Fig. 41: Connect Simple01

While the ConnectionPatch instance can be added to any axes, you may want to add it to the axes that is latest in drawing order to prevent overlap by other axes.

Advanced Topics

Zoom effect between Axes

`mpl_toolkits.axes_grid1.inset_locator` defines some patch classes useful for interconnecting two axes. Understanding the code requires some knowledge of how mpl's transform works. But, utilizing it will be straight forward.

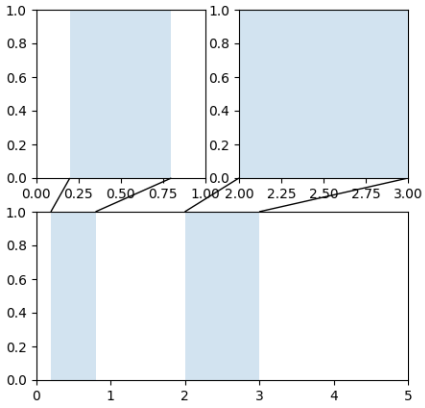


Fig. 42: Axes Zoom Effect

Define Custom BoxStyle

You can use a custom box style. The value for the `boxstyle` can be a callable object in the following forms.:

```
def __call__(self, x0, y0, width, height, mutation_size,
             aspect_ratio=1.):
    '''
    Given the location and size of the box, return the path of
    the box around it.

      - *x0*, *y0*, *width*, *height* : location and size of the box
      - *mutation_size* : a reference scale for the mutation.
      - *aspect_ratio* : aspect-ratio for the mutation.
    '''
    path = ...
    return path
```

Here is a complete example.

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

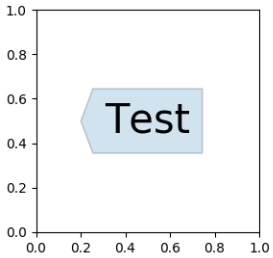


Fig. 43: Custom Boxstyle01

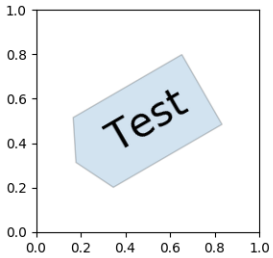


Fig. 44: Custom Boxstyle02

Similarly, you can define a custom ConnectionStyle and a custom ArrowStyle. See the source code of `lib/matplotlib/patches.py` and check how each style class is defined.

Note: Click *here* to download the full example code

3.5.4 Text rendering With LaTeX

Rendering text with LaTeX in Matplotlib.

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`:

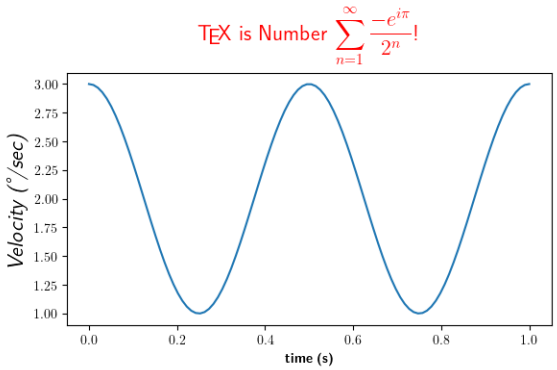


Fig. 45: TeX Demo

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.

---

usetex with unicode

It is also possible to use unicode strings with the LaTeX text manager, here is an example taken from `tex_demo.py`. The axis labels include Unicode text:

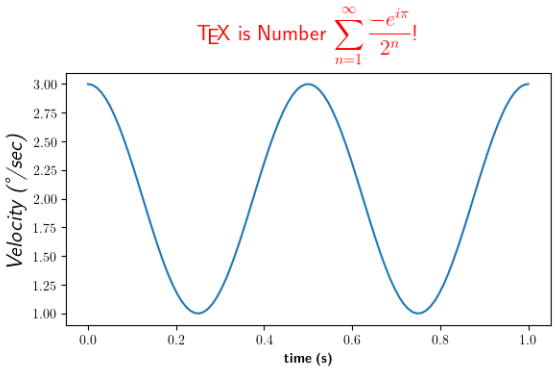


Fig. 46: TeX Unicode Demo

Postscript options

In order to produce encapsulated postscript files that can be embedded in a new LaTeX document, the default behavior of matplotlib is to distill the output, which removes some postscript operators used by LaTeX that are illegal in an eps file. This step produces results which may be unacceptable to some users, because the text is coarsely rasterized and converted to bitmaps, which are not scalable like standard postscript, and the text is not searchable. One workaround is to set `ps.distiller.res` to a higher value (perhaps 6000) in your rc settings, which will produce larger files but may look better and scale reasonably. A better workaround, which requires Poppler or Xpdf, can be activated by changing the `ps.usedistiller` rc setting to `xpdf`. This alternative produces postscript without rasterizing text, so it scales properly, can be edited in Adobe Illustrator, and searched text in pdf documents.

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
- 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.

Troubleshooting

- Try deleting your `.matplotlib/tex.cache` directory. If you don't know where to find `.matplotlib`, see *matplotlib configuration and cache directory locations*.
- 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 *Getting help*

Note: Click *here* to download the full example code

3.5.5 Typesetting With XeLaTeX/LuaLaTeX

How to typeset text with the `pgf` backend in Matplotlib.

Using the `pgf` backend, matplotlib can export figures as pgf drawing commands that can be processed with pdflatex, xelatex or lualatex. XeLaTeX and LuaLaTeX have full unicode support and can use any font that is installed in the operating system, making use of advanced typographic features of OpenType, AAT and Graphite. Pgf pictures created by `plt.savefig('figure.pgf')` can be embedded as raw commands in LaTeX documents. Figures can also be directly compiled and saved to PDF with `plt.savefig('figure.pdf')` by either switching to the backend

```
matplotlib.use('pgf')
```

or registering it for handling pdf output

```
from matplotlib.backends.backend_pgf import FigureCanvasPgf
matplotlib.backend_bases.register_backend('pdf', FigureCanvasPgf)
```

The second method allows you to keep using regular interactive backends and to save xelatex, lualatex or pdflatex compiled PDF files from the graphical user interface.

Matplotlib's pgf support requires a recent LaTeX installation that includes the TikZ/PGF packages (such as TeXLive), preferably with XeLaTeX or LuaLaTeX installed. If either pdftocairo or ghostscript is present on your system, figures can optionally be saved to PNG images as well. The executables for all applications must be located on your *PATH*.

Rc parameters that control the behavior of the pgf backend:

Parameter	Documentation
pgf.preamble	Lines to be included in the LaTeX preamble
pgf.rcfonts	Setup fonts from rc params using the fontspec package
pgf.texsystem	Either "xelatex" (default), "lualatex" or "pdflatex"

Note: TeX defines a set of special characters, such as:

```
# $ % & ~ _ ^ \ { }
```

Generally, these characters must be escaped correctly. For convenience, some characters (_,^,%) are automatically escaped outside of math environments.

Font specification

The fonts used for obtaining the size of text elements or when compiling figures to PDF are usually defined in the matplotlib rc parameters. You can also use the LaTeX default Computer Modern fonts by clearing the lists for `font.serif`, `font.sans-serif` or `font.monospace`. Please note that the glyph coverage of these fonts is very limited. If you want to keep the Computer Modern font face but require extended unicode support, consider installing the Computer Modern Unicode fonts *CMU Serif*, *CMU Sans Serif*, etc.

When saving to `.pgf`, the font configuration matplotlib used for the layout of the figure is included in the header of the text file.

```
"""
=========
Pgf Fonts
=========

"""
# -*- coding: utf-8 -*-

import matplotlib as mpl
mpl.use("pgf")
pgf_with_rc_fonts = {
    "font.family": "serif",
    "font.serif": [],                   # use latex default serif font
    "font.sans-serif": ["DejaVu Sans"],  # use a specific sans-serif font
}
mpl.rcParams.update(pgf_with_rc_fonts)

import matplotlib.pyplot as plt
plt.figure(figsize=(4.5, 2.5))
plt.plot(range(5))
plt.text(0.5, 3., "serif")
plt.text(0.5, 2., "monospace", family="monospace")
plt.text(2.5, 2., "sans-serif", family="sans-serif")
plt.text(2.5, 1., "comic sans", family="Comic Sans MS")
```

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```
plt.xlabel(u"µ is not $\\mu$")
plt.tight_layout(.5)
```

Custom preamble

Full customization is possible by adding your own commands to the preamble. Use the `pgf.preamble` parameter if you want to configure the math fonts, using `unicode-math` for example, or for loading additional packages. Also, if you want to do the font configuration yourself instead of using the fonts specified in the rc parameters, make sure to disable `pgf.rcfonts`.

```
"""
============
Pgf Preamble
============

"""
# -*- coding: utf-8 -*-
from __future__ import (absolute_import, division, print_function,
                        unicode_literals)

import six

import matplotlib as mpl
mpl.use("pgf")
pgf_with_custom_preamble = {
    "font.family": "serif",  # use serif/main font for text elements
    "text.usetex": True,     # use inline math for ticks
    "pgf.rcfonts": False,    # don't setup fonts from rc parameters
    "pgf.preamble": [
         "\\usepackage{units}",          # load additional packages
         "\\usepackage{metalogo}",
         "\\usepackage{unicode-math}",   # unicode math setup
         r"\setmathfont{xits-math.otf}",
         r"\setmainfont{DejaVu Serif}",  # serif font via preamble
         ]
}
mpl.rcParams.update(pgf_with_custom_preamble)
```

Choosing the TeX system

The TeX system to be used by matplotlib is chosen by the `pgf.texsystem` parameter. Possible values are `'xelatex'` (default), `'lualatex'` and `'pdflatex'`. Please note that when selecting pdflatex the fonts and unicode handling must be configured in the preamble.

```
"""
=============
```

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```
Pgf Texsystem
=============

"""
# -*- coding: utf-8 -*-

import matplotlib as mpl
mpl.use("pgf")
pgf_with_pdflatex = {
    "pgf.texsystem": "pdflatex",
    "pgf.preamble": [
         r"\usepackage[utf8x]{inputenc}",
         r"\usepackage[T1]{fontenc}",
         r"\usepackage{cmbright}",
         ]
}
mpl.rcParams.update(pgf_with_pdflatex)

import matplotlib.pyplot as plt
plt.figure(figsize=(4.5, 2.5))
plt.plot(range(5))
plt.text(0.5, 3., "serif", family="serif")
plt.text(0.5, 2., "monospace", family="monospace")
plt.text(2.5, 2., "sans-serif", family="sans-serif")
plt.xlabel(u"µ is not $\\mu$")
plt.tight_layout(.5)
```

Troubleshooting

- Please note that the TeX packages found in some Linux distributions and MiKTeX installations are dramatically outdated. Make sure to update your package catalog and upgrade or install a recent TeX distribution.
- 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.
- A limitation on Windows causes the backend to keep file handles that have been opened by your application open. As a result, it may not be possible to delete the corresponding files until the application closes (see #1324).
- Sometimes the font rendering in figures that are saved to png images is very bad. This happens when the pdftocairo tool is not available and ghostscript is used for the pdf to png conversion.
- 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.
- The `pgf.preamble` rc setting provides lots of flexibility, and lots of ways to cause problems. When experiencing problems, try to minimalize or disable the custom preamble.

- Configuring an `unicode-math` environment can be a bit tricky. The TeXLive distribution for example provides a set of math fonts which are usually not installed system-wide. XeTeX, unlike LuaLatex, cannot find these fonts by their name, which is why you might have to specify `\setmathfont{xits-math.otf}` instead of `\setmathfont{XITS Math}` or alternatively make the fonts available to your OS. See this tex.stackexchange.com question for more details.
- If the font configuration used by matplotlib differs from the font setting in yout LaTeX document, the alignment of text elements in imported figures may be off. Check the header of your `.pgf` file if you are unsure about the fonts matplotlib used for the layout.
- Vector images and hence `.pgf` files can become bloated if there are a lot of objects in the graph. This can be the case for image processing or very big scatter graphs. In an extreme case this can cause TeX to run out of memory: "TeX capacity exceeded, sorry" You can configure latex to increase the amount of memory available to generate the `.pdf` image as discussed on tex.stackexchange.com. Another way would be to "rasterize" parts of the graph causing problems using either the `rasterized=True` keyword, or `.set_rasterized(True)` as per this example.
- If you still need help, please see *Getting help*

Note: Click *here* to download the full example code

3.5.6 Writing mathematical expressions

An introduction to writing mathematical expressions in Matplotlib.

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

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

Any text element can use math text. You should use raw strings (precede the quotes with an `'r'`), and surround the math text with dollar signs ($), as in TeX. Regular text and mathtext can be interleaved within the same string. Mathtext can use DejaVu Sans (default), DejaVu Serif, 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 with style sheets and rcParams*)

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.

Subscripts and superscripts

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

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

$$\alpha_i > \beta_i \tag{3.1}$$

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

$$\sum_{i=0}^{\infty} x_i \tag{3.2}$$

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

$$\frac{3}{4}\binom{3}{4}\stackrel{3}{4} \tag{3.3}$$

Fractions can be arbitrarily nested:

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

produces

$$\frac{5 - \frac{1}{x}}{4} \tag{3.4}$$

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

$$(\frac{5 - \frac{1}{x}}{4}) \tag{3.5}$$

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

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

$$\left(\frac{5 - \frac{1}{x}}{4}\right) \tag{3.6}$$

Radicals

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

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

$$\sqrt{2} \tag{3.7}$$

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

$$\sqrt[3]{x} \tag{3.8}$$

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, e.g., to write "sin" in a Roman font, enclose the text in a font command:

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

$$s(t) = \mathcal{A}\mathrm{sin}(2\omega t) \tag{3.9}$$

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

$$s(t) = \mathcal{A}\sin(2\omega t) \tag{3.10}$$

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

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

$$s(t) = \mathcal{A}\,\sin(2\omega t) \tag{3.11}$$

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}`	$\mathbb{blackboard}$
`\mathrm{\mathbb{blackboard}}`	$\mathrm{\mathbb{blackboard}}$
`\mathfrak{Fraktur}`	$\mathfrak{Fraktur}$
`\mathsf{sansserif}`	sansserif
`\mathrm{\mathsf{sansserif}}`	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.

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	$\vec{a}$
\overline{abc}	$\overline{abc}$

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

$$\hat{i}\ \hat{\imath} \tag{3.12}$$

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	F \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

ℵ \aleph	ℶ \beth	ℸ \daleth	ℷ \gimel		

Delimiters

/ /	[[	⇓ \Downarrow	⇑ \Uparrow	‖ \Vert	\ \backslash
↓ \downarrow	⟨ \langle	⌈ \lceil	⌊ \lfloor	⌞ \llcorner	⌟ \lrcorner
⟩ \rangle	⌉ \rceil	⌋ \rfloor	⌜ \ulcorner	↑ \uparrow	⌝ \urcorner
| \vert	{ \{	‖ \\|	} \}	]]	| |

Big symbols

⋂ \bigcap	⋃ \bigcup	⨀ \bigodot	⨁ \bigoplus	⨂ \bigotimes	⨄ \biguplus
⋁ \bigvee	⋀ \bigwedge	∐ \coprod	∫ \int	∮ \oint	∏ \prod
∑ \sum					

Standard function names

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

Binary operation and relation symbols

≎ \Bumpeq	⋒ \Cap	⋓ \Cup	≑ \Doteq
⋈ \Join	⋐ \Subset	⋑ \Supset	⊩ \Vdash
⊪ \Vvdash	≈ \approx	≊ \approxeq	∗ \ast

Continued on next page

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≍ \asymp	϶ \backepsilon	∽ \backsim	⋍ \backsimeq
⩒ \barwedge	∵ \because	≬ \between	◯ \bigcirc
▽ \bigtriangledown	△ \bigtriangleup	◀ \blacktriangleleft	▶ \blacktriangleright
⊥ \bot	⋈ \bowtie	⊡ \boxdot	⊟ \boxminus
⊞ \boxplus	⊠ \boxtimes	• \bullet	≏ \bumpeq
∩ \cap	· \cdot	○ \circ	≗ \circeq
:− \coloneq	≅ \cong	∪ \cup	≼ \curlyeqprec
≽ \curlyeqsucc	⋎ \curlyvee	⋏ \curlywedge	† \dag
⊣ \dashv	‡ \ddag	⋄ \diamond	÷ \div
⋇ \divideontimes	≐ \doteq	÷ \doteqdot	∔ \dotplus
⩖ \doublebarwedge	⧦ \eqcirc	−: \eqcolon	≂ \eqsim
⪖ \eqslantgtr	⪕ \eqslantless	≡ \equiv	≒ \fallingdotseq
⌢ \frown	≥ \geq	≧ \geqq	⩾ \geqslant
≫ \gg	⋙ \ggg	⪺ \gnapprox	≩ \gneqq
≳ \gnsim	⪆ \gtrapprox	⋗ \gtrdot	≷ \gtreqless
⪌ \gtreqqless	≷ \gtrless	≳ \gtrsim	∈ \in
⊺ \intercal	⋋ \leftthreetimes	≤ \leq	≦ \leqq
⩽ \leqslant	⪅ \lessapprox	⋖ \lessdot	⋚ \lesseqgtr
⪋ \lesseqqgtr	≶ \lessgtr	≲ \lesssim	≪ \ll
⋘ \lll	⪉ \lnapprox	≨ \lneqq	⋦ \lnsim
⋉ \ltimes	∣ \mid	⊨ \models	∓ \mp
⊮ \nVDash	⊭ \nVdash	≉ \napprox	≇ \ncong
≠ \ne	≠ \neq	≠ \neq	≢ \nequiv
≱ \ngeq	≯ \ngtr	∋ \ni	≰ \nleq
≮ \nless	∤ \nmid	∉ \notin	∦ \nparallel
⊀ \nprec	≁ \nsim	⊄ \nsubset	⊈ \nsubseteq
⊁ \nsucc	⊅ \nsupset	⊉ \nsupseteq	⋪ \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

Continued on next page

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⊢ \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 \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'$\u23ce$'
```

Example

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

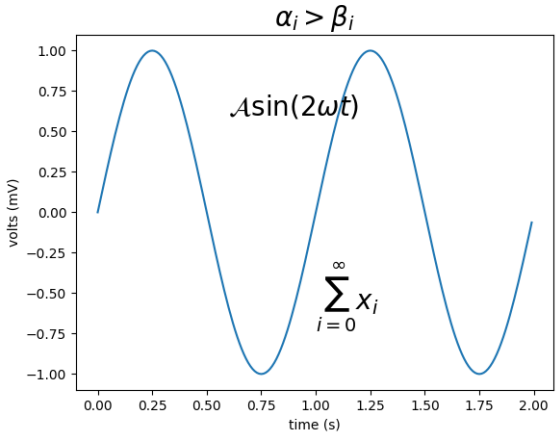

Fig. 47: Pyplot Mathtext

Note: Click *here* to download the full example code

3.5.7 Text properties and layout

Controlling properties of text and its layout with Matplotlib.

The *matplotlib.text.Text* instances have a variety of properties which can be configured via keyword arguments to the text commands (e.g., *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	bool
clip_path	a *Path* instance and a *Transform* instance, a *Patch*
color	any matplotlib *color*
family	['serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
fontproperties	a *FontProperties* instance
horizontalalignment or ha	['center' | 'right' | 'left']
label	any string
linespacing	float
multialignment	['left' | 'right' | 'center']
name or fontname	string e.g., ['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, e.g., 'smaller', 'x-large']
style or fontstyle	['normal' | 'italic' | 'oblique']
text	string or anything printable with '%s' conversion
transform	a *Transform* instance
variant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	['normal' | 'bold' | 'heavy' | 'light' | 'ultrabold' | 'ultralight']
x	float
y	float
zorder	any number

You can lay out 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',
```

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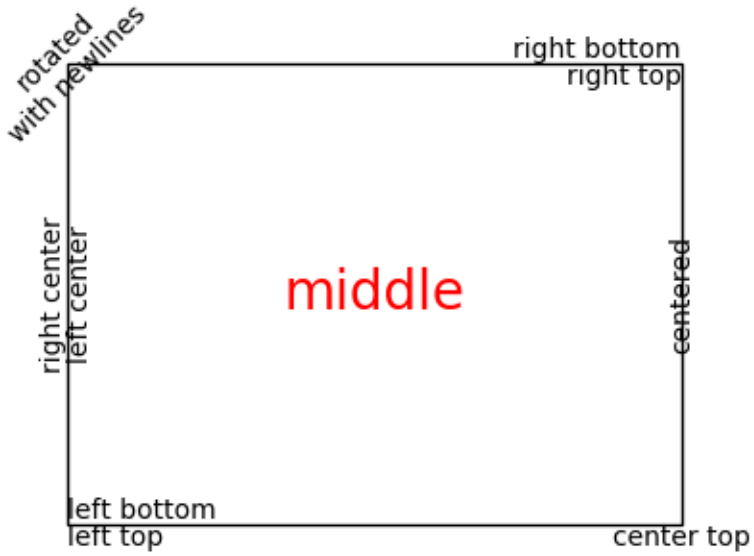
```
        verticalalignment='center',
        rotation='vertical',
        transform=ax.transAxes)

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()
```



3.5.8 Default Font

The base default font is controlled by a set of rcParams. To set the font for mathematical expressions, use the rcParams beginning with `mathtext` (see *mathtext*).

rcParam	usage
`'font.family'`	List of either names of font or `{'cursive', 'fantasy', 'monospace', 'sans', 'sans serif', 'sans-serif', 'serif'}`.
`'font.style'`	The default style, ex `'normal'`, `'italic'`.
`'font.variant'`	Default variant, ex `'normal'`, `'small-caps'` (untested)
`'font.stretch'`	Default stretch, ex `'normal'`, `'condensed'` (incomplete)
`'font.weight'`	Default weight. Either string or integer
`'font.size'`	Default font size in points. Relative font sizes (`'large'`, `'x-small'`) are computed against this size.

The mapping between the family aliases (`{'cursive', 'fantasy', 'monospace', 'sans', 'sans`

serif', 'sans-serif', 'serif'}) and actual font names is controlled by the following rcParams:

family alias	rcParam with mappings
'serif'	'font.serif'
'monospace'	'font.monospace'
'fantasy'	'font.fantasy'
'cursive'	'font.cursive'
{'sans', 'sans serif', 'sans-serif'}	'font.sans-serif'

which are lists of font names.

Text with non-latin glyphs

As of v2.0 the *default font* contains glyphs for many western alphabets, but still does not cover all of the glyphs that may be required by mpl users. For example, DejaVu has no coverage of Chinese, Korean, or Japanese.

To set the default font to be one that supports the code points you need, prepend the font name to 'font.family' or the desired alias lists

```
matplotlib.rcParams['font.sans-serif'] = ['Source Han Sans TW', 'sans-serif']
```

or set it in your .matplotlibrc file:

```
font.sans-serif: Source Han Sans TW, Arial, sans-serif
```

To control the font used on per-artist basis use the 'name', 'fontname' or 'fontproperties' kwargs documented *above*.

On linux, fc-list can be a useful tool to discover the font name; for example

```
$ fc-list :lang=zh family
Noto to Sans Mono CJK TC,Noto Sans Mono CJK TC Bold
Noto Sans CJK TC,Noto Sans CJK TC Medium
Noto Sans CJK TC,Noto Sans CJK TC DemiLight
Noto Sans CJK KR,Noto Sans CJK KR Black
Noto Sans CJK TC,Noto Sans CJK TC Black
Noto Sans Mono CJK TC,Noto Sans Mono CJK TC Regular
Noto Sans CJK SC,Noto Sans CJK SC Light
```

lists all of the fonts that support Chinese.

Note: Click *here* to download the full example code

3.5.9 Text in Matplotlib Plots

Introduction to plotting and working with text in Matplotlib.

Matplotlib has extensive text support, including support for mathematical expressions, truetype support for raster and vector outputs, newline separated text with arbitrary rotations, and unicode support.

Because it embeds fonts directly in output documents, e.g., for postscript or PDF, what you see on the screen is what you get in the hardcopy. FreeType 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.

The user has a great deal of control over text properties (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, supporting *mathematical expressions* anywhere in your figure.

Basic text commands

The following commands are used to create text in the pyplot interface and the object-oriented API:

pyplot API	OO API	description
text	*text*	Add text at an arbitrary location of the *Axes*.
annotate	*annotate*	Add an annotation, with an optional arrow, at an arbitrary location of the *Axes*.
xlabel	*set_xlabel*	Add a label to the *Axes*'s x-axis.
ylabel	*set_ylabel*	Add a label to the *Axes*'s y-axis.
title	*set_title*	Add a title to the *Axes*.
figtext	*text*	Add text at an arbitrary location of the *Figure*.
suptitle	*suptitle*	Add a title to the *Figure*.

All of these functions create and return a *Text* instance, which can be configured with a variety of font and other properties. The example below shows all of these commands in action, and more detail is provided in the sections that follow.

```
import matplotlib
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)
```

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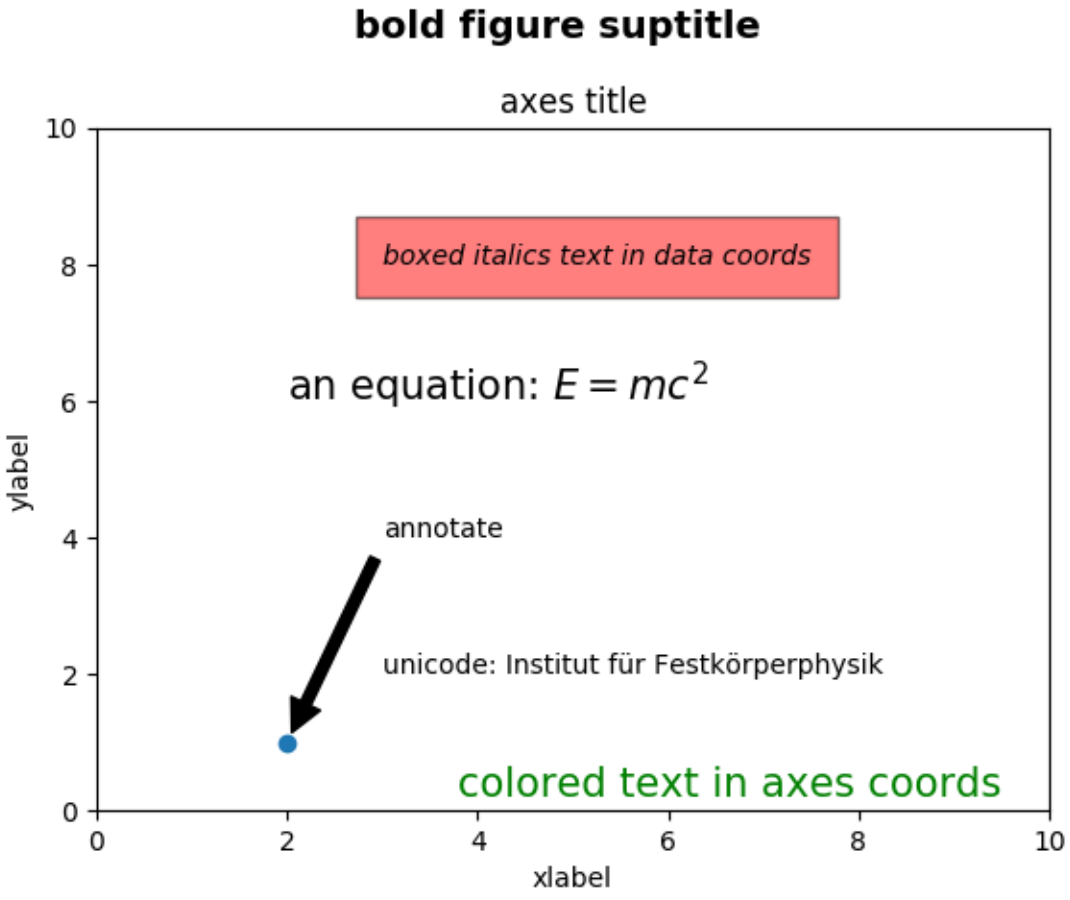
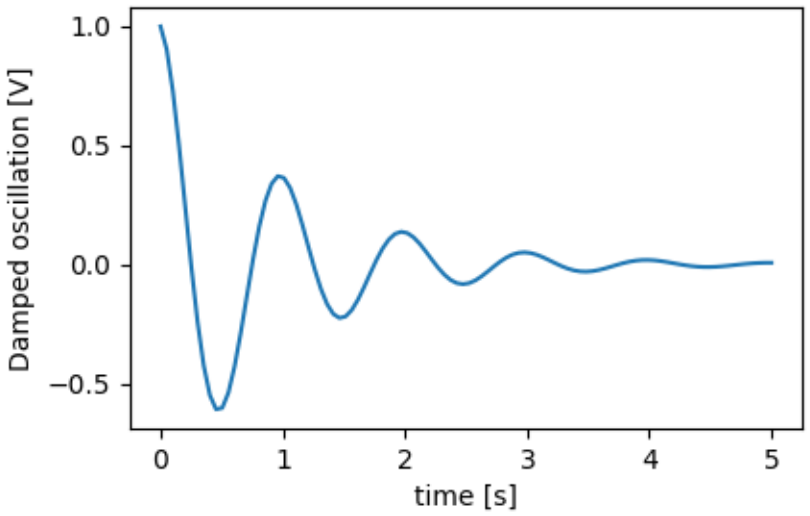
```
ax.text(3, 2, u'unicode: Institut für Festkörperphysik')

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()
```



Labels for x- and y-axis

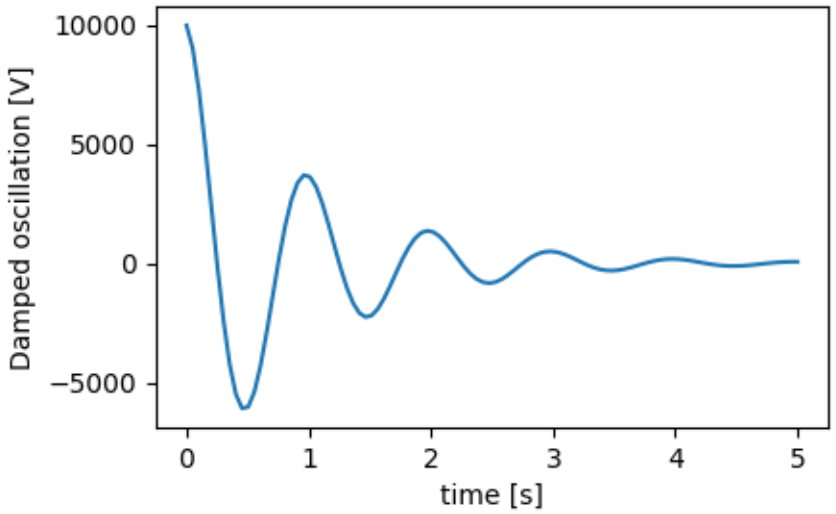
Specifying the labels for the x- and y-axis is strightforward, via the *set_xlabel* and *set_ylabel* methods.

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

x1 = np.linspace(0.0, 5.0, 100)
y1 = np.cos(2 * np.pi * x1) * np.exp(-x1)

fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]')

plt.show()
```



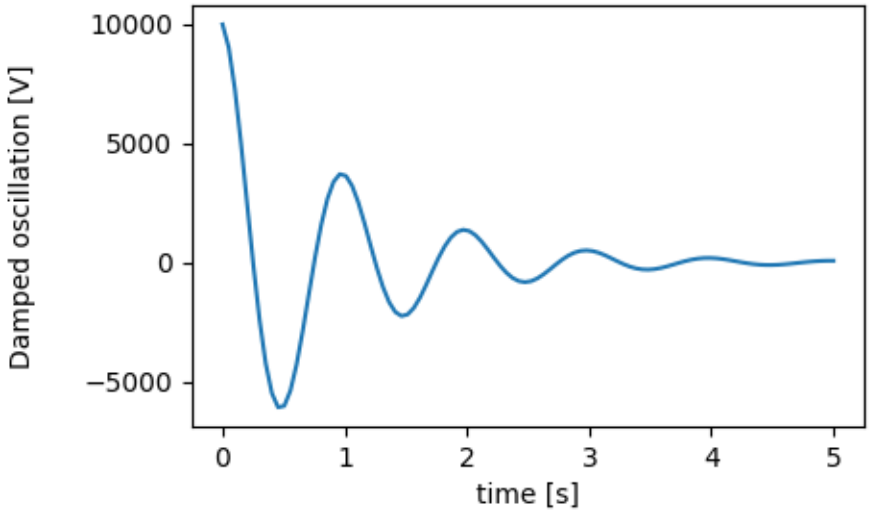
The x- and y-labels are automatically placed so that they clear the x- and y-ticklabels. Compare the plot below with that above, and note the y-label is to the left of the one above.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1*10000)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]')

plt.show()
```



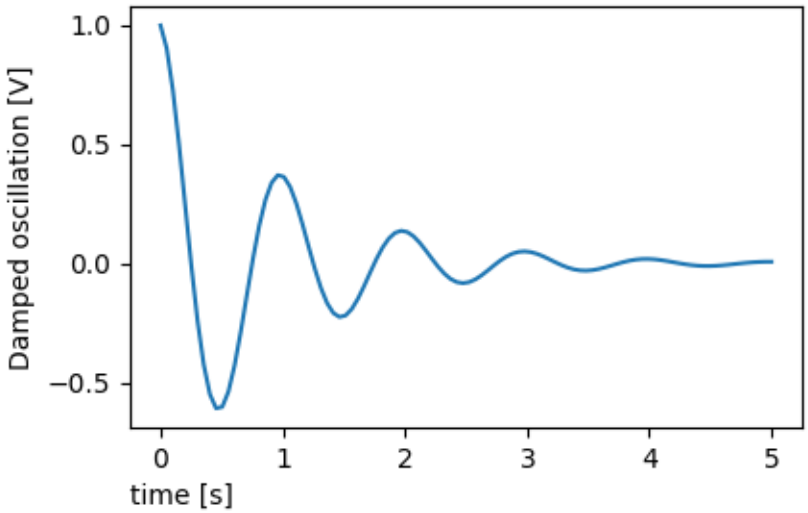
If you want to move the labels, you can specify the *labelpad* kyeword argument, where the value is points (1/72", the same unit used to specify fontsizes).

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1*10000)
ax.set_xlabel('time [s]')
ax.set_ylabel('Damped oscillation [V]', labelpad=18)

plt.show()
```



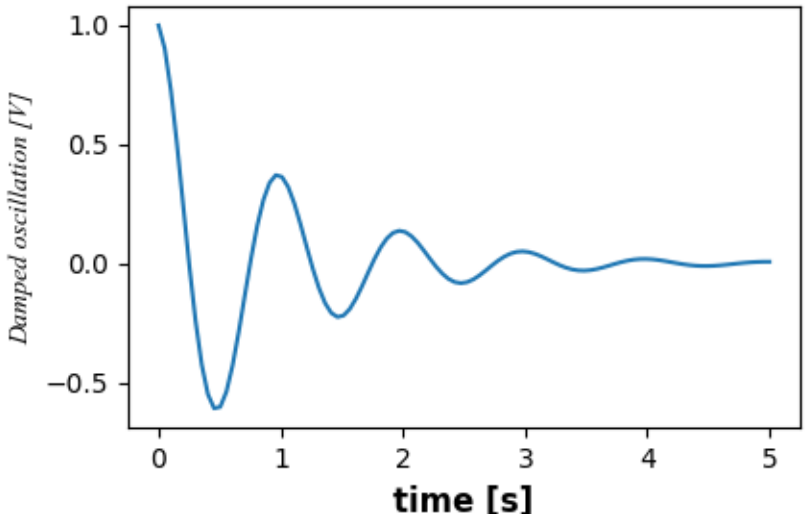
Or, the labels accept all the `Text` keyword arguments, including *position*, via which we can manually specify the label positions. Here we put the xlabel to the far left of the axis. Note, that the y-coordinate of this position has no effect - to adjust the y-position we need to use the *labelpad* kwarg.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]', position=(0., 1e6),
                      horizontalalignment='left')
ax.set_ylabel('Damped oscillation [V]')

plt.show()
```



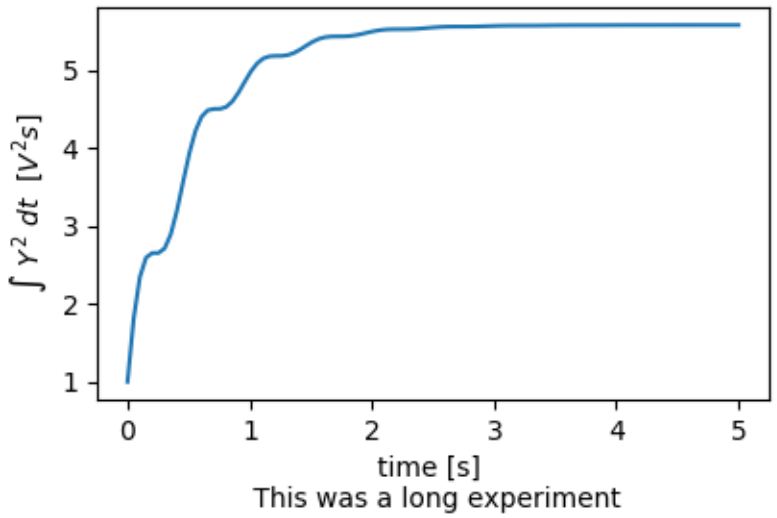
All the labelling in this tutorial can be changed by manipulating the *matplotlib.font_manager.FontProperties* method, or by named kwargs to *set_xlabel*

```
from matplotlib.font_manager import FontProperties

font = FontProperties()
font.set_family('serif')
font.set_name('Times New Roman')
font.set_style('italic')

fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.15, left=0.2)
ax.plot(x1, y1)
ax.set_xlabel('time [s]', fontsize='large', fontweight='bold')
ax.set_ylabel('Damped oscillation [V]', fontproperties=font)

plt.show()
```



Finally, we can use native TeX rendering in all text objects and have multiple lines:

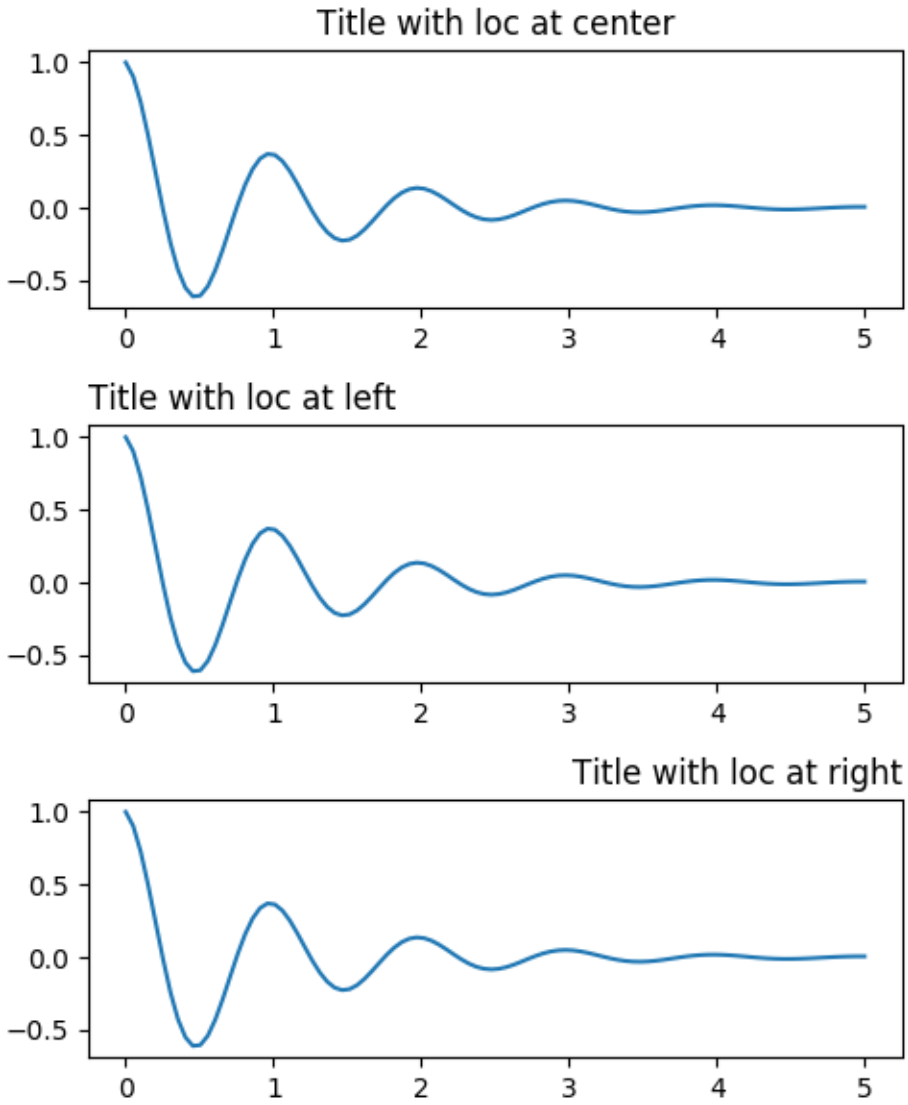
```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(bottom=0.2, left=0.2)
ax.plot(x1, np.cumsum(y1**2))
ax.set_xlabel('time [s] \n This was a long experiment')
ax.set_ylabel(r'$\int\ Y^2\ dt\ \ [V^2 s]$')
plt.show()
```



Titles

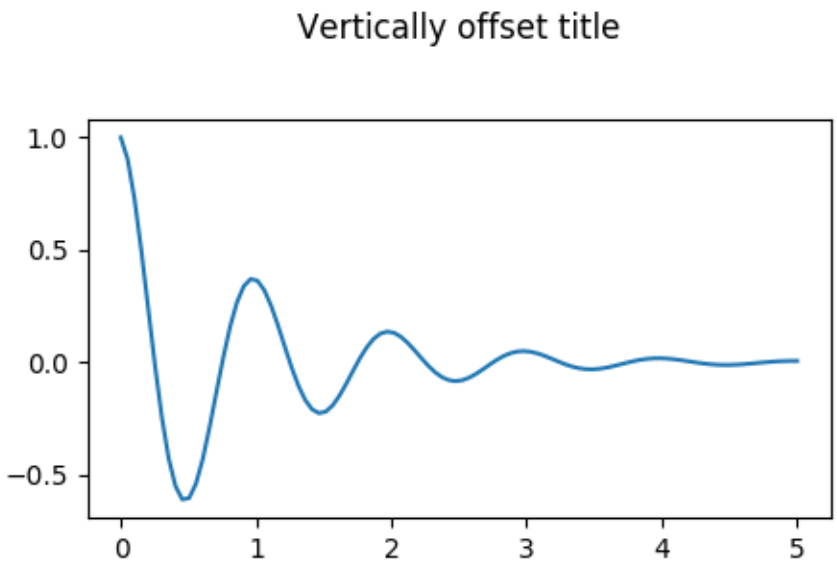
Subplot titles are set in much the same way as labels, but there is the *loc* keyword arguments that can change the position and justification from the default value of `loc=center`.

```
fig, axs = plt.subplots(3, 1, figsize=(5, 6), tight_layout=True)
locs = ['center', 'left', 'right']
for ax, loc in zip(axs, locs):
    ax.plot(x1, y1)
    ax.set_title('Title with loc at '+loc, loc=loc)
plt.show()
```



Vertical spacing for titles is controlled via `rcParams[axes.titlepad]`, which defaults to 5 points. Setting to a different value moves the title.

```
fig, ax = plt.subplots(figsize=(5, 3))
fig.subplots_adjust(top=0.8)
ax.plot(x1, y1)
ax.set_title('Vertically offset title', pad=30)
plt.show()
```



Ticks and ticklabels

Placing ticks and ticklabels is a very tricky aspect of making a figure. Matplotlib does the best it can automatically, but it also offers a very flexible framework for determining the choices for tick locations, and how they are labelled.

Terminology

Axes have an *matplotlib.axis* object for the `ax.xaxis` and `ax.yaxis` that contain the information about how the labels in the axis are laid out.

The axis API is explained in detail in the documentation to *axis*.

An Axis object has major and minor ticks. The Axis has a `matplotlib.xaxis.set_major_locator` and `matplotlib.xaxis.set_minor_locator` methods that use the data being plotted to determine the location of major and minor ticks. There are also `matplotlib.xaxis.set_major_formatter` and `matplotlib.xaxis.set_minor_formatters` methods that format the tick labels.

Simple ticks

It often is convenient to simply define the tick values, and sometimes the tick labels, overriding the default locators and formatters. This is discouraged because it breaks itneractive navigation of the plot. It also can reset the axis limits: note that the second plot has the ticks we asked for, including ones that are well outside the automatic view limits.

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
```

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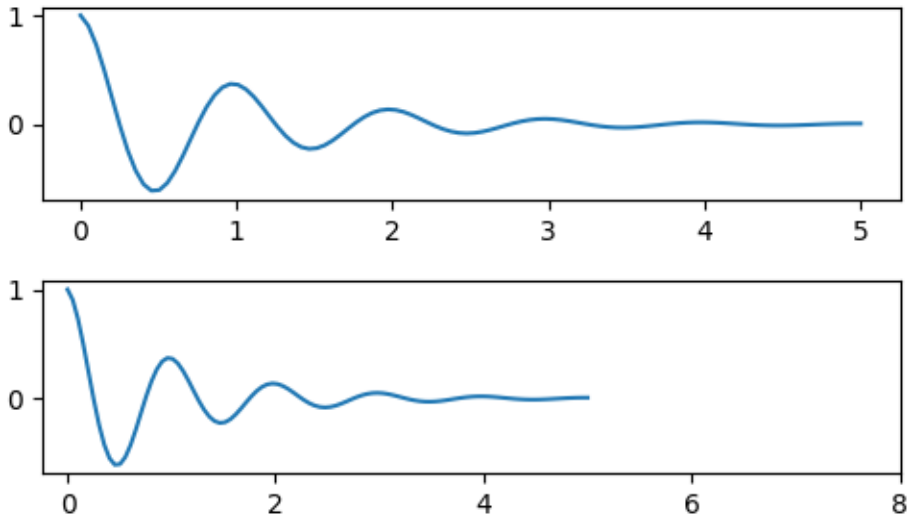
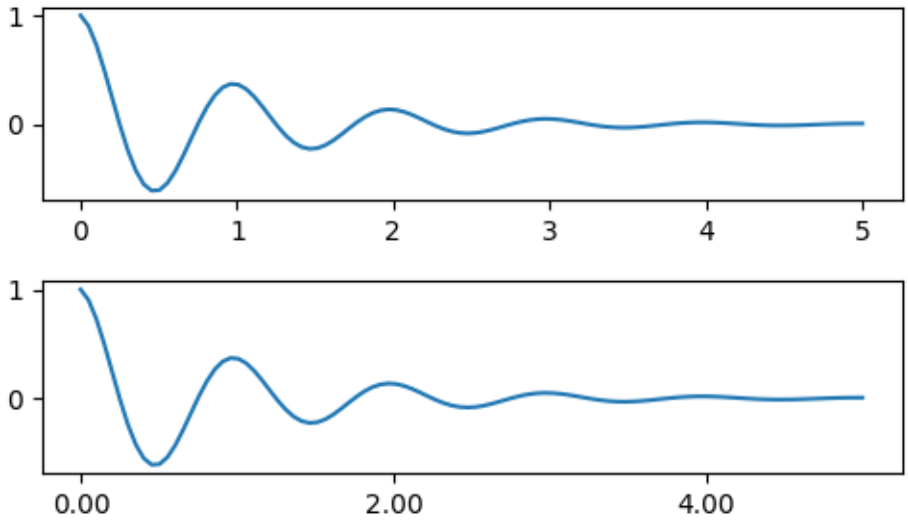
```
axs[1].xaxis.set_ticks(np.arange(0., 8.1, 2.))
plt.show()
```



We can of course fix this after the fact, but it does highlight a weakness of hard-coding the ticks. This example also changes the format of the ticks:

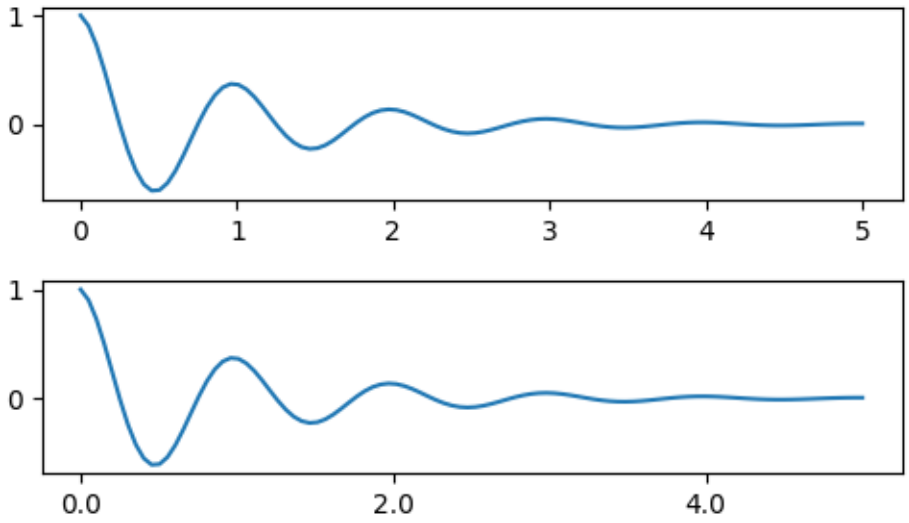
```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
ticks = np.arange(0., 8.1, 2.)
# list comprehension to get all tick labels...
tickla = ['%1.2f' % tick for tick in ticks]
axs[1].xaxis.set_ticks(ticks)
axs[1].xaxis.set_ticklabels(tickla)
axs[1].set_xlim(axs[0].get_xlim())
plt.show()
```



Tick Locators and Formatters

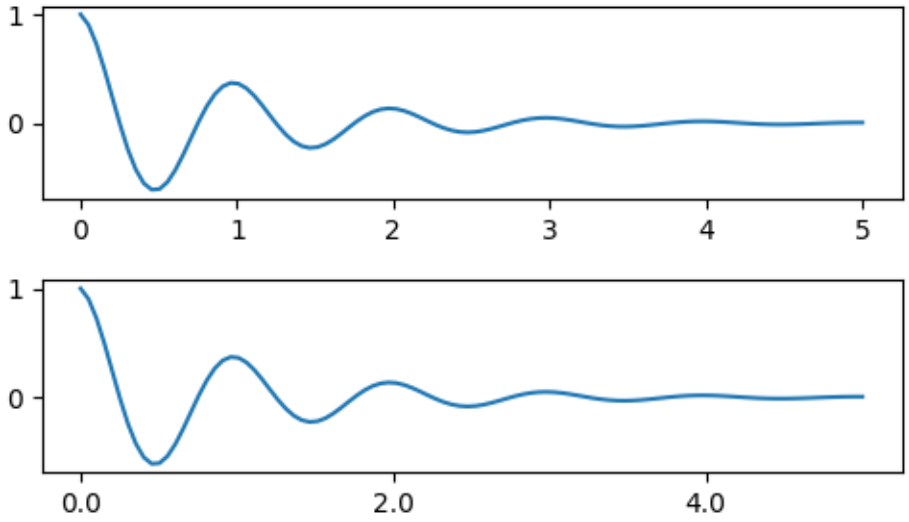
Instead of making a list of all the tickalbels, we could have used a *matplotlib.ticker.FormatStrFormatter* and passed it to the `ax.xaxis`

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
ticks = np.arange(0., 8.1, 2.)
# list comprehension to get all tick labels...
formatter = matplotlib.ticker.StrMethodFormatter('{x:1.1f}')
axs[1].xaxis.set_ticks(ticks)
axs[1].xaxis.set_major_formatter(formatter)
axs[1].set_xlim(axs[0].get_xlim())
plt.show()
```



And of course we could have used a non-default locator to set the tick locations. Note we still pass in the tick values, but the x-limit fix used above is *not* needed.

```
fig, axs = plt.subplots(2, 1, figsize=(5, 3), tight_layout=True)
axs[0].plot(x1, y1)
axs[1].plot(x1, y1)
formatter = matplotlib.ticker.FormatStrFormatter('%1.1f')
locator = matplotlib.ticker.FixedLocator(ticks)
axs[1].xaxis.set_major_locator(locator)
axs[1].xaxis.set_major_formatter(formatter)
plt.show()
```



The default formatter is the *matplotlib.ticker.MaxNLocator* called as `ticker.MaxNLocator(self, nbins='auto', steps=[1, 2, 2.5, 5, 10])` The *steps* keyword contains a list of multiples that can be used for tick values. i.e. in this case, 2, 4, 6 would be acceptable ticks, as would 20, 40, 60 or 0.2, 0.4, 0.6. However, 3, 6, 9 would not be acceptable because 3 doesn't appear in the list of steps.

`nbins=auto` uses an algorithm to determine how many ticks will be acceptable based on how long the axis is. The fontsize of the ticklabel is taken into account, but the length of the tick string is not (because its not yet known.) In the bottom row, the ticklabels are quite large, so we set `nbins=4` to make the labels fit in the right-hand plot.

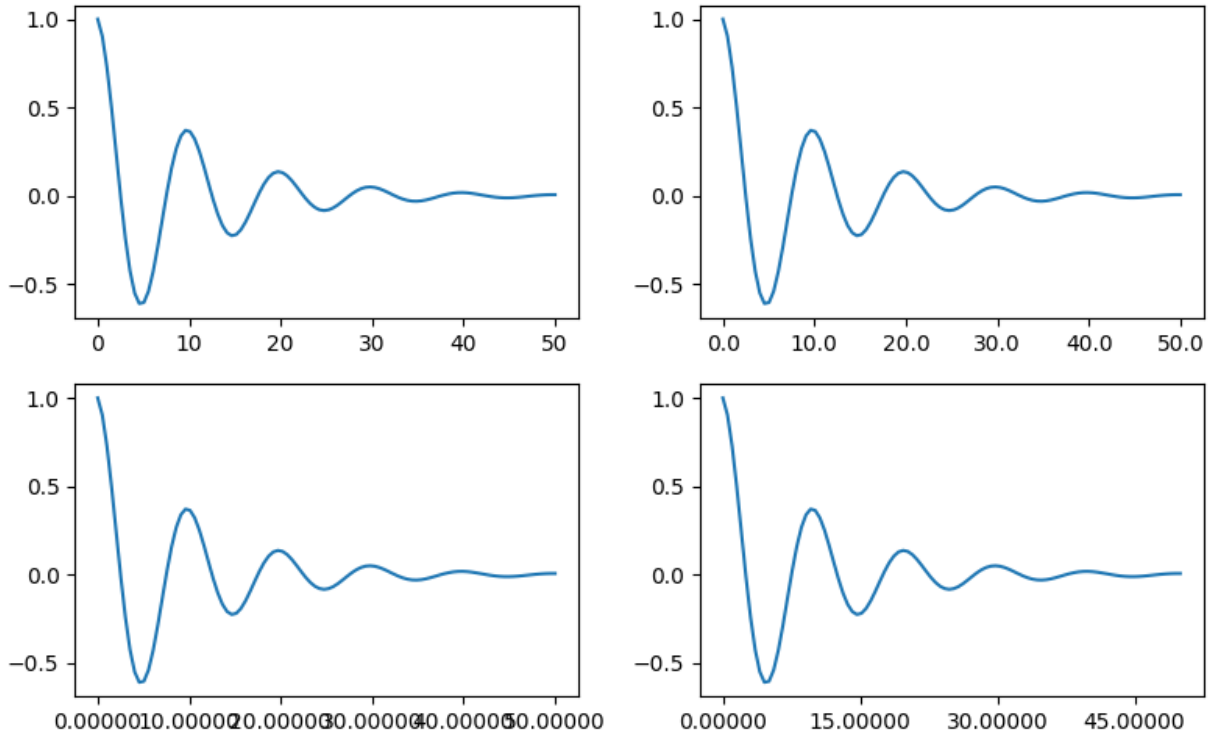
```
fig, axs = plt.subplots(2, 2, figsize=(8, 5), tight_layout=True)
axs = axs.flatten()
for n, ax in enumerate(axs):
    ax.plot(x1*10., y1)

formatter = matplotlib.ticker.FormatStrFormatter('%1.1f')
locator = matplotlib.ticker.MaxNLocator(nbins='auto', steps=[1, 4, 10])
axs[1].xaxis.set_major_locator(locator)
axs[1].xaxis.set_major_formatter(formatter)

formatter = matplotlib.ticker.FormatStrFormatter('%1.5f')
locator = matplotlib.ticker.AutoLocator()
axs[2].xaxis.set_major_formatter(formatter)
axs[2].xaxis.set_major_locator(locator)

formatter = matplotlib.ticker.FormatStrFormatter('%1.5f')
locator = matplotlib.ticker.MaxNLocator(nbins=4)
axs[3].xaxis.set_major_formatter(formatter)
axs[3].xaxis.set_major_locator(locator)

plt.show()
```

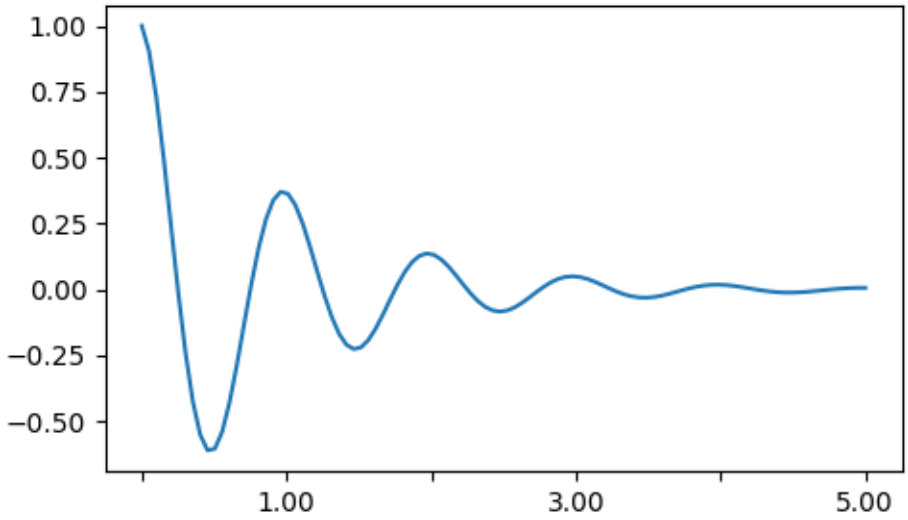


Finally, we can specify functions for the formatter using *matplotlib.ticker.FuncFormatter*.

```
def formatoddticks(x, pos):
    """Format odd tick positions
    """
    if x % 2:
        return '%1.2f' % x
    else:
        return ''

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
ax.plot(x1, y1)
formatter = matplotlib.ticker.FuncFormatter(formatoddticks)
locator = matplotlib.ticker.MaxNLocator(nbins=6)
ax.xaxis.set_major_formatter(formatter)
ax.xaxis.set_major_locator(locator)

plt.show()
```



Dateticks

Matplotlib can accept `datetime.datetime` and `numpy.datetime64` objects as plotting arguments. Dates and times require special formatting, which can often benefit from manual intervention. In order to help, dates have spectial Locators and Formatters, defined in the *`matplotlib.dates`* module.

A simple example is as follows. Note how we have to rotate the tick labels so that they don't over-run each other.

```
import datetime

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
base = datetime.datetime(2017, 1, 1, 0, 0, 1)
time = [base + datetime.timedelta(days=x) for x in range(len(y1))]
```

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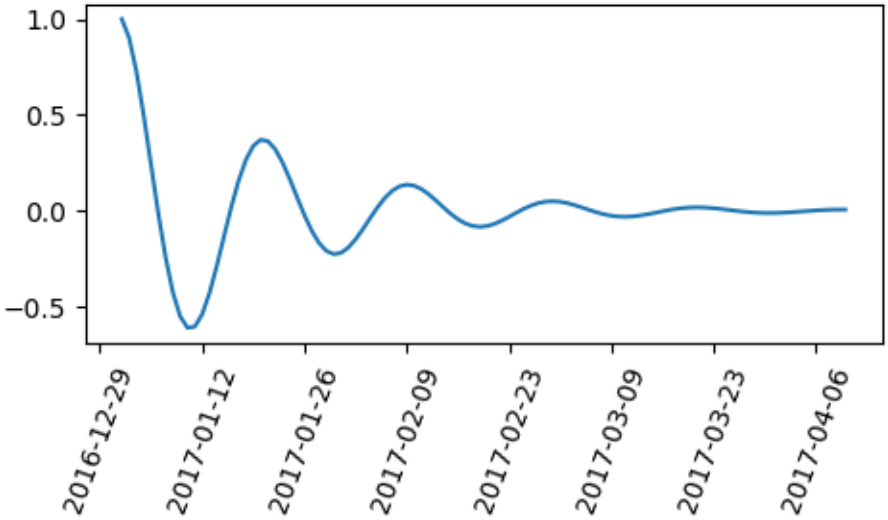
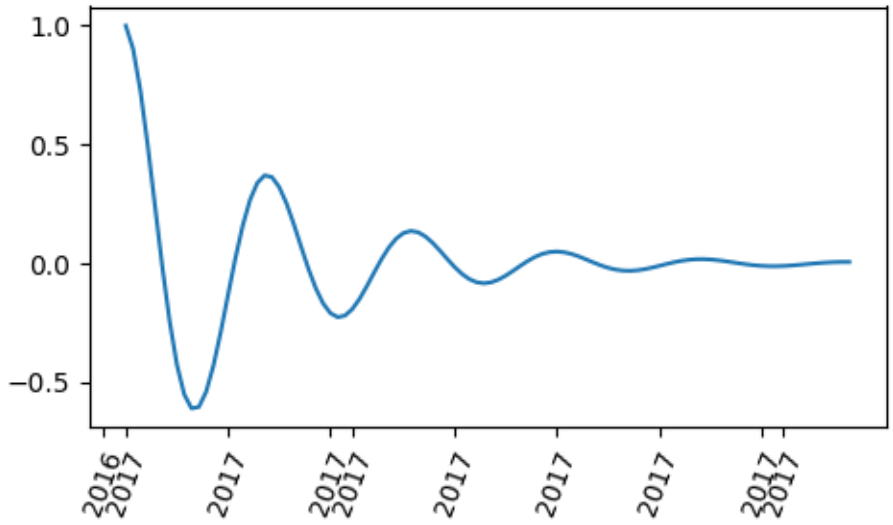
```
ax.plot(time, y1)
ax.tick_params(axis='x', rotation=70)
plt.show()
```



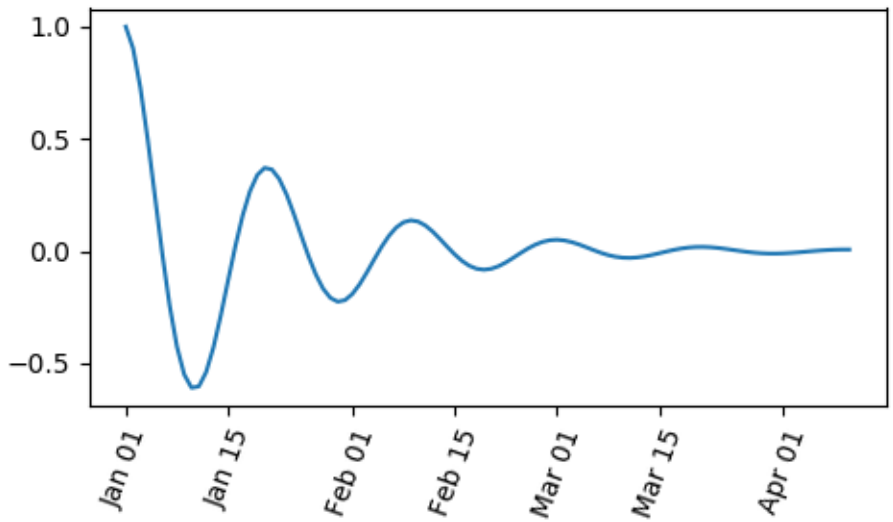
Maybe the format of the labels above is acceptable, but the choices is rather idiosyncratic. We can make the ticks fall on the start of the month by modifying *matplotlib.dates.AutoDateLocator*

```
import matplotlib.dates as mdates

locator = mdates.AutoDateLocator(interval_multiples=True)

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
ax.xaxis.set_major_locator(locator)
ax.plot(time, y1)
ax.tick_params(axis='x', rotation=70)
plt.show()
```



However, this changes the tick labels. The easiest fix is to pass a format to *matplotlib.dates.DateFormatter*. Also note that the 29th and the next month are very close together. We can fix this by using the `dates.DayLocator` class, which allows us to specify a list of days of the month to use. Similar formatters are listed in the *matplotlib.dates* module.

```
locator = mdates.DayLocator(bymonthday=[1, 15])
formatter = mdates.DateFormatter('%b %d')

fig, ax = plt.subplots(figsize=(5, 3), tight_layout=True)
ax.xaxis.set_major_locator(locator)
ax.xaxis.set_major_formatter(formatter)
ax.plot(time, y1)
ax.tick_params(axis='x', rotation=70)
plt.show()
```



Legends and Annotations

- Legends: *Legend guide*
- Annotations: *Annotations*

3.6 Toolkits

These tutorials cover toolkits designed to extend the functionality of Matplotlib in order to accomplish specific goals.

Note: Click *here* to download the full example code

3.6.1 The mplot3d Toolkit

Generating 3D plots using the mplot3d toolkit.

Contents

- *The mplot3d Toolkit*
  - *Getting started*
    - *Line plots*
    - *Scatter plots*
    - *Wireframe plots*
    - *Surface plots*
    - *Tri-Surface plots*
    - *Contour plots*
    - *Filled contour plots*
    - *Polygon plots*
    - *Bar plots*
    - *Quiver*
    - *2D plots in 3D*
    - *Text*
    - *Subplotting*

Getting started

An Axes3D object is created just like any other axes using the projection='3d' keyword. Create a new *matplotlib.figure.Figure* and add a new axes to it of type `Axes3D`:

```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
```

New in version 1.0.0: This approach is the preferred method of creating a 3D axes.

Note: Prior to version 1.0.0, the method of creating a 3D axes was different. For those using older versions of matplotlib, change `ax = fig.add_subplot(111, projection='3d')` to `ax = Axes3D(fig)`.

See the *mplot3d FAQ* for more information about the mplot3d toolkit.

Line plots

`Axes3D.`**`plot`**(*xs*, *ys*, **args*, ***kwargs*)

Plot 2D or 3D data.

Argument	Description
xs, *ys*	x, y coordinates of vertices
zs	z value(s), either one for all points or one for each point.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.

Other arguments are passed on to *plot()*

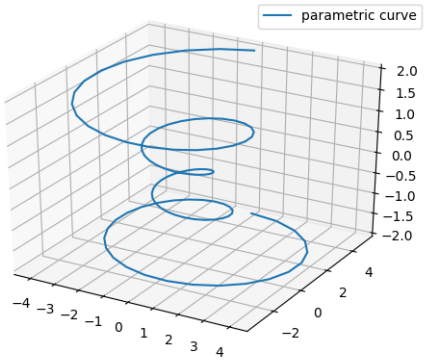


Fig. 48: Lines3d

Scatter plots

Axes3D.**scatter**(*xs*, *ys*, *zs=0*, *zdir='z'*, *s=20*, *c=None*, *depthshade=True*, **args*, ***kwargs*)
Create a scatter plot.

Argument	Description
xs, *ys*	Positions of data points.
zs	Either an array of the same length as *xs* and *ys* or a single value to place all points in the same plane. Default is 0.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.
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, including the case of a single row to specify the same color for all points.
depthshade	Whether or not to shade the scatter markers to give the appearance of depth. Default is *True*.

Keyword arguments are passed on to `scatter()`.

Returns a `Patch3DCollection`

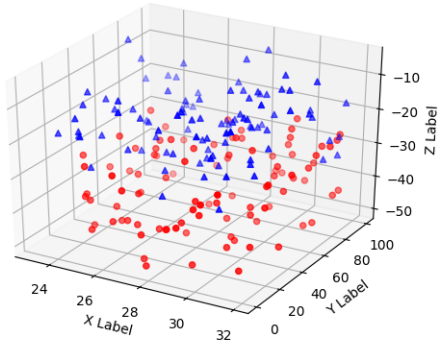


Fig. 49: Scatter3d

Wireframe plots

Axes3D.**plot_wireframe**(*X*, *Y*, *Z*, **args*, ***kwargs*)
Plot a 3D wireframe.

Note: The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.

Parameters

X, Y, Z [2d arrays] Data values.

rcount, ccount [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Setting a count to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot. Defaults to 50.

New in version 2.0.

rstride, cstride [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 1. Setting a stride to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot.

'classic' mode uses a default of `rstride = cstride = 1` instead of the new default of `rcount = ccount = 50`.

****kwargs :** Other arguments are forwarded to *Line3DCollection*.

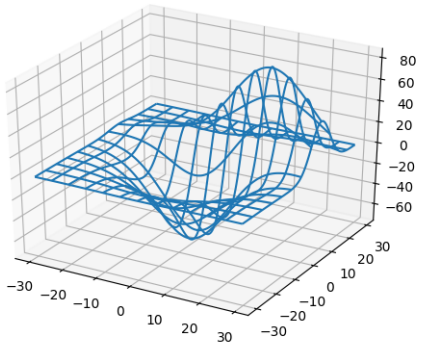


Fig. 50: Wire3d

Surface plots

`Axes3D.plot_surface`(*X*, *Y*, *Z*, **args*, ***kwargs*)

Create a surface plot.

By default it will be colored in shades of a solid color, but it also supports color mapping by supplying the *cmap* argument.

Note: The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.

Parameters

X, Y, Z [2d arrays] Data values.

rcount, ccount [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Defaults to 50.

New in version 2.0.

rstride, cstride [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 10.

'classic' mode uses a default of `rstride = cstride = 10` instead of the new default of `rcount = ccount = 50`.

color [color-like] Color of the surface patches.

cmap [Colormap] Colormap of the surface patches.

facecolors [array-like of colors.] Colors of each individual patch.

norm [Normalize] Normalization for the colormap.

vmin, vmax [float] Bounds for the normalization.

shade [bool] Whether to shade the face colors.

****kwargs :** Other arguments are forwarded to *Poly3DCollection*.

Tri-Surface plots

`Axes3D.plot_trisurf(*args, **kwargs)`

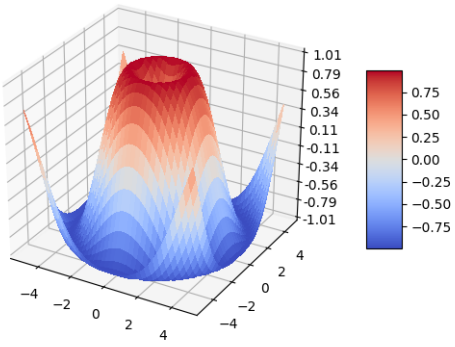


Fig. 51: Surface3d
Surface3d 2
Surface3d 3

Argument	Description
X, *Y*, *Z*	Data values as 1D arrays
color	Color of the surface patches
cmap	A colormap for the surface patches.
norm	An instance of Normalize to map values to colors
vmin	Minimum value to map
vmax	Maximum value to map
shade	Whether to shade the facecolors

The (optional) triangulation can be specified in one of two ways; either:

```
plot_trisurf(triangulation, ...)
```

where triangulation is a *Triangulation* object, or:

```
plot_trisurf(X, Y, ...)
plot_trisurf(X, Y, triangles, ...)
plot_trisurf(X, Y, triangles=triangles, ...)
```

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

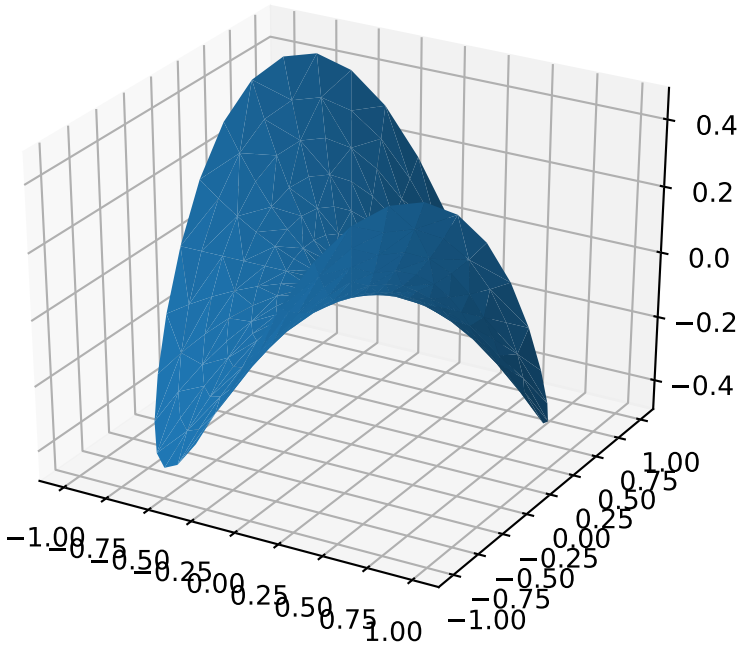
The remaining arguments are:

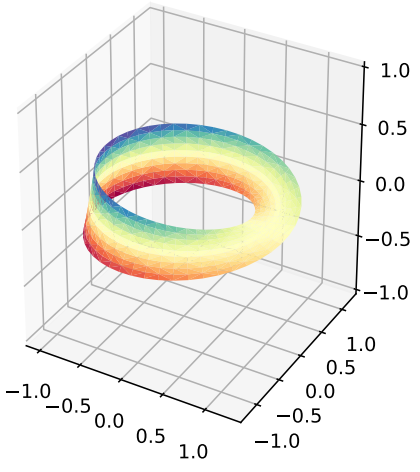
```
plot_trisurf(..., Z)
```

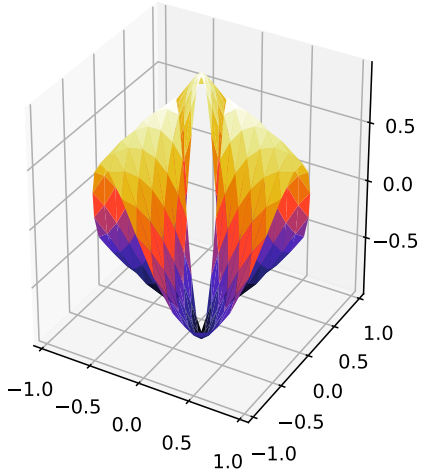
where *Z* is the array of values to contour, one per point in the triangulation.

Other arguments are passed on to *Poly3DCollection*

Examples:


0.4
0.2
0.0
−0.2
−0.4
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
1.0
0.5
0.0
−0.5
−1.0


0.5
0.0
−0.5
−1.0
−0.5
0.0
0.5
1.0
1.0
0.5
0.0
−0.5
−1.0

New in version 1.2.0: This plotting function was added for the v1.2.0 release.

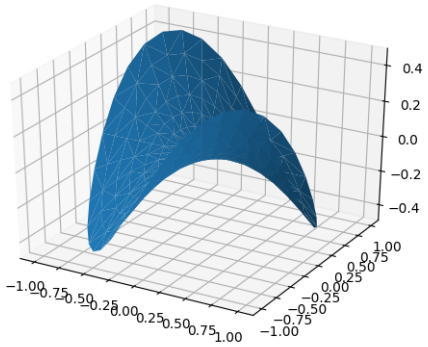


Fig. 52: Trisurf3d

Contour plots

`Axes3D.contour`(*X*, *Y*, *Z*, **args*, ***kwargs*)

Create a 3D contour plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
extend3d	Whether to extend contour in 3D (default: False)
stride	Stride (step size) for extending contour
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the contour lines on this position in plane normal to zdir

The positional and other keyword arguments are passed on to *contour()*

Returns a *contour*

Filled contour plots

`Axes3D.contourf`(*X*, *Y*, *Z*, **args*, ***kwargs*)

Create a 3D contourf plot.

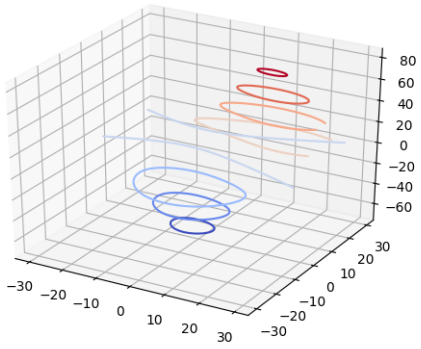


Fig. 53: Contour3d
Contour3d 2
Contour3d 3

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the filled contour on this position in plane normal to zdir

The positional and keyword arguments are passed on to `contourf()`

Returns a `contourf`

Changed in version 1.1.0: The *zdir* and *offset* kwargs were added.

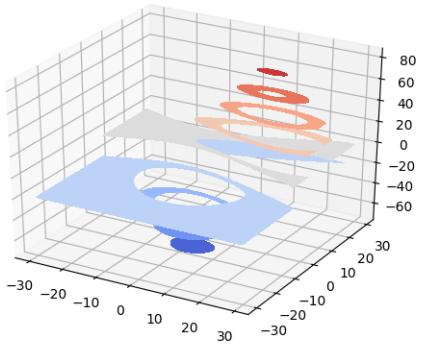


Fig. 54: Contourf3d
Contourf3d 2

New in version 1.1.0: The feature demoed in the second contourf3d example was enabled as a result of a bugfix for version 1.1.0.

Polygon plots

`Axes3D.add_collection3d`(*col*, *zs=0*, *zdir='z'*)

Add a 3D collection object to the plot.

2D collection types are converted to a 3D version by modifying the object and adding z coordinate information.

Supported are:

- PolyCollection
- LineCollection
- PatchCollection

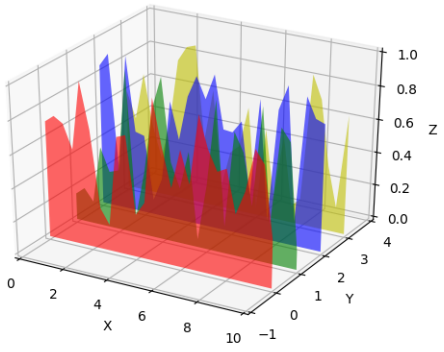


Fig. 55: Polys3d

Bar plots

`Axes3D.bar`(*left*, *height*, *zs=0*, *zdir='z'*, **args*, ***kwargs*)

Add 2D bar(s).

Argument	Description
left	The x coordinates of the left sides of the bars.
height	The height of the bars.
zs	Z coordinate of bars, if one value is specified they will all be placed at the same z.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.

Keyword arguments are passed onto *bar()*.

Returns a *Patch3DCollection*

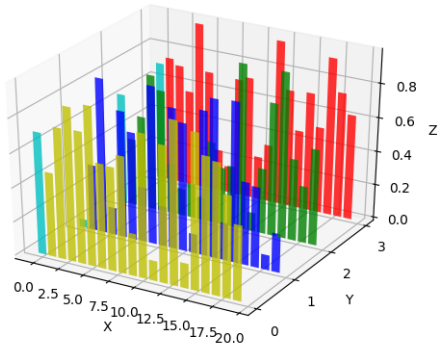


Fig. 56: Bars3d

Quiver

`Axes3D.quiver`(**args*, ***kwargs*)

Plot a 3D field of arrows.

call signatures:

```
quiver(X, Y, Z, U, V, W, **kwargs)
```

Arguments:

***X*, *Y*, *Z*:** The x, y and z coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

***U*, *V*, *W*:** The x, y and z components of the arrow vectors

The arguments could be array-like or scalars, so long as they they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

Keyword arguments:

***length*: [1.0 | float]** The length of each quiver, default to 1.0, the unit is the same with the axes

***arrow_length_ratio*: [0.3 | float]** The ratio of the arrow head with respect to the quiver, default to 0.3

***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*. Default is 'tail'

***normalize*: bool** When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

Any additional keyword arguments are delegated to *LineCollection*

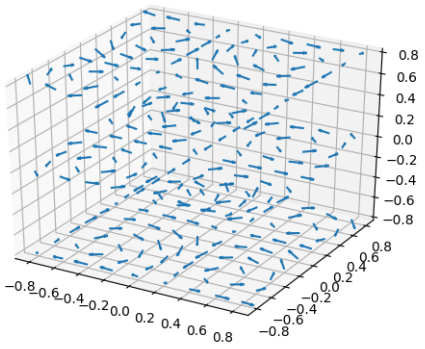


Fig. 57: Quiver3d

2D plots in 3D

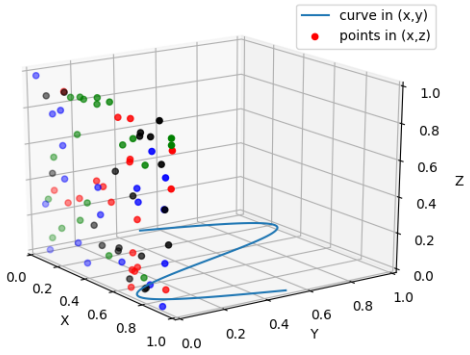


Fig. 58: 2dcollections3d

Text

`Axes3D.text`(*x*, *y*, *z*, *s*, *zdir=None*, ***kwargs*)

Add text to the plot. kwargs will be passed on to Axes.text, except for the `zdir` keyword, which sets the direction to be used as the z direction.

Subplotting

Having multiple 3D plots in a single figure is the same as it is for 2D plots. Also, you can have both 2D and 3D plots in the same figure.

New in version 1.0.0: Subplotting 3D plots was added in v1.0.0. Earlier version can not do this.

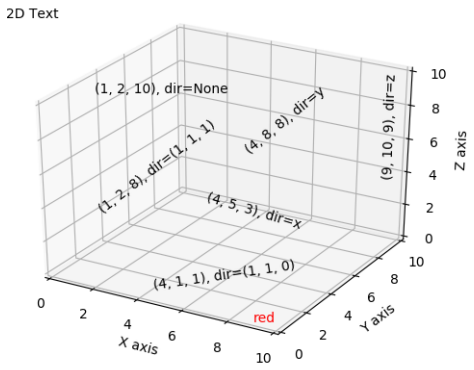


Fig. 59: Text3d

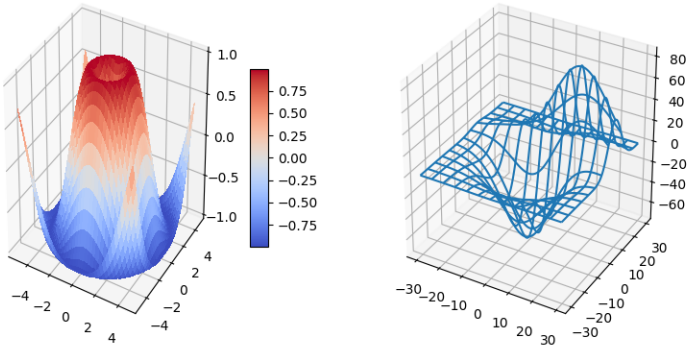


Fig. 60: Subplot3d
Mixed Subplots

Note: Click *here* to download the full example code

3.6.2 Overview of axisartist toolkit

The axisartist toolkit tutorial.

Warning: *axisartist* uses a custom Axes class (derived from the mpl's original Axes class). As a side effect, some commands (mostly tick-related) do not work.

The *axisartist* contains a custom Axes class that is meant to support curvilinear grids (e.g., the world coordinate system in astronomy). Unlike mpl's original Axes class which uses Axes.xaxis and Axes.yaxis to draw ticks, ticklines, etc., axisartist uses a special artist (AxisArtist) that can handle ticks, ticklines, etc. for curved coordinate systems.

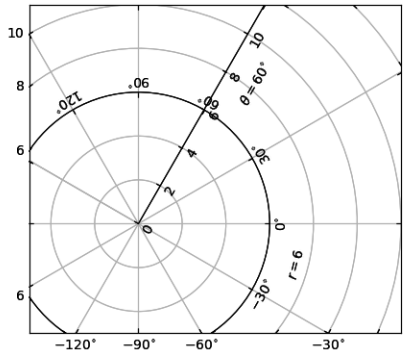


Fig. 61: Demo Floating Axis

Since it uses special artists, some Matplotlib commands that work on Axes.xaxis and Axes.yaxis may not work.

axisartist

The *axisartist* module provides a custom (and very experimental) Axes class, where each axis (left, right, top, and bottom) have a separate associated artist which is responsible for drawing the axis-line, ticks, ticklabels, and labels. You can also create your own axis, which can pass through a fixed position in the axes coordinate, or a fixed position in the data coordinate (i.e., the axis floats around when viewlimit changes).

The axes class, by default, has its xaxis and yaxis invisible, and has 4 additional artists which are responsible for drawing the 4 axis spines in "left", "right", "bottom", and "top". They are accessed as ax.axis["left"], ax.axis["right"], and so on, i.e., ax.axis is a dictionary that contains artists (note that ax.axis is still a callable method and it behaves as an original Axes.axis method in Matplotlib).

To create an axes,

```
import mpl_toolkits.axisartist as AA
fig = plt.figure(1)
ax = AA.Axes(fig, [0.1, 0.1, 0.8, 0.8])
fig.add_axes(ax)
```

or to create a subplot

```
ax = AA.Subplot(fig, 111)
fig.add_subplot(ax)
```

For example, you can hide the right and top spines using:

```
ax.axis["right"].set_visible(False)
ax.axis["top"].set_visible(False)
```

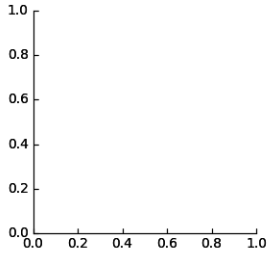


Fig. 62: Simple Axisline3

It is also possible to add a horizontal axis. For example, you may have an horizontal axis at y=0 (in data coordinate).

```
ax.axis["y=0"] = ax.new_floating_axis(nth_coord=0, value=0)
```

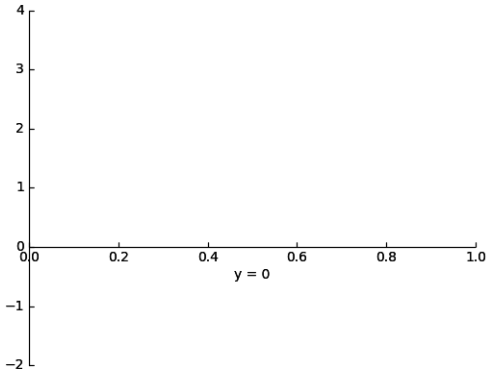


Fig. 63: Simple Axisartist1

Or a fixed axis with some offset

```
# make new (right-side) yaxis, but with some offset
ax.axis["right2"] = ax.new_fixed_axis(loc="right",
                offset=(20, 0))
```

axisartist with ParasiteAxes

Most commands in the axes_grid1 toolkit can take an axes_class keyword argument, and the commands create an axes of the given class. For example, to create a host subplot with axisartist.Axes,

```
import mpl_toolkits.axisartist as AA
from mpl_toolkits.axes_grid1 import host_subplot

host = host_subplot(111, axes_class=AA.Axes)
```

Here is an example that uses ParasiteAxes.

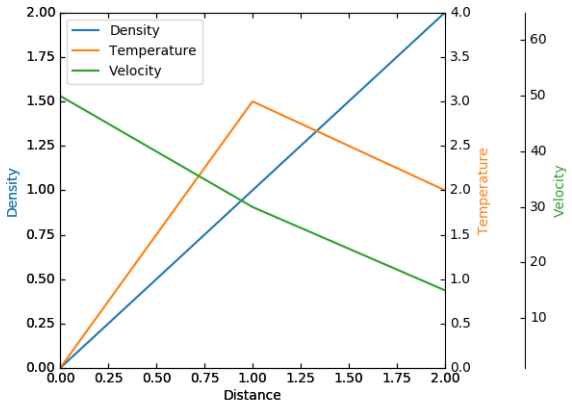


Fig. 64: Demo Parasite Axes2

Curvilinear Grid

The motivation behind the AxisArtist module is to support a curvilinear grid and ticks.

Floating Axes

AxisArtist also supports a Floating Axes whose outer axes are defined as floating axis.

axisartist namespace

The *axisartist* namespace includes a derived Axes implementation. The biggest difference is that the artists responsible to draw axis line, ticks, ticklabel and axis labels are separated out from the mpl's Axis class,

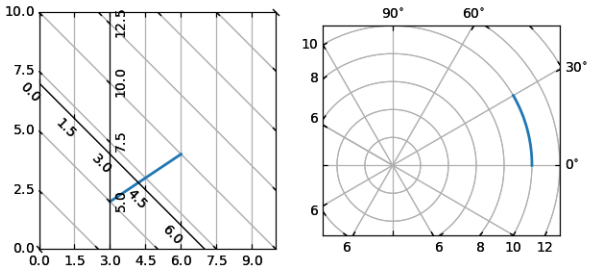


Fig. 65: Demo Curvelinear Grid

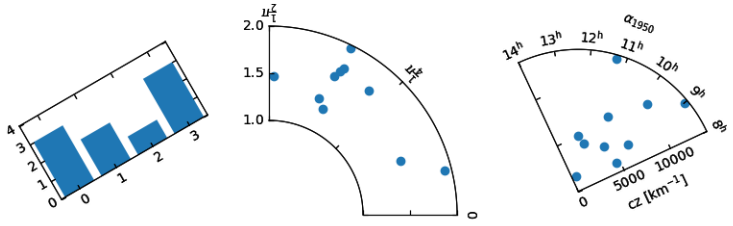


Fig. 66: Demo Floating Axes

which are much more than artists in the original mpl. This change was strongly motivated to support curvilinear grid. Here are a few things that mpl_tootlkits.axisartist.Axes is different from original Axes from mpl.

- Axis elements (axis line(spine), ticks, ticklabel and axis labels) are drawn by a AxisArtist instance. Unlike Axis, left, right, top and bottom axis are drawn by separate artists. And each of them may have different tick location and different tick labels.
- gridlines are drawn by a Gridlines instance. The change was motivated that in curvilinear coordinate, a gridline may not cross axis-lines (i.e., no associated ticks). In the original Axes class, gridlines are tied to ticks.
- ticklines can be rotated if necessary (i.e, along the gridlines)

In summary, all these changes was to support

- a curvilinear grid.
- a floating axis

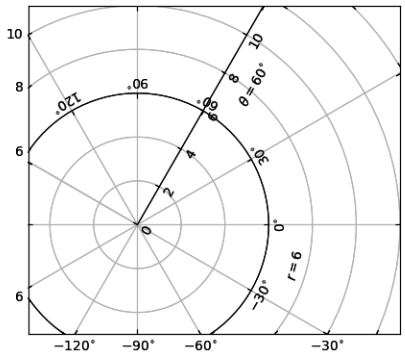


Fig. 67: Demo Floating Axis

mpl_toolkits.axisartist.Axes class defines a *axis* attribute, which is a dictionary of AxisArtist instances. By default, the dictionary has 4 AxisArtist instances, responsible for drawing of left, right, bottom and top axis.

xaxis and yaxis attributes are still available, however they are set to not visible. As separate artists are used for rendering axis, some axis-related method in mpl may have no effect. In addition to AxisArtist instances, the mpl_toolkits.axisartist.Axes will have *gridlines* attribute (Gridlines), which obviously draws grid lines.

In both AxisArtist and Gridlines, the calculation of tick and grid location is delegated to an instance of GridHelper class. mpl_toolkits.axisartist.Axes class uses GridHelperRectlinear as a grid helper. The GridHelperRectlinear class is a wrapper around the *xaxis* and *yaxis* of mpl's original Axes, and it was meant to work as the way how mpl's original axes works. For example, tick location changes using set_ticks method and etc. should work as expected. But change in artist properties (e.g., color) will not work in general, although some effort has been made so that some often-change attributes (color, etc.) are respected.

AxisArtist

AxisArtist can be considered as a container artist with following attributes which will draw ticks, labels, etc.

- line
- major_ticks, major_ticklabels
- minor_ticks, minor_ticklabels
- offsetText
- label

line

Derived from Line2d class. Responsible for drawing a spinal(?) line.

major_ticks, minor_ticks

Derived from Line2d class. Note that ticks are markers.

major_ticklabels, minor_ticklabels

Derived from Text. Note that it is not a list of Text artist, but a single artist (similar to a collection).

axislabel

Derived from Text.

Default AxisArtists

By default, following for axis artists are defined.:

```
ax.axis["left"], ax.axis["bottom"], ax.axis["right"], ax.axis["top"]
```

The ticklabels and axislabel of the top and the right axis are set to not visible.

For example, if you want to change the color attributes of major_ticklabels of the bottom x-axis

```
ax.axis["bottom"].major_ticklabels.set_color("b")
```

Similarly, to make ticklabels invisible

```
ax.axis["bottom"].major_ticklabels.set_visible(False)
```

AxisAritst provides a helper method to control the visibility of ticks, ticklabels, and label. To make ticklabel invisible,

```
ax.axis["bottom"].toggle(ticklabels=False)
```

To make all of ticks, ticklabels, and (axis) label invisible

```
ax.axis["bottom"].toggle(all=False)
```

To turn all off but ticks on

```
ax.axis["bottom"].toggle(all=False, ticks=True)
```

To turn all on but (axis) label off

```
ax.axis["bottom"].toggle(all=True, label=False))
```

ax.axis's __getitem__ method can take multiple axis names. For example, to turn ticklabels of "top" and "right" axis on,

```
ax.axis["top","right"].toggle(ticklabels=True))
```

Note that 'ax.axis["top","right"]' returns a simple proxy object that translate above code to something like below.

```
for n in ["top","right"]:
  ax.axis[n].toggle(ticklabels=True))
```

So, any return values in the for loop are ignored. And you should not use it anything more than a simple method.

Like the list indexing ":" means all items, i.e.,

```
ax.axis[:].major_ticks.set_color("r")
```

changes tick color in all axis.

HowTo

1. Changing tick locations and label.

   Same as the original mpl's axes.:

   ```
   ax.set_xticks([1,2,3])
   ```

2. Changing axis properties like color, etc.

   Change the properties of appropriate artists. For example, to change the color of the ticklabels:

   ```
   ax.axis["left"].major_ticklabels.set_color("r")
   ```

3. To change the attributes of multiple axis:

```
ax.axis["left","bottom"].major_ticklabels.set_color("r")
```

or to change the attributes of all axis:

```
ax.axis[:].major_ticklabels.set_color("r")
```

4. **To change the tick size (length), you need to use** axis.major_ticks.set_ticksize method. To change the direction of the ticks (ticks are in opposite direction of ticklabels by default), use axis.major_ticks.set_tick_out method.

   To change the pad between ticks and ticklabels, use axis.major_ticklabels.set_pad method.

   To change the pad between ticklabels and axis label, axis.label.set_pad method.

Rotation and Alignment of TickLabels

This is also quite different from the original mpl and can be confusing. When you want to rotate the ticklabels, first consider using "set_axis_direction" method.

```
ax1.axis["left"].major_ticklabels.set_axis_direction("top")
ax1.axis["right"].label.set_axis_direction("left")
```

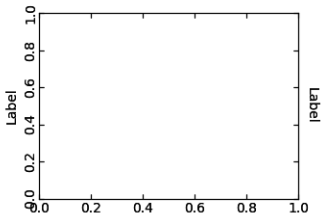


Fig. 68: Simple Axis Direction01

The parameter for set_axis_direction is one of ["left", "right", "bottom", "top"].

You must understand some underlying concept of directions.

1. There is a reference direction which is defined as the direction of the axis line with increasing coordinate. For example, the reference direction of the left x-axis is from bottom to top.

Fig. 69: Axis Direction Demo - Step 01

The direction, text angle, and alignments of the ticks, ticklabels and axis-label is determined with respect to the reference direction

2. *ticklabel_direction* is either the right-hand side (+) of the reference direction or the left-hand side (-).

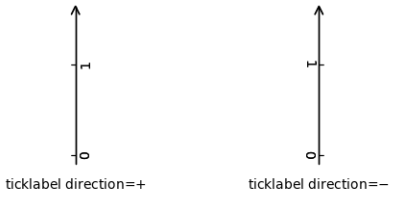


Fig. 70: Axis Direction Demo - Step 02

3. same for the *label_direction*

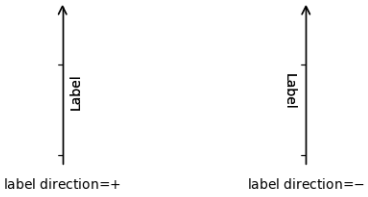


Fig. 71: Axis Direction Demo - Step 03

4. ticks are by default drawn toward the opposite direction of the ticklabels.
5. text rotation of ticklabels and label is determined in reference to the *ticklabel_direction* or *label_direction*, respectively. The rotation of ticklabels and label is anchored.

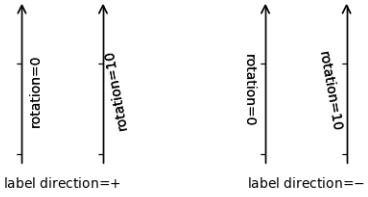


Fig. 72: Axis Direction Demo - Step 04

On the other hand, there is a concept of "axis_direction". This is a default setting of above properties for each, "bottom", "left", "top", and "right" axis.

?	?	left	bottom	right	top
axislabel	direction	'-'	'+'	'+'	'-'
axislabel	rotation	180	0	0	180
axislabel	va	center	top	center	bottom
axislabel	ha	right	center	right	center
ticklabel	direction	'-'	'+'	'+'	'-'
ticklabels	rotation	90	0	-90	180
ticklabel	ha	right	center	right	center
ticklabel	va	center	baseline	center	baseline

And, 'set_axis_direction("top")' means to adjust the text rotation etc, for settings suitable for "top" axis. The concept of axis direction can be more clear with curved axis.

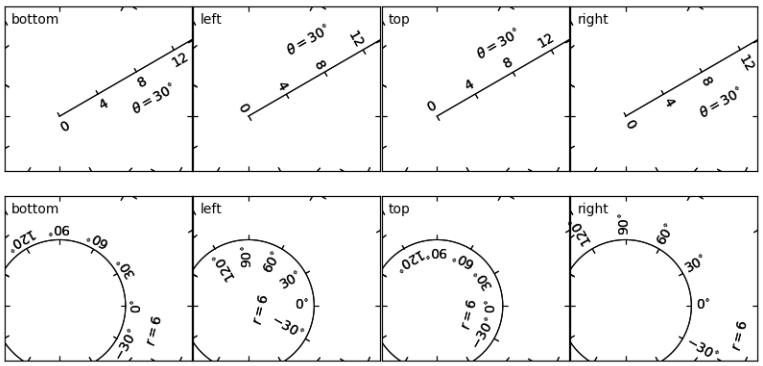


Fig. 73: Demo Axis Direction

The axis_direction can be adjusted in the AxisArtist level, or in the level of its child arists, i.e., ticks, ticklabels, and axis-label.

```
ax1.axis["left"].set_axis_direction("top")
```

changes axis_direction of all the associated artist with the "left" axis, while

```
ax1.axis["left"].major_ticklabels.set_axis_direction("top")
```

changes the axis_direction of only the major_ticklabels. Note that set_axis_direction in the AxisArtist level changes the ticklabel_direction and label_direction, while changing the axis_direction of ticks, ticklabels, and axis-label does not affect them.

If you want to make ticks outward and ticklabels inside the axes, use invert_ticklabel_direction method.

```
ax.axis[:].invert_ticklabel_direction()
```

A related method is "set_tick_out". It makes ticks outward (as a matter of fact, it makes ticks toward the opposite direction of the default direction).

```
ax.axis[:].major_ticks.set_tick_out(True)
```

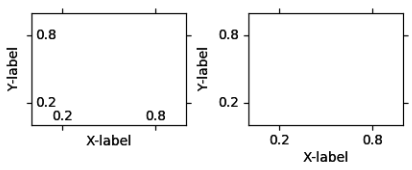


Fig. 74: Simple Axis Direction03

So, in summary,

- **AxisArtist's methods**
  - set_axis_direction : "left", "right", "bottom", or "top"
  - set_ticklabel_direction : "+" or "-"
  - set_axislabel_direction : "+" or "-"
  - invert_ticklabel_direction
- **Ticks' methods (major_ticks and minor_ticks)**
  - set_tick_out : True or False
  - set_ticksize : size in points
- **TickLabels' methods (major_ticklabels and minor_ticklabels)**
  - set_axis_direction : "left", "right", "bottom", or "top"
  - set_rotation : angle with respect to the reference direction
  - set_ha and set_va : see below
- **AxisLabels' methods (label)**
  - set_axis_direction : "left", "right", "bottom", or "top"
  - set_rotation : angle with respect to the reference direction
  - set_ha and set_va

Adjusting ticklabels alignment

Alignment of TickLabels are treated specially. See below

Adjusting pad

To change the pad between ticks and ticklabels

```
ax.axis["left"].major_ticklabels.set_pad(10)
```

Or ticklabels and axis-label

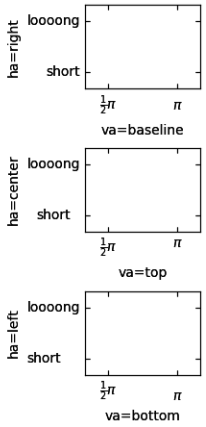


Fig. 75: Demo Ticklabel Alignment

```
ax.axis["left"].label.set_pad(10)
```

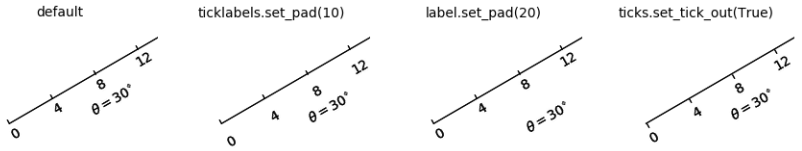


Fig. 76: Simple Axis Pad

GridHelper

To actually define a curvilinear coordinate, you have to use your own grid helper. A generalised version of grid helper class is supplied and this class should suffice in most of cases. A user may provide two functions which defines a transformation (and its inverse pair) from the curved coordinate to (rectilinear) image coordinate. Note that while ticks and grids are drawn for curved coordinate, the data transform of the axes itself (ax.transData) is still rectilinear (image) coordinate.

```
from  mpl_toolkits.axisartist.grid_helper_curvelinear \
     import GridHelperCurveLinear
from mpl_toolkits.axisartist import Subplot

# from curved coordinate to rectlinear coordinate.
def tr(x, y):
    x, y = np.asarray(x), np.asarray(y)
    return x, y-x
```

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```
# from rectlinear coordinate to curved coordinate.
def inv_tr(x,y):
    x, y = np.asarray(x), np.asarray(y)
    return x, y+x

grid_helper = GridHelperCurveLinear((tr, inv_tr))

ax1 = Subplot(fig, 1, 1, 1, grid_helper=grid_helper)

fig.add_subplot(ax1)
```

You may use matplotlib's Transform instance instead (but a inverse transformation must be defined). Often, coordinate range in a curved coordinate system may have a limited range, or may have cycles. In those cases, a more customized version of grid helper is required.

```
import  mpl_toolkits.axisartist.angle_helper as angle_helper

# PolarAxes.PolarTransform takes radian. However, we want our coordinate
# system in degree
tr = Affine2D().scale(np.pi/180., 1.) + PolarAxes.PolarTransform()

# extreme finder :  find a range of coordinate.
# 20, 20 : number of sampling points along x, y direction
# The first coordinate (longitude, but theta in polar)
#   has a cycle of 360 degree.
# The second coordinate (latitude, but radius in polar)  has a minimum of 0
extreme_finder = angle_helper.ExtremeFinderCycle(20, 20,
                                                 lon_cycle = 360,
                                                 lat_cycle = None,
                                                 lon_minmax = None,
                                                 lat_minmax = (0, np.inf),
                                                 )

# Find a grid values appropriate for the coordinate (degree,
# minute, second). The argument is a approximate number of grids.
grid_locator1 = angle_helper.LocatorDMS(12)

# And also uses an appropriate formatter.  Note that,the
# acceptable Locator and Formatter class is a bit different than
# that of mpl's, and you cannot directly use mpl's Locator and
# Formatter here (but may be possible in the future).
tick_formatter1 = angle_helper.FormatterDMS()

grid_helper = GridHelperCurveLinear(tr,
                                    extreme_finder=extreme_finder,
                                    grid_locator1=grid_locator1,
                                    tick_formatter1=tick_formatter1
                                    )
```

Again, the *transData* of the axes is still a rectilinear coordinate (image coordinate). You may manually do conversion between two coordinates, or you may use Parasite Axes for convenience.:

```
ax1 = SubplotHost(fig, 1, 2, 2, grid_helper=grid_helper)

# A parasite axes with given transform
ax2 = ParasiteAxesAuxTrans(ax1, tr, "equal")
# note that ax2.transData == tr + ax1.transData
# Anthing you draw in ax2 will match the ticks and grids of ax1.
ax1.parasites.append(ax2)
```

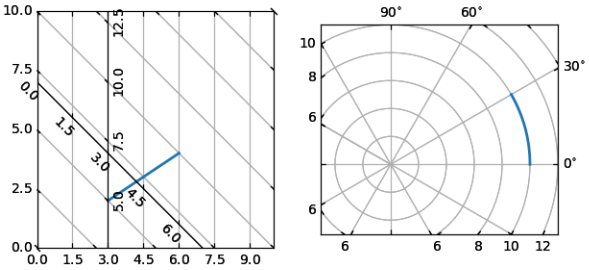


Fig. 77: Demo Curvelinear Grid

FloatingAxis

A floating axis is an axis one of whose data coordinate is fixed, i.e, its location is not fixed in Axes coordinate but changes as axes data limits changes. A floating axis can be created using *new_floating_axis* method. However, it is your responsibility that the resulting AxisArtist is properly added to the axes. A recommended way is to add it as an item of Axes's axis attribute.:

```
# floating axis whose first (index starts from 0) coordinate
# (theta) is fixed at 60

ax1.axis["lat"] = axis = ax1.new_floating_axis(0, 60)
axis.label.set_text(r"$\theta = 60^{\circ}$")
axis.label.set_visible(True)
```

See the first example of this page.

Current Limitations and TODO's

The code need more refinement. Here is a incomplete list of issues and TODO's

- No easy way to support a user customized tick location (for curvilinear grid). A new Locator class needs to be created.
- FloatingAxis may have coordinate limits, e.g., a floating axis of x = 0, but y only spans from 0 to 1.
- The location of axislabel of FloatingAxis needs to be optionally given as a coordinate value. ex, a floating axis of x=0 with label at y=1

Note: Click *here* to download the full example code

3.6.3 Overview of axes_grid1 toolkit

Controlling the layout of plots with the axes_grid toolkit.

What is axes_grid1 toolkit?

axes_grid1 is a collection of helper classes to ease displaying (multiple) images with matplotlib. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates, which may not be ideal for displaying images that needs to have a given aspect ratio. For example, it helps if you have a colorbar whose height always matches that of the image. *ImageGrid*, *RGB Axes* and *AxesDivider* are helper classes that deals with adjusting the location of (multiple) Axes. They provides a framework to adjust the position of multiple axes at the drawing time. *ParasiteAxes* provides twinx(or twiny)-like features so that you can plot different data (e.g., different y-scale) in a same Axes. *AnchoredArtists* includes custom artists which are placed at some anchored position, like the legend.

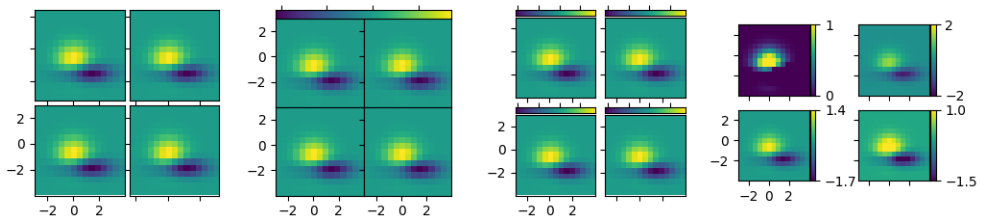


Fig. 78: Demo Axes Grid

axes_grid1

ImageGrid

A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. ImageGrid is used in such case.

- The position of each axes is determined at the drawing time (see *AxesDivider*), so that the size of the entire grid fits in the given rectangle (like the aspect of axes). Note that in this example, the paddings between axes are fixed even if you changes the figure size.
- axes in the same column has a same axes width (in figure coordinate), and similarly, axes in the same row has a same height. The widths (height) of the axes in the same row (column) are scaled according to their view limits (xlim or ylim).

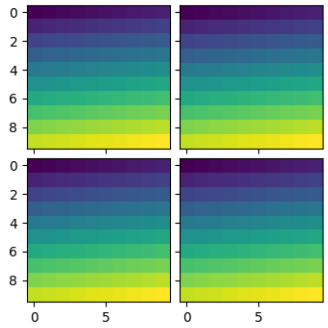


Fig. 79: Simple Axesgrid

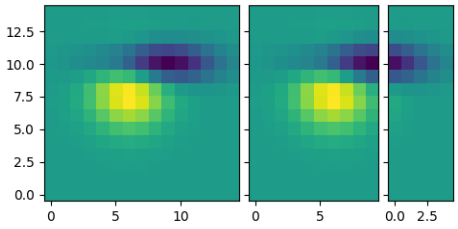


Fig. 80: Simple Axes Grid

- xaxis are shared among axes in a same column. Similarly, yaxis are shared among axes in a same row. Therefore, changing axis properties (view limits, tick location, etc. either by plot commands or using your mouse in interactive backends) of one axes will affect all other shared axes.

When initialized, ImageGrid creates given number (*ngrids* or *ncols* * *nrows* if *ngrids* is None) of Axes instances. A sequence-like interface is provided to access the individual Axes instances (e.g., grid[0] is the first Axes in the grid. See below for the order of axes).

ImageGrid takes following arguments,

Name	Default	Description
fig		
rect		
nrows_ncols		number of rows and cols. e.g., (2,2)
ngrids	None	number of grids. nrows x ncols if None
direction	"row"	increasing direction of axes number. [row|column]
axes_pad	0.02	pad between axes in inches
add_all	True	Add axes to figures if True
share_all	False	xaxis & yaxis of all axes are shared if True
aspect	True	aspect of axes
label_mode	"L"	location of tick labels thaw will be displayed. "1" (only the lower left axes), "L" (left most and bottom most axes), or "all".
cbar_mode	None	[None|single|each]
cbar_location	"right"	[right|top]
cbar_pad	None	pad between image axes and colorbar axes
cbar_size	"5%"	size of the colorbar
axes_class	None	

rect specifies the location of the grid. You can either specify coordinates of the rectangle to be used (e.g., (0.1, 0.1, 0.8, 0.8) as in the Axes), or the subplot-like position (e.g., "121").

direction means the increasing direction of the axes number.

aspect By default (False), widths and heights of axes in the grid are scaled independently. If True, they are scaled according to their data limits (similar to aspect parameter in mpl).

share_all if True, xaxis and yaxis of all axes are shared.

direction direction of increasing axes number. For "row",

grid[0]	grid[1]
grid[2]	grid[3]

For "column",

grid[0]	grid[2]
grid[1]	grid[3]

You can also create a colorbar (or colorbars). You can have colorbar for each axes (cbar_mode="each"), or you can have a single colorbar for the grid (cbar_mode="single"). The colorbar can be placed on your right, or top. The axes for each colorbar is stored as a *cbar_axes* attribute.

The examples below show what you can do with ImageGrid.

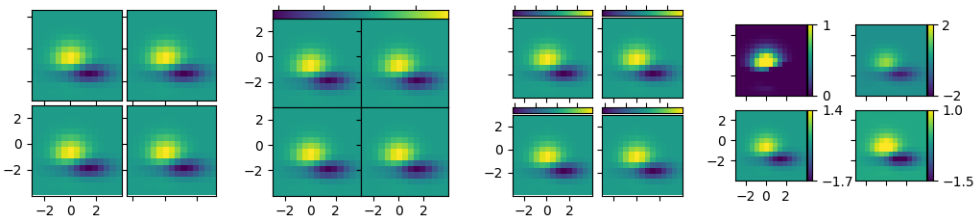


Fig. 81: Demo Axes Grid

AxesDivider Class

Behind the scene, the ImageGrid class and the RGBAxes class utilize the AxesDivider class, whose role is to calculate the location of the axes at drawing time. While a more about the AxesDivider is (will be) explained in (yet to be written) AxesDividerGuide, direct use of the AxesDivider class will not be necessary for most users. The axes_divider module provides a helper function make_axes_locatable, which can be useful. It takes a existing axes instance and create a divider for it.

```
ax = subplot(1,1,1)
divider = make_axes_locatable(ax)
```

make_axes_locatable returns an instance of the AxesLocator class, derived from the Locator. It provides *append_axes* method that creates a new axes on the given side of ("top", "right", "bottom" and "left") of the original axes.

colorbar whose height (or width) in sync with the master axes

scatter_hist.py with AxesDivider

The "scatter_hist.py" example in mpl can be rewritten using *make_axes_locatable*.

```
axScatter = subplot(111)
axScatter.scatter(x, y)
axScatter.set_aspect(1.)

# create new axes on the right and on the top of the current axes.
divider = make_axes_locatable(axScatter)
axHistx = divider.append_axes("top", size=1.2, pad=0.1, sharex=axScatter)
axHisty = divider.append_axes("right", size=1.2, pad=0.1, sharey=axScatter)

# the scatter plot:
```

(continues on next page)

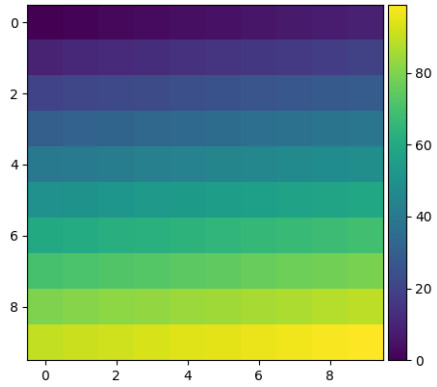


Fig. 82: Simple Colorbar

(continued from previous page)

```
# histograms
bins = np.arange(-lim, lim + binwidth, binwidth)
axHistx.hist(x, bins=bins)
axHisty.hist(y, bins=bins, orientation='horizontal')
```

See the full source code below.

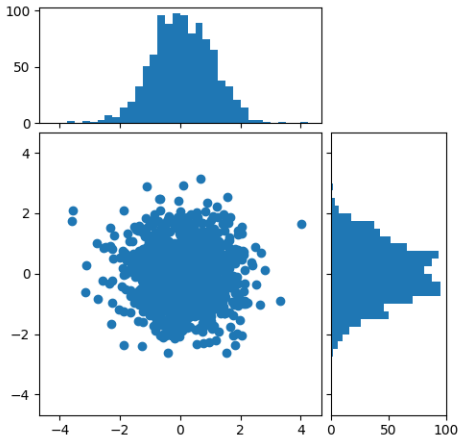


Fig. 83: Scatter Hist

The scatter_hist using the AxesDivider has some advantage over the original scatter_hist.py in mpl. For example, you can set the aspect ratio of the scatter plot, even with the x-axis or y-axis is shared accordingly.

ParasiteAxes

The ParasiteAxes is an axes whose location is identical to its host axes. The location is adjusted in the drawing time, thus it works even if the host change its location (e.g., images).

In most cases, you first create a host axes, which provides a few method that can be used to create parasite axes. They are *twinx*, *twiny* (which are similar to twinx and twiny in the matplotlib) and *twin*. *twin* takes an arbitrary transformation that maps between the data coordinates of the host axes and the parasite axes. *draw* method of the parasite axes are never called. Instead, host axes collects artists in parasite axes and draw them as if they belong to the host axes, i.e., artists in parasite axes are merged to those of the host axes and then drawn according to their zorder. The host and parasite axes modifies some of the axes behavior. For example, color cycle for plot lines are shared between host and parasites. Also, the legend command in host, creates a legend that includes lines in the parasite axes. To create a host axes, you may use *host_suplot* or *host_axes* command.

Example 1. twinx

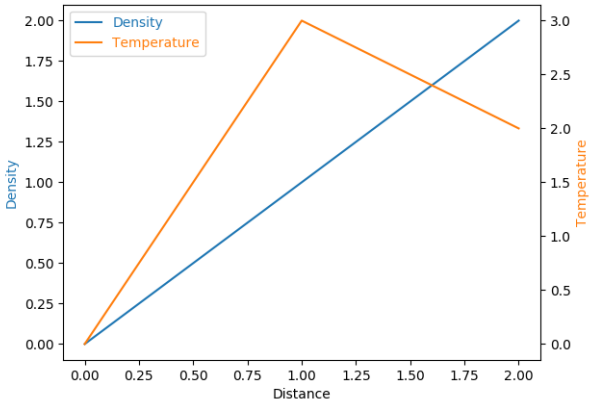


Fig. 84: Parasite Simple

Example 2. twin

twin without a transform argument assumes that the parasite axes has the same data transform as the host. This can be useful when you want the top(or right)-axis to have different tick-locations, tick-labels, or tick-formatter for bottom(or left)-axis.

```
ax2 = ax.twin() # now, ax2 is responsible for "top" axis and "right" axis
ax2.set_xticks([0., .5*np.pi, np.pi, 1.5*np.pi, 2*np.pi])
ax2.set_xticklabels(["0", r"$\frac{1}{2}\pi$",
                     r"$\pi$", r"$\frac{3}{2}\pi$", r"$2\pi$"])
```

A more sophisticated example using twin. Note that if you change the x-limit in the host axes, the x-limit of the parasite axes will change accordingly.

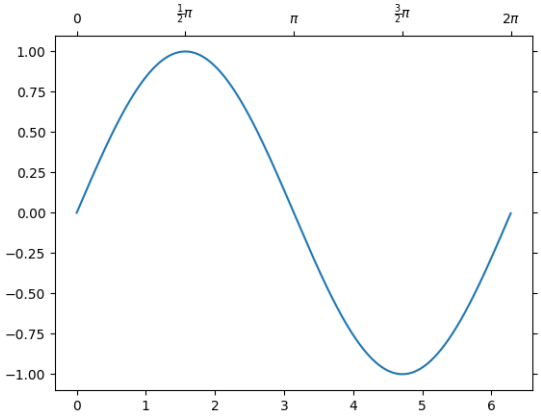


Fig. 85: Simple Axisline4

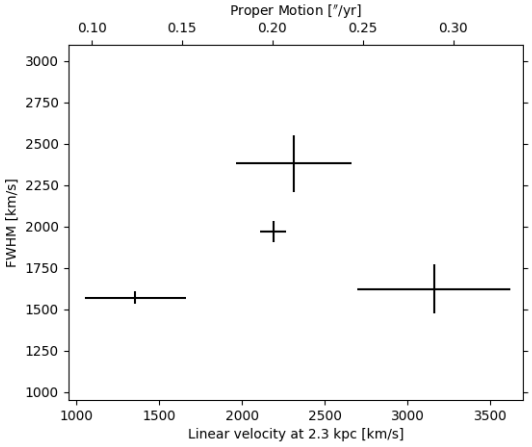


Fig. 86: Parasite Simple2

AnchoredArtists

It's a collection of artists whose location is anchored to the (axes) bbox, like the legend. It is derived from *OffsetBox* in mpl, and artist need to be drawn in the canvas coordinate. But, there is a limited support for an arbitrary transform. For example, the ellipse in the example below will have width and height in the data coordinate.

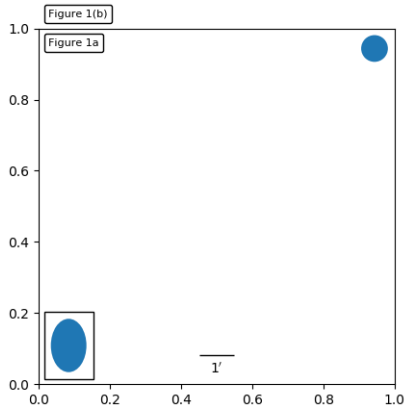


Fig. 87: Simple Anchored Artists

InsetLocator

mpl_toolkits.axes_grid1.inset_locator provides helper classes and functions to place your (inset) axes at the anchored position of the parent axes, similarly to AnchoredArtist.

Using *mpl_toolkits.axes_grid1.inset_locator.inset_axes()*, you can have inset axes whose size is either fixed, or a fixed proportion of the parent axes. For example,:

```
inset_axes = inset_axes(parent_axes,
                        width="30%", # width = 30% of parent_bbox
                        height=1., # height : 1 inch
                        loc=3)
```

creates an inset axes whose width is 30% of the parent axes and whose height is fixed at 1 inch.

You may creates your inset whose size is determined so that the data scale of the inset axes to be that of the parent axes multiplied by some factor. For example,

```
inset_axes = zoomed_inset_axes(ax,
                               0.5, # zoom = 0.5
                               loc=1)
```

creates an inset axes whose data scale is half of the parent axes. Here is complete examples.

For example, `zoomed_inset_axes()` can be used when you want the inset represents the zoom-up of the small portion in the parent axes. And `mpl_toolkits/axes_grid/inset_locator` provides a helper function `mark_inset()` to mark the location of the area represented by the inset axes.

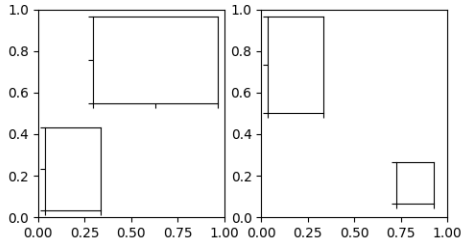


Fig. 88: Inset Locator Demo

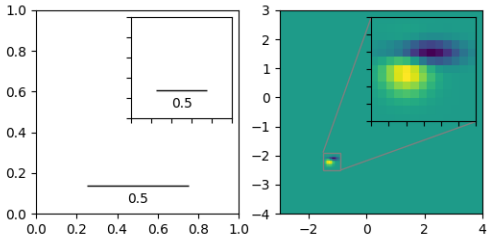


Fig. 89: Inset Locator Demo2

RGB Axes

RGBAxes is a helper class to conveniently show RGB composite images. Like ImageGrid, the location of axes are adjusted so that the area occupied by them fits in a given rectangle. Also, the xaxis and yaxis of each axes are shared.

```
from mpl_toolkits.axes_grid1.axes_rgb import RGBAxes

fig = plt.figure(1)
ax = RGBAxes(fig, [0.1, 0.1, 0.8, 0.8])

r, g, b = get_rgb() # r,g,b are 2-d images
ax.imshow_rgb(r, g, b,
              origin="lower", interpolation="nearest")
```

AxesDivider

The axes_divider module provides helper classes to adjust the axes positions of a set of images at drawing time.

- *axes_size* provides a class of units that are used to determine the size of each axes. For example, you can specify a fixed size.
- `Divider` is the class that calculates the axes position. It divides the given rectangular area into several areas. The divider is initialized by setting the lists of horizontal and vertical sizes on which the division will be based. Then use `new_locator()`, which returns a callable object that can be used to set the axes_locator of the axes.

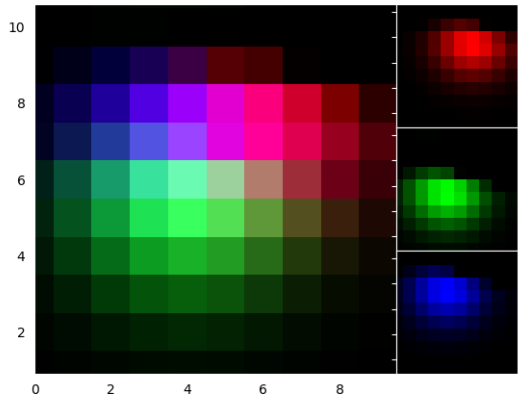


Fig. 90: Simple Rgb

First, initialize the divider by specifying its grids, i.e., horizontal and vertical.

for example,:

```
rect = [0.2, 0.2, 0.6, 0.6]
horiz=[h0, h1, h2, h3]
vert=[v0, v1, v2]
divider = Divider(fig, rect, horiz, vert)
```

where, rect is a bounds of the box that will be divided and h0,..h3, v0,..v2 need to be an instance of classes in the *axes_size*. They have *get_size* method that returns a tuple of two floats. The first float is the relative size, and the second float is the absolute size. Consider a following grid.

v0			
v1			
h0,v2	h1	h2	h3

- v0 => 0, 2
- v1 => 2, 0
- v2 => 3, 0

The height of the bottom row is always 2 (axes_divider internally assumes that the unit is inches). The first and the second rows have a height ratio of 2:3. For example, if the total height of the grid is 6, then the first and second row will each occupy 2/(2+3) and 3/(2+3) of (6-1) inches. The widths of the horizontal columns will be similarly determined. When the aspect ratio is set, the total height (or width) will be adjusted accordingly.

The *mpl_toolkits.axes_grid1.axes_size* contains several classes that can be used to set the horizontal and vertical configurations. For example, for vertical configuration one could use:

```
from mpl_toolkits.axes_grid1.axes_size import Fixed, Scaled
vert = [Fixed(2), Scaled(2), Scaled(3)]
```

After you set up the divider object, then you create a locator instance that will be given to the axes object.:

```
locator = divider.new_locator(nx=0, ny=1)
ax.set_axes_locator(locator)
```

The return value of the new_locator method is an instance of the AxesLocator class. It is a callable object that returns the location and size of the cell at the first column and the second row. You may create a locator that spans over multiple cells.:

```
locator = divider.new_locator(nx=0, nx=2, ny=1)
```

The above locator, when called, will return the position and size of the cells spanning the first and second column and the first row. In this example, it will return [0:2, 1].

See the example,

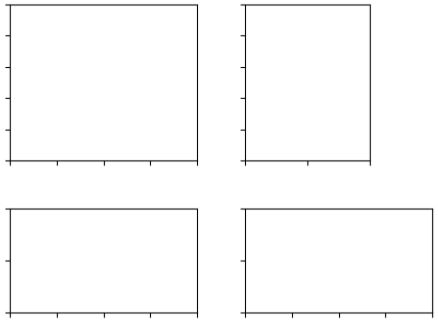


Fig. 91: Simple Axes Divider2

You can adjust the size of each axes according to its x or y data limits (AxesX and AxesY).

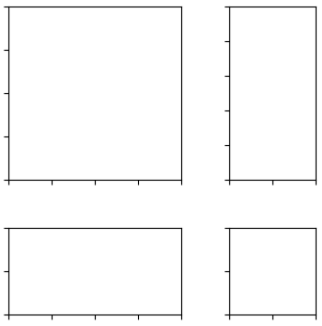


Fig. 92: Simple Axes Divider3

CHAPTER

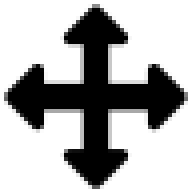
FOUR

INTERACTIVE PLOTS

4.1 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

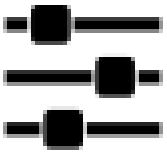
The `Home`, `Forward` and `Back` buttons These are akin to a web browser's home, forward and back controls. `Forward` and `Back` are used to navigate back and forth between previously defined views. They have no meaning unless you have already navigated somewhere else using the pan and zoom buttons. This is analogous to trying to click `Back` on your web browser before visiting a new page or `Forward` before you have gone back to a page – nothing happens. `Home` always takes you to the first, default view of your data. Again, all of these buttons should feel very familiar to any user of a web browser.



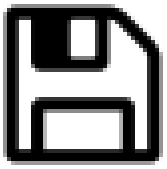
The Pan/Zoom button This button has two modes: pan and zoom. Click the toolbar button to activate panning and zooming, then put your mouse somewhere over an axes. Press the left mouse button and hold it to pan the figure, dragging it to a new position. When you release it, the data under the point where 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 proportionately to the rightward movement and zoomed out proportionately to the leftward movement. The same is true for the y axis and up/down motions. The point under your mouse when you begin the zoom remains stationary, allowing you to zoom in or out around that point as much as you wish. You can use the modifier keys 'x', 'y' or 'CONTROL' to constrain the zoom to the x axis, the y axis, or aspect ratio preserve, respectively.

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

The Zoom-to-rectangle button Click this toolbar button to activate this mode. Put your mouse somewhere over an axes and press a mouse button. Define a rectangular region by dragging the mouse while holding the button to a new location. When using the left mouse button, the axes view limits will be zoomed to the defined region. When using the right mouse button, the axes view limits will be zoomed out, placing the original axes in the defined region.



The Subplot-configuration button Use this tool to configure the appearance of the subplot: you can stretch or compress the left, right, top, or bottom side of the subplot, or the space between the rows or 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`.

4.1.1 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	**ctrl** + **s**
Toggle fullscreen	**f** or **ctrl** + **f**
Close plot	**ctrl** + **w**
Close all plots	**shift** + **w**
Constrain pan/zoom to x axis	hold **x** when panning/zooming with mouse
Constrain pan/zoom to y axis	hold **y** when panning/zooming with mouse
Preserve aspect ratio	hold **CONTROL** when panning/zooming with mouse
Toggle major grids	**g** when mouse is over an axes
Toggle minor grids	**G** when mouse is over an axes
Toggle x axis scale (log/linear)	**L** or **k** when mouse is over an axes
Toggle y axis scale (log/linear)	**l** when mouse is over an axes

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:

```
import 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)
```

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```
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()
```

4.2 Using matplotlib in a python shell

Warning: This page is significantly out of date

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, e.g., 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.

4.2.1 IPython to the rescue

Note: The mode described here still exists for historical reasons, but it is highly advised not to use. It pollutes namespaces with functions that will shadow python built-in and can lead to hard to track bugs. To get IPython integration without imports the use of the `%matplotlib` magic is preferred. See ipython documentation .

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
Python 2.4.5 (#4, Apr 12 2008, 09:09:16)
IPython 0.9.0 -- An enhanced Interactive Python.

In [1]: %pylab

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

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```
In [2]: x = randn(10000)

In [3]: 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.

4.2.2 Other python interpreters

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

With the TkAgg backend, which uses the Tkinter user interface toolkit, you can use matplotlib from an arbitrary non-gui python shell. Just set your `backend : TkAgg` and `interactive : True` in your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams*) and fire up python. Then:

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

should work out of the box. This is also likely to work with recent versions of the qt4agg and gtkagg backends, and with the macosx backend on the Macintosh. Note, in batch mode, i.e. 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 via the `matplotlibrc` file instead of using the functions listed in the next section.

Gui shells are at best problematic, because they have to run a mainloop, but interactive plotting also involves a mainloop. Ipython has sorted all this out for the primary matplotlib backends. There may be other shells and IDEs that also work with matplotlib in interactive mode, but one obvious candidate does not: the python IDLE IDE is a Tkinter gui app that does not support pylab interactive mode, regardless of backend.

4.2.3 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)
```

4.3 Event handling and picking

matplotlib works with a number of user interface toolkits (wxpython, tkinter, qt4, gtk, 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.

4.3.1 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, ax = plt.subplots()
ax.plot(np.random.rand(10))

def onclick(event):
    print('%s click: button=%d, x=%d, y=%d, xdata=%f, ydata=%f' %
          ('double' if event.dblclick else 'single', event.button,
           event.x, event.y, event.xdata, event.ydata))

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

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

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

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

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

Event name	Class and description
'button_press_event'	*MouseEvent* - mouse button is pressed
'button_release_event'	*MouseEvent* - mouse button is released
'draw_event'	*DrawEvent* - canvas draw (but before screen update)
'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

4.3.2 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'

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
```

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```
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)
```

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

plt.show()
```

Extra credit: use the animation blit techniques discussed in the animations recipe to make the animated drawing faster and smoother.

Extra credit solution:

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

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

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

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

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

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```
        # 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)
```

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```
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()
```

4.3.3 Mouse enter and leave

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

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

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

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

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

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

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

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

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```
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()
```

4.3.4 Object picking

You can enable picking by setting the `picker` property of an *Artist* (e.g., 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 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, e.g., 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. e.g.:

```
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, e.g., 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 (e.g., all the points in the line that are within the specified epsilon tolerance)

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
    points = tuple(zip(xdata[ind], ydata[ind]))
    print('onpick points:', points)

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

plt.show()
```

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

FIVE

WHAT'S NEW IN MATPLOTLIB

For a list of all of the issues and pull requests since the last revision, see the *GitHub Stats*.

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5.1 What's new in unreleased Matplotlib?

Please place new portions of `whats_new.rst` in the `next_whats_new` directory.

When adding an entry please look at the currently existing files to see if you can extend any of them. If you create a file, name it something like `cool_new_feature.rst` if you have added a brand new feature or something like `updated_feature.rst` for extensions of existing features. Include contents of the form:

```
Section Title for Feature
-------------------------

A bunch of text about how awesome the new feature is and examples of how
to use it.

A sub-section
~~~~~~~~~~~~~
```

5.2 New in Matplotlib 2.2

5.2.1 Constrained Layout Manager

Warning: Constrained Layout is **experimental**. The behaviour and API are subject to change, or the whole functionality may be removed without a deprecation period.

A new method to automatically decide spacing between subplots and their organizing `GridSpec` instances has been added. It is meant to replace the venerable `tight_layout` method. It is invoked via a new `constrained_layout=True` kwarg to *`Figure`* or `subplots`.

There are new `rcParams` for this package, and spacing can be more finely tuned with the new *`set_constrained_layout_pads`*.

Features include:

- Automatic spacing for subplots with a fixed-size padding in inches around subplots and all their decorators, and space between as a fraction of subplot size between subplots.
- Spacing for `suptitle`, and colorbars that are attached to more than one axes.
- Nested *GridSpec* layouts using *GridSpecFromSubplotSpec*.

For more details and capabilities please see the new tutorial: *Constrained Layout Guide*

Note the new API to access this:

New `plt.figure` and `plt.subplots` kwarg: `constrained_layout`

figure() and *subplots()* can now be called with `constrained_layout=True` kwarg to enable constrained_layout.

New `ax.set_position` behaviour

`set_position()` now makes the specified axis no longer responsive to `constrained_layout`, consistent with the idea that the user wants to place an axis manually.

Internally, this means that old `ax.set_position` calls *inside* the library are changed to private `ax._set_position` calls so that `constrained_layout` will still work with these axes.

New `figure` kwarg for `GridSpec`

In order to facilitate `constrained_layout`, `GridSpec` now accepts a `figure` keyword. This is backwards compatible, in that not supplying this will simply cause `constrained_layout` to not operate on the subplots orgainzed by this `GridSpec` instance. Routines that use `GridSpec` (e.g. `fig.subplots`) have been modified to pass the figure to `GridSpec`.

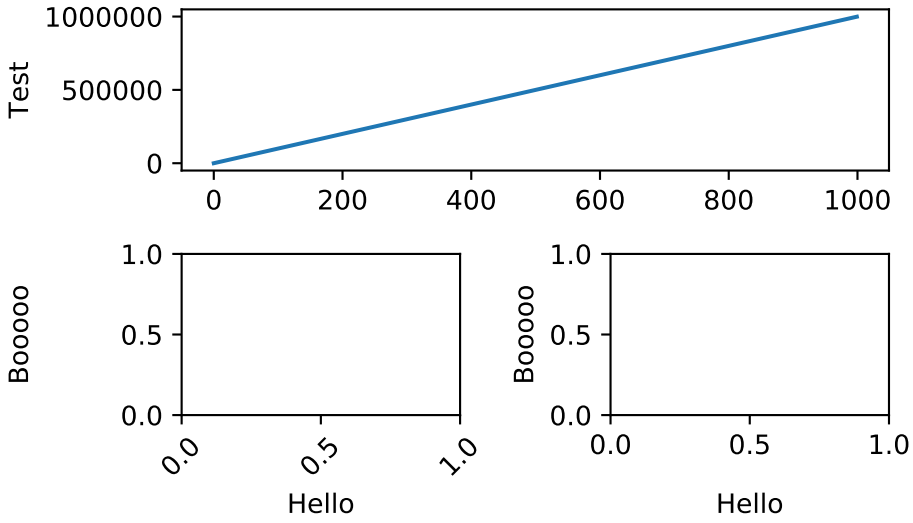
5.2.2 xlabels and ylabels can now be automatically aligned

Subplot axes `ylabels` can be misaligned horizontally if the tick labels are very different widths. The same can happen to `xlabels` if the ticklabels are rotated on one subplot (for instance). The new methods on the `Figure` class: `Figure.align_xlabels` and `Figure.align_ylabels` will now align these labels horizontally or vertically. If the user only wants to align some axes, a list of axes can be passed. If no list is passed, the algorithm looks at all the labels on the figure.

Only labels that have the same subplot locations are aligned. i.e. the ylabels are aligned only if the subplots are in the same column of the subplot layout.

Alignemnt is persistent and automatic after these are called.

A convenience wrapper `Figure.align_labels` calls both functions at once.



5.2.3 Axes legends now included in tight_bbox

Legends created via `ax.legend` can sometimes overspill the limits of the axis. Tools like `fig.tight_layout()` and `fig.savefig(bbox_inches='tight')` would clip these legends. A change was made to include them in the `tight` calculations.

5.2.4 Cividis colormap

A new dark blue/yellow colormap named 'cividis' was added. Like viridis, cividis is perceptually uniform and colorblind friendly. However, cividis also goes a step further: not only is it usable by colorblind users, it should actually look effectively identical to colorblind and non-colorblind users. For more details, see Nunez J, Anderton C, and Renslow R. (submitted). Optimizing colormaps with consideration for color vision deficiency to enable accurate interpretation of scientific data."

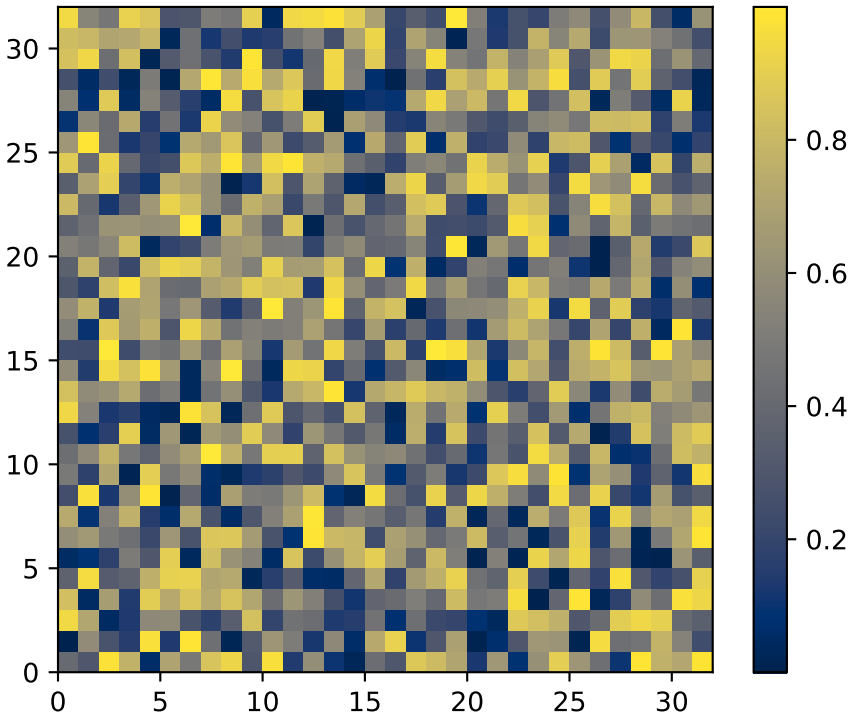
5.2.5 New style colorblind-friendly color cycle

A new style defining a color cycle has been added, tableau-colorblind10, to provide another option for colorblind-friendly plots. A demonstration of this new style can be found in the reference of style sheets. To load this color cycle in place of the default one:

```
import matplotlib.pyplot as plt
plt.style.use('tableau-colorblind10')
```

5.2.6 Support for numpy.datetime64

Matplotlib has supported `datetime.datetime` dates for a long time in *matplotlib.dates*. We now support `numpy.datetime64` dates as well. Anywhere that `dateime.datetime` could be used, `numpy.datetime64` can be used. eg:




```
time = np.arange('2005-02-01', '2005-02-02', dtype='datetime64[h]')
plt.plot(time)
```

5.2.7 Writing animations with Pillow

It is now possible to use Pillow as an animation writer. Supported output formats are currently gif (Pillow>=3.4) and webp (Pillow>=5.0). Use e.g. as

```
from __future__ import division

from matplotlib import pyplot as plt
from matplotlib.animation import FuncAnimation, PillowWriter

fig, ax = plt.subplots()
line, = plt.plot([0, 1])

def animate(i):
   line.set_ydata([0, i / 20])
   return [line]

anim = FuncAnimation(fig, animate, 20, blit=True)
anim.save("movie.gif", writer=PillowWriter(fps=24))
```

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```
plt.show()
```

5.2.8 Slider UI widget can snap to discrete values

The slider UI widget can take the optional argument *valstep*. Doing so forces the slider to take on only discrete values, starting from *valmin* and counting up to *valmax* with steps of size *valstep*.

If *closedmax*==*True*, then the slider will snap to *valmax* as well.

5.2.9 `capstyle` and `joinstyle` attributes added to `Collection`

The `Collection` class now has customizable `capstyle` and `joinstyle` attributes. This allows the user for example to set the `capstyle` of errorbars.

5.2.10 *pad* kwarg added to ax.set_title

The method `axes.set_title` now has a *pad* kwarg, that specifies the distance from the top of an axes to where the title is drawn. The units of *pad* is points, and the default is the value of the (already-existing) `rcParams['axes.titlepad']`.

5.2.11 Comparison of 2 colors in Matplotlib

As the colors in Matplotlib can be specified with a wide variety of ways, the `matplotlib.colors.same_color` method has been added which checks if two *colors* are the same.

5.2.12 Autoscaling a polar plot snaps to the origin

Setting the limits automatically in a polar plot now snaps the radial limit to zero if the automatic limit is nearby. This means plotting from zero doesn't automatically scale to include small negative values on the radial axis.

The limits can still be set manually in the usual way using `set_ylim`.

5.2.13 PathLike support

On Python 3.6+, *savefig*, *imsave*, *imread*, and animation writers now accept `os.PathLike`s as input.

5.2.14 `Axes.tick_params` can set gridline properties

`Tick` objects hold gridlines as well as the tick mark and its label. `Axis.set_tick_params`, `Axes.tick_params` and `pyplot.tick_params` now have keyword arguments 'grid_color', 'grid_alpha', 'grid_linewidth', and 'grid_linestyle' for overriding the defaults in `rcParams`: 'grid.color', etc.

5.2.15 `Axes.imshow` clips RGB values to the valid range

When `Axes.imshow` is passed an RGB or RGBA value with out-of-range values, it now logs a warning and clips them to the valid range. The old behaviour, wrapping back in to the range, often hid outliers and made interpreting RGB images unreliable.

5.2.16 Properties in `matplotlibrc` to place xaxis and yaxis tick labels

Introducing four new boolean properties in `matplotlibrc` for default positions of xaxis and yaxis tick labels, namely, `xtick.labeltop`, `xtick.labelbottom`, `ytick.labelright` and `ytick.labelleft`. These can also be changed in rcParams.

5.2.17 PGI bindings for gtk3

The GTK3 backends can now use PGI instead of PyGObject. PGI is a fairly incomplete binding for GObject, thus its use is not recommended; its main benefit is its availability on Travis (thus allowing CI testing for the gtk3agg and gtk3cairo backends).

The binding selection rules are as follows: - if `gi` has already been imported, use it; else - if `pgi` has already been imported, use it; else - if `gi` can be imported, use it; else - if `pgi` can be imported, use it; else - error out.

Thus, to force usage of PGI when both bindings are installed, import it first.

5.2.18 Cairo rendering for Qt, WX, and Tk canvases

The new `Qt4Cairo`, `Qt5Cairo`, `WXCairo`, and `TkCairo` backends allow Qt, Wx, and Tk canvases to use Cairo rendering instead of Agg.

5.2.19 Added support for QT in new ToolManager

Now it is possible to use the ToolManager with Qt5 For example

> import matplotlib
>
> matplotlib.use('QT5AGG') matplotlib.rcParams['toolbar'] = 'toolmanager' import matplotlib.pyplot as plt
>
> plt.plot([1,2,3]) plt.show()

Treat the new Tool classes experimental for now, the API will likely change and perhaps the rcParam as well

The main example `examples/user_interfaces/toolmanager_sgskip.py` shows more details, just adjust the header to use QT instead of GTK3

5.2.20 TkAgg backend reworked to support PyPy

PyPy can now plot using the TkAgg backend, supported on PyPy 5.9 and greater (both PyPy for python 2.7 and PyPy for python 3.5).

5.2.21 Python logging library used for debug output

Matplotlib has in the past (sporadically) used an internal verbose-output reporter. This version converts those calls to using the standard python `logging` library.

Support for the old `rcParams` `verbose.level` and `verbose.fileo` is dropped.

The command-line options `--verbose-helpful` and `--verbose-debug` are still accepted, but deprecated. They are now equivalent to setting `logging.INFO` and `logging.DEBUG`.

The logger's root name is `matplotlib` and can be accessed from programs as:

```
import logging
mlog = logging.getLogger('matplotlib')
```

Instructions for basic usage are in *Troubleshooting* and for developers in *Contributing*.

5.2.22 Improved `repr` for `Transforms`

`Transforms` now indent their `reprs` in a more legible manner:

```
In [1]: l, = plt.plot([]); l.get_transform()
Out[1]:
CompositeGenericTransform(
   TransformWrapper(
      BlendedAffine2D(
            IdentityTransform(),
            IdentityTransform())),
   CompositeGenericTransform(
      BboxTransformFrom(
            TransformedBbox(
               Bbox(x0=-0.05500000000000001, y0=-0.05500000000000001, x1=0.
↪05500000000000001, y1=0.05500000000000001),
               TransformWrapper(
                  BlendedAffine2D(
                        IdentityTransform(),
                        IdentityTransform())))),
      BboxTransformTo(
            TransformedBbox(
               Bbox(x0=0.125, y0=0.10999999999999999, x1=0.9, y1=0.88),
               BboxTransformTo(
                  TransformedBbox(
                        Bbox(x0=0.0, y0=0.0, x1=6.4, y1=4.8),
                        Affine2D(
                           [[ 100.    0.    0.]
```

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```
                    [   0.  100.    0.]
                    [   0.    0.    1.]]]]]]]]]
```

5.3 Previous Whats New

5.3.1 List of changes to Matplotlib prior to 2015

This is a list of the changes made to Matplotlib from 2003 to 2015. For more recent changes, please refer to the what's new or the API changes.

2015-11-16 Levels passed to contour(f) and tricontour(f) must be in increasing order.

2015-10-21 Added TextBox widget

2015-10-21 Added get_ticks_direction()

2015-02-27 Added the rcParam 'image.composite_image' to permit users to decide whether they want the vector graphics backends to combine all images within a set of axes into a single composite image. (If images do not get combined, users can open vector graphics files in Adobe Illustrator or Inkscape and edit each image individually.)

2015-02-19 Rewrite of C++ code that calculates contours to add support for corner masking. This is controlled by the 'corner_mask' keyword in plotting commands 'contour' and 'contourf'. - IMT

2015-01-23 Text bounding boxes are now computed with advance width rather than ink area. This may result in slightly different placement of text.

2014-10-27 Allowed selection of the backend using the `MPLBACKEND` environment variable. Added documentation on backend selection methods.

2014-09-27 Overhauled `colors.LightSource`. Added `LightSource.hillshade` to allow the independent generation of illumination maps. Added new types of blending for creating more visually appealing shaded relief plots (e.g. `blend_mode="overlay"`, etc, in addition to the legacy "hsv" mode).

2014-06-10 Added Colorbar.remove()

2014-06-07 Fixed bug so radial plots can be saved as ps in py3k.

2014-06-01 Changed the fmt kwarg of errorbar to support the the mpl convention that "none" means "don't draw it", and to default to the empty string, so that plotting of data points is done with the plot() function defaults. Deprecated use of the None object in place "none".

2014-05-22 Allow the linscale keyword parameter of symlog scale to be smaller than one.

2014-05-20 Added logic to in FontManager to invalidate font-cache if if font-family rcparams have changed.

2014-05-16 Fixed the positioning of multi-line text in the PGF backend.

2014-05-14 Added Axes.add_image() as the standard way to add AxesImage instances to Axes. This improves the consistency with add_artist(), add_collection(), add_container(), add_line(), add_patch(), and add_table().

2014-05-02 Added colorblind-friendly colormap, named 'Wistia'.

2014-04-27 Improved input clean up in Axes.{h|v}lines Coerce input into a 1D ndarrays (after dealing with units).

2014-04-27 removed un-needed cast to float in stem

2014-04-23 Updated references to "ipython -pylab" The preferred method for invoking pylab is now using the "%pylab" magic. -Chris G.

2014-04-22 Added (re-)generate a simple automatic legend to "Figure Options" dialog of the Qt4Agg backend.

2014-04-22 Added an example showing the difference between interpolation = 'none' and interpolation = 'nearest' in `imshow()` when saving vector graphics files.

2014-04-22 Added violin plotting functions. See `Axes.violinplot`, `Axes.violin`, `cbook.violin_stats` and `mlab.GaussianKDE` for details.

2014-04-10 Fixed the triangular marker rendering error. The "Up" triangle was rendered instead of "Right" triangle and vice-versa.

2014-04-08 Fixed a bug in parasite_axes.py by making a list out of a generator at line 263.

2014-04-02 Added `clipon=False` to patch creation of wedges and shadows in `pie`.

2014-02-25 In backend_qt4agg changed from using update -> repaint under windows. See comment in source near `self._priv_update` for longer explaination.

2014-03-27 Added tests for pie ccw parameter. Removed pdf and svg images from tests for pie linewidth parameter.

2014-03-24 Changed the behaviour of axes to not ignore leading or trailing patches of height 0 (or width 0) while calculating the x and y axis limits. Patches having both height == 0 and width == 0 are ignored.

2014-03-24 Added bool kwarg (manage_xticks) to boxplot to enable/disable the managemnet of the xlimits and ticks when making a boxplot. Default in True which maintains current behavior by default.

2014-03-23 Fixed a bug in projections/polar.py by making sure that the theta value being calculated when given the mouse coordinates stays within the range of 0 and 2 * pi.

2014-03-22 Added the keyword arguments wedgeprops and textprops to pie. Users can control the wedge and text properties of the pie in more detail, if they choose.

2014-03-17 Bug was fixed in append_axes from the AxesDivider class would not append axes in the right location with respect to the reference locator axes

2014-03-13 Add parameter 'clockwise' to function pie, True by default.

2014-02-28 Added 'origin' kwarg to `spy`

2014-02-27 Implemented separate horizontal/vertical axes padding to the ImageGrid in the AxesGrid toolkit

2014-02-27 Allowed markevery property of matplotlib.lines.Line2D to be, an int numpy fancy index, slice object, or float. The float behaviour turns on markers at approximately equal display-coordinate-distances along the line.

2014-02-25 In backend_qt4agg changed from using update -> repaint under windows. See comment in source near `self._priv_update` for longer explaination.

2014-01-02 `triplot` now returns the artist it adds and support of line and marker kwargs has been improved. GBY

2013-12-30 Made streamplot grid size consistent for different types of density argument. A 30x30 grid is now used for both density=1 and density=(1, 1).

2013-12-03 Added a pure boxplot-drawing method that allow a more complete customization of boxplots. It takes a list of dicts contains stats. Also created a function (`cbook.boxplot_stats`) that generates the stats needed.

2013-11-28 Added qhull extension module to perform Delaunay triangulation more robustly than before. It is used by tri.Triangulation (and hence all pyplot.tri* methods) and mlab.griddata. Deprecated matplotlib.delaunay module. - IMT

2013-11-05 Add power-law normalization method. This is useful for, e.g., showing small populations in a "hist2d" histogram.

2013-10-27 Added get_rlabel_position and set_rlabel_position methods to PolarAxes to control angular position of radial tick labels.

2013-10-06 Add stride-based functions to mlab for easy creation of 2D arrays with less memory.

2013-10-06 Improve window and detrend functions in mlab, particulart support for 2D arrays.

2013-10-06 Improve performance of all spectrum-related mlab functions and plots.

2013-10-06 Added support for magnitude, phase, and angle spectrums to axes.specgram, and support for magnitude, phase, angle, and complex spectrums to mlab-specgram.

2013-10-06 Added magnitude_spectrum, angle_spectrum, and phase_spectrum plots, as well as magnitude_spectrum, angle_spectrum, phase_spectrum, and complex_spectrum functions to mlab

2013-07-12 Added support for datetime axes to 2d plots. Axis values are passed through Axes.convert_xunits/Axes.convert_yunits before being used by contour/contourf, pcolormesh and pcolor.

2013-07-12 Allowed matplotlib.dates.date2num, matplotlib.dates.num2date, and matplotlib.dates.datestr2num to accept n-d inputs. Also factored in support for n-d arrays to matplotlib.dates.DateConverter and matplotlib.units.Registry.

2013-06-26 Refactored the axes module: the axes module is now a folder,

containing the following submodule:

- _subplots.py, containing all the subplots helper methods
- _base.py, containing several private methods and a new _AxesBase class. This _AxesBase class contains all the methods that are not directly linked to plots of the "old" Axes

- _axes.py contains the Axes class. This class now inherits from _AxesBase: it contains all "plotting" methods and labelling methods.

This refactoring should not affect the API. Only private methods are not importable from the axes module anymore.

2013-05-18 Added support for arbitrary rasterization resolutions to the SVG backend. Previously the resolution was hard coded to 72 dpi. Now the backend class takes a image_dpi argument for its constructor, adjusts the image bounding box accordingly and forwards a magnification factor to the image renderer. The code and results now resemble those of the PDF backend. - MW

2013-05-08 Changed behavior of hist when given stacked=True and normed=True. Histograms are now stacked first, then the sum is normalized. Previously, each histogram was normalized, then they were stacked.

2013-04-25 Changed all instances of:

from matplotlib import MatplotlibDeprecationWarning as mplDeprecation to:

from cbook import mplDeprecation

and removed the import into the matplotlib namespace in __init__.py Thomas Caswell

2013-04-15 Added 'axes.xmargin' and 'axes.ymargin' to rpParams to set default margins on auto-scaleing. - TAC

2013-04-16 Added patheffect support for Line2D objects. -JJL

2013-03-31 Added support for arbitrary unstructured user-specified triangulations to Axes3D.tricontour[f] - Damon McDougall

2013-03-19 Added support for passing `linestyle` kwarg to `step` so all `plot` kwargs are passed to the underlying `plot` call. -TAC

2013-02-25 Added classes CubicTriInterpolator, UniformTriRefiner, TriAnalyzer to matplotlib.tri module. - GBy

2013-01-23 Add 'savefig.directory' to rcParams to remember and fill in the last directory saved to for figure save dialogs - Martin Spacek

2013-01-13 Add eventplot method to axes and pyplot and EventCollection class to collections.

2013-01-08 Added two extra titles to axes which are flush with the left and right edges of the plot respectively. Andrew Dawson

2013-01-07 Add framealpha keyword argument to legend - PO

2013-01-16 Till Stensitzki added a baseline feature to stackplot

2012-12-22 Added classes for interpolation within triangular grids (LinearTriInterpolator) and to find the triangles in which points lie (TrapezoidMapTriFinder) to matplotlib.tri module. - IMT

2012-12-05 Added MatplotlibDeprecationWarning class for signaling deprecation. Matplotlib developers can use this class as follows:

from matplotlib import MatplotlibDeprecationWarning as mplDeprecation

In light of the fact that Python builtin DeprecationWarnings are ignored by default as of Python 2.7, this class was put in to allow for the signaling of deprecation, but via UserWarnings which are not ignored by default. - PI

2012-11-27 Added the *mtext* parameter for supplying matplotlib.text.Text instances to RendererBase.draw_tex and RendererBase.draw_text. This allows backends to utilize additional text attributes, like the alignment of text elements. - pwuertz

2012-11-26 deprecate matplotlib/mpl.py, which was used only in pylab.py and is now replaced by the more suitable `import matplotlib as mpl`. - PI

2012-11-25 Make rc_context available via pyplot interface - PI

2012-11-16 plt.set_cmap no longer throws errors if there is not already an active colorable artist, such as an image, and just sets up the colormap to use from that point forward. - PI

2012-11-16 Added the funcction _get_rbga_face, which is identical to _get_rbg_face except it return a (r,g,b,a) tuble, to line2D. Modified Line2D.draw to use _get_rbga_face to get the markerface color so that any alpha set by markerfacecolor will respected. - Thomas Caswell

2012-11-13 Add a symmetric log normalization class to colors.py. Also added some tests for the normalization class. Till Stensitzki

2012-11-12 Make axes.stem take at least one argument. Uses a default range(n) when the first arg not provided. Damon McDougall

2012-11-09 Make plt.subplot() without arguments act as subplot(111) - PI

2012-11-08 Replaced plt.figure and plt.subplot calls by the newer, more convenient single call to plt.subplots() in the documentation examples - PI

2012-10-05 Add support for saving animations as animated GIFs. - JVDP

2012-08-11 Fix path-closing bug in patches.Polygon, so that regardless of whether the path is the initial one or was subsequently set by set_xy(), get_xy() will return a closed path if and only if get_closed() is True. Thanks to Jacob Vanderplas. - EF

2012-08-05 When a norm is passed to contourf, either or both of the vmin, vmax attributes of that norm are now respected. Formerly they were respected only if both were specified. In addition, vmin and/or vmax can now be passed to contourf directly as kwargs. - EF

2012-07-24 Contourf handles the extend kwarg by mapping the extended ranges outside the normed 0-1 range so that they are handled by colormap colors determined by the set_under and set_over methods. Previously the extended ranges were mapped to 0 or 1 so that the "under" and "over" colormap colors were ignored. This change also increases slightly the color contrast for a given set of contour levels. - EF

2012-06-24 Make use of mathtext in tick labels configurable - DSD

2012-06-05 Images loaded through PIL are now ordered correctly - CG

2012-06-02 Add new Axes method and pyplot function, hist2d. - PO

2012-05-31 Remove support for 'cairo.<format>' style of backend specification. Deprecate 'cairo.format' and 'savefig.extension' rcParams and replace with 'savefig.format'. - Martin Spacek

2012-05-29 pcolormesh now obeys the passed in "edgecolor" kwarg. To support this, the "shading" argument to pcolormesh now only takes "flat" or "gouraud". To achieve the old "faceted" behavior, pass "edgecolors='k'". - MGD

2012-05-22 Added radius kwarg to pie charts. - HH

2012-05-22 Collections now have a setting "offset_position" to select whether the offsets are given in "screen" coordinates (default, following the old behavior) or "data" coordinates. This is currently used internally to improve the performance of hexbin.

As a result, the "draw_path_collection" backend methods have grown a new argument "offset_position". - MGD

2012-05-04 Add a new argument to pie charts - startingangle - that allows one to specify the angle offset for the first wedge of the chart. - EP

2012-05-03 symlog scale now obeys the logarithmic base. Previously, it was completely ignored and always treated as base e. - MGD

2012-05-03 Allow linscalex/y keyword to symlog scale that allows the size of the linear portion relative to the logarithmic portion to be adjusted. - MGD

2012-04-14 Added new plot style: stackplot. This new feature supports stacked area plots. - Damon McDougall

2012-04-06 When path clipping changes a LINETO to a MOVETO, it also changes any CLOSEPOLY command to a LINETO to the initial point. This fixes a problem with pdf and svg where the CLOSEPOLY would then draw a line to the latest MOVETO position instead of the intended initial position. - JKS

2012-03-27 Add support to ImageGrid for placing colorbars only at one edge of each column/row. - RMM

2012-03-07 Refactor movie writing into useful classes that make use of pipes to write image data to ffmpeg or mencoder. Also improve settings for these and the ability to pass custom options. - RMM

2012-02-29 errorevery keyword added to errorbar to enable errorbar subsampling. fixes issue #600.

2012-02-28 Added plot_trisurf to the mplot3d toolkit. This supports plotting three dimensional surfaces on an irregular grid. - Damon McDougall

2012-01-23 The radius labels in polar plots no longer use a fixed padding, but use a different alignment depending on the quadrant they are in. This fixes numerical problems when (rmax - rmin) gets too small. - MGD

2012-01-08 Add axes.streamplot to plot streamlines of a velocity field. Adapted from Tom Flannaghan streamplot implementation. -TSY

2011-12-29 ps and pdf markers are now stroked only if the line width is nonzero for consistency with agg, fixes issue #621. - JKS

2011-12-27 Work around an EINTR bug in some versions of subprocess. - JKS

2011-10-25 added support for operatorname to mathtext, including the ability to insert spaces, such as $operatorname{arg,max}$ - PI

2011-08-18 Change api of Axes.get_tightbbox and add an optional keyword parameter *call_axes_locator*. - JJL

2011-07-29 A new rcParam "axes.formatter.use_locale" was added, that, when True, will use the current locale to format tick labels. This means that, for example, in the fr_FR locale, ',' will be used as a decimal separator. - MGD

2011-07-15 The set of markers available in the plot() and scatter() commands has been unified. In general, this gives more options to both than were previously available, however, there is one backward-incompatible change to the markers in scatter:

> "d" used to mean "diamond", it now means "narrow diamond". "D" can be used for a "diamond".

-MGD

2011-07-13 Fix numerical problems in symlog scale, particularly when linthresh <= 1.0. Symlog plots may look different if one was depending on the old broken behavior - MGD

2011-07-10 Fixed argument handling error in tripcolor/triplot/tricontour, issue #203. - IMT

2011-07-08 Many functions added to mplot3d.axes3d to bring Axes3D objects more feature-parity with regular Axes objects. Significant revisions to the documentation as well. - BVR

2011-07-07 Added compatibility with IPython strategy for picking a version of Qt4 support, and an rcParam for making the choice explicitly: backend.qt4. - EF

2011-07-07 Modified AutoMinorLocator to improve automatic choice of the number of minor intervals per major interval, and to allow one to specify this number via a kwarg. - EF

2011-06-28 3D versions of scatter, plot, plot_wireframe, plot_surface, bar3d, and some other functions now support empty inputs. - BVR

2011-06-22 Add set_theta_offset, set_theta_direction and set_theta_zero_location to polar axes to control the location of 0 and directionality of theta. - MGD

2011-06-22 Add axes.labelweight parameter to set font weight to axis labels - MGD.

2011-06-20 Add pause function to pyplot. - EF

2011-06-16 Added *bottom* keyword parameter for the stem command. Also, implemented a legend handler for the stem plot. - JJL

2011-06-16 Added legend.frameon rcParams. - Mike Kaufman

2011-05-31 Made backend_qt4 compatible with PySide . - Gerald Storer

2011-04-17 Disable keyboard auto-repeat in qt4 backend by ignoring key events resulting from auto-repeat. This makes constrained zoom/pan work. - EF

2011-04-14 interpolation="nearest" always interpolate images. A new mode "none" is introduced for no interpolation - JJL

2011-04-03 Fixed broken pick interface to AsteriskCollection objects used by scatter. - EF

2011-04-01 The plot directive Sphinx extension now supports all of the features in the Numpy fork of that extension. These include doctest formatting, an 'include-source' option, and a number of new configuration options. - MGD

2011-03-29 Wrapped ViewVCCachedServer definition in a factory function. This class now inherits from urllib2.HTTPSHandler in order to fetch data from github, but HTTPSHandler is not defined if python was built without SSL support. - DSD

2011-03-10 Update pytz version to 2011c, thanks to Simon Cross. - JKS

2011-03-06 Add standalone tests.py test runner script. - JKS

2011-03-06 Set edgecolor to 'face' for scatter asterisk-type symbols; this fixes a bug in which these symbols were not responding to the c kwarg. The symbols have no face area, so only the edgecolor is visible. - EF

2011-02-27 Support libpng version 1.5.x; suggestion by Michael Albert. Changed installation specification to a minimum of libpng version 1.2. - EF

2011-02-20 clabel accepts a callable as an fmt kwarg; modified patch by Daniel Hyams. - EF

2011-02-18 scatter([], []) is now valid. Also fixed issues with empty collections - BVR

2011-02-07 Quick workaround for dviread bug #3175113 - JKS

2011-02-05 Add cbook memory monitoring for Windows, using tasklist. - EF

2011-02-05 Speed up Normalize and LogNorm by using in-place operations and by using float32 for float32 inputs and for ints of 2 bytes or shorter; based on patch by Christoph Gohlke. - EF

2011-02-04 Changed imshow to use rgba as uint8 from start to finish, instead of going through an intermediate step as double precision; thanks to Christoph Gohlke. - EF

2011-01-13 Added zdir and offset arguments to contourf3d to bring contourf3d in feature parity with contour3d. - BVR

2011-01-04 Tag 1.0.1 for release at r8896

2011-01-03 Added display of ticker offset to 3d plots. - BVR

2011-01-03 Turn off tick labeling on interior subplots for pyplots.subplots when sharex/sharey is True. - JDH

2010-12-29 Implement axes_divider.HBox and VBox. -JJL

2010-11-22 Fixed error with Hammer projection. - BVR

2010-11-12 Fixed the placement and angle of axis labels in 3D plots. - BVR

2010-11-07 New rc parameters examples.download and examples.directory allow bypassing the download mechanism in get_sample_data. - JKS

2010-10-04 Fix JPEG saving bug: only accept the kwargs documented by PIL for JPEG files. - JKS

2010-09-15 Remove unused _wxagg extension and numerix.h. - EF

2010-08-25 Add new framework for doing animations with examples.- RM

2010-08-21 Remove unused and inappropriate methods from Tick classes: set_view_interval, get_minpos, and get_data_interval are properly found in the Axis class and don't need to be duplicated in XTick and YTick. - EF

2010-08-21 Change Axis.set_view_interval() so that when updating an existing interval, it respects the orientation of that interval, and can enlarge but not reduce the interval. This fixes a bug in which Axis.set_ticks would change the view limits of an inverted axis. Whether set_ticks should be affecting the viewLim at all remains an open question. - EF

2010-08-16 Handle NaN's correctly in path analysis routines. Fixes a bug where the best location for a legend was not calculated correctly when the line contains NaNs. - MGD

2010-08-14 Fix bug in patch alpha handling, and in bar color kwarg - EF

2010-08-12 Removed all traces of numerix module after 17 months of deprecation warnings. - EF

2010-08-05 Added keyword arguments 'thetaunits' and 'runits' for polar plots. Fixed PolarAxes so that when it set default Formatters, it marked them as such. Fixed semilogx and semilogy to no longer blindly reset the ticker information on the non-log axis. Axes.arrow can now accept unitized data. - JRE

2010-08-03 Add support for MPLSETUPCFG variable for custom setup.cfg filename. Used by sage buildbot to build an mpl w/ no gui support - JDH

2010-08-01 Create directory specified by MPLCONFIGDIR if it does not exist. - ADS

2010-07-20 Return Qt4's default cursor when leaving the canvas - DSD

2010-07-06 Tagging for mpl 1.0 at r8502

2010-07-05 Added Ben Root's patch to put 3D plots in arbitrary axes, allowing you to mix 3d and 2d in different axes/subplots or to have multiple 3D plots in one figure. See examples/mplot3d/subplot3d_demo.py - JDH

2010-07-05 Preferred kwarg names in set_xlim are now 'left' and 'right'; in set_ylim, 'bottom' and 'top'; original kwargs are still accepted without complaint. - EF

2010-07-05 TkAgg and FltkAgg backends are now consistent with other interactive backends: when used in scripts from the command line (not from ipython -pylab), show blocks, and can be called more than once. - EF

2010-07-02 Modified CXX/WrapPython.h to fix "swab bug" on solaris so mpl can compile on Solaris with CXX6 in the trunk. Closes tracker bug 3022815 - JDH

2010-06-30 Added autoscale convenience method and corresponding pyplot function for simplified control of autoscaling; and changed axis, set_xlim, and set_ylim so that by default, they turn off the autoscaling on the relevant axis or axes. Therefore one can call set_xlim before plotting a line, for example, and the limits will be retained. - EF

2010-06-20 Added Axes.tick_params and corresponding pyplot function to control tick and tick label appearance after an Axes has been created. - EF

2010-06-09 Allow Axes.grid to control minor gridlines; allow Axes.grid and Axis.grid to control major and minor gridlines in the same method call. - EF

2010-06-06 Change the way we do split/dividend adjustments in finance.py to handle dividends and fix the zero division bug reported in sf bug 2949906 and 2123566. Note that volume is not adjusted because the Yahoo CSV does not distinguish between share split and dividend adjustments making it near impossible to get volume adjustement right (unless we want to guess based on the size of the adjustment or scrape the html tables, which we don't) - JDH

2010-06-06 Updated dateutil to 1.5 and pytz to 2010h.

2010-06-02 Add error_kw kwarg to Axes.bar(). - EF

2010-06-01 Fix pcolormesh() and QuadMesh to pass on kwargs as appropriate. - RM

2010-05-18 Merge mpl_toolkits.gridspec into the main tree. - JJL

2010-05-04 Improve backend_qt4 so it displays figures with the correct size - DSD

2010-04-20 Added generic support for connecting to a timer for events. This adds TimerBase, TimerGTK, TimerQT, TimerWx, and TimerTk to the backends and a new_timer() method to each backend's canvas to allow ease of creating a new timer. - RM

2010-04-20 Added margins() Axes method and pyplot function. - EF

2010-04-18 update the axes_grid documentation. -JJL

2010-04-18 Control MaxNLocator parameters after instantiation, and via Axes.locator_params method, with corresponding pyplot function. -EF

2010-04-18 Control ScalarFormatter offsets directly and via the Axes.ticklabel_format() method, and add that to pyplot. -EF

2010-04-16 Add a close_event to the backends. -RM

2010-04-06 modify axes_grid examples to use axes_grid1 and axisartist. -JJL

2010-04-06 rebase axes_grid using axes_grid1 and axisartist modules. -JJL

2010-04-06 axes_grid toolkit is splitted into two separate modules, axes_grid1 and axisartist. -JJL

2010-04-05 Speed up import: import pytz only if and when it is needed. It is not needed if the rc time-zone is UTC. - EF

2010-04-03 Added color kwarg to Axes.hist(), based on work by Jeff Klukas. - EF

2010-03-24 refactor colorbar code so that no cla() is necessary when mappable is changed. -JJL

2010-03-22 fix incorrect rubber band during the zoom mode when mouse leaves the axes. -JJL

2010-03-21 x/y key during the zoom mode only changes the x/y limits. -JJL

2010-03-20 Added pyplot.sca() function suggested by JJL. - EF

2010-03-20 Added conditional support for new Tooltip API in gtk backend. - EF

2010-03-20 Changed plt.fig_subplot() to plt.subplots() after discussion on list, and changed its API to return axes as a numpy object array (with control of dimensions via squeeze keyword). FP.

2010-03-13 Manually brought in commits from branch:

```
  ------------------------------------------------------------------------
  r8191 | leejjoon | 2010-03-13 17:27:57 -0500 (Sat, 13 Mar 2010) | 1 line

fix the bug that handles for scatter are incorrectly set when dpi!=72.
Thanks to Ray Speth for the bug report.
```

2010-03-03 Manually brought in commits from branch via diff/patch (svnmerge is broken):

```
------------------------------------------------------------------------
r8175 | leejjoon | 2010-03-03 10:03:30 -0800 (Wed, 03 Mar 2010) | 1 line

fix arguments of allow_rasterization.draw_wrapper
------------------------------------------------------------------------
r8174 | jdh2358 | 2010-03-03 09:15:58 -0800 (Wed, 03 Mar 2010) | 1 line

added support for favicon in docs build
------------------------------------------------------------------------
r8173 | jdh2358 | 2010-03-03 08:56:16 -0800 (Wed, 03 Mar 2010) | 1 line

applied Mattias get_bounds patch
------------------------------------------------------------------------
r8172 | jdh2358 | 2010-03-03 08:31:42 -0800 (Wed, 03 Mar 2010) | 1 line

fix svnmerge download instructions
------------------------------------------------------------------------
r8171 | jdh2358 | 2010-03-03 07:47:48 -0800 (Wed, 03 Mar 2010) | 1 line
```

2010-02-25 add annotation_demo3.py that demonstrates new functionality. -JJL

2010-02-25 refactor Annotation to support arbitrary Transform as xycoords or textcoords. Also, if a tuple of two coordinates is provided, they are interpreted as coordinates for each x and y position. -JJL

2010-02-24 Added pyplot.fig_subplot(), to create a figure and a group of subplots in a single call. This offers an easier pattern than manually making figures and calling add_subplot() multiple times. FP

2010-02-17 Added Gokhan's and Mattias' customizable keybindings patch for the toolbar. You can now set the keymap.* properties in the matplotlibrc file. Newbindings were added for toggling log scaling on the x-axis. JDH

2010-02-16 Committed TJ's filled marker patch for left|right|bottom|top|full filled markers. See examples/pylab_examples/filledmarker_demo.py. JDH

2010-02-11 Added 'bootstrap' option to boxplot. This allows bootstrap estimates of median confidence intervals. Based on an initial patch by Paul Hobson. - ADS

2010-02-06 Added setup.cfg "basedirlist" option to override setting in setupext.py "basedir" dictionary; added "gnu0" platform requested by Benjamin Drung. - EF

2010-02-06 Added 'xy' scaling option to EllipseCollection. - EF

2010-02-03 Made plot_directive use a custom PlotWarning category, so that warnings can be turned into fatal errors easily if desired. - FP

2010-01-29 Added draggable method to Legend to allow mouse drag placement. Thanks Adam Fraser. JDH

2010-01-25 Fixed a bug reported by Olle Engdegard, when using histograms with stepfilled and log=True - MM

2010-01-16 Upgraded CXX to 6.1.1 - JDH

2009-01-16 Don't create minor ticks on top of existing major ticks. Patch by Neil Crighton. -ADS

2009-01-16 Ensure three minor ticks always drawn (SF# 2924245). Patch by Neil Crighton. -ADS

2010-01-16 Applied patch by Ian Thomas to fix two contouring problems: now contourf handles interior masked regions, and the boundaries of line and filled contours coincide. - EF

2009-01-11 The color of legend patch follows the rc parameters axes.facecolor and axes.edgecolor. - JJL

2009-01-11 adjustable of Axes can be "box-forced" which allow sharing axes. -JJL

2009-01-11 Add add_click and pop_click methods in BlockingContourLabeler. -JJL

2010-01-03 Added rcParams['axes.color_cycle'] - EF

2010-01-03 Added Pierre's qt4 formlayout editor and toolbar button - JDH

2009-12-31 Add support for using math text as marker symbols (Thanks to tcb)

- MGD

2009-12-31 Commit a workaround for a regression in PyQt4-4.6.{0,1} - DSD

2009-12-22 Fix cmap data for gist_earth_r, etc. -JJL

2009-12-20 spines: put spines in data coordinates, add set_bounds() call. -ADS

2009-12-18 Don't limit notch size in boxplot to q1-q3 range, as this is effectively making the data look better than it is. - ADS

2009-12-18 mlab.prctile handles even-length data, such that the median is the mean of the two middle values. - ADS

2009-12-15 Add raw-image (unsampled) support for the ps backend. - JJL

2009-12-14 Add patch_artist kwarg to boxplot, but keep old default. Convert boxplot_demo2.py to use the new patch_artist. - ADS

2009-12-06 axes_grid: reimplemented AxisArtist with FloatingAxes support. Added new examples. - JJL

2009-12-01 Applied Laurent Dufrechou's patch to improve blitting with the qt4 backend - DSD

2009-11-13 The pdf backend now allows changing the contents of a pdf file's information dictionary via PdfPages.infodict. - JKS

2009-11-12 font_manager.py should no longer cause EINTR on Python 2.6 (but will on the 2.5 version of subprocess). Also the fc-list command in that file was fixed so now it should actually find the list of fontconfig fonts. - JKS

2009-11-10 Single images, and all images in renderers with option_image_nocomposite (i.e. agg, macosx and the svg backend when rcParams['svg.image_noscale'] is True), are now drawn respecting the zorder relative to other artists. (Note that there may now be inconsistencies across backends when more than one image is drawn at varying zorders, but this change introduces correct behavior for the backends in which it's easy to do so.)

2009-10-21 Make AutoDateLocator more configurable by adding options to control the maximum and minimum number of ticks. Also add control of the intervals to be used for ticking. This does not change behavior but opens previously hard-coded behavior to runtime modification'. - RMM

2009-10-19 Add "path_effects" support for Text and Patch. See examples/pylab_examples/patheffect_demo.py -JJL

2009-10-19 Add "use_clabeltext" option to clabel. If True, clabels will be created with ClabelText class, which recalculates rotation angle of the label during the drawing time. -JJL

2009-10-16 Make AutoDateFormatter actually use any specified timezone setting.This was only working correctly when no timezone was specified. - RMM

2009-09-27 Beginnings of a capability to test the pdf backend. - JKS

2009-09-27 Add a savefig.extension rcparam to control the default filename extension used by savefig. - JKS

2009-09-21 Tagged for release 0.99.1

2009-09-20 Fix usetex spacing errors in pdf backend. - JKS

2009-09-20 Add Sphinx extension to highlight IPython console sessions, originally authored (I think) by Michael Droetboom. - FP

2009-09-20 Fix off-by-one error in dviread.Tfm, and additionally protect against exceptions in case a dvi font is missing some metrics. - JKS

2009-09-15 Implement draw_text and draw_tex method of backend_base using the textpath module. Implement draw_tex method of the svg backend. - JJL

2009-09-15 Don't fail on AFM files containing floating-point bounding boxes - JKS

2009-09-13 AxesGrid [add modified version of colorbar. Add colorbar] location howto. - JJL

2009-09-07 AxesGrid [implemented axisline style.] Added a demo examples/axes_grid/demo_axisline_style.py- JJL

2009-09-04 Make the textpath class as a separate moduel (textpath.py). Add support for mathtext and tex.- JJL

2009-09-01 Added support for Gouraud interpolated triangles. pcolormesh now accepts shading='gouraud' as an option. - MGD

2009-08-29 Added matplotlib.testing package, which contains a Nose plugin and a decorator that lets tests be marked as KnownFailures - ADS

2009-08-20 Added scaled dict to AutoDateFormatter for customized scales - JDH

2009-08-15 Pyplot interface: the current image is now tracked at the figure and axes level, addressing tracker item 1656374. - EF

2009-08-15 Docstrings are now manipulated with decorators defined in a new module, docstring.py, thanks to Jason Coombs. - EF

2009-08-14 Add support for image filtering for agg back end. See the example demo_agg_filter.py. -JJL

2009-08-09 AnnotationBbox added. Similar to Annotation, but works with OffsetBox instead of Text. See the example demo_annotation_box.py. -JJL

2009-08-07 BboxImage implemented. Two examples, demo_bboximage.py and demo_ribbon_box.py added. - JJL

2009-08-07 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)

becomes:

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)

becomes:

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)

becomes:

draw_image(self, gc, x, y, im)

- MGD

2009-08-06 Tagging the 0.99.0 release at svn r7397 - JDH

- fixed an alpha colormapping bug posted on sf 2832575
- fix typo in axes_divider.py. use nanmin, nanmax in angle_helper.py (patch by Christoph Gohlke)
- remove dup gui event in enter/leave events in gtk
- lots of fixes for os x binaries (Thanks Russell Owen)
- attach gtk events to mpl events – fixes sf bug 2816580
- applied sf patch 2815064 (middle button events for wx) and patch 2818092 (resize events for wx)
- fixed boilerplate.py so it doesn't break the ReST docs.
- removed a couple of cases of mlab.load
- fixed rec2csv win32 file handle bug from sf patch 2831018
- added two examples from Josh Hemann: examples/pylab_examples/barchart_demo2.py and examples/pylab_examples/boxplot_demo2.py
- handled sf bugs 2831556 and 2830525; better bar error messages and backend driver configs
- added miktex win32 patch from sf patch 2820194
- apply sf patches 2830233 and 2823885 for osx setup and 64 bit; thanks Michiel

2009-08-04 Made cbook.get_sample_data make use of the ETag and Last-Modified headers of mod_dav_svn. - JKS

2009-08-03 Add PathCollection; modify contourf to use complex paths instead of simple paths with cuts. - EF

2009-08-03 Fixed boilerplate.py so it doesn't break the ReST docs. - JKS

2009-08-03 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. - JDH

2009-07-31 Added cbook.get_sample_data for urllib enabled fetching and cacheing of data needed for examples. See examples/misc/sample_data_demo.py - JDH

2009-07-31 Tagging 0.99.0.rc1 at 7314 - MGD

2009-07-30 Add set_cmap and register_cmap, and improve get_cmap, to provide convenient handling of user-generated colormaps. Reorganized _cm and cm modules. - EF

2009-07-28 Quiver speed improved, thanks to tip by Ray Speth. -EF

2009-07-27 Simplify argument handling code for plot method. -EF

2009-07-25 Allow "plot(1, 2, 'r*')" to work. - EF

2009-07-22 Added an 'interp' keyword to griddata so the faster linear interpolation method can be chosen. Default is 'nn', so default behavior (using natural neighbor method) is unchanged (JSW)

2009-07-22 Improved boilerplate.py so that it generates the correct signatures for pyplot functions. - JKS

2009-07-19 Fixed the docstring of Axes.step to reflect the correct meaning of the kwargs "pre" and "post" - See SF bug https://sourceforge.net/tracker/index.php?func=detail&aid=2823304&group_id=80706&atid=560720 - JDH

2009-07-18 Fix support for hatches without color fills to pdf and svg backends. Add an example of that to hatch_demo.py. - JKS

2009-07-17 Removed fossils from swig version of agg backend. - EF

2009-07-14 initial submission of the annotation guide. -JJL

2009-07-14 axes_grid [minor improvements in anchored_artists and] inset_locator. -JJL

2009-07-14 Fix a few bugs in ConnectionStyle algorithms. Add ConnectionPatch class. -JJL

2009-07-11 Added a fillstyle Line2D property for half filled markers – see examples/pylab_examples/fillstyle_demo.py JDH

2009-07-08 Attempt to improve performance of qt4 backend, do not call qApp.processEvents while processing an event. Thanks Ole Streicher for tracking this down - DSD

2009-06-24 Add withheader option to mlab.rec2csv and changed use_mrecords default to False in mlab.csv2rec since this is partially broken - JDH

2009-06-24 backend_agg.draw_marker quantizes the main path (as in the draw_path). - JJL

2009-06-24 axes_grid: floating axis support added. - JJL

2009-06-14 Add new command line options to backend_driver.py to support running only some directories of tests - JKS

2009-06-13 partial cleanup of mlab and its importation in pylab - EF

2009-06-13 Introduce a rotation_mode property for the Text artist. See examples/pylab_examples/demo_text_rotation_mode.py -JJL

2009-06-07 add support for bz2 files per sf support request 2794556 - JDH

2009-06-06 added a properties method to the artist and inspector to return a dict mapping property name -> value; see sf feature request 2792183 - JDH

2009-06-06 added Neil's auto minor tick patch; sf patch #2789713 - JDH

2009-06-06 do not apply alpha to rgba color conversion if input is already rgba - JDH

2009-06-03 axes_grid [Initial check-in of curvelinear grid support. See] examples/axes_grid/demo_curvelinear_grid.py - JJL

2009-06-01 Add set_color method to Patch - EF

2009-06-01 Spine is now derived from Patch - ADS

2009-06-01 use cbook.is_string_like() instead of isinstance() for spines - ADS

2009-06-01 cla() support for spines - ADS

2009-06-01 Removed support for gtk < 2.4. - EF

2009-05-29 Improved the animation_blit_qt4 example, which was a mix of the object-oriented and pylab interfaces. It is now strictly object-oriented - DSD

2009-05-28 Fix axes_grid toolkit to work with spine patch by ADS. - JJL

2009-05-28 Applied fbianco's patch to handle scroll wheel events in the qt4 backend - DSD

2009-05-26 Add support for "axis spines" to have arbitrary location. -ADS

2009-05-20 Add an empty matplotlibrc to the tests/ directory so that running tests will use the default set of rcparams rather than the user's config. - RMM

2009-05-19 Axis.grid(): allow use of which='major,minor' to have grid on major and minor ticks. - ADS

2009-05-18 Make psd(), csd(), and cohere() wrap properly for complex/two-sided versions, like specgram() (SF #2791686) - RMM

2009-05-18 Fix the linespacing bug of multiline text (#1239682). See examples/pylab_examples/multiline.py -JJL

2009-05-18 Add *annotation_clip* attr. for text.Annotation class. If True, annotation is only drawn when the annotated point is inside the axes area. -JJL

2009-05-17 Fix bug(#2749174) that some properties of minor ticks are not conserved -JJL

2009-05-17 applied Michiel's sf patch 2790638 to turn off gtk event loop in setupext for pygtk>=2.15.10 - JDH

2009-05-17 applied Michiel's sf patch 2792742 to speed up Cairo and macosx collections; speedups can be 20x. Also fixes some bugs in which gc got into inconsistent state

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2008-05-17 Release 0.98.5.3 at r7107 from the branch - JDH

2009-05-13 An optional offset and bbox support in restore_bbox. Add animation_blit_gtk2.py. -JJL

2009-05-13 psfrag in backend_ps now uses baseline-alignment when preview.sty is used ((default is bottom-alignment). Also, a small api imporvement in OffsetBox-JJL

2009-05-13 When the x-coordinate of a line is monotonically increasing, it is now automatically clipped at the stage of generating the transformed path in the draw method; this greatly speeds up zooming and panning when one is looking at a short segment of a long time series, for example. - EF

2009-05-11 aspect=1 in log-log plot gives square decades. -JJL

2009-05-08 clabel takes new kwarg, rightside_up; if False, labels will not be flipped to keep them rightside-up. This allows the use of clabel to make streamfunction arrows, as requested by Evan Mason. - EF

2009-05-07 'labelpad' can now be passed when setting x/y labels. This allows controlling the spacing between the label and its axis. - RMM

2009-05-06 print_ps now uses mixed-mode renderer. Axes.draw rasterize artists whose zorder smaller than rasterization_zorder. -JJL

2009-05-06 Per-artist Rasterization, originally by Eric Bruning. -JJ

2009-05-05 Add an example that shows how to make a plot that updates using data from another process. Thanks to Robert Cimrman - RMM

2009-05-05 Add Axes.get_legend_handles_labels method. - JJL

2009-05-04 Fix bug that Text.Annotation is still drawn while set to not visible. - JJL

2009-05-04 Added TJ's fill_betweenx patch - JDH

2009-05-02 Added options to plotfile based on question from Joseph Smidt and patch by Matthias Michler. - EF

2009-05-01 Changed add_artist and similar Axes methods to return their argument. - EF

2009-04-30 Incorrect eps bbox for landscape mode fixed - JJL

2009-04-28 Fixed incorrect bbox of eps output when usetex=True. - JJL

2009-04-24 Changed use of os.open* to instead use subprocess.Popen. os.popen* are deprecated in 2.6 and are removed in 3.0. - RMM

2009-04-20 Worked on axes_grid documentation. Added axes_grid.inset_locator. - JJL

2009-04-17 Initial check-in of the axes_grid toolkit. - JJL

2009-04-17 Added a support for bbox_to_anchor in offsetbox.AnchoredOffsetbox. Improved a documentation. - JJL

2009-04-16 Fixed a offsetbox bug that multiline texts are not correctly aligned. - JJL

2009-04-16 Fixed a bug in mixed mode renderer that images produced by an rasterizing backend are placed with incorrect size. - JJL

2009-04-14 Added Jonathan Taylor's Reinier Heeres' port of John Porters' mplot3d to svn trunk. Package in mpl_toolkits.mplot3d and demo is examples/mplot3d/demo.py. Thanks Reiner

2009-04-06 The pdf backend now escapes newlines and linefeeds in strings. Fixes sf bug #2708559; thanks to Tiago Pereira for the report.

2009-04-06 texmanager.make_dvi now raises an error if LaTeX failed to create an output file. Thanks to Joao Luis Silva for reporting this. - JKS

2009-04-05 _png.read_png() reads 12 bit PNGs (patch from Tobias Wood) - ADS

2009-04-04 Allow log axis scale to clip non-positive values to small positive value; this is useful for errorbars. - EF

2009-03-28 Make images handle nan in their array argument. A helper, cbook.safe_masked_invalid() was added. - EF

2009-03-25 Make contour and contourf handle nan in their Z argument. - EF

2009-03-20 Add AuxTransformBox in offsetbox.py to support some transformation. anchored_text.py example is enhanced and renamed (anchored_artists.py). - JJL

2009-03-20 Add "bar" connection style for annotation - JJL

2009-03-17 Fix bugs in edge color handling by contourf, found by Jae-Joon Lee. - EF

2009-03-14 Added 'LightSource' class to colors module for creating shaded relief maps. shading_example.py added to illustrate usage. - JSW

2009-03-11 Ensure wx version >= 2.8; thanks to Sandro Tosi and Chris Barker. - EF

2009-03-10 Fix join style bug in pdf. - JKS

2009-03-07 Add pyplot access to figure number list - EF

2009-02-28 hashing of FontProperties accounts current rcParams - JJL

2009-02-28 Prevent double-rendering of shared axis in twinx, twiny - EF

2009-02-26 Add optional bbox_to_anchor argument for legend class - JJL

2009-02-26 Support image clipping in pdf backend. - JKS

2009-02-25 Improve tick location subset choice in FixedLocator. - EF

2009-02-24 Deprecate numerix, and strip out all but the numpy part of the code. - EF

2009-02-21 Improve scatter argument handling; add an early error message, allow inputs to have more than one dimension. - EF

2009-02-16 Move plot_directive.py to the installed source tree. Add support for inline code content - MGD

2009-02-16 Move mathmpl.py to the installed source tree so it is available to other projects. - MGD

2009-02-14 Added the legend title support - JJL

2009-02-10 Fixed a bug in backend_pdf so it doesn't break when the setting pdf.use14corefonts=True is used. Added test case in unit/test_pdf_use14corefonts.py. - NGR

2009-02-08 Added a new imsave function to image.py and exposed it in the pyplot interface - GR

2009-02-04 Some reorgnization of the legend code. anchored_text.py added as an example. - JJL

2009-02-04 Add extent keyword arg to hexbin - ADS

2009-02-04 Fix bug in mathtext related to dots and ldots - MGD

2009-02-03 Change default joinstyle to round - MGD

2009-02-02 Reduce number of marker XObjects in pdf output - JKS

2009-02-02 Change default resolution on polar plot to 1 - MGD

2009-02-02 Avoid malloc errors in ttconv for fonts that don't have e.g., PostName (a version of Tahoma triggered this) - JKS

2009-01-30 Remove support for pyExcelerator in exceltools – use xlwt instead - JDH

2009-01-29 Document 'resolution' kwarg for polar plots. Support it when using pyplot.polar, not just Figure.add_axes. - MGD

2009-01-29 Rework the nan-handling/clipping/quantizing/simplification framework so each is an independent part of a pipeline. Expose the C++-implementation of all of this so it can be used from all Python backends. Add rcParam "path.simplify_threshold" to control the threshold of similarity below which vertices will be removed.

2009-01-26 Improved tight bbox option of the savefig. - JJL

2009-01-26 Make curves and NaNs play nice together - MGD

2009-01-21 Changed the defaults of acorr and xcorr to use usevlines=True, maxlags=10 and normed=True since these are the best defaults

2009-01-19 Fix bug in quiver argument handling. - EF

2009-01-19 Fix bug in backend_gtk: don't delete nonexistent toolbar. - EF

2009-01-16 Implement bbox_inches option for savefig. If bbox_inches is "tight", try to determine the tight bounding box. - JJL

2009-01-16 Fix bug in is_string_like so it doesn't raise an unnecessary exception. - EF

2009-01-16 Fix an infinite recursion in the unit registry when searching for a converter for a sequence of strings. Add a corresponding test. - RM

2009-01-16 Bugfix of C typedef of MPL_Int64 that was failing on Windows XP 64 bit, as reported by George Goussard on numpy mailing list. - ADS

2009-01-16 Added helper function LinearSegmentedColormap.from_list to facilitate building simple custom colomaps. See examples/pylab_examples/custom_cmap_fromlist.py - JDH

2009-01-16 Applied Michiel's patch for macosx backend to fix rounding bug. Closed sf bug 2508440 - JSW

2009-01-10 Applied Michiel's hatch patch for macosx backend and draw_idle patch for qt. Closes sf patched 2497785 and 2468809 - JDH

2009-01-10 Fix bug in pan/zoom with log coordinates. - EF

2009-01-06 Fix bug in setting of dashed negative contours. - EF

2009-01-06 Be fault tolerant when len(linestyles)>NLev in contour. - MM

2009-01-06 Added marginals kwarg to hexbin to plot marginal densities JDH

2009-01-06 Change user-visible multipage pdf object to PdfPages to avoid accidents with the file-like PdfFile. - JKS

2009-01-05 Fix a bug in pdf usetex: allow using non-embedded fonts. - JKS

2009-01-05 optional use of preview.sty in usetex mode. - JJL

2009-01-02 Allow multipage pdf files. - JKS

2008-12-31 Improve pdf usetex by adding support for font effects (slanting and extending). - JKS

2008-12-29 Fix a bug in pdf usetex support, which occurred if the same Type-1 font was used with different encodings, e.g., with Minion Pro and MnSymbol. - JKS

2008-12-20 fix the dpi-dependent offset of Shadow. - JJL

2008-12-20 fix the hatch bug in the pdf backend. minor update in docs and example - JJL

2008-12-19 Add axes_locator attribute in Axes. Two examples are added.

- JJL

2008-12-19 Update Axes.legend documnetation. /api/api_changes.rst is also updated to describe chages in keyword parameters. Issue a warning if old keyword parameters are used. - JJL

2008-12-18 add new arrow style, a line + filled triangles. -JJL

2008-12-18 Re-Released 0.98.5.2 from v0_98_5_maint at r6679 Released 0.98.5.2 from v0_98_5_maint at r6667

2008-12-18 Removed configobj, experimental traits and doc/mpl_data link - JDH

2008-12-18 Fix bug where a line with NULL data limits prevents subsequent data limits from calculating correctly - MGD

2008-12-17 Major documentation generator changes - MGD

2008-12-17 Applied macosx backend patch with support for path collections, quadmesh, etc... - JDH

2008-12-17 fix dpi-dependent behavior of text bbox and arrow in annotate -JJL

2008-12-17 Add group id support in artist. Two examples which demostrate svg filter are added. -JJL

2008-12-16 Another attempt to fix dpi-dependent behavior of Legend. -JJL

2008-12-16 Fixed dpi-dependent behavior of Legend and fancybox in Text.

2008-12-16 Added markevery property to Line2D to support subsampling of markers - JDH

2008-12-15 Removed mpl_data symlink in docs. On platforms that do not support symlinks, these become copies, and the font files are large, so the distro becomes unneccessarily bloaded. Keeping the mpl_examples dir because relative links are harder for the plot directive and the *.py files are not so large. - JDH

2008-12-15 Fix $ in non-math text with usetex off. Document differences between usetex on/off - MGD

2008-12-15 Fix anti-aliasing when auto-snapping - MGD

2008-12-15 Fix grid lines not moving correctly during pan and zoom - MGD

2008-12-12 Preparations to eliminate maskedarray rcParams key: its use will now generate a warning. Similarly, importing the obsolete numerix.npyma will generate a warning. - EF

2008-12-12 Added support for the numpy.histogram() weights parameter to the axes hist() method. Docs taken from numpy - MM

2008-12-12 Fixed warning in hist() with numpy 1.2 - MM

2008-12-12 Removed external packages: configobj and enthought.traits which are only required by the experimental traited config and are somewhat out of date. If needed, install them independently, see:

http://code.enthought.com/pages/traits.html

and:

http://www.voidspace.org.uk/python/configobj.html

2008-12-12 Added support to asign labels to histograms of multiple data. - MM

2008-12-11 Released 0.98.5 at svn r6573

2008-12-11 Use subprocess.Popen instead of os.popen in dviread (Windows problem reported by Jorgen Stenarson) - JKS

2008-12-10 Added Michael's font_manager fix and Jae-Joon's figure/subplot fix. Bumped version number to 0.98.5 - JDH

2008-12-09 Released 0.98.4 at svn r6536

2008-12-08 Added mdehoon's native macosx backend from sf patch 2179017 - JDH

2008-12-08 Removed the prints in the set_*style commands. Return the list of pprinted strings instead - JDH

2008-12-08 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, e.g., 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

2008-12-08 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

2008-12-08 Fixed alignment of ticks in colorbars. -MGD

2008-12-07 drop the deprecated "new" keyword of np.histogram() for numpy 1.2 or later. -JJL

2008-12-06 Fixed a bug in svg backend that new_figure_manager() ignores keywords arguments such as figsize, etc. -JJL

2008-12-05 Fixed a bug that the handlelength of the new legend class set too short when numpoints=1 -JJL

2008-12-04 Added support for data with units (e.g., dates) to Axes.fill_between. -RM

2008-12-04 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

2008-12-02 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

2008-12-02 Fixed a bug in the new legend class that didn't allowed a tuple of coordinate vlaues as loc. -JJL

2008-12-02 Improve checks for external dependencies, using subprocess (instead of deprecated popen*) and distutils (for version checking) - DSD

2008-11-30 Reimplementation of the legend which supports baseline alignement, multi-column, and expand mode. - JJL

2008-12-01 Fixed histogram autoscaling bug when bins or range are given explicitly (fixes Debian bug 503148) - MM

2008-11-25 Added rcParam axes.unicode_minus which allows plain hypen for minus when False - JDH

2008-11-25 Added scatterpoints support in Legend. patch by Erik Tollerud - JJL

2008-11-24 Fix crash in log ticking. - MGD

2008-11-20 Added static helper method BrokenHBarCollection.span_where and Axes/pyplot method fill_between. See examples/pylab/fill_between.py - JDH

2008-11-12 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

2008-11-11 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

2008-11-11 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

2008-11-10 Fix handling of c kwarg by scatter; generalize is_string_like to accept numpy and numpy.ma string array scalars. - RM and EF

2008-11-09 Fix a possible EINTR problem in dviread, which might help when saving pdf files from the qt backend. - JKS

2008-11-05 Fix bug with zoom to rectangle and twin axes - MGD

2008-10-24 Added Jae Joon's fancy arrow, box and annotation enhancements – see examples/pylab_examples/annotation_demo2.py

2008-10-23 Autoscaling is now supported with shared axes - EF

2008-10-23 Fixed exception in dviread that happened with Minion - JKS

2008-10-21 set_xlim, ylim now return a copy of the viewlim array to avoid modify inplace surprises

2008-10-20 Added image thumbnail generating function matplotlib.image.thumbnail. See examples/misc/image_thumbnail.py - JDH

2008-10-20 Applied scatleg patch based on ideas and work by Erik Tollerud and Jae-Joon Lee. - MM

2008-10-11 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

2008-10-08 Add path simplification support to paths with gaps. - EF

2008-10-05 Fix problem with AFM files that don't specify the font's full name or family name. - JKS

2008-10-04 Added 'scilimits' kwarg to Axes.ticklabel_format() method, for easy access to the set_powerlimits method of the major ScalarFormatter. - EF

2008-10-04 Experimental new kwarg borderpad to replace pad in legend, based on suggestion by Jae-Joon Lee. - EF

2008-09-27 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

2008-09-24 Introduce drawstyles for lines. Transparently split linestyles like 'steps–' into drawstyle 'steps' and linestyle '–'. Legends always use drawstyle 'default'. - MM

2008-09-18 Fixed quiver and quiverkey bugs (failure to scale properly when resizing) and added additional methods for determining the arrow angles - EF

2008-09-18 Fix polar interpolation to handle negative values of theta - MGD

2008-09-14 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

2008-09-11 Fix backtick in Postscript output. - MGD

2008-09-10 [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

2008-09-10 Add "filled" kwarg to Path.intersects_path and Path.intersects_bbox. - MGD

2008-09-07 Changed full arrows slightly to avoid an xpdf rendering problem reported by Friedrich Hagedorn. - JKS

2008-09-07 Fix conversion of quadratic to cubic Bezier curves in PDF and PS backends. Patch by Jae-Joon Lee. - JKS

2008-09-06 Added 5-point star marker to plot command - EF

2008-09-05 Fix hatching in PS backend - MGD

2008-09-03 Fix log with base 2 - MGD

2008-09-01 Added support for bilinear interpolation in NonUniformImage; patch by Gregory Lielens. - EF

2008-08-28 Added support for multiple histograms with data of different length - MM

2008-08-28 Fix step plots with log scale - MGD

2008-08-28 Fix masked arrays with markers in non-Agg backends - MGD

2008-08-28 Fix clip_on kwarg so it actually works correctly - MGD

2008-08-25 Fix locale problems in SVG backend - MGD

2008-08-22 fix quiver so masked values are not plotted - JSW

2008-08-18 improve interactive pan/zoom in qt4 backend on windows - DSD

2008-08-11 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

2008-08-03 Released 0.98.3 at svn r5947

2008-08-01 Backported memory leak fixes in _ttconv.cpp - MGD

2008-07-31 Added masked array support to griddata. - JSW

2008-07-26 Added optional C and reduce_C_function arguments to axes.hexbin(). This allows hexbin to accumulate the values of C based on the x,y coordinates and display in hexagonal bins. - ADS

2008-07-24 Deprecated (raise NotImplementedError) all the mlab2 functions from matplotlib.mlab out of concern that some of them were not clean room implementations. JDH

2008-07-24 Rewrite of a significant portion of the clabel code (class ContourLabeler) to improve inlining. - DMK

2008-07-22 Added Barbs polygon collection (similar to Quiver) for plotting wind barbs. Added corresponding helpers to Axes and pyplot as well. (examples/pylab_examples/barb_demo.py shows it off.) - RMM

2008-07-21 Added scikits.delaunay as matplotlib.delaunay. Added griddata function in matplotlib.mlab, with example (griddata_demo.py) in pylab_examples. griddata function will use mpl_toolkits._natgrid if installed. - JSW

2008-07-21 Re-introduced offset_copy that works in the context of the new transforms. - MGD

2008-07-21 Committed patch by Ryan May to add get_offsets and set_offsets to Collections base class - EF

2008-07-21 Changed the "asarray" strategy in image.py so that colormapping of masked input should work for all image types (thanks Klaus Zimmerman) - EF

2008-07-20 Rewrote cbook.delete_masked_points and corresponding unit test to support rgb color array inputs, datetime inputs, etc. - EF

2008-07-20 Renamed unit/axes_unit.py to cbook_unit.py and modified in accord with Ryan's move of delete_masked_points from axes to cbook. - EF

2008-07-18 Check for nan and inf in axes.delete_masked_points(). This should help hexbin and scatter deal with nans. - ADS

2008-07-17 Added ability to manually select contour label locations. Also added a waitforbuttonpress function. - DMK

2008-07-17 Fix bug with NaNs at end of path (thanks, Andrew Straw for the report) - MGD

2008-07-16 Improve error handling in texmanager, thanks to Ian Henry for reporting - DSD

2008-07-12 Added support for external backends with the "module://my_backend" syntax - JDH

2008-07-11 Fix memory leak related to shared axes. Grouper should store weak references. - MGD

2008-07-10 Bugfix: crash displaying fontconfig pattern - MGD

2008-07-10 Bugfix: [2013963] update_datalim_bounds in Axes not works - MGD

2008-07-10 Bugfix: [2014183] multiple imshow() causes gray edges - MGD

2008-07-09 Fix rectangular axes patch on polar plots bug - MGD

2008-07-09 Improve mathtext radical rendering - MGD

2008-07-08 Improve mathtext superscript placement - MGD

2008-07-07 Fix custom scales in pcolormesh (thanks Matthew Turk) - MGD

2008-07-03 Implemented findobj method for artist and pyplot - see examples/pylab_examples/findobj_demo.py - JDH

2008-06-30 Another attempt to fix TextWithDash - DSD

2008-06-30 Removed Qt4 NavigationToolbar2.destroy – it appears to have been unnecessary and caused a bug reported by P. Raybaut - DSD

2008-06-27 Fixed tick positioning bug - MM

2008-06-27 Fix dashed text bug where text was at the wrong end of the dash - MGD

2008-06-26 Fix mathtext bug for expressions like $x_{leftarrow}$ - MGD

2008-06-26 Fix direction of horizontal/vertical hatches - MGD

2008-06-25 Figure.figurePatch renamed Figure.patch, Axes.axesPatch renamed Axes.patch, Axes.axesFrame renamed Axes.frame, Axes.get_frame, which returns Axes.patch, is deprecated. Examples and users guide updated - JDH

2008-06-25 Fix rendering quality of pcolor - MGD

2008-06-24 Released 0.98.2 at svn r5667 - (source only for debian) JDH

2008-06-24 Added "transparent" kwarg to savefig. - MGD

2008-06-24 Applied Stefan's patch to draw a single centered marker over a line with numpoints==1 - JDH

2008-06-23 Use splines to render circles in scatter plots - MGD

2008-06-22 Released 0.98.1 at revision 5637

2008-06-22 Removed axes3d support and replaced it with a NotImplementedError for one release cycle

2008-06-21 fix marker placement bug in backend_ps - DSD

2008-06-20 [1978629] scale documentation missing/incorrect for log - MGD

2008-06-20 Added closed kwarg to PolyCollection. Fixes bug [1994535] still missing lines on graph with svn (r 5548). - MGD

2008-06-20 Added set/get_closed method to Polygon; fixes error in hist - MM

2008-06-19 Use relative font sizes (e.g., 'medium' and 'large') in rcsetup.py and matplotlibrc.template so that text will be scaled by default when changing rcParams['font.size'] - EF

2008-06-17 Add a generic PatchCollection class that can contain any kind of patch. - MGD

2008-06-13 Change pie chart label alignment to avoid having labels overwrite the pie - MGD

2008-06-12 Added some helper functions to the mathtext parser to return bitmap arrays or write pngs to make it easier to use mathtext outside the context of an mpl figure. modified the mathpng sphinxext to use the mathtext png save functionality - see examples/api/mathtext_asarray.py - JDH

2008-06-11 Use matplotlib.mathtext to render math expressions in online docs - MGD

2008-06-11 Move PNG loading/saving to its own extension module, and remove duplicate code in _backend_agg.cpp and _image.cpp that does the same thing - MGD

2008-06-11 Numerous mathtext bugfixes, primarily related to dpi-independence - MGD

2008-06-10 Bar now applies the label only to the first patch only, and sets '_nolegend_' for the other patch labels. This lets autolegend work as expected for hist and bar - see https://sourceforge.net/tracker/index.php?func=detail&aid=1986597&group_id=80706&atid=560720 JDH

2008-06-10 Fix text baseline alignment bug. [1985420] Repair of baseline alignment in Text._get_layout. Thanks Stan West - MGD

2008-06-09 Committed Gregor's image resample patch to downsampling images with new rcparam image.resample - JDH

2008-06-09 Don't install Enthought.Traits along with matplotlib. For matplotlib developers convenience, it can still be installed by setting an option in setup.cfg while we figure decide if there is a future for the traited config - DSD

2008-06-09 Added range keyword arg to hist() - MM

2008-06-07 Moved list of backends to rcsetup.py; made use of lower case for backend names consistent; use validate_backend when importing backends subpackage - EF

2008-06-06 hist() revision, applied ideas proposed by Erik Tollerud and Olle Engdegard: make histtype='step' unfilled by default and introduce histtype='stepfilled'; use default color cycle; introduce reverse cumulative histogram; new align keyword - MM

2008-06-06 Fix closed polygon patch and also provide the option to not close the polygon - MGD

2008-06-05 Fix some dpi-changing-related problems with PolyCollection, as called by Axes.scatter() - MGD

2008-06-05 Fix image drawing so there is no extra space to the right or bottom - MGD

2006-06-04 Added a figure title command suptitle as a Figure method and pyplot command – see examples/figure_title.py - JDH

2008-06-02 Added support for log to hist with histtype='step' and fixed a bug for log-scale stacked histograms - MM

2008-05-29 Released 0.98.0 at revision 5314

2008-05-29 matplotlib.image.imread now no longer always returns RGBA – 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.

2008-05-29 Implement path clipping in PS backend - JDH

2008-05-29 Fixed two bugs in texmanager.py: improved comparison of dvipng versions fixed a bug introduced when get_grey method was added - DSD

2008-05-28 Fix crashing of PDFs in xpdf and ghostscript when two-byte characters are used with Type 3 fonts - MGD

2008-05-28 Allow keyword args to configure widget properties as requested in http://sourceforge.net/tracker/index.php?func=detail&aid=1866207&group_id=80706&atid=560722 - JDH

2008-05-28 Replaced '-' with u'u2212' for minus sign as requested in http://sourceforge.net/tracker/index.php?func=detail&aid=1962574&group_id=80706&atid=560720

2008-05-28 zero width/height Rectangles no longer influence the autoscaler. Useful for log histograms with empty bins - JDH

2008-05-28 Fix rendering of composite glyphs in Type 3 conversion (particularly as evidenced in the Eunjin.ttf Korean font) Thanks Jae-Joon Lee for finding this!

2008-05-27 Rewrote the cm.ScalarMappable callback infrastructure to use cbook.CallbackRegistry rather than custom callback handling. Amy users of add_observer/notify of the cm.ScalarMappable should uae the cm.ScalarMappable.callbacksSM CallbackRegistry instead. JDH

2008-05-27 Fix TkAgg build on Ubuntu 8.04 (and hopefully a more general solution for other platforms, too.)

2008-05-24 Added PIL support for loading images to imread (if PIL is available) - JDH

2008-05-23 Provided a function and a method for controlling the plot color cycle. - EF

2008-05-23 Major revision of hist(). Can handle 2D arrays and create stacked histogram plots; keyword 'width' deprecated and rwidth (relative width) introduced; align='edge' changed to center of bin - MM

2008-05-22 Added support for ReST-based doumentation using Sphinx. Documents are located in doc/, and are broken up into a users guide and an API reference. To build, run the make.py files. Sphinx-0.4 is needed to build generate xml, which will be useful for rendering equations with mathml, use sphinx from svn until 0.4 is released - DSD

2008-05-21 Fix segfault in TkAgg backend - MGD

2008-05-21 Fix a "local variable unreferenced" bug in plotfile - MM

2008-05-19 Fix crash when Windows can not access the registry to determine font path [Bug 1966974, thanks Patrik Simons] - MGD

2008-05-16 removed some unneeded code w/ the python 2.4 requirement. cbook no longer provides compatibility for reversed, enumerate, set or izip. removed lib/subprocess, mpl1, sandbox/units, and the swig code. This stuff should remain on the maintenance branch for archival purposes. JDH

2008-05-16 Reorganized examples dir - JDH

2008-05-16 Added 'elinewidth' keyword arg to errorbar, based on patch by Christopher Brown - MM

2008-05-16 Added 'cumulative' keyword arg to hist to plot cumulative histograms. For normed hists, this is normalized to one - MM

2008-05-15 Fix Tk backend segfault on some machines - MGD

2008-05-14 Don't use stat on Windows (fixes font embedding problem) - MGD

2008-05-09 Fix /singlequote (') in Postscript backend - MGD

2008-05-08 Fix kerning in SVG when embedding character outlines - MGD

2008-05-07 Switched to future numpy histogram semantic in hist - MM

2008-05-06 Fix strange colors when blitting in QtAgg and Qt4Agg - MGD

2008-05-05 pass notify_axes_change to the figure's add_axobserver in the qt backends, like we do for the other backends. Thanks Glenn Jones for the report - DSD

2008-05-02 Added step histograms, based on patch by Erik Tollerud. - MM

2008-05-02 On PyQt <= 3.14 there is no way to determine the underlying Qt version. [1851364] - MGD

2008-05-02 Don't call sys.exit() when pyemf is not found [1924199] - MGD

2008-05-02 Update _subprocess.c from upstream Python 2.5.2 to get a few memory and reference-counting-related bugfixes. See bug 1949978. - MGD

2008-04-30 Added some record array editing widgets for gtk – see examples/rec_edit*.py - JDH

2008-04-29 Fix bug in mlab.sqrtm - MM

2008-04-28 Fix bug in SVG text with Mozilla-based viewers (the symbol tag is not supported) - MGD

2008-04-27 Applied patch by Michiel de Hoon to add hexbin axes method and pyplot function - EF

2008-04-25 Enforce python >= 2.4; remove subprocess build - EF

2008-04-25 Enforce the numpy requirement at build time - JDH

2008-04-24 Make numpy 1.1 and python 2.3 required when importing matplotlib - EF

2008-04-24 Fix compilation issues on VS2003 (Thanks Martin Spacek for all the help) - MGD

2008-04-24 Fix sub/superscripts when the size of the font has been changed - MGD

2008-04-22 Use "svg.embed_char_paths" consistently everywhere - MGD

2008-04-20 Add support to MaxNLocator for symmetric axis autoscaling. - EF

2008-04-20 Fix double-zoom bug. - MM

2008-04-15 Speed up color mapping. - EF

2008-04-12 Speed up zooming and panning of dense images. - EF

2008-04-11 Fix global font rcParam setting after initialization time. - MGD

2008-04-11 Revert commits 5002 and 5031, which were intended to avoid an unnecessary call to draw(). 5002 broke saving figures before show(). 5031 fixed the problem created in 5002, but broke interactive plotting. Unnecessary call to draw still needs resolution - DSD

2008-04-07 Improve color validation in rc handling, suggested by Lev Givon - EF

2008-04-02 Allow to use both linestyle definition arguments, '-' and 'solid' etc. in plots/collections - MM

2008-03-27 Fix saving to Unicode filenames with Agg backend (other backends appear to already work...) (Thanks, Christopher Barker) - MGD

2008-03-26 Fix SVG backend bug that prevents copying and pasting in Inkscape (thanks Kaushik Ghose) - MGD

2008-03-24 Removed an unnecessary call to draw() in the backend_qt* mouseReleaseEvent. Thanks to Ted Drain - DSD

2008-03-23 Fix a pdf backend bug which sometimes caused the outermost gsave to not be balanced with a grestore. - JKS

2008-03-20 Fixed a minor bug in ContourSet._process_linestyles when len(linestyles)==Nlev - MM

2008-03-19 Changed ma import statements to "from numpy import ma"; this should work with past and future versions of numpy, whereas "import numpy.ma as ma" will work only with numpy >= 1.05, and "import numerix.npyma as ma" is obsolete now that maskedarray is replacing the earlier implementation, as of numpy 1.05.

2008-03-14 Removed an apparently unnecessary call to FigureCanvasAgg.draw in backend_qt*agg. Thanks to Ted Drain - DSD

2008-03-10 Workaround a bug in backend_qt4agg's blitting due to a buffer width/bbox width mismatch in _backend_agg's copy_from_bbox - DSD

2008-02-29 Fix class Wx toolbar pan and zoom functions (Thanks Jeff Peery) - MGD

2008-02-16 Added some new rec array functionality to mlab (rec_summarize, rec2txt and rec_groupby). See examples/rec_groupby_demo.py. Thanks to Tim M for rec2txt.

2008-02-12 Applied Erik Tollerud's span selector patch - JDH

2008-02-11 Update plotting() doc string to refer to getp/setp. - JKS

2008-02-10 Fixed a problem with square roots in the pdf backend with usetex. - JKS

2008-02-08 Fixed minor __str__ bugs so getp(gca()) works. - JKS

2008-02-05 Added getters for title, xlabel, ylabel, as requested by Brandon Kieth - EF

2008-02-05 Applied Gael's ginput patch and created examples/ginput_demo.py - JDH

2008-02-03 Expose interpnames, a list of valid interpolation methods, as an AxesImage class attribute. - EF

2008-02-03 Added BoundaryNorm, with examples in colorbar_only.py and image_masked.py. - EF

2008-02-03 Force dpi=72 in pdf backend to fix picture size bug. - JKS

2008-02-01 Fix doubly-included font problem in Postscript backend - MGD

2008-02-01 Fix reference leak in ft2font Glyph objects. - MGD

2008-01-31 Don't use unicode strings with usetex by default - DSD

2008-01-31 Fix text spacing problems in PDF backend with *some* fonts, such as STIXGeneral.

2008-01-31 Fix sqrt with radical number (broken by making [and] work below) - MGD

2008-01-27 Applied Martin Teichmann's patch to improve the Qt4 backend. Uses Qt's builtin toolbars and statusbars. See bug 1828848 - DSD

2008-01-10 Moved toolkits to mpl_toolkits, made mpl_toolkits a namespace package - JSWHIT

2008-01-10 Use setup.cfg to set the default parameters (tkagg, numpy) when building windows installers - DSD

2008-01-10 Fix bug displaying [and] in mathtext - MGD

2008-01-10 Fix bug when displaying a tick value offset with scientific notation. (Manifests itself as a warning that the times symbol can not be found). - MGD

2008-01-10 Use setup.cfg to set the default parameters (tkagg, numpy) when building windows installers - DSD

2008-01-06 Released 0.91.2 at revision 4802

2007-12-26 Reduce too-late use of matplotlib.use() to a warning instead of an exception, for backwards compatibility - EF

2007-12-25 Fix bug in errorbar, identified by Noriko Minakawa - EF

2007-12-25 Changed masked array importing to work with the upcoming numpy 1.05 (now the maskedarray branch) as well as with earlier versions. - EF

2007-12-16 rec2csv saves doubles without losing precision. Also, it does not close filehandles passed in open. - JDH,ADS

2007-12-13 Moved rec2gtk to matplotlib.toolkits.gtktools and rec2excel to matplotlib.toolkits.exceltools - JDH

2007-12-12 Support alpha-blended text in the Agg and Svg backends - MGD

2007-12-10 Fix SVG text rendering bug. - MGD

2007-12-10 Increase accuracy of circle and ellipse drawing by using an 8-piece bezier approximation, rather than a 4-piece one. Fix PDF, SVG and Cairo backends so they can draw paths (meaning ellipses as well). - MGD

2007-12-07 Issue a warning when drawing an image on a non-linear axis. - MGD

2007-12-06 let widgets.Cursor initialize to the lower x and y bounds rather than 0,0, which can cause havoc for dates and other transforms - DSD

2007-12-06 updated references to mpl data directories for py2exe - DSD

2007-12-06 fixed a bug in rcsetup, see bug 1845057 - DSD

2007-12-05 Fix how fonts are cached to avoid loading the same one multiple times. (This was a regression since 0.90 caused by the refactoring of font_manager.py) - MGD

2007-12-05 Support arbitrary rotation of usetex text in Agg backend. - MGD

2007-12-04 Support '|' as a character in mathtext - MGD

2007-11-27 Released 0.91.1 at revision 4517

2007-11-27 Released 0.91.0 at revision 4478

2007-11-13 All backends now support writing to a file-like object, not just a regular file. savefig() can be passed a file-like object in place of a file path. - MGD

2007-11-13 Improved the default backend selection at build time: SVG -> Agg -> TkAgg -> WXAgg -> GTK -> GTKAgg. The last usable backend in this progression will be chosen in the default config file. If a backend is defined in setup.cfg, that will be the default backend - DSD

2007-11-13 Improved creation of default config files at build time for traited config package - DSD

2007-11-12 Exposed all the build options in setup.cfg. These options are read into a dict called "options" by setupext.py. Also, added "-mpl" tags to the version strings for packages provided by matplotlib. Versions provided by mpl will be identified and updated on subsequent installs - DSD

2007-11-12 Added support for STIX fonts. A new rcParam, mathtext.fontset, can be used to choose between:

'cm': The TeX/LaTeX Computer Modern fonts

'stix': The STIX fonts (see stixfonts.org)

'stixsans': The STIX fonts, using sans-serif glyphs by default

'custom': A generic Unicode font, in which case the mathtext font must be specified using mathtext.bf, mathtext.it, mathtext.sf etc.

Added a new example, stix_fonts_demo.py to show how to access different fonts and unusual symbols.

- MGD

2007-11-12 Options to disable building backend extension modules moved from setup.py to setup.cfg - DSD

2007-11-09 Applied Martin Teichmann's patch 1828813: a QPainter is used in paintEvent, which has to be destroyed using the method end(). If matplotlib raises an exception before the call to end - and it does if you feed it with bad data - this method end() is never called and Qt4 will start spitting error messages

2007-11-09 Moved pyparsing back into matplotlib namespace. Don't use system pyparsing, API is too variable from one release to the next - DSD

2007-11-08 Made pylab use straight numpy instead of oldnumeric by default - EF

2007-11-08 Added additional record array utilites to mlab (rec2excel, rec2gtk, rec_join, rec_append_field, rec_drop_field) - JDH

2007-11-08 Updated pytz to version 2007g - DSD

2007-11-08 Updated pyparsing to version 1.4.8 - DSD

2007-11-08 Moved csv2rec to recutils and added other record array utilities - JDH

2007-11-08 If available, use existing pyparsing installation - DSD

2007-11-07 Removed old enthought.traits from lib/matplotlib, added Gael Varoquaux's enthought.traits-2.6b1, which is stripped of setuptools. The package is installed to site-packages if not already available - DSD

2007-11-05 Added easy access to minor tick properties; slight mod of patch by Pierre G-M - EF

2007-11-02 Commited Phil Thompson's patch 1599876, fixes to Qt4Agg backend and qt4 blitting demo - DSD

2007-11-02 Commited Phil Thompson's patch 1599876, fixes to Qt4Agg backend and qt4 blitting demo - DSD

2007-10-31 Made log color scale easier to use with contourf; automatic level generation now works. - EF

2007-10-29 TRANSFORMS REFACTORING

The primary goal of this refactoring was to make it easier to extend matplotlib to support new kinds of projections. This is primarily an internal improvement, and the possible user-visible changes it allows are yet to come.

The transformation framework was completely rewritten in Python (with Numpy). This will make it easier to add news kinds of transformations without writing C/C++ code.

Transforms are composed into a 'transform tree', made of transforms whose value depends on other transforms (their children). When the contents of children change, their parents are automatically updated to reflect those changes. To do this an "invalidation" method is used: when children change, all of their ancestors are marked as "invalid". When the value of a transform is accessed at a later time, its value is recomputed only if it is invalid, otherwise a cached value may be used. This prevents unnecessary recomputations of transforms, and contributes to better interactive performance.

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 + affine

Much of the drawing has been refactored in terms of compound paths. Therefore, many methods have been removed from the backend interface and replaced with a a handful to draw compound paths. This will make updating the backends easier, since there is less to update. It also should make the backends more consistent in terms of functionality.

User visible changes:

- POLAR PLOTS: Polar plots are now interactively zoomable, and the r-axis labels can be interactively rotated. Straight line segments are now interpolated to follow the curve of the r-axis.
- Non-rectangular clipping works in more backends and with more types of objects.
- Sharing an axis across figures is now done in exactly the same way as sharing an axis between two axes in the same figure:

```
fig1 = figure()
fig2 = figure()

 ax1 = fig1.add_subplot(111)
 ax2 = fig2.add_subplot(111, sharex=ax1, sharey=ax1)
```

- linestyles now include steps-pre, steps-post and steps-mid. The old step still works and is equivalent to step-pre.
- Multiple line styles may be provided to a collection.

See API_CHANGES for more low-level information about this refactoring.

2007-10-24 Added ax kwarg to Figure.colorbar and pyplot.colorbar - EF

2007-10-19 Removed a gsave/grestore pair surrounding _draw_ps, which was causing a loss graphics state info (see "EPS output problem - scatter & edgecolors" on mpl-dev, 2007-10-29) - DSD

2007-10-15 Fixed a bug in patches.Ellipse that was broken for aspect='auto'. Scale free ellipses now work properly for equal and auto on Agg and PS, and they fall back on a polygonal approximation for nonlinear transformations until we convince oursleves that the spline approximation holds for nonlinear transformations. Added unit/ellipse_compare.py to compare spline with vertex approx for both aspects. JDH

2007-10-05 remove generator expressions from texmanager and mpltraits. generator expressions are not supported by python-2.3 - DSD

2007-10-01 Made matplotlib.use() raise an exception if called after backends has been imported. - EF

2007-09-30 Modified update* methods of Bbox and Interval so they work with reversed axes. Prior to this, trying to set the ticks on a reversed axis failed with an uninformative error message. - EF

2007-09-30 Applied patches to axes3d to fix index error problem - EF

2007-09-24 Applied Eike Welk's patch reported on mpl-dev on 2007-09-22 Fixes a bug with multiple plot windows in the qt backend, ported the changes to backend_qt4 as well - DSD

2007-09-21 Changed cbook.reversed to yield the same result as the python reversed builtin - DSD

2007-09-13 The usetex support in the pdf backend is more usable now, so I am enabling it. - JKS

2007-09-12 Fixed a Axes.bar unit bug - JDH

2007-09-10 Made skiprows=1 the default on csv2rec - JDH

2007-09-09 Split out the plotting part of pylab and put it in pyplot.py; removed numerix from the remaining pylab.py, which imports everything from pyplot.py. The intention is that apart from cleanups, the result of importing from pylab is nearly unchanged, but there is the new alternative of importing from pyplot to get the state-engine graphics without all the numeric functions. Numpified examples; deleted two that were obsolete; modified some to use pyplot. - EF

2007-09-08 Eliminated gd and paint backends - EF

2007-09-06 .bmp file format is now longer an alias for .raw

2007-09-07 Added clip path support to pdf backend. - JKS

2007-09-06 Fixed a bug in the embedding of Type 1 fonts in PDF. Now it doesn't crash Preview.app. - JKS

2007-09-06 Refactored image saving code so that all GUI backends can save most image types. See FILETYPES for a matrix of backends and their supported file types. Backend canvases should no longer write their own print_figure() method – instead they should write a print_xxx method for each filetype they can output and add an entry to their class-scoped filetypes dictionary. - MGD

2007-09-05 Fixed Qt version reporting in setupext.py - DSD

2007-09-04 Embedding Type 1 fonts in PDF, and thus usetex support via dviread, sort of works. To test, enable it by renaming _draw_tex to draw_tex. - JKS

2007-09-03 Added ability of errorbar show limits via caret or arrowhead ends on the bars; patch by Manual Metz. - EF

2007-09-03 Created type1font.py, added features to AFM and FT2Font (see API_CHANGES), started work on embedding Type 1 fonts in pdf files. - JKS

2007-09-02 Continued work on dviread.py. - JKS

2007-08-16 Added a set_extent method to AxesImage, allow data extent to be modified after initial call to imshow - DSD

2007-08-14 Fixed a bug in pyqt4 subplots-adjust. Thanks to Xavier Gnata for the report and suggested fix - DSD

2007-08-13 Use pickle to cache entire fontManager; change to using font_manager module-level function findfont wrapper for the fontManager.findfont method - EF

2007-08-11 Numpification and cleanup of mlab.py and some examples - EF

2007-08-06 Removed mathtext2

2007-07-31 Refactoring of distutils scripts.

- Will not fail on the entire build if an optional Python package (e.g., Tkinter) is installed but its development headers are not (e.g., tk-devel). Instead, it will continue to build all other extensions.
- Provide an overview at the top of the output to display what dependencies and their versions were found, and (by extension) what will be built.
- Use pkg-config, when available, to find freetype2, since this was broken on Mac OS-X when using MacPorts in a non- standard location.

2007-07-30 Reorganized configuration code to work with traited config objects. The new config system is located in the matplotlib.config package, but it is disabled by default. To enable it, set NEWCONFIG=True in matplotlib.__init__.py. The new configuration system will still use the old matplotlibrc files by default. To switch to the experimental, traited configuration, set USE_TRAITED_CONFIG=True in config.__init__.py.

2007-07-29 Changed default pcolor shading to flat; added aliases to make collection kwargs agree with setter names, so updating works; related minor cleanups. Removed quiver_classic, scatter_classic, pcolor_classic. - EF

2007-07-26 Major rewrite of mathtext.py, using the TeX box layout model.

There is one (known) backward incompatible change. The 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, e.g., $mathcal{R}$.

Other new features include:

- Math may be interspersed with non-math text. Any text with an even number of $'s (non-escaped) will be sent to the mathtext parser for layout.
- Sub/superscripts are less likely to accidentally overlap.
- Support for sub/superscripts in either order, e.g., x^i_j and x_j^i are equivalent.
- Double sub/superscripts (e.g., x_i_j) are considered ambiguous and raise an exception. Use braces to disambiguate.
- $frac{x}{y}$ can be used for displaying fractions.
- $sqrt[3]{x}$ can be used to display the radical symbol with a root number and body.

- $left(frac{x}{y}right)$ may be used to create parentheses and other delimiters that automatically resize to the height of their contents.
- Spacing around operators etc. is now generally more like TeX.
- Added support (and fonts) for boldface (bf) and sans-serif (sf) symbols.
- Log-like function name shortcuts are supported. For example, $sin(x)$ may be used instead of ${rm sin}(x)$
- Limited use of kerning for the easy case (same font)

Behind the scenes, the pyparsing.py module used for doing the math parsing was updated to the latest stable version (1.4.6). A lot of duplicate code was refactored out of the Font classes.

- MGD

2007-07-19 completed numpification of most trivial cases - NN

2007-07-19 converted non-numpy relicts throughout the code - NN

2007-07-19 replaced the Python code in numerix/ by a minimal wrapper around numpy that explicitly mentions all symbols that need to be addressed for further numpification - NN

2007-07-18 make usetex respect changes to rcParams. texmanager used to only configure itself when it was created, now it reconfigures when rcParams are changed. Thank you Alexander Schmolck for contributing a patch - DSD

2007-07-17 added validation to setting and changing rcParams - DSD

2007-07-17 bugfix segfault in transforms module. Thanks Ben North for the patch. - ADS

2007-07-16 clean up some code in ticker.ScalarFormatter, use unicode to render multiplication sign in offset ticklabel - DSD

2007-07-16 fixed a formatting bug in ticker.ScalarFormatter's scientific notation (10^0 was being rendered as 10 in some cases) - DSD

2007-07-13 Add MPL_isfinite64() and MPL_isinf64() for testing doubles in (the now misnamed) MPL_isnan.h. - ADS

2007-07-13 The matplotlib._isnan module removed (use numpy.isnan) - ADS

2007-07-13 Some minor cleanups in _transforms.cpp - ADS

2007-07-13 Removed the rest of the numerix extension code detritus, numpified axes.py, and cleaned up the imports in axes.py - JDH

2007-07-13 Added legend.loc as configurable option that could in future default to 'best'. - NN

2007-07-12 Bugfixes in mlab.py to coerce inputs into numpy arrays. -ADS

2007-07-11 Added linespacing kwarg to text.Text - EF

2007-07-11 Added code to store font paths in SVG files. - MGD

2007-07-10 Store subset of TTF font as a Type 3 font in PDF files. - MGD

2007-07-09 Store subset of TTF font as a Type 3 font in PS files. - MGD

2007-07-09 Applied Paul's pick restructure pick and add pickers, sourceforge patch 1749829 - JDH

2007-07-09 Applied Allan's draw_lines agg optimization. JDH

2007-07-08 Applied Carl Worth's patch to fix cairo draw_arc - SC

2007-07-07 fixed bug 1712099: xpdf distiller on windows - DSD

2007-06-30 Applied patches to tkagg, gtk, and wx backends to reduce memory leakage. Patches supplied by Mike Droettboom; see tracker numbers 1745400, 1745406, 1745408. Also made unit/memleak_gui.py more flexible with command-line options. - EF

2007-06-30 Split defaultParams into separate file rcdefaults (together with validation code). Some heavy refactoring was necessary to do so, but the overall behavior should be the same as before. - NN

2007-06-27 Added MPLCONFIGDIR for the default location for mpl data and configuration. useful for some apache installs where HOME is not writable. Tried to clean up the logic in _get_config_dir to support non-writable HOME where are writable HOME/.matplotlib already exists - JDH

2007-06-27 Fixed locale bug reported at http://sourceforge.net/tracker/index.php?func=detail&aid=1744154&group_id=80706&atid=560720 by adding a cbook.unicode_safe function - JDH

2007-06-27 Applied Micheal's tk savefig bugfix described at http://sourceforge.net/tracker/index.php?func=detail&aid=1716732&group_id=80706&atid=560720 Thanks Michael!

2007-06-27 Patch for get_py2exe_datafiles() to work with new directory layout. (Thanks Tocer and also Werner Bruhin.) -ADS

2007-06-27 Added a scroll event to the mpl event handling system and implemented it for backends GTK* – other backend users/developers/maintainers, please add support for your backend. - JDH

2007-06-25 Changed default to clip=False in colors.Normalize; modified ColorbarBase for easier colormap display - EF

2007-06-13 Added maskedarray option to rc, numerix - EF

2007-06-11 Python 2.5 compatibility fix for mlab.py - EF

2007-06-10 In matplotlibrc file, use 'dashed' | 'solid' instead of a pair of floats for contour.negative_linestyle - EF

2007-06-08 Allow plot and fill fmt string to be any mpl string colorspec - EF

2007-06-08 Added gnuplot file plotfile function to pylab – see examples/plotfile_demo.py - JDH

2007-06-07 Disable build of numarray and Numeric extensions for internal MPL use and the numerix layer. - ADS

2007-06-07 Added csv2rec to matplotlib.mlab to support automatically converting csv files to record arrays using type introspection, and turned on native datetime support using the new units support in matplotlib.dates. See examples/loadrec.py ! JDH

2007-06-07 Simplified internal code of _auto_legend_data - NN

2007-06-04 Added labeldistance arg to Axes.pie to control the raidal distance of the wedge labels - JDH

2007-06-03 Turned mathtext in SVG into single <text> with multiple <tspan> objects (easier to edit in inkscape). - NN

2007-06-02 Released 0.90.1 at revision 3352

2007-06-02 Display only meaningful labels when calling legend() without args. - NN

2007-06-02 Have errorbar follow the color cycle even if line is not plotted. Suppress plotting of errorbar caps for capsize=0. - NN

2007-06-02 Set markers to same alpha value as line. - NN

2007-06-02 Fix mathtext position in svg backend. - NN

2007-06-01 Deprecate Numeric and numarray for use as numerix. Props to Travis – job well done. - ADS

2007-05-18 Added LaTeX unicode support. Enable with the 'text.latex.unicode' rcParam. This requires the ucs and inputenc LaTeX packages. - ADS

2007-04-23 Fixed some problems with polar – added general polygon clipping to clip the lines a nd grids to the polar axes. Added support for set_rmax to easily change the maximum radial grid. Added support for polar legend - JDH

2007-04-16 Added Figure.autofmt_xdate to handle adjusting the bottom and rotating the tick labels for date plots when the ticks often overlap - JDH

2007-04-09 Beginnings of usetex support for pdf backend. -JKS

2007-04-07 Fixed legend/LineCollection bug. Added label support to collections. - EF

2007-04-06 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. - EF

2007-04-06 Fixed rotation of ellipses in pdf backend (sf bug #1690559) -JKS

2007-04-04 More matshow tweaks; documentation updates; new method set_bounds() for formatters and locators. - EF

2007-04-02 Fixed problem with imshow and matshow of integer arrays; fixed problems with changes to color autoscaling. - EF

2007-04-01 Made image color autoscaling work correctly with a tracking colorbar; norm.autoscale now scales unconditionally, while norm.autoscale_None changes only None-valued vmin, vmax. - EF

2007-03-31 Added a qt-based subplot-adjustment dialog - DSD

2007-03-30 Fixed a bug in backend_qt4, reported on mpl-dev - DSD

2007-03-26 Removed colorbar_classic from figure.py; fixed bug in Figure.clf() in which _axobservers was not getting cleared. Modernization and cleanups. - EF

2007-03-26 Refactored some of the units support – units now live in the respective x and y Axis instances. See also API_CHANGES for some alterations to the conversion interface. JDH

2007-03-25 Fix masked array handling in quiver.py for numpy. (Numeric and numarray support for masked arrays is broken in other ways when using quiver. I didn't pursue that.) - ADS

2007-03-23 Made font_manager.py close opened files. - JKS

2007-03-22 Made imshow default extent match matshow - EF

2007-03-22 Some more niceties for xcorr – a maxlags option, normed now works for xcorr as well as axorr, usevlines is supported, and a zero correlation hline is added. See examples/xcorr_demo.py. Thanks Sameer for the patch. - JDH

2007-03-21 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. Modified Axes.errorbar which uses vlines and hlines. See API_CHANGES; the return signature for these three functions is now different

2007-03-20 Refactored units support and added new examples - JDH

2007-03-19 Added Mike's units patch - JDH

2007-03-18 Matshow as an Axes method; test version matshow1() in pylab; added 'integer' Boolean kwarg to MaxNLocator initializer to force ticks at integer locations. - EF

2007-03-17 Preliminary support for clipping to paths agg - JDH

2007-03-17 Text.set_text() accepts anything convertible with '%s' - EF

2007-03-14 Add masked-array support to hist. - EF

2007-03-03 Change barh to take a kwargs dict and pass it to bar. Fixes sf bug #1669506.

2007-03-02 Add rc parameter pdf.inheritcolor, which disables all color-setting operations in the pdf backend. The idea is that you include the resulting file in another program and set the colors (both stroke and fill color) there, so you can use the same pdf file for e.g., a paper and a presentation and have them in the surrounding color. You will probably not want to draw figure and axis frames in that case, since they would be filled in the same color. - JKS

2007-02-26 Prevent building _wxagg.so with broken Mac OS X wxPython. - ADS

2007-02-23 Require setuptools for Python 2.3 - ADS

2007-02-22 WXAgg accelerator updates - KM WXAgg's C++ accelerator has been fixed to use the correct wxBitmap constructor.

The backend has been updated to use new wxPython functionality to provide fast blit() animation without the C++ accelerator. This requires wxPython 2.8 or later. Previous versions of wxPython can use the C++ acclerator or the old pure Python routines.

setup.py no longer builds the C++ accelerator when wxPython >= 2.8 is present.

The blit() method is now faster regardless of which agg/wxPython conversion routines are used.

2007-02-21 Applied the PDF backend patch by Nicolas Grilly. This impacts several files and directories in matplotlib:

- Created the directory lib/matplotlib/mpl-data/fonts/pdfcorefonts, holding AFM files for the 14 PDF core fonts. These fonts are embedded in every PDF viewing application.

- setup.py: Added the directory pdfcorefonts to package_data.
- lib/matplotlib/__init__.py: Added the default parameter 'pdf.use14corefonts'. When True, the PDF backend uses only the 14 PDF core fonts.
- lib/matplotlib/afm.py: Added some keywords found in recent AFM files. Added a little workaround to handle Euro symbol.
- lib/matplotlib/fontmanager.py: Added support for the 14 PDF core fonts. These fonts have a dedicated cache (file pdfcorefont.cache), not the same as for other AFM files (file .afm-font.cache). Also cleaned comments to conform to CODING_GUIDE.
- lib/matplotlib/backends/backend_pdf.py: Added support for 14 PDF core fonts. Fixed some issues with incorrect character widths and encodings (works only for the most common encoding, WinAnsiEncoding, defined by the official PDF Reference). Removed parameter 'dpi' because it causes alignment issues.

-JKS (patch by Nicolas Grilly)

2007-02-17 Changed ft2font.get_charmap, and updated all the files where get_charmap is mentioned - ES

2007-02-13 Added barcode demo- JDH

2007-02-13 Added binary colormap to cm - JDH

2007-02-13 Added twiny to pylab - JDH

2007-02-12 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 - ADS

2007-02-07 Committed Rob Hetland's patch for qt4: remove references to text()/latin1(), plus some improvements to the toolbar layout - DSD

2007-02-06 Released 0.90.0 at revision 3003

2007-01-22 Extended the new picker API to text, patches and patch collections. Added support for user customizable pick hit testing and attribute tagging of the PickEvent - Details and examples in examples/pick_event_demo.py - JDH

2007-01-16 Begun work on a new pick API using the mpl event handling frameowrk. Artists will define their own pick method with a configurable epsilon tolerance and return pick attrs. All artists that meet the tolerance threshold will fire a PickEvent with artist dependent attrs; e.g., a Line2D can set the indices attribute that shows the indices into the line that are within epsilon of the pick point. See examples/pick_event_demo.py. The implementation of pick for the remaining Artists remains to be done, but the core infrastructure at the level of event handling is in place with a proof-of-concept implementation for Line2D - JDH

2007-01-16 src/_image.cpp: update to use Py_ssize_t (for 64-bit systems). Use return value of fread() to prevent warning messages - SC.

2007-01-15 src/_image.cpp: combine buffer_argb32() and buffer_bgra32() into a new method color_conv(format) - SC

2007-01-14 backend_cairo.py: update draw_arc() so that examples/arctest.py looks correct - SC

2007-01-12 backend_cairo.py: enable clipping. Update draw_image() so that examples/contour_demo.py looks correct - SC

2007-01-12 backend_cairo.py: fix draw_image() so that examples/image_demo.py now looks correct - SC

2007-01-11 Added Axes.xcorr and Axes.acorr to plot the cross correlation of x vs y or the autocorrelation of x. pylab wrappers also provided. See examples/xcorr_demo.py - JDH

2007-01-10 Added "Subplot.label_outer" method. It will set the visibility of the ticklabels so that yticklabels are only visible in the first column and xticklabels are only visible in the last row - JDH

2007-01-02 Added additional kwarg documentation - JDH

2006-12-28 Improved error message for nonpositive input to log transform; added log kwarg to bar, barh, and hist, and modified bar method to behave sensibly by default when the ordinate has a log scale. (This only works if the log scale is set before or by the call to bar, hence the utility of the log kwarg.) - EF

2006-12-27 backend_cairo.py: update draw_image() and _draw_mathtext() to work with numpy - SC

2006-12-20 Fixed xpdf dependency check, which was failing on windows. Removed ps2eps dependency check. - DSD

2006-12-19 Added Tim Leslie's spectral patch - JDH

2006-12-17 Added rc param 'axes.formatter.limits' to control the default threshold for switching to scientific notation. Added convenience method Axes.ticklabel_format() for turning scientific notation on or off on either or both axes. - EF

2006-12-16 Added ability to turn control scientific notation in ScalarFormatter - EF

2006-12-16 Enhanced boxplot to handle more flexible inputs - EF

2006-12-13 Replaced calls to where() in colors.py with much faster clip() and putmask() calls; removed inappropriate uses of getmaskorNone (which should be needed only very rarely); all in response to profiling by David Cournapeau. Also fixed bugs in my 2-D array support from 12-09. - EF

2006-12-09 Replaced spy and spy2 with the new spy that combines marker and image capabilities - EF

2006-12-09 Added support for plotting 2-D arrays with plot: columns are plotted as in Matlab - EF

2006-12-09 Added linewidth kwarg to bar and barh; fixed arg checking bugs - EF

2006-12-07 Made pcolormesh argument handling match pcolor; fixed kwarg handling problem noted by Pierre GM - EF

2006-12-06 Made pcolor support vector X and/or Y instead of requiring 2-D arrays - EF

2006-12-05 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 - JDH

2006-12-03 Added LogNorm to colors.py as illustrated by examples/pcolor_log.py, based on suggestion by Jim McDonald. Colorbar modified to handle LogNorm. Norms have additional "inverse" method. - EF

2006-12-02 Changed class names in colors.py to match convention: normalize -> Normalize, no_norm -> NoNorm. Old names are still available. Changed __init__.py rc defaults to match those in matplotlibrc - EF

2006-11-22 Fixed bug in set_*lim that I had introduced on 11-15 - EF

2006-11-22 Added examples/clippedline.py, which shows how to clip line data based on view limits – it also changes the marker style when zoomed in - JDH

2006-11-21 Some spy bug-fixes and added precision arg per Robert C's suggestion - JDH

2006-11-19 Added semi-automatic docstring generation detailing all the kwargs that functions take using the artist introspection tools; e.g., 'help text now details the scatter kwargs that control the Text properties - JDH

2006-11-17 Removed obsolete scatter_classic, leaving a stub to raise NotImplementedError; same for pcolor_classic - EF

2006-11-15 Removed obsolete pcolor_classic - EF

2006-11-15 Fixed 1588908 reported by Russel Owen; factored nonsingular method out of ticker.py, put it into transforms.py as a function, and used it in set_xlim and set_ylim. - EF

2006-11-14 Applied patch 1591716 by Ulf Larssen to fix a bug in apply_aspect. Modified and applied patch 1594894 by mdehoon to fix bugs and improve formatting in lines.py. Applied patch 1573008 by Greg Willden to make psd etc. plot full frequency range for complex inputs. - EF

2006-11-14 Improved the ability of the colorbar to track changes in corresponding image, pcolor, or contourf. - EF

2006-11-11 Fixed bug that broke Numeric compatibility; added support for alpha to colorbar. The alpha information is taken from the mappable object, not specified as a kwarg. - EF

2006-11-05 Added broken_barh function for makring a sequence of horizontal bars broken by gaps – see examples/broken_barh.py

2006-11-05 Removed lineprops and markerprops from the Annotation code and replaced them with an arrow configurable with kwarg arrowprops. See examples/annotation_demo.py - JDH

2006-11-02 Fixed a pylab subplot bug that was causing axes to be deleted with hspace or wspace equals zero in subplots_adjust - JDH

2006-10-31 Applied axes3d patch 1587359 http://sourceforge.net/tracker/index.php?func=detail&aid=1587359&group_id=80706&atid=560722 JDH

2006-10-26 Released 0.87.7 at revision 2835

2006-10-25 Made "tiny" kwarg in Locator.nonsingular much smaller - EF

2006-10-17 Closed sf bug 1562496 update line props dash/solid/cap/join styles - JDH

2006-10-17 Complete overhaul of the annotations API and example code - See matplotlib.text.Annotation and examples/annotation_demo.py JDH

2006-10-12 Committed Manuel Metz's StarPolygon code and examples/scatter_star_poly.py - JDH

2006-10-11 commented out all default values in matplotlibrc.template Default values should generally be taken from defaultParam in __init__.py - the file matplotlib should only contain those values that the user wants to explicitly change from the default. (see thread "marker color handling" on matplotlib-devel)

2006-10-10 Changed default comment character for load to '#' - JDH

2006-10-10 deactivated rcfile-configurability of markerfacecolor and markeredgecolor. Both are now hardcoded to the special value 'auto' to follow the line color. Configurability at run-time (using function arguments) remains functional. - NN

2006-10-07 introduced dummy argument magnification=1.0 to FigImage.make_image to satisfy unit test figimage_demo.py The argument is not yet handled correctly, which should only show up when using non-standard DPI settings in PS backend, introduced by patch #1562394. - NN

2006-10-06 add backend-agnostic example: simple3d.py - NN

2006-09-29 fix line-breaking for SVG-inline images (purely cosmetic) - NN

2006-09-29 reworked set_linestyle and set_marker markeredgecolor and markerfacecolor now default to a special value "auto" that keeps the color in sync with the line color further, the intelligence of axes.plot is cleaned up, improved and simplified. Complete compatibility cannot be guaranteed, but the new behavior should be much more predictable (see patch #1104615 for details) - NN

2006-09-29 changed implementation of clip-path in SVG to work around a limitation in inkscape - NN

2006-09-29 added two options to matplotlibrc: svg.image_inline svg.image_noscale see patch #1533010 for details - NN

2006-09-29 axes.py: cleaned up kwargs checking - NN

2006-09-29 setup.py: cleaned up setup logic - NN

2006-09-29 setup.py: check for required pygtk versions, fixes bug #1460783 - SC

2006-09-27 Released 0.87.6 at revision 2783

2006-09-24 Added line pointers to the Annotation code, and a pylab interface. See matplotlib.text.Annotation, examples/annotation_demo.py and examples/annotation_demo_pylab.py - JDH

2006-09-18 mathtext2.py: The SVG backend now supports the same things that the AGG backend does. Fixed some bugs with rendering, and out of bounds errors in the AGG backend - ES. Changed the return values of math_parse_s_ft2font_svg to support lines (fractions etc.)

2006-09-17 Added an Annotation class to facilitate annotating objects and an examples file examples/annotation_demo.py. I want to add dash support as in TextWithDash, but haven't decided yet whether inheriting from TextWithDash is the right base class or if another approach is needed - JDH

2006-09-05 Released 0.87.5 at revision 2761

2006-09-04 Added nxutils for some numeric add-on extension code – specifically a better/more efficient inside polygon tester (see unit/inside_poly_*.py) - JDH

2006-09-04 Made bitstream fonts the rc default - JDH

2006-08-31 Fixed alpha-handling bug in ColorConverter, affecting collections in general and contour/contourf in particular. - EF

2006-08-30 ft2font.cpp: Added draw_rect_filled method (now used by mathtext2 to draw the fraction bar) to FT2Font - ES

2006-08-29 setupext.py: wrap calls to tk.getvar() with str(). On some systems, getvar returns a Tcl_Obj instead of a string - DSD

2006-08-28 mathtext2.py: Sub/superscripts can now be complex (i.e. fractions etc.). The demo is also updated - ES

2006-08-28 font_manager.py: Added /usr/local/share/fonts to list of X11 font directories - DSD

2006-08-28 mahtext2.py: Initial support for complex fractions. Also, rendering is now completely separated from parsing. The sub/superscripts now work better. Updated the mathtext2_demo.py - ES

2006-08-27 qt backends: don't create a QApplication when backend is imported, do it when the FigureCanvasQt is created. Simplifies applications where mpl is embedded in qt. Updated embedding_in_qt* examples - DSD

2006-08-27 mahtext2.py: Now the fonts are searched in the OS font dir and in the mpl-data dir. Also env is not a dict anymore. - ES

2006-08-26 minor changes to __init__.py, mathtex2_demo.py. Added matplotlibrc key "mathtext.mathtext2" (removed the key "mathtext2") - ES

2006-08-21 mathtext2.py: Initial support for fractions Updated the mathtext2_demo.py _mathtext_data.py: removed "" from the unicode dicts mathtext.py: Minor modification (because of _mathtext_data.py)- ES

2006-08-20 Added mathtext2.py: Replacement for mathtext.py. Supports _ ^, rm, cal etc., sin, cos etc., unicode, recursive nestings, inline math mode. The only backend currently supported is Agg __init__.py: added new rc params for mathtext2 added mathtext2_demo.py example - ES

2006-08-19 Added embedding_in_qt4.py example - DSD

2006-08-11 Added scale free Ellipse patch for Agg - CM

2006-08-10 Added converters to and from julian dates to matplotlib.dates (num2julian and julian2num) - JDH

2006-08-08 Fixed widget locking so multiple widgets could share the event handling - JDH

2006-08-07 Added scale free Ellipse patch to SVG and PS - CM

2006-08-05 Re-organized imports in numerix for numpy 1.0b2 – TEO

2006-08-04 Added draw_markers to PDF backend. - JKS

2006-08-01 Fixed a bug in postscript's rendering of dashed lines - DSD

2006-08-01 figure.py: savefig() update docstring to add support for 'format' argument. backend_cairo.py: print_figure() add support 'format' argument. - SC

2006-07-31 Don't let postscript's xpdf distiller compress images - DSD

2006-07-31 Added shallowcopy() methods to all Transformations; removed copy_bbox_transform and copy_bbox_transform_shallow from transforms.py; added offset_copy() function to transforms.py to facilitate positioning artists with offsets. See examples/transoffset.py. - EF

2006-07-31 Don't let postscript's xpdf distiller compress images - DSD

2006-07-29 Fixed numerix polygon bug reported by Nick Fotopoulos. Added inverse_numerix_xy() transform method. Made autoscale_view() preserve axis direction (e.g., increasing down).- EF

2006-07-28 Added shallow bbox copy routine for transforms – mainly useful for copying transforms to apply offset to. - JDH

2006-07-28 Added resize method to FigureManager class for Qt and Gtk backend - CM

2006-07-28 Added subplots_adjust button to Qt backend - CM

2006-07-26 Use numerix more in collections. Quiver now handles masked arrays. - EF

2006-07-22 Fixed bug #1209354 - DSD

2006-07-22 make scatter() work with the kwarg "color". Closes bug 1285750 - DSD

2006-07-20 backend_cairo.py: require pycairo 1.2.0. print_figure() update to output SVG using cairo.

2006-07-19 Added blitting for Qt4Agg - CM

2006-07-19 Added lasso widget and example examples/lasso_demo.py - JDH

2006-07-18 Added blitting for QtAgg backend - CM

2006-07-17 Fixed bug #1523585: skip nans in semilog plots - DSD

2006-07-12 Add support to render the scientific notation label over the right-side y-axis - DSD

2006-07-11 Released 0.87.4 at revision 2558

2006-07-07 Fixed a usetex bug with older versions of latex - DSD

2006-07-07 Add compatibility for NumPy 1.0 - TEO

2006-06-29 Added a Qt4Agg backend. Thank you James Amundson - DSD

2006-06-26 Fixed a usetex bug. On windows, usetex will prcess postscript output in the current directory rather than in a temp directory. This is due to the use of spaces and tildes in windows paths, which cause problems with latex. The subprocess module is no longer used. - DSD

2006-06-22 Various changes to bar(), barh(), and hist(). Added 'edgecolor' keyword arg to bar() and barh(). The x and y args in barh() have been renamed to width and bottom respectively, and their order has been swapped to maintain a (position, value) order ala matlab. left, height, width and bottom args can now all be scalars or sequences. barh() now defaults to edge alignment instead of center alignment. Added a keyword arg 'align' to bar(), barh() and hist() that controls between edge or center bar alignment. Fixed ignoring the rcParams['patch.facecolor'] for bar color in bar() and barh(). Fixed ignoring the rcParams['lines.color'] for error bar color in bar() and barh(). Fixed a bug where patches would be cleared when error bars were plotted if rcParams['axes.hold'] was False. - MAS

2006-06-22 Added support for numerix 2-D arrays as alternatives to a sequence of (x,y) tuples for specifying paths in collections, quiver, contour, pcolor, transforms. Fixed contour bug involving setting limits for color mapping. Added numpy-style all() to numerix. - EF

2006-06-20 Added custom FigureClass hook to pylab interface - see examples/custom_figure_class.py

2006-06-16 Added colormaps from gist (gist_earth, gist_stern, gist_rainbow, gist_gray, gist_yarg, gist_heat, gist_ncar) - JW

2006-06-16 Added a pointer to parent in figure canvas so you can access the container with fig.canvas.manager. Useful if you want to set the window title, e.g., in gtk fig.canvas.manager.window.set_title, though a GUI neutral method would be preferable JDH

2006-06-16 Fixed colorbar.py to handle indexed colors (i.e., norm = no_norm()) by centering each colored region on its index. - EF

2006-06-15 Added scalex and scaley to Axes.autoscale_view to support selective autoscaling just the x or y axis, and supported these command in plot so you can say plot(something, scaley=False) and just the x axis will be autoscaled. Modified axvline and axhline to support this, so for example axvline will no longer autoscale the y axis. JDH

2006-06-13 Fix so numpy updates are backward compatible - TEO

2006-06-12 Updated numerix to handle numpy restructuring of oldnumeric - TEO

2006-06-12 Updated numerix.fft to handle numpy restructuring Added ImportError to numerix.linear_algebra for numpy -TEO

2006-06-11 Added quiverkey command to pylab and Axes, using QuiverKey class in quiver.py. Changed pylab and Axes to use quiver2 if possible, but drop back to the newly-renamed quiver_classic if necessary. Modified examples/quiver_demo.py to illustrate the new quiver and quiverkey. Changed LineCollection implementation slightly to improve compatibility with PolyCollection. - EF

2006-06-11 Fixed a usetex bug for windows, running latex on files with spaces in their names or paths was failing - DSD

2006-06-09 Made additions to numerix, changes to quiver to make it work with all numeric flavors. - EF

2006-06-09 Added quiver2 function to pylab and method to axes, with implementation via a Quiver class in quiver.py. quiver2 will replace quiver before the next release; it is placed alongside it initially to facilitate testing and transition. See also examples/quiver2_demo.py. - EF

2006-06-08 Minor bug fix to make ticker.py draw proper minus signs with usetex - DSD

2006-06-06 Released 0.87.3 at revision 2432

2006-05-30 More partial support for polygons with outline or fill, but not both. Made LineCollection inherit from ScalarMappable. - EF

2006-05-29 Yet another revision of aspect-ratio handling. - EF

2006-05-27 Committed a patch to prevent stroking zero-width lines in the svg backend - DSD

2006-05-24 Fixed colorbar positioning bug identified by Helge Avlesen, and improved the algorithm; added a 'pad' kwarg to control the spacing between colorbar and parent axes. - EF

2006-05-23 Changed color handling so that collection initializers can take any mpl color arg or sequence of args; deprecated float as grayscale, replaced by string representation of float. - EF

2006-05-19 Fixed bug: plot failed if all points were masked - EF

2006-05-19 Added custom symbol option to scatter - JDH

2006-05-18 New example, multi_image.py; colorbar fixed to show offset text when the ScalarFormatter is used; FixedFormatter augmented to accept and display offset text. - EF

2006-05-14 New colorbar; old one is renamed to colorbar_classic. New colorbar code is in colorbar.py, with wrappers in figure.py and pylab.py. Fixed aspect-handling bug reported by Michael Mossey. Made backend_bases.draw_quad_mesh() run.- EF

2006-05-08 Changed handling of end ranges in contourf: replaced "clip-ends" kwarg with "extend". See docstring for details. -EF

2006-05-08 Added axisbelow to rc - JDH

2006-05-08 If using PyGTK require version 2.2+ - SC

2006-04-19 Added compression support to PDF backend, controlled by new pdf.compression rc setting. - JKS

2006-04-19 Added Jouni's PDF backend

2006-04-18 Fixed a bug that caused agg to not render long lines

2006-04-16 Masked array support for pcolormesh; made pcolormesh support the same combinations of X,Y,C dimensions as pcolor does; improved (I hope) description of grid used in pcolor, pcolormesh. - EF

2006-04-14 Reorganized axes.py - EF

2006-04-13 Fixed a bug Ryan found using usetex with sans-serif fonts and exponential tick labels - DSD

2006-04-11 Refactored backend_ps and backend_agg to prevent module-level texmanager imports. Now these imports only occur if text.usetex rc setting is true - DSD

2006-04-10 Committed changes required for building mpl on win32 platforms with visual studio. This allows wxpython blitting for fast animations. - CM

2006-04-10 Fixed an off-by-one bug in Axes.change_geometry.

2006-04-10 Fixed bug in pie charts where wedge wouldn't have label in legend. Submitted by Simon Hildebrandt. - ADS

2006-05-06 Usetex makes temporary latex and dvi files in a temporary directory, rather than in the user's current working directory - DSD

2006-04-05 Apllied Ken's wx deprecation warning patch closing sf patch #1465371 - JDH

2006-04-05 Added support for the new API in the postscript backend. Allows values to be masked using nan's, and faster file creation - DSD

2006-04-05 Use python's subprocess module for usetex calls to external programs. subprocess catches when they exit abnormally so an error can be raised. - DSD

2006-04-03 Fixed the bug in which widgets would not respond to events. This regressed the twinx functionality, so I also updated subplots_adjust to update axes that share an x or y with a subplot instance. - CM

2006-04-02 Moved PBox class to transforms and deleted pbox.py; made pylab axis command a thin wrapper for Axes.axis; more tweaks to aspect-ratio handling; fixed Axes.specgram to account for the new imshow default of unit aspect ratio; made contour set the Axes.dataLim. - EF

2006-03-31 Fixed the Qt "Underlying C/C++ object deleted" bug. - JRE

2006-03-31 Applied Vasily Sulatskov's Qt Navigation Toolbar enhancement. - JRE

2006-03-31 Ported Norbert's rewriting of Halldor's stineman_interp algorithm to make it numerix compatible and added code to matplotlib.mlab. See examples/interp_demo.py - JDH

2006-03-30 Fixed a bug in aspect ratio handling; blocked potential crashes when panning with button 3; added axis('image') support. - EF

2006-03-28 More changes to aspect ratio handling; new PBox class in new file pbox.py to facilitate resizing and repositioning axes; made PolarAxes maintain unit aspect ratio. - EF

2006-03-23 Refactored TextWithDash class to inherit from, rather than delegate to, the Text class. Improves object inspection and closes bug # 1357969 - DSD

2006-03-22 Improved aspect ratio handling, including pylab interface. Interactive resizing, pan, zoom of images and plots (including panels with a shared axis) should work. Additions and possible refactoring are still likely. - EF

2006-03-21 Added another colorbrewer colormap (RdYlBu) - JSWHIT

2006-03-21 Fixed tickmarks for logscale plots over very large ranges. Closes bug # 1232920 - DSD

2006-03-21 Added Rob Knight's arrow code; see examples/arrow_demo.py - JDH

2006-03-20 Added support for masking values with nan's, using ADS's isnan module and the new API. Works for *Agg backends - DSD

2006-03-20 Added contour.negative_linestyle rcParam - ADS

2006-03-20 Added _isnan extension module to test for nan with Numeric

- ADS

2006-03-17 Added Paul and Alex's support for faceting with quadmesh in sf patch 1411223 - JDH

2006-03-17 Added Charle Twardy's pie patch to support colors=None. Closes sf patch 1387861 - JDH

2006-03-17 Applied sophana's patch to support overlapping axes with toolbar navigation by toggling activation with the 'a' key. Closes sf patch 1432252 - JDH

2006-03-17 Applied Aarre's linestyle patch for backend EMF; closes sf patch 1449279 - JDH

2006-03-17 Applied Jordan Dawe's patch to support kwarg properties for grid lines in the grid command. Closes sf patch 1451661 - JDH

2006-03-17 Center postscript output on page when using usetex - DSD

2006-03-17 subprocess module built if Python <2.4 even if subprocess can be imported from an egg - ADS

2006-03-17 Added _subprocess.c from Python upstream and hopefully enabled building (without breaking) on Windows, although not tested. - ADS

2006-03-17 Updated subprocess.py to latest Python upstream and reverted name back to subprocess.py - ADS

2006-03-16 Added John Porter's 3D handling code

2006-03-16 Released 0.87.2 at revision 2150

2006-03-15 Fixed bug in MaxNLocator revealed by daigos@infinito.it. The main change is that Locator.nonsingular now adjusts vmin and vmax if they are nearly the same, not just if they are equal. A new kwarg, "tiny", sets the threshold. - EF

2006-03-14 Added import of compatibility library for newer numpy linear_algebra - TEO

2006-03-12 Extended "load" function to support individual columns and moved "load" and "save" into matplotlib.mlab so they can be used outside of pylab – see examples/load_converter.py - JDH

2006-03-12 Added AutoDateFormatter and AutoDateLocator submitted by James Evans. Try the load_converter.py example for a demo. - ADS

2006-03-11 Added subprocess module from python-2.4 - DSD

2006-03-11 Fixed landscape orientation support with the usetex option. The backend_ps print_figure method was getting complicated, I added a _print_figure_tex method to maintain some degree of sanity - DSD

2006-03-11 Added "papertype" savefig kwarg for setting postscript papersizes. papertype and ps.papersize rc setting can also be set to "auto" to autoscale pagesizes - DSD

2006-03-09 Apply P-J's patch to make pstoeps work on windows patch report # 1445612 - DSD

2006-03-09 Make backend rc parameter case-insensitive - DSD

2006-03-07 Fixed bug in backend_ps related to C0-C6 papersizes, which were causing problems with postscript viewers. Supported page sizes include letter, legal, ledger, A0-A10, and B0-B10 - DSD

2006-03-07 Released 0.87.1

2006-03-04 backend_cairo.py: fix get_rgb() bug reported by Keith Briggs. Require pycairo 1.0.2. Support saving png to file-like objects. - SC

2006-03-03 Fixed pcolor handling of vmin, vmax - EF

2006-03-02 improve page sizing with usetex with the latex geometry package. Closes bug # 1441629 - DSD

2006-03-02 Fixed dpi problem with usetex png output. Accepted a modified version of patch # 1441809 - DSD

2006-03-01 Fixed axis('scaled') to deal with case xmax < xmin - JSWHIT

2006-03-01 Added reversed colormaps (with '_r' appended to name) - JSWHIT

2006-02-27 Improved eps bounding boxes with usetex - DSD

2006-02-27 Test svn commit, again!

2006-02-27 Fixed two dependency checking bugs related to usetex on Windows - DSD

2006-02-27 Made the rc deprecation warnings a little more human readable.

2006-02-26 Update the previous gtk.main_quit() bug fix to use gtk.main_level()

- SC

2006-02-24 Implemented alpha support in contour and contourf - EF

2006-02-22 Fixed gtk main quit bug when quit was called before mainloop. - JDH

2006-02-22 Small change to colors.py to workaround apparent bug in numpy masked array module - JSWHIT

2006-02-22 Fixed bug in ScalarMappable.to_rgba() reported by Ray Jones, and fixed incorrect fix found by Jeff Whitaker - EF

2006-02-22 Released 0.87

2006-02-21 Fixed portrait/landscape orientation in postscript backend - DSD

2006-02-21 Fix bug introduced in yesterday's bug fix - SC

2006-02-20 backend_gtk.py FigureCanvasGTK.draw(): fix bug reported by David Tremouilles - SC

2006-02-20 Remove the "pygtk.require('2.4')" error from examples/embedding_in_gtk2.py - SC

2006-02-18 backend_gtk.py FigureCanvasGTK.draw(): simplify to use (rather than duplicate) the expose_event() drawing code - SC

2006-02-12 Added stagger or waterfall plot capability to LineCollection; illustrated in examples/collections.py. - EF

2006-02-11 Massive cleanup of the usetex code in the postscript backend. Possibly fixed the clipping issue users were reporting with older versions of ghostscript - DSD

2006-02-11 Added autolim kwarg to axes.add_collection. Changed collection get_verts() methods accordingly. - EF

2006-02-09 added a temporary rc parameter text.dvipnghack, to allow Mac users to get nice results with the usetex option. - DSD

2006-02-09 Fixed a bug related to setting font sizes with the usetex option. - DSD

2006-02-09 Fixed a bug related to usetex's latex code. - DSD

2006-02-09 Modified behavior of font.size rc setting. You should define font.size in pts, which will set the "medium" or default fontsize. Special text sizes like axis labels or tick labels can be given relative font sizes like small, large, x-large, etc. and will scale accordingly. - DSD

2006-02-08 Added py2exe specific datapath check again. Also added new py2exe helper function get_py2exe_datafiles for use in py2exe setup.py scripts. - CM

2006-02-02 Added box function to pylab

2006-02-02 Fixed a problem in setupext.py, tk library formatted in unicode caused build problems - DSD

2006-02-01 Dropped TeX engine support in usetex to focus on LaTeX. - DSD

2006-01-29 Improved usetex option to respect the serif, sans-serif, monospace, and cursive rc settings. Removed the font.latex.package rc setting, it is no longer required - DSD

2006-01-29 Fixed tex's caching to include font.family rc information - DSD

2006-01-29 Fixed subpixel rendering bug in *Agg that was causing uneven gridlines - JDH

2006-01-28 Added fontcmd to backend_ps's RendererPS.draw_tex, to support other font families in eps output - DSD

2006-01-28 Added MaxNLocator to ticker.py, and changed contour.py to use it by default. - EF

2006-01-28 Added fontcmd to backend_ps's RendererPS.draw_tex, to support other font families in eps output - DSD

2006-01-27 Buffered reading of matplotlibrc parameters in order to allow 'verbose' settings to be processed first (allows verbose.report during rc validation process) - DSD

2006-01-27 Removed setuptools support from setup.py and created a separate setupegg.py file to replace it. - CM

2006-01-26 Replaced the ugly datapath logic with a cleaner approach from http://wiki.python.org/moin/DistutilsInstallDataScattered. Overrides the install_data command. - CM

2006-01-24 Don't use character typecodes in cntr.c — changed to use defined typenumbers instead. - TEO

2006-01-24 Fixed some bugs in usetex's and ps.usedistiller's dependency

2006-01-24 Added masked array support to scatter - EF

2006-01-24 Fixed some bugs in usetex's and ps.usedistiller's dependency checking - DSD

2006-01-24 Released 0.86.2

2006-01-20 Added a converters dict to pylab load to convert selected coloumns to float – especially useful for files with date strings, uses a datestr2num converter - JDH

2006-01-20 Added datestr2num to matplotlib dates to convert a string or sequence of strings to a matplotlib datenum

2006-01-18 Added quadrilateral pcolormesh patch 1409190 by Alex Mont and Paul Kienzle – this is *Agg only for now. See examples/quadmesh_demo.py - JDH

2006-01-18 Added Jouni's boxplot patch - JDH

2006-01-18 Added comma delimiter for pylab save - JDH

2006-01-12 Added Ryan's legend patch - JDH

2006-1-12 Fixed numpy / numeric to use .dtype.char to keep in SYNC with numpy SVN

2006-1-11 Released 0.86.1

2006-1-11 Fixed setup.py for win32 build and added rc template to the MANIFEST.in

2006-1-10 Added xpdf distiller option. matplotlibrc ps.usedistiller can now be none, false, ghostscript, or xpdf. Validation checks for dependencies. This needs testing, but the xpdf option should produce the highest-quality output and small file sizes - DSD

2006-01-10 For the usetex option, backend_ps now does all the LaTeX work in the os's temp directory - DSD

2006-1-10 Added checks for usetex dependencies. - DSD

2006-1-9 Released 0.86

2006-1-4 Changed to support numpy (new name for scipy_core) - TEO

2006-1-4 Added Mark's scaled axes patch for shared axis

2005-12-28 Added Chris Barker's build_wxagg patch - JDH

2005-12-27 Altered numerix/scipy to support new scipy package structure - TEO

2005-12-20 Fixed Jame's Boyles date tick reversal problem - JDH

2005-12-20 Added Jouni's rc patch to support lists of keys to set on - JDH

2005-12-12 Updated pyparsing and mathtext for some speed enhancements (Thanks Paul McGuire) and minor fixes to scipy numerix and setuptools

2005-12-12 Matplotlib data is now installed as package_data in the matplotlib module. This gets rid of checking the many possibilities in matplotlib._get_data_path() - CM

2005-12-11 Support for setuptools/pkg_resources to build and use matplotlib as an egg. Still allows matplotlib to exist using a traditional distutils install. - ADS

2005-12-03 Modified setup to build matplotlibrc based on compile time findings. It will set numerix in the order of scipy, numarray, Numeric depending on which are founds, and backend as in preference order GTKAgg, WXAgg, TkAgg, GTK, Agg, PS

2005-12-03 Modified scipy patch to support Numeric, scipy and numarray Some work remains to be done because some of the scipy imports are broken if only the core is installed. e.g., apparently we need from scipy.basic.fftpack import * rather than from scipy.fftpack import *

2005-12-03 Applied some fixes to Nicholas Young's nonuniform image patch

2005-12-01 Applied Alex Gontmakher hatch patch - PS only for now

2005-11-30 Added Rob McMullen's EMF patch

2005-11-30 Added Daishi's patch for scipy

2005-11-30 Fixed out of bounds draw markers segfault in agg

2005-11-28 Got TkAgg blitting working 100% (cross fingers) correctly. - CM

2005-11-27 Multiple changes in cm.py, colors.py, figure.py, image.py, contour.py, contour_demo.py; new _cm.py, examples/image_masked.py. 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. Also added some line breaks to the color data dictionaries. 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. Reworked color handling in contour.py, especially in the ContourLabeller mixin. - EF

2005-11-25 Changed text.py to ensure color is hashable. EF

2005-11-16 Released 0.85

2005-11-16 Changed the default default linewidth in rc to 1.0

2005-11-16 Replaced agg_to_gtk_drawable with pure pygtk pixbuf code in backend_gtkagg. When the equivalent is doe for blit, the agg extension code will no longer be needed

2005-11-16 Added a maxdict item to cbook to prevent caches from growing w/o bounds

2005-11-15 Fixed a colorup/colordown reversal bug in finance.py – Thanks Gilles

2005-11-15 Applied Jouni K Steppanen's boxplot patch SF patch#1349997

- JDH

2005-11-09 added axisbelow attr for Axes to determine whether ticks and such are above or below the actors

2005-11-08 Added Nicolas' irregularly spaced image patch

2005-11-08 Deprecated HorizontalSpanSelector and replaced with SpanSelection that takes a third arg, direction. The new SpanSelector supports horizontal and vertical span selection, and the appropriate min/max is returned. - CM

2005-11-08 Added lineprops dialog for gtk

2005-11-03 Added FIFOBuffer class to mlab to support real time feeds and examples/fifo_buffer.py

2005-11-01 Contributed Nickolas Young's patch for afm mathtext to support mathtext based upon the standard postscript Symbol font when ps.usetex = True.

2005-10-26 Added support for scatter legends - thanks John Gill

2005-10-20 Fixed image clipping bug that made some tex labels disappear. JDH

2005-10-14 Removed sqrt from dvipng 1.6 alpha channel mask.

2005-10-14 Added width kwarg to hist function

2005-10-10 Replaced all instances of os.rename with shutil.move

2005-10-05 Added Michael Brady's ydate patch

2005-10-04 Added rkern's texmanager patch

2005-09-25 contour.py modified to use a single ContourSet class that handles filled contours, line contours, and labels; added keyword arg (clip_ends) to contourf. Colorbar modified to work with new ContourSet object; if the ContourSet has lines rather than polygons, the colorbar will follow suit. Fixed a bug introduced in 0.84, in which contourf(...,colors=...) was broken - EF

2005-09-19 Released 0.84

2005-09-14 Added a new 'resize_event' which triggers a callback with a backend_bases.ResizeEvent object - JDH

2005-09-14 font_manager.py: removed chkfontpath from x11FontDirectory() - SC

2005-09-14 Factored out auto date locator/formatter factory code into matplotlib.date.date_ticker_factory; applies John Bryne's quiver patch.

2005-09-13 Added Mark's axes positions history patch #1286915

2005-09-09 Added support for auto canvas resizing with fig.set_figsize_inches(9,5,forward=True) # inches OR fig.resize(400,300) # pixels

2005-09-07 figure.py: update Figure.draw() to use the updated renderer.draw_image() so that examples/figimage_demo.py works again. examples/stock_demo.py: remove data_clipping (which no longer exists) - SC

2005-09-06 Added Eric's tick.direction patch: in or out in rc

2005-09-06 Added Martin's rectangle selector widget

2005-09-04 Fixed a logic err in text.py that was preventing rgxsuper from matching - JDH

2005-08-29 Committed Ken's wx blit patch #1275002

2005-08-26 colorbar modifications - now uses contourf instead of imshow so that colors used by contourf are displayed correctly. Added two new keyword args (cspacing and clabels) that are only relevant for ContourMappable images - JSWHIT

2005-08-24 Fixed a PS image bug reported by Darren - JDH

2005-08-23 colors.py: change hex2color() to accept unicode strings as well as normal strings. Use isinstance() instead of types.IntType etc - SC

2005-08-16 removed data_clipping line and rc property - JDH

2005-08-22 backend_svg.py: Remove redundant "x=0.0 y=0.0" from svg element. Increase svg version from 1.0 to 1.1. Add viewBox attribute to svg element to allow SVG documents to scale-to-fit into an arbitrary viewport - SC

2005-08-16 Added Eric's dot marker patch - JDH

2005-08-08 Added blitting/animation for TkAgg - CM

2005-08-05 Fixed duplicate tickline bug - JDH

2005-08-05 Fixed a GTK animation bug that cropped up when doing animations in gtk//gtkagg canvases that had widgets packed above them

2005-08-05 Added Clovis Goldemberg patch to the tk save dialog

2005-08-04 Removed origin kwarg from backend.draw_image. origin is handled entirely by the frontend now.

2005-07-03 Fixed a bug related to TeX commands in backend_ps

2005-08-03 Fixed SVG images to respect upper and lower origins.

2005-08-03 Added flipud method to image and removed it from to_str.

2005-07-29 Modified figure.figaspect to take an array or number; modified backend_svg to write utf-8 - JDH

2005-07-30 backend_svg.py: embed png image files in svg rather than linking to a separate png file, fixes bug #1245306 (thanks to Norbert Nemec for the patch) - SC

2005-07-29 Released 0.83.2

2005-07-27 Applied SF patch 1242648: minor rounding error in IndexDateFormatter in dates.py

2005-07-27 Applied sf patch 1244732: Scale axis such that circle looks like circle - JDH

2005-07-29 Improved message reporting in texmanager and backend_ps - DSD

2005-07-28 backend_gtk.py: update FigureCanvasGTK.draw() (needed due to the recent expose_event() change) so that examples/anim.py works in the usual way - SC

2005-07-26 Added new widgets Cursor and HorizontalSpanSelector to matplotlib.widgets. See examples/widgets/cursor.py and examples/widgets/span_selector.py - JDH

2005-07-26 added draw event to mpl event hierarchy – triggered on figure.draw

2005-07-26 backend_gtk.py: allow 'f' key to toggle window fullscreen mode

2005-07-26 backend_svg.py: write "<.../>" elements all on one line and remove surplus spaces - SC

2005-07-25 backend_svg.py: simplify code by deleting GraphicsContextSVG and RendererSVG.new_gc(), and moving the gc.get_capstyle() code into RendererSVG._get_gc_props_svg() - SC

2005-07-24 backend_gtk.py: call FigureCanvasBase.motion_notify_event() on all motion-notify-events, not just ones where a modifier key or button has been pressed (fixes bug report from Niklas Volbers) - SC

2005-07-24 backend_gtk.py: modify print_figure() use own pixmap, fixing problems where print_figure() overwrites the display pixmap. return False from all button/key etc events - to allow the event to propagate further - SC

2005-07-23 backend_gtk.py: change expose_event from using set_back_pixmap(); clear() to draw_drawable() - SC

2005-07-23 backend_gtk.py: removed pygtk.require() matplotlib/__init__.py: delete 'FROZEN' and 'McPLError' which are no longer used - SC

2005-07-22 backend_gdk.py: removed pygtk.require() - SC

2005-07-21 backend_svg.py: Remove unused imports. Remove methods doc strings which just duplicate the docs from backend_bases.py. Rename draw_mathtext to _draw_mathtext. - SC

2005-07-17 examples/embedding_in_gtk3.py: new example demonstrating placing a FigureCanvas in a gtk.ScrolledWindow - SC

2005-07-14 Fixed a Windows related bug (#1238412) in texmanager - DSD

2005-07-11 Fixed color kwarg bug, setting color=1 or 0 caused an exception - DSD

2005-07-07 Added Eric's MA set_xdata Line2D fix - JDH

2005-07-06 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. e.g., the new names are matplotlibrc tex.cache 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. Also fixed texmanager to put all files, including temp files in ~/.matplotlib/tex.cache, which allows you to usetex in non-writable dirs.

2005-07-05 Fixed bug #1231611 in subplots adjust layout. The problem was that the text cacheing mechanism was not using the transformation affine in the key. - JDH

2005-07-05 Fixed default backend import problem when using API (SF bug # 1209354 - see API_CHANGES for more info - JDH

2005-07-04 backend_gtk.py: require PyGTK version 2.0.0 or higher - SC

2005-06-30 setupext.py: added numarray_inc_dirs for building against numarray when not installed in standard location - ADS

2005-06-27 backend_svg.py: write figure width, height as int, not float. Update to fix some of the py-checker warnings - SC

2005-06-23 Updated examples/agg_test.py to demonstrate curved paths and fills - JDH

2005-06-21 Moved some texmanager and backend_agg tex caching to class level rather than instance level - JDH

2005-06-20 setupext.py: fix problem where _nc_backend_gdk is installed to the wrong directory - SC

2005-06-19 Added 10.4 support for CocoaAgg. - CM

2005-06-18 Move Figure.get_width_height() to FigureCanvasBase and return int instead of float. - SC

2005-06-18 Applied Ted Drain's QtAgg patch: 1) Changed the toolbar to be a horizontal bar of push buttons instead of a QToolbar and updated the layout algorithms in the main window accordingly. This eliminates the ability to drag and drop the toolbar and detach it from the window. 2) Updated the resize algorithm in the main window to show the correct size for the plot widget as requested. This works almost correctly right now. It looks to me like the final size of the widget is off by the border of the main window but I haven't figured out a way to get that information yet. We could just add a small margin to the new size but that seems a little hacky. 3) Changed the x/y location label to be in the toolbar like the Tk backend instead of as a status line at the bottom of the widget. 4) Changed the toolbar pixmaps to use the ppm files instead of the png files. I noticed that the Tk backend buttons looked much nicer and it uses the ppm files so I switched them.

2005-06-17 Modified the gtk backend to not queue mouse motion events. This allows for live updates when dragging a slider. - CM

2005-06-17 Added starter CocoaAgg backend. Only works on OS 10.3 for now and requires PyObjC. (10.4 is high priority) - CM

2005-06-17 Upgraded pyparsing and applied Paul McGuire's suggestions for speeding things up. This more than doubles the speed of mathtext in my simple tests. JDH

2005-06-16 Applied David Cooke's subplot make_key patch

2005-06-15 0.82 released

2005-06-15 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

2005-06-15 backend_cairo.py: updated to use pycairo 0.5.0 - SC

2005-06-14 Wrote some GUI neutral widgets (Button, Slider, RadioButtons, CheckButtons) in matplotlib.widgets. See examples/widgets/*.py - JDH

2005-06-14 Exposed subplot parameters as rc vars and as the fig SubplotParams instance subplotpars. See figure.SubplotParams, figure.Figure.subplots_adjust and the pylab method subplots_adjust and examples/subplots_adjust.py . Also added a GUI neutral widget for adjusting subplots, see examples/subplot_toolbar.py - JDH

2005-06-13 Exposed cap and join style for lines with new rc params and

line properties

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

2005-06-13 Added kwargs to Axes init

2005-06-13 Applied Baptiste's tick patch - JDH

2005-06-13 Fixed rc alias 'l' bug reported by Fernando by removing aliases for mainlevel rc options. - JDH

2005-06-10 Fixed bug #1217637 in ticker.py - DSD

2005-06-07 Fixed a bug in texmanager.py: .aux files not being removed - DSD

2005-06-08 Added Sean Richard's hist binning fix – see API_CHANGES - JDH

2005-06-07 Fixed a bug in texmanager.py: .aux files not being removed

- DSD

2005-06-07 matplotlib-0.81 released

2005-06-06 Added autoscale_on prop to axes

2005-06-06 Added Nick's picker "among" patch - JDH

2005-06-05 Fixed a TeX/LaTeX font discrepency in backend_ps. - DSD

2005-06-05 Added a ps.distill option in rc settings. If True, postscript output will be distilled using ghostscript, which should trim the file size and allow it to load more quickly. Hopefully this will address the issue of large ps files due to font definitions. Tested with gnu-ghostscript-8.16. - DSD

2005-06-03 Improved support for tex handling of text in backend_ps. - DSD

2005-06-03 Added rc options to render text with tex or latex, and to select the latex font package. - DSD

2005-06-03 Fixed a bug in ticker.py causing a ZeroDivisionError

2005-06-02 backend_gtk.py remove DBL_BUFFER, add line to expose_event to try to fix pygtk 2.6 redraw problem - SC

2005-06-01 The default behavior of ScalarFormatter now renders scientific notation and large numerical offsets in a label at the end of the axis. - DSD

2005-06-01 Added Nicholas' frombyte image patch - JDH

2005-05-31 Added vertical TeX support for agg - JDH

2005-05-31 Applied Eric's cntr patch - JDH

2005-05-27 Finally found the pesky agg bug (which Maxim was kind enough to fix within hours) that was causing a segfault in the win32 cached marker drawing. Now windows users can get the enormouse performance benefits of caced markers w/o those occasional pesy screenshots. - JDH

2005-05-27 Got win32 build system working again, using a more recent version of gtk and pygtk in the win32 build, gtk 2.6 from http://www.gimp.org/~tml/gimp/win32/downloads.html (you will also need libpng12.dll to use these). I haven't tested whether this binary build of mpl for win32 will work with older gtk runtimes, so you may need to upgrade.

2005-05-27 Fixed bug where 2nd wxapp could be started if using wxagg backend. - ADS

2005-05-26 Added Daishi text with dash patch – see examples/dashtick.py

2005-05-26 Moved backend_latex functionality into backend_ps. If text.usetex=True, the PostScript backend will use LaTeX to generate the .ps or .eps file. Ghostscript is required for eps output. - DSD

2005-05-24 Fixed alignment and color issues in latex backend. - DSD

2005-05-21 Fixed raster problem for small rasters with dvipng – looks like it was a premultipled alpha problem - JDH

2005-05-20 Added linewidth and faceted kwarg to scatter to control edgewidth and color. Also added autolegend patch to inspect line segments.

2005-05-18 Added Orsay and JPL qt fixes - JDH

2005-05-17 Added a psfrag latex backend – some alignment issues need to be worked out. Run with -dLaTeX and a *.tex file and *.eps file are generated. latex and dvips the generated latex file to get ps output. Note xdvi *does* not work, you must generate ps.- JDH

2005-05-13 Added Florent Rougon's Axis set_label1 patch

2005-05-17 pcolor optimization, fixed bug in previous pcolor patch - JSWHIT

2005-05-16 Added support for masked arrays in pcolor - JSWHIT

2005-05-12 Started work on TeX text for antigrain using pngdvi – see examples/tex_demo.py and the new module matplotlib.texmanager. Rotated text not supported and rendering small glyps is not working right yet. BUt large fontsizes and/or high dpi saved figs work great.

2005-05-10 New image resize options interpolation options. New values for the interp kwarg are

'nearest', 'bilinear', 'bicubic', 'spline16', 'spline36', 'hanning', 'hamming', 'hermite', 'kaiser', 'quadric', 'catrom', 'gaussian', 'bessel', 'mitchell', 'sinc', 'lanczos', 'blackman'

See help(imshow) for details, particularly the interpolation, filternorm and filterrad kwargs

2005-05-10 Applied Eric's contour mem leak fixes - JDH

2005-05-10 Extended python agg wrapper and started implementing backend_agg2, an agg renderer based on the python wrapper. This will be more flexible and easier to extend than the current backend_agg. See also examples/agg_test.py - JDH

2005-05-09 Added Marcin's no legend patch to exclude lines from the autolegend builder

plot(x, y, label='nolegend')

2005-05-05 Upgraded to agg23

2005-05-05 Added newscalarformatter_demo.py to examples. -DSD

2005-05-04 Added NewScalarFormatter. Improved formatting of ticklabels, scientific notation, and the ability to plot large large numbers with small ranges, by determining a numerical offset. See ticker.NewScalarFormatter for more details. -DSD

2005-05-03 Added the option to specify a delimiter in pylab.load -DSD

2005-04-28 Added Darren's line collection example

2005-04-28 Fixed aa property in agg - JDH

2005-04-27 Set postscript page size in .matplotlibrc - DSD

2005-04-26 Added embedding in qt example. - JDH

2005-04-14 Applied Michael Brady's qt backend patch: 1) fix a bug where keyboard input was grabbed by the figure and not released 2) turn on cursor changes 3) clean up a typo and commented-out print statement. - JDH

2005-04-14 Applied Eric Firing's masked data lines patch and contour patch. 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. - see examples/masked_demo.py - JDH

2005-04-13 Applied Tim Leslie's arrow key event handling patch - JDH

0.80 released

2005-04-11 Applied a variant of rick's xlim/ylim/axis patch. These functions now take kwargs to let you selectively alter only the min or max if desired. e.g., xlim(xmin=2) or axis(ymax=3). They always return the new lim. - JDH

2005-04-11 Incorporated Werner's wx patch – wx backend should be compatible with wxpython2.4 and recent versions of 2.5. Some early versions of wxpython 2.5 will not work because there was a temporary change in the dc API that was rolled back to make it 2.4 compliant

2005-04-11 modified tkagg show so that new figure window pops up on call to figure

2005-04-11 fixed wxapp init bug

2005-04-02 updated backend_ps.draw_lines, draw_markers for use with the new API - DSD

2005-04-01 Added editable polygon example

2005-03-31 0.74 released

2005-03-30 Fixed and added checks for floating point inaccuracy in ticker.Base - DSD

2005-03-30 updated /ellipse definition in backend_ps.py to address bug #1122041 - DSD

2005-03-29 Added unicode support for Agg and PS - JDH

2005-03-28 Added Jarrod's svg patch for text - JDH

2005-03-28 Added Ludal's arrow and quiver patch - JDH

2005-03-28 Added label kwarg to Axes to facilitate forcing the creation of new Axes with otherwise identical attributes

2005-03-28 Applied boxplot and OSX font search patches

2005-03-27 Added ft2font NULL check to fix Japanase font bug - JDH

2005-03-27 Added sprint legend patch plus John Gill's tests and fix – see examples/legend_auto.py - JDH

2005-03-19 0.73.1 released

2005-03-19 Reverted wxapp handling because it crashed win32 - JDH

2005-03-18 Add .number attribute to figure objects returned by figure() - FP

2005-03-18 0.73 released

2005-03-16 Fixed labelsep bug

2005-03-16 Applied Darren's ticker fix for small ranges - JDH

2005-03-16 Fixed tick on horiz colorbar - JDH

2005-03-16 Added Japanses winreg patch - JDH

2005-03-15 backend_gtkagg.py: changed to use double buffering, this fixes the problem reported Joachim Berdal Haga - "Parts of plot lagging from previous frame in animation". Tested with anim.py and it makes no noticable difference to performance (23.7 before, 23.6 after) - SC

2005-03-14 add src/_backend_gdk.c extension to provide a substitute function for pixbuf.get_pixels_array(). Currently pixbuf.get_pixels_array() only works with Numeric, and then only works if pygtk has been compiled with Numeric support. The change provides a function pixbuf_get_pixels_array() which works with Numeric and numarray and is always available. It means that backend_gtk should be able to display images and mathtext in all circumstances. - SC

2005-03-11 Upgraded CXX to 5.3.1

2005-03-10 remove GraphicsContextPS.set_linestyle() and GraphicsContextSVG.set_linestyle() since they do no more than the base class GraphicsContext.set_linestyle() - SC

2005-03-09 Refactored contour functionality into dedicated module

2005-03-09 Added Eric's contourf updates and Nadia's clabel functionality

2005-03-09 Moved colorbar to figure.Figure to expose it for API developers

- JDH

2005-03-09 backend_cairo.py: implemented draw_markers() - SC

2005-03-09 cbook.py: only use enumerate() (the python version) if the builtin

version is not available. Add new function 'izip' which is set to itertools.izip if available and the python equivalent if not available. - SC

2005-03-07 backend_gdk.py: remove PIXELS_PER_INCH from points_to_pixels(), but

still use it to adjust font sizes. This allows the GTK version of line_styles.py to more closely match GTKAgg, previously the markers were being drawn too large. - SC

2005-03-01 Added Eric's contourf routines

2005-03-01 Added start of proper agg SWIG wrapper. I would like to expose agg functionality directly a the user level and this module will serve that purpose eventually, and will hopefully take over most of the functionality of the current _image and _backend_agg modules. - JDH

2005-02-28 Fixed polyfit / polyval to convert input args to float arrays - JDH

2005-02-25 Add experimental feature to backend_gtk.py to enable/disable double buffering (DBL_BUFFER=True/False) - SC

2005-02-24 colors.py change ColorConverter.to_rgb() so it always returns rgb (and not rgba), allow cnames keys to be cached, change the exception raised from RuntimeError to ValueError (like hex2color()) hex2color() use a regular expression to check the color string is valid - SC

2005-02-23 Added rc param ps.useafm so backend ps can use native afm fonts or truetype. afme breaks mathtext but causes much smaller font sizes and may result in images that display better in some contexts (e.g., pdfs incorporated into latex docs viewed in acrobat reader). I would like to extend this approach to allow the user to use truetype only for mathtext, which should be easy.

2005-02-23 Used sequence protocol rather than tuple in agg collection drawing routines for greater flexibility - JDH

2005-02-22 0.72.1 released

2005-02-21 fixed linestyles for collections – contour now dashes for levels <0

2005-02-21 fixed ps color bug - JDH

2005-02-15 fixed missing qt file

2005-02-15 banished error_msg and report_error. Internal backend methods like error_msg_gtk are preserved. backend writers, check your backends, and diff against 0.72 to make sure I did the right thing! - JDH

2005-02-14 Added enthought traits to matplotlib tree - JDH

2005-02-14 0.72 released

2005-02-14 fix bug in cbook alltrue() and onetrue() - SC

2005-02-11 updated qtagg backend from Ted - JDH

2005-02-11 matshow fixes for figure numbering, return value and docs - FP

2005-02-09 new zorder example for fine control in zorder_demo.py - FP

2005-02-09 backend renderer draw_lines now has transform in backend, as in draw_markers; use numerix in _backend_agg, aded small line optimization to agg

2005-02-09 subplot now deletes axes that it overlaps

2005-02-08 Added transparent support for gzipped files in load/save - Fernando Perez (FP from now on).

2005-02-08 Small optimizations in PS backend. They may have a big impact for large plots, otherwise they don't hurt - FP

2005-02-08 Added transparent support for gzipped files in load/save - Fernando Perez (FP from now on).

2005-02-07 Added newstyle path drawing for markers - only implemented in agg currently - JDH

2005-02-05 Some superscript text optimizations for ticking log plots

2005-02-05 Added some default key press events to pylab figures: 'g' toggles grid - JDH

2005-02-05 Added some support for handling log switching for lines that have nonpos data - JDH

2005-02-04 Added Nadia's contour patch - contour now has matlab compatible syntax; this also fixed an unequal sized contour array bug- JDH

2005-02-04 Modified GTK backends to allow the FigureCanvas to be resized smaller than its original size - SC

2005-02-02 Fixed a bug in dates mx2num - JDH

2005-02-02 Incorporated Fernando's matshow - JDH

2005-02-01 Added Fernando's figure num patch, including experemental support for pylab backend switching, LineCOllection.color warns, savefig now a figure method, fixed a close(fig) bug - JDH

2005-01-31 updated datalim in contour - JDH

2005-01-30 Added backend_qtagg.py provided by Sigve Tjora - SC

2005-01-28 Added tk.inspect rc param to .matplotlibrc. IDLE users should set tk.pythoninspect:True and interactive:True and backend:TkAgg

2005-01-28 Replaced examples/interactive.py with an updated script from Fernando Perez - SC

2005-01-27 Added support for shared x or y axes. See examples/shared_axis_demo.py and examples/ganged_plots.py

2005-01-27 Added Lee's patch for missing symbols leq and LEFTbracket to _mathtext_data - JDH

2005-01-26 Added Baptiste's two scales patch – see help(twinx) in the pylab interface for more info. See also examples/two_scales.py

2005-01-24 Fixed a mathtext parser bug that prevented font changes in sub/superscripts - JDH

2005-01-24 Fixed contour to work w/ interactive changes in colormaps, clim, etc - JDH

2005-01-21 matplotlib-0.71 released

2005-01-21 Refactored numerix to solve vexing namespace issues - JDH

2005-01-21 Applied Nadia's contour bug fix - JDH

2005-01-20 Made some changes to the contour routine - particularly region=1 seems t fix a lot of the zigzag strangeness. Added colormaps as default for contour - JDH

2005-01-19 Restored builtin names which were overridden (min, max, abs, round, and sum) in pylab. This is a potentially significant change for those who were relying on an array version of those functions that previously overrode builtin function names. - ADS

2005-01-18 Added accents to mathtext: hat, breve, grave, bar, acute, tilde, vec, dot, ddot. All of them have the same syntax, e.g., to make an overbar you do bar{o} or to make an o umlaut you do ddot{o}. The shortcuts are also provided, e.g., "o 'e `e ~n .x ^y - JDH

2005-01-18 Plugged image resize memory leaks - JDH

2005-01-18 Fixed some mathtext parser problems relating to superscripts

2005-01-17 Fixed a yticklabel problem for colorbars under change of clim - JDH

2005-01-17 Cleaned up Destroy handling in wx reducing memleak/fig from approx 800k to approx 6k- JDH

2005-01-17 Added kappa to latex_to_bakoma - JDH

2005-01-15 Support arbitrary colorbar axes and horizontal colorbars - JDH

2005-01-15 Fixed colormap number of colors bug so that the colorbar has the same discretization as the image - JDH

2005-01-15 Added Nadia's x,y contour fix - JDH

2005-01-15 backend_cairo: added PDF support which requires pycairo 0.1.4. Its not usable yet, but is ready for when the Cairo PDF backend matures - SC

2005-01-15 Added Nadia's x,y contour fix

2005-01-12 Fixed set clip_on bug in artist - JDH

2005-01-11 Reverted pythoninspect in tkagg - JDH

2005-01-09 Fixed a backend_bases event bug caused when an event is triggered when location is None - JDH

2005-01-07 Add patch from Stephen Walton to fix bug in pylab.load() when the % character is included in a comment. - ADS

2005-01-07 Added markerscale attribute to Legend class. This allows the marker size in the legend to be adjusted relative to that in the plot. - ADS

2005-01-06 Add patch from Ben Vanhaeren to make the FigureManagerGTK vbox a public attribute - SC

2004-12-30 Release 0.70

2004-12-28 Added coord location to key press and added a examples/picker_demo.py

2004-12-28 Fixed coords notification in wx toolbar - JDH

2004-12-28 Moved connection and disconnection event handling to the FigureCanvasBase. Backends now only need to connect one time for each of the button press, button release and key press/release functions. The base class deals with callbacks and multiple connections. This fixes flakiness on some backends (tk, wx) in the presence of multiple connections and/or disconnect - JDH

2004-12-27 Fixed PS mathtext bug where color was not set - Jochen please verify correct - JDH

2004-12-27 Added Shadow class and added shadow kwarg to legend and pie for shadow effect - JDH

2004-12-27 Added pie charts and new example/pie_demo.py

2004-12-23 Fixed an agg text rotation alignment bug, fixed some text kwarg processing bugs, and added examples/text_rotation.py to explain and demonstrate how text rotations and alignment work in matplotlib. - JDH

2004-12-22 0.65.1 released - JDH

2004-12-22 Fixed colorbar bug which caused colorbar not to respond to changes in colormap in some instances - JDH

2004-12-22 Refactored NavigationToolbar in tkagg to support app embedding , init now takes (canvas, window) rather than (canvas, figman) - JDH

2004-12-21 Refactored axes and subplot management - removed add_subplot and add_axes from the FigureManager. classic toolbar updates are done via an observer pattern on the figure using add_axobserver. Figure now maintains the axes stack (for gca) and supports axes deletion. Ported changes to GTK, Tk, Wx, and FLTK. Please test! Added delaxes - JDH

2004-12-21 Lots of image optimizations - 4x performance boost over 0.65 JDH

2004-12-20 Fixed a figimage bug where the axes is shown and modified tkagg to move the destroy binding into the show method.

2004-12-18 Minor refactoring of NavigationToolbar2 to support embedding in an application - JDH

2004-12-14 Added linestyle to collections (currently broken) - JDH

2004-12-14 Applied Nadia's setupext patch to fix libstdc++ link problem with contour and solaris - JDH

2004-12-14 A number of pychecker inspired fixes, including removal of True and False from cbook which I erroneously thought was needed for python2.2 - JDH

2004-12-14 Finished porting doc strings for set introspection. Used silent_list for many get funcs that return lists. JDH

2004-12-13 dates.py: removed all timezone() calls, except for UTC - SC

2004-12-13 0.65 released - JDH

2004-12-13 colors.py: rgb2hex(), hex2color() made simpler (and faster), also rgb2hex() - added round() instead of integer truncation hex2color() - changed 256.0 divisor to 255.0, so now '#ffffff' becomes (1.0,1.0,1.0) not (0.996,0.996,0.996) - SC

2004-12-11 Added ion and ioff to pylab interface - JDH

2004-12-11 backend_template.py: delete FigureCanvasTemplate.realize() - most backends don't use it and its no longer needed

backend_ps.py, backend_svg.py: delete show() and draw_if_interactive() - they are not needed for image backends

backend_svg.py: write direct to file instead of StringIO - SC

2004-12-10 Added zorder to artists to control drawing order of lines, patches and text in axes. See examples/zoder_demo.py - JDH

2004-12-10 Fixed colorbar bug with scatter - JDH

2004-12-10 Added Nadia Dencheva <dencheva@stsci.edu> contour code - JDH

2004-12-10 backend_cairo.py: got mathtext working - SC

2004-12-09 Added Norm Peterson's svg clipping patch

2004-12-09 Added Matthew Newville's wx printing patch

2004-12-09 Migrated matlab to pylab - JDH

2004-12-09 backend_gtk.py: split into two parts

- backend_gdk.py - an image backend
- backend_gtk.py - A GUI backend that uses GDK - SC

2004-12-08 backend_gtk.py: remove quit_after_print_xvfb(*args), show_xvfb(), Dialog_MeasureTool(gtk.Dialog) one month after sending mail to matplotlib-users asking if anyone still uses these functions - SC

2004-12-02 backend_bases.py, backend_template.py: updated some of the method documentation to make them consistent with each other - SC

2004-12-04 Fixed multiple bindings per event for TkAgg mpl_connect and mpl_disconnect. Added a "test_disconnect" command line parameter to coords_demo.py JTM

2004-12-04 Fixed some legend bugs JDH

2004-11-30 Added over command for oneoff over plots. e.g., over(plot, x, y, lw=2). Works with any plot function.

2004-11-30 Added bbox property to text - JDH

2004-11-29 Zoom to rect now respect reversed axes limits (for both linear and log axes). - GL

2004-11-29 Added the over command to the matlab interface. over allows you to add an overlay plot regardless of hold state. - JDH

2004-11-25 Added Printf to mplutils for printf style format string formatting in C++ (should help write better exceptions)

2004-11-24 IMAGE_FORMAT: remove from agg and gtkagg backends as its no longer used - SC

2004-11-23 Added matplotlib compatible set and get introspection. See set_and_get.py

2004-11-23 applied Norbert's patched and exposed legend configuration to kwargs - JDH

2004-11-23 backend_gtk.py: added a default exception handler - SC

2004-11-18 backend_gtk.py: change so that the backend knows about all image formats and does not need to use IMAGE_FORMAT in other backends - SC

2004-11-18 Fixed some report_error bugs in string interpolation as reported on SF bug tracker- JDH

2004-11-17 backend_gtkcairo.py: change so all print_figure() calls render using Cairo and get saved using backend_gtk.print_figure() - SC

2004-11-13 backend_cairo.py: Discovered the magic number (96) required for Cairo PS plots to come out the right size. Restored Cairo PS output and added support for landscape mode - SC

2004-11-13 Added ishold - JDH

2004-11-12 Added many new matlab colormaps - autumn bone cool copper flag gray hot hsv jet pink prism spring summer winter - PG

2004-11-11 greatly simplify the emitted postscript code - JV

2004-11-12 Added new plotting functions spy, spy2 for sparse matrix visualization - JDH

2004-11-11 Added rgrids, thetragrids for customizing the grid locations and labels for polar plots - JDH

2004-11-11 make the Gtk backends build without an X-server connection - JV

2004-11-10 matplotlib/__init__.py: Added FROZEN to signal we are running under py2exe (or similar) - is used by backend_gtk.py - SC

2004-11-09 backend_gtk.py: Made fix suggested by maffew@cat.org.au to prevent problems when py2exe calls pygtk.require(). - SC

2004-11-09 backend_cairo.py: Added support for printing to a fileobject. Disabled cairo PS output which is not working correctly. - SC

2004-11-08 matplotlib-0.64 released

2004-11-04 Changed -dbackend processing to only use known backends, so we don't clobber other non-matplotlib uses of -d, like -debug.

2004-11-04 backend_agg.py: added IMAGE_FORMAT to list the formats that the backend can save to. backend_gtkagg.py: added support for saving JPG files by using the GTK backend - SC

2004-10-31 backend_cairo.py: now produces png and ps files (although the figure sizing needs some work). pycairo did not wrap all the necessary functions, so I wrapped them myself, they are included in the backend_cairo.py doc string. - SC

2004-10-31 backend_ps.py: clean up the generated PostScript code, use the PostScript stack to hold itermediate values instead of storing them in the dictionary. - JV

2004-10-30 backend_ps.py, ft2font.cpp, ft2font.h: fix the position of text in the PostScript output. The new FT2Font method get_descent gives the distance between the lower edge of the bounding box and the baseline of a string. In backend_ps the text is shifted upwards by this amount. - JV

2004-10-30 backend_ps.py: clean up the code a lot. Change the PostScript output to be more DSC compliant. All definitions for the generated PostScript are now in a PostScript dictionary 'mpldict'. Moved the long comment about drawing ellipses from the PostScript output into a Python comment. - JV

2004-10-30 backend_gtk.py: removed FigureCanvasGTK.realize() as its no longer needed. Merged ColorManager into GraphicsContext backend_bases.py: For set_capstyle/joinstyle() only set cap or joinstyle if there is no error. - SC

2004-10-30 backend_gtk.py: tidied up print_figure() and removed some of the dependency on widget events - SC

2004-10-28 backend_cairo.py: The renderer is complete except for mathtext, draw_image() and clipping. gtkcairo works reasonably well. cairo does not yet create any files since I can't figure how to set the 'target surface', I don't think pycairo wraps the required functions - SC

2004-10-28 backend_gtk.py: Improved the save dialog (GTK 2.4 only) so it presents the user with a menu of supported image formats - SC

2004-10-28 backend_svg.py: change print_figure() to restore original face/edge color backend_ps.py : change print_figure() to ensure original face/edge colors are restored even if there's an IOError - SC

2004-10-27 Applied Norbert's errorbar patch to support barsabove kwarg

2004-10-27 Applied Norbert's legend patch to support None handles

2004-10-27 Added two more backends: backend_cairo.py, backend_gtkcairo.py They are not complete yet, currently backend_gtkcairo just renders polygons, rectangles and lines - SC

2004-10-21 Added polar axes and plots - JDH

2004-10-20 Fixed corrcoef bug exposed by corrcoef(X) where X is matrix

- JDH

2004-10-19 Added kwarg support to xticks and yticks to set ticklabel text properties – thanks to T. Edward Whalen for the suggestion

2004-10-19 Added support for PIL images in imshow(), image.py - ADS

2004-10-19 Re-worked exception handling in _image.py and _transforms.py to avoid masking problems with shared libraries. - JTM

2004-10-16 Streamlined the matlab interface wrapper, removed the noplot option to hist - just use mlab.hist instead.

2004-09-30 Added Andrew Dalke's strftime code to extend the range of dates supported by the DateFormatter - JDH

2004-09-30 Added barh - JDH

2004-09-30 Removed fallback to alternate array package from numerix so that ImportErrors are easier to debug. JTM

2004-09-30 Add GTK+ 2.4 support for the message in the toolbar. SC

2004-09-30 Made some changes to support python22 - lots of doc fixes. - JDH

2004-09-29 Added a Verbose class for reporting - JDH

2004-09-28 Released 0.63.0

2004-09-28 Added save to file object for agg - see examples/print_stdout.py

2004-09-24 Reorganized all py code to lib subdir

2004-09-24 Fixed axes resize image edge effects on interpolation - required upgrade to agg22 which fixed an agg bug related to this problem

2004-09-20 Added toolbar2 message display for backend_tkagg. JTM

2004-09-17 Added coords formatter attributes. These must be callable,

and return a string for the x or y data. These will be used to format the x and y data for the coords box. Default is the axis major formatter. e.g.:

format the coords message box def price(x): return '$%1.2f'%x ax.format_xdata = DateFormatter('%Y-%m-%d') ax.format_ydata = price

2004-09-17 Total rewrite of dates handling to use python datetime with num2date, date2num and drange. pytz for timezone handling, dateutils for spohisticated ticking. date ranges from 0001-9999 are supported. rrules allow arbitrary date ticking. examples/date_demo*.py converted to show new usage. new example examples/date_demo_rrule.py shows how to use rrules in date plots. The date locators are much more general and almost all of them have different constructors. See matplotlib.dates for more info.

2004-09-15 Applied Fernando's backend __init__ patch to support easier backend maintenance. Added his numutils to mlab. JDH

2004-09-16 Re-designated all files in matplotlib/images as binary and w/o keyword substitution using "cvs admin -kb *.svg ...". See binary files in "info cvs" under Linux. This was messing up builds from CVS on windows since CVS was doing lf -> cr/lf and keyword substitution on the bitmaps. - JTM

2004-09-15 Modified setup to build array-package-specific extensions for those extensions which are array-aware. Setup builds extensions automatically for either Numeric, numarray, or both, depending on what you have installed. Python proxy modules for the array-aware extensions import the version optimized for numarray or Numeric determined by numerix. - JTM

2004-09-15 Moved definitions of infinity from mlab to numerix to avoid divide by zero warnings for numarray - JTM

2004-09-09 Added axhline, axvline, axhspan and axvspan

2004-08-30 matplotlib 0.62.4 released

2004-08-30 Fixed a multiple images with different extent bug, Fixed markerfacecolor as RGB tuple

2004-08-27 Mathtext now more than 5x faster. Thanks to Paul Mcguire for fixes both to pyparsing and to the matplotlib grammar! mathtext broken on python2.2

2004-08-25 Exposed Darren's and Greg's log ticking and formatting options to semilogx and friends

2004-08-23 Fixed grid w/o args to toggle grid state - JDH

2004-08-11 Added Gregory's log patches for major and minor ticking

2004-08-18 Some pixel edge effects fixes for images

2004-08-18 Fixed TTF files reads in backend_ps on win32.

2004-08-18 Added base and subs properties for logscale plots, user modifiable using set_[x,y]scale('log',base=b,subs=[mt1,mt2,...]) - GL

2004-08-18 fixed a bug exposed by trying to find the HOME dir on win32 thanks to Alan Issac for pointing to the light - JDH

2004-08-18 fixed errorbar bug in setting ecolor - JDH

2004-08-12 Added Darren Dale's exponential ticking patch

2004-08-11 Added Gregory's fltkagg backend

2004-08-09 matplotlib-0.61.0 released

2004-08-08 backend_gtk.py: get rid of the final PyGTK deprecation warning by replacing gtkOptionMenu with gtkMenu in the 2.4 version of the classic toolbar.

2004-08-06 Added Tk zoom to rect rectangle, proper idle drawing, and keybinding - JDH

2004-08-05 Updated installing.html and INSTALL - JDH

2004-08-01 backend_gtk.py: move all drawing code into the expose_event()

2004-07-28 Added Greg's toolbar2 and backend_*agg patches - JDH

2004-07-28 Added image.imread with support for loading png into numerix arrays

2004-07-28 Added key modifiers to events - implemented dynamic updates and rubber banding for interactive pan/zoom - JDH

2004-07-27 did a readthrough of SVG, replacing all the string additions with string interps for efficiency, fixed some layout problems, added font and image support (through external pngs) - JDH

2004-07-25 backend_gtk.py: modify toolbar2 to make it easier to support GTK+ 2.4. Add GTK+ 2.4 toolbar support. - SC

2004-07-24 backend_gtk.py: Simplified classic toolbar creation - SC

2004-07-24 Added images/matplotlib.svg to be used when GTK+ windows are minimised - SC

2004-07-22 Added right mouse click zoom for NavigationToolbar2 panning mode. - JTM

2004-07-22 Added NavigationToolbar2 support to backend_tkagg. Minor tweak to backend_bases. - JTM

2004-07-22 Incorporated Gergory's renderer cache and buffer object cache - JDH

2004-07-22 Backend_gtk.py: Added support for GtkFileChooser, changed FileSelection/FileChooser so that only one instance pops up, and made them both modal. - SC

2004-07-21 Applied backend_agg memory leak patch from hayden - jocallo@online.no. Found and fixed a leak in binary operations on transforms. Moral of the story: never incref where you meant to decref! Fixed several leaks in ft2font: moral of story: almost always return Py::asObject over Py::Object - JDH

2004-07-21 Fixed a to string memory allocation bug in agg and image modules - JDH

2004-07-21 Added mpl_connect and mpl_disconnect to matlab interface - JDH

2004-07-21 Added beginnings of users_guide to CVS - JDH

2004-07-20 ported toolbar2 to wx

2004-07-20 upgraded to agg21 - JDH

2004-07-20 Added new icons for toolbar2 - JDH

2004-07-19 Added vertical mathtext for *Agg and GTK - thanks Jim Benson! - JDH

2004-07-16 Added ps/eps/svg savefig options to wx and gtk JDH

2004-07-15 Fixed python framework tk finder in setupext.py - JDH

2004-07-14 Fixed layer images demo which was broken by the 07/12 image extent fixes - JDH

2004-07-13 Modified line collections to handle arbitrary length segments for each line segment. - JDH

2004-07-13 Fixed problems with image extent and origin - set_image_extent deprecated. Use imshow(blah, blah, extent=(xmin, xmax, ymin, ymax) instead - JDH

2004-07-12 Added prototype for new nav bar with codifed event handling. Use mpl_connect rather than connect for matplotlib event handling. toolbar style determined by rc toolbar param. backend status: gtk: prototype, wx: in progress, tk: not started - JDH

2004-07-11 backend_gtk.py: use builtin round() instead of redefining it.

- SC

2004-07-10 Added embedding_in_wx3 example - ADS

2004-07-09 Added dynamic_image_wxagg to examples - ADS

2004-07-09 added support for embedding TrueType fonts in PS files - PEB

2004-07-09 fixed a sfnt bug exposed if font cache is not built

2004-07-09 added default arg None to matplotlib.matlab grid command to toggle current grid state

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2004-07-08 0.60.2 released

2004-07-08 fixed a mathtext bug for '6'

2004-07-08 added some numarray bug workarounds

2004-07-07 0.60 released

2004-07-07 Fixed a bug in dynamic_demo_wx

2004-07-07 backend_gtk.py: raise SystemExit immediately if 'import pygtk' fails - SC

2004-07-05 Added new mathtext commands over{sym1}{sym2} and under{sym1}{sym2}

2004-07-05 Unified image and patch collections colormapping and scaling args. Updated docstrings for all - JDH

2004-07-05 Fixed a figure legend bug and added examples/figlegend_demo.py - JDH

2004-07-01 Fixed a memory leak in image and agg to string methods

2004-06-25 Fixed fonts_demo spacing problems and added a kwargs version of the fonts_demo fonts_demo_kw.py - JDH

2004-06-25 finance.py: handle case when urlopen() fails - SC

2004-06-24 Support for multiple images on axes and figure, with blending. Support for upper and lower image origins. clim, jet and gray functions in matlab interface operate on current image - JDH

2004-06-23 ported code to Perry's new colormap and norm scheme. Added new rc attributes image.aspect, image.interpolation, image.cmap, image.lut, image.origin

2004-06-20 backend_gtk.py: replace gtk.TRUE/FALSE with True/False. simplified _make_axis_menu(). - SC

2004-06-19 anim_tk.py: Updated to use TkAgg by default (not GTK) backend_gtk_py: Added '_' in front of private widget creation functions - SC

2004-06-17 backend_gtk.py: Create a GC once in realise(), not every time draw() is called. - SC

2004-06-16 Added new py2exe FAQ entry and added frozen support in get_data_path for py2exe - JDH

2004-06-16 Removed GTKGD, which was always just a proof-of-concept backend - JDH

2004-06-16 backend_gtk.py updates to replace deprecated functions

gtk.mainquit(), gtk.mainloop(). Update NavigationToolbar to use the new GtkToolbar API - SC

2004-06-15 removed set_default_font from font_manager to unify font customization using the new function rc. See API_CHANGES for more info. The examples fonts_demo.py and fonts_demo_kw.py are ported to the new API - JDH

2004-06-15 Improved (yet again!) axis scaling to properly handle singleton plots - JDH

2004-06-15 Restored the old FigureCanvasGTK.draw() - SC

2004-06-11 More memory leak fixes in transforms and ft2font - JDH

2004-06-11 Eliminated numerix .numerix file and environment variable NUMERIX. Fixed bug which prevented command line overrides: –numarray or –numeric. - JTM

2004-06-10 Added rc configuration function rc; deferred all rc param setting until object creation time; added new rc attrs: lines.markerfacecolor, lines.markeredgecolor, lines.markeredgewidth, patch.linewidth, patch.facecolor, patch.edgecolor, patch.antialiased; see examples/customize_rc.py for usage - JDH

2004-06-09 0.54.2 released

2004-06-08 Rewrote ft2font using CXX as part of general memory leak fixes; also fixed transform memory leaks - JDH

2004-06-07 Fixed several problems with log ticks and scaling - JDH

2004-06-07 Fixed width/height issues for images - JDH

2004-06-03 Fixed draw_if_interactive bug for semilogx;

2004-06-02 Fixed text clipping to clip to axes - JDH

2004-06-02 Fixed leading newline text and multiple newline text - JDH

2004-06-02 Fixed plot_date to return lines - JDH

2004-06-01 Fixed plot to work with x or y having shape N,1 or 1,N - JDH

2004-05-31 Added renderer markeredgewidth attribute of Line2D. - ADS

2004-05-29 Fixed tick label clipping to work with navigation.

2004-05-28 Added renderer grouping commands to support groups in SVG/PS. - JDH

2004-05-28 Fixed, this time I really mean it, the singleton plot plot([0]) scaling bug; Fixed Flavio's shape = N,1 bug - JDH

2004-05-28 added colorbar - JDH

2004-05-28 Made some changes to the matplotlib.colors.Colormap to propertly support clim - JDH

2004-05-27 0.54.1 released

2004-05-27 Lots of small bug fixes: rotated text at negative angles, errorbar capsize and autoscaling, right tick label position, gtkagg on win98, alpha of figure background, singleton plots - JDH

2004-05-26 Added Gary's errorbar stuff and made some fixes for length one plots and constant data plots - JDH

2004-05-25 Tweaked TkAgg backend so that canvas.draw() works more like the other backends. Fixed a bug resulting in 2 draws per figure mangager show(). - JTM

2004-05-19 0.54 released

2004-05-18 Added newline separated text with rotations to text.Text layout - JDH

2004-05-16 Added fast pcolor using PolyCollections. - JDH

2004-05-14 Added fast polygon collections - changed scatter to use them. Added multiple symbols to scatter. 10x speedup on large scatters using *Agg and 5X speedup for ps. - JDH

2004-05-14 On second thought... created an "nx" namespace in in numerix which maps type names onto typecodes the same way for both numarray and Numeric. This undoes my previous change immediately below. To get a typename for Int16 useable in a Numeric extension: say nx.Int16. - JTM

2004-05-15 Rewrote transformation class in extension code, simplified all the artist constructors - JDH

2004-05-14 Modified the type definitions in the numarray side of numerix so that they are Numeric typecodes and can be used with Numeric compilex extensions. The original numarray types were renamed to type<old_name>. - JTM

2004-05-06 Gary Ruben sent me a bevy of new plot symbols and markers. See matplotlib.matlab.plot - JDH

2004-05-06 Total rewrite of mathtext - factored ft2font stuff out of layout engine and defined abstract class for font handling to lay groundwork for ps mathtext. Rewrote parser and made layout engine much more precise. Fixed all the layout hacks. Added spacing commands / and hspace. Added composite chars and defined angstrom. - JDH

2004-05-05 Refactored text instances out of backend; aligned text with arbitrary rotations is now supported - JDH

2004-05-05 Added a Matrix capability for numarray to numerix. JTM

2004-05-04 Updated whats_new.html.template to use dictionary and template loop, added anchors for all versions and items; updated goals.txt to use those for links. PG

2004-05-04 Added fonts_demo.py to backend_driver, and AFM and TTF font caches to font_manager.py - PEB

2004-05-03 Redid goals.html.template to use a goals.txt file that has a pseudo restructured text organization. PG

2004-05-03 Removed the close buttons on all GUIs and added the python #! bang line to the examples following Steve Chaplin's advice on matplotlib dev

2004-04-29 Added CXX and rewrote backend_agg using it; tracked down and fixed agg memory leak - JDH

2004-04-29 Added stem plot command - JDH

2004-04-28 Fixed PS scaling and centering bug - JDH

2004-04-26 Fixed errorbar autoscale problem - JDH

2004-04-22 Fixed copy tick attribute bug, fixed singular datalim ticker bug; fixed mathtext fontsize interactive bug. - JDH

2004-04-21 Added calls to draw_if_interactive to axes(), legend(), and pcolor(). Deleted duplicate pcolor(). - JTM

2004-04-21 matplotlib 0.53 release

2004-04-19 Fixed vertical alignment bug in PS backend - JDH

2004-04-17 Added support for two scales on the "same axes" with tick different ticking and labeling left right or top bottom. See examples/two_scales.py - JDH

2004-04-17 Added default dirs as list rather than single dir in setupext.py - JDH

2004-04-16 Fixed wx exception swallowing bug (and there was much rejoicing!) - JDH

2004-04-16 Added new ticker locator a formatter, fixed default font return - JDH

2004-04-16 Added get_name method to FontProperties class. Fixed font lookup in GTK and WX backends. - PEB

2004-04-16 Added get- and set_fontstyle msethods. - PEB

2004-04-10 Mathtext fixes: scaling with dpi, - JDH

2004-04-09 Improved font detection algorithm. - PEB

2004-04-09 Move deprecation warnings from text.py to __init__.py - PEB

2004-04-09 Added default font customization - JDH

2004-04-08 Fixed viewlim set problem on axes and axis. - JDH

2004-04-07 Added validate_comma_sep_str and font properties paramaters to __init__. Removed font families and added rcParams to FontProperties __init__ arguments in font_manager. Added default font property parameters to .matplotlibrc file with descriptions. Added deprecation warnings to the get_ - and set_fontXXX methods of the Text object. - PEB

2004-04-06 Added load and save commands for ASCII data - JDH

2004-04-05 Improved font caching by not reading AFM fonts until needed. Added better documentation. Changed the behaviour of the get_family, set_family, and set_name methods of FontProperties. - PEB

2004-04-05 Added WXAgg backend - JDH

2004-04-04 Improved font caching in backend_agg with changes to font_manager - JDH

2004-03-29 Fixed fontdicts and kwargs to work with new font manager - JDH

This is the Old, stale, never used changelog

2002-12-10 - Added a TODO file and CHANGELOG. Lots to do – get

crackin'!

- Fixed y zoom tool bug
- Adopted a compromise fix for the y data clipping problem. The problem was that for solid lines, the y data clipping (as opposed to the gc clipping) caused artifactual horizontal solid lines near the ylim boundaries. I did a 5% offset hack in Axes set_ylim functions which helped, but didn't cure the problem for very high gain y zooms. So I disabled y data clipping for connected lines . If you need extensive y clipping, either plot(y,x) because x data clipping is always enabled, or change the _set_clip code to 'if 1' as indicated in the lines.py src. See _set_clip in lines.py and set_ylim in figure.py for more information.

2002-12-11 - Added a measurement dialog to the figure window to

measure axes position and the delta x delta y with a left mouse drag. These defaults can be overridden by deriving from Figure and overrriding button_press_event, button_release_event, and motion_notify_event, and _dialog_measure_tool.

- fixed the navigation dialog so you can check the axes the navigation buttons apply to.

2003-04-23 Released matplotlib v0.1

2003-04-24 Added a new line style PixelLine2D which is the plots the markers as pixels (as small as possible) with format symbol ','

Added a new class Patch with derived classes Rectangle, RegularPolygon and Circle

2003-04-25 Implemented new functions errorbar, scatter and hist

Added a new line type '|' which is a vline. syntax is plot(x, Y, '|') where y.shape = len(x),2 and each row gives the ymin,ymax for the respective values of x. Previously I had implemented vlines as a list of lines, but I needed the efficientcy of the numeric clipping for large numbers of vlines outside the viewport, so I wrote a dedicated class Vline2D which derives from Line2D

2003-05-01

Fixed ytick bug where grid and tick show outside axis viewport with gc clip

2003-05-14

Added new ways to specify colors 1) matlab format string 2) html-style hex string, 3) rgb tuple. See examples/color_demo.py

2003-05-28

Changed figure rendering to draw form a pixmap to reduce flicker. See examples/system_monitor.py for an example where the plot is continusouly updated w/o flicker. This example is meant to simulate a system monitor that shows free CPU, RAM, etc...

2003-08-04

Added Jon Anderson's GTK shell, which doesn't require pygtk to have threading built-in and looks nice!

2003-08-25

Fixed deprecation warnings for python2.3 and pygtk-1.99.18

2003-08-26

Added figure text with new example examples/figtext.py

2003-08-27

Fixed bugs i figure text with font override dictionairies and fig text that was placed outside the window bounding box

2003-09-1 thru 2003-09-15

Added a postscript and a GD module backend

2003-09-16

Fixed font scaling and point scaling so circles, squares, etc on lines will scale with DPI as will fonts. Font scaling is not fully implemented on the gtk backend because I have not figured out how to scale fonts to arbitrary sizes with GTK

2003-09-17

Fixed figure text bug which crashed X windows on long figure text extending beyond display area. This was, I believe, due to the vestigial erase functionality that was no longer needed since I began rendering to a pixmap

2003-09-30 Added legend

2003-10-01 Fixed bug when colors are specified with rgb tuple or hex string.

2003-10-21 Andrew Straw provided some legend code which I modified and incorporated. Thanks Andrew!

2003-10-27 Fixed a bug in axis.get_view_distance that affected zoom in versus out with interactive scrolling, and a bug in the axis text reset system that prevented the text from being redrawn on a interactive gtk view lim set with the widget

Fixed a bug in that prevented the manual setting of ticklabel strings from working properly

2003-11-02 - Do a nearest neighbor color pick on GD when allocate fails

2003-11-02

- Added pcolor plot
- Added MRI example
- Fixed bug that screwed up label position if xticks or yticks were empty
- added nearest neighbor color picker when GD max colors exceeded
- fixed figure background color bug in GD backend

2003-11-10 - 2003-11-11

- major refactoring.
  - Ticks (with labels, lines and grid) handled by dedicated class
  - Artist now know bounding box and dpi
  - Bounding boxes and transforms handled by dedicated classes
  - legend in dedicated class. Does a better job of alignment and bordering. Can be initialized with specific line instances. See examples/legend_demo2.py

2003-11-14 Fixed legend positioning bug and added new position args

2003-11-16 Finsihed porting GD to new axes API

2003-11-20 - add TM for matlab on website and in docs

2003-11-20 - make a nice errorbar and scatter screenshot

2003-11-20 - auto line style cycling for multiple line types broken

2003-11-18 (using inkrect) :logical rect too big on gtk backend

2003-11-18 ticks don't reach edge of axes in gtk mode – rounding error?

2003-11-20 - port Gary's errorbar code to new API before 0.40

2003-11-20 - problem with stale _set_font. legend axes box doesn't resize on save in GTK backend – see htdocs legend_demo.py

2003-11-21 - make a dash-dot dict for the GC

2003-12-15 - fix install path bug

5.3.2 New in matplotlib 0.98.4

Table of Contents

- *New in matplotlib 0.98.4*
  - *Legend enhancements*
  - *Fancy annotations and arrows*
  - *Native OS X backend*
  - *psd amplitude scaling*
  - *Fill between*
  - *Lots more*

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

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`.

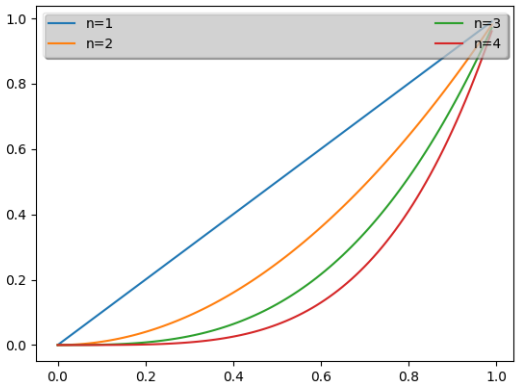

Fig. 1: Whats New 98 4 Legend

Fancy annotations and arrows

Jae-Joon has added lots of support to annotations for drawing fancy boxes and connectors in annotations. See *annotate()* and *BoxStyle*, *ArrowStyle*, and *ConnectionStyle*.

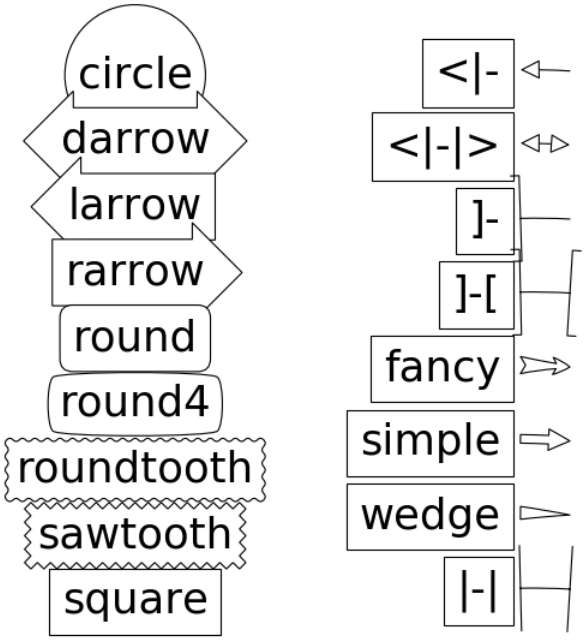

Fig. 2: Whats New 98 4 Fancy

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
```

psd amplitude scaling

Ryan May did a lot of work to rationalize the amplitude scaling of *psd()* and friends. See /gallery/lines_bars_and_markers/psd_demo. The changes should increase MATLAB compatibility and increase scaling options.

Fill between

Added a *fill_between()* function to make it easier to do shaded region plots in the presence of masked data. You can pass an *x* array and a *ylower* and *yupper* array to fill between, and an optional *where* argument which is a logical mask where you want to do the filling.

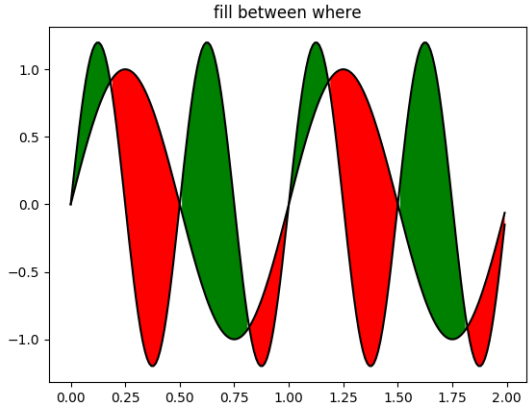

Fig. 3: Whats New 98 4 Fill Between

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
pretty-printed 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, e.g., 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.  The 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
```

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```
Fixed a bug in svg backend that new_figure_manager() ignores
keywords arguments such as figsize, etc. -JJL

Fixed a bug that the handlelength of the new legend class set too
short when numpoints=1 -JJL

Added support for data with units (e.g., dates) to
Axes.fill_between. -RM

Added fancybox keyword to legend. Also applied some changes for
better look, including baseline adjustment of the multiline texts
so that it is center aligned. -JJL

The transmuter classes in the patches.py are reorganized as
subclasses of the Style classes. A few more box and arrow styles
are added. -JJL

Fixed a bug in the new legend class that didn't allowed a tuple of
coordinate values as loc. -JJL

Improve checks for external dependencies, using subprocess
(instead of deprecated popen*) and distutils (for version
checking) - DSD

Reimplementation of the legend which supports baseline alignment,
multi-column, and expand mode. - JJL

Fixed histogram autoscaling bug when bins or range are given
explicitly (fixes Debian bug 503148) - MM

Added rcParam axes.unicode_minus which allows plain hyphen 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
```

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```
Add 'pad_to' and 'sides' parameters to mlab.psd() to allow
controlling of zero padding and returning of negative frequency
components, respectively.  These are added in a way that does not
change the API. - RM

Fix handling of c kwarg by scatter; generalize is_string_like to
accept numpy and numpy.ma string array scalars. - RM and EF

Fix a possible EINTR problem in dviread, which might help when
saving pdf files from the qt backend. - JKS

Fix bug with zoom to rectangle and twin axes - MGD

Added Jae Joon's fancy arrow, box and annotation enhancements --
see examples/pylab_examples/annotation_demo2.py

Autoscaling is now supported with shared axes - EF

Fixed exception in dviread that happened with Minion - JKS

set_xlim, ylim now return a copy of the viewlim array to avoid
modify inplace surprises

Added image thumbnail generating function
matplotlib.image.thumbnail.  See examples/misc/image_thumbnail.py
- JDH

Applied scatleg patch based on ideas and work by Erik Tollerud and
Jae-Joon Lee. - MM

Fixed bug in pdf backend: if you pass a file object for output
instead of a filename, e.g., in a 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
```

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```
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
```

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```
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

Added support for arbitrary rasterization resolutions to the SVG
backend. - MW
```

5.3.3 New in matplotlib 0.99

Table of Contents

- *New in matplotlib 0.99*
  - *New documentation*
  - *mplot3d*
  - *axes grid toolkit*
  - *Axis spine placement*

New documentation

Jae-Joon Lee has written two new guides *Legend guide* and *Advanced Annotation*. Michael Sarahan has written *Image tutorial*. John Hunter has written two new tutorials on working with paths and transformations: *Path Tutorial* and *Transformations Tutorial*.

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-index and *Getting started*

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

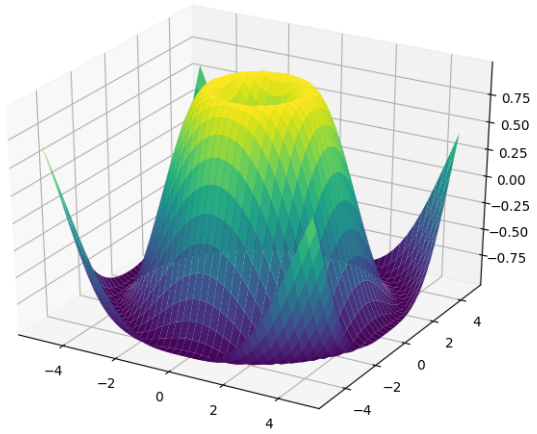


Fig. 4: Whats New 99 Mplot3d

all new mpl installs. See axes_grid1-examples-index, axisartist-examples-index, *What is axes_grid1 toolkit?* and *axisartist*

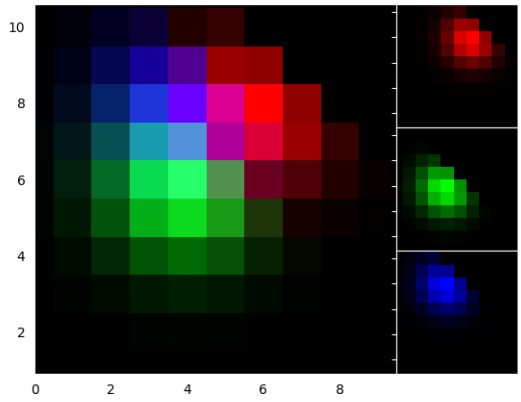


Fig. 5: Whats New 99 Axes Grid

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 /gallery/ticks_and_spines/spine_placement_demo and `matplotlib.spines.Spine`.

5.3.4 New in matplotlib 1.0

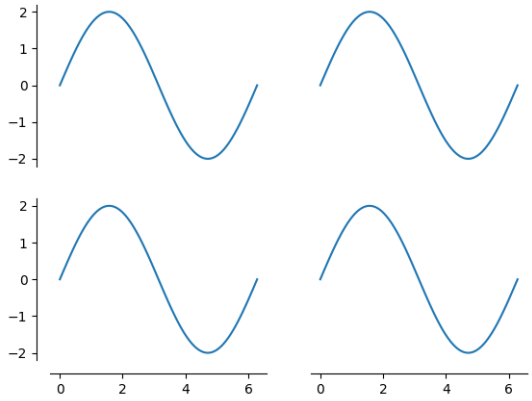


Fig. 6: Whats New 99 Spines

Table of Contents

- *New in matplotlib 1.0*
  - *HTML5/Canvas backend*
  - *Sophisticated subplot grid layout*
  - *Easy pythonic subplots*
  - *Contour fixes and and triplot*
  - *multiple calls to show supported*
  - *mplot3d graphs can be embedded in arbitrary axes*
  - *tick_params*
  - *Lots of performance and feature enhancements*
  - *Much improved software carpentry*
  - *Bugfix marathon*

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.

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 Figure Layouts Using GridSpec and Other Functions* for a tutorial overview.

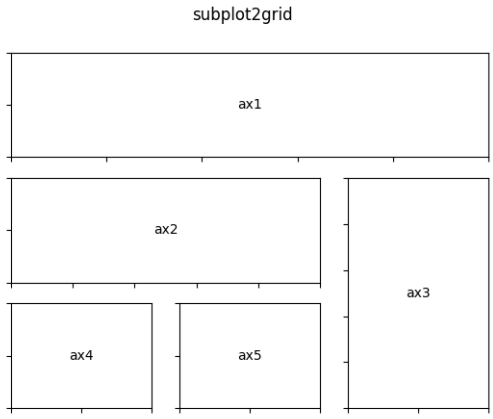


Fig. 7: Demo Gridspec01

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). e.g.:

```
fig, axarr = plt.subplots(2, 2)
axarr[0,0].plot([1,2,3])   # upper, left
```

See /gallery/subplots_axes_and_figures/subplot_demo for several code examples.

Contour fixes and and triplot

Ian Thomas has fixed a long-standing bug that has vexed our most talented developers for years. *contourf()* now handles interior masked regions, and the boundaries of line and filled contours coincide.

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

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

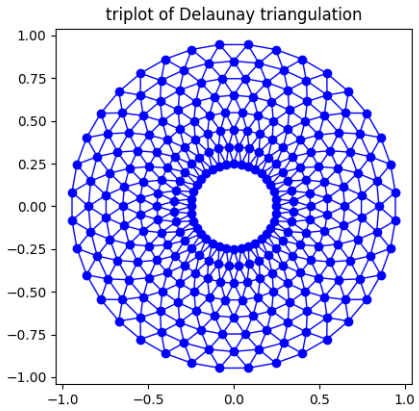


Fig. 8: Triplot Demo

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.

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.

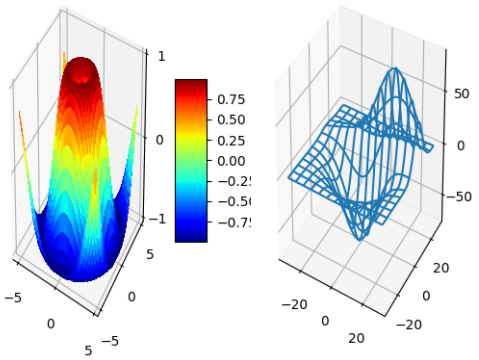


Fig. 9: Whats New 1 Subplot3d

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()*.

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

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.

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.

5.3.5 New in matplotlib 1.1

Table of Contents

- *New in matplotlib 1.1*
  - *Sankey Diagrams*
  - *Animation*
  - *Tight Layout*
  - *PyQT4, PySide, and IPython*
  - *Legend*
  - *mplot3d*
  - *Numerix support removed*
  - *Markers*
  - *Other improvements*

Note: matplotlib 1.1 supports Python 2.4 to 2.7

Sankey Diagrams

Kevin Davies has extended Yannick Copin's original Sankey example into a module (*sankey*) and provided new examples (/gallery/api/sankey_basics, /gallery/api/sankey_links, /gallery/api/sankey_rankine).

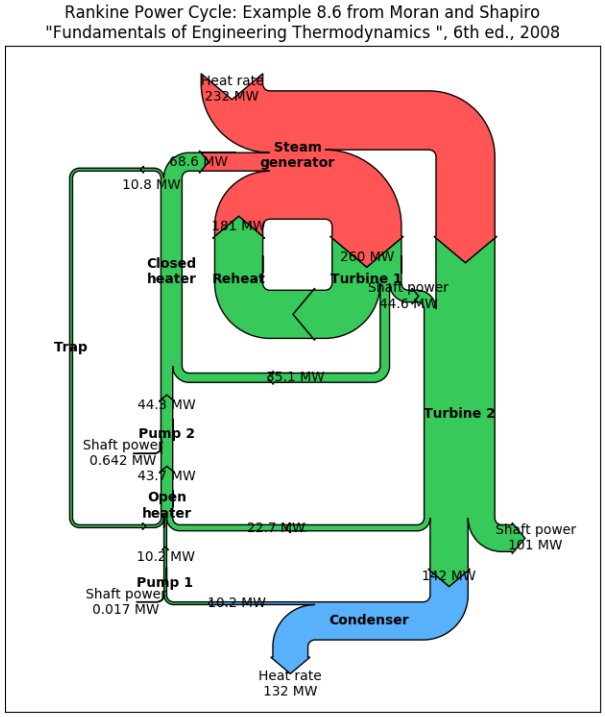


Fig. 10: Sankey Rankine

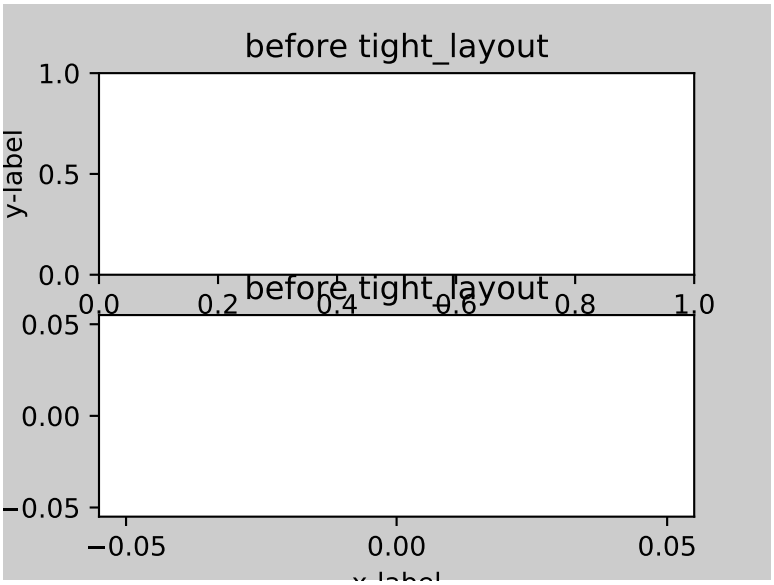
Animation

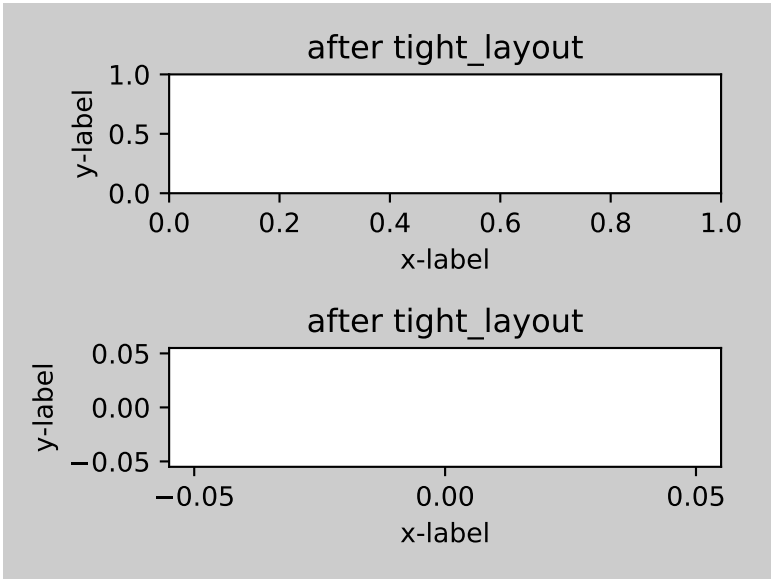
Ryan May has written a backend-independent framework for creating animated figures. The *animation* module is intended to replace the backend-specific examples formerly in the examples-index listings. Examples using the new framework are in animation-examples-index; see the entrancing `double pendulum <gallery/animation/double_pendulum_sgskip.py>` which uses *matplotlib.animation.Animation.save()* to create the movie below.

This should be considered as a beta release of the framework; please try it and provide feedback.

Tight Layout

A frequent issue raised by users of matplotlib is the lack of a layout engine to nicely space out elements of the plots. While matplotlib still adheres to the philosophy of giving users complete control over the placement of plot elements, Jae-Joon Lee created the *tight_layout* module and introduced a new command *tight_layout()* to address the most common layout issues.





The usage of this functionality can be as simple as

```
plt.tight_layout()
```

and it will adjust the spacing between subplots so that the axis labels do not overlap with neighboring subplots. A *Tight Layout guide* has been created to show how to use this new tool.

PyQT4, PySide, and IPython

Gerald Storer made the Qt4 backend compatible with PySide as well as PyQT4. At present, however, PySide does not support the PyOS_InputHook mechanism for handling gui events while waiting for text input, so it cannot be used with the new version 0.11 of IPython. Until this feature appears in PySide, IPython users should use the PyQT4 wrapper for QT4, which remains the matplotlib default.

An rcParam entry, "backend.qt4", has been added to allow users to select PyQt4, PyQt4v2, or PySide. The latter two use the Version 2 Qt API. In most cases, users can ignore this rcParam variable; it is available to aid in testing, and to provide control for users who are embedding matplotlib in a PyQt4 or PySide app.

Legend

Jae-Joon Lee has improved plot legends. First, legends for complex plots such as `stem()` plots will now display correctly. Second, the 'best' placement of a legend has been improved in the presence of NANs.

See the *Legend guide* for more detailed explanation and examples.

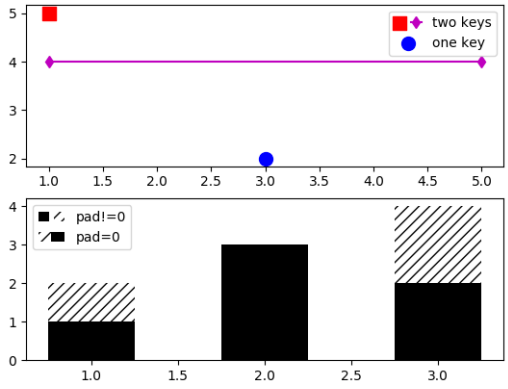


Fig. 11: Legend Demo4

mplot3d

In continuing the efforts to make 3D plotting in matplotlib just as easy as 2D plotting, Ben Root has made several improvements to the `mplot3d` module.

- `Axes3D` has been improved to bring the class towards feature-parity with regular Axes objects
- Documentation for *Getting started* was significantly expanded
- Axis labels and orientation improved
- Most 3D plotting functions now support empty inputs
- Ticker offset display added:
- `contourf()` gains *zdir* and *offset* kwargs. You can now do this:

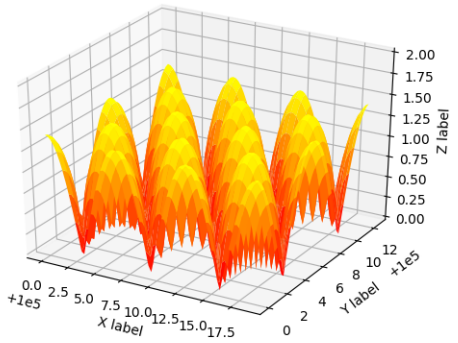


Fig. 12: Offset

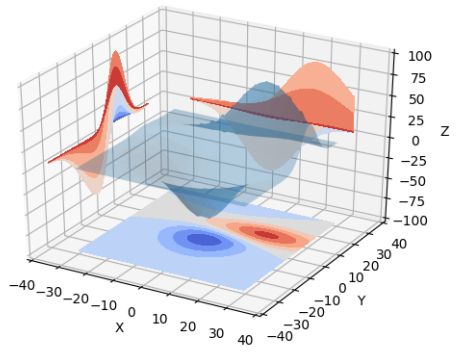


Fig. 13: Contourf3d 2

Numerix support removed

After more than two years of deprecation warnings, Numerix support has now been completely removed from matplotlib.

Markers

The list of available markers for *plot()* and *scatter()* has now been merged. While they were mostly similar, some markers existed for one function, but not the other. This merge did result in a conflict for the 'd' diamond marker. Now, 'd' will be interpreted to always mean "thin" diamond while 'D' will mean "regular" diamond.

Thanks to Michael Droettboom for this effort.

Other improvements

- Unit support for polar axes and *arrow()*
- *PolarAxes* gains getters and setters for "theta_direction", and "theta_offset" to allow for theta to go in either the clock-wise or counter-clockwise direction and to specify where zero degrees should be placed. *set_theta_zero_location()* is an added convenience function.
- Fixed error in argument handling for tri-functions such as *tripcolor()*
- `axes.labelweight` parameter added to rcParams.
- For *imshow()*, *interpolation='nearest'* will now always perform an interpolation. A "none" option has been added to indicate no interpolation at all.
- An error in the Hammer projection has been fixed.
- *clabel* for *contour()* now accepts a callable. Thanks to Daniel Hyams for the original patch.
- Jae-Joon Lee added the `HBox` and `VBox` classes.
- Christoph Gohlke reduced memory usage in *imshow()*.
- *scatter()* now accepts empty inputs.
- The behavior for 'symlog' scale has been fixed, but this may result in some minor changes to existing plots. This work was refined by ssyr.
- Peter Butterworth added named figure support to *figure()*.
- Michiel de Hoon has modified the MacOSX backend to make its interactive behavior consistent with the other backends.
- Pim Schellart added a new colormap called "cubehelix". Sameer Grover also added a colormap called "coolwarm". See it and all other colormaps *here*.
- Many bug fixes and documentation improvements.

5.3.6 New in matplotlib 1.2

Table of Contents

- *New in matplotlib 1.2*
  - *Python 3.x support*
  - *PGF/TikZ backend*
  - *Locator interface*
  - *Tri-Surface Plots*
  - *Control the lengths of colorbar extensions*
  - *Figures are picklable*
  - *Set default bounding box in matplotlibrc*
  - *New Boxplot Functionality*
  - *New RC parameter functionality*
  - *Streamplot*
  - *New hist functionality*
  - *Updated shipped dependencies*
  - *Face-centred colors in tripcolor plots*
  - *Hatching patterns in filled contour plots, with legends*
  - *Known issues in the matplotlib 1.2 release*

Note: matplotlib 1.2 supports Python 2.6, 2.7, and 3.1

Python 3.x support

Matplotlib 1.2 is the first version to support Python 3.x, specifically Python 3.1 and 3.2. To make this happen in a reasonable way, we also had to drop support for Python versions earlier than 2.6.

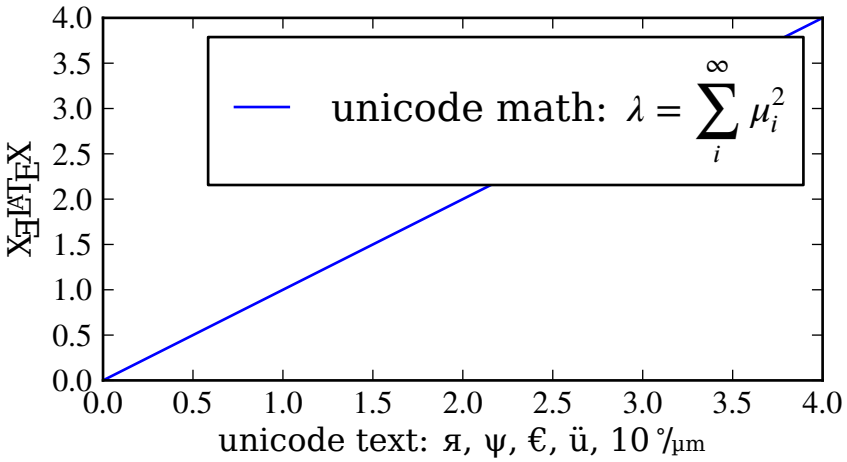
This work was done by Michael Droettboom, the Cape Town Python Users' Group, many others and supported financially in part by the SAGE project.

The following GUI backends work under Python 3.x: Gtk3Cairo, Qt4Agg, TkAgg and MacOSX. The other GUI backends do not yet have adequate bindings for Python 3.x, but continue to work on Python 2.6 and 2.7, particularly the Qt and QtAgg backends (which have been deprecated). The non-GUI backends, such as PDF, PS and SVG, work on both Python 2.x and 3.x.

Features that depend on the Python Imaging Library, such as JPEG handling, do not work, since the version of PIL for Python 3.x is not sufficiently mature.

PGF/TikZ backend

Peter Würtz wrote a backend that allows matplotlib to export figures as drawing commands for LaTeX. These can be processed by PdfLaTeX, XeLaTeX or LuaLaTeX using the PGF/TikZ package. Usage examples and documentation are found in *Typesetting With XeLaTeX/LuaLaTeX*.



Locator interface

Philip Elson exposed the intelligence behind the tick Locator classes with a simple interface. For instance, to get no more than 5 sensible steps which span the values 10 and 19.5:

```
>>> import matplotlib.ticker as mticker
>>> locator = mticker.MaxNLocator(nbins=5)
>>> print(locator.tick_values(10, 19.5))
[ 10.  12.  14.  16.  18.  20.]
```

Tri-Surface Plots

Damon McDougall added a new plotting method for the `mplot3d` toolkit called *plot_trisurf()*.

Control the lengths of colorbar extensions

Andrew Dawson added a new keyword argument *extendfrac* to *colorbar()* to control the length of minimum and maximum colorbar extensions.

Figures are picklable

Philip Elson added an experimental feature to make figures picklable for quick and easy short-term storage of plots. Pickle files are not designed for long term storage, are unsupported when restoring a pickle saved in another matplotlib version and are insecure when restoring a pickle from an untrusted source. Having said this, they are useful for short term storage for later modification inside matplotlib.

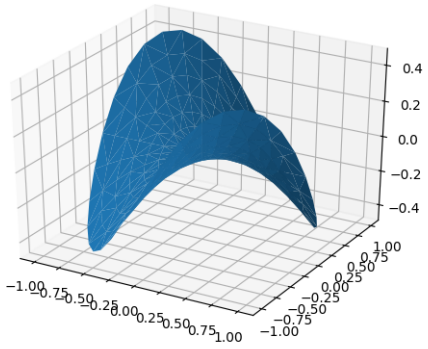
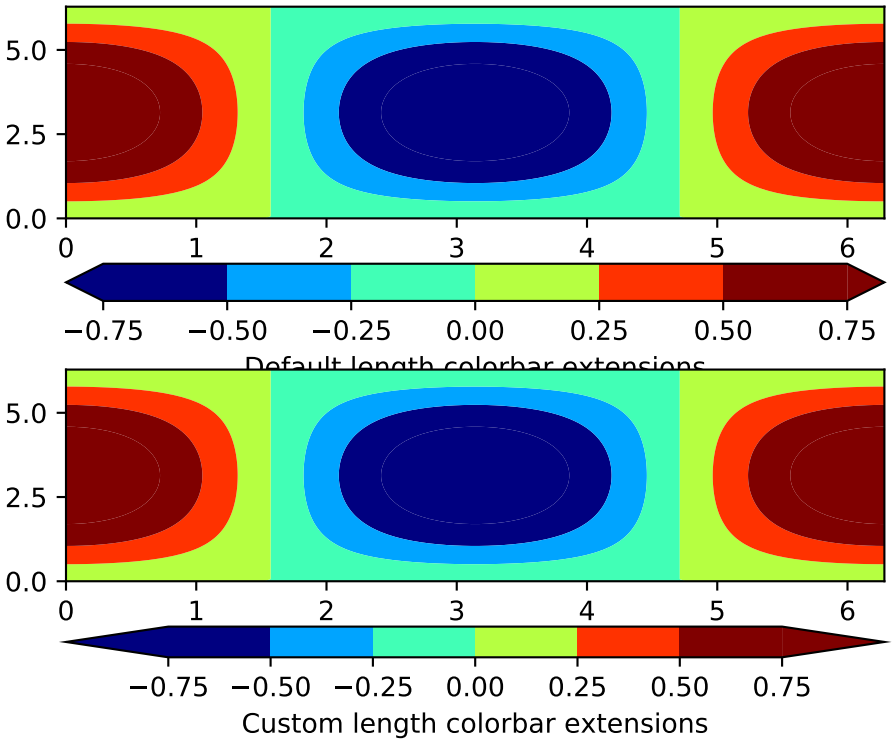


Fig. 14: Trisurf3d



Set default bounding box in matplotlibrc

Two new defaults are available in the matplotlibrc configuration file: `savefig.bbox`, which can be set to 'standard' or 'tight', and `savefig.pad_inches`, which controls the bounding box padding.

New Boxplot Functionality

Users can now incorporate their own methods for computing the median and its confidence intervals into the `boxplot()` method. For every column of data passed to boxplot, the user can specify an accompanying median and confidence interval.

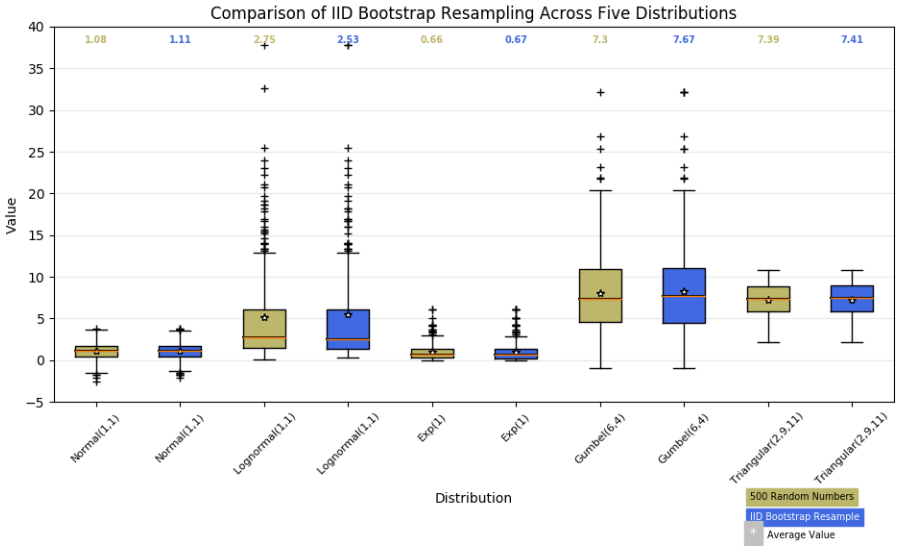


Fig. 15: Boxplot Demo3

New RC parameter functionality

Matthew Emmett added a function and a context manager to help manage RC parameters: *rc_file()* and *rc_context*. To load RC parameters from a file:

```
>>> mpl.rc_file('mpl.rc')
```

To temporarily use RC parameters:

```
>>> with mpl.rc_context(fname='mpl.rc', rc={'text.usetex': True}):
>>>     ...
```

Streamplot

Tom Flannaghan and Tony Yu have added a new *streamplot()* function to plot the streamlines of a vector field. This has been a long-requested feature and complements the existing *quiver()* function for plotting

vector fields. In addition to simply plotting the streamlines of the vector field, *streamplot()* allows users to map the colors and/or line widths of the streamlines to a separate parameter, such as the speed or local intensity of the vector field.

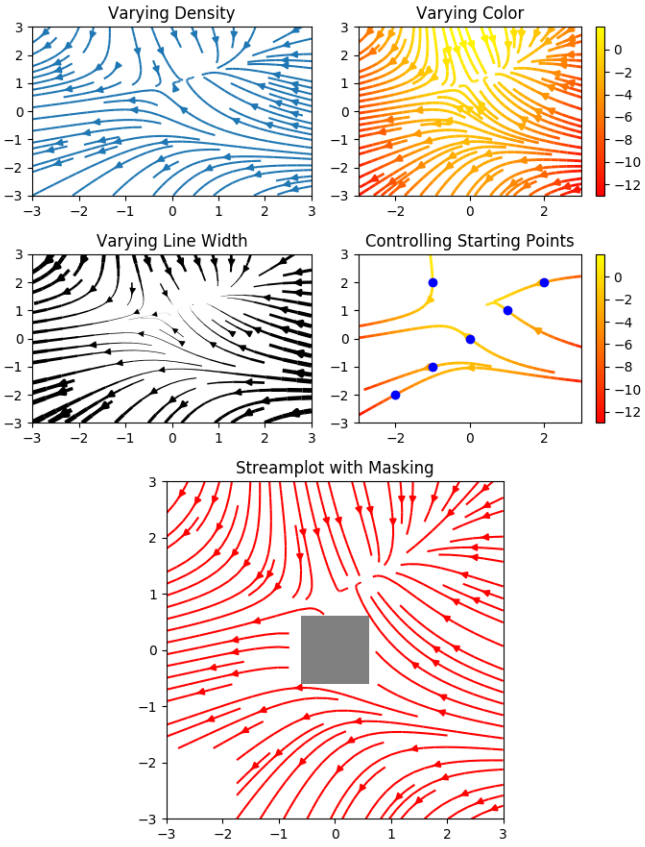


Fig. 16: Plot Streamplot

New hist functionality

Nic Eggert added a new `stacked` kwarg to *hist()* that allows creation of stacked histograms using any of the histogram types. Previously, this functionality was only available by using the `barstacked` histogram type. Now, when `stacked=True` is passed to the function, any of the histogram types can be stacked. The `barstacked` histogram type retains its previous functionality for backwards compatibility.

Updated shipped dependencies

The following dependencies that ship with matplotlib and are optionally installed alongside it have been updated:

- `pytz` 2012d
- `dateutil` 1.5 on Python 2.x, and 2.1 on Python 3.x

Face-centred colors in tripcolor plots

Ian Thomas extended *tripcolor()* to allow one color value to be specified for each triangular face rather than for each point in a triangulation.

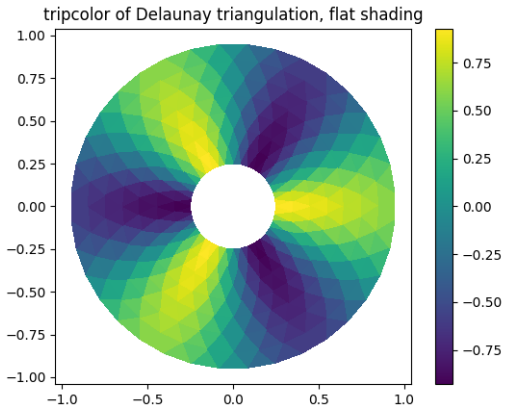


Fig. 17: Tripcolor Demo

Hatching patterns in filled contour plots, with legends

Phil Elson added support for hatching to *contourf()*, together with the ability to use a legend to identify contoured ranges.

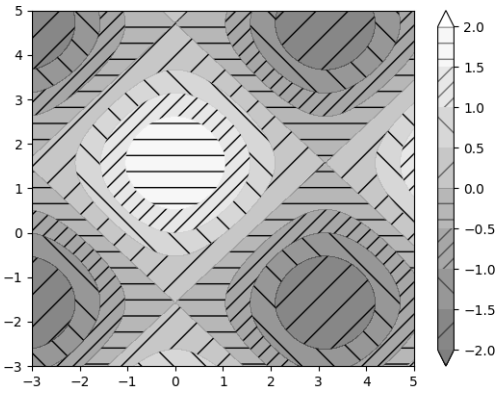


Fig. 18: Contourf Hatching

Known issues in the matplotlib 1.2 release

- When using the Qt4Agg backend with IPython 0.11 or later, the save dialog will not display. This should be fixed in a future version of IPython.

5.3.7 New in matplotlib 1.2.2

Table of Contents

- *New in matplotlib 1.2.2*
  - *Improved collections*
  - *Multiple images on same axes are correctly transparent*

Improved collections

The individual items of a collection may now have different alpha values and be rendered correctly. This also fixes a bug where collections were always filled in the PDF backend.

Multiple images on same axes are correctly transparent

When putting multiple images onto the same axes, the background color of the axes will now show through correctly.

5.3.8 New in matplotlib 1.3

Table of Contents

- *New in matplotlib 1.3*
  - *New in 1.3.1*
  - *New plotting features*
  - *Updated Axes3D.contour methods*
  - *Drawing*
  - *Text*
  - *Configuration (rcParams)*
  - *Backends*
  - *Documentation and examples*
  - *Infrastructure*

Note: matplotlib 1.3 supports Python 2.6, 2.7, 3.2, and 3.3

New in 1.3.1

1.3.1 is a bugfix release, primarily dealing with improved setup and handling of dependencies, and correcting and enhancing the documentation.

The following changes were made in 1.3.1 since 1.3.0.

Enhancements

- Added a context manager for creating multi-page pdfs (see *matplotlib.backends.backend_pdf.PdfPages*).
- The WebAgg backend should now have lower latency over heterogeneous Internet connections.

Bug fixes

- Histogram plots now contain the endline.
- Fixes to the Molleweide projection.
- Handling recent fonts from Microsoft and Macintosh-style fonts with non-ascii metadata is improved.
- Hatching of fill between plots now works correctly in the PDF backend.
- Tight bounding box support now works in the PGF backend.
- Transparent figures now display correctly in the Qt4Agg backend.
- Drawing lines from one subplot to another now works.
- Unit handling on masked arrays has been improved.

Setup and dependencies

- Now works with any version of pyparsing 1.5.6 or later, without displaying hundreds of warnings.
- Now works with 64-bit versions of Ghostscript on MS-Windows.
- When installing from source into an environment without Numpy, Numpy will first be downloaded and built and then used to build matplotlib.
- Externally installed backends are now always imported using a fully-qualified path to the module.
- Works with newer version of wxPython.
- Can now build with a PyCXX installed globally on the system from source.
- Better detection of Gtk3 dependencies.

Testing

- Tests should now work in non-English locales.
- PEP8 conformance tests now report on locations of issues.

New plotting features

xkcd-style sketch plotting

To give your plots a sense of authority that they may be missing, Michael Droettboom (inspired by the work of many others in PR #1329) has added an xkcd-style sketch plotting mode. To use it, simply call *matplotlib.pyplot.xkcd()* before creating your plot. For really fine control, it is also possible to modify each artist's sketch parameters individually with *matplotlib.artist.Artist.set_sketch_params()*.

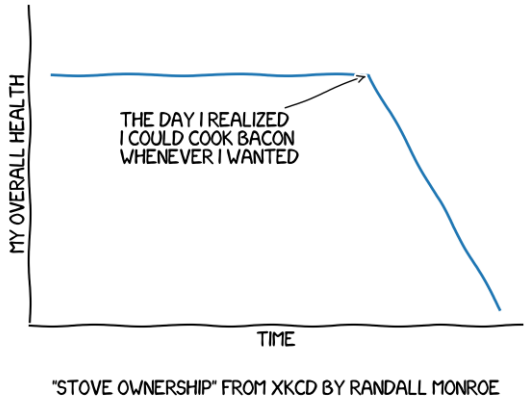


Fig. 19: Xkcd

Updated Axes3D.contour methods

Damon McDougall updated the *tricontour()* and *tricontourf()* methods to allow 3D contour plots on abitrary unstructured user-specified triangulations.

New eventplot plot type

Todd Jennings added a *eventplot()* function to create multiple rows or columns of identical line segments

As part of this feature, there is a new *EventCollection* class that allows for plotting and manipulating rows or columns of identical line segments.

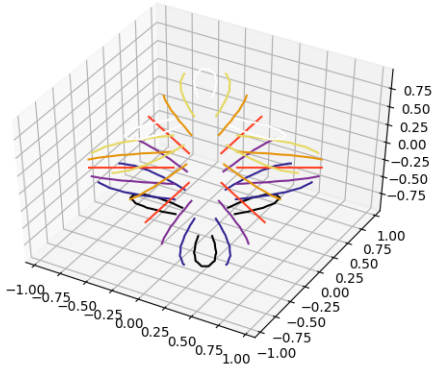


Fig. 20: Tricontour3d

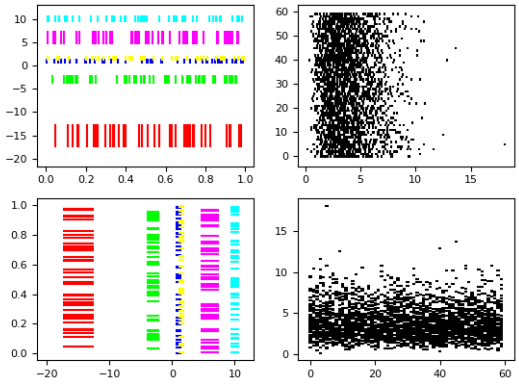


Fig. 21: Eventplot Demo

Triangular grid interpolation

Geoffroy Billotey and Ian Thomas added classes to perform interpolation within triangular grids: (`LinearTriInterpolator` and `CubicTriInterpolator`) and a utility class to find the triangles in which points lie (`TrapezoidMapTriFinder`). A helper class to perform mesh refinement and smooth contouring was also added (`UniformTriRefiner`). Finally, a class implementing some basic tools for triangular mesh improvement was added (`TriAnalyzer`).

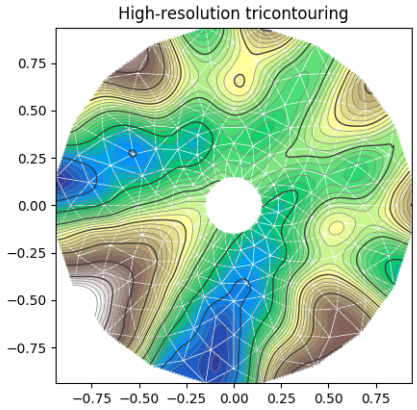


Fig. 22: Tricontour Smooth User

Baselines for stackplot

Till Stensitzki added non-zero baselines to `stackplot()`. They may be symmetric or weighted.

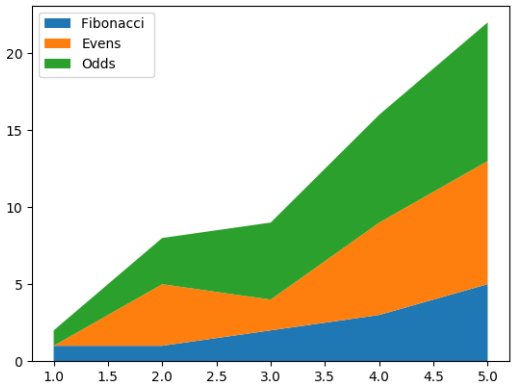


Fig. 23: Stackplot Demo2

Rectangular colorbar extensions

Andrew Dawson added a new keyword argument *extendrect* to `colorbar()` to optionally make colorbar extensions rectangular instead of triangular.

More robust boxplots

Paul Hobson provided a fix to the `boxplot()` method that prevent whiskers from being drawn inside the box for oddly distributed data sets.

Calling subplot() without arguments

A call to `subplot()` without any arguments now acts the same as `subplot(111)` or `subplot(1,1,1)` – it creates one axes for the whole figure. This was already the behavior for both `axes()` and `subplots()`, and now this consistency is shared with `subplot()`.

Drawing

Independent alpha values for face and edge colors

Wes Campaigne modified how `Patch` objects are drawn such that (for backends supporting transparency) you can set different alpha values for faces and edges, by specifying their colors in RGBA format. Note that if you set the alpha attribute for the patch object (e.g. using `set_alpha()` or the `alpha` keyword argument), that value will override the alpha components set in both the face and edge colors.

Path effects on lines

Thanks to Jae-Joon Lee, path effects now also work on plot lines.

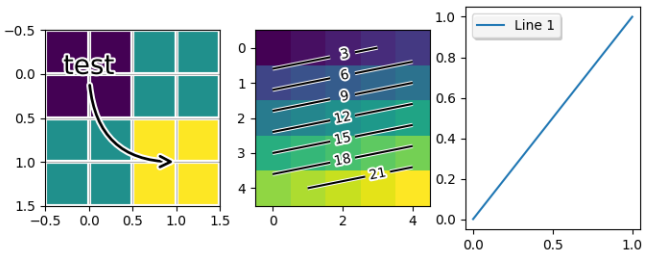


Fig. 24: Patheffect Demo

Easier creation of colormap and normalizer for levels with colors

Phil Elson added the *matplotlib.colors.from_levels_and_colors()* function to easily create a colormap and normalizer for representation of discrete colors for plot types such as *matplotlib.pyplot.pcolormesh()*, with a similar interface to that of `contourf()`.

Full control of the background color

Wes Campaigne and Phil Elson fixed the Agg backend such that PNGs are now saved with the correct background color when `fig.patch.get_alpha()` is not 1.

Improved `bbox_inches="tight"` functionality

Passing `bbox_inches="tight"` through to `plt.save()` now takes into account *all* artists on a figure - this was previously not the case and led to several corner cases which did not function as expected.

Initialize a rotated rectangle

Damon McDougall extended the *Rectangle* constructor to accept an `angle` kwarg, specifying the rotation of a rectangle in degrees.

Text

Anchored text support

The `svg` and `pgf` backends are now able to save text alignment information to their output formats. This allows to edit text elements in saved figures, using Inkscape for example, while preserving their intended position. For `svg` please note that you'll have to disable the default text-to-path conversion (`mpl.rc('svg', fonttype='none')`).

Better vertical text alignment and multi-line text

The vertical alignment of text is now consistent across backends. You may see small differences in text placement, particularly with rotated text.

If you are using a custom backend, note that the `draw_text` renderer method is now passed the location of the baseline, not the location of the bottom of the text bounding box.

Multi-line text will now leave enough room for the height of very tall or very low text, such as superscripts and subscripts.

Left and right side axes titles

Andrew Dawson added the ability to add axes titles flush with the left and right sides of the top of the axes using a new keyword argument `loc` to *title()*.

Improved manual contour plot label positioning

Brian Mattern modified the manual contour plot label positioning code to interpolate along line segments and find the actual closest point on a contour to the requested position. Previously, the closest path vertex was used, which, in the case of straight contours was sometimes quite distant from the requested location. Much more precise label positioning is now possible.

Configuration (rcParams)

Quickly find rcParams

Phil Elson made it easier to search for rcParameters by passing a valid regular expression to *matplotlib.RcParams.find_all()*. *matplotlib.RcParams* now also has a pretty repr and str representation so that search results are printed prettily:

```
>>> import matplotlib
>>> print(matplotlib.rcParams.find_all('\.size'))
RcParams({'font.size': 12,
          'xtick.major.size': 4,
          'xtick.minor.size': 2,
          'ytick.major.size': 4,
          'ytick.minor.size': 2})
```

`axes.xmargin` and `axes.ymargin` added to rcParams

`rcParam` values (`axes.xmargin` and `axes.ymargin`) were added to configure the default margins used. Previously they were hard-coded to default to 0, default value of both rcParam values is 0.

Changes to font rcParams

The `font.*` rcParams now affect only text objects created after the rcParam has been set, and will not retroactively affect already existing text objects. This brings their behavior in line with most other rcParams.

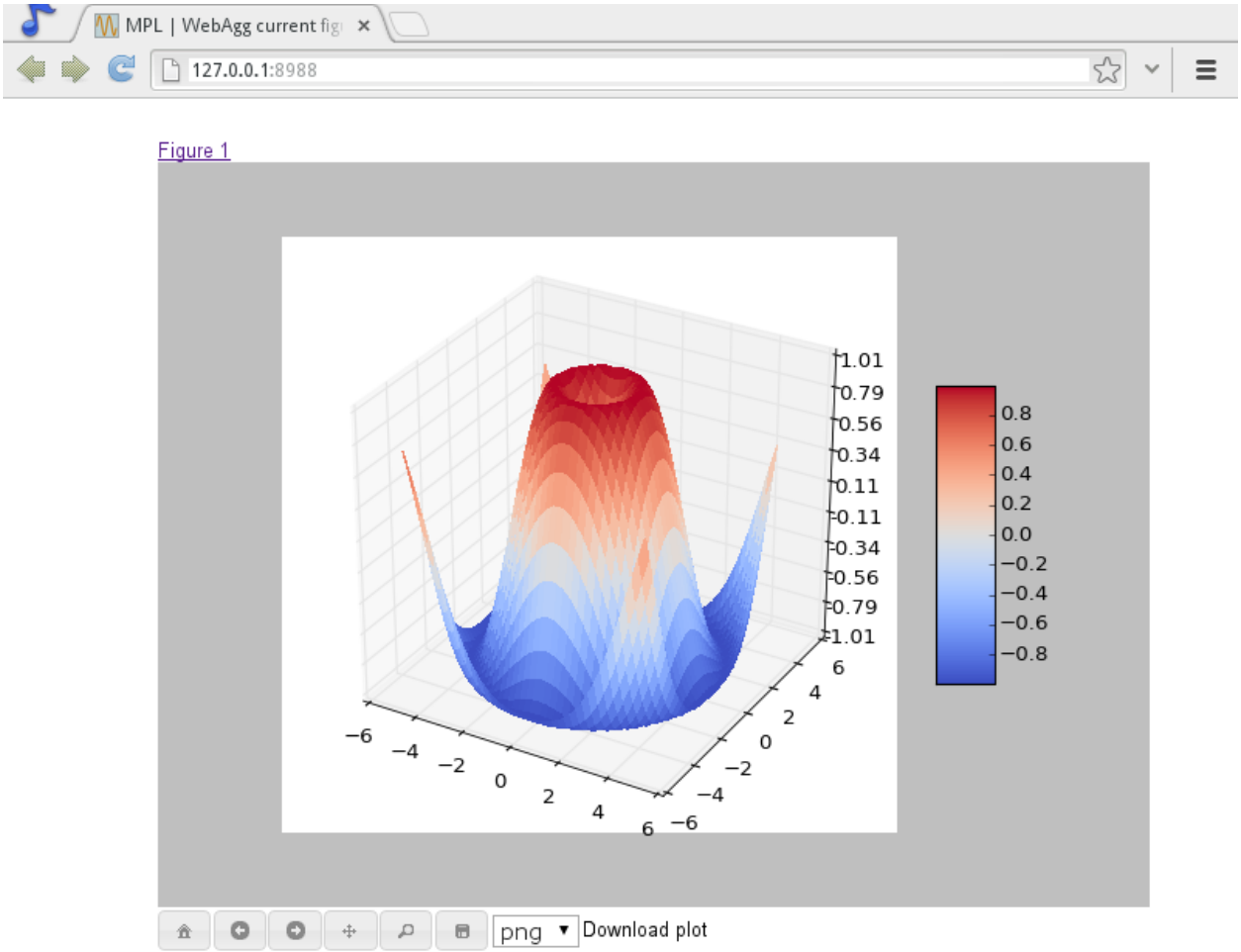
`savefig.jpeg_quality` added to rcParams

rcParam value `savefig.jpeg_quality` was added so that the user can configure the default quality used when a figure is written as a JPEG. The default quality is 95; previously, the default quality was 75. This change minimizes the artifacting inherent in JPEG images, particularly with images that have sharp changes in color as plots often do.

Backends

WebAgg backend

Michael Droettboom, Phil Elson and others have developed a new backend, WebAgg, to display figures in a web browser. It works with animations as well as being fully interactive.



Future versions of matplotlib will integrate this backend with the IPython notebook for a fully web browser based plotting frontend.

Remember save directory

Martin Spacek made the save figure dialog remember the last directory saved to. The default is configurable with the new `savefig.directory` rcParam in `matplotlibrc`.

Documentation and examples

Numpydoc docstrings

Nelle Varoquaux has started an ongoing project to convert matplotlib's docstrings to numpydoc format. See MEP10 for more information.

Example reorganization

Tony Yu has begun work reorganizing the examples into more meaningful categories. The new gallery page is the fruit of this ongoing work. See MEP12 for more information.

Examples now use subplots()

For the sake of brevity and clarity, most of the examples now use the newer *subplots()*, which creates a figure and one (or multiple) axes object(s) in one call. The old way involved a call to *figure()*, followed by one (or multiple) *subplot()* calls.

Infrastructure

Housecleaning

A number of features that were deprecated in 1.2 or earlier, or have not been in a working state for a long time have been removed. Highlights include removing the Qt version 3 backends, and the FltkAgg and Emf backends. See *Changes in 1.3.x* for a complete list.

New setup script

matplotlib 1.3 includes an entirely rewritten setup script. We now ship fewer dependencies with the tarballs and installers themselves. Notably, `pytz`, `dateutil`, `pyparsing` and `six` are no longer included with matplotlib. You can either install them manually first, or let `pip` install them as dependencies along with matplotlib. It is now possible to not include certain subcomponents, such as the unit test data, in the install. See `setup.cfg.template` for more information.

XDG base directory support

On Linux, matplotlib now uses the `XDG base directory specification` to find the `matplotlibrc` configuration file. `matplotlibrc` should now be kept in `config/matplotlib`, rather than `matplotlib`. If your configuration is found in the old location, it will still be used, but a warning will be displayed.

Catch opening too many figures using pyplot

Figures created through `pyplot.figure` are retained until they are explicitly closed. It is therefore common for new users of matplotlib to run out of memory when creating a large series of figures in a loop without

closing them.

matplotlib will now display a `RuntimeWarning` when too many figures have been opened at once. By default, this is displayed for 20 or more figures, but the exact number may be controlled using the `figure.max_open_warning` rcParam.

5.3.9 New in matplotlib 1.4

Thomas A. Caswell served as the release manager for the 1.4 release.

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- *New in matplotlib 1.4*
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  - *The nbagg backend*
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Note: matplotlib 1.4 supports Python 2.6, 2.7, 3.3, and 3.4

New colormap

In heatmaps, a green-to-red spectrum is often used to indicate intensity of activity, but this can be problematic for the red/green colorblind. A new, colorblind-friendly colormap is now available at `matplotlib.cm.Wistia`. This colormap maintains the red/green symbolism while achieving deuteranopic legibility through brightness variations. See here for more information.

The nbagg backend

Phil Elson added a new backend, named "nbagg", which enables interactive figures in a live IPython notebook session. The backend makes use of the infrastructure developed for the webagg backend, which itself gives standalone server backed interactive figures in the browser, however nbagg does not require a dedicated matplotlib server as all communications are handled through the IPython Comm machinery.

As with other backends nbagg can be enabled inside the IPython notebook with:

```
import matplotlib
matplotlib.use('nbagg')
```

Once figures are created and then subsequently shown, they will placed in an interactive widget inside the notebook allowing panning and zooming in the same way as any other matplotlib backend. Because figures require a connection to the IPython notebook server for their interactivity, once the notebook is saved, each figure will be rendered as a static image - thus allowing non-interactive viewing of figures on services such as nbviewer.

New plotting features

Power-law normalization

Ben Gamari added a power-law normalization method, *PowerNorm*. This class maps a range of values to the interval [0,1] with power-law scaling with the exponent provided by the constructor's `gamma` argument. Power law normalization can be useful for, e.g., emphasizing small populations in a histogram.

Fully customizable boxplots

Paul Hobson overhauled the *boxplot()* method such that it is now completely customizable in terms of the styles and positions of the individual artists. Under the hood, *boxplot()* relies on a new function (*boxplot_stats()*), which accepts any data structure currently compatible with *boxplot()*, and returns a list of dictionaries containing the positions for each element of the boxplots. Then a second method, `bxp()` is called to draw the boxplots based on the stats.

The *boxplot()* function can be used as before to generate boxplots from data in one step. But now the user has the flexibility to generate the statistics independently, or to modify the output of *boxplot_stats()* prior to plotting with `bxp()`.

Lastly, each artist (e.g., the box, outliers, cap, notches) can now be toggled on or off and their styles can be passed in through individual kwargs. See the examples: /gallery/statistics/boxplot and /gallery/statistics/bxp

Added a bool kwarg, `manage_xticks`, which if False disables the management of the ticks and limits on the x-axis by *bxp()*.

Support for datetime axes in 2d plots

Andrew Dawson added support for datetime axes to *contour()*, *contourf()*, *pcolormesh()* and *pcolor()*.

Support for additional spectrum types

Todd Jennings added support for new types of frequency spectrum plots: *magnitude_spectrum()*, *phase_spectrum()*, and *angle_spectrum()*, as well as corresponding functions in mlab.

He also added these spectrum types to *specgram()*, as well as adding support for linear scaling there (in addition to the existing dB scaling). Support for additional spectrum types was also added to *specgram()*.

He also increased the performance for all of these functions and plot types.

Support for detrending and windowing 2D arrays in mlab

Todd Jennings added support for 2D arrays in the *detrend_mean()*, *detrend_none()*, and *detrend()*, as well as adding *apply_window()* which support windowing 2D arrays.

Support for strides in mlab

Todd Jennings added some functions to mlab to make it easier to use numpy strides to create memory-efficient 2D arrays. This includes *stride_repeat()*, which repeats an array to create a 2D array, and *stride_windows()*, which uses a moving window to create a 2D array from a 1D array.

Formatter for new-style formatting strings

Added `FormatStrFormatterNewStyle` which does the same job as `FormatStrFormatter`, but accepts new-style formatting strings instead of printf-style formatting strings

Consistent grid sizes in streamplots

streamplot() uses a base grid size of 30x30 for both `density=1` and `density=(1, 1)`. Previously a grid size of 30x30 was used for `density=1`, but a grid size of 25x25 was used for `density=(1, 1)`.

Get a list of all tick labels (major and minor)

Added the `kwarg` 'which' to `get_xticklabels()`, `get_yticklabels()` and `get_ticklabels()`. 'which' can be 'major', 'minor', or 'both' select which ticks to return, like `set_ticks_position()`. If 'which' is `None` then the old behaviour (controlled by the bool `minor`).

Separate horizontal/vertical axes padding support in ImageGrid

The `kwarg` 'axes_pad' to `mpl_toolkits.axes_grid1.ImageGrid` can now be a tuple if separate horizontal/vertical padding is needed. This is supposed to be very helpful when you have a labelled legend next to every subplot and you need to make some space for legend's labels.

Support for skewed transformations

The *Affine2D* gained additional methods `skew` and `skew_deg` to create skewed transformations. Additionally, matplotlib internals were cleaned up to support using such transforms in `Axes`. This transform is important for some plot types, specifically the Skew-T used in meteorology.

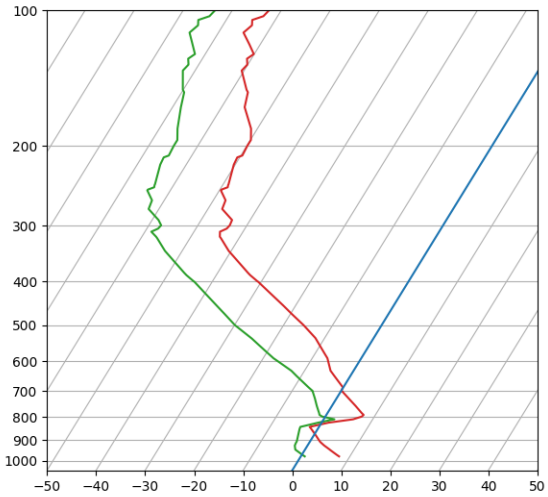

Fig. 25: Skewt

Support for specifying properties of wedge and text in pie charts.

Added the `kwargs` 'wedgeprops' and 'textprops' to `pie()` to accept properties for wedge and text objects in a pie. For example, one can specify wedgeprops = {'linewidth':3} to specify the width of the borders of the wedges in the pie. For more properties that the user can specify, look at the docs for the wedge and text objects.

Fixed the direction of errorbar upper/lower limits

Larry Bradley fixed the *errorbar()* method such that the upper and lower limits (*lolims*, *uplims*, *xlolims*, *xuplims*) now point in the correct direction.

More consistent add-object API for Axes

Added the Axes method *add_image* to put image handling on a par with artists, collections, containers, lines, patches, and tables.

Violin Plots

Per Parker, Gregory Kelsie, Adam Ortiz, Kevin Chan, Geoffrey Lee, Deokjae Donald Seo, and Taesu Terry Lim added a basic implementation for violin plots. Violin plots can be used to represent the distribution of sample data. They are similar to box plots, but use a kernel density estimation function to present a smooth approximation of the data sample used. The added features are:

`violin()` - Renders a violin plot from a collection of statistics. *violin_stats()* - Produces a collection of statistics suitable for rendering a violin plot. *violinplot()* - Creates a violin plot from a set of sample data. This method makes use of *violin_stats()* to process the input data, and *violin_stats()* to do the actual rendering. Users are also free to modify or replace the output of *violin_stats()* in order to customize the violin plots to their liking.

This feature was implemented for a software engineering course at the University of Toronto, Scarborough, run in Winter 2014 by Anya Tafliovich.

More `markevery` options to show only a subset of markers

Rohan Walker extended the `markevery` property in *Line2D*. You can now specify a subset of markers to show with an int, slice object, numpy fancy indexing, or float. Using a float shows markers at approximately equal display-coordinate-distances along the line.

Added size related functions to specialized `Collections`

Added the `get_size` and `set_size` functions to control the size of elements of specialized collections (*AsteriskPolygonCollection* *BrokenBarHCollection* *CircleCollection* *PathCollection* *PolyCollection* *RegularPolyCollection* *StarPolygonCollection*).

Fixed the mouse coordinates giving the wrong theta value in Polar graph

Added code to `transform_non_affine()` to ensure that the calculated theta value was between the range of 0 and 2 * pi since the problem was that the value can become negative after applying the direction and rotation to the theta calculation.

Simple quiver plot for mplot3d toolkit

A team of students in an *Engineering Large Software Systems* course, taught by Prof. Anya Tafliovich at the University of Toronto, implemented a simple version of a quiver plot in 3D space for the mplot3d toolkit

as one of their term project. This feature is documented in *quiver()*. The team members are: Ryan Steve D'Souza, Victor B, xbtsw, Yang Wang, David, Caradec Bisesar and Vlad Vassilovski.

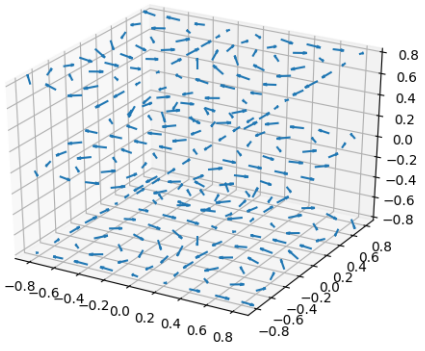

Fig. 26: Quiver3d

polar-plot r-tick locations

Added the ability to control the angular position of the r-tick labels on a polar plot via `set_rlabel_position()`.

Date handling

n-d array support for date conversion

Andrew Dawson added support for n-d array handling to *matplotlib.dates.num2date()*, *matplotlib.dates.date2num()* and `matplotlib.dates.datestr2num()`. Support is also added to the unit conversion interfaces `matplotlib.dates.DateConverter` and *matplotlib.units.Registry*.

Configuration (rcParams)

`savefig.transparent` added

Controls whether figures are saved with a transparent background by default. Previously `savefig` always defaulted to a non-transparent background.

`axes.titleweight`

Added rcParam to control the weight of the title

axes.formatter.useoffset added

Controls the default value of `useOffset` in `ScalarFormatter`. If `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. If `False` then the full number will be formatted in all conditions.

nbagg.transparent added

Controls whether nbagg figures have a transparent background. `nbagg.transparent` is `True` by default.

XDG compliance

Matplotlib now looks for configuration files (both rcparams and style) in XDG compliant locations.

style package added

You can now easily switch between different styles using the new `style` package:

```
>>> from matplotlib import style
>>> style.use('dark_background')
```

Subsequent plots will use updated colors, sizes, etc. To list all available styles, use:

```
>>> print style.available
```

You can add your own custom `<style name>.mplstyle` files to `~/.matplotlib/stylelib` or call `use` with a URL pointing to a file with `matplotlibrc` settings.

Note that this is an experimental feature, and the interface may change as users test out this new feature.

Backends

Qt5 backend

Martin Fitzpatrick and Tom Badran implemented a Qt5 backend. The differences in namespace locations between Qt4 and Qt5 was dealt with by shimming Qt4 to look like Qt5, thus the Qt5 implementation is the primary implementation. Backwards compatibility for Qt4 is maintained by wrapping the Qt5 implementation.

The Qt5Agg backend currently does not work with IPython's %matplotlib magic.

The 1.4.0 release has a known bug where the toolbar is broken. This can be fixed by:

```
cd path/to/installed/matplotlib
wget https://github.com/matplotlib/matplotlib/pull/3322.diff
# unix2dos 3322.diff (if on windows to fix line endings)
patch -p2 < 3322.diff
```

Qt4 backend

Rudolf Höfler changed the appearance of the subplottool. All sliders are vertically arranged now, buttons for tight layout and reset were added. Furthermore, the subplottool is now implemented as a modal dialog. It was previously a QMainWindow, leaving the SPT open if one closed the plot window.

In the figure options dialog one can now choose to (re-)generate a simple automatic legend. Any explicitly set legend entries will be lost, but changes to the curves' label, linestyle, et cetera will now be updated in the legend.

Interactive performance of the Qt4 backend has been dramatically improved under windows.

The mapping of key-signals from Qt to values matplotlib understands was greatly improved (For both Qt4 and Qt5).

Cairo backends

The Cairo backends are now able to use the cairocffi bindings which are more actively maintained than the pycairo bindings.

Gtk3Agg backend

The Gtk3Agg backend now works on Python 3.x, if the cairocffi bindings are installed.

PDF backend

Added context manager for saving to multi-page PDFs.

Text

Text URLs supported by SVG backend

The `svg` backend will now render *`Text`* objects' url as a link in output SVGs. This allows one to make clickable text in saved figures using the url kwarg of the *`Text`* class.

Anchored sizebar font

Added the `fontproperties` kwarg to `AnchoredSizeBar` to control the font properties.

Sphinx extensions

The `:context:` directive in the *`plot_directive`* Sphinx extension can now accept an optional `reset` setting, which will cause the context to be reset. This allows more than one distinct context to be present in

documentation. To enable this option, use `:context: reset` instead of `:context:` any time you want to reset the context.

Legend and PathEffects documentation

The *Legend guide* and *Path effects guide* have both been updated to better reflect the full potential of each of these powerful features.

Widgets

Span Selector

Added an option `span_stays` to the *SpanSelector* which makes the selector rectangle stay on the axes after you release the mouse.

GAE integration

Matplotlib will now run on google app engine.

5.3.10 New in matplotlib 1.5

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  - *Interactive OO usage*
  - *Working with labeled data like pandas DataFrames*
  - *Added `axes.prop_cycle` key to rcParams*
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  - *Styles*
  - *Backends*
  - *Configuration (rcParams)*
  - *Widgets*
  - *New plotting features*
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  - *New `close-figs` argument for plot directive*
  - *Support for URL string arguments to `imread`*

- *Display hook for animations in the IPython notebook*
- *Prefixed pkg-config for building*

Note: matplotlib 1.5 supports Python 2.7, 3.4, and 3.5

Interactive OO usage

All `Artists` now keep track of if their internal state has been changed but not reflected in the display ('stale') by a call to `draw`. It is thus possible to pragmatically determine if a given `Figure` needs to be re-drawn in an interactive session.

To facilitate interactive usage a `draw_all` method has been added to `pyplot` which will redraw all of the figures which are 'stale'.

To make this convenient for interactive use matplotlib now registers a function either with IPython's 'post_execute' event or with the displayhook in the standard python REPL to automatically call `plt.draw_all` just before control is returned to the REPL. This ensures that the draw command is deferred and only called once.

The upshot of this is that for interactive backends (including `%matplotlib notebook`) in interactive mode (with `plt.ion()`)

```
In [1]: import matplotlib.pyplot as plt

In [2]: fig, ax = plt.subplots()

In [3]: ln, = ax.plot([0, 1, 4, 9, 16])

In [4]: plt.show()

In [5]: ln.set_color('g')
```

will automatically update the plot to be green. Any subsequent modifications to the `Artist` objects will do likewise.

This is the first step of a larger consolidation and simplification of the pyplot internals.

Working with labeled data like pandas DataFrames

Plot methods which take arrays as inputs can now also work with labeled data and unpack such data.

This means that the following two examples produce the same plot:

Example

```
df = pandas.DataFrame({"var1":[1,2,3,4,5,6], "var2":[1,2,3,4,5,6]})
plt.plot(df["var1"], df["var2"])
```

Example

```
plt.plot("var1", "var2", data=df)
```

This works for most plotting methods, which expect arrays/sequences as inputs. `data` can be anything which supports `__getitem__` (`dict`, `pandas.DataFrame`, `h5py`, ...) to access `array` like values with string keys.

In addition to this, some other changes were made, which makes working with labeled data (ex `pandas.Series`) easier:

- For plotting methods with `label` keyword argument, one of the data inputs is designated as the label source. If the user does not supply a `label` that value object will be introspected for a label, currently by looking for a `name` attribute. If the value object does not have a `name` attribute but was specified by as a key into the `data` kwarg, then the key is used. In the above examples, this results in an implicit `label="var2"` for both cases.
- `plot()` now uses the index of a `Series` instead of `np.arange(len(y))`, if no `x` argument is supplied.

Added `axes.prop_cycle` key to rcParams

This is a more generic form of the now-deprecated `axes.color_cycle` param. Now, we can cycle more than just colors, but also linestyles, hatches, and just about any other artist property. Cycler notation is used for defining property cycles. Adding cyclers together will be like you are `zip()`-ing together two or more property cycles together:

```
axes.prop_cycle: cycler('color', 'rgb') + cycler('lw', [1, 2, 3])
```

You can even multiply cyclers, which is like using `itertools.product()` on two or more property cycles. Remember to use parentheses if writing a multi-line `prop_cycle` parameter.

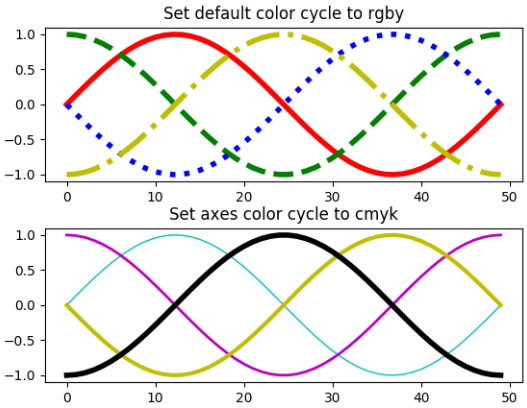
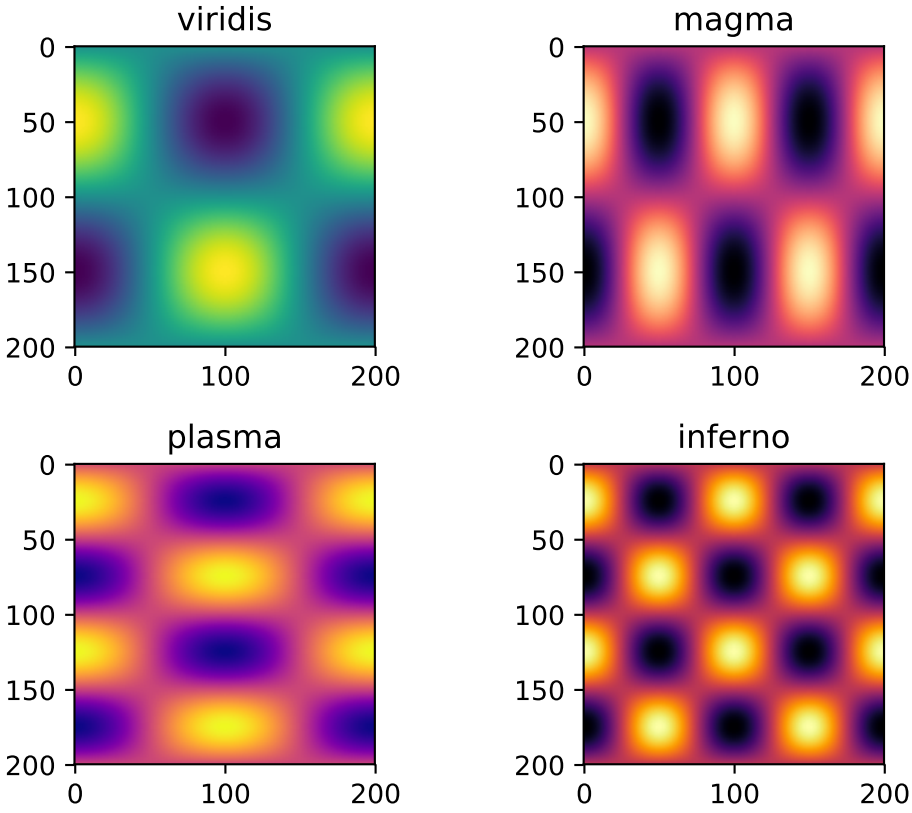


Fig. 27: Color Cycle

New Colormaps

All four of the colormaps proposed as the new default are available as `'viridis'` (the new default in 2.0), `'magma'`, `'plasma'`, and `'inferno'`



Styles

Several new styles have been added, including many styles from the Seaborn project. Additionally, in order to prep for the upcoming 2.0 style-change release, a 'classic' and 'default' style has been added. For this release, the 'default' and 'classic' styles are identical. By using them now in your scripts, you can help ensure a smooth transition during future upgrades of matplotlib, so that you can upgrade to the snazzy new defaults when you are ready!

```
import matplotlib.style
matplotlib.style.use('classic')
```

The 'default' style will give you matplotlib's latest plotting styles:

```
matplotlib.style.use('default')
```

Backends

New backend selection

The environment variable *MPLBACKEND* can now be used to set the matplotlib backend.

wx backend has been updated

The wx backend can now be used with both wxPython classic and Phoenix.

wxPython classic has to be at least version 2.8.12 and works on Python 2.x. As of May 2015 no official release of wxPython Phoenix is available but a current snapshot will work on Python 2.7+ and 3.4+.

If you have multiple versions of wxPython installed, then the user code is responsible setting the wxPython version. How to do this is explained in the comment at the beginning of the example `examplesuser_interfacesembedding_in_wx2.py`.

Configuration (rcParams)

Some parameters have been added, others have been improved.

Parameter	Description
`{x,y}axis.labelpad`	mplot3d now respects these parameters
`axes.labelpad`	Default space between the axis and the label
`errorbar.capsize`	Default length of end caps on error bars
`{x,y}tick.minor.visible`	Default visibility of minor x/y ticks
`legend.framealpha`	Default transparency of the legend frame box
`legend.facecolor`	Default facecolor of legend frame box (or `'inherit'` from `axes.facecolor`)
`legend.edgecolor`	Default edgecolor of legend frame box (or `'inherit'` from `axes.edgecolor`)
`figure.titlesize`	Default font size for figure suptitles
`figure.titleweight`	Default font weight for figure suptitles
`image.composite_image`	Whether a vector graphics backend should composite several images into a single image or not when saving. Useful when needing to edit the files further in Inkscape or other programs.
`markers.fillstyle`	Default fillstyle of markers. Possible values are `'full'` (the default), `'left'`, `'right'`, `'bottom'`, `'top'` and `'none'`
`toolbar`	Added `'toolmanager'` as a valid value, enabling the experimental `ToolManager` feature.

Widgets

Active state of Selectors

All selectors now implement `set_active` and `get_active` methods (also called when accessing the `active` property) to properly update and query whether they are active.

Moved `ignore`, `set_active`, and `get_active` methods to base class `Widget`

Pushes up duplicate methods in child class to parent class to avoid duplication of code.

Adds enable/disable feature to MultiCursor

A MultiCursor object can be disabled (and enabled) after it has been created without destroying the object. Example:

```
multi_cursor.active = False
```

Improved RectangleSelector and new EllipseSelector Widget

Adds an `interactive` keyword which enables visible handles for manipulating the shape after it has been drawn.

Adds keyboard modifiers for:

- Moving the existing shape (default key = 'space')
- Making the shape square (default 'shift')
- Make the initial point the center of the shape (default 'control')
- Square and center can be combined

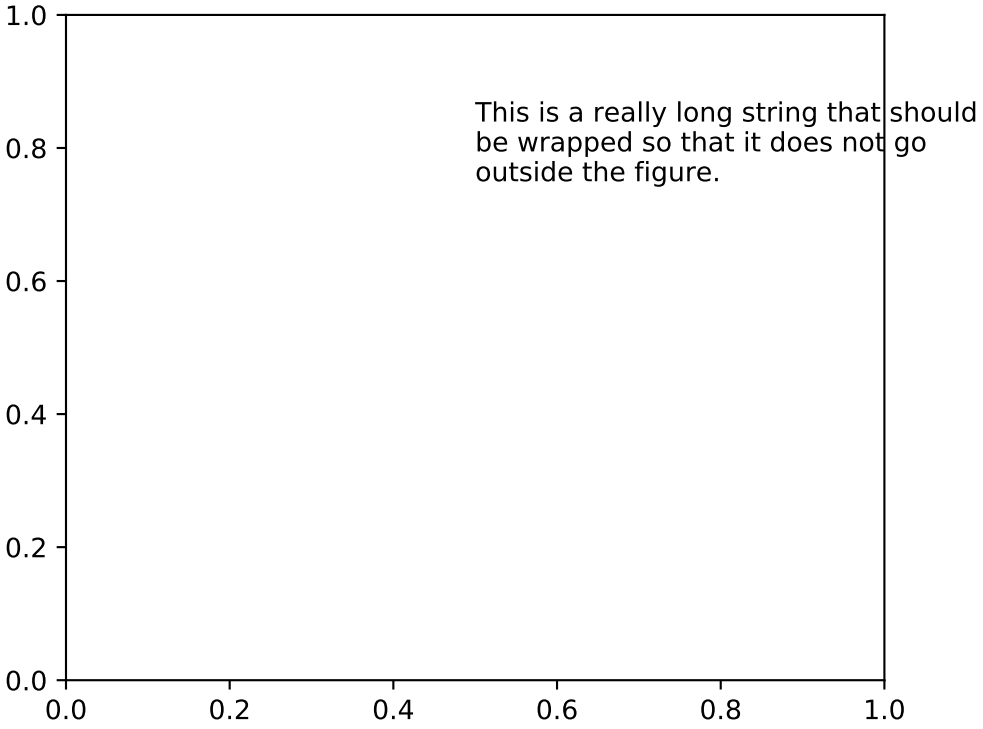
Allow Artists to Display Pixel Data in Cursor

Adds `get_pixel_data` and `format_pixel_data` methods to artists which can be used to add zdata to the cursor display in the status bar. Also adds an implementation for Images.

New plotting features

Auto-wrapping Text

Added the keyword argument "wrap" to Text, which automatically breaks long lines of text when being drawn. Works for any rotated text, different modes of alignment, and for text that are either labels or titles. This breaks at the `Figure`, not `Axes` edge.



Contour plot corner masking

Ian Thomas rewrote the C++ code that calculates contours to add support for corner masking. This is controlled by a new keyword argument `corner_mask` in the functions *`contour()`* and *`contourf()`*. The previous behaviour, which is now obtained using `corner_mask=False`, was for a single masked point to completely mask out all four quads touching that point. The new behaviour, obtained using `corner_mask=True`, only masks the corners of those quads touching the point; any triangular corners comprising three unmasked points are contoured as usual. If the `corner_mask` keyword argument is not specified, the default value is taken from rcParams.

Mostly unified linestyles for `Line2D`, `Patch` and `Collection`

The handling of linestyles for Lines, Patches and Collections has been unified. Now they all support defining linestyles with short symbols, like `"--"`, as well as with full names, like `"dashed"`. Also the definition using a dash pattern (`(0., [3., 3.])`) is supported for all methods using `Line2D`, `Patch` or `Collection`.

Legend marker order

Added ability to place the label before the marker in a legend box with `markerfirst` keyword

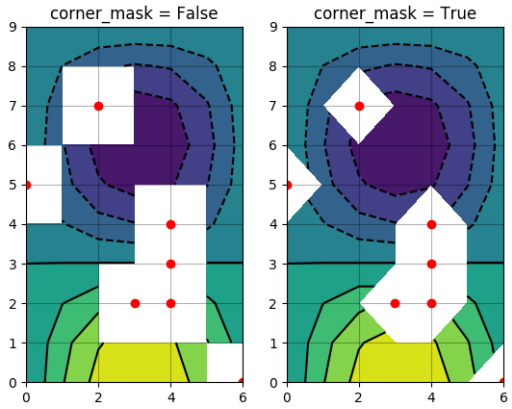


Fig. 28: Contour Corner Mask

Support for legend for PolyCollection and stackplot

Added a `legend_handler` for *`PolyCollection`* as well as a `labels` argument to *`stackplot()`*.

Support for alternate pivots in mplot3d quiver plot

Added a `pivot` kwarg to *`quiver()`* that controls the pivot point around which the quiver line rotates. This also determines the placement of the arrow head along the quiver line.

Logit Scale

Added support for the 'logit' axis scale, a nonlinear transformation

$$x- > \log 10(x/(1-x)) \tag{5.1}$$

for data between 0 and 1 excluded.

Add step kwargs to fill_between

Added `step` kwarg to `Axes.fill_between` to allow to fill between lines drawn using the 'step' draw style. The values of `step` match those of the `where` kwarg of `Axes.step`. The asymmetry of of the kwargs names is not ideal, but `Axes.fill_between` already has a `where` kwarg.

This is particularly useful for plotting pre-binned histograms.

Square Plot

Implemented square plots feature as a new parameter in the axis function. When argument 'square' is specified, equal scaling is set, and the limits are set such that `xmax-xmin == ymax-ymin`.

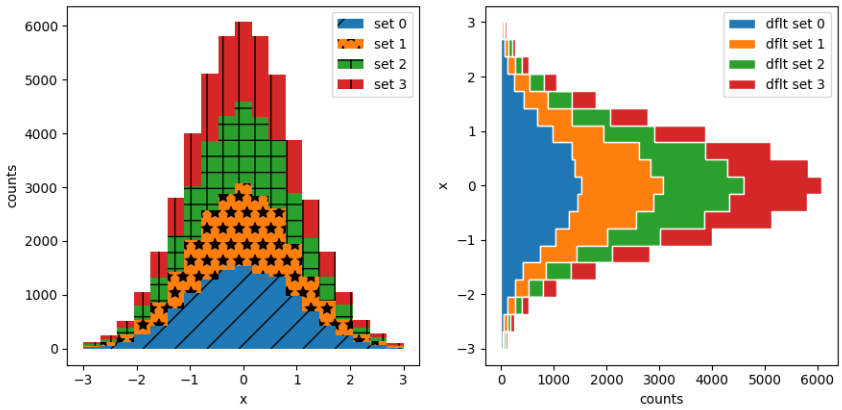
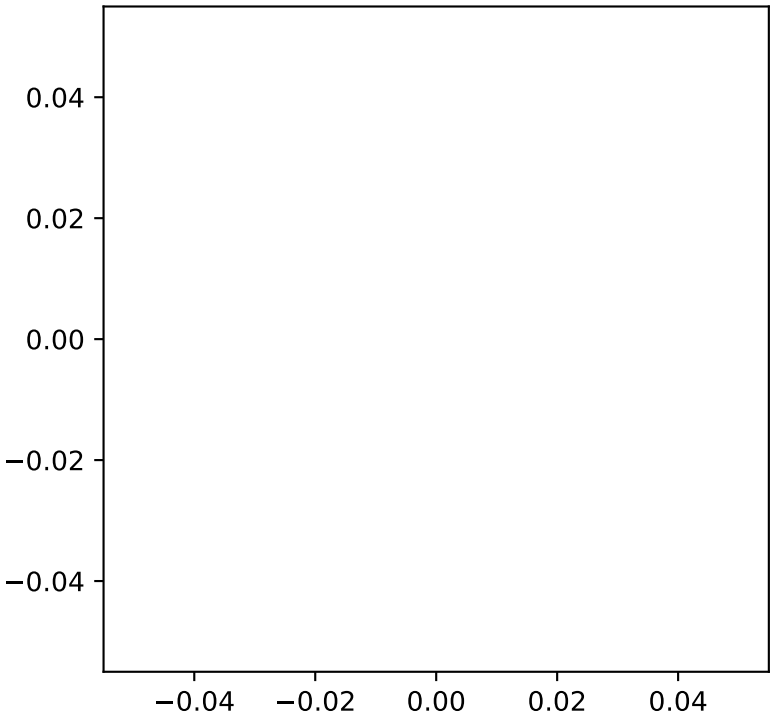
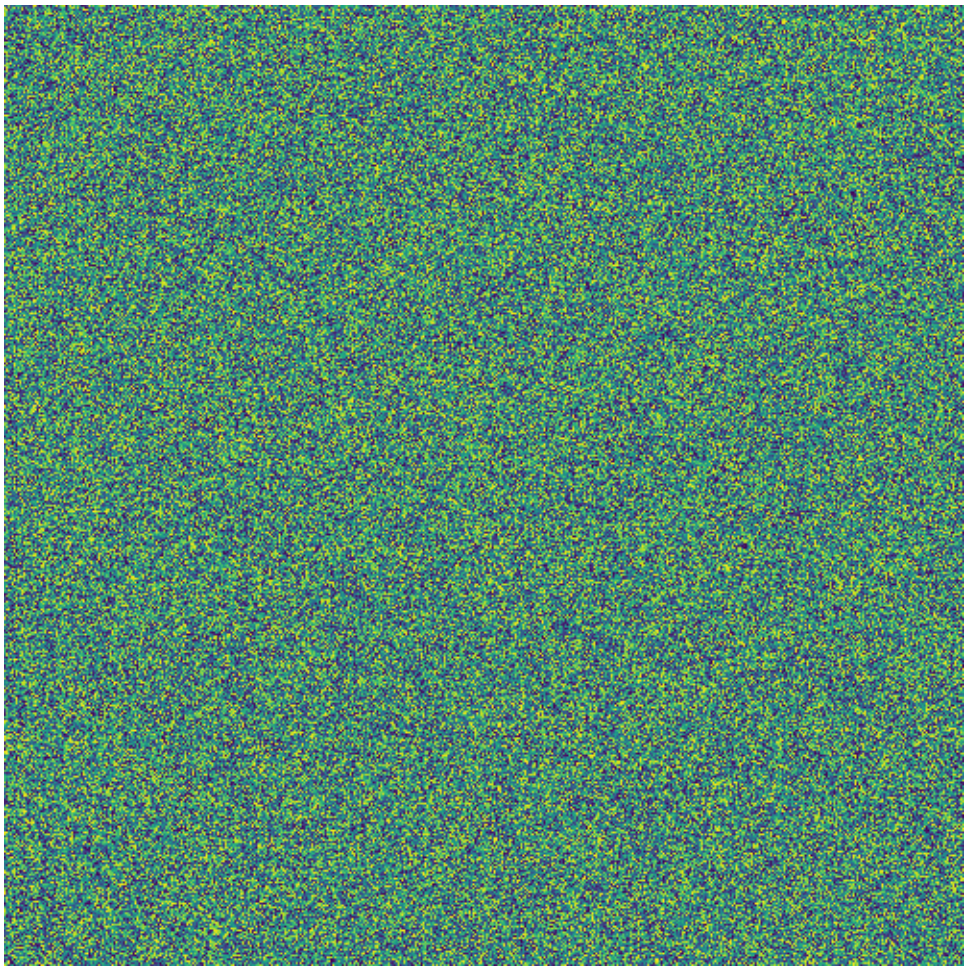


Fig. 29: Filled Step



Updated figimage to take optional resize parameter

Added the ability to plot simple 2D-Array using `plt.figimage(X, resize=True)`. This is useful for plotting simple 2D-Array without the Axes or whitespacing around the image.



Updated Figure.savefig() can now use figure's dpi

Added support to save the figure with the same dpi as the figure on the screen using `dpi='figure'`.

Example:

```
f = plt.figure(dpi=25)                # dpi set to 25
S = plt.scatter([1,2,3],[4,5,6])
f.savefig('output.png', dpi='figure')    # output savefig dpi set to 25 (same as figure)
```

Updated Table to control edge visibility

Added the ability to toggle the visibility of lines in Tables. Functionality added to the `pyplot.table()` factory function under the keyword argument "edges". Values can be the strings "open", "closed", "horizon-

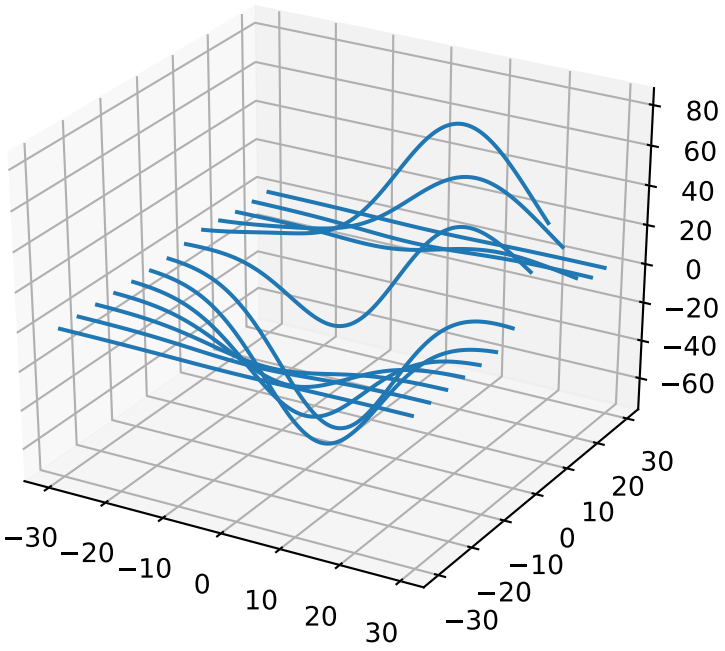
tal", "vertical" or combinations of the letters "L", "R", "T", "B" which represent left, right, top, and bottom respectively.

Example:

```
table(..., edges="open")  # No line visible
table(..., edges="closed")  # All lines visible
table(..., edges="horizontal")  # Only top and bottom lines visible
table(..., edges="LT")  # Only left and top lines visible.
```

Zero r/cstride support in plot_wireframe

Adam Hughes added support to mplot3d's plot_wireframe to draw only row or column line plots.

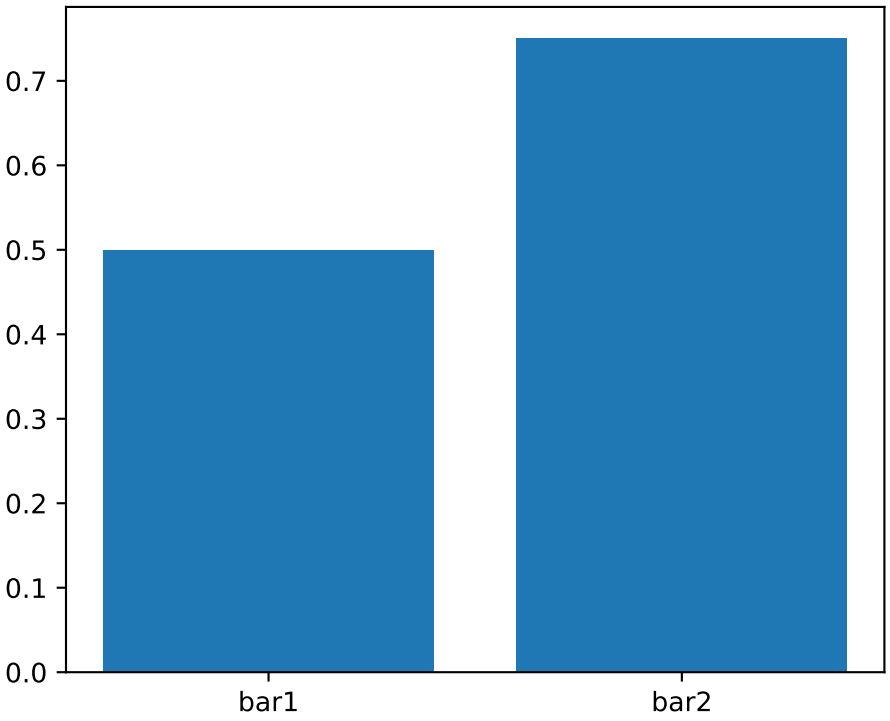


Plot bar and barh with labels

Added kwarg `"tick_label"` to `bar` and `barh` to support plotting bar graphs with a text label for each bar.

Added center and frame kwargs to pie

These control where the center of the pie graph are and if the Axes frame is shown.



Fixed 3D filled contour plot polygon rendering

Certain cases of 3D filled contour plots that produce polygons with multiple holes produced improper rendering due to a loss of path information between *PolyCollection* and *Poly3DCollection*. A function *set_verts_and_codes()* was added to allow path information to be retained for proper rendering.

Dense colorbars are rasterized

Vector file formats (pdf, ps, svg) are efficient for many types of plot element, but for some they can yield excessive file size and even rendering artifacts, depending on the renderer used for screen display. This is a problem for colorbars that show a large number of shades, as is most commonly the case. Now, if a colorbar is showing 50 or more colors, it will be rasterized in vector backends.

DateFormatter strftime

`strftime` method will format a `datetime.datetime` object with the format string passed to the formatter's constructor. This method accepts datetimes with years before 1900, unlike `datetime.datetime.strftime()`.

Artist-level {get,set}_usetex for text

Add `{get,set}_usetex` methods to *Text* objects which allow artist-level control of LaTeX rendering vs the internal mathtex rendering.

`ax.remove()` works as expected

As with artists added to an *Axes*, `Axes` objects can be removed from their figure via *remove()*.

API Consistency fix within Locators set_params() function

set_params() function, which sets parameters within a *Locator* type instance, is now available to all `Locator` types. The implementation also prevents unsafe usage by strictly defining the parameters that a user can set.

To use, call `set_params()` on a `Locator` instance with desired arguments:

```
loc = matplotlib.ticker.LogLocator()
# Set given attributes for loc.
loc.set_params(numticks=8, numdecs=8, subs=[2.0], base=8)
# The below will error, as there is no such parameter for LogLocator
# named foo
# loc.set_params(foo='bar')
```

Date Locators

Date Locators (derived from *DateLocator*) now implement the `tick_values()` method. This is expected of all Locators derived from `Locator`.

The Date Locators can now be used easily without creating axes

```
from datetime import datetime
from matplotlib.dates import YearLocator
t0 = datetime(2002, 10, 9, 12, 10)
tf = datetime(2005, 10, 9, 12, 15)
loc = YearLocator()
values = loc.tick_values(t0, tf)
```

OffsetBoxes now support clipping

`Artists` draw onto objects of type `OffsetBox` through `DrawingArea` and `TextArea`. The `TextArea` calculates the required space for the text and so the text is always within the bounds, for this nothing has changed.

However, `DrawingArea` acts as a parent for zero or more `Artists` that draw on it and may do so beyond the bounds. Now child `Artists` can be clipped to the bounds of the `DrawingArea`.

OffsetBoxes now considered by tight_layout

When *tight_layout()* or `Figure.tight_layout()` or `GridSpec.tight_layout()` is called, `OffsetBoxes` that are anchored outside the axes will not get chopped out. The `OffsetBoxes` will also not get overlapped by other axes in case of multiple subplots.

Per-page pdf notes in multi-page pdfs (PdfPages)

Add a new method *attach_note()* to the PdfPages class, allowing the attachment of simple text notes to pages in a multi-page pdf of figures. The new note is visible in the list of pdf annotations in a viewer that has this facility (Adobe Reader, OSX Preview, Skim, etc.). Per default the note itself is kept off-page to prevent it to appear in print-outs.

`PdfPages.attach_note` needs to be called before `savefig()` in order to be added to the correct figure.

Updated fignum_exists to take figure name

Added the ability to check the existence of a figure using its name instead of just the figure number. Example:

```
figure('figure')
fignum_exists('figure') #true
```

ToolManager

Federico Ariza wrote the new *ToolManager* that comes as replacement for `NavigationToolbar2`

`ToolManager` offers a new way of looking at the user interactions with the figures. Before we had the `NavigationToolbar2` with its own tools like `zoom/pan/home/save/...` and also we had the shortcuts like `yscale/grid/quit/....` `Toolmanager` relocate all those actions as `Tools` (located in *backend_tools*), and defines a way to `access/trigger/reconfigure` them.

The `Toolbars` are replaced for `ToolContainers` that are just GUI interfaces to `trigger` the tools. But don't worry the default backends include a `ToolContainer` called `toolbar`

Note: At the moment, we release this primarily for feedback purposes and should be treated as experimental until further notice as API changes will occur. For the moment the `ToolManager` works only with the `GTK3` and `Tk` backends. Make sure you use one of those. Port for the rest of the backends is comming soon.

To activate the `ToolManager` include the following at the top of your file

```
>>> matplotlib.rcParams['toolbar'] = 'toolmanager'
```

Interact with the ToolContainer

The most important feature is the ability to easily reconfigure the ToolContainer (aka toolbar). For example, if we want to remove the "forward" button we would just do.

```
>>> fig.canvas.manager.toolmanager.remove_tool('forward')
```

Now if you want to programmatically trigger the "home" button

```
>>> fig.canvas.manager.toolmanager.trigger_tool('home')
```

New Tools for ToolManager

It is possible to add new tools to the ToolManager

A very simple tool that prints "You're awesome" would be:

```
from matplotlib.backend_tools import ToolBase
class AwesomeTool(ToolBase):
    def trigger(self, *args, **kwargs):
        print("You're awesome")
```

To add this tool to `ToolManager`

```
>>> fig.canvas.manager.toolmanager.add_tool('Awesome', AwesomeTool)
```

If we want to add a shortcut ("d") for the tool

```
>>> fig.canvas.manager.toolmanager.update_keymap('Awesome', 'd')
```

To add it to the toolbar inside the group 'foo'

```
>>> fig.canvas.manager.toolbar.add_tool('Awesome', 'foo')
```

There is a second class of tools, "Toggleable Tools", this are almost the same as our basic tools, just that belong to a group, and are mutually exclusive inside that group. For tools derived from `ToolToggleBase` there are two basic methods `enable` and `disable` that are called automatically whenever it is toggled.

A full example is located in /gallery/user_interfaces/toolmanager_sgskip

cbook.is_sequence_of_strings recognizes string objects

This is primarily how pandas stores a sequence of strings

```
import pandas as pd
import matplotlib.cbook as cbook

a = np.array(['a', 'b', 'c'])
print(cbook.is_sequence_of_strings(a))  # True
```

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```
a = np.array(['a', 'b', 'c'], dtype=object)
print(cbook.is_sequence_of_strings(a))  # True

s = pd.Series(['a', 'b', 'c'])
print(cbook.is_sequence_of_strings(s))  # True
```

Previously, the last two prints returned false.

New `close-figs` argument for plot directive

Matplotlib has a sphinx extension `plot_directive` that creates plots for inclusion in sphinx documents. Matplotlib 1.5 adds a new option to the plot directive - `close-figs` - that closes any previous figure windows before creating the plots. This can help avoid some surprising duplicates of plots when using `plot_directive`.

Support for URL string arguments to `imread`

The *imread()* function now accepts URL strings that point to remote PNG files. This circumvents the generation of a HTTPResponse object directly.

Display hook for animations in the IPython notebook

Animation instances gained a `_repr_html_` method to support inline display of animations in the notebook. The method used to display is controlled by the `animation.html` rc parameter, which currently supports values of `none` and `html5`. `none` is the default, performing no display. `html5` converts the animation to an h264 encoded video, which is embedded directly in the notebook.

Users not wishing to use the `_repr_html_` display hook can also manually call the `to_html5_video` method to get the HTML and display using IPython's `HTML` display class:

```
from IPython.display import HTML
HTML(anim.to_html5_video())
```

Prefixed pkg-config for building

Handling of `pkg-config` has been fixed in so far as it is now possible to set it using the environment variable `PKG_CONFIG`. This is important if your toolchain is prefixed. This is done in a simpilar way as setting `CC` or `CXX` before building. An example follows.

```
export PKG_CONFIG=x86_64-pc-linux-gnu-pkg-config
```

5.3.11 New in matplotlib 2.0

Note: matplotlib 2.0 supports Python 2.7, and 3.4+

Default style changes

The major changes in v2.0 are related to overhauling the default styles.

Changes to the default style

The most important changes in matplotlib 2.0 are the changes to the default style.

While it is impossible to select the best default for all cases, these are designed to work well in the most common cases.

A 'classic' style sheet is provided so reverting to the 1.x default values is a single line of python

```
import matplotlib.style
import matplotlib as mpl
mpl.style.use('classic')
```

See *The matplotlibrc file* for details about how to persistently and selectively revert many of these changes.

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Colors, color cycles, and color maps

Colors in default property cycle

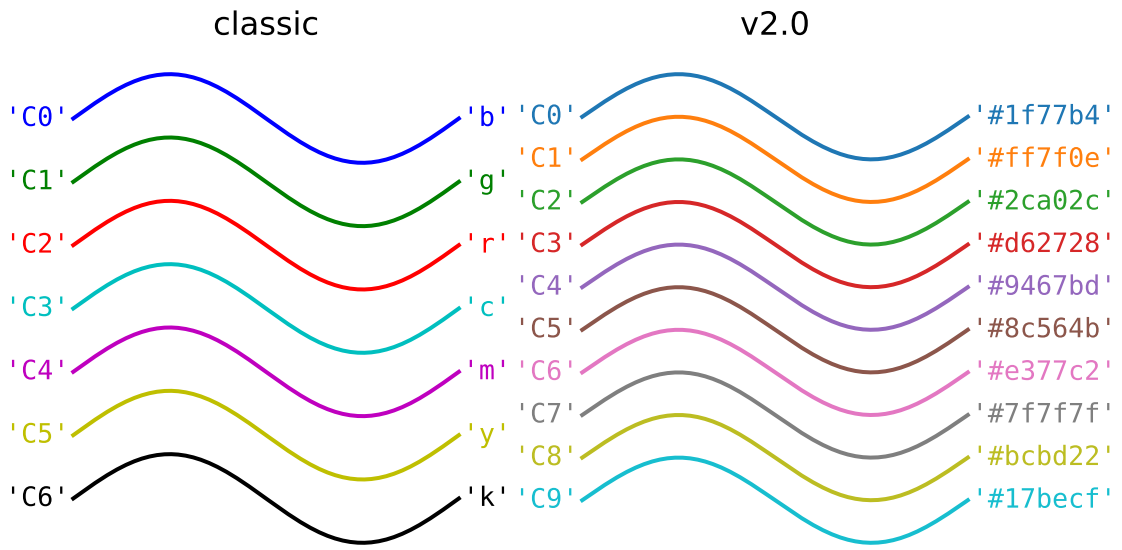
The colors in the default property cycle have been changed from `['b', 'g', 'r', 'c', 'm', 'y', 'k']` to the category10 color palette used by Vega and d3 originally developed at Tableau.

In addition to changing the colors, an additional method to specify colors was added. Previously, the default colors were the single character short-hand notations for red, green, blue, cyan, magenta, yellow, and black. This made them easy to type and usable in the abbreviated style string in `plot`, however the new default colors are only specified via hex values. To access these colors outside of the property cycling the notation for colors `'CN'`, where `N` takes values 0-9, was added to denote the first 10 colors in `mpl.rcParams['axes.prop_cycle']` See *Specifying Colors* for more details.

To restore the old color cycle use

```
from cycler import cycler
mpl.rcParams['axes.prop_cycle'] = cycler(color='bgrcmyk')
```

or set

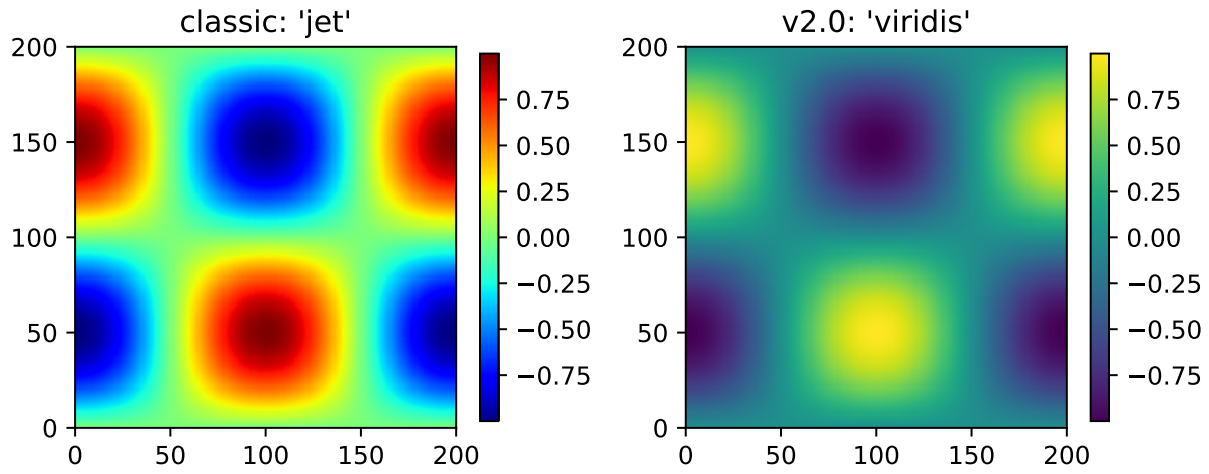



```
axes.prop_cycle    : cycler('color', 'bgrcmyk')
```

in your `matplotlibrc` file.

Colormap

The new default color map used by *`matplotlib.cm.ScalarMappable`* instances is `'viridis'` (aka option D).



For an introduction to color theory and how 'viridis' was generated watch Nathaniel Smith and Stéfan van der Walt's talk from SciPy2015. See here for many more details about the other alternatives and the tools used to create the color map. For details on all of the color maps available in matplotlib see *Colormaps in Matplotlib*.

The previous default can be restored using

```
mpl.rcParams['image.cmap'] = 'jet'
```

or setting

```
image.cmap    : 'jet'
```

in your `matplotlibrc` file; however this is strongly discouraged.

Interactive figures

The default interactive figure background color has changed from grey to white, which matches the default background color used when saving.

The previous defaults can be restored by

```
mpl.rcParams['figure.facecolor'] = '0.75'
```

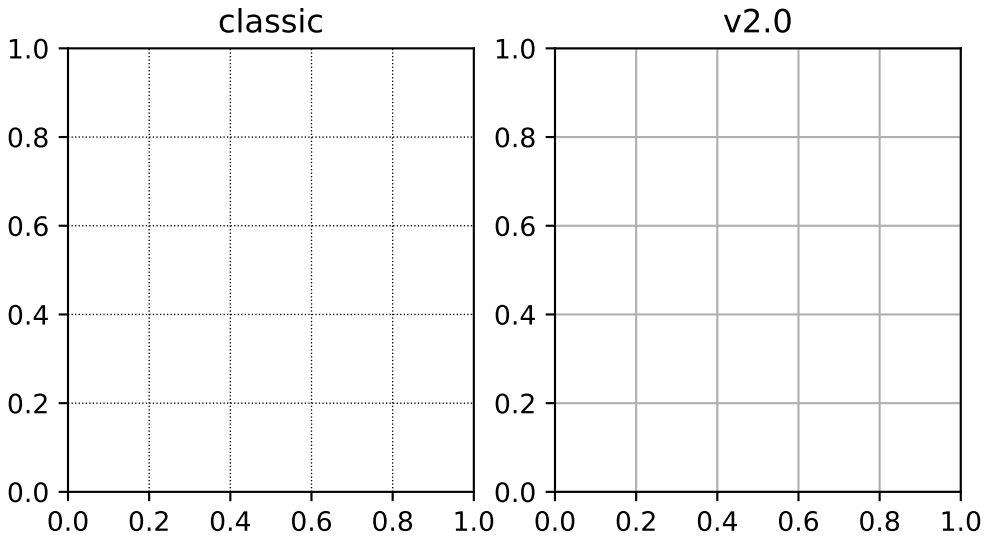
or by setting

```
figure.facecolor : '0.75'
```

in your `matplotlibrc` file.

Grid lines

The default style of grid lines was changed from black dashed lines to thicker solid light grey lines.



The previous default can be restored by using:

```
mpl.rcParams['grid.color'] = 'k'
mpl.rcParams['grid.linestyle'] = ':'
mpl.rcParams['grid.linewidth'] = 0.5
```

or by setting:

```
grid.color       :   k       # grid color
grid.linestyle   :   :       # dotted
grid.linewidth   :   0.5     # in points
```

in your `matplotlibrc` file.

Figure size, font size, and screen dpi

The default dpi used for on-screen display was changed from 80 dpi to 100 dpi, the same as the default dpi for saving files. Due to this change, the on-screen display is now more what-you-see-is-what-you-get for saved files. To keep the figure the same size in terms of pixels, in order to maintain approximately the same size on the screen, the default figure size was reduced from 8x6 inches to 6.4x4.8 inches. As a consequence of this the default font sizes used for the title, tick labels, and axes labels were reduced to maintain their size relative to the overall size of the figure. By default the dpi of the saved image is now the dpi of the *Figure* instance being saved.

This will have consequences if you are trying to match text in a figure directly with external text.

The previous defaults can be restored by

```
mpl.rcParams['figure.figsize'] = [8.0, 6.0]
mpl.rcParams['figure.dpi'] = 80
mpl.rcParams['savefig.dpi'] = 100

mpl.rcParams['font.size'] = 12
mpl.rcParams['legend.fontsize'] = 'large'
mpl.rcParams['figure.titlesize'] = 'medium'
```

or by setting:

```
figure.figsize   : [8.0, 6.0]
figure.dpi       : 80
savefig.dpi      : 100

font.size        : 12.0
legend.fontsize  : 'large'
figure.titlesize : 'medium'
```

In your `matplotlibrc` file.

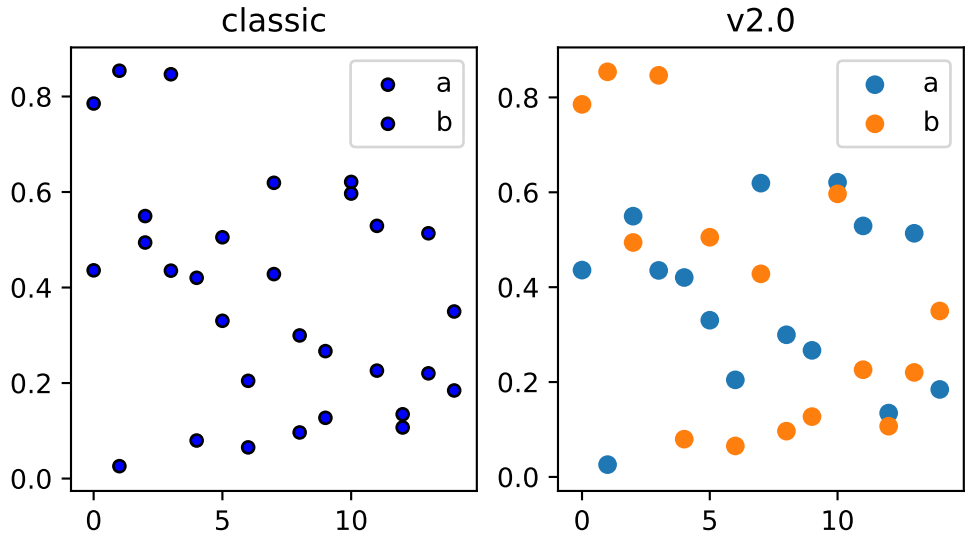
In addition, the `forward` kwarg to `set_size_inches` now defaults to `True` to improve the interactive experience. Backend canvases that adjust the size of their bound *matplotlib.figure.Figure* must pass `forward=False` to avoid circular behavior. This default is not configurable.

Plotting functions

scatter

The following changes were made to the default behavior of *scatter*

- The default size of the elements in a scatter plot is now based on the rcParam `lines.markersize` so it is consistent with `plot(X, Y, 'o')`. The old value was 20, and the new value is 36 (6^2).
- scatter markers no longer have a black edge.
- if the color of the markers is not specified it will follow the property cycle, pulling from the 'patches' cycle on the `Axes`.



The classic default behavior of *scatter* can only be recovered through `mpl.style.use('classic')`. The marker size can be recovered via

```
mpl.rcParam['lines.markersize'] = np.sqrt(20)
```

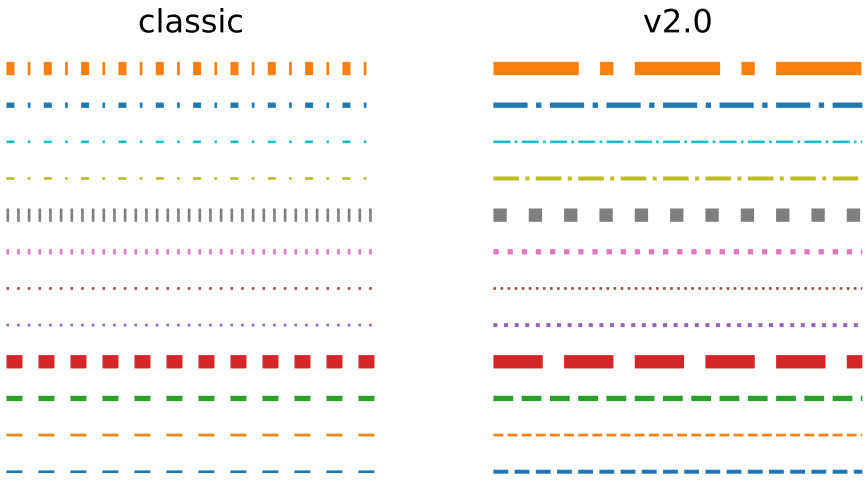
however, this will also affect the default marker size of *plot*. To recover the classic behavior on a per-call basis pass the following kwargs:

```
classic_kwargs = {'s': 20, 'edgecolors': 'k', 'c': 'b'}
```

plot

The following changes were made to the default behavior of *plot*

- the default linewidth increased from 1 to 1.5
- the dash patterns associated with `'--'`, `':'`, and `'-.'` have changed
- the dash patterns now scale with line width



The previous defaults can be restored by setting:

```
mpl.rcParams['lines.linewidth'] = 1.0
mpl.rcParams['lines.dashed_pattern'] = [6, 6]
mpl.rcParams['lines.dashdot_pattern'] = [3, 5, 1, 5]
mpl.rcParams['lines.dotted_pattern'] = [1, 3]
mpl.rcParams['lines.scale_dashes'] = False
```

or by setting:

```
lines.linewidth   : 1.0
lines.dashed_pattern : 6, 6
lines.dashdot_pattern : 3, 5, 1, 5
lines.dotted_pattern : 1, 3
lines.scale_dashes: False
```

in your `matplotlibrc` file.

errorbar

By default, caps on the ends of errorbars are not present.

This also changes the return value of *`errorbar()`* as the list of 'caplines' will be empty by default.

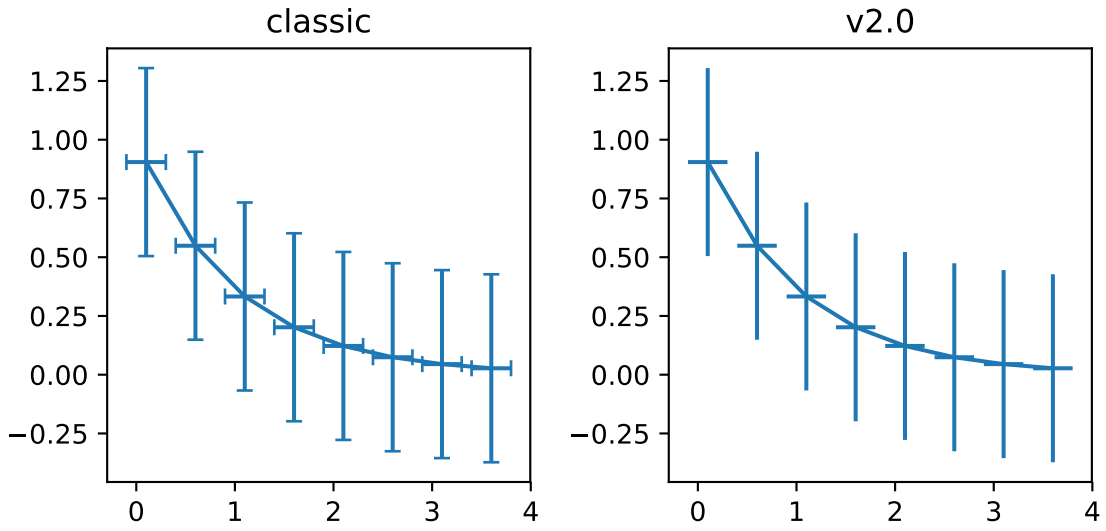
The previous defaults can be restored by setting:

```
mpl.rcParams['errorbar.capsize'] = 3
```

or by setting

```
errorbar.capsize : 3
```

in your `matplotlibrc` file.



boxplot

Previously, boxplots were composed of a mish-mash of styles that were, for better for worse, inherited from Matlab. Most of the elements were blue, but the medians were red. The fliers (outliers) were black plus-symbols (+) and the whiskers were dashed lines, which created ambiguity if the (solid and black) caps were not drawn.

For the new defaults, everything is black except for the median and mean lines (if drawn), which are set to the first two elements of the current color cycle. Also, the default flier markers are now hollow circles, which maintain the ability of the plus-symbols to overlap without obscuring data too much.

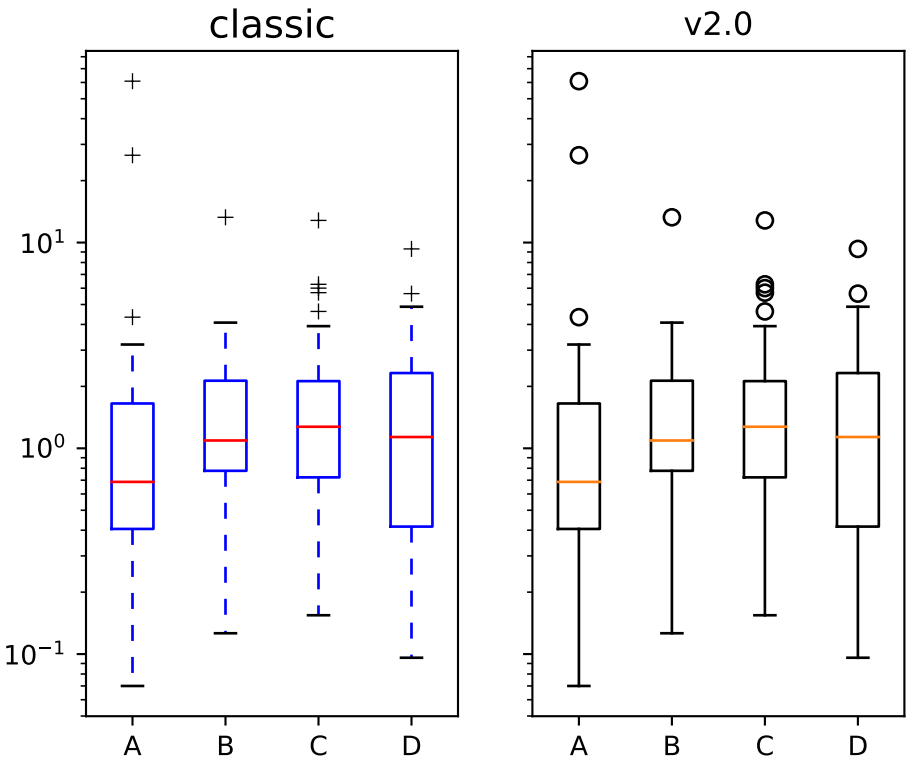
The previous defaults can be restored by setting:

```
mpl.rcParams['boxplot.flierprops.color'] = 'k'
mpl.rcParams['boxplot.flierprops.marker'] = '+'
mpl.rcParams['boxplot.flierprops.markerfacecolor'] = 'none'
mpl.rcParams['boxplot.flierprops.markeredgecolor'] = 'k'
mpl.rcParams['boxplot.boxprops.color'] = 'b'
mpl.rcParams['boxplot.whiskerprops.color'] = 'b'
mpl.rcParams['boxplot.whiskerprops.linestyle'] = '--'
mpl.rcParams['boxplot.medianprops.color'] = 'r'
mpl.rcParams['boxplot.meanprops.color'] = 'r'
mpl.rcParams['boxplot.meanprops.marker'] = '^'
mpl.rcParams['boxplot.meanprops.markerfacecolor'] = 'r'
mpl.rcParams['boxplot.meanprops.markeredgecolor'] = 'k'
mpl.rcParams['boxplot.meanprops.markersize'] = 6
mpl.rcParams['boxplot.meanprops.linestyle'] = '--'
mpl.rcParams['boxplot.meanprops.linewidth'] = 1.0
```

or by setting:

```
boxplot.flierprops.color:          'k'
boxplot.flierprops.marker:         '+'
```

(continues on next page)



(continued from previous page)

```
boxplot.flierprops.markerfacecolor: 'none'
boxplot.flierprops.markeredgecolor: 'k'
boxplot.boxprops.color:             'b'
boxplot.whiskerprops.color:         'b'
boxplot.whiskerprops.linestyle:     '--'
boxplot.medianprops.color:          'r'
boxplot.meanprops.color:            'r'
boxplot.meanprops.marker:           '^'
boxplot.meanprops.markerfacecolor:  'r'
boxplot.meanprops.markeredgecolor:  'k'
boxplot.meanprops.markersize:        6
boxplot.meanprops.linestyle:         '--'
boxplot.meanprops.linewidth:         1.0
```

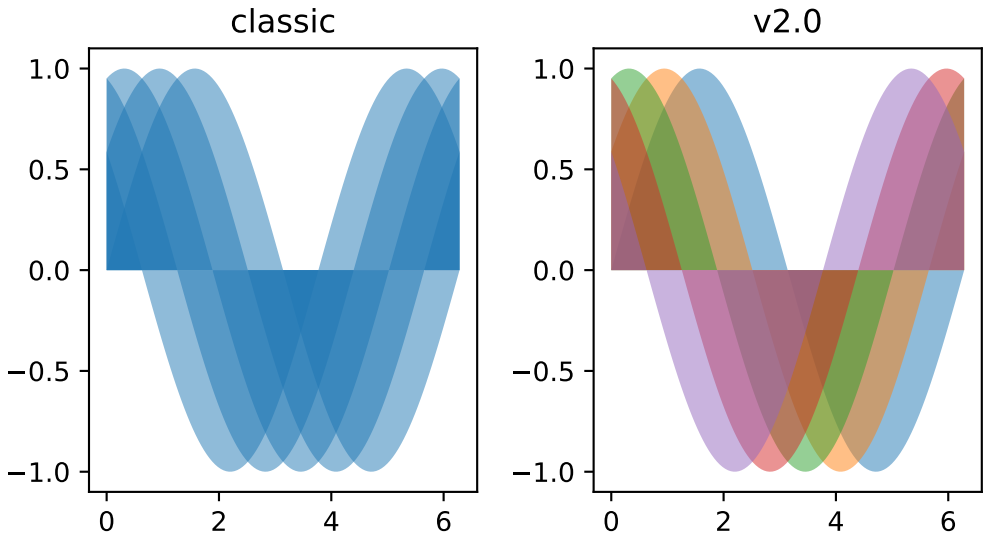
in your `matplotlibrc` file.

`fill_between` and `fill_betweenx`

`fill_between` and *`fill_betweenx`* both follow the patch color cycle.

If the facecolor is set via the `facecolors` or `color` keyword argument, then the color is not cycled.

To restore the previous behavior, explicitly pass the keyword argument `facecolors='C0'` to the method



call.

Patch edges and color

Most artists drawn with a patch (`~matplotlib.axes.Axes.bar`, `~matplotlib.axes.Axes.pie`, etc) no longer have a black edge by default. The default face color is now `'C0'` instead of `'b'`.

The previous defaults can be restored by setting:

```
mpl.rcParams['patch.force_edgecolor'] = True
mpl.rcParams['patch.facecolor'] = 'b'
```

or by setting:

```
patch.facecolor        : b
patch.force_edgecolor  : True
```

in your `matplotlibrc` file.

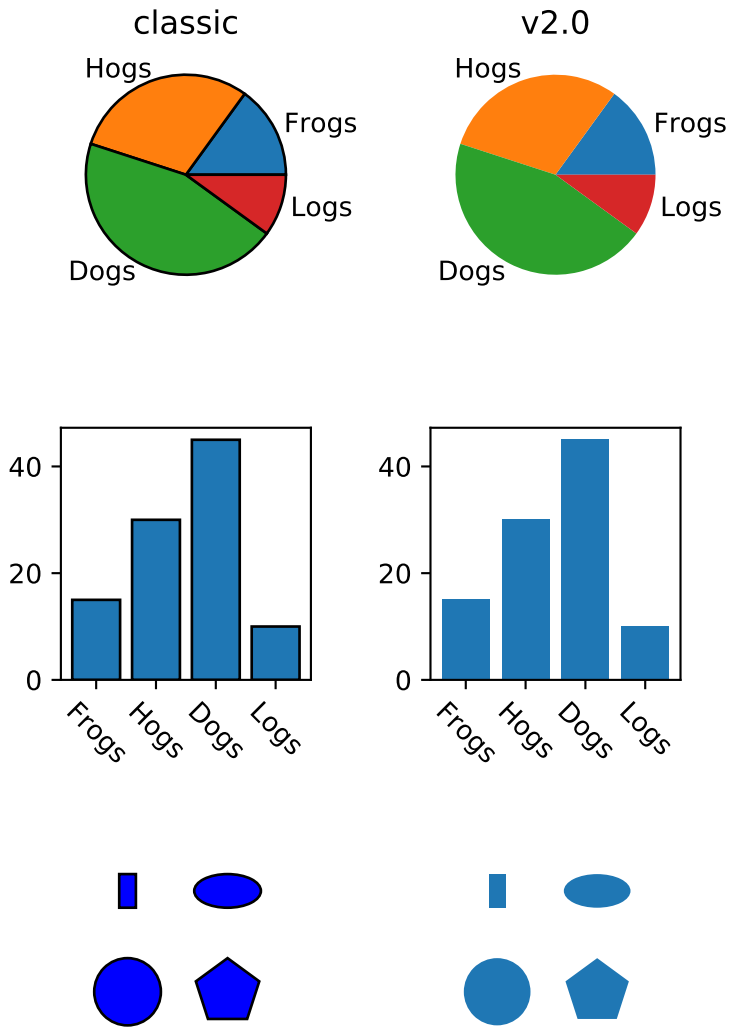
`hexbin`

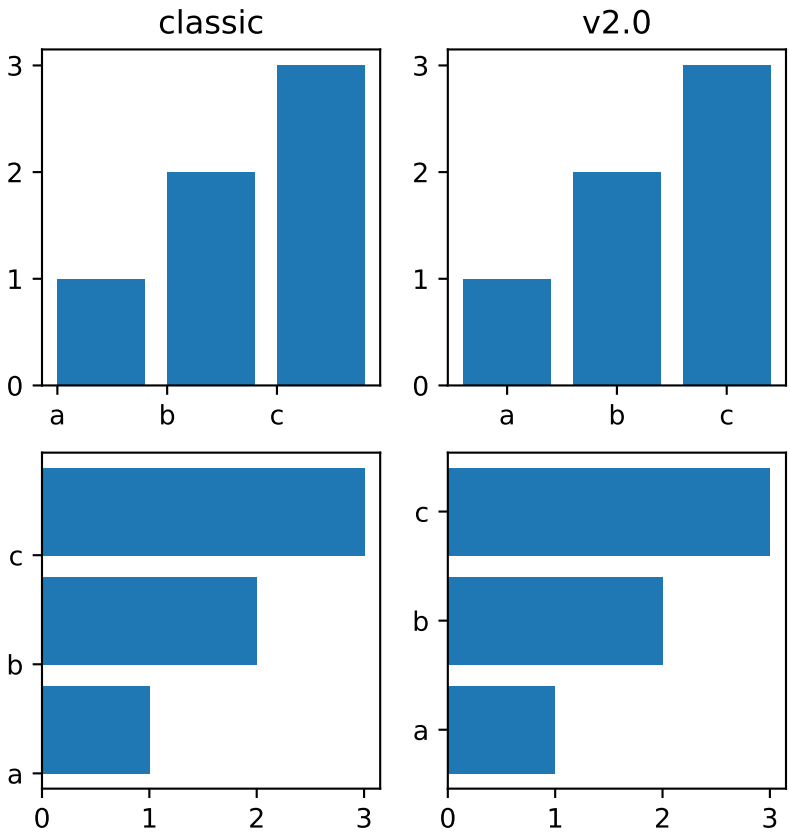
The default value of the `linecolor` kwarg for `hexbin` has changed from `'none'` to `'face'`. If 'none' is now supplied, no line edges are drawn around the hexagons.

`bar` and `barh`

The default value of the `align` kwarg for both `bar` and `barh` is changed from `'edge'` to `'center'`.

To restore the previous behavior explicitly pass the keyword argument `align='edge'` to the method call.


classic
Hogs
Frogs
Logs
Dogs
v2.0
Hogs
Frogs
Logs
Dogs
40
20
0
Frogs
Hogs
Dogs
Logs
40
20
0
Frogs
Hogs
Dogs
Logs


classic
v2.0
3
2
1
0
a
b
c
c
b
a
0
1
2
3

Hatching

The color of the lines in the hatch is now determined by

- If an edge color is explicitly set, use that for the hatch color
- If the edge color is not explicitly set, use `rcParam['hatch.color']` which is looked up at artist creation time.

The width of the lines in a hatch pattern is now configurable by the rcParams `hatch.linewidth`, which defaults to 1 point. The old behavior for the line width was different depending on backend:

- PDF: 0.1 pt
- SVG: 1.0 pt
- PS: 1 px
- Agg: 1 px

The old line width behavior can not be restored across all backends simultaneously, but can be restored for a single backend by setting:

```
mpl.rcParams['hatch.linewidth'] = 0.1  # previous pdf hatch linewidth
mpl.rcParams['hatch.linewidth'] = 1.0  # previous svg hatch linewidth
```

The behavior of the PS and Agg backends was DPI dependent, thus:

```
mpl.rcParams['figure.dpi'] = dpi
mpl.rcParams['savefig.dpi'] = dpi  # or leave as default 'figure'
mpl.rcParams['hatch.linewidth'] = 1.0 / dpi  # previous ps and Agg hatch linewidth
```

There is no direct API level control of the hatch color or linewidth.

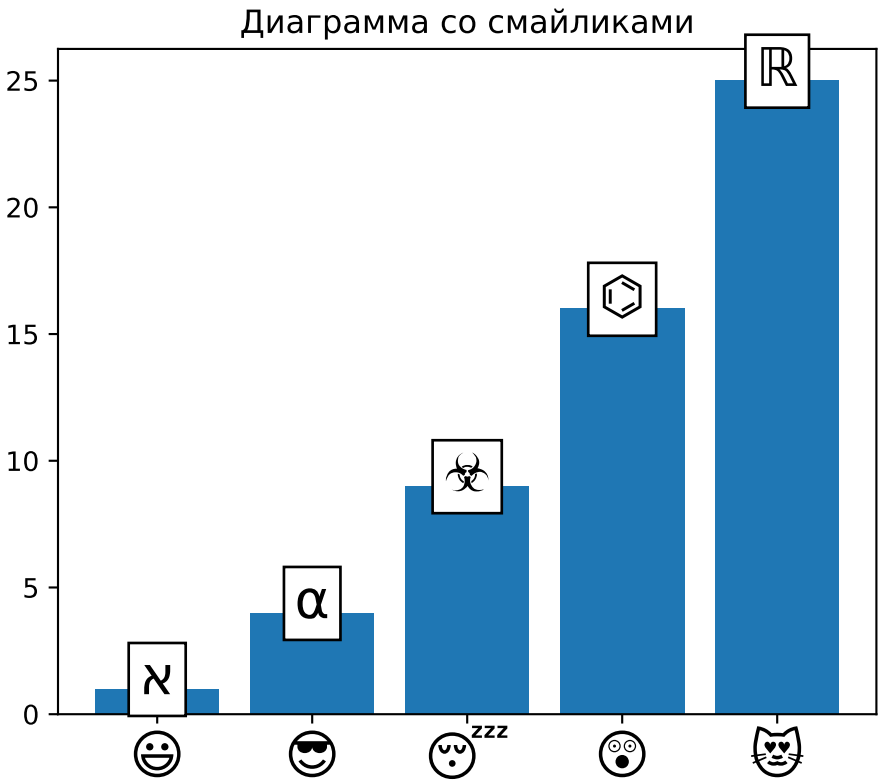
Hatching patterns are now rendered at a consistent density, regardless of DPI. Formerly, high DPI figures would be more dense than the default, and low DPI figures would be less dense. This old behavior cannot be directly restored, but the density may be increased by repeating the hatch specifier.

Fonts

Normal text

The default font has changed from "Bitstream Vera Sans" to "DejaVu Sans". DejaVu Sans has additional international and math characters, but otherwise has the same appearance as Bitstream Vera Sans. Latin, Greek, Cyrillic, Armenian, Georgian, Hebrew, and Arabic are all supported (but right-to-left rendering is still not handled by matplotlib). In addition, DejaVu contains a sub-set of emoji symbols.

See the DejaVu Sans PDF sample for full coverage.



Math text

The default math font when using the built-in math rendering engine (mathtext) has changed from "Computer Modern" (i.e. LaTeX-like) to "DejaVu Sans". This change has no effect if the TeX backend is used (i.e. `text.usetex` is `True`).

To revert to the old behavior set the:

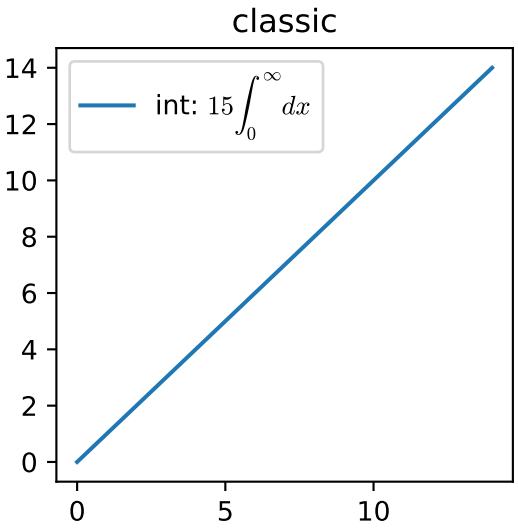
```
mpl.rcParams['mathtext.fontset'] = 'cm'
mpl.rcParams['mathtext.rm'] = 'serif'
```

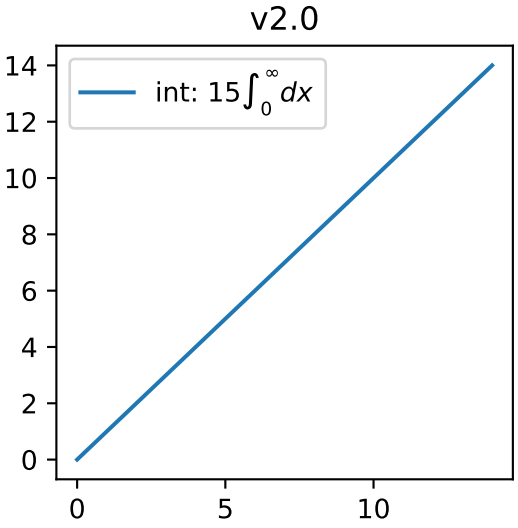
or set:

```
mathtext.fontset: cm
mathtext.rm : serif
```

in your `matplotlibrc` file.

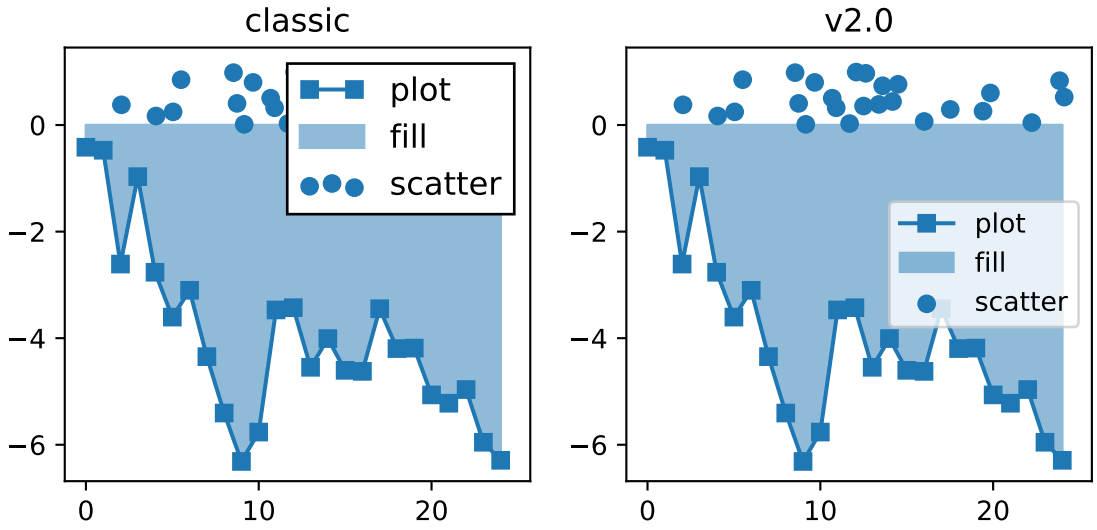
This `rcParam` is consulted when the text is drawn, not when the artist is created. Thus all mathtext on a given `canvas` will use the same fontset.


classic
int: $15\int_0^\infty dx$
14
12
10
8
6
4
2
0
0
5
10


v2.0
int: $15\int_0^\infty dx$
14
12
10
8
6
4
2
0
0
5
10

Legends

- By default, the number of points displayed in a legend is now 1.
- The default legend location is `'best'`, so the legend will be automatically placed in a location to minimize overlap with data.
- The legend defaults now include rounded corners, a lighter boundary, and partially transparent boundary and background.



The previous defaults can be restored by setting:

```
mpl.rcParams['legend.fancybox'] = False
mpl.rcParams['legend.loc'] = 'upper right'
mpl.rcParams['legend.numpoints'] = 2
mpl.rcParams['legend.fontsize'] = 'large'
mpl.rcParams['legend.framealpha'] = None
mpl.rcParams['legend.scatterpoints'] = 3
mpl.rcParams['legend.edgecolor'] = 'inherit'
```

or by setting:

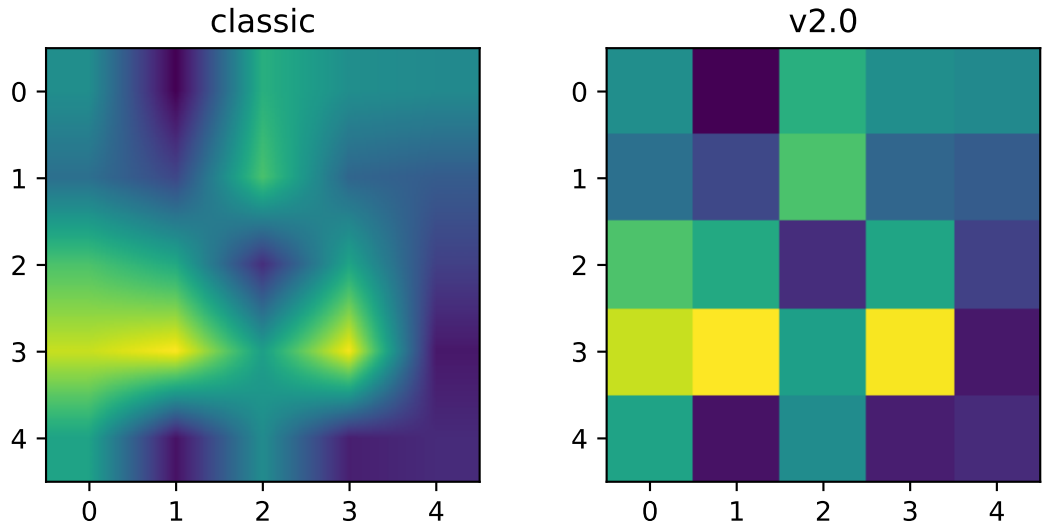
```
legend.fancybox      : False
legend.loc           : upper right
legend.numpoints     : 2      # the number of points in the legend line
legend.fontsize      : large
legend.framealpha    : None    # opacity of legend frame
legend.scatterpoints : 3 # number of scatter points
legend.edgecolor     : inherit   # legend edge color ('inherit'
                                 # means it uses axes.edgecolor)
```

in your `matplotlibrc` file.

Image

Interpolation

The default interpolation method for *imshow* is now `'nearest'` and by default it resamples the data (both up and down sampling) before color mapping.



To restore the previous behavior set:

```
mpl.rcParams['image.interpolation'] = 'bilinear'
mpl.rcParams['image.resample'] = False
```

or set:

```
image.interpolation  : bilinear  # see help(imshow) for options
image.resample  : False
```

in your `matplotlibrc` file.

Colormapping pipeline

Previously, the input data was normalized, then color mapped, and then resampled to the resolution required for the screen. This meant that the final resampling was being done in color space. Because the color maps are not generally linear in RGB space, colors not in the color map may appear in the final image. This bug was addressed by an almost complete overhaul of the image handling code.

The input data is now normalized, then resampled to the correct resolution (in normalized dataspace), and then color mapped to RGB space. This ensures that only colors from the color map appear in the final image. (If your viewer subsequently resamples the image, the artifact may reappear.)

The previous behavior cannot be restored.

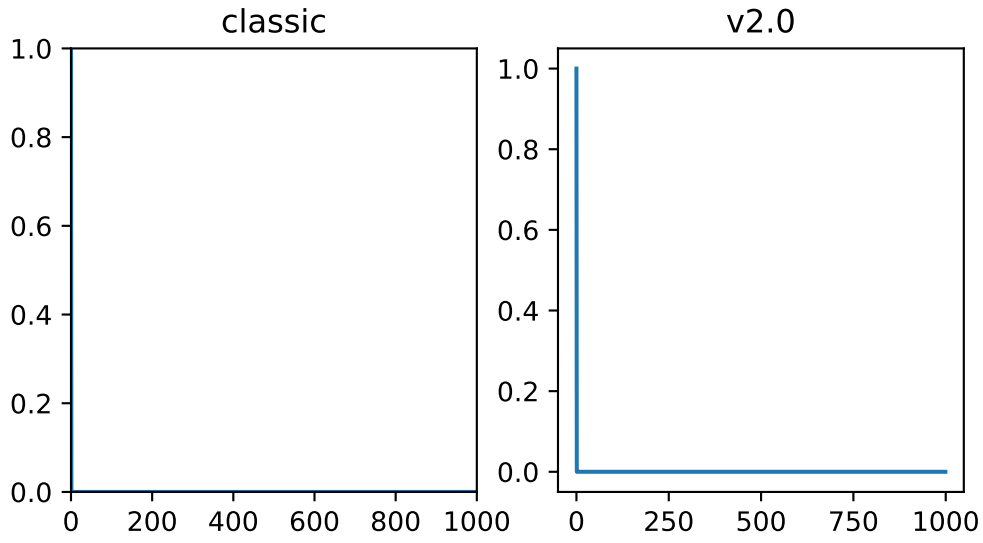
Shading

- The default shading mode for light source shading, in `matplotlib.colors.LightSource.shade`, is now `overlay`. Formerly, it was `hsv`.

Plot layout

Auto limits

The previous auto-scaling behavior was to find 'nice' round numbers as view limits that enclosed the data limits, but this could produce bad plots if the data happened to fall on a vertical or horizontal line near the chosen 'round number' limit. The new default sets the view limits to 5% wider than the data range.



The size of the padding in the x and y directions is controlled by the `'axes.xmargin'` and `'axes.ymargin'` rcParams respectively. Whether the view limits should be 'round numbers' is controlled by the `'axes.autolimit_mode'` rcParam. In the original `'round_number'` mode, the view limits coincide with ticks.

The previous default can be restored by using:

```
mpl.rcParams['axes.autolimit_mode'] = 'round_numbers'
mpl.rcParams['axes.xmargin'] = 0
mpl.rcParams['axes.ymargin'] = 0
```

or setting:

```
axes.autolimit_mode: round_numbers
axes.xmargin: 0
axes.ymargin: 0
```

in your `matplotlibrc` file.

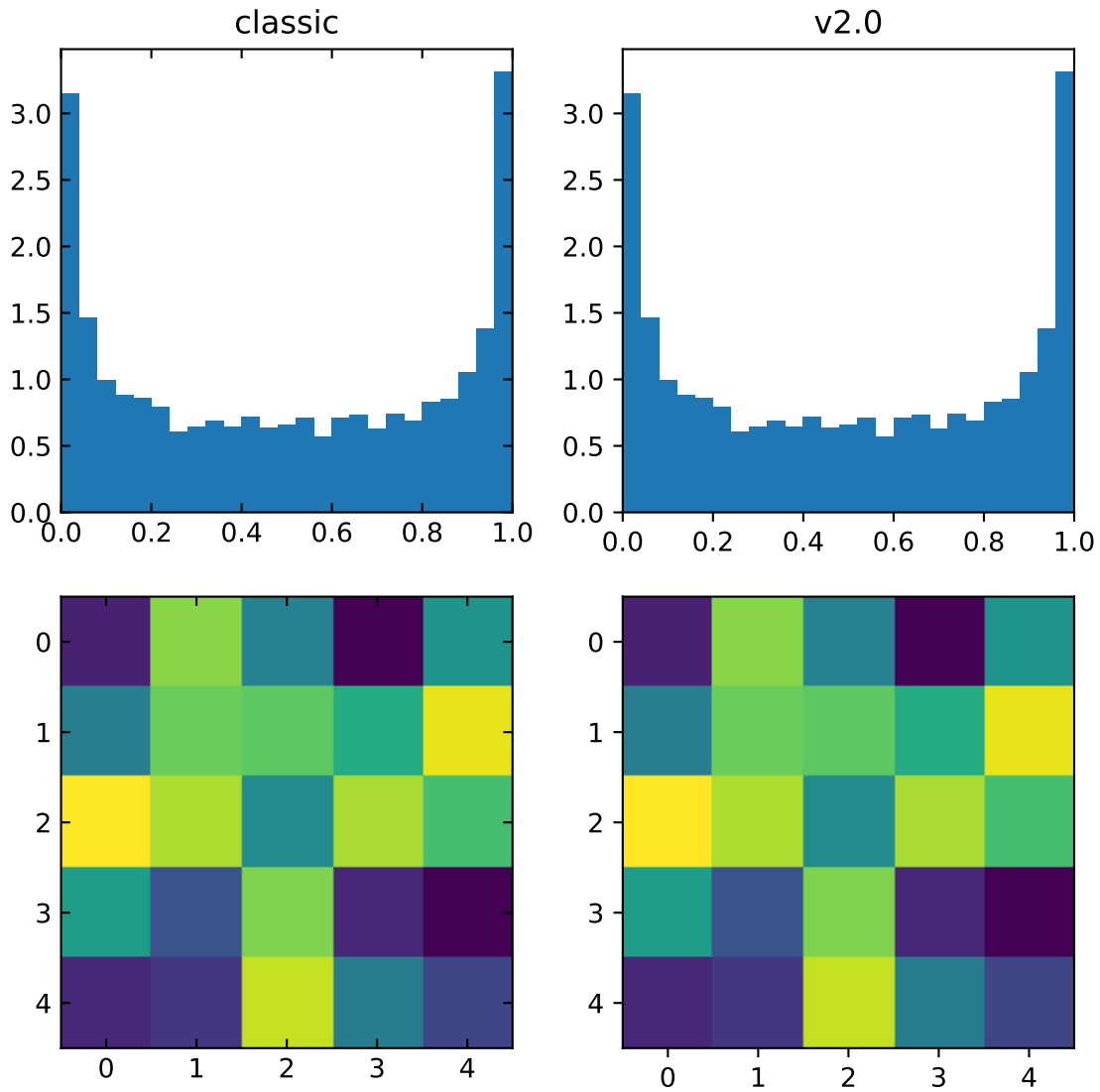
Z-order

- Ticks and grids are now plotted above solid elements such as filled contours, but below lines. To return to the previous behavior of plotting ticks and grids above lines, set `rcParams['axes.axisbelow'] = False`.

Ticks

Direction

To reduce the collision of tick marks with data, the default ticks now point outward by default. In addition, ticks are now drawn only on the bottom and left spines to prevent a porcupine appearance, and for a cleaner separation between subplots.



To restore the previous behavior set:

```
mpl.rcParams['xtick.direction'] = 'in'
mpl.rcParams['ytick.direction'] = 'in'
mpl.rcParams['xtick.top'] = True
mpl.rcParams['ytick.right'] = True
```

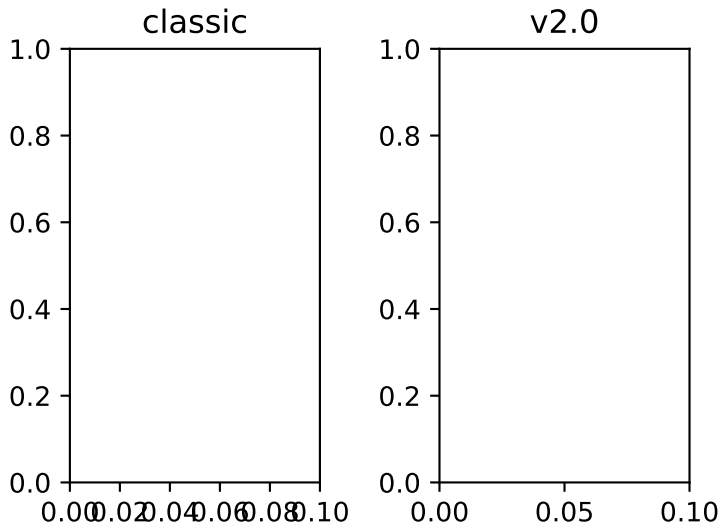
or set:

```
xtick.top: True
xtick.direction: in

ytick.right: True
ytick.direction: in
```

in your `matplotlibrc` file.

Number of ticks

The default *Locator* used for the x and y axis is *AutoLocator* which tries to find, up to some maximum number, 'nicely' spaced ticks. The locator now includes an algorithm to estimate the maximum number of ticks that will leave room for the tick labels. By default it also ensures that there are at least two ticks visible.



There is no way, other than using `mpl.style.use('classic')`, to restore the previous behavior as the default. On an axis-by-axis basis you may either control the existing locator via:

```
ax.xaxis.get_major_locator().set_params(nbins=9, steps=[1, 2, 5, 10])
```

or create a new *MaxNLocator*:

```
import matplotlib.ticker as mticker
ax.set_major_locator(mticker.MaxNLocator(nbins=9, steps=[1, 2, 5, 10])
```

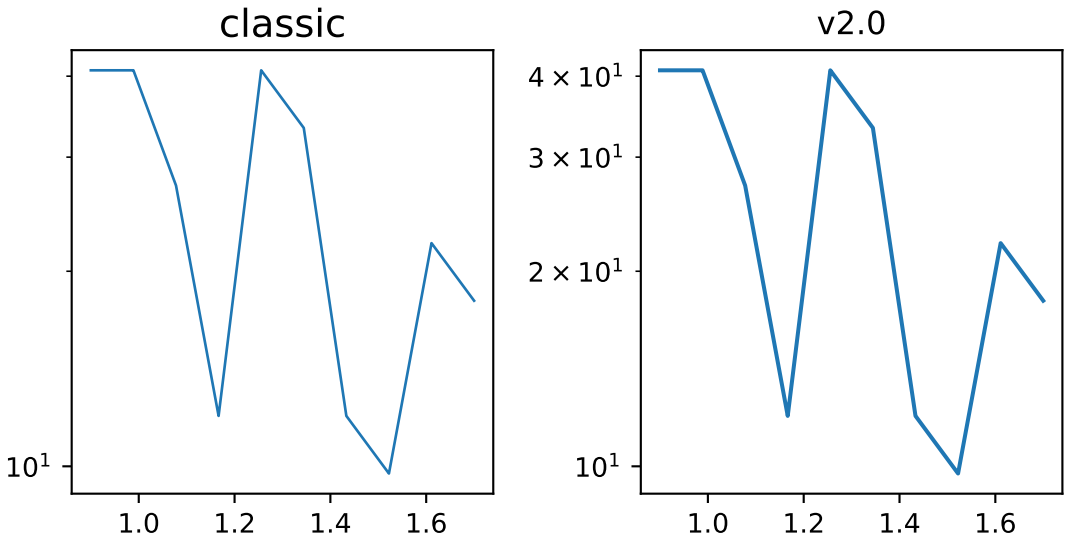
The algorithm used by *MaxNLocator* has been improved, and this may change the choice of tick locations in some cases. This also affects *AutoLocator*, which uses `MaxNLocator` internally.

For a log-scaled axis the default locator is the *LogLocator*. Previously the maximum number of ticks was set to 15, and could not be changed. Now there is a `numticks` kwarg for setting the maximum to any integer value, to the string 'auto', or to its default value of None which is equivalent to 'auto'. With the 'auto' setting the maximum number will be no larger than 9, and will be reduced depending on the length of the axis in units of the tick font size. As in the case of the AutoLocator, the heuristic algorithm reduces the incidence of overlapping tick labels but does not prevent it.

Tick label formatting

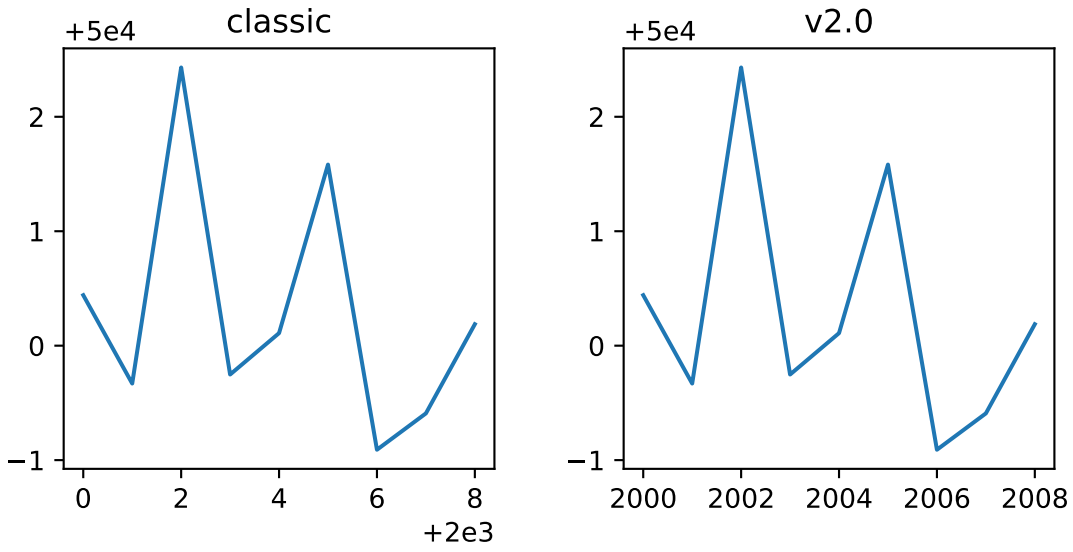
`LogFormatter` labeling of minor ticks

Minor ticks on a log axis are now labeled when the axis view limits span a range less than or equal to the interval between two major ticks. See *LogFormatter* for details. The minor tick labeling is turned off when using `mpl.style.use('classic')`, but cannot be controlled independently via `rcParams`.



`ScalarFormatter` tick label formatting with offsets

With the default of `rcParams['axes.formatter.useoffset'] = True`, an offset will be used when it will save 4 or more digits. This can be controlled with the new rcParam, `axes.formatter.offset_threshold`. To restore the previous behavior of using an offset to save 2 or more digits, use `rcParams['axes.formatter.offset_threshold'] = 2`.



`AutoDateFormatter` format strings

The default date formats are now all based on ISO format, i.e., with the slowest-moving value first. The date formatters are configurable through the `date.autoformatter.*` rcParams.

Threshold (tick interval >= than)	rcParam	classic	v2.0
365 days	`'date.autoformatter.year'`	`'%Y'`	`'%Y'`
30 days	`'date.autoformatter.month'`	`'%b %Y'`	`'%Y-%m'`
1 day	`'date.autoformatter.day'`	`'%b %d %Y'`	`'%Y-%m-%d'`
1 hour	`'date.autoformatter.hour'`	`'%H:%M:%S'`	`'%H:%M'`
1 minute	`'date.autoformatter.minute'`	`'%H:%M:%S.%f'`	`'%H:%M:%S'`
1 second	`'date.autoformatter.second'`	`'%H:%M:%S.%f'`	`'%H:%M:%S'`
1 microsecond	`'date.autoformatter.microsecond'`	`'%H:%M:%S.%f'`	`'%H:%M:%S.%f'`

Python's `%x` and `%X` date formats may be of particular interest to format dates based on the current locale.

The previous default can be restored by:

```
mpl.rcParams['date.autoformatter.year'] = '%Y'
mpl.rcParams['date.autoformatter.month'] = '%b %Y'
mpl.rcParams['date.autoformatter.day'] = '%b %d %Y'
mpl.rcParams['date.autoformatter.hour'] = '%H:%M:%S'
mpl.rcParams['date.autoformatter.minute'] = '%H:%M:%S.%f'
mpl.rcParams['date.autoformatter.second'] = '%H:%M:%S.%f'
mpl.rcParams['date.autoformatter.microsecond'] = '%H:%M:%S.%f'
```

or setting

```
date.autoformatter.year   : %Y
date.autoformatter.month  : %b %Y
date.autoformatter.day    : %b %d %Y
date.autoformatter.hour   : %H:%M:%S
date.autoformatter.minute : %H:%M:%S.%f
date.autoformatter.second : %H:%M:%S.%f
date.autoformatter.microsecond : %H:%M:%S.%f
```

in your `matplotlibrc` file.

mplot3d

- mplot3d now obeys some style-related rcParams, rather than using hard-coded defaults. These include:
  - xtick.major.width
  - ytick.major.width
  - xtick.color
  - ytick.color
  - axes.linewidth
  - axes.edgecolor
  - grid.color
  - grid.linewidth
  - grid.linestyle

Improved color conversion API and RGBA support

The *colors* gained a new color conversion API with full support for the alpha channel. The main public functions are *is_color_like()*, *matplotlib.colors.to_rgba()*, *matplotlib.colors.to_rgba_array()* and *to_hex()*. RGBA quadruplets are encoded in hex format as `#rrggbbaa`.

A side benefit is that the Qt options editor now allows setting the alpha channel of the artists as well.

New Configuration (rcParams)

New rcparams added

Parameter	Description
date.autoformatter.year	format string for 'year' scale dates
date.autoformatter.month	format string for 'month' scale dates
date.autoformatter.day	format string for 'day' scale dates
date.autoformatter.hour	format string for 'hour' scale times
date.autoformatter.minute	format string for 'minute' scale times
date.autoformatter.second	format string for 'second' scale times
date.autoformatter.microsecond	format string for 'microsecond' scale times
scatter.marker	default marker for scatter plot
svg.hashsalt	see note
xtick.top, xtick.minor.top, xtick.major.top xtick.bottom, xtick.minor.bottom, xtick.major.bottom ytick.left, ytick.minor.left, ytick.major.left ytick.right, ytick.minor.right, ytick.major.right	Control where major and minor ticks are drawn. The global values are and ed with the corresponding major/minor values.
hist.bins	The default number of bins to use in *hist*. This can be an int, a list of floats, or 'auto' if numpy >= 1.11 is installed.
lines.scale_dashes	Whether the line dash patterns should scale with linewidth.
axes.formatter.offset_threshold	Minimum number of digits saved in tick labels that triggers using an offset.

Added svg.hashsalt key to rcParams

If svg.hashsalt is None (which it is by default), the svg backend uses uuid4 to generate the hash salt. If it is not None, it must be a string that is used as the hash salt instead of uuid4. This allows for deterministic SVG output.

Removed the svg.image_noscale rcParam

As a result of the extensive changes to image handling, the svg.image_noscale rcParam has been removed. The same functionality may be achieved by setting interpolation='none' on individual images or globally using the image.interpolation rcParam.

Qualitative colormaps

ColorBrewer's "qualitative" colormaps ("Accent", "Dark2", "Paired", "Pastel1", "Pastel2", "Set1", "Set2", "Set3") were intended for discrete categorical data, with no implication of value, and therefore have been converted to `ListedColormap` instead of `LinearSegmentedColormap`, so the colors will no longer be interpolated and they can be used for choropleths, labeled image features, etc.

Axis offset label now responds to `labelcolor`

Axis offset labels are now colored the same as axis tick markers when `labelcolor` is altered.

Improved offset text choice

The default offset-text choice was changed to only use significant digits that are common to all ticks (e.g. 1231..1239 -> 1230, instead of 1231), except when they straddle a relatively large multiple of a power of ten, in which case that multiple is chosen (e.g. 1999..2001->2000).

Style parameter blacklist

In order to prevent unexpected consequences from using a style, style files are no longer able to set parameters that affect things unrelated to style. These parameters include:

```
'interactive', 'backend', 'backend.qt4', 'webagg.port',
'webagg.port_retries', 'webagg.open_in_browser', 'backend_fallback',
'toolbar', 'timezone', 'datapath', 'figure.max_open_warning',
'savefig.directory', 'tk.window_focus', 'docstring.hardcopy'
```

Change in default font

The default font used by matplotlib in text has been changed to DejaVu Sans and DejaVu Serif for the sans-serif and serif families, respectively. The DejaVu font family is based on the previous matplotlib default –Bitstream Vera– but includes a much wider range of characters.

The default mathtext font has been changed from Computer Modern to the DejaVu family to maintain consistency with regular text. Two new options for the `mathtext.fontset` configuration parameter have been added: `dejavusans` (default) and `dejavuserif`. Both of these options use DejaVu glyphs whenever possible and fall back to STIX symbols when a glyph is not found in DejaVu. To return to the previous behavior, set the rcParam `mathtext.fontset` to `cm`.

Faster text rendering

Rendering text in the Agg backend is now less fuzzy and about 20% faster to draw.

Improvements for the Qt figure options editor

Various usability improvements were implemented for the Qt figure options editor, among which:

- Line style entries are now sorted without duplicates.
- The colormap and normalization limits can now be set for images.
- Line edits for floating values now display only as many digits as necessary to avoid precision loss. An important bug was also fixed regarding input validation using Qt5 and a locale where the decimal separator is ",".
- The axes selector now uses shorter, more user-friendly names for axes, and does not crash if there are no axes.
- Line and image entries using the default labels ("_lineX", "_imageX") are now sorted numerically even when there are more than 10 entries.

Improved image support

Prior to version 2.0, matplotlib resampled images by first applying the color map and then resizing the result. Since the resampling was performed on the colored image, this introduced colors in the output image that didn't actually exist in the color map. Now, images are resampled first (and entirely in floating-point, if the input image is floating-point), and then the color map is applied.

In order to make this important change, the image handling code was almost entirely rewritten. As a side effect, image resampling uses less memory and fewer datatype conversions than before.

The experimental private feature where one could "skew" an image by setting the private member `_image_skew_coordinate` has been removed. Instead, images will obey the transform of the axes on which they are drawn.

Non-linear scales on image plots

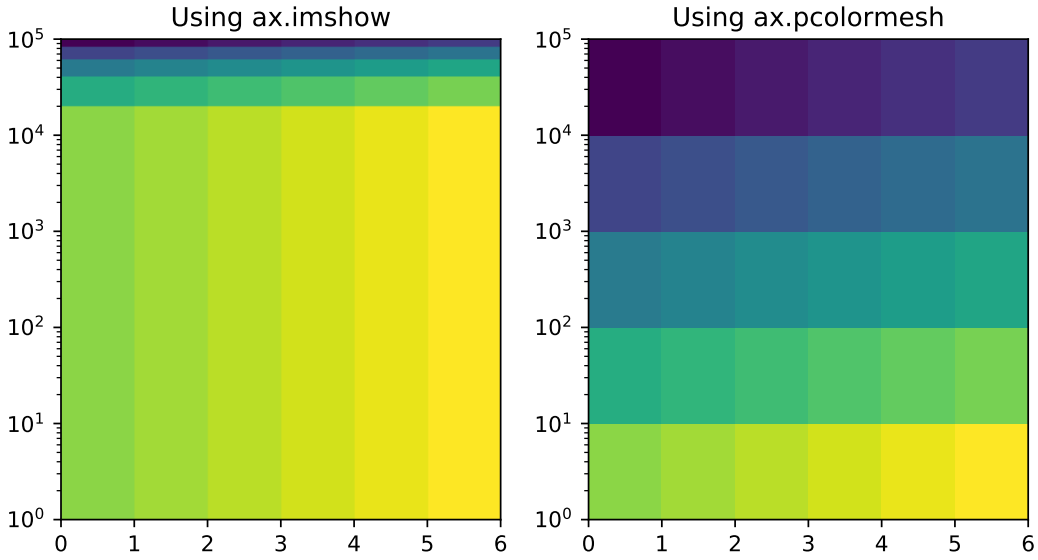
`imshow()` now draws data at the requested points in data space after the application of non-linear scales.

The image on the left demonstrates the new, correct behavior. The old behavior can be recreated using `pcolormesh()` as demonstrated on the right.

This can be understood by analogy to plotting a histogram with linearly spaced bins with a logarithmic x-axis. Equal sized bins will be displayed as wider for small x and narrower for large x.

Support for HiDPI (Retina) displays in the NbAgg and WebAgg backends

The NbAgg and WebAgg backends will now use the full resolution of your high-pixel-density display.



Change in the default animation codec

The default animation codec has been changed from `mpeg4` to `h264`, which is more efficient. It can be set via the `animation.codec` rcParam.

Deprecated support for mencoder in animation

The use of mencoder for writing video files with mpl is problematic; switching to ffmpeg is strongly advised. All support for mencoder will be removed in version 2.2.

Boxplot Zorder Keyword Argument

The `zorder` parameter now exists for `boxplot()`. This allows the zorder of a boxplot to be set in the plotting function call.

```
boxplot(np.arange(10), zorder=10)
```

Filled + and x markers

New fillable *plus* and *x* markers have been added. See the *markers* module and marker reference examples.

`rcount` and `ccount` for `plot_surface()`

As of v2.0, mplot3d's `plot_surface()` now accepts `rcount` and `ccount` arguments for controlling the sampling of the input data for plotting. These arguments specify the maximum number of evenly spaced

samples to take from the input data. These arguments are also the new default sampling method for the function, and is considered a style change.

The old `rstride` and `cstride` arguments, which specified the size of the evenly spaced samples, become the default when 'classic' mode is invoked, and are still available for use. There are no plans for deprecating these arguments.

Streamplot Zorder Keyword Argument Changes

The `zorder` parameter for `streamplot()` now has default value of `None` instead of `2`. If `None` is given as `zorder`, `streamplot()` has a default `zorder` of `matplotlib.lines.Line2D.zorder`.

Extension to `matplotlib.backend_bases.GraphicsContextBase`

To support standardizing hatch behavior across the backends we ship the *matplotlib.backend_bases.GraphicsContextBase.get_hatch_color* method as added to *matplotlib.backend_bases.GraphicsContextBase*. This is only used during the render process in the backends we ship so will not break any third-party backends.

If you maintain a third-party backend which extends *GraphicsContextBase* this method is now available to you and should be used to color hatch patterns.

5.3.12 New in Matplotlib 2.1.0

Documentation

The examples have been migrated to use sphinx gallery. This allows better mixing of prose and code in the examples, provides links to download the examples as both a Python script and a Jupyter notebook, and improves the thumbnail galleries. The examples have been re-organized into *Tutorials* and a gallery.

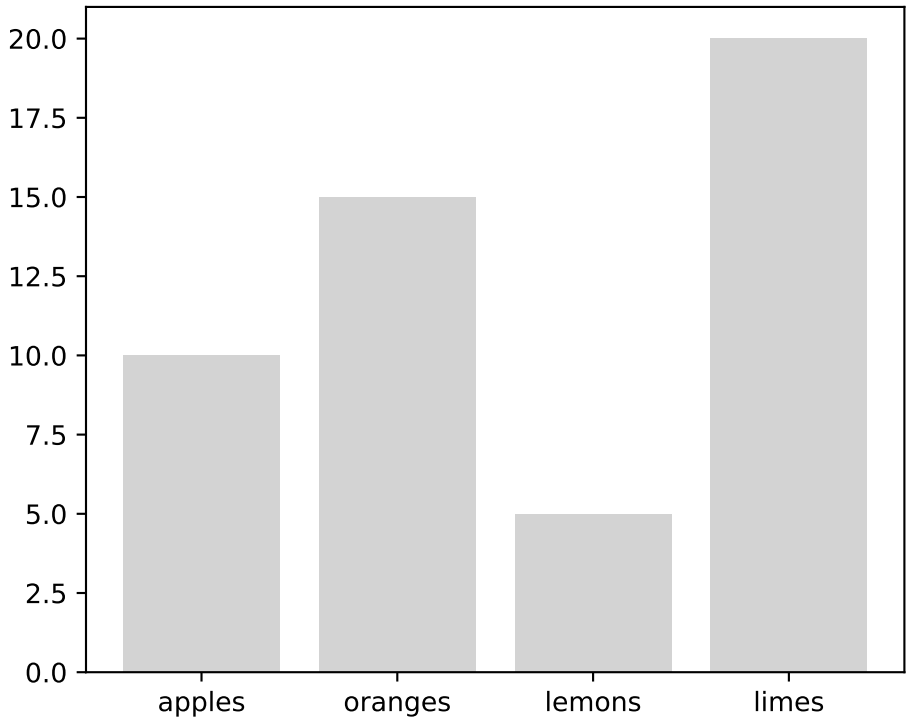
Many docstrings and examples have been clarified and improved.

New features

String categorical values

All plotting functions now support string categorical values as input. For example:

```
data = {'apples': 10, 'oranges': 15, 'lemons': 5, 'limes': 20}
fig, ax = plt.subplots()
ax.bar(data.keys(), data.values(), color='lightgray')
```



Interactive JS widgets for animation

Jake Vanderplas' JSAnimation package has been merged into Matplotlib. This adds to Matplotlib the `HTMLWriter` class for generating a JavaScript HTML animation, suitable for the IPython notebook. This can be activated by default by setting the `animation.html` rc parameter to `jshtml`. One can also call the *to_jshtml* method to manually convert an animation. This can be displayed using IPython's `HTML` display class:

```
from IPython.display import HTML
HTML(animation.to_jshtml())
```

The `HTMLWriter` class can also be used to generate an HTML file by asking for the `html` writer.

Enhancements to polar plot

The polar axes transforms have been greatly re-factored to allow for more customization of view limits and tick labelling. Additional options for view limits allow for creating an annulus, a sector, or some combination of the two.

The *set_rorigin()* method may be used to provide an offset to the minimum plotting radius, producing an annulus.

The *set_theta_zero_location()* method now has an optional `offset` argument. This argument may be used to further specify the zero location based on the given anchor point.

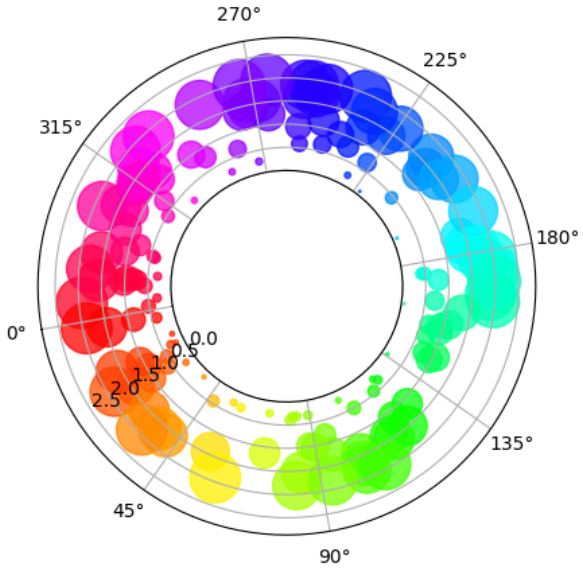


Fig. 30: Polar Offset Demo

The *set_thetamin()* and *set_thetamax()* methods may be used to limit the range of angles plotted, producing sectors of a circle.

Previous releases allowed plots containing negative radii for which the negative values are simply used as labels, and the real radius is shifted by the configured minimum. This release also allows negative radii to be used for grids and ticks, which were previously silently ignored.

Radial ticks have been modified to be parallel to the circular grid line, and angular ticks have been modified to be parallel to the grid line. It may also be useful to rotate tick *labels* to match the boundary. Calling `ax.tick_params(rotation='auto')` will enable the new behavior: radial tick labels will be parallel to the circular grid line, and angular tick labels will be perpendicular to the grid line (i.e., parallel to the outer boundary). Additionally, tick labels now obey the padding settings that previously only worked on Cartesian plots. Consequently, the `frac` argument to *PolarAxes.set_thetagrids* is no longer applied. Tick padding can be modified with the `pad` argument to *Axes.tick_params* or *Axis.set_tick_params*.

`Figure` class now has `subplots` method

The *Figure* class now has a *subplots()* method which behaves the same as *pyplot.subplots()* but on an existing figure.

Metadata savefig keyword argument

savefig() now accepts `metadata` as a keyword argument. It can be used to store key/value pairs in the image metadata.

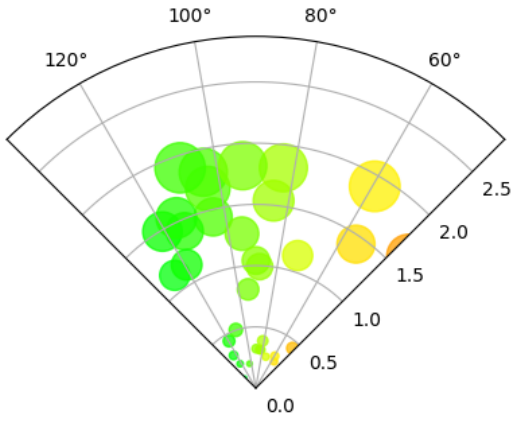


Fig. 31: Polar Sector Demo

- 'png' with Agg backend
- 'pdf' with PDF backend (see *writeInfoDict()* for a list of supported keywords)
- 'eps' and 'ps' with PS backend (only 'Creator' key is accepted)

```
plt.savefig('test.png', metadata={'Software': 'My awesome software'})
```

Busy Cursor

The interactive GUI backends will now change the cursor to busy when Matplotlib is rendering the canvas.

PolygonSelector

A *PolygonSelector* class has been added to *matplotlib.widgets*. See /gallery/widgets/polygon_selector_demo for details.

Added `matplotlib.ticker.PercentFormatter`

The new *PercentFormatter* formatter has some nice features like being able to convert from arbitrary data scales to percents, a customizable percent symbol and either automatic or manual control over the decimal points.

Reproducible PS, PDF and SVG output

The `SOURCE_DATE_EPOCH` environment variable can now be used to set the timestamp value in the PS and PDF outputs. See source date epoch.

Alternatively, calling `savefig` with `metadata={'CreationDate': None}` will omit the timestamp altogether for the PDF backend.

The reproducibility of the output from the PS and PDF backends has so far been tested using various plot elements but only default values of options such as `{ps,pdf}.fonttype` that can affect the output at a low level, and not with the mathtext or usetex features. When Matplotlib calls external tools (such as PS distillers or LaTeX) their versions need to be kept constant for reproducibility, and they may add sources of nondeterminism outside the control of Matplotlib.

For SVG output, the `svg.hashsalt` rc parameter has been added in an earlier release. This parameter changes some random identifiers in the SVG file to be deterministic. The downside of this setting is that if more than one file is generated using deterministic identifiers and they end up as parts of one larger document, the identifiers can collide and cause the different parts to affect each other.

These features are now enabled in the tests for the PDF and SVG backends, so most test output files (but not all of them) are now deterministic.

Orthographic projection for mplot3d

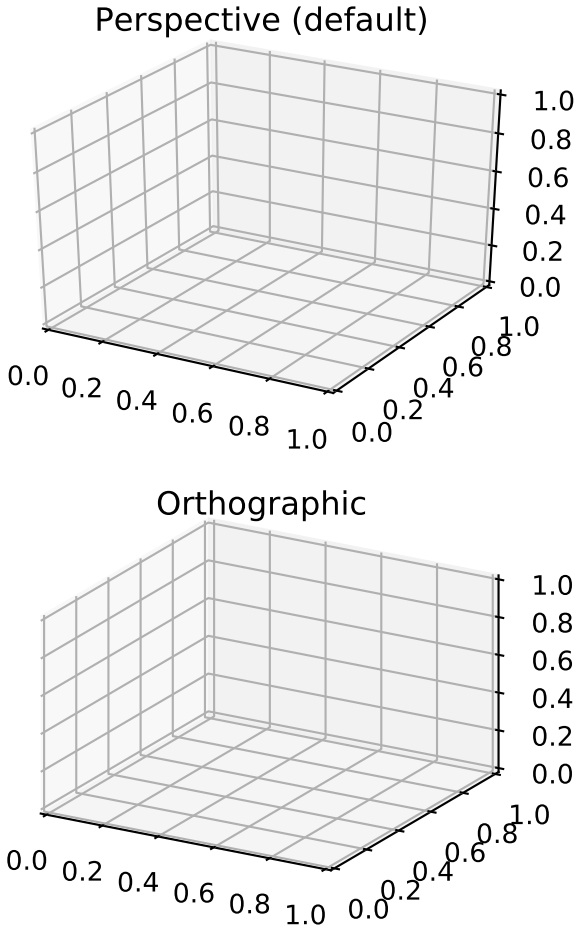
Axes3D now accepts `proj_type` keyword argument and has a method *set_proj_type()*. The default option is `'persp'` as before, and supplying `'ortho'` enables orthographic view.

Compare the z-axis which is vertical in orthographic view, but slightly skewed in the perspective view.

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure(figsize=(4, 6))
ax1 = fig.add_subplot(2, 1, 1, projection='3d')
ax1.set_proj_type('persp')
ax1.set_title('Perspective (default)')

ax2 = fig.add_subplot(2, 1, 2, projection='3d')
ax2.set_proj_type('ortho')
ax2.set_title('Orthographic')

plt.show()
```

`voxels` function for mplot3d

Axes3D now has a *voxels* method, for visualizing boolean 3D data. Uses could include plotting a sparse 3D heat map, or visualizing a volumetric model.


Perspective (default)
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0
Orthographic
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0

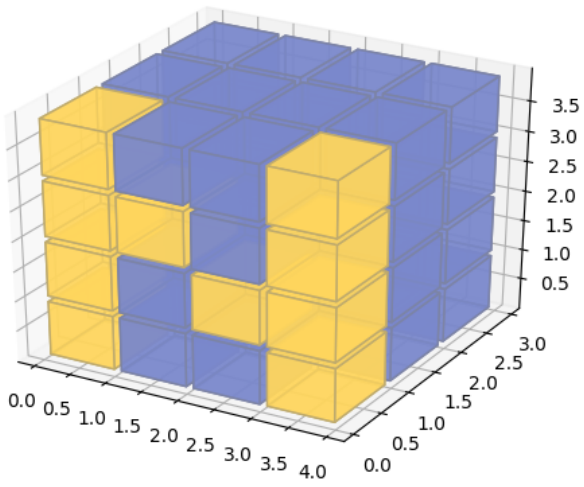


Fig. 32: Voxel Demo

Improvements

CheckButtons widget `get_status` function

A *`get_status()`* method has been added to the *`matplotlib.widgets.CheckButtons`* class. This `get_status` method allows user to query the status (True/False) of all of the buttons in the `CheckButtons` object.

Add `fill_bar` argument to `AnchoredSizeBar`

The `mpl_toolkits` class *`AnchoredSizeBar`* now has an additional `fill_bar` argument, which makes the size bar a solid rectangle instead of just drawing the border of the rectangle. The default is `None`, and whether or not the bar will be filled by default depends on the value of `size_vertical`. If `size_vertical` is nonzero, `fill_bar` will be set to `True`. If `size_vertical` is zero then `fill_bar` will be set to `False`. If you wish to override this default behavior, set `fill_bar` to `True` or `False` to unconditionally always or never use a filled patch rectangle for the size bar.

```
import matplotlib.pyplot as plt
from mpl_toolkits.axes_grid1.anchored_artists import AnchoredSizeBar

fig, ax = plt.subplots(figsize=(3, 3))

bar0 = AnchoredSizeBar(ax.transData, 0.3, 'unfilled', loc=3, frameon=False,
                       size_vertical=0.05, fill_bar=False)
ax.add_artist(bar0)
bar1 = AnchoredSizeBar(ax.transData, 0.3, 'filled', loc=4, frameon=False,
```

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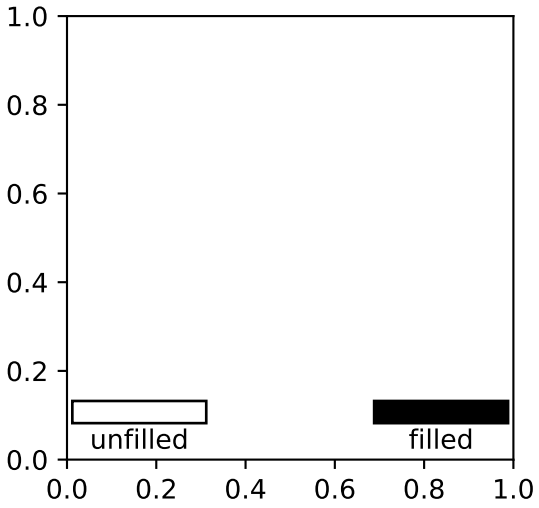
```
                        size_vertical=0.05, fill_bar=True)
ax.add_artist(bar1)

plt.show()
```



Annotation can use a default arrow style

Annotations now use the default arrow style when setting `arrowprops={}`, rather than no arrow (the new behavior actually matches the documentation).

Barbs and Quiver Support Dates

When using the *quiver()* and *barbs()* plotting methods, it is now possible to pass dates, just like for other methods like *plot()*. This also allows these functions to handle values that need unit-conversion applied.

Hexbin default line color

The default `linecolor` keyword argument for *hexbin()* is now `'face'`, and supplying `'none'` now prevents lines from being drawn around the hexagons.

Figure.legend() can be called without arguments

Calling *Figure.legend()* can now be done with no arguments. In this case a legend will be created that contains all the artists on all the axes contained within the figure.

Multiple legend keys for legend entries

A legend entry can now contain more than one legend key. The extended *HandlerTuple* class now accepts two parameters: `ndivide` divides the legend area in the specified number of sections; `pad` changes the padding between the legend keys.

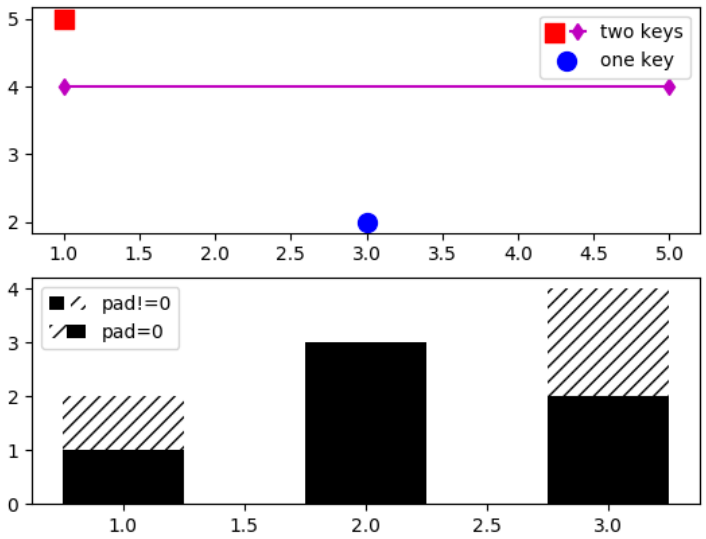


Fig. 33: Multiple Legend Keys

New parameter `clear` for `figure()`

When the pyplot's function *figure()* is called with a `num` parameter, a new window is only created if no existing window with the same value exists. A new bool parameter `clear` was added for explicitly clearing its existing contents. This is particularly useful when utilized in interactive sessions. Since *subplots()* also accepts keyword arguments from *figure()*, it can also be used there:

```
import matplotlib.pyplot as plt

fig0 = plt.figure(num=1)
fig0.suptitle("A fancy plot")
print("fig0.texts: ", [t.get_text() for t in fig0.texts])

fig1 = plt.figure(num=1, clear=False)  # do not clear contents of window
fig1.text(0.5, 0.5, "Really fancy!")
print("fig0 is fig1: ",  fig0 is fig1)
print("fig1.texts: ", [t.get_text() for t in fig1.texts])

fig2, ax2 = plt.subplots(2, 1, num=1, clear=True)  # clear contents
print("fig0 is fig2: ",  fig0 is fig2)
print("fig2.texts: ", [t.get_text() for t in fig2.texts])
```

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```
# The output:
# fig0.texts:  ['A fancy plot']
# fig0 is fig1:  True
# fig1.texts:  ['A fancy plot', 'Really fancy!']
# fig0 is fig2:  True
# fig2.texts:  []
```

Specify minimum value to format as scalar for `LogFormatterMathtext`

LogFormatterMathtext now includes the option to specify a minimum value exponent to format as a scalar (i.e., 0.001 instead of 10^{-3}).

New quiverkey angle keyword argument

Plotting a *quiverkey()* now admits the `angle` keyword argument, which sets the angle at which to draw the key arrow.

Colormap reversed method

The methods *matplotlib.colors.LinearSegmentedColormap.reversed()* and *matplotlib.colors.ListedColormap.reversed()* return a reversed instance of the Colormap. This implements a way for any Colormap to be reversed.

`Artist.setp` (and `pyplot.setp`) accept a `file` argument

The argument is keyword-only. It allows an output file other than `sys.stdout` to be specified. It works exactly like the `file` argument to `print`.

`streamplot` streamline generation more configurable

The starting point, direction, and length of the stream lines can now be configured. This allows to follow the vector field for a longer time and can enhance the visibility of the flow pattern in some use cases.

`Axis.set_tick_params` now responds to `rotation`

Bulk setting of tick label rotation is now possible via *tick_params()* using the `rotation` keyword.

```
ax.tick_params(which='both', rotation=90)
```

Ticklabels are turned off instead of being invisible

Internally, the `Tick`'s `label1On()` attribute is now used to hide tick labels instead of setting the visibility on the tick label objects. This improves overall performance and fixes some issues. As a consequence, in case those labels ought to be shown, *tick_params()* needs to be used, e.g.

```
ax.tick_params(labelbottom=True)
```

Shading in 3D bar plots

A new `shade` parameter has been added the 3D *bar* plotting method. The default behavior remains to shade the bars, but now users have the option of setting `shade` to `False`.

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

x = np.arange(2)
y = np.arange(3)
x2d, y2d = np.meshgrid(x, y)
x, y = x2d.ravel(), y2d.ravel()
z = np.zeros_like(x)
dz = x + y

fig = plt.figure(figsize=(4, 6))
ax1 = fig.add_subplot(2, 1, 1, projection='3d')
ax1.bar3d(x, y, z, 1, 1, dz, shade=True)
ax1.set_title('Shading On')

ax2 = fig.add_subplot(2, 1, 2, projection='3d')
ax2.bar3d(x, y, z, 1, 1, dz, shade=False)
ax2.set_title('Shading Off')

plt.show()
```

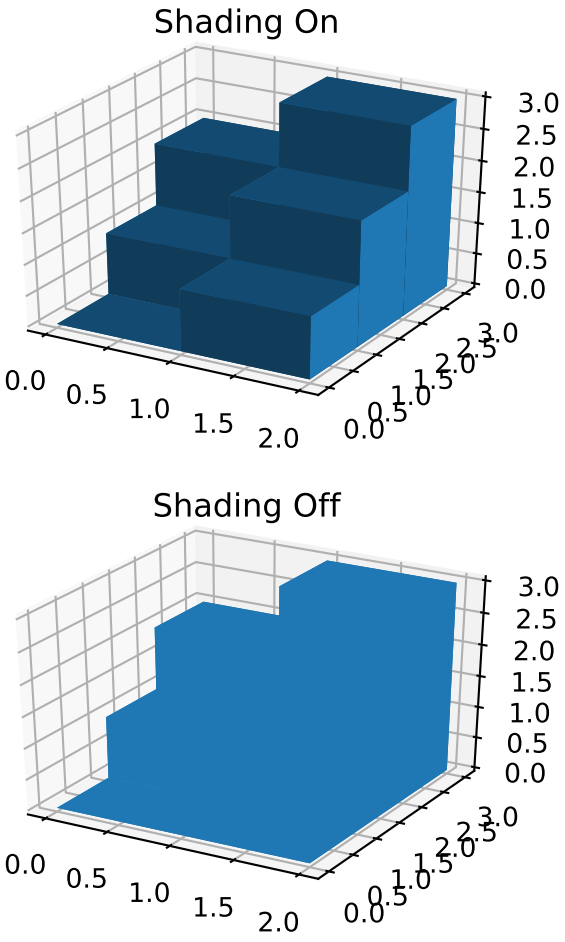
New `which` Parameter for `autofmt_xdate`

A `which` parameter now exists for the method *autofmt_xdate()*. This allows a user to format `major`, `minor` or `both` tick labels selectively. The default behavior will rotate and align the `major` tick labels.

```
fig.autofmt_xdate(bottom=0.2, rotation=30, ha='right', which='minor')
```

New Figure Parameter for `subplot2grid`

A `fig` parameter now exists for the function *subplot2grid()*. This allows a user to specify the figure where the subplots will be created. If `fig` is `None` (default) then the method will use the current figure retrieved by *gcf()*.


Shading On
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
Shading Off
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

```
subplot2grid(shape, loc, rowspan=1, colspan=1, fig=myfig)
```

Interpolation in `fill_betweenx`

The `interpolate` parameter now exists for the method *`fill_betweenx()`*. This allows a user to interpolate the data and fill the areas in the crossover points, similarly to *`fill_between()`*.

New keyword argument `sep` for EngFormatter

A new `sep` keyword argument has been added to *`EngFormatter`* and provides a means to define the string that will be used between the value and its unit. The default string is `" "`, which preserves the former behavior. Additionally, the separator is now present between the value and its unit even in the absence of SI prefix. There was formerly a bug that was causing strings like `"3.14V"` to be returned instead of the expected `"3.14 V"` (with the default behavior).

Extend `MATPLOTLIBRC` behavior

The environmental variable can now specify the full file path or the path to a directory containing a `matplotlibrc` file.

`density` kwarg to hist

The *`hist()`* method now prefers `density` to `normed` to control if the histogram should be normalized, following a change upstream to NumPy. This will reduce confusion as the behavior has always been that the integral of the histogram is 1 (rather than sum or maximum value).

Internals

New TransformedPatchPath caching object

A newly added *`TransformedPatchPath`* provides a means to transform a *`Patch`* into a *`Path`* via a *`Transform`* while caching the resulting path. If neither the patch nor the transform have changed, a cached copy of the path is returned.

This class differs from the older *`TransformedPath`* in that it is able to refresh itself based on the underlying patch while the older class uses an immutable path.

Abstract base class for movie writers

The new *`AbstractMovieWriter`* class defines the API required by a class that is to be used as the `writer` in the *`matplotlib.animation.Animation.save()`* method. The existing *`MovieWriter`* class now derives from the new abstract base class.

Stricter validation of line style rcParams

The validation of rcParams that are related to line styles (`lines.linestyle`, `boxplot.*.linestyle`, `grid.linestyle` and `contour.negative_linestyle`) now effectively checks that the values are valid line styles. Strings like `'dashed'` or `'--'` are accepted, as well as even-length sequences of on-off ink like `[1, 1.65]`. In this latter case, the offset value is handled internally and should *not* be provided by the user.

The new validation scheme replaces the former one used for the `contour.negative_linestyle` rcParams, that was limited to `'solid'` and `'dashed'` line styles.

The validation is case-insensitive. The following are now valid:

```
grid.linestyle             : (1, 3)   # loosely dotted grid lines
contour.negative_linestyle : dashdot  # previously only solid or dashed
```

pytest

The automated tests have been switched from `nose` to `pytest`.

Performance

Path simplification updates

Line simplification controlled by the `path.simplify` and `path.simplify_threshold` parameters has been improved. You should notice better rendering performance when plotting large amounts of data (as long as the above parameters are set accordingly). Only the line segment portion of paths will be simplified – if you are also drawing markers and experiencing problems with rendering speed, you should consider using the `markevery` option to *plot*. See the *Performance* section in the usage tutorial for more information.

The simplification works by iteratively merging line segments into a single vector until the next line segment's perpendicular distance to the vector (measured in display-coordinate space) is greater than the `path.simplify_threshold` parameter. Thus, higher values of `path.simplify_threshold` result in quicker rendering times. If you are plotting just to explore data and not for publication quality, pixel perfect plots, then a value of `1.0` can be safely used. If you want to make sure your plot reflects your data *exactly*, then you should set `path.simplify` to false and/or `path.simplify_threshold` to `0`. Matplotlib currently defaults to a conservative value of `1/9`, smaller values are unlikely to cause any visible differences in your plots.

Implement intersects_bbox in c++

intersects_bbox() has been implemented in c++ which improves the performance of automatically placing the legend.

CHAPTER

SIX

GITHUB STATS

GitHub stats for 2018/03/05 - 2018/08/09 (tag: v2.2.0)

These lists are automatically generated, and may be incomplete or contain duplicates.

We closed 27 issues and merged 101 pull requests. The full list can be seen on GitHub

The following 28 authors contributed 347 commits.

- 816-8055
- Andreas Gustafsson
- Andrew Nelson
- Antony Lee
- Ben Root
- Charles Ruan
- dahlbaek
- David Stansby
- DietmarSchwertberger
- Elizabeth Seiver
- Elliott Sales de Andrade
- Eric Firing
- Federico Ariza
- fredrik-1
- hannah
- Importance of Being Ernest
- ImportanceOfBeingErnest
- Jens Hedegaard Nielsen
- Jody Klymak
- joelostblom

- Jouni K. Seppänen
- Michael Droettboom
- Nelle Varoquaux
- Paul Hobson
- Paul Ivanov
- Ryan May
- Thomas A Caswell
- Tim Hoffmann

GitHub issues and pull requests:

Pull Requests (101):

- PR #11835: Backport PR #11831 on branch v2.2.x
- PR #11831: animation api documentation changes
- PR #11834: Backport PR #11824 on branch v2.2.x
- PR #11824: facecolor stale missing
- PR #11827: FIX: correct macro logic in file_compat.h
- PR #11817: Merge pull request #11533 from tacaswell/update_for_py37
- PR #11533: MNT: updates for python 3.7
- PR #11813: Backport axes grid work
- PR #11808: updates error message to run pytest instead of tests.py standalone
- PR #11812: Final backports
- PR #11811: Backport: resolve conflict to get this into v2.2.3
- PR #9993: Rewrite and greatly simplify qt_compat.py.
- PR #11786: Fix collections import warnings for Python 3.7
- PR #11733: MAINT: use collections.abc for 3.7
- PR #11697: Backport PR #11694 on branch v2.2.x
- PR #11694: moving toolmanager initialization up before toolbar
- PR #11671: refresh the github stats
- PR #11669: Fix invalid escape sequences on branch v2.2.x
- PR #11638: Backport PR #11636 on branch v2.2.x
- PR #11634: Backport #11624
- PR #11636: Don't flush file object opened for reading
- PR #11624: Don't use Popen(..., shell=True).

- PR #11599: Backport PR #11559 on branch v2.2.x
- PR #11598: Backport PR #10915 on branch v2.2.x
- PR #11588: DOC: warn if user is using constrained layout and use subplots_adjust
- PR #11580: Use plt.subplots()
- PR #11574: Backport PR #11565 on branch v2.2.x
- PR #11565: Update docstring of pyplot.matshow()
- PR #11559: FIX: Toolbar disappears in TkAgg if window if resized
- PR #11567: Backport PR #11500 on branch v2.2.x
- PR #11500: Fix shims with PyQt5 5.11
- PR #11060: Fix inset_axes + doc
- PR #11535: Backport PR #11517 on branch v2.2.x
- PR #11517: Update legend loc default value in docstring
- PR #11489: Backport PR #11485 on branch v2.2.x
- PR #11485: Use null character instead of recasting NULL to char
- PR #11419: Backport PR #11409: plt.box_bug_fix
- PR #11379: Backport PR #11363 on branch v2.2.x
- PR #11409: plt.box_bug_fix
- PR #11407: Properly position markers in step plots.
- PR #11330: FIX: Don't let constrained_layout counter overflow
- PR #11363: Improve docstring of Axes.pcolorfast
- PR #11354: Backport PR #11344 on branch v2.2.x
- PR #11344: Improve docstring of Axes.pcolormesh
- PR #11336: Use raw string literals for docstrings with escapes
- PR #11334: Backport pull request #10858
- PR #11333: Backport #10806 to v2.2.x
- PR #11312: Replace :ref:`sphx_glr_...` by :doc:`/...`.
- PR #11327: Backport PR #11317 on branch v2.2.x
- PR #11317: Improve docstring of Axes.pcolor
- PR #11262: Use dummy_threading if threading not available
- PR #11260: Backport PR #11189 on branch v2.2.x
- PR #11047: FIX: image respect norm limits w/ None
- PR #11173: Define `__repr__`, not `__str__` for transforms.

- PR #11189: FIX: remove recursive call to str in transform repr
- PR #11184: Manual backport #11035
- PR #11035: FIX: constrained_layout and repeated calls to suptitle
- PR #11171: FIX: str method for SymmetricalLogTransform
- PR #11162: Backport PR #11161 on branch v2.2.x
- PR #11161: DOC: small-doc-improvements1
- PR #11079: Resurrecting axes_grid1 documentation
- PR #11105: When drawing markers, don't set the GraphicsContext alpha.
- PR #10881: FIX: make un-used ticks not be visible
- PR #10968: Improve docstring of contour
- PR #11120: Backport PR #10981 on branch v2.2.x
- PR #10981: Document change of label visibility on shared axes
- PR #11114: Backport PR #10792 on branch v2.2.x
- PR #10792: Fixed not being able to set vertical/horizontal alignments in polar graphs
- PR #11111: Pin sphinx!=1.7.3 on v2.2.x
- PR #11107: Pin sphinx to 1.7.2 to unbreak the doc build.
- PR #11090: Clean docstring of CountourSet
- PR #11084: Backport PR #10899: Update cycler docstrings and favor kwarg over two...
- PR #10899: Update cycler docstrings and favor kwarg over two-args form
- PR #11071: Add note about hist2d resetting axis limits
- PR #11067: Remove unnecessary shebang.
- PR #11054: Backport PR #11052 on branch v2.2.x
- PR #11052: Fix CircleCI build.
- PR #11023: Backport PR #11022 on branch v2.2.x
- PR #11022: MNT: remove distutils.sysconfig import from toplevel module
- PR #11011: Backport PR #11002 on branch v2.2.x
- PR #11002: Fix logic error in ScalarMappable.to_rgba
- PR #10952: Backport PR #10951 on branch v2.2.x
- PR #10979: Backport PR #10978 on branch v2.2.x
- PR #10978: Remove to-be-deprecated NumPy imports.
- PR #10951: fix wx rubberband: correctly ensure x0<=x1
- PR #10937: Backport PR #10935 on branch v2.2.x

- PR #10935: FIX: Postscript allow empty markers
- PR #10858: FIX: ioerror font cache, second try
- PR #10929: Fix rctemplate tests when user config file exists.
- PR #10927: Backport PR #10919 on branch v2.2.x
- PR #10919: Fix overflow when resizing path-to-string buffer.
- PR #10877: Fix invalid escape sequence in docstring.
- PR #10868: Backport PR #10867 on branch v2.2.x
- PR #10867: MNT: move bz2 back to function level
- PR #10860: Backport PR #10856 on branch v2.2.x
- PR #10856: Fix xkcd style garbage collection.
- PR #10853: Backport PR #10662 on branch v2.2.x
- PR #10662: Update docs on Axes.set_prop_cycle
- PR #10833: Propagate marker antialias setting to GraphicsContext.
- PR #10806: MNT: catch more illegal ”
- PR #10595: Improve Figure docstrings

Issues (27):

- #11822: matplotlib.pyplot import gives error on MacOSX
- #11832: Marker disappears with markerfacecolor='None' when saving as eps file
- #11810: Figure gets collapsed after nth iteration using constrained_layout
- #11389: Incorrect processing of plot_args when using data argument
- #11635: "import matplotlib.pyplot" fails on NetBSD with version 2.2.2
- #6781: Toolbar disappears in TkAgg if window if resized
- #10890: Bug causes to_rgba to fail inside cm.py
- #9582: axes_grid1 docs do not appear on mpl.org anymore.
- #11484: Matplotlib does not build on OpenBSD using clang
- #11302: [DOC] Build of documentation fails
- #11031: wrong x-position of marker with drawstyle='steps-xxx'
- #11372: Symbols not showing in eps format
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- #11163: RecursionError when calling get_yaxis_transform() on a Symlog-scaled axis.
- #11156: Error in documentation of pyplot.errorbar()

- #11104: pyplot.plot conflict: markerfacecolor ='none' and alpha
- #11126: Legend positioning behavior change from matplotlib {2.1.0 -> 2.2.2}
- #10633: Type Error when saving jpg image (Pillow 3)
- #10911: Get ticklabels back on shared axis
- #5609: Segfaults with wxpython 3.0.2.0 backend
- #11021: remove `import distutils.sysconfig` from `lib/matplotlib/__init__.py`
- #10949: Qt5Agg blitting issue with matplotlib 2.2.2
- #10966: pillow animation writer failing macOS tests
- #10921: No markers in EPS if fillstyle='none'
- #10889: memory error using savefig with ylim to create pdf of box plots
- #10866: bz2 mistakenly made a hard requirement of matplotlib 2.2.2

CHAPTER

SEVEN

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CHAPTER

EIGHT

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We also thank all who have reported bugs, commented on proposed changes, or otherwise contributed to Matplotlib's development and usefulness.

Part II

The Matplotlib FAQ

CHAPTER

NINE

INSTALLATION

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9.1 Report a compilation problem

See *Getting help*.

9.2 matplotlib compiled fine, but nothing shows up when I use it

The first thing to try is a *clean install* and see if that helps. If not, the best way to test your install is by running a script, rather than working interactively from a python shell or an integrated development environment such as **IDLE** which add additional complexities. Open up a UNIX shell or a DOS command prompt and run, for example:

```
python -c "from pylab import *; plot(); show()" --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 *Getting help*.

9.3 How to completely remove Matplotlib

Occasionally, problems with Matplotlib can be solved with a clean installation of the package. In order to fully remove an installed Matplotlib:

1. Delete the caches from your *Matplotlib configuration directory*.
2. Delete any Matplotlib directories or eggs from your *installation directory*.

9.4 Linux Notes

To install Matplotlib at the system-level, we recommend that you use your distribution's package manager. This will guarantee that Matplotlib's dependencies will be installed as well.

If, for some reason, you cannot use the package manager, you may use the wheels available on PyPI:

```
python -mpip install matplotlib
```

or *build Matplotlib from source*.

9.5 OSX Notes

9.5.1 Which python for OSX?

Apple ships OSX with its own Python, in `/usr/bin/python`, and its own copy of Matplotlib. Unfortunately, the way Apple currently installs its own copies of NumPy, Scipy and Matplotlib means that these packages are difficult to upgrade (see system python packages). For that reason we strongly suggest that you install a fresh version of Python and use that as the basis for installing libraries such as NumPy and Matplotlib. One convenient way to install matplotlib with other useful Python software is to use one of the excellent Python scientific software collections that are now available:

- Anaconda from Continuum Analytics
- Canopy from Enthought

These collections include Python itself and a wide range of libraries; if you need a library that is not available from the collection, you can install it yourself using standard methods such as *pip*. Continuum and Enthought offer their own installation support for these collections; see the Ananconda and Canopy web pages for more information.

Other options for a fresh Python install are the standard installer from python.org, or installing Python using a general OSX package management system such as homebrew or macports. Power users on OSX will likely want one of homebrew or macports on their system to install open source software packages, but it is perfectly possible to use these systems with another source for your Python binary, such as Anaconda, Canopy or Python.org Python.

9.5.2 Installing OSX binary wheels

If you are using recent Python from https://www.python.org, Macports or Homebrew, then you can use the standard pip installer to install Matplotlib binaries in the form of wheels.

Python.org Python

Install pip following the standard pip install instructions. For the impatient, open a new Terminal.app window and:

```
curl -O https://bootstrap.pypa.io/get-pip.py
```

Then (Python 2):

```
python get-pip.py
```

or (Python 3):

```
python3 get-pip.py
```

You can now install matplotlib and all its dependencies with

```
python -mpip install matplotlib
```

or

```
python3 -mpip install matplotlib
```

Macports Python

For Python 2:

```
sudo port install py27-pip
sudo python2 -mpip install matplotlib
```

For Python 3:

```
sudo port install py36-pip
sudo python3.6 -mpip install matplotlib
```

Homebrew Python

For Python 2:

```
python2 -mpip install matplotlib
```

For Python 3:

```
python3 -mpip install matplotlib
```

You might also want to install IPython or the Jupyter notebook (`pythonX -mpip install ipython`, `pythonX -mpip install notebook`, where `pythonX` is set as above).

pip problems

If you get errors with pip trying to run a compiler like `gcc` or `clang`, then the first thing to try is to install xcode and retry the install. If that does not work, then check *Getting help*.

9.5.3 Checking your installation

The new version of Matplotlib should now be on your Python "path". Check this with one of these commands at the Terminal.app command line:

```
python2 -c 'import matplotlib; print matplotlib.__version__, matplotlib.__file__'
```

(Python 2) or:

```
python3 -c 'import matplotlib; print(matplotlib.__version__, matplotlib.__file__)'
```

(Python 3). You should see something like this:

```
2.1.0 /Library/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-packages/
↪matplotlib/__init__.pyc
```

where `2.1.0` is the Matplotlib version you just installed, and the path following depends on whether you are using Python.org Python, Homebrew or Macports. If you see another version, or you get an error like this:

```
Traceback (most recent call last):
  File "<string>", line 1, in <module>
ImportError: No module named matplotlib
```

then check that the Python binary is the one you expected by doing one of these commands in Terminal.app:

```
which python2
```

or:

```
which python3
```

If you get the result `/usr/bin/python2.7`, then you are getting the Python installed with OSX, which is probably not what you want. Try closing and restarting Terminal.app before running the check again. If that doesn't fix the problem, depending on which Python you wanted to use, consider reinstalling Python.org Python, or check your homebrew or macports setup. Remember that the disk image installer only works for Python.org Python, and will not get picked up by other Pythons. If all these fail, please *let us know*.

9.6 Windows Notes

See *Windows*.

9.7 Install from source

Clone the main source using one of:

```
git clone git@github.com:matplotlib/matplotlib.git
```

or:

```
git clone git://github.com/matplotlib/matplotlib.git
```

and build and install as usual with:

```
cd matplotlib
python -mpip install .
```

Note: If you are on Debian/Ubuntu, you can get all the dependencies required to build Matplotlib with:

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

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

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

This does not build Matplotlib, but it does get all of the build dependencies, which will make building from source easier.

If you want to be able to follow the development branch as it changes just replace the last step with:

```
python -mpip install -e .
```

This creates links and installs the command line script in the appropriate places.

Note: OSX users please see the *Building on macOS* guide.

Windows users please see the *Building on Windows* guide.

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

```
git pull
```

When you run `git pull`, if the output shows that only Python files have been updated, you are all set. If C files have changed, you need to run `pip install -e .` again to compile them.

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

CHAPTER

TEN

HOW-TO

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10.1 Plotting: howto

10.1.1 Plot `numpy.datetime64` values

As of Matplotlib 2.2, `numpy.datetime64` objects are handled the same way as `datetime.datetime` objects.

If you prefer the pandas converters and locators, you can register their converter with the `matplolib.units` module:

```
from pandas.tseries import converter as pdtc
pdtc.register()
```

If you only want to use the `pandas` converter for `datetime64` values

```
from pandas.tseries import converter as pdtc
import matplotlib.units as munits
import numpy as np

munits.registry[np.datetime64] = pdtc.DatetimeConverter()
```

10.1.2 Find all objects in a figure of a certain type

Every Matplotlib artist (see *Artist tutorial*) has a method called *`findobj()`* that can be used to recursively search the artist for any artists it may contain that meet some criteria (e.g., 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')
```

10.1.3 How to prevent ticklabels from having an offset

The default formatter will use an offset to reduce the length of the ticklabels. To turn this feature off on a per-axis basis:

```
ax.get_xaxis().get_major_formatter().set_useOffset(False)
```

set the rcParam `axes.formatter.useoffset`, or use a different formatter. See *ticker* for details.

10.1.4 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, e.g., you do not want full transparency or you want to affect the screen displayed version as well, you can set the alpha properties directly. The figure has a *Rectangle* instance called *patch* and the axes has a Rectangle instance called *patch*. You can set any property on them directly (*facecolor*, *edgecolor*, *linewidth*, *linestyle*, *alpha*). e.g.:

```
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, e.g.:

```
ax.plot(x, y, alpha=0.5)
ax.set_xlabel('volts', alpha=0.5)
```

10.1.5 Save multiple plots to one pdf file

Many image file formats can only have one image per file, but some formats support multi-page files. Currently only the pdf backend has support for this. To make a multi-page pdf file, first initialize the file:

```
from matplotlib.backends.backend_pdf import PdfPages
pp = PdfPages('multipage.pdf')
```

You can give the *PdfPages* object to *savefig()*, but you have to specify the format:

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

An easier way is to call *PdfPages.savefig*:

```
pp.savefig()
```

Finally, the multipage pdf object has to be closed:

```
pp.close()
```

10.1.6 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 with style sheets and rcParams*. 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 space between subplots, expressed as a fraction of the average axis width

***hspace* = 0.2** the amount of height reserved for space between subplots, expressed as a fraction of the average axis height

If you want additional control, you can create an *Axes* using the *axes()* command (or equivalently the figure *add_axes()* method), which allows you to specify the location explicitly:

```
ax = fig.add_axes([left, bottom, width, height])
```

where all values are in fractional (0 to 1) coordinates. See /gallery/subplots_axes_and_figures/axes_demo for an example of placing axes manually.

10.1.7 Automatically make room for tick labels

Note: This is now easier to handle than ever before. Calling *tight_layout()* can fix many common layout issues. See the *Tight Layout guide*.

The information below is kept here in case it is useful for other purposes.

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

The `RendererBase` instance, which is used to calculate the text size, is not known until the figure is drawn (`draw()`). After the window is drawn and the text instance knows its renderer, you can call `get_window_extent()`. One way to solve this chicken and egg problem is to wait until the figure is draw by connecting (`mpl_connect()`) to the "on_draw" signal (`DrawEvent`) and get the window extent there, and then do something with it, e.g., move the left of the canvas over; see *Event handling and picking*.

Here is an example that gets a bounding box in relative figure coordinates (0..1) of each of the labels and uses it to move the left of the subplots over so that the tick labels fit in the figure:

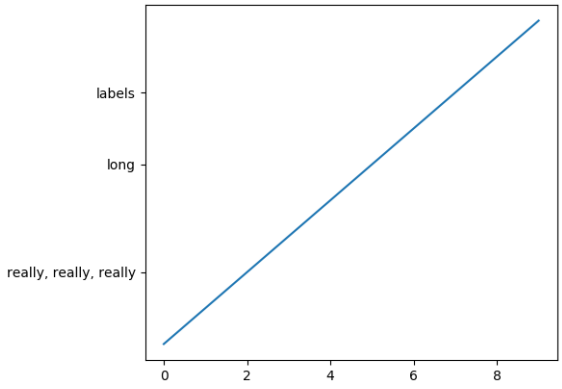


Fig. 1: Auto Subplots Adjust

10.1.8 Configure the tick widths

Wherever possible, it is recommended to use the `tick_params()` or `set_tick_params()` methods to modify tick properties:

```
import matplotlib.pyplot as plt

fig, ax = plt.subplots()
ax.plot(range(10))

ax.tick_params(width=10)

plt.show()
```

For more control of tick properties that are not provided by the above methods, it is important to know that in Matplotlib, the ticks are *markers*. All *Line2D* objects support a line (solid, dashed, etc) and a marker (circle, square, tick). The tick width is controlled by the "markeredgewidth" property, so the above effect can also be achieved by:

```
import matplotlib.pyplot as plt

fig, ax = plt.subplots()
ax.plot(range(10))

for line in ax.get_xticklines() + ax.get_yticklines():
    line.set_markeredgewidth(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*.

10.1.9 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.

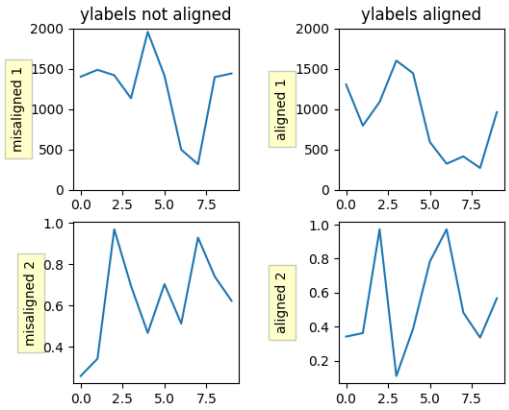


Fig. 2: Align Ylabels

10.1.10 Skip dates where there is no data

When plotting time series, e.g., financial time series, one often wants to leave out days on which there is no data, e.g., 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, e.g., evenly sampled indices, and then use

a custom formatter to format these as dates. The example below shows how to use an 'index formatter' to achieve the desired plot:

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

r = mlab.csv2rec('../data/aapl.csv')
r.sort()
r = r[-30:]  # get the last 30 days

N = len(r)
ind = np.arange(N)  # the evenly spaced plot indices

def format_date(x, pos=None):
    thisind = np.clip(int(x+0.5), 0, N-1)
    return r.date[thisind].strftime('%Y-%m-%d')

fig = plt.figure()
ax = fig.add_subplot(111)
ax.plot(ind, r.adj_close, 'o-')
ax.xaxis.set_major_formatter(ticker.FuncFormatter(format_date))
fig.autofmt_xdate()

plt.show()
```

10.1.11 Control the depth of plot elements

Within an axes, the order that the various lines, markers, text, collections, etc appear is determined by the *set_zorder()* property. The default order is patches, lines, text, with collections of lines and collections of patches appearing at the same level as regular lines and patches, respectively:

```
line, = ax.plot(x, y, zorder=10)
```

You can also use the Axes property *set_axisbelow()* to control whether the grid lines are placed above or below your other plot elements.

10.1.12 Make the aspect ratio for plots equal

The Axes property *set_aspect()* controls the aspect ratio of the axes. You can set it to be 'auto', 'equal', or some ratio which controls the ratio:

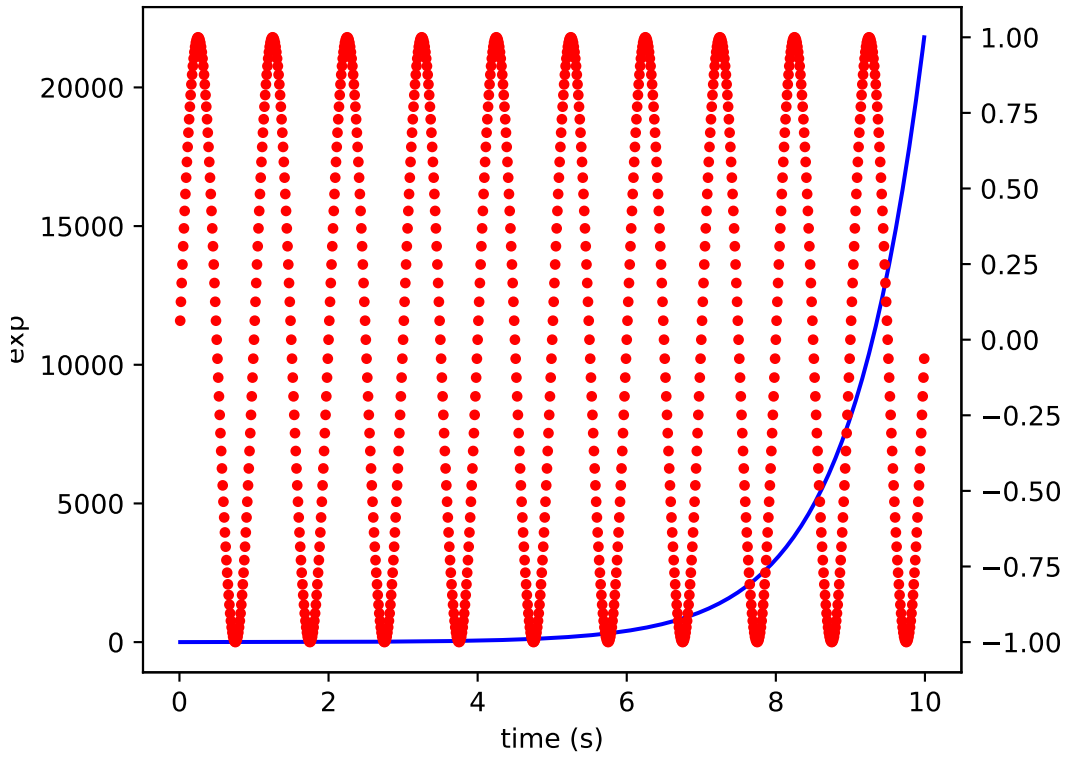
```
ax = fig.add_subplot(111, aspect='equal')
```

10.1.13 Multiple y-axis scales

A frequent request is to have two scales for the left and right y-axis, which is possible using *twinx()* (more than two scales are not currently supported, though it is on the wish list). This works pretty well, though

there are some quirks when you are trying to interactively pan and zoom, because both scales do not get the signals.

The approach uses *twinx()* (and its sister *twiny()*) to use *2 different axes*, turning the axes rectangular frame off on the 2nd axes to keep it from obscuring the first, and manually setting the tick locs and labels as desired. You can use separate `matplotlib.ticker` formatters and locators as desired because the two axes are independent.



10.1.14 Generate images without having a window appear

The easiest way to do this is use a non-interactive backend (see *What is a backend?*) such as Agg (for PNGs), PDF, SVG or PS. In your figure-generating script, just call the *matplotlib.use()* directive before importing pylab or pyplot:

```
import matplotlib
matplotlib.use('Agg')
import matplotlib.pyplot as plt
plt.plot([1,2,3])
plt.savefig('myfig')
```

See also:

Matplotlib in a web application server for information about running matplotlib inside of a web application.

10.1.15 Use show()

When you want to view your plots on your display, the user interface backend will need to start the GUI mainloop. This is what *show()* does. It tells Matplotlib to raise all of the figure windows created so far and start the mainloop. Because this mainloop is blocking by default (i.e., script execution is paused), you should only call this once per script, at the end. Script execution is resumed after the last window is closed. Therefore, if you are using Matplotlib to generate only images and do not want a user interface window, you do not need to call `show` (see *Generate images without having a window appear* and *What is a backend?*).

Note: Because closing a figure window invokes the destruction of its plotting elements, you should call *savefig()* *before* calling `show` if you wish to save the figure as well as view it.

New in version v1.0.0: `show` now starts the GUI mainloop only if it isn't already running. Therefore, multiple calls to `show` are now allowed.

Having `show` block further execution of the script or the python interpreter depends on whether Matplotlib is set for interactive mode or not. In non-interactive mode (the default setting), execution is paused until the last figure window is closed. In interactive mode, the execution is not paused, which allows you to create additional figures (but the script won't finish until the last figure window is closed).

Note: Support for interactive/non-interactive mode depends upon the backend. Until version 1.0.0 (and subsequent fixes for 1.0.1), the behavior of the interactive mode was not consistent across backends. As of v1.0.1, only the macosx backend differs from other backends because it does not support non-interactive mode.

Because it is expensive to draw, you typically will not want Matplotlib to redraw a figure many times in a script such as the following:

```
plot([1,2,3])            # draw here ?
xlabel('time')           # and here ?
ylabel('volts')          # and here ?
title('a simple plot')   # and here ?
show()
```

However, it is *possible* to force Matplotlib to draw after every command, which might be what you want when working interactively at the python console (see *Using matplotlib in a python shell*), but in a script you want to defer all drawing until the call to `show`. This is especially important for complex figures that take some time to draw. *show()* is designed to tell Matplotlib that you're all done issuing commands and you want to draw the figure now.

Note: *show()* should typically only be called at most once per script and it should be the last line of your script. At that point, the GUI takes control of the interpreter. If you want to force a figure draw, use *draw()* instead.

Many users are frustrated by `show` because they want it to be a blocking call that raises the figure, pauses the script until they close the figure, and then allow the script to continue running until the next figure is created

and the next show is made. Something like this:

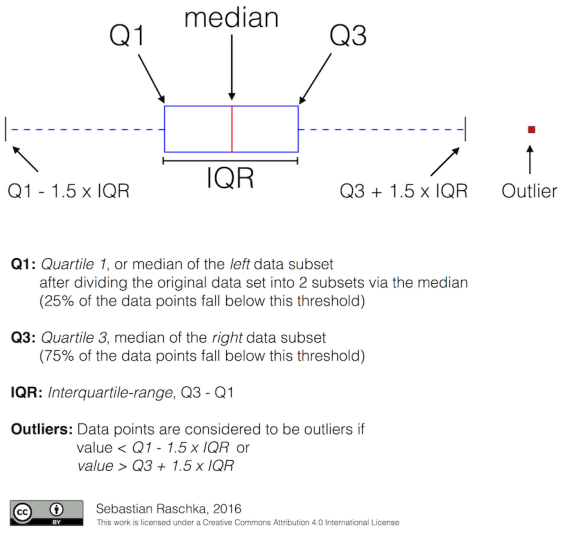
```
# WARNING : illustrating how NOT to use show
for i in range(10):
    # make figure i
    show()
```

This is not what show does and unfortunately, because doing blocking calls across user interfaces can be tricky, is currently unsupported, though we have made significant progress towards supporting blocking events.

New in version v1.0.0: As noted earlier, this restriction has been relaxed to allow multiple calls to `show`. In *most* backends, you can now expect to be able to create new figures and raise them in a subsequent call to `show` after closing the figures from a previous call to `show`.

10.1.16 Interpreting box plots and violin plots

Tukey's box plots (Robert McGill, John W. Tukey and Wayne A. Larsen: "The American Statistician" Vol. 32, No. 1, Feb., 1978, pp. 12-16) are statistical plots that provide useful information about the data distribution such as skewness. However, bar plots with error bars are still the common standard in most scientific literature, and thus, the interpretation of box plots can be challenging for the unfamiliar reader. The figure below illustrates the different visual features of a box plot.



Violin plots are closely related to box plots but add useful information such as the distribution of the sample data (density trace). Violin plots were added in Matplotlib 1.4.

10.2 Contributing: howto

10.2.1 Request a new feature

Is there a feature you wish Matplotlib had? Then ask! The best way to get started is to email the developer mailing list for discussion. This is an open source project developed primarily in the contributors free time, so there is no guarantee that your feature will be added. The *best* way to get the feature you need added is to contribute it your self.

10.2.2 Reporting a bug or submitting a patch

The development of Matplotlib is organized through github. If you would like to report a bug or submit a patch please use that interface.

To report a bug create an issue on github (this requires having a github account). Please include a Short, Self Contained, Correct (Compilable), Example demonstrating what the bug is. Including a clear, easy to test example makes it easy for the developers to evaluate the bug. Expect that the bug reports will be a conversation. If you do not want to register with github, please email bug reports to the mailing list.

The easiest way to submit patches to Matplotlib is through pull requests on github. Please see the *The Matplotlib Developers' Guide* for the details.

10.2.3 Contribute to Matplotlib documentation

Matplotlib is a big library, which is used in many ways, and the documentation has only scratched the surface of everything it can do. So far, the place most people have learned all these features are through studying the examples (*Search examples*), which is a recommended and great way to learn, but it would be nice to have more official narrative documentation guiding people through all the dark corners. This is where you come in.

There is a good chance you know more about Matplotlib usage in some areas, the stuff you do every day, than many of the core developers who wrote most of the documentation. Just pulled your hair out compiling Matplotlib for windows? Write a FAQ or a section for the *Installation* page. Are you a digital signal processing wizard? Write a tutorial on the signal analysis plotting functions like `xcorr()`, `psd()` and `specgram()`. Do you use Matplotlib with django or other popular web application servers? Write a FAQ or tutorial and we'll find a place for it in the *User's Guide*. Bundle Matplotlib in a py2exe app? ... I think you get the idea.

Matplotlib is documented using the sphinx extensions to restructured text (ReST). sphinx is an extensible python framework for documentation projects which generates HTML and PDF, and is pretty easy to write; you can see the source for this document or any page on this site by clicking on the *Show Source* link at the end of the page in the sidebar.

The sphinx website is a good resource for learning sphinx, but we have put together a cheat-sheet at *Writing documentation* which shows you how to get started, and outlines the Matplotlib conventions and extensions, e.g., for including plots directly from external code in your documents.

Once your documentation contributions are working (and hopefully tested by actually *building* the docs) you can submit them as a patch against git. See *Install git* and *Reporting a bug or submitting a patch*. Looking for something to do? Search for TODO or look at the open issues on github.

10.3 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 altogether, which will give you a little more control, by calling the API directly as shown in /gallery/api/agg_oo_sgskip.

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 Pillow. First, the figure is saved to a BytesIO object which is then fed to Pillow for further processing:

```
from io import BytesIO
from PIL import Image
imgdata = BytesIO()
fig.savefig(imgdata, format='png')
imgdata.seek(0)  # rewind the data
im = Image.open(imgdata)
```

10.3.1 Matplotlib with apache

TODO; see *Contribute to Matplotlib documentation*.

10.3.2 Matplotlib with django

TODO; see *Contribute to Matplotlib documentation*.

10.3.3 Matplotlib with zope

TODO; see *Contribute to Matplotlib documentation*.

10.3.4 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. If you are interested in contributing to these efforts that would be great.

10.4 Search examples

The nearly 300 code examples-index included with the Matplotlib source distribution are full-text searchable from the search page, but sometimes when you search, you get a lot of results from the *The Matplotlib API* or other documentation that you may not be interested in if you just want to find a complete, free-standing, working piece of example code. To facilitate example searches, we have tagged every code example page with the keyword `codex` for *code example* which shouldn't appear anywhere else on this site except in the FAQ. So if you want to search for an example that uses an ellipse, search for `codex ellipse`.

10.5 Cite Matplotlib

If you want to refer to Matplotlib in a publication, you can use "Matplotlib: A 2D Graphics Environment" by J. D. Hunter In Computing in Science & Engineering, Vol. 9, No. 3. (2007), pp. 90-95 (see this reference page):

```
@article{Hunter:2007,
        Address = {10662 LOS VAQUEROS CIRCLE, PO BOX 3014, LOS ALAMITOS, CA 90720-1314␣
↪USA},
        Author = {Hunter, John D.},
        Date-Added = {2010-09-23 12:22:10 -0700},
        Date-Modified = {2010-09-23 12:22:10 -0700},
        Isi = {000245668100019},
        Isi-Recid = {155389429},
        Journal = {Computing In Science \& Engineering},
        Month = {May-Jun},
        Number = {3},
```

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```
        Pages = {90--95},
        Publisher = {IEEE COMPUTER SOC},
        Times-Cited = {21},
        Title = {Matplotlib: A 2D graphics environment},
        Type = {Editorial Material},
        Volume = {9},
        Year = {2007},
        Abstract = {Matplotlib is a 2D graphics package used for Python for application
                    development, interactive scripting, and publication-quality image
                    generation across user interfaces and operating systems.},
        Bdsk-Url-1 = {http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&
↪SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord;
↪KeyUT=000245668100019}}
```

CHAPTER

ELEVEN

TROUBLESHOOTING

Contents

- *Troubleshooting*
  - *Obtaining Matplotlib version*
  - *`matplotlib` install location*
  - *`matplotlib` configuration and cache directory locations*
  - *Getting help*
  - *Problems with recent git versions*

11.1 Obtaining Matplotlib version

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

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

11.2 `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'
```

11.3 matplotlib configuration and cache directory locations

Each user has a Matplotlib configuration directory which may contain a *matplotlibrc* file. To locate your matplotlib/ configuration directory, use matplotlib.get_configdir():

```
>>> import matplotlib as mpl
>>> mpl.get_configdir()
'/home/darren/.config/matplotlib'
```

On unix-like systems, this directory is generally located in your *HOME* directory under the .config/ directory.

In addition, users have a cache directory. On unix-like systems, this is separate from the configuration directory by default. To locate your .cache/ directory, use matplotlib.get_cachedir():

```
>>> import matplotlib as mpl
>>> mpl.get_cachedir()
'/home/darren/.cache/matplotlib'
```

On windows, both the config directory and the cache directory are the same and are in your Documents and Settings or Users directory by default:

```
>>> import matplotlib as mpl
>>> mpl.get_configdir()
'C:\\Documents and Settings\\jdhunter\\.matplotlib'
>>> mpl.get_cachedir()
'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*. Note that *MPLCONFIGDIR* sets the location of both the configuration directory and the cache directory.

11.4 Getting help

There are a number of good resources for getting help with Matplotlib. There is a good chance your question has already been asked:

- The mailing list archive.
- Github issues.
- Stackoverflow questions tagged matplotlib.

If you are unable to find an answer to your question through search, please provide the following information in your e-mail to the mailing list:

- Your operating system (Linux/UNIX users: post the output of uname -a).
- Matplotlib version:

```
python -c "import matplotlib; print matplotlib.__version__"
```

- Where you obtained Matplotlib (e.g., your Linux distribution's packages, Github, PyPi, or Anaconda or Enthought Canopy).
- Any customizations to your `matplotlibrc` file (see *Customizing Matplotlib with style sheets and rcParams*).
- 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 helpful debugging output from Matlotlib by using the `logging` library in your code and posting the verbose output to the lists. For a command-line version of this, try:

```
python -c "from logging import *; basicConfig(level=DEBUG); from pylab import *;␣
↪plot(); show()"
```

  If you want to put the debugging hooks in your own code, then the most simple way to do so is to insert the following *before* any calls to `import matplotlib`:

```
import logging
logging.basicConfig(level=logging.DEBUG)

import matplotlib.pyplot as plt
```

  Note that if you want to use `logging` in your own code, but do not want verbose Matplotlib output, you can set the logging level for Matplotlib independently:

```
import logging
# set DEBUG for everything
logging.basicConfig(level=logging.DEBUG)
logger = logging.getLogger('matplotlib')
# set WARNING for Matplotlib
logger.setLevel(logging.WARNING)
```

  The `logging` module is very flexible, and can be a valuable tool in chasing down errors.

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 – e.g., `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.

11.5 Problems with recent git versions

First make sure you have a clean build and install (see *How to completely remove Matplotlib*), get the latest git update, install it and run a simple test script in debug mode:

```
rm -rf /path/to/site-packages/matplotlib*
git clean -xdf
git pull
python -mpip install -v . > build.out
python examples/pylab_examples/simple_plot.py --verbose-debug > run.out
```

and post `build.out` and `run.out` to the matplotlib-devel mailing list (please do not post git problems to the users list).

Of course, you will want to clearly describe your problem, what you are expecting and what you are getting, but often a clean build and install will help. See also *Getting help*.

CHAPTER

TWELVE

ENVIRONMENT VARIABLES

Contents

- *Environment Variables*
  - *Setting environment variables in Linux and OS-X*
    - *BASH/KSH*
    - *CSH/TCSH*
  - *Setting environment variables in windows*

HOME
: The user's home directory. On linux, ~ is shorthand for *HOME*.

PATH
: The list of directories searched to find executable programs

PYTHONPATH
: The list of directories that is added to Python's standard search list when importing packages and modules

MPLCONFIGDIR
: This is the directory used to store user customizations to matplotlib, as well as some caches to improve performance. If *MPLCONFIGDIR* is not defined, *HOME*`/.config/matplotlib` is generally used on unix-like systems and *HOME*`/.matplotlib` is used on other platforms, if they are writable. Otherwise, the python standard library `tempfile.gettempdir()` is used to find a base directory in which the `matplotlib` subdirectory is created.

MPLBACKEND
: This optional variable can be set to choose the matplotlib backend. See *What is a backend?*.

12.1 Setting environment variables in Linux and OS-X

To list the current value of *PYTHONPATH*, which may be empty, try:

```
echo $PYTHONPATH
```

The procedure for setting environment variables in depends on what your default shell is. **BASH** seems to be the most common, but **CSH** is also common. You should be able to determine which by running at the command prompt:

```
echo $SHELL
```

12.1.1 BASH/KSH

To create a new environment variable:

```
export PYTHONPATH=~/Python
```

To prepend to an existing environment variable:

```
export PATH=~/bin:${PATH}
```

The search order may be important to you, do you want `~/bin` to be searched first or last? To append to an existing environment variable:

```
export PATH=${PATH}:~/bin
```

To make your changes available in the future, add the commands to your `~/.bashrc` file.

12.1.2 CSH/TCSH

To create a new environment variable:

```
setenv PYTHONPATH ~/Python
```

To prepend to an existing environment variable:

```
setenv PATH ~/bin:${PATH}
```

The search order may be important to you, do you want `~/bin` to be searched first or last? To append to an existing environment variable:

```
setenv PATH ${PATH}:~/bin
```

To make your changes available in the future, add the commands to your `~/.cshrc` file.

12.2 Setting environment variables in windows

Open the **Control Panel** (*Start* → *Control Panel*), start the **System** program. Click the *Advanced* tab and select the *Environment Variables* button. You can edit or add to the *User Variables*.

CHAPTER

THIRTEEN

WORKING WITH MATPLOTLIB IN VIRTUAL ENVIRONMENTS

When running Matplotlib in a virtual environment you may discover a few issues. Matplotlib itself has no issue with virtual environments. However, some of the external GUI frameworks that Matplotlib uses for interactive figures may be tricky to install in a virtual environment. Everything below assumes some familiarity with the Matplotlib backends as found in *What is a backend?*.

If you only use the IPython and Jupyter Notebook's `inline` and `notebook` backends, or non-interactive backends, you should not have any issues and can ignore everything below.

Likewise, the `Tk` framework (`TkAgg` backend) does not require any external dependencies and is normally always available. On certain Linux distributions, a package named `python-tk` (or similar) needs to be installed.

Otherwise, the situation (at the time of writing) is as follows:

GUI framework	pip-installable?	conda or conda-forge-installable?
PyQt5	on Python>=3.5	yes
PyQt4	PySide: on Windows and OSX	yes
PyGObject	no	on Linux
PyGTK	no	no
wxPython	yes[1]	yes

In other cases, you need to install the package in the global (system) site-packages, and somehow make it available from within the virtual environment. This can be achieved by any of the following methods (in all cases, the system-wide Python and the virtualenv Python must be of the same version):

- Using `virtualenv`'s `--system-site-packages` option when creating an environment adds all system-wide packages to the virtual environment. However, this breaks the isolation between the virtual environment and the system install. Among other issues it results in hard to debug problems with system packages shadowing the environment packages. If you use virtualenvwrapper, this can be toggled with the `toggleglobalsitepackages` command.
- vext allows controlled access from within the virtualenv to specific system-wide packages without the overall shadowing issue. A specific package needs to be installed for each framework, e.g. vext.pyqt5, etc. It is recommended to use `vext>=0.7.0` as earlier versions misconfigure the logging system.

If you are using Matplotlib on OSX, you may also want to consider the *OSX framework FAQ*.

[1] OSX and Windows wheels available on PyPI. Linux wheels available but not on PyPI, see https://wxpython.org/pages/downloads/.

CHAPTER

FOURTEEN

WORKING WITH MATPLOTLIB ON OSX

Contents

- *Working with Matplotlib on OSX*
  - *Introduction*
  - *Short version*
    - *VirtualEnv*
    - *Pyenv*
    - *Conda*
  - *Long version*
    - *PYTHONHOME Function*
      - *PYTHONHOME and Jupyter*
      - *PYTHONHOME Script*
    - *PythonW Compiler*

14.1 Introduction

On OSX, two different types of Python builds exist: a regular build and a framework build. In order to interact correctly with OSX through the native GUI frameworks you need a framework build of Python. At the time of writing the `macosx` and `WXAgg` backends require a framework build to function correctly. This can result in issues for a Python installation not build as a framework and may also happen in virtual envs and when using (Ana)Conda. From Matplotlib 1.5 onwards, both backends check that a framework build is available and fail if a non framework build is found.

Without this check a partially functional figure is created. Among the issues with it is that it is produced in the background and cannot be put in front of any other window. Several solutions and work arounds exist see below.

14.2 Short version

14.2.1 VirtualEnv

If you are on Python 3, use venv instead of virtualenv:

```
python -m venv my-virtualenv
source my-virtualenv/bin/activate
```

Otherwise you will need one of the workarounds below.

14.2.2 Pyenv

If you are using pyenv and virtualenv you can enable your python version to be installed as a framework:

```
PYTHON_CONFIGURE_OPTS="--enable-framework" pyenv install x.x.x
```

14.2.3 Conda

The default python provided in (Ana)Conda is not a framework build. However, the Conda developers have made it easy to install a framework build in both the main environment and in Conda envs. To use this install python.app `conda install python.app` and use `pythonw` rather than `python`

14.3 Long version

Unfortunately virtualenv creates a non framework build even if created from a framework build of Python. As documented above you can use venv as an alternative on Python 3.

The issue has been reported on the virtualenv bug tracker here and here

Until this is fixed, one of the following workarounds can be used:

14.3.1 PYTHONHOME Function

The best known work around is to use the non virtualenv python along with the PYTHONHOME environment variable. This can be done by defining a function in your `.bashrc` using

```
function frameworkpython {
    if [[ ! -z "$VIRTUAL_ENV" ]]; then
        PYTHONHOME=$VIRTUAL_ENV /usr/local/bin/python "$@"
    else
        /usr/local/bin/python "$@"
    fi
}
```

This function can then be used in all of your virtualenvs without having to fix every single one of them.

With this in place you can run `frameworkpython` to get an interactive framework build within the virtualenv. To run a script you can do `frameworkpython test.py` where `test.py` is a script that requires a framework build. To run an interactive `IPython` session with the framework build within the virtual environment you can do `frameworkpython -m IPython`

PYTHONHOME and Jupyter

This approach can be followed even if using Jupyter notebooks: you just need to setup a kernel with the suitable `PYTHONHOME` definition. The jupyter-virtualenv-osx script automates the creation of such a kernel.

PYTHONHOME Script

An alternative work around borrowed from the WX wiki, is to use the non virtualenv python along with the PYTHONHOME environment variable. This can be implemented in a script as below. To use this modify `PYVER` and `PATHTOPYTHON` and put the script in the virtualenv bin directory i.e. `PATHTOVENV/bin/frameworkpython`

```
#!/bin/bash

# what real Python executable to use
PYVER=2.7
PATHTOPYTHON=/usr/local/bin/
PYTHON=${PATHTOPYTHON}python${PYVER}

# find the root of the virtualenv, it should be the parent of the dir this script is in
ENV=`$PYTHON -c "import os; print(os.path.abspath(os.path.join(os.path.dirname(\"$0\"),
 ↪'..')))"`

# now run Python with the virtualenv set as Python's HOME
export PYTHONHOME=$ENV
exec $PYTHON "$@"
```

With this in place you can run `frameworkpython` as above but will need to add this script to every virtualenv

14.3.2 PythonW Compiler

In addition virtualenv-pythonw-osx provides an alternative workaround which may be used to solve the issue.

Part III

Toolkits

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

CHAPTER

FIFTEEN

MPLOT3D

`mpl_toolkits.mplot3d` provides some basic 3D plotting (scatter, surf, line, mesh) tools. Not the fastest or most feature complete 3D library out there, but it ships with Matplotlib and thus may be a lighter weight solution for some use cases. Check out the *mplot3d tutorial* for more information.

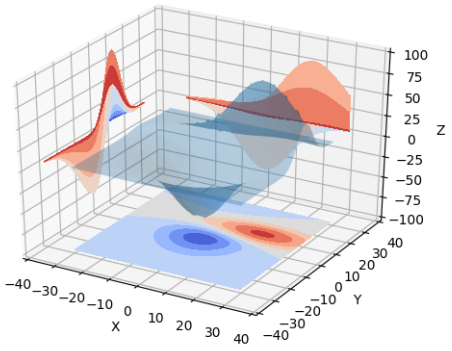


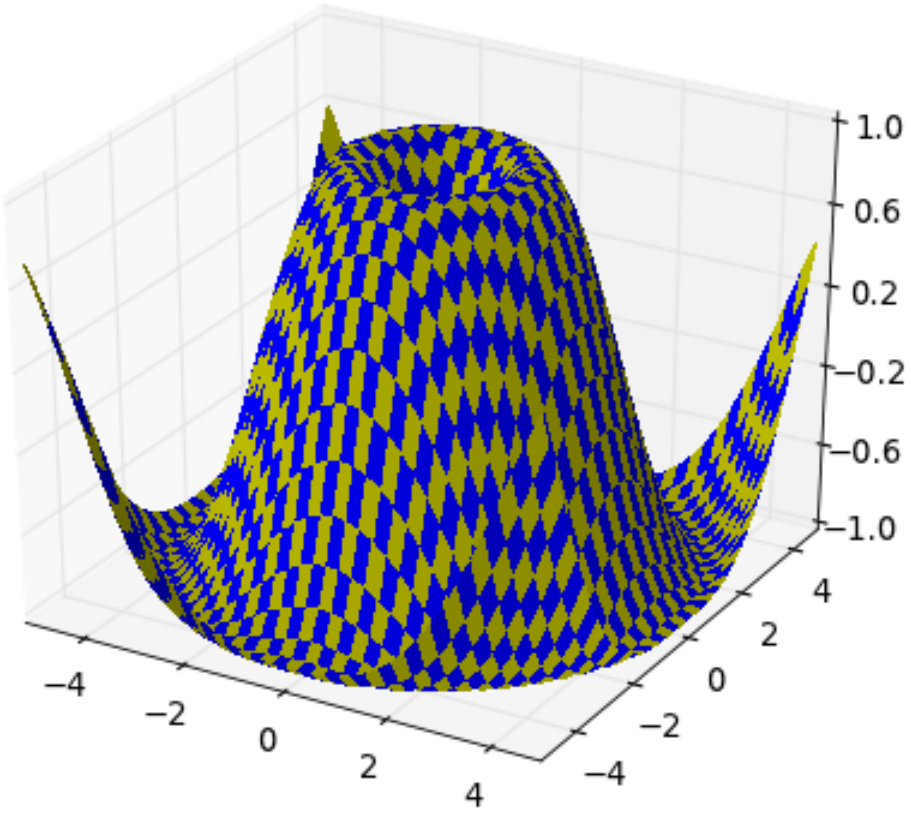
Fig. 1: Contourf3d 2

15.1 mplot3d

15.1.1 Matplotlib mplot3d toolkit

The mplot3d toolkit adds simple 3D plotting capabilities to matplotlib by supplying an axes object that can create a 2D projection of a 3D scene. The resulting graph will have the same look and feel as regular 2D plots.

See the *mplot3d tutorial* for more information on how to use this toolkit.



The interactive backends also provide the ability to rotate and zoom the 3D scene. One can rotate the 3D scene by simply clicking-and-dragging the scene. Zooming is done by right-clicking the scene and dragging the mouse up and down. Note that one does not use the zoom button like one would use for regular 2D plots.

mplot3d FAQ

How is mplot3d different from MayaVi?

MayaVi2 is a very powerful and featureful 3D graphing library. For advanced 3D scenes and excellent rendering capabilities, it is highly recommended to use MayaVi2.

mplot3d was intended to allow users to create simple 3D graphs with the same "look-and-feel" as matplotlib's 2D plots. Furthermore, users can use the same toolkit that they are already familiar with to generate both their 2D and 3D plots.

My 3D plot doesn't look right at certain viewing angles

This is probably the most commonly reported issue with mplot3d. The problem is that – from some viewing angles – a 3D object would appear in front of another object, even though it is physically behind it. This can result in plots that do not look "physically correct."

Unfortunately, while some work is being done to reduce the occurrence of this artifact, it is currently an intractable problem, and can not be fully solved until matplotlib supports 3D graphics rendering at its core.

The problem occurs due to the reduction of 3D data down to 2D + z-order scalar. A single value represents the 3rd dimension for all parts of 3D objects in a collection. Therefore, when the bounding boxes of two collections intersect, it becomes possible for this artifact to occur. Furthermore, the intersection of two 3D objects (such as polygons or patches) can not be rendered properly in matplotlib's 2D rendering engine.

This problem will likely not be solved until OpenGL support is added to all of the backends (patches are greatly welcomed). Until then, if you need complex 3D scenes, we recommend using MayaVi.

I don't like how the 3D plot is laid out, how do I change that?

Historically, mplot3d has suffered from a hard-coding of parameters used to control visuals such as label spacing, tick length, and grid line width. Work is being done to eliminate this issue. For matplotlib v1.1.0, there is a semi-official manner to modify these parameters. See the note in the *axis3d* section of the mplot3d API documentation for more information.

15.2 Links

- mpl3d API: *mplot3d API*

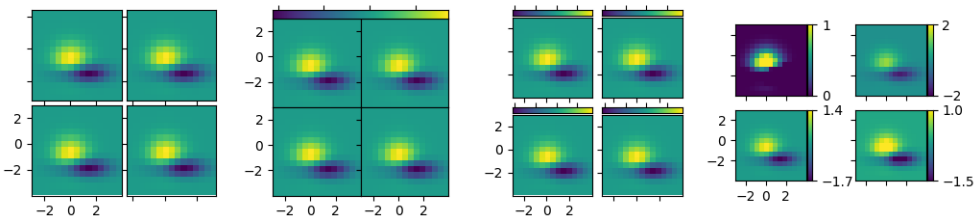
CHAPTER

SIXTEEN

MATPLOTLIB AXES_GRID1 TOOLKIT

The matplotlib `mpl_toolkits.axes_grid1` toolkit is a collection of helper classes to ease displaying multiple images in matplotlib. While the aspect parameter in matplotlib adjust the position of the single axes, axes_grid1 toolkit provides a framework to adjust the position of multiple axes according to their aspects.

See *What is axes_grid1 toolkit?* for a guide on the usage of axes_grid1.



The submodules of the axes_grid1 API are:

axes_grid1.anchored_artists	
axes_grid1.axes_divider	The axes_divider module provides helper classes to adjust the positions of multiple axes at drawing time.
axes_grid1.axes_grid	
axes_grid1.axes_rgb	
axes_grid1.axes_size	provides a classes of simple units that will be used with AxesDivider class (or others) to determine the size of each axes.
axes_grid1.colorbar	Colorbar toolkit with two classes and a function:
axes_grid1.inset_locator	A collection of functions and objects for creating or placing inset axes.
axes_grid1.mpl_axes	
axes_grid1.parasite_axes	

16.1 mpl_toolkits.axes_grid1.anchored_artists

16.1.1 Classes

AnchoredAuxTransformBox(transform, loc[, ...])	An anchored container with transformed coordinates.
AnchoredDrawingArea(width, height, xdescent, ...)	An anchored container with a fixed size and fillable DrawingArea.
AnchoredEllipse(transform, width, height, ...)	Draw an anchored ellipse of a given size.
AnchoredSizeBar(transform, size, label, loc)	Draw a horizontal scale bar with a center-aligned label underneath.

mpl_toolkits.axes_grid1.anchored_artists.AnchoredAuxTransformBox

class mpl_toolkits.axes_grid1.anchored_artists.**AnchoredAuxTransformBox**(*transform*, *loc*, *pad=0.4*, *borderpad=0.5*, *prop=None*, *frameon=True*, ***kwargs*)

An anchored container with transformed coordinates.

Artists added to the *drawing_area* are scaled according to the coordinates of the transformation used. The dimensions of this artist will scale to contain the artists added.

Parameters

transform [*matplotlib.transforms.Transform*] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transData`.

loc [int] Location of this artist. Valid location codes are:

```
'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
```

pad [int or float, optional] Padding around the child objects, in fraction of the font size. Defaults to 0.4.

borderpad [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.5.

prop [*matplotlib.font_manager.FontProperties*, optional] Font property used as a reference for paddings.

frameon [bool, optional] If True, draw a box around this artists. Defaults to True.

****kwargs :** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

Examples

To display an ellipse in the upper left, with a width of 0.1 and height of 0.4 in data coordinates:

```
>>> box = AnchoredAuxTransformBox(ax.transData, loc=2)
>>> el = Ellipse((0,0), width=0.1, height=0.4, angle=30)
>>> box.drawing_area.add_artist(el)
>>> ax.add_artist(box)
```

Attributes

drawing_area [*matplotlib.offsetbox.AuxTransformBox*] A container for artists to display.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredAuxTransformBox`

- sphx_glr_gallery_userdemo_anchored_box03.py

mpl_toolkits.axes_grid1.anchored_artists.AnchoredDrawingArea

class mpl_toolkits.axes_grid1.anchored_artists.**AnchoredDrawingArea**(*width*, *height*, *xdescent*, *ydescent*, *loc*, *pad=0.4*, *borderpad=0.5*, *prop=None*, *frameon=True*, ***kwargs*)

An anchored container with a fixed size and fillable DrawingArea.

Artists added to the *drawing_area* will have their coordinates interpreted as pixels. Any transformations set on the artists will be overridden.

Parameters

width, height [int or float] width and height of the container, in pixels.

xdescent, ydescent [int or float] descent of the container in the x- and y- direction, in pixels.

loc [int] Location of this artist. Valid location codes are:

```
'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
```

pad [int or float, optional] Padding around the child objects, in fraction of the font size. Defaults to 0.4.

borderpad [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.5.

prop [*matplotlib.font_manager.FontProperties*, optional] Font property used as a reference for paddings.

frameon [bool, optional] If True, draw a box around this artists. Defaults to True.

****kwargs :** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

Examples

To display blue and red circles of different sizes in the upper right of an axes *ax*:

```
>>> ada = AnchoredDrawingArea(20, 20, 0, 0, loc=1, frameon=False)
>>> ada.drawing_area.add_artist(Circle((10, 10), 10, fc="b"))
>>> ada.drawing_area.add_artist(Circle((30, 10), 5, fc="r"))
>>> ax.add_artist(ada)
```

Attributes

drawing_area [*matplotlib.offsetbox.DrawingArea*] A container for artists to display.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredDrawingArea`

- sphx_glr_gallery_axes_grid1_simple_anchored_artists.py
- sphx_glr_gallery_userdemo_anchored_box02.py

mpl_toolkits.axes_grid1.anchored_artists.AnchoredEllipse

class mpl_toolkits.axes_grid1.anchored_artists.**AnchoredEllipse**(*transform*, *width*, *height*, *angle*, *loc*, *pad=0.1*, *borderpad=0.1*, *prop=None*, *frameon=True*, ***kwargs*)

Draw an anchored ellipse of a given size.

Parameters

transform [*matplotlib.transforms.Transform*] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transData`.

width, height [int or float] Width and height of the ellipse, given in coordinates of *transform*.

angle [int or float] Rotation of the ellipse, in degrees, anti-clockwise.

loc [int] Location of this size bar. Valid location codes are:

```
'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
```

pad [int or float, optional] Padding around the ellipse, in fraction of the font size. Defaults to 0.1.

borderpad [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.1.

frameon [bool, optional] If True, draw a box around the ellipse. Defaults to True.

prop [*matplotlib.font_manager.FontProperties*, optional] Font property used as a reference for paddings.

****kwargs :** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

Attributes

ellipse [*matplotlib.patches.Ellipse*] Ellipse patch drawn.

Examples using mpl_toolkits.axes_grid1.anchored_artists.AnchoredEllipse

- sphx_glr_gallery_axes_grid1_simple_anchored_artists.py

mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar

class mpl_toolkits.axes_grid1.anchored_artists.**AnchoredSizeBar**(*transform*, *size*, *label*, *loc*, *pad=0.1*, *borderpad=0.1*, *sep=2*, *frameon=True*, *size_vertical=0*, *color='black'*, *label_top=False*, *fontproperties=None*, *fill_bar=None*, ***kwargs*)

Draw a horizontal scale bar with a center-aligned label underneath.

Parameters

transform [*matplotlib.transforms.Transform*] The transformation object for the coordinate system in use, i.e., `matplotlib.axes.Axes.transData`.

size [int or float] Horizontal length of the size bar, given in coordinates of *transform*.

label [str] Label to display.

loc [int] Location of this size bar. Valid location codes are:

```
'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
```

pad [int or float, optional] Padding around the label and size bar, in fraction of the font size. Defaults to 0.1.

borderpad [int or float, optional] Border padding, in fraction of the font size. Defaults to 0.1.

sep [int or float, optional] Separation between the label and the size bar, in points. Defaults to 2.

frameon [bool, optional] If True, draw a box around the horizontal bar and label. Defaults to True.

size_vertical [int or float, optional] Vertical length of the size bar, given in coordinates of *transform*. Defaults to 0.

color [str, optional] Color for the size bar and label. Defaults to black.

label_top [bool, optional] If True, the label will be over the size bar. Defaults to False.

fontproperties [*matplotlib.font_manager.FontProperties*, optional] Font properties for the label text.

fill_bar [bool, optional] If True and if size_vertical is nonzero, the size bar will be filled in with the color specified by the size bar. Defaults to True if `size_vertical` is greater than zero and False otherwise.

****kwargs :** Keyworded arguments to pass to *matplotlib.offsetbox.AnchoredOffsetbox*.

Notes

If *prop* is passed as a keyworded argument, but *fontproperties* is not, then *prop* is be assumed to be the intended *fontproperties*. Using both *prop* and *fontproperties* is not supported.

Examples

```
>>> import matplotlib.pyplot as plt
>>> import numpy as np
>>> from mpl_toolkits.axes_grid1.anchored_artists import AnchoredSizeBar
>>> fig, ax = plt.subplots()
>>> ax.imshow(np.random.random((10,10)))
>>> bar = AnchoredSizeBar(ax.transData, 3, '3 data units', 4)
>>> ax.add_artist(bar)
>>> fig.show()
```

Using all the optional parameters

```
>>> import matplotlib.font_manager as fm
>>> fontprops = fm.FontProperties(size=14, family='monospace')
>>> bar = AnchoredSizeBar(ax.transData, 3, '3 units', 4, pad=0.5, sep=5,␣
↪borderpad=0.5, frameon=False, size_vertical=0.5, color='white',␣
↪fontproperties=fontprops)
```

Attributes

size_bar [*matplotlib.offsetbox.AuxTransformBox*] Container for the size bar.

txt_label [*matplotlib.offsetbox.TextArea*] Container for the label of the size bar.

Examples using `mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar`

- sphx_glr_gallery_axes_grid1_simple_anchored_artists.py
- sphx_glr_gallery_axes_grid1_inset_locator_demo2.py

16.2 mpl_toolkits.axes_grid1.axes_divider

The axes_divider module provides helper classes to adjust the positions of multiple axes at drawing time.

Divider: this is the class that is used to calculate the axes position. It divides the given rectangular area into several sub rectangles. You initialize the divider by setting the horizontal and vertical lists of sizes that the division will be based on. You then use the new_locator method, whose return value is a callable object that can be used to set the axes_locator of the axes.

16.2.1 Classes

AxesDivider(axes[, xref, yref])	Divider based on the pre-existing axes.
AxesLocator(axes_divider, nx, ny[, nx1, ny1])	A simple callable object, initialized with AxesDivider class, returns the position and size of the given cell.
Divider(fig, pos, horizontal, vertical[, ...])	This class calculates the axes position.
HBoxDivider(fig, *args, **kwargs)	
LocatableAxes(*kl, **kw)	
LocatableAxesBase(*kl, **kw)	
SubplotDivider(fig, *args, **kwargs)	The Divider class whose rectangle area is specified as a subplot geometry.
VBoxDivider(fig, *args, **kwargs)	The Divider class whose rectangle area is specified as a subplot geometry.

mpl_toolkits.axes_grid1.axes_divider.AxesDivider

class mpl_toolkits.axes_grid1.axes_divider.**AxesDivider**(*axes*, *xref=None*, *yref=None*)

Divider based on the pre-existing axes.

Parameters

axes [*Axes*]

xref

yref

append_axes(*position*, *size*, *pad=None*, *add_to_figure=True*, ***kwargs*)
create an axes at the given *position* with the same height (or width) of the main axes.

position ["left"|"right"|"bottom"|"top"]

size and *pad* should be axes_grid.axes_size compatible.

get_anchor()
return the anchor

get_aspect()
return aspect

get_position()
return the position of the rectangle.

get_subplotspec()

new_horizontal(*size*, *pad=None*, *pack_start=False*, ***kwargs*)
Add a new axes on the right (or left) side of the main axes.

Parameters

size [axes_size or float or string] A width of the axes. If float or string is given, *from_any* function is used to create the size, with *ref_size* set to AxesX instance of the current axes.

pad [axes_size or float or string] Pad between the axes. It takes same argument as *size*.

pack_start [bool] If False, the new axes is appended at the end of the list, i.e., it became the right-most axes. If True, it is inserted at the start of the list, and becomes the left-most axes.

kwargs All extra keywords arguments are passed to the created axes. If *axes_class* is given, the new axes will be created as an instance of the given class. Otherwise, the same class of the main axes will be used.

new_vertical(*size*, *pad=None*, *pack_start=False*, ***kwargs*)
Add a new axes on the top (or bottom) side of the main axes.

Parameters

size [axes_size or float or string] A height of the axes. If float or string is given, *from_any* function is used to create the size, with *ref_size* set to AxesX instance of the current axes.

pad [axes_size or float or string] Pad between the axes. It takes same argument as *size*.

pack_start [bool] If False, the new axes is appended at the end of the list, i.e., it became the right-most axes. If True, it is inserted at the start of the list, and becomes the left-most axes.

kwargs All extra keywords arguments are passed to the created axes. If *axes_class* is given, the new axes will be created as an instance of the given class. Otherwise, the same class of the main axes will be used.

mpl_toolkits.axes_grid1.axes_divider.AxesLocator

class mpl_toolkits.axes_grid1.axes_divider.**AxesLocator**(*axes_divider*, *nx*, *ny*, *nx1=None*, *ny1=None*)

A simple callable object, initialized with AxesDivider class, returns the position and size of the given cell.

Parameters

axes_divider [AxesDivider]

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

get_subplotspec()

mpl_toolkits.axes_grid1.axes_divider.Divider

class mpl_toolkits.axes_grid1.axes_divider.**Divider**(*fig*, *pos*, *horizontal*, *vertical*, *aspect=None*, *anchor='C'*)

This class calculates the axes position. It divides the given rectangular area into several sub-rectangles. You initialize the divider by setting the horizontal and vertical lists of sizes (mpl_toolkits.axes_grid.axes_size) that the division will be based on. You then use the new_locator method to create a callable object that can be used as the axes_locator of the axes.

Parameters

fig [Figure]

pos [tuple of 4 floats] position of the rectangle that will be divided

horizontal [list of axes_size] sizes for horizontal division

vertical [list of axes_size] sizes for vertical division

aspect [bool] if True, the overall rectangular area is reduced so that the relative part of the horizontal and vertical scales have the same scale.

anchor [{'C', 'SW', 'S', 'SE', 'E', 'NE', 'N', 'NW', 'W'}] placement of the reduced rectangle when *aspect* is True

add_auto_adjustable_area(*use_axes*, *pad=0.1*, *adjust_dirs=None*)

append_size(*position*, *size*)

get_anchor()
return the anchor

get_aspect()
return aspect

get_horizontal()
return horizontal sizes

get_horizontal_sizes(*renderer*)

get_locator()

get_position()
return the position of the rectangle.

get_position_runtime(*ax*, *renderer*)

get_vertical()
return vertical sizes

get_vertical_sizes(*renderer*)

get_vsize_hsize()

locate(*nx*, *ny*, *nx1=None*, *ny1=None*, *axes=None*, *renderer=None*)

Parameters

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

axes

renderer

new_locator(*nx*, *ny*, *nx1=None*, *ny1=None*)
Returns a new locator (mpl_toolkits.axes_grid.axes_divider.AxesLocator) for specified cell.

Parameters

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

set_anchor(*anchor*)

Parameters

anchor [{'C', 'SW', 'S', 'SE', 'E', 'NE', 'N', 'NW', 'W'}]

anchor position

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=False*)

Parameters

aspect [bool]

set_horizontal(*h*)

Parameters

h [list of `axes_size`] sizes for horizontal division

set_locator(*_locator*)

set_position(*pos*)

set the position of the rectangle.

Parameters

pos [tuple of 4 floats] position of the rectangle that will be divided

set_vertical(*v*)

Parameters

v [list of `axes_size`] sizes for vertical division

mpl_toolkits.axes_grid1.axes_divider.HBoxDivider

class mpl_toolkits.axes_grid1.axes_divider.**HBoxDivider**(*fig*, **args*, ***kwargs*)

locate(*nx*, *ny*, *nx1=None*, *ny1=None*, *axes=None*, *renderer=None*)

Parameters

axes_divider [AxesDivider]

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

axes

renderer

new_locator(*nx*, *nx1=None*)
returns a new locator (mpl_toolkits.axes_grid.axes_divider.AxesLocator) for specified cell.

Parameters

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

Examples using mpl_toolkits.axes_grid1.axes_divider.HBoxDivider

- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py

mpl_toolkits.axes_grid1.axes_divider.LocatableAxes

class mpl_toolkits.axes_grid1.axes_divider.**LocatableAxes**(**kl*, ***kw*)

mpl_toolkits.axes_grid1.axes_divider.LocatableAxesBase

class mpl_toolkits.axes_grid1.axes_divider.**LocatableAxesBase**(**kl*, ***kw*)

apply_aspect(*position=None*)

draw(*renderer=None*, *inframe=False*)

get_axes_locator()

set_axes_locator(*locator*)

mpl_toolkits.axes_grid1.axes_divider.SubplotDivider

class mpl_toolkits.axes_grid1.axes_divider.**SubplotDivider**(*fig*, **args*, ***kwargs*)
The Divider class whose rectangle area is specified as a subplot geometry.

Parameters

fig [*matplotlib.figure.Figure*]

args [tuple (*numRows*, *numCols*, *plotNum*)] The array of subplots in the figure has dimensions *numRows*, *numCols*, and *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, e.g., from 1,1,1 to 2,2,3

get_geometry()
get the subplot geometry, e.g., 2,2,3

get_position()
return the bounds of the subplot box

get_subplotspec()
get the SubplotSpec instance

set_subplotspec(*subplotspec*)
set the SubplotSpec instance

update_params()
update the subplot position from fig.subplotpars

mpl_toolkits.axes_grid1.axes_divider.VBoxDivider

class mpl_toolkits.axes_grid1.axes_divider.**VBoxDivider**(*fig*, **args*, ***kwargs*)
The Divider class whose rectangle area is specified as a subplot geometry.

locate(*nx*, *ny*, *nx1=None*, *ny1=None*, *axes=None*, *renderer=None*)

Parameters

axes_divider [AxesDivider]

nx, nx1 [int] Integers specifying the column-position of the cell. When *nx1* is None, a single *nx*-th column is specified. Otherwise location of columns spanning between *nx* to *nx1* (but excluding *nx1*-th column) is specified.

ny, ny1 [int] Same as *nx* and *nx1*, but for row positions.

axes

renderer

new_locator(*ny*, *ny1=None*)

returns a new locator (mpl_toolkits.axes_grid.axes_divider.AxesLocator) for specified cell.

Parameters

ny, ny1 [int] Integers specifying the row-position of the cell. When *ny1* is None, a single *ny*-th row is specified. Otherwise location of rows spanning between *ny* to *ny1* (but excluding *ny1*-th row) is specified.

16.2.2 Functions

locatable_axes_factory(axes_class)
make_axes_area_auto_adjustable(ax[, ...])
make_axes_locatable(axes)

mpl_toolkits.axes_grid1.axes_divider.locatable_axes_factory

mpl_toolkits.axes_grid1.axes_divider.**locatable_axes_factory**(*axes_class*)

mpl_toolkits.axes_grid1.axes_divider.make_axes_area_auto_adjustable

mpl_toolkits.axes_grid1.axes_divider.**make_axes_area_auto_adjustable**(*ax*, *use_axes=None*, *pad=0.1*, *adjust_dirs=None*)

Examples using mpl_toolkits.axes_grid1.axes_divider.make_axes_area_auto_adjustable

- sphx_glr_gallery_axes_grid1_make_room_for_ylabel_using_axesgrid.py

mpl_toolkits.axes_grid1.axes_divider.make_axes_locatable

mpl_toolkits.axes_grid1.axes_divider.**make_axes_locatable**(*axes*)

16.3 mpl_toolkits.axes_grid1.axes_grid

16.3.1 Classes

AxesGrid	alias of *mpl_toolkits.axes_grid1.axes_grid.ImageGrid*
CbarAxes(*kl, **kwargs)	
CbarAxesBase	
Grid(fig, rect, nrows_ncols[, ngrids, ...])	A class that creates a grid of Axes.
ImageGrid(fig, rect, nrows_ncols[, ngrids, ...])	A class that creates a grid of Axes.

mpl_toolkits.axes_grid1.axes_grid.AxesGrid

mpl_toolkits.axes_grid1.axes_grid.**AxesGrid**
alias of *mpl_toolkits.axes_grid1.axes_grid.ImageGrid*

mpl_toolkits.axes_grid1.axes_grid.CbarAxes

class mpl_toolkits.axes_grid1.axes_grid.**CbarAxes**(**kl*, ***kwargs*)

cla()
Clear the current axes.

mpl_toolkits.axes_grid1.axes_grid.CbarAxesBase

class mpl_toolkits.axes_grid1.axes_grid.**CbarAxesBase**

colorbar(*mappable*, ***kwargs*)

toggle_label(*b*)

mpl_toolkits.axes_grid1.axes_grid.Grid

class mpl_toolkits.axes_grid1.axes_grid.**Grid**(*fig*, *rect*, *nrows_ncols*, *ngrids=None*, *direction='row'*, *axes_pad=0.02*, *add_all=True*, *share_all=False*, *share_x=True*, *share_y=True*, *label_mode='L'*, *axes_class=None*)
A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. AxesGrid is used in such case.

Build an *Grid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

Optional keyword arguments:

Key-word	De-fault	Description
direc-tion	"row"	["row" | "column"]
axes_pad	0.02	float| pad between axes given in inches or tuple-like of floats, (hori-zontal padding, vertical padding)
add_all	True	bool
share_all	False	bool
share_x	True	bool
share_y	True	bool
la-bel_mode	"L"	["L" | "1" | "all"]
axes_class	None	a type object which must be a subclass of *Axes*

get_aspect()
get aspect

get_axes_locator()

get_axes_pad()
get axes_pad

Returns

tuple Padding in inches, (horizontal pad, vertical pad)

get_divider()

get_geometry()
get geometry of the grid. Returns a tuple of two integer, representing number of rows and number of columns.

get_vsize_hsize()

set_aspect(*aspect*)
set aspect

set_axes_locator(*locator*)

set_axes_pad(*axes_pad*)
set axes_pad

set_label_mode(*mode*)
set label_mode

mpl_toolkits.axes_grid1.axes_grid.ImageGrid

class mpl_toolkits.axes_grid1.axes_grid.**ImageGrid**(*fig*, *rect*, *nrows_ncols*, *ngrids=None*, *direction='row'*, *axes_pad=0.02*, *add_all=True*, *share_all=False*, *aspect=True*, *label_mode='L'*, *cbar_mode=None*, *cbar_location='right'*, *cbar_pad=None*, *cbar_size='5%'*, *cbar_set_cax=True*, *axes_class=None*)

A class that creates a grid of Axes. In matplotlib, the axes location (and size) is specified in the normalized figure coordinates. This may not be ideal for images that needs to be displayed with a given aspect ratio. For example, displaying images of a same size with some fixed padding between them cannot be easily done in matplotlib. ImageGrid is used in such case.

Build an *ImageGrid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

Optional keyword arguments:

Keyword	Default	Description
direction	"row"	["row" | "column"]
axes_pad	0.02	float| pad between axes given in inches or tuple-like of floats, (horizontal padding, vertical padding)
add_all	True	bool
share_all	False	bool
aspect	True	bool
label_mode	"L"	["L" | "1" | "all"]
cbar_mode	None	["each" | "single" | "edge"]
cbar_location	"right"	["left" | "right" | "bottom" | "top"]
cbar_pad	None	
cbar_size	"5%"	
cbar_set_cax	True	bool
axes_class	None	a type object which must be a subclass of axes_grid's subclass of *Axes*

cbar_set_cax [if True, each axes in the grid has a cax] attribute that is bind to associated cbar_axes.

16.4 mpl_toolkits.axes_grid1.axes_rgb

16.4.1 Classes

RGBAxes(*kl, **kwargs)	**Parameters**
RGBAxesBase(*kl, **kwargs)	base class for a 4-panel imshow (RGB, R, G, B)

mpl_toolkits.axes_grid1.axes_rgb.RGBAxes

class mpl_toolkits.axes_grid1.axes_rgb.**RGBAxes**(**kl*, ***kwargs*)

Parameters

pad [float] fraction of the axes height to put as padding. defaults to 0.0

add_all [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to True.

axes_class [matplotlib.axes.Axes]

kl : Unpacked into axes_class() init for RGB

kwargs : Unpacked into axes_class() init for RGB, R, G, B axes

Examples using mpl_toolkits.axes_grid1.axes_rgb.RGBAxes

- sphx_glr_gallery_pyplots_whats_new_99_axes_grid.py
- sphx_glr_gallery_axes_grid1_simple_rgb.py
- sphx_glr_gallery_axes_grid1_demo_axes_rgb.py

mpl_toolkits.axes_grid1.axes_rgb.RGBAxesBase

class mpl_toolkits.axes_grid1.axes_rgb.**RGBAxesBase**(**kl*, ***kwargs*)

base class for a 4-panel imshow (RGB, R, G, B)

Layout: +———————+—-+ | | R | + +—-+ | RGB | G | + +—-+ | | B | +———————+—-+

Attributes

_defaultAxesClass [matplotlib.axes.Axes] defaults to 'Axes' in RGBAxes child class. No default in abstract base class

RGB [_defaultAxesClass] The axes object for the three-channel imshow

R [_defaultAxesClass] The axes object for the red channel imshow

G [_defaultAxesClass] The axes object for the green channel imshow

B [_defaultAxesClass] The axes object for the blue channel imshow

Parameters

pad [float] fraction of the axes height to put as padding. defaults to 0.0

add_all [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to True.

axes_class [matplotlib.axes.Axes]

kl : Unpacked into axes_class() init for RGB

kwargs : Unpacked into axes_class() init for RGB, R, G, B axes

add_RGB_to_figure()
Add the red, green and blue axes to the RGB composite's axes figure

imshow_rgb(*r*, *g*, *b*, ***kwargs*)
Create the four images {rgb, r, g, b}

Parameters

r [array-like] The red array

g [array-like] The green array

b [array-like] The blue array

kwargs [imshow kwargs] kwargs get unpacked into the imshow calls for the four images

Returns

rgb [matplotlib.image.AxesImage]

r [matplotlib.image.AxesImage]

g [matplotlib.image.AxesImage]

b [matplotlib.image.AxesImage]

16.4.2 Functions

imshow_rgb(ax, r, g, b, **kwargs)	
make_rgb_axes(ax[, pad, axes_class, add_all])	pad : fraction of the axes height.

mpl_toolkits.axes_grid1.axes_rgb.imshow_rgb

mpl_toolkits.axes_grid1.axes_rgb.**imshow_rgb**(*ax*, *r*, *g*, *b*, ***kwargs*)

mpl_toolkits.axes_grid1.axes_rgb.make_rgb_axes

mpl_toolkits.axes_grid1.axes_rgb.**make_rgb_axes**(*ax*, *pad=0.01*, *axes_class=None*, *add_all=True*)

pad : fraction of the axes height.

Examples using mpl_toolkits.axes_grid1.axes_rgb.make_rgb_axes

- sphx_glr_gallery_axes_grid1_demo_axes_rgb.py

16.5 mpl_toolkits.axes_grid1.axes_size

provides a classes of simple units that will be used with AxesDivider class (or others) to determine the size of each axes. The unit classes define `get_size` method that returns a tuple of two floats, meaning relative and absolute sizes, respectively.

Note that this class is nothing more than a simple tuple of two floats. Take a look at the Divider class to see how these two values are used.

16.5.1 Classes

Add(a, b)	
AddList(add_list)	
AxesX(axes[, aspect, ref_ax])	Scaled size whose relative part corresponds to the data width of the *axes* multiplied by the *aspect*.
AxesY(axes[, aspect, ref_ax])	Scaled size whose relative part corresponds to the data height of the *axes* multiplied by the *aspect*.
Fixed(fixed_size)	Simple fixed size with absolute part = *fixed_size* and relative part = 0
Fraction(fraction, ref_size)	An instance whose size is a *fraction* of the *ref_size*.
GetExtentHelper(ax, direction)	
MaxExtent(artist_list, w_or_h)	Size whose absolute part is the largest width (or height) of the given *artist_list*.
MaxHeight(artist_list)	Size whose absolute part is the largest height of the given *artist_list*.
MaxWidth(artist_list)	Size whose absolute part is the largest width of the given *artist_list*.
Padded(size, pad)	Return a instance where the absolute part of *size* is increase by the amount of *pad*.
Scalable	alias of *mpl_toolkits.axes_grid1.axes_size.Scaled*
Scaled(scalable_size)	Simple scaled(?) size with absolute part = 0 and relative part = *scalable_size*

Continued on next page

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SizeFromFunc(func)

mpl_toolkits.axes_grid1.axes_size.Add

class mpl_toolkits.axes_grid1.axes_size.**Add**(*a*, *b*)

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.AddList

class mpl_toolkits.axes_grid1.axes_size.**AddList**(*add_list*)

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.AxesX

class mpl_toolkits.axes_grid1.axes_size.**AxesX**(*axes*, *aspect=1.0*, *ref_ax=None*)

Scaled size whose relative part corresponds to the data width of the *axes* multiplied by the *aspect*.

get_size(*renderer*)

Examples using mpl_toolkits.axes_grid1.axes_size.AxesX

- sphx_glr_gallery_axes_grid1_simple_axes_divider3.py
- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py

mpl_toolkits.axes_grid1.axes_size.AxesY

class mpl_toolkits.axes_grid1.axes_size.**AxesY**(*axes*, *aspect=1.0*, *ref_ax=None*)

Scaled size whose relative part corresponds to the data height of the *axes* multiplied by the *aspect*.

get_size(*renderer*)

Examples using mpl_toolkits.axes_grid1.axes_size.AxesY

- sphx_glr_gallery_axes_grid1_simple_axes_divider3.py
- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py

mpl_toolkits.axes_grid1.axes_size.Fixed

class mpl_toolkits.axes_grid1.axes_size.**Fixed**(*fixed_size*)

Simple fixed size with absolute part = *fixed_size* and relative part = 0

get_size(*renderer*)

Examples using mpl_toolkits.axes_grid1.axes_size.Fixed

- sphx_glr_gallery_axes_grid1_simple_axes_divider2.py
- sphx_glr_gallery_axes_grid1_simple_axes_divider3.py
- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py

mpl_toolkits.axes_grid1.axes_size.Fraction

class mpl_toolkits.axes_grid1.axes_size.**Fraction**(*fraction*, *ref_size*)

An instance whose size is a *fraction* of the *ref_size*.

```
>>> s = Fraction(0.3, AxesX(ax))
```

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.GetExtentHelper

class mpl_toolkits.axes_grid1.axes_size.**GetExtentHelper**(*ax*, *direction*)

mpl_toolkits.axes_grid1.axes_size.MaxExtent

class mpl_toolkits.axes_grid1.axes_size.**MaxExtent**(*artist_list*, *w_or_h*)

Size whose absolute part is the largest width (or height) of the given *artist_list*.

add_artist(*a*)

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.MaxHeight

class mpl_toolkits.axes_grid1.axes_size.**MaxHeight**(*artist_list*)

Size whose absolute part is the largest height of the given *artist_list*.

add_artist(*a*)

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.MaxWidth

class mpl_toolkits.axes_grid1.axes_size.**MaxWidth**(*artist_list*)
Size whose absolute part is the largest width of the given *artist_list*.

add_artist(*a*)

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.Padded

class mpl_toolkits.axes_grid1.axes_size.**Padded**(*size*, *pad*)
Return a instance where the absolute part of *size* is increase by the amount of *pad*.

get_size(*renderer*)

mpl_toolkits.axes_grid1.axes_size.Scalable

mpl_toolkits.axes_grid1.axes_size.**Scalable**
alias of *mpl_toolkits.axes_grid1.axes_size.Scaled*

mpl_toolkits.axes_grid1.axes_size.Scaled

class mpl_toolkits.axes_grid1.axes_size.**Scaled**(*scalable_size*)
Simple scaled(?) size with absolute part = 0 and relative part = *scalable_size*

get_size(*renderer*)

Examples using mpl_toolkits.axes_grid1.axes_size.Scaled

- sphx_glr_gallery_axes_grid1_simple_axes_divider2.py
- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py

mpl_toolkits.axes_grid1.axes_size.SizeFromFunc

class mpl_toolkits.axes_grid1.axes_size.**SizeFromFunc**(*func*)

get_size(*renderer*)

16.5.2 Functions

from_any(size[, fraction_ref])	Creates Fixed unit when the first argument is a float, or a Fraction unit if that is a string that ends with %.

mpl_toolkits.axes_grid1.axes_size.from_any

mpl_toolkits.axes_grid1.axes_size.**from_any**(*size*, *fraction_ref=None*)

Creates Fixed unit when the first argument is a float, or a Fraction unit if that is a string that ends with %. The second argument is only meaningful when Fraction unit is created.:

```
>>> a = Size.from_any(1.2) # => Size.Fixed(1.2)
>>> Size.from_any("50%", a) # => Size.Fraction(0.5, a)
```

16.6 mpl_toolkits.axes_grid1.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 mpl_toolkits.axes_grid1.colorbar.**CbarAxesLocator**(*locator=None*, *extend='neither'*, *orientation='vertical'*)

CbarAxesLocator is a axes_locator for colorbar axes. It adjust the position of the axes to make a room for extended ends, i.e., the extended ends are located outside the axes area.

locator [the bbox returned from the locator is used as a] initial axes location. If None, axes.bbox is used.

extend : same as in ColorbarBase *orientation* : same as in ColorbarBase

get_end_vertices()
return a tuple of two vertices for the colorbar extended ends. The first vertices is for the minimum end, and the second is for the maximum end.

get_original_position(*axes*, *renderer*)
get the original position of the axes.

get_path_ends()
get the paths for extended ends

get_path_patch()
get the path for axes patch

class mpl_toolkits.axes_grid1.colorbar.**Colorbar**(*ax*, *mappable*, ***kw*)

add_lines(*CS*)
Add the lines from a non-filled *ContourSet* to the colorbar.

update_bruteforce(*mappable*)
Update the colorbar artists to reflect the change of the associated mappable.

class mpl_toolkits.axes_grid1.colorbar.**ColorbarBase**(*ax*, *cmap=None*, *norm=None*, *alpha=1.0*, *values=None*, *boundaries=None*, *orientation='vertical'*, *extend='neither'*, *spacing='uniform'*, *ticks=None*, *format=None*, *drawedges=False*, *filled=True*)

Draw a colorbar in an existing axes.

This is a base class for the *Colorbar* class, which is the basis for the *colorbar()* method and pylab function.

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. It deletes preexisting lines.

set_alpha(*alpha*)
set alpha value.

set_label_text(*label*, ***kw*)
Label the long axis of the colorbar

update_artists()
Update the colorbar associated artists, *filled* and *ends*. Note that *lines* are not updated. This needs to be called whenever clim of associated image changes.

mpl_toolkits.axes_grid1.colorbar.**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 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	bool Whether to 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.

It is known that some vector graphics viewer (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers not matplotlib. As a workaround the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances. Particularly with semi transparent images (alpha < 1) and colorbar extensions and is not enabled by default see (issue #1188).

returns: *Colorbar* instance; see also its base class, *ColorbarBase*. Call the *set_label()* method to label the colorbar.

The transData of the *cax* is adjusted so that the limits in the longest axis actually corresponds to the limits in colorbar range. On the other hand, the shortest axis has a data limits of [1,2], whose unconventional value is to prevent underflow when log scale is used.

mpl_toolkits.axes_grid1.colorbar.**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.

16.7 mpl_toolkits.axes_grid1.inset_locator

A collection of functions and objects for creating or placing inset axes.

16.7.1 Classes

AnchoredLocatorBase(bbox_to_anchor, ...[, ...])	
AnchoredSizeLocator(bbox_to_anchor, x_size, ...)	
AnchoredZoomLocator(parent_axes, zoom, loc)	
BboxConnector(bbox1, bbox2, loc1[, loc2])	Connect two bboxes with a straight line.
BboxConnectorPatch(bbox1, bbox2, loc1a, ...)	Connect two bboxes with a quadrilateral.
BboxPatch(bbox, **kwargs)	Patch showing the shape bounded by a Bbox.
InsetPosition(parent, lbwh)	An object for positioning an inset axes.

mpl_toolkits.axes_grid1.inset_locator.AnchoredLocatorBase

class mpl_toolkits.axes_grid1.inset_locator.**AnchoredLocatorBase**(*bbox_to_anchor*, *offsetbox*, *loc*, *borderpad=0.5*, *bbox_transform=None*)

draw(*renderer*)
draw the artist

mpl_toolkits.axes_grid1.inset_locator.AnchoredSizeLocator

class mpl_toolkits.axes_grid1.inset_locator.**AnchoredSizeLocator**(*bbox_to_anchor*, *x_size*, *y_size*, *loc*, *borderpad=0.5*, *bbox_transform=None*)

get_extent(*renderer*)
return the extent of the artist. The extent of the child added with the pad is returned

mpl_toolkits.axes_grid1.inset_locator.AnchoredZoomLocator

class mpl_toolkits.axes_grid1.inset_locator.**AnchoredZoomLocator**(*parent_axes*, *zoom*, *loc*, *borderpad=0.5*, *bbox_to_anchor=None*, *bbox_transform=None*)

get_extent(*renderer*)
return the extent of the artist. The extent of the child added with the pad is returned

mpl_toolkits.axes_grid1.inset_locator.BboxConnector

class mpl_toolkits.axes_grid1.inset_locator.**BboxConnector**(*bbox1*, *bbox2*, *loc1*, *loc2=None*, ***kwargs*)

Connect two bboxes with a straight line.

Parameters

bbox1, bbox2 [*matplotlib.transforms.Bbox*] Bounding boxes to connect.

loc1 [{1, 2, 3, 4}] Corner of *bbox1* to draw the line. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

loc2 [{1, 2, 3, 4}, optional] Corner of *bbox2* to draw the line. If None, defaults to *loc1*. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

****kwargs** Patch properties for the line drawn. Valid arguments include:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a Bbox instance
clip_on	bool
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a Figure instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | ':' | 'None' | ' ' | '']
linewidth or lw	float or None for default
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	Transform
url	a url string
visible	bool
zorder	float

static connect_bbox(*bbox1*, *bbox2*, *loc1*, *loc2=None*)

Helper function to obtain a Path from one bbox to another.

Parameters

bbox1, bbox2 [matplotlib.transforms.Bbox] Bounding boxes to connect.

loc1 [{1, 2, 3, 4}] Corner of *bbox1* to use. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

loc2 [{1, 2, 3, 4}, optional] Corner of *bbox2* to use. If None, defaults to *loc1*. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

Returns

path [*matplotlib.path.Path*] A line segment from the *loc1* corner of *bbox1* to the *loc2* corner of *bbox2*.

static get_bbox_edge_pos(*bbox*, *loc*)

Helper function to obtain the location of a corner of a bbox

Parameters

bbox [*matplotlib.transforms.Bbox*]

loc [{1, 2, 3, 4}] Corner of *bbox*. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

Returns

x, y [float] Coordinates of the corner specified by *loc*.

get_path()

Return the path of this patch

Examples using mpl_toolkits.axes_grid1.inset_locator.BboxConnector

- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py

mpl_toolkits.axes_grid1.inset_locator.BboxConnectorPatch

class mpl_toolkits.axes_grid1.inset_locator.**BboxConnectorPatch**(*bbox1*, *bbox2*, *loc1a*, *loc2a*, *loc1b*, *loc2b*, ***kwargs*)

Connect two bboxes with a quadrilateral.

The quadrilateral is specified by two lines that start and end at corners of the bboxes. The four sides of the quadrilateral are defined by the two lines given, the line between the two corners specified in *bbox1* and the line between the two corners specified in *bbox2*.

Parameters

bbox1, bbox2 [*matplotlib.transforms.Bbox*] Bounding boxes to connect.

loc1a, loc2a [{1, 2, 3, 4}] Corners of *bbox1* and *bbox2* to draw the first line. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

loc1b, loc2b [{1, 2, 3, 4}] Corners of *bbox1* and *bbox2* to draw the second line. Valid values are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4
```

****kwargs** Patch properties for the line drawn:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_path()
Return the path of this patch

Examples using `mpl_toolkits.axes_grid1.inset_locator.BboxConnectorPatch`

- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py

mpl_toolkits.axes_grid1.inset_locator.BboxPatch

class mpl_toolkits.axes_grid1.inset_locator.**BboxPatch**(*bbox*, ***kwargs*)

Patch showing the shape bounded by a Bbox.

Parameters

bbox [*matplotlib.transforms.Bbox*] Bbox to use for the extents of this patch.

****kwargs** Patch properties. Valid arguments include:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_path()
Return the path of this patch

Examples using mpl_toolkits.axes_grid1.inset_locator.BboxPatch

- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py

mpl_toolkits.axes_grid1.inset_locator.InsetPosition

class mpl_toolkits.axes_grid1.inset_locator.**InsetPosition**(*parent*, *lbwh*)
An object for positioning an inset axes.

This is created by specifying the normalized coordinates in the axes, instead of the figure.

Parameters

parent [*matplotlib.axes.Axes*] Axes to use for normalizing coordinates.

lbwh [iterable of four floats] The left edge, bottom edge, width, and height of the inset axes, in units of the normalized coordinate of the *parent* axes.

See also:

matplotlib.axes.Axes.set_axes_locator()

Examples

The following bounds the inset axes to a box with 20% of the parent axes's height and 40% of the width. The size of the axes specified ([0, 0, 1, 1]) ensures that the axes completely fills the bounding box:

```
>>> parent_axes = plt.gca()
>>> ax_ins = plt.axes([0, 0, 1, 1])
>>> ip = InsetPosition(ax, [0.5, 0.1, 0.4, 0.2])
>>> ax_ins.set_axes_locator(ip)
```

16.7.2 Functions

inset_axes(parent_axes, width, height[, ...])	Create an inset axes with a given width and height.
mark_inset(parent_axes, inset_axes, loc1, ...)	Draw a box to mark the location of an area represented by an inset axes.
zoomed_inset_axes(parent_axes, zoom[, loc, ...])	Create an anchored inset axes by scaling a parent axes.

mpl_toolkits.axes_grid1.inset_locator.inset_axes

mpl_toolkits.axes_grid1.inset_locator.**inset_axes**(*parent_axes*, *width*, *height*, *loc=1*, *bbox_to_anchor=None*, *bbox_transform=None*, *axes_class=None*, *axes_kwargs=None*, *borderpad=0.5*)

Create an inset axes with a given width and height.

Both sizes used can be specified either in inches or percentage. For example,:

```
inset_axes(parent_axes, width='40%', height='30%', loc=3)
```

creates in inset axes in the lower left corner of *parent_axes* which spans over 30% in height and 40% in width of the *parent_axes*. Since the usage of `inset_axes` may become slightly tricky when exceeding such standard cases, it is recommended to read the examples.

Parameters

parent_axes [`matplotlib.axes.Axes`] Axes to place the inset axes.

width, height [float or str] Size of the inset axes to create. If a float is provided, it is the size in inches, e.g. *width=1.3*. If a string is provided, it is the size in relative units, e.g. *width='40%'*. By default, i.e. if neither *bbox_to_anchor* nor *bbox_transform* are specified, those are relative to the parent_axes. Otherwise they are to be understood relative to the bounding box provided via *bbox_to_anchor*.

loc [int or string, optional, default to 1] Location to place the inset axes. The valid locations are:

```
'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
```

bbox_to_anchor [tuple or `matplotlib.transforms.BboxBase`, optional] Bbox that the inset axes will be anchored to. If None, *parent_axes.bbox* is used. If a tuple, can be either [left, bottom, width, height], or [left, bottom]. If the kwargs *width* and/or *height* are specified in relative units, the 2-tuple [left, bottom] cannot be used. Note that the units of the bounding box are determined through the transform in use. When using *bbox_to_anchor* it almost always makes sense to also specify a *bbox_transform*. This might often be the axes transform *parent_axes.transAxes*.

bbox_transform [*matplotlib.transforms.Transform*, optional] Transformation for the bbox that contains the inset axes. If None, a *transforms.IdentityTransform* is used (i.e. pixel coordinates). This is useful when not providing any argument to *bbox_to_anchor*. When using *bbox_to_anchor* it almost always makes sense to also specify a *bbox_transform*. This might often be the axes transform *parent_axes.transAxes*. Inversely, when specifying the axes- or figure-transform here, be aware that not specifying *bbox_to_anchor* will use *parent_axes.bbox*, the units of which are in display (pixel) coordinates.

axes_class [*matplotlib.axes.Axes* type, optional] If specified, the inset axes created will be created with this class's constructor.

axes_kwargs [dict, optional] Keyword arguments to pass to the constructor of the inset axes. Valid arguments include:

Property	Description
adjustable	['box' | 'datalim']
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) arra
alpha	float (0.0 transparent through 1.0 opaque)
anchor	['C' | 'SW' | 'S' | 'SE' | 'E' | 'NE' | 'N' | 'NW' | 'W']
animated	bool
aspect	unknown
autoscale_on	bool
autoscalex_on	bool
autoscaley_on	bool
axes_locator	a callable object which takes an axes instance and renderer and returns a bbox.
axisbelow	[bool | 'line']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
contains	a callable function
facecolor	color
fc	color
figure	*Figure*
frame_on	bool
gid	an id string
label	object
navigate	bool
navigate_mode	unknown
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	unknown
rasterization_zorder	float or None
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None

Continued on next pag

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Property	Description
title	unknown
transform	Transform
url	a url string
visible	bool
xbound	(lower: float, upper: float)
xlabel	unknown
xlim	(left: float, right: float)
xmargin	float greater than -0.5
xscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
xticklabels	list of string labels
xticks	list of tick locations.
ybound	(lower: float, upper: float)
ylabel	unknown
ylim	(bottom: float, top: float)
ymargin	float greater than -0.5
yscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
yticklabels	list of string labels
yticks	list of tick locations.
zorder	float

borderpad [float, optional] Padding between inset axes and the bbox_to_anchor. Defaults to 0.5. The units are axes font size, i.e. for a default font size of 10 points *borderpad = 0.5* is equivalent to a padding of 5 points.

Returns

inset_axes [axes_class] Inset axes object created.

Examples using mpl_toolkits.axes_grid1.inset_locator.inset_axes

- sphx_glr_gallery_axes_grid1_demo_colorbar_with_inset_locator.py
- sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py
- sphx_glr_gallery_axes_grid1_inset_locator_demo.py

mpl_toolkits.axes_grid1.inset_locator.mark_inset

mpl_toolkits.axes_grid1.inset_locator.**mark_inset**(*parent_axes*, *inset_axes*, *loc1*, *loc2*, ***kwargs*)

Draw a box to mark the location of an area represented by an inset axes.

This function draws a box in *parent_axes* at the bounding box of *inset_axes*, and shows a connection with the inset axes by drawing lines at the corners, giving a "zoomed in" effect.

Parameters

parent_axes [*matplotlib.axes.Axes*] Axes which contains the area of the inset axes.

inset_axes [*matplotlib.axes.Axes*] The inset axes.

loc1, loc2 [{1, 2, 3, 4}] Corners to use for connecting the inset axes and the area in the parent axes.

****kwargs** Patch properties for the lines and box drawn:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

Returns

pp [*matplotlib.patches.Patch*] The patch drawn to represent the area of the inset axes.

p1, p2 [*matplotlib.patches.Patch*] The patches connecting two corners of the inset axes and its area.

Examples using `mpl_toolkits.axes_grid1.inset_locator.mark_inset`

- sphx_glr_gallery_axes_grid1_inset_locator_demo2.py

mpl_toolkits.axes_grid1.inset_locator.zoomed_inset_axes

mpl_toolkits.axes_grid1.inset_locator.**zoomed_inset_axes**(*parent_axes*, *zoom*, *loc=1*, *bbox_to_anchor=None*, *bbox_transform=None*, *axes_class=None*, *axes_kwargs=None*, *borderpad=0.5*)

Create an anchored inset axes by scaling a parent axes. For usage, also see the examples.

Parameters

parent_axes [*matplotlib.axes.Axes*] Axes to place the inset axes.

zoom [float] Scaling factor of the data axes. *zoom* > 1 will enlargen the coordinates (i.e., "zoomed in"), while *zoom* < 1 will shrink the coordinates (i.e., "zoomed out").

loc [int or string, optional, default to 1] Location to place the inset axes. The valid locations are:

```
'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
```

bbox_to_anchor [tuple or *matplotlib.transforms.BboxBase*, optional] Bbox that the inset axes will be anchored to. If None, *parent_axes.bbox* is used. If a tuple, can be either [left, bottom, width, height], or [left, bottom]. If the kwargs *width* and/or *height* are specified in relative units, the 2-tuple [left, bottom] cannot be used. Note that the units of the bounding box are determined through the transform in use. When using *bbox_to_anchor* it almost always makes sense to also specify a *bbox_transform*. This might often be the axes transform *parent_axes.transAxes*.

bbox_transform [*matplotlib.transforms.Transform*, optional] Transformation for the bbox that contains the inset axes. If None, a *transforms.IdentityTransform* is used (i.e. pixel coordinates). This is useful when not providing any argument to *bbox_to_anchor*. When using *bbox_to_anchor* it almost always makes sense to also specify a *bbox_transform*. This might often be the axes transform *parent_axes.transAxes*. Inversely, when specifying the axes- or figure-transform here, be aware that not specifying *bbox_to_anchor* will use *parent_axes.bbox*, the units of which are in display (pixel) coordinates.

axes_class [*matplotlib.axes.Axes* type, optional] If specified, the inset axes created will be created with this class's constructor.

axes_kwargs [dict, optional] Keyword arguments to pass to the constructor of the inset axes. Valid arguments include:

Property	Description
adjustable	['box' | 'datalim']
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) arra
alpha	float (0.0 transparent through 1.0 opaque)
anchor	['C' | 'SW' | 'S' | 'SE' | 'E' | 'NE' | 'N' | 'NW' | 'W']
animated	bool
aspect	unknown
autoscale_on	bool
autoscalex_on	bool
autoscaley_on	bool
axes_locator	a callable object which takes an axes instance and renderer and returns a bbox.
axisbelow	[bool | 'line']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
contains	a callable function
facecolor	color
fc	color
figure	*Figure*
frame_on	bool
gid	an id string
label	object
navigate	bool
navigate_mode	unknown
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	unknown
rasterization_zorder	float or None
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None

Continued on next pag

Table 13 – continued from previous page

Property	Description
title	unknown
transform	*Transform*
url	a url string
visible	bool
xbound	(lower: float, upper: float)
xlabel	unknown
xlim	(left: float, right: float)
xmargin	float greater than -0.5
xscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
xticklabels	list of string labels
xticks	list of tick locations.
ybound	(lower: float, upper: float)
ylabel	unknown
ylim	(bottom: float, top: float)
ymargin	float greater than -0.5
yscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
yticklabels	list of string labels
yticks	list of tick locations.
zorder	float

borderpad [float, optional] Padding between inset axes and the bbox_to_anchor. Defaults to 0.5. The units are axes font size, i.e. for a default font size of 10 points *borderpad = 0.5* is equivalent to a padding of 5 points.

Returns

inset_axes [axes_class] Inset axes object created.

Examples using `mpl_toolkits.axes_grid1.inset_locator.zoomed_inset_axes`

- sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py
- sphx_glr_gallery_axes_grid1_inset_locator_demo2.py

16.8 mpl_toolkits.axes_grid1.mpl_axes

16.8.1 Classes

Axes(*kl, **kw)
SimpleAxisArtist(axis, axisnum, spine)
SimpleChainedObjects(objects)

mpl_toolkits.axes_grid1.mpl_axes.Axes

class mpl_toolkits.axes_grid1.mpl_axes.**Axes**(**kl*, ***kw*)

class **AxisDict**() -> new empty dictionary dict(mapping) -> new dictionary initialized from a mapping object's (key, value) pairs dict(iterable) -> new dictionary initialized as if via: d = {} for k, v in iterable: d[k] = v dict(**kwargs) -> new dictionary initialized with the name=value pairs in the keyword argument list. For example: dict(one=1, two=2)

axis

cla()
Clear the current axes.

mpl_toolkits.axes_grid1.mpl_axes.SimpleAxisArtist

class mpl_toolkits.axes_grid1.mpl_axes.**SimpleAxisArtist**(*axis*, *axisnum*, *spine*)

label

major_ticklabels

major_ticks

set_label(*txt*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

toggle(*all=None*, *ticks=None*, *ticklabels=None*, *label=None*)

mpl_toolkits.axes_grid1.mpl_axes.SimpleChainedObjects

class mpl_toolkits.axes_grid1.mpl_axes.**SimpleChainedObjects**(*objects*)

16.9 mpl_toolkits.axes_grid1.parasite_axes

16.9.1 Classes

HostAxes	alias of mpl_toolkits.axes_grid1.parasite_axes.AxesHostAxes
HostAxesBase(*args, **kwargs)	
ParasiteAxes	alias of mpl_toolkits.axes_grid1.parasite_axes.AxesParasite
ParasiteAxesAuxTrans	alias of mpl_toolkits.axes_grid1.parasite_axes.AxesParasiteParasiteAuxTrans
ParasiteAxesAuxTransBase(parent_axes, ...[, ...])	
ParasiteAxesBase(parent_axes, **kargs)	

mpl_toolkits.axes_grid1.parasite_axes.HostAxes

mpl_toolkits.axes_grid1.parasite_axes.**HostAxes**
alias of mpl_toolkits.axes_grid1.parasite_axes.AxesHostAxes

mpl_toolkits.axes_grid1.parasite_axes.HostAxesBase

class mpl_toolkits.axes_grid1.parasite_axes.**HostAxesBase**(**args*, ***kwargs*)

cla()

draw(*renderer*)

get_aux_axes(*tr*, *viewlim_mode='equal'*, *axes_class=None*)

get_tightbbox(*renderer*, *call_axes_locator=True*)

twin(*aux_trans=None*, *axes_class=None*)
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

twinx(*axes_class=None*)
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(*axes_class=None*)
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

mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxes

mpl_toolkits.axes_grid1.parasite_axes.**ParasiteAxes**
alias of mpl_toolkits.axes_grid1.parasite_axes.AxesParasite

mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTrans

mpl_toolkits.axes_grid1.parasite_axes.**ParasiteAxesAuxTrans**
alias of mpl_toolkits.axes_grid1.parasite_axes.AxesParasiteParasiteAuxTrans

mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesAuxTransBase

class mpl_toolkits.axes_grid1.parasite_axes.**ParasiteAxesAuxTransBase**(*parent_axes*, *aux_transform*, *viewlim_mode=None*, ***kwargs*)

apply_aspect(*position=None*)

contour(**XYCL*, ***kwargs*)

contourf(**XYCL*, ***kwargs*)

get_viewlim_mode()

pcolor(**XYC*, ***kwargs*)

pcolormesh(**XYC*, ***kwargs*)

set_viewlim_mode(*mode*)

update_viewlim()

mpl_toolkits.axes_grid1.parasite_axes.ParasiteAxesBase

class mpl_toolkits.axes_grid1.parasite_axes.**ParasiteAxesBase**(*parent_axes*, ***kargs*)

cla()

get_images_artists()

16.9.2 Functions

host_axes(*args, **kwargs)	Create axes that can act as a hosts to parasitic axes.
host_axes_class_factory([axes_class])	
host_subplot(*args, **kwargs)	Create a subplot that can act as a host to parasitic axes.
host_subplot_class_factory(axes_class)	
parasite_axes_auxtrans_class_factory([...])	
parasite_axes_class_factory([axes_class])	

mpl_toolkits.axes_grid1.parasite_axes.host_axes

mpl_toolkits.axes_grid1.parasite_axes.**host_axes**(**args*, ***kwargs*)

Create axes that can act as a hosts to parasitic axes.

Parameters

figure [*matplotlib.figure.Figure*] Figure to which the axes will be added. Defaults to the current figure `pyplot.gcf()`.

***args, **kwargs :** Will be passed on to the underlying `Axes` object creation.

mpl_toolkits.axes_grid1.parasite_axes.host_axes_class_factory

mpl_toolkits.axes_grid1.parasite_axes.**host_axes_class_factory**(*axes_class=None*)

mpl_toolkits.axes_grid1.parasite_axes.host_subplot

mpl_toolkits.axes_grid1.parasite_axes.**host_subplot**(**args*, ***kwargs*)

Create a subplot that can act as a host to parasitic axes.

Parameters

figure [*matplotlib.figure.Figure*] Figure to which the subplot will be added. Defaults to the current figure `pyplot.gcf()`.

***args, **kwargs :** Will be passed on to the underlying `Axes` object creation.

mpl_toolkits.axes_grid1.parasite_axes.host_subplot_class_factory

mpl_toolkits.axes_grid1.parasite_axes.**host_subplot_class_factory**(*axes_class*)

mpl_toolkits.axes_grid1.parasite_axes.parasite_axes_auxtrans_class_factory

mpl_toolkits.axes_grid1.parasite_axes.**parasite_axes_auxtrans_class_factory**(*axes_class=None*)

mpl_toolkits.axes_grid1.parasite_axes.parasite_axes_class_factory

mpl_toolkits.axes_grid1.parasite_axes.**parasite_axes_class_factory**(*axes_class=None*)

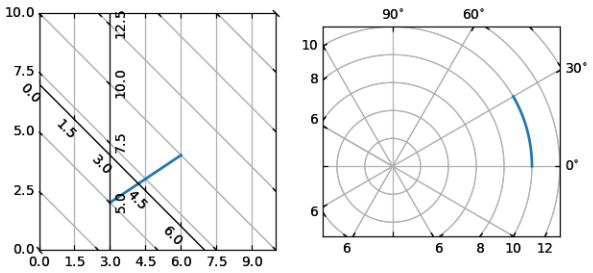
CHAPTER

SEVENTEEN

MATPLOTLIB AXISARTIST TOOLKIT

The *axisartist* namespace includes a derived Axes implementation (`mpl_toolkits.axisartist.Axes`). The biggest difference is that the artists that are responsible for drawing axis lines, ticks, ticklabels, and axis labels are separated out from the mpl's Axis class. This change was strongly motivated to support curvilinear grid.

You can find a tutorial describing usage of axisartist at the *axisartist* user guide.



The submodules of the axisartist API are:

axisartist.angle_helper	
axisartist.axes_divider	
axisartist.axes_grid	
axisartist.axes_rgb	
axisartist.axis_artist	axis_artist.py module provides axis-related artists.
axisartist.axisline_style	
axisartist.axislines	Axislines includes modified implementation of the Axes class.
axisartist.clip_path	
axisartist.floating_axes	An experimental support for curvilinear grid.
axisartist.grid_finder	
axisartist.grid_helper_curvelinear	An experimental support for curvilinear grid.
axisartist.parasite_axes	

17.1 mpl_toolkits.axisartist.angle_helper

17.1.1 Classes

ExtremeFinderCycle(nx, ny[, lon_cycle, ...])	When there is a cycle, e.g., longitude goes from 0-360.
FormatterDMS	
FormatterHMS	
LocatorBase(den[, include_last])	
LocatorD(den[, include_last])	
LocatorDM(den[, include_last])	
LocatorDMS(den[, include_last])	
LocatorH(den[, include_last])	
LocatorHM(den[, include_last])	
LocatorHMS(den[, include_last])	

mpl_toolkits.axisartist.angle_helper.ExtremeFinderCycle

class mpl_toolkits.axisartist.angle_helper.**ExtremeFinderCycle**(*nx*, *ny*, *lon_cycle=360.0*, *lat_cycle=None*, *lon_minmax=None*, *lat_minmax=(-90, 90)*)

When there is a cycle, e.g., longitude goes from 0-360.

Examples using mpl_toolkits.axisartist.angle_helper.ExtremeFinderCycle

- sphx_glr_gallery_axisartist_demo_curvelinear_grid2.py
- sphx_glr_gallery_axisartist_demo_floating_axis.py
- sphx_glr_gallery_axisartist_demo_axis_direction.py
- sphx_glr_gallery_axisartist_simple_axis_pad.py
- sphx_glr_gallery_axisartist_demo_curvelinear_grid.py

mpl_toolkits.axisartist.angle_helper.FormatterDMS

class mpl_toolkits.axisartist.angle_helper.**FormatterDMS**

deg_mark = '^{\\circ}'

fmt_d = '$%d^{\\circ}$'

```
fmt_d_m = '$%s%d^{\\circ}\\,%02d^{\\prime}$'

fmt_d_m_partial = '$%s%d^{\\circ}\\,%02d^{\\prime}\\,'

fmt_d_ms = '$%s%d^{\\circ}\\,%02d.%s^{\\prime}$'

fmt_ds = '$%d.%s^{\\circ}$'

fmt_s_partial = '%02d^{\\prime\\prime}$'

fmt_ss_partial = '%02d.%s^{\\prime\\prime}$'

min_mark = '^{\\prime}'

sec_mark = '^{\\prime\\prime}'
```

Examples using mpl_toolkits.axisartist.angle_helper.FormatterDMS

- sphx_glr_gallery_axisartist_demo_floating_axis.py
- sphx_glr_gallery_axisartist_demo_axis_direction.py
- sphx_glr_gallery_axisartist_simple_axis_pad.py
- sphx_glr_gallery_axisartist_demo_curvelinear_grid.py

mpl_toolkits.axisartist.angle_helper.FormatterHMS

class mpl_toolkits.axisartist.angle_helper.**FormatterHMS**

```
deg_mark = '^\\mathrm{h}'

fmt_d = '$%d^\\mathrm{h}$'

fmt_d_m = '$%s%d^\\mathrm{h}\\,%02d^\\mathrm{m}$'

fmt_d_m_partial = '$%s%d^\\mathrm{h}\\,%02d^\\mathrm{m}\\,'

fmt_d_ms = '$%s%d^\\mathrm{h}\\,%02d.%s^\\mathrm{m}$'
```

```
fmt_ds = '$%d.%s^\\mathrm{h}$'

fmt_s_partial = '%02d^\\mathrm{s}$'

fmt_ss_partial = '%02d.%s^\\mathrm{s}$'

min_mark = '^\\mathrm{m}'

sec_mark = '^\\mathrm{s}'
```

Examples using mpl_toolkits.axisartist.angle_helper.FormatterHMS

- sphx_glr_gallery_axisartist_demo_floating_axes.py

mpl_toolkits.axisartist.angle_helper.LocatorBase

class mpl_toolkits.axisartist.angle_helper.**LocatorBase**(*den*, *include_last=True*)

nbins

set_params(*nbins=None*)

mpl_toolkits.axisartist.angle_helper.LocatorD

class mpl_toolkits.axisartist.angle_helper.**LocatorD**(*den*, *include_last=True*)

mpl_toolkits.axisartist.angle_helper.LocatorDM

class mpl_toolkits.axisartist.angle_helper.**LocatorDM**(*den*, *include_last=True*)

mpl_toolkits.axisartist.angle_helper.LocatorDMS

class mpl_toolkits.axisartist.angle_helper.**LocatorDMS**(*den*, *include_last=True*)

Examples using mpl_toolkits.axisartist.angle_helper.LocatorDMS

- sphx_glr_gallery_axisartist_demo_floating_axis.py
- sphx_glr_gallery_axisartist_demo_axis_direction.py
- sphx_glr_gallery_axisartist_simple_axis_pad.py
- sphx_glr_gallery_axisartist_demo_curvelinear_grid.py

mpl_toolkits.axisartist.angle_helper.LocatorH

class mpl_toolkits.axisartist.angle_helper.**LocatorH**(*den*, *include_last=True*)

mpl_toolkits.axisartist.angle_helper.LocatorHM

class mpl_toolkits.axisartist.angle_helper.**LocatorHM**(*den*, *include_last=True*)

mpl_toolkits.axisartist.angle_helper.LocatorHMS

class mpl_toolkits.axisartist.angle_helper.**LocatorHMS**(*den*, *include_last=True*)

Examples using mpl_toolkits.axisartist.angle_helper.LocatorHMS

- sphx_glr_gallery_axisartist_demo_floating_axes.py

17.1.2 Functions

select_step(v1, v2, nv[, hour, ...])	
select_step24(v1, v2, nv[, include_last, ...])	
select_step360(v1, v2, nv[, include_last, ...])	
select_step_degree(dv)	
select_step_hour(dv)	
select_step_sub(dv)	

mpl_toolkits.axisartist.angle_helper.select_step

mpl_toolkits.axisartist.angle_helper.**select_step**(*v1*, *v2*, *nv*, *hour=False*, *include_last=True*, *threshold_factor=3600.0*)

mpl_toolkits.axisartist.angle_helper.select_step24

mpl_toolkits.axisartist.angle_helper.**select_step24**(*v1*, *v2*, *nv*, *include_last=True*, *threshold_factor=3600*)

mpl_toolkits.axisartist.angle_helper.select_step360

mpl_toolkits.axisartist.angle_helper.**select_step360**(*v1*, *v2*, *nv*, *include_last=True*, *threshold_factor=3600*)

mpl_toolkits.axisartist.angle_helper.select_step_degree

mpl_toolkits.axisartist.angle_helper.**select_step_degree**(*dv*)

mpl_toolkits.axisartist.angle_helper.select_step_hour

mpl_toolkits.axisartist.angle_helper.**select_step_hour**(*dv*)

mpl_toolkits.axisartist.angle_helper.select_step_sub

mpl_toolkits.axisartist.angle_helper.**select_step_sub**(*dv*)

17.2 mpl_toolkits.axisartist.axes_divider

17.3 mpl_toolkits.axisartist.axes_grid

17.3.1 Classes

AxesGrid	alias of *mpl_toolkits.axisartist.axes_grid.ImageGrid*
CbarAxes(*kl, **kwargs)	
Grid(fig, rect, nrows_ncols[, ngrids, ...])	Build an *Grid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

Continued on next page

Table 4 – continued from previous page

ImageGrid(fig, rect, nrows_ncols[, ngrids, ...])	Build an *ImageGrid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

mpl_toolkits.axisartist.axes_grid.AxesGrid

mpl_toolkits.axisartist.axes_grid.**AxesGrid**
alias of *mpl_toolkits.axisartist.axes_grid.ImageGrid*

mpl_toolkits.axisartist.axes_grid.CbarAxes

class mpl_toolkits.axisartist.axes_grid.**CbarAxes**(**kl*, ***kwargs*)

cla()
Clear the current axes.

mpl_toolkits.axisartist.axes_grid.Grid

class mpl_toolkits.axisartist.axes_grid.**Grid**(*fig*, *rect*, *nrows_ncols*, *ngrids=None*, *direction='row'*, *axes_pad=0.02*, *add_all=True*, *share_all=False*, *share_x=True*, *share_y=True*, *label_mode='L'*, *axes_class=None*)

Build an *Grid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

Optional keyword arguments:

Keyword	Default	Description
direction	"row"	["row" | "column"]
axes_pad	0.02	float| pad between axes given in inches or tuple-like of floats, (horizontal padding, vertical padding)
add_all	True	bool
share_all	False	bool
share_x	True	bool
share_y	True	bool
label_mode	"L"	["L" | "1" | "all"]
axes_class	None	a type object which must be a subclass of *Axes*

mpl_toolkits.axisartist.axes_grid.ImageGrid

class mpl_toolkits.axisartist.axes_grid.**ImageGrid**(*fig*, *rect*, *nrows_ncols*, *ngrids=None*, *direction='row'*, *axes_pad=0.02*, *add_all=True*, *share_all=False*, *aspect=True*, *label_mode='L'*, *cbar_mode=None*, *cbar_location='right'*, *cbar_pad=None*, *cbar_size='5%'*, *cbar_set_cax=True*, *axes_class=None*)

Build an *ImageGrid* instance with a grid nrows*ncols *Axes* in *Figure* *fig* with *rect=[left, bottom, width, height]* (in *Figure* coordinates) or the subplot position code (e.g., "121").

Optional keyword arguments:

Keyword	Default	Description
direction	"row"	["row" | "column"]
axes_pad	0.02	float| pad between axes given in inches or tuple-like of floats, (horizontal padding, vertical padding)
add_all	True	bool
share_all	False	bool
aspect	True	bool
label_mode	"L"	["L" | "1" | "all"]
cbar_mode	None	["each" | "single" | "edge"]
cbar_location	"right"	["left" | "right" | "bottom" | "top"]
cbar_pad	None	
cbar_size	"5%"	
cbar_set_cax	True	bool
axes_class	None	a type object which must be a subclass of axes_grid's subclass of *Axes*

cbar_set_cax [if True, each axes in the grid has a cax] attribute that is bind to associated cbar_axes.

17.4 mpl_toolkits.axisartist.axes_rgb

17.4.1 Classes

RGBAxes(*kl, **kwargs)

Parameters

mpl_toolkits.axisartist.axes_rgb.RGBAxes

class mpl_toolkits.axisartist.axes_rgb.**RGBAxes**(**kl*, ***kwargs*)

Parameters

pad [float] fraction of the axes height to put as padding. defaults to 0.0

add_all [bool] True: Add the {rgb, r, g, b} axes to the figure defaults to True.

axes_class [matplotlib.axes.Axes]

kl : Unpacked into axes_class() init for RGB

kwargs : Unpacked into axes_class() init for RGB, R, G, B axes

17.5 mpl_toolkits.axisartist.axis_artist

axis_artist.py module provides axis-related artists. They are

- axis line
- tick lines
- tick labels
- axis label
- grid lines

The main artist class is a AxisArtist and a GridlinesCollection. The GridlinesCollection is responsible for drawing grid lines and the AxisArtist is responsible for all other artists. The AxisArtist class has attributes that are associated with each type of artists.

- line : axis line
- major_ticks : major tick lines
- major_ticklabels : major tick labels
- minor_ticks : minor tick lines
- minor_ticklabels : minor tick labels
- label : axis label

Typically, the AxisArtist associated with a axes will be accessed with the *axis* dictionary of the axes, i.e., the AxisArtist for the bottom axis is

```
ax.axis["bottom"]
```

where *ax* is an instance of axes (mpl_toolkits.axislines.Axes). Thus, ax.axis["bottom"].line is an artist associated with the axis line, and ax.axis["bottom"].major_ticks is an artist associated with the major tick lines.

You can change the colors, fonts, line widths, etc. of these artists by calling suitable set method. For example, to change the color of the major ticks of the bottom axis to red,

```
ax.axis["bottom"].major_ticks.set_color("r")
```

However, things like the locations of ticks, and their ticklabels need to be changed from the side of the grid_helper.

17.5.1 axis_direction

AxisArtist, AxisLabel, TickLabels have *axis_direction* attribute, which adjusts the location, angle, etc.,. The *axis_direction* must be one of [left, right, bottom, top] and they follow the matplotlib convention for the rectangle axis.

For example, for the *bottom* axis (the left and right is relative to the direction of the increasing coordinate),

- ticklabels and axislabel are on the right
- ticklabels and axislabel have text angle of 0
- ticklabels are baseline, center-aligned
- axislabel is top, center-aligned

The text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

> Parameter left bottom right top ticklabels location left right right left axislabel location left right right left ticklabels angle 90 0 -90 180 axislabel angle 180 0 0 180 ticklabel va center baseline center baseline axislabel va center top center bottom ticklabel ha right center right center axislabel ha right center right center

Ticks are by default direct opposite side of the ticklabels. To make ticks to the same side of the ticklabels,

```
ax.axis["bottom"].major_ticks.set_ticks_out(True)
```

Following attributes can be customized (use set_xxx method)

- Ticks : ticksize, tick_out
- TickLabels : pad
- AxisLabel : pad

17.5.2 Classes

AttributeCopier(ref_artist[, klass])	
AxisArtist(axes, helper[, offset, ...])	An artist which draws axis (a line along which the n-th axes coord is constant) line, ticks, ticklabels, and axis label.
AxisLabel(*kl, **kwargs)	Axis Label.
BezierPath(path, *kl, **kw)	

Continued on next page

Table 6 – continued from previous page

GridlinesCollection(*kl, **kwargs)	*which* : "major" or "minor" *axis* : "both", "x" or "y"
LabelBase(*kl, **kwargs)	A base class for AxisLabel and TickLabels.
TickLabels(**kwargs)	Tick Labels.
Ticks(ticksize[, tick_out])	Ticks are derived from Line2D, and note that ticks themselves are markers.

mpl_toolkits.axisartist.axis_artist.AttributeCopier

class mpl_toolkits.axisartist.axis_artist.**AttributeCopier**(*ref_artist*, *klass=<class 'matplotlib.artist.Artist'>*)

get_attribute_from_ref_artist(*attr_name*, *default_value*)

get_ref_artist()

set_ref_artist(*artist*)

mpl_toolkits.axisartist.axis_artist.AxisArtist

class mpl_toolkits.axisartist.axis_artist.**AxisArtist**(*axes*, *helper*, *offset=None*, *axis_direction='bottom'*, ***kw*)

An artist which draws axis (a line along which the n-th axes coord is constant) line, ticks, ticklabels, and axis label.

axes : axes *helper* : an AxisArtistHelper instance.

LABELPAD

ZORDER = 2.5

draw(*renderer*)
Draw the axis lines, tick lines and labels

get_axisline_style()
return the current axisline style.

get_helper()
Return axis artist helper instance.

get_tightbbox(*renderer*)

get_transform()
Return the *Transform* instance used by this artist.

invert_ticklabel_direction()

set_axis_direction(*axis_direction*)

Adjust the direction, text angle, text alignment of ticklabels, labels following the matplotlib convention for the rectangle axes.

The *axis_direction* must be one of [left, right, bottom, top].

property	left	bottom	right	top
ticklabels location	"-"	"+"	"+"	"-"
axislabel location	"-"	"+"	"+"	"-"
ticklabels angle	90	0	-90	180
ticklabel va	center	baseline	center	baseline
ticklabel ha	right	center	right	center
axislabel angle	180	0	0	180
axislabel va	center	top	center	bottom
axislabel ha	right	center	right	center

Note that the direction "+" and "-" are relative to the direction of the increasing coordinate. Also, the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

set_axislabel_direction(*label_direction*)

Adjust the direction of the axislabel.

ACCEPTS: ["+" | "-"]

Note that the label_direction '+' and '-' are relative to the direction of the increasing coordinate.

set_axisline_style(*axisline_style=None*, ***kw*)

Set the axisline style.

***axisline_style* can be a string with axisline style name with optional** comma-separated attributes. Alternatively, the attrs can be provided as keywords.

set_arrowstyle("->,size=1.5") set_arrowstyle("->", size=1.5)

Old attrs simply are forgotten.

Without argument (or with arrowstyle=None), return available styles as a list of strings.

set_label(*s*)

Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_ticklabel_direction(*tick_direction*)

Adjust the direction of the ticklabel.

ACCEPTS: ["+" | "-"]

Note that the label_direction '+' and '-' are relative to the direction of the increasing coordinate.

toggle(*all=None*, *ticks=None*, *ticklabels=None*, *label=None*)

Toggle visibility of ticks, ticklabels, and (axis) label. To turn all off,

```
axis.toggle(all=False)
```

To turn all off but ticks on

```
axis.toggle(all=False, ticks=True)
```

To turn all on but (axis) label off

```
axis.toggle(all=True, label=False))
```

mpl_toolkits.axisartist.axis_artist.AxisLabel

class mpl_toolkits.axisartist.axis_artist.**AxisLabel**(**kl*, ***kwargs*)

Axis Label. Derived from Text. The position of the text is updated in the fly, so changing text position has no effect. Otherwise, the properties can be changed as a normal Text.

To change the pad between ticklabels and axis label, use set_pad.

draw(*renderer*)

Draws the `Text` object to the given *renderer*.

get_color()

Return the color of the text

get_pad()

return pad in points. See set_pad for more details.

get_ref_artist()

get_text()

Get the text as string

get_window_extent(*renderer*)

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.

set_axis_direction(*d*)

Adjust the text angle and text alignment of axis label according to the matplotlib convention.

property	left	bottom	right	top
axislabel angle	180	0	0	180
axislabel va	center	top	center	bottom
axislabel ha	right	center	right	center

Note that the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

set_default_alignment(*d*)

set_default_angle(*d*)

set_pad(*pad*)
Set the pad in points. Note that the actual pad will be the sum of the internal pad and the external pad (that are set automatically by the AxisArtist), and it only set the internal pad

mpl_toolkits.axisartist.axis_artist.BezierPath

class mpl_toolkits.axisartist.axis_artist.**BezierPath**(*path*, **kl*, ***kw*)

draw(*renderer*)
draw the Line with `renderer` unless visibility is False

recache()

set_path(*path*)

mpl_toolkits.axisartist.axis_artist.GridlinesCollection

class mpl_toolkits.axisartist.axis_artist.**GridlinesCollection**(**kl*, ***kwargs*)
which : "major" or "minor" *axis* : "both", "x" or "y"

draw(*renderer*)
Derived classes drawing method

set_axis(*axis*)

set_grid_helper(*grid_helper*)

set_which(*which*)

mpl_toolkits.axisartist.axis_artist.LabelBase

class mpl_toolkits.axisartist.axis_artist.**LabelBase**(**kl*, ***kwargs*)

A base class for AxisLabel and TickLabels. The position and angle of the text are calculated by to offset_ref_angle, text_ref_angle, and offset_radius attributes.

draw(*renderer*)

Draws the Text object to the given *renderer*.

get_window_extent(*renderer*)

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.

mpl_toolkits.axisartist.axis_artist.TickLabels

class mpl_toolkits.axisartist.axis_artist.**TickLabels**(***kwargs*)

Tick Labels. While derived from Text, this single artist draws all ticklabels. As in AxisLabel, the position of the text is updated in the fly, so changing text position has no effect. Otherwise, the properties can be changed as a normal Text. Unlike the ticklabels of the mainline matplotlib, properties of single ticklabel alone cannot modified.

To change the pad between ticks and ticklabels, use set_pad.

draw(*renderer*)

Draws the Text object to the given *renderer*.

get_ref_artist()

get_texts_widths_heights_descents(*renderer*)

return a list of width, height, descent for ticklabels.

get_window_extents(*renderer*)

invert_axis_direction()

set_axis_direction(*label_direction*)

Adjust the text angle and text alignment of ticklabels according to the matplotlib convention.

The *label_direction* must be one of [left, right, bottom, top].

property	left	bottom	right	top
ticklabels angle	90	0	-90	180
ticklabel va	center	baseline	center	baseline
ticklabel ha	right	center	right	center

Note that the text angles are actually relative to (90 + angle of the direction to the ticklabel), which gives 0 for bottom axis.

set_locs_angles_labels(*locs_angles_labels*)

mpl_toolkits.axisartist.axis_artist.Ticks

class mpl_toolkits.axisartist.axis_artist.**Ticks**(*ticksize*, *tick_out=False*, ***kwargs*)

Ticks are derived from Line2D, and note that ticks themselves are markers. Thus, you should use set_mec, set_mew, etc.

To change the tick size (length), you need to use set_ticksize. To change the direction of the ticks (ticks are in opposite direction of ticklabels by default), use set_tick_out(False).

draw(*renderer*)

draw the Line with `renderer` unless visibility is False

get_color()

get_markeredgecolor()

get_markeredgewidth()

get_ref_artist()

get_tick_out()

Return True if the tick will be rotated by 180 degree.

get_ticksize()

Return length of the ticks in points.

set_locs_angles(*locs_angles*)

set_tick_out(*b*)

set True if tick need to be rotated by 180 degree.

set_ticksize(*ticksize*)

set length of the ticks in points.

17.6 mpl_toolkits.axisartist.axisline_style

17.6.1 Classes

AxislineStyle	*AxislineStyle* is a container class which defines style classes for AxisArtists.

mpl_toolkits.axisartist.axisline_style.AxislineStyle

class mpl_toolkits.axisartist.axisline_style.**AxislineStyle**

AxislineStyle is a container class which defines style classes for AxisArtists.

An instance of any axisline style class is an callable object, whose call signature is

```
__call__(self, axis_artist, path, transform)
```

When called, this should return a mpl artist with following methods implemented.

```
def set_path(self, path):
    # set the path for axisline.

def set_line_mutation_scale(self, scale):
    # set the scale

def draw(self, renderer):
    # draw
```

return the instance of the subclass with the given style name.

class FilledArrow(*size=1*)

size size of the arrow as a fraction of the ticklabel size.

ArrowAxisClass
alias of _FancyAxislineStyle.FilledArrow

class SimpleArrow(*size=1*)
A simple arrow.

size size of the arrow as a fraction of the ticklabel size.

ArrowAxisClass
alias of _FancyAxislineStyle.SimpleArrow

new_line(*axis_artist*, *transform*)

17.7 mpl_toolkits.axisartist.axislines

Axislines includes modified implementation of the Axes class. The biggest difference is that the artists responsible for drawing the axis spine, ticks, ticklabels and axis labels are separated out from mpl's Axis class. Originally, this change was motivated to support curvilinear grid. Here are a few reasons that I came up with a new axes class:

- "top" and "bottom" x-axis (or "left" and "right" y-axis) can have different ticks (tick locations and labels). This is not possible with the current mpl, although some twin axes trick can help.
- Curvilinear grid.
- angled ticks.

In the new axes class, xaxis and yaxis is set to not visible by default, and new set of artist (AxisArtist) are defined to draw axis line, ticks, ticklabels and axis label. Axes.axis attribute serves as a dictionary of these artists, i.e., ax.axis["left"] is a AxisArtist instance responsible to draw left y-axis. The default Axes.axis contains "bottom", "left", "top" and "right".

AxisArtist can be considered as a container artist and has following children artists which will draw ticks, labels, etc.

- line
- major_ticks, major_ticklabels
- minor_ticks, minor_ticklabels
- offsetText
- label

Note that these are separate artists from Axis class of the original mpl, thus most of tick-related command in the original mpl won't work, although some effort has made to work with. For example, color and markerwidth of the ax.axis["bottom"].major_ticks will follow those of Axes.xaxis unless explicitly specified.

In addition to AxisArtist, the Axes will have *gridlines* attribute, which obviously draws grid lines. The gridlines needs to be separated from the axis as some gridlines can never pass any axis.

17.7.1 Classes

Axes(*kl, **kw)	
AxesZero(*kl, **kw)	
AxisArtistHelper	AxisArtistHelper should define following method with given APIs.
AxisArtistHelperRectlinear	
GridHelperBase()	
GridHelperRectlinear(axes)	
SimpleChainedObjects(objects)	

mpl_toolkits.axisartist.axislines.Axes

class mpl_toolkits.axisartist.axislines.**Axes**(**kl*, ***kw*)

class AxisDict() -> *new empty dictionary dict(mapping) -> new dictionary initialized from a mapping object's (key, value) pairs dict(iterable) -> new dictionary initialized as if via: d = {} for k, v in iterable: d[k] = v dict(**kwargs) -> new dictionary initialized with the name=value pairs in the keyword argument list. For example: dict(one=1, two=2)*

axis

Set axis properties.

Valid signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis(list_arg)
xmin, xmax, ymin, ymax = axis(string_arg)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

Parameters

v [list of float or {'on', 'off', 'equal', 'tight', 'scaled', 'normal', 'auto', 'image', 'square'}] Optional positional argument

Axis data limits set from a list; or a command relating to axes:

Value	Description
'on'	Toggle axis lines and labels on
'off'	Toggle axis lines and labels off
'equal'	Equal scaling by changing limits
'scaled'	Equal scaling by changing box dimensions
'tight'	Limits set such that all data is shown
'auto'	Automatic scaling, fill rectangle with data
'normal'	Same as 'auto'; deprecated
'image'	'scaled' with axis limits equal to data limits
'square'	Square plot; similar to 'scaled', but initially forcing xmax-xmin = ymax-ymin

emit [bool, optional] Passed to set_{x,y}lim functions, if observers are notified of axis limit change

xmin, ymin, xmax, ymax [float, optional] The axis limits to be set

Returns

xmin, xmax, ymin, ymax [float] The axis limits

cla()
Clear the current axes.

draw(*renderer*, *inframe=False*)
Draw everything (plot lines, axes, labels)

get_children()
return a list of child artists

get_grid_helper()

get_tightbbox(*renderer*, *call_axes_locator=True*)
Return the tight bounding box of the axes. The dimension of the Bbox in canvas coordinate.

If *call_axes_locator* is *False*, it does not call the _axes_locator attribute, which is necessary to get the correct bounding box. `call_axes_locator==False` can be used if the caller is only intereted in the relative size of the tightbbox compared to the axes bbox.

grid(*b=None*, *which='major'*, *axis='both'*, ***kwargs*)
Toggle the gridlines, and optionally set the properties of the lines.

invalidate_grid_helper()

new_fixed_axis(*loc*, *offset=None*)

new_floating_axis(*nth_coord*, *value*, *axis_direction='bottom'*)

new_gridlines(*grid_helper=None*)
Create and return a new GridlineCollection instance.

which : "major" or "minor" *axis* : "both", "x" or "y"

toggle_axisline(*b=None*)

mpl_toolkits.axisartist.axislines.AxesZero

class mpl_toolkits.axisartist.axislines.**AxesZero**(**kl*, ***kw*)

mpl_toolkits.axisartist.axislines.AxisArtistHelper

class mpl_toolkits.axisartist.axislines.**AxisArtistHelper**
AxisArtistHelper should define following method with given APIs. Note that the first axes argument will be axes attribute of the caller artist.:

```
# LINE (spinal line?)

def get_line(self, axes):
    # path : Path
    return path

def get_line_transform(self, axes):
    # ...
    # trans : transform
    return trans

# LABEL

def get_label_pos(self, axes):
    # x, y : position
    return (x, y), trans

def get_label_offset_transform(self,                axes,
        pad_points, fontprops, renderer,
        bboxes,
        ):
    # va : vertical alignment
    # ha : horizontal alignment
    # a : angle
    return trans, va, ha, a

# TICK

def get_tick_transform(self, axes):
    return trans

def get_tick_iterators(self, axes):
    # iter : iterable object that yields (c, angle, l) where
    # c, angle, l is position, tick angle, and label

    return iter_major, iter_minor
```

class Fixed(*loc*, *nth_coord=None*)

Helper class for a fixed (in the axes coordinate) axis.

nth_coord = along which coordinate value varies in 2d, nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

get_axislabel_pos_angle(*axes*)

label reference position in transAxes.

get_label_transform() returns a transform of (transAxes+offset)

get_axislabel_transform(*axes*)

get_line(*axes*)

get_line_transform(*axes*)

get_nth_coord()

get_tick_transform(*axes*)

class Floating(*nth_coord*, *value*)

get_line(*axes*)

get_nth_coord()

mpl_toolkits.axisartist.axislines.AxisArtistHelperRectlinear

class mpl_toolkits.axisartist.axislines.**AxisArtistHelperRectlinear**

class Fixed(*axes*, *loc*, *nth_coord=None*)

nth_coord = along which coordinate value varies in 2d, nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

get_tick_iterators(*axes*)

tick_loc, tick_angle, tick_label

class Floating(*axes*, *nth_coord*, *passingthrough_point*, *axis_direction='bottom'*)

get_axislabel_pos_angle(*axes*)

label reference position in transAxes.

get_label_transform() returns a transform of (transAxes+offset)

get_axislabel_transform(*axes*)

get_line(*axes*)

get_line_transform(*axes*)

get_tick_iterators(*axes*)

tick_loc, tick_angle, tick_label

get_tick_transform(*axes*)

mpl_toolkits.axisartist.axislines.GridHelperBase

class mpl_toolkits.axisartist.axislines.**GridHelperBase**

get_gridlines(*which*, *axis*)
Return list of grid lines as a list of paths (list of points).

which : "major" or "minor" *axis* : "both", "x" or "y"

invalidate()

new_gridlines(*ax*)
Create and return a new GridlineCollection instance.

which : "major" or "minor" *axis* : "both", "x" or "y"

update_lim(*axes*)

valid()

mpl_toolkits.axisartist.axislines.GridHelperRectlinear

class mpl_toolkits.axisartist.axislines.**GridHelperRectlinear**(*axes*)

get_gridlines(*which='major'*, *axis='both'*)
return list of gridline coordinates in data coordinates.

which : "major" or "minor" *axis* : "both", "x" or "y"

new_fixed_axis(*loc*, *nth_coord=None*, *axis_direction=None*, *offset=None*, *axes=None*)

new_floating_axis(*nth_coord*, *value*, *axis_direction='bottom'*, *axes=None*)

mpl_toolkits.axisartist.axislines.SimpleChainedObjects

class mpl_toolkits.axisartist.axislines.**SimpleChainedObjects**(*objects*)

17.8 mpl_toolkits.axisartist.clip_path

17.8.1 Functions

atan2(dy, dx)	
clip(xlines, ylines, x0[, clip, xdir, ydir])	
clip_line_to_rect(xline, yline, bbox)	

mpl_toolkits.axisartist.clip_path.atan2

mpl_toolkits.axisartist.clip_path.**atan2**(*dy*, *dx*)

mpl_toolkits.axisartist.clip_path.clip

mpl_toolkits.axisartist.clip_path.**clip**(*xlines*, *ylines*, *x0*, *clip='right'*, *xdir=True*, *ydir=True*)

mpl_toolkits.axisartist.clip_path.clip_line_to_rect

mpl_toolkits.axisartist.clip_path.**clip_line_to_rect**(*xline*, *yline*, *bbox*)

17.9 mpl_toolkits.axisartist.floating_axes

An experimental support for curvilinear grid.

17.9.1 Classes

ExtremeFinderFixed(extremes)	
FixedAxisArtistHelper(grid_helper, side[, ...])	nth_coord = along which coordinate value varies.
FloatingAxes	alias of mpl_toolkits.axisartist.floating_axes.Floating AxesHostAxes
FloatingAxesBase(*kl, **kwargs)	
FloatingAxisArtistHelper(grid_helper, ...[, ...])	nth_coord = along which coordinate value varies.
GridHelperCurveLinear(aux_trans, extremes[, ...])	aux_trans : a transform from the source (curved) coordinate to target (rectilinear) coordinate.

mpl_toolkits.axisartist.floating_axes.ExtremeFinderFixed

class mpl_toolkits.axisartist.floating_axes.**ExtremeFinderFixed**(*extremes*)

mpl_toolkits.axisartist.floating_axes.FixedAxisArtistHelper

class mpl_toolkits.axisartist.floating_axes.**FixedAxisArtistHelper**(*grid_helper*, *side*, *nth_coord_ticks=None*)

nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

get_axislabel_pos_angle(*axes*)

get_line(*axes*)

get_line_transform(*axes*)

get_tick_iterators(*axes*)
tick_loc, tick_angle, tick_label, (optionally) tick_label

get_tick_transform(*axes*)

update_lim(*axes*)

mpl_toolkits.axisartist.floating_axes.FloatingAxes

mpl_toolkits.axisartist.floating_axes.**FloatingAxes**
alias of mpl_toolkits.axisartist.floating_axes.Floating AxesHostAxes

mpl_toolkits.axisartist.floating_axes.FloatingAxesBase

class mpl_toolkits.axisartist.floating_axes.**FloatingAxesBase**(**kl*, ***kwargs*)

adjust_axes_lim()

cla()

mpl_toolkits.axisartist.floating_axes.FloatingAxisArtistHelper

class mpl_toolkits.axisartist.floating_axes.**FloatingAxisArtistHelper**(*grid_helper*, *nth_coord*, *value*, *axis_direction=None*)

nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

mpl_toolkits.axisartist.floating_axes.GridHelperCurveLinear

class mpl_toolkits.axisartist.floating_axes.**GridHelperCurveLinear**(*aux_trans*, *extremes*, *grid_locator1=None*, *grid_locator2=None*, *tick_formatter1=None*, *tick_formatter2=None*)

aux_trans : a transform from the source (curved) coordinate to target (rectilinear) coordinate. An instance of MPL's Transform (inverse transform should be defined) or a tuple of two callable objects which defines the transform and its inverse. The callables need take two arguments of array of source coordinates and should return two target coordinates: e.g., *x2, y2 = trans(x1, y1)*

get_boundary()
return Nx2 array of x,y coordinate of the boundary

get_data_boundary(*side*)
return v= 0 , nth=1

get_gridlines(*which='major'*, *axis='both'*)
Return list of grid lines as a list of paths (list of points).

which : "major" or "minor" *axis* : "both", "x" or "y"

new_fixed_axis(*loc*, *nth_coord=None*, *axis_direction=None*, *offset=None*, *axes=None*)

Examples using mpl_toolkits.axisartist.floating_axes.GridHelperCurveLinear

- sphx_glr_gallery_axisartist_demo_floating_axes.py

17.9.2 Functions

floatingaxes_class_factory(axes_class)

mpl_toolkits.axisartist.floating_axes.floatingaxes_class_factory

mpl_toolkits.axisartist.floating_axes.**floatingaxes_class_factory**(*axes_class*)

17.10 mpl_toolkits.axisartist.grid_finder

17.10.1 Classes

DictFormatter(format_dict[, formatter])	format_dict : dictionary for format strings to be used.
ExtremeFinderSimple(nx, ny)	
FixedLocator(locs)	
FormatterPrettyPrint([useMathText])	
GridFinder(transform[, extreme_finder, ...])	transform : transform from the image coordinate (which will be the transData of the axes to the world coordinate.
GridFinderBase(extreme_finder, ...[, ...])	the transData of the axes to the world coordinate.
MaxNLocator([nbins, steps, trim, integer, ...])	

mpl_toolkits.axisartist.grid_finder.DictFormatter

class mpl_toolkits.axisartist.grid_finder.**DictFormatter**(*format_dict*, *formatter=None*)

format_dict : dictionary for format strings to be used. formatter : fall-back formatter

Examples using mpl_toolkits.axisartist.grid_finder.DictFormatter

- sphx_glr_gallery_axisartist_demo_floating_axes.py

mpl_toolkits.axisartist.grid_finder.ExtremeFinderSimple

class mpl_toolkits.axisartist.grid_finder.**ExtremeFinderSimple**(*nx*, *ny*)

mpl_toolkits.axisartist.grid_finder.FixedLocator

class mpl_toolkits.axisartist.grid_finder.**FixedLocator**(*locs*)

set_factor(*f*)

Examples using mpl_toolkits.axisartist.grid_finder.FixedLocator

- sphx_glr_gallery_axisartist_demo_floating_axes.py

mpl_toolkits.axisartist.grid_finder.FormatterPrettyPrint

class mpl_toolkits.axisartist.grid_finder.**FormatterPrettyPrint**(*useMathText=True*)

mpl_toolkits.axisartist.grid_finder.GridFinder

class mpl_toolkits.axisartist.grid_finder.**GridFinder**(*transform*, *extreme_finder=None*, *grid_locator1=None*, *grid_locator2=None*, *tick_formatter1=None*, *tick_formatter2=None*)

transform : transform from the image coordinate (which will be the transData of the axes to the world coordinate.

or transform = (transform_xy, inv_transform_xy)

locator1, locator2 : grid locator for 1st and 2nd axis.

mpl_toolkits.axisartist.grid_finder.GridFinderBase

class mpl_toolkits.axisartist.grid_finder.**GridFinderBase**(*extreme_finder*, *grid_locator1*, *grid_locator2*, *tick_formatter1=None*, *tick_formatter2=None*)

the transData of the axes to the world coordinate. locator1, locator2 : grid locator for 1st and 2nd axis.

Derived must define "transform_xy, inv_transform_xy" (may use update_transform)

get_grid_info(*x1*, *y1*, *x2*, *y2*)

lon_values, lat_values [list of grid values. if integer is given,] rough number of grids in each direction.

update(***kw*)

update_transform(*aux_trans*)

mpl_toolkits.axisartist.grid_finder.MaxNLocator

class mpl_toolkits.axisartist.grid_finder.**MaxNLocator**(*nbins=10*, *steps=None*, *trim=True*, *integer=False*, *symmetric=False*, *prune=None*)

set_factor(*f*)

Examples using mpl_toolkits.axisartist.grid_finder.MaxNLocator

- sphx_glr_gallery_axisartist_demo_axis_direction.py
- sphx_glr_gallery_axisartist_simple_axis_pad.py
- sphx_glr_gallery_axisartist_demo_floating_axes.py

17.11 mpl_toolkits.axisartist.grid_helper_curvelinear

An experimental support for curvilinear grid.

17.11.1 Classes

FixedAxisArtistHelper(grid_helper, side[, ...])	Helper class for a fixed axis.
FloatingAxisArtistHelper(grid_helper, ...[, ...])	nth_coord = along which coordinate value varies.
GridHelperCurveLinear(aux_trans[, ...])	aux_trans : a transform from the source (curved) coordinate to target (rectilinear) coordinate.

mpl_toolkits.axisartist.grid_helper_curvelinear.FixedAxisArtistHelper

class mpl_toolkits.axisartist.grid_helper_curvelinear.**FixedAxisArtistHelper**(*grid_helper*, *side*, *nth_coord_ticks=None*)

Helper class for a fixed axis.

nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

change_tick_coord(*coord_number=None*)

get_tick_iterators(*axes*)
tick_loc, tick_angle, tick_label

get_tick_transform(*axes*)

update_lim(*axes*)

mpl_toolkits.axisartist.grid_helper_curvelinear.FloatingAxisArtistHelper

class mpl_toolkits.axisartist.grid_helper_curvelinear.**FloatingAxisArtistHelper**(*grid_helper*, *nth_coord*, *value*, *axis_direction=Non*

nth_coord = along which coordinate value varies. nth_coord = 0 -> x axis, nth_coord = 1 -> y axis

get_axislabel_pos_angle(*axes*)

get_axislabel_transform(*axes*)

get_line(*axes*)

get_line_transform(*axes*)

get_tick_iterators(*axes*)
tick_loc, tick_angle, tick_label, (optionally) tick_label

get_tick_transform(*axes*)

set_extremes(*e1*, *e2*)

update_lim(*axes*)

mpl_toolkits.axisartist.grid_helper_curvelinear.GridHelperCurveLinear

class mpl_toolkits.axisartist.grid_helper_curvelinear.**GridHelperCurveLinear**(*aux_trans*, *extreme_finder=None*, *grid_locator1=None*, *grid_locator2=None*, *tick_formatter1=None*, *tick_formatter2=None*)

aux_trans : a transform from the source (curved) coordinate to target (rectilinear) coordinate. An instance of MPL's Transform (inverse transform should be defined) or a tuple of two callable objects

which defines the transform and its inverse. The callables need take two arguments of array of source coordinates and should return two target coordinates.

e.g., `x2, y2 = trans(x1, y1)`

get_gridlines(*which='major'*, *axis='both'*)
Return list of grid lines as a list of paths (list of points).

which : "major" or "minor" *axis* : "both", "x" or "y"

get_tick_iterator(*nth_coord*, *axis_side*, *minor=False*)

new_fixed_axis(*loc*, *nth_coord=None*, *axis_direction=None*, *offset=None*, *axes=None*)

new_floating_axis(*nth_coord*, *value*, *axes=None*, *axis_direction='bottom'*)

update_grid_finder(*aux_trans=None*, ***kw*)

17.12 mpl_toolkits.axisartist.parasite_axes

CHAPTER

EIGHTEEN

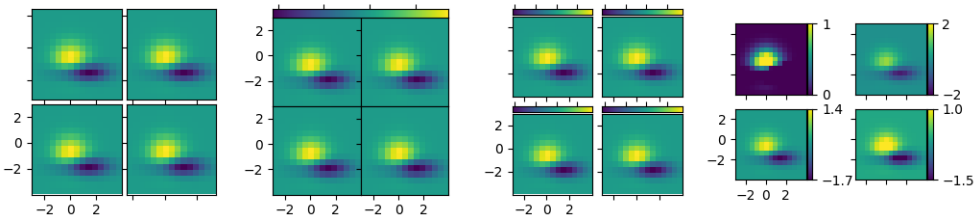
MATPLOTLIB AXES_GRID TOOLKIT

Note: AxesGrid toolkit has been a part of matplotlib since v 0.99. Originally, the toolkit had a single namespace of *axes_grid*. In more recent version, the toolkit has divided into two separate namespace (*axes_grid1* and *axisartist*). While *axes_grid* namespace is maintained for the backward compatibility, use of *axes_grid1* and *axisartist* is recommended. For the documentation on `axes_grid`, see the previous version of the docs.

18.1 Matplotlib axes_grid1 Toolkit

The matplotlib `mpl_toolkits.axes_grid1` toolkit is a collection of helper classes to ease displaying multiple images in matplotlib. While the aspect parameter in matplotlib adjust the position of the single axes, axes_grid1 toolkit provides a framework to adjust the position of multiple axes according to their aspects.

See *What is axes_grid1 toolkit?* for a guide on the usage of axes_grid1.



The submodules of the axes_grid1 API are:

axes_grid1.anchored_artists	
axes_grid1.axes_divider	The axes_divider module provides helper classes to adjust the positions of multiple axes at drawing time.
axes_grid1.axes_grid	
axes_grid1.axes_rgb	

Continued on next page

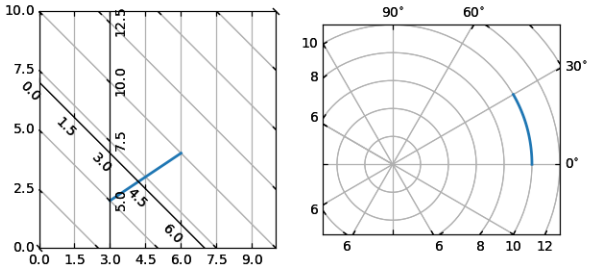
Table 1 – continued from previous page

axes_grid1.axes_size	provides a classes of simple units that will be used with AxesDivider class (or others) to determine the size of each axes.
axes_grid1.colorbar	Colorbar toolkit with two classes and a function:
axes_grid1.inset_locator	A collection of functions and objects for creating or placing inset axes.
axes_grid1.mpl_axes	
axes_grid1.parasite_axes	

18.2 Matplotlib axisartist Toolkit

The *axisartist* namespace includes a derived Axes implementation (`mpl_toolkits.axisartist.Axes`). The biggest difference is that the artists that are responsible for drawing axis lines, ticks, ticklabels, and axis labels are separated out from the mpl's Axis class. This change was strongly motivated to support curvilinear grid.

You can find a tutorial describing usage of axisartist at the *axisartist* user guide.



The submodules of the axisartist API are:

axisartist.angle_helper	
axisartist.axes_divider	
axisartist.axes_grid	
axisartist.axes_rgb	
axisartist.axis_artist	axis_artist.py module provides axis-related artists.
axisartist.axisline_style	
axisartist.axislines	Axislines includes modified implementation of the Axes class.
axisartist.clip_path	
axisartist.floating_axes	An experimental support for curvilinear grid.
axisartist.grid_finder	
axisartist.grid_helper_curvelinear	An experimental support for curvilinear grid.
axisartist.parasite_axes	

Part IV

External Resources

CHAPTER

NINETEEN

BOOKS, CHAPTERS AND ARTICLES

- Mastering matplotlib by Duncan M. McGreggor
- Interactive Applications Using Matplotlib by Benjamin Root
- Matplotlib for Python Developers by Sandro Tosi
- Matplotlib chapter by John Hunter and Michael Droettboom in The Architecture of Open Source Applications
- Graphics with Matplotlib by David J. Raymond
- Ten Simple Rules for Better Figures by Nicolas P. Rougier, Michael Droettboom and Philip E. Bourne
- Learning Scientific Programming with Python chapter 7 by Christian Hill

CHAPTER

TWENTY

VIDEOS

- Plotting with matplotlib by Mike Müller
- Introduction to NumPy and Matplotlib by Eric Jones
- Anatomy of Matplotlib by Benjamin Root
- Data Visualization Basics with Python (O'Reilly) by Randal S. Olson

CHAPTER

TWENTYONE

TUTORIALS

- Matplotlib tutorial by Nicolas P. Rougier
- Anatomy of Matplotlib - IPython Notebooks by Benjamin Root

Part V

Third party packages

Several external packages that extend or build on Matplotlib functionality are listed below. They are maintained and distributed separately from Matplotlib and thus need to be installed individually.

Please submit an issue or pull request on Github if you have created a package that you would like to have included. We are also happy to host third party packages within the Matplotlib Github Organization.

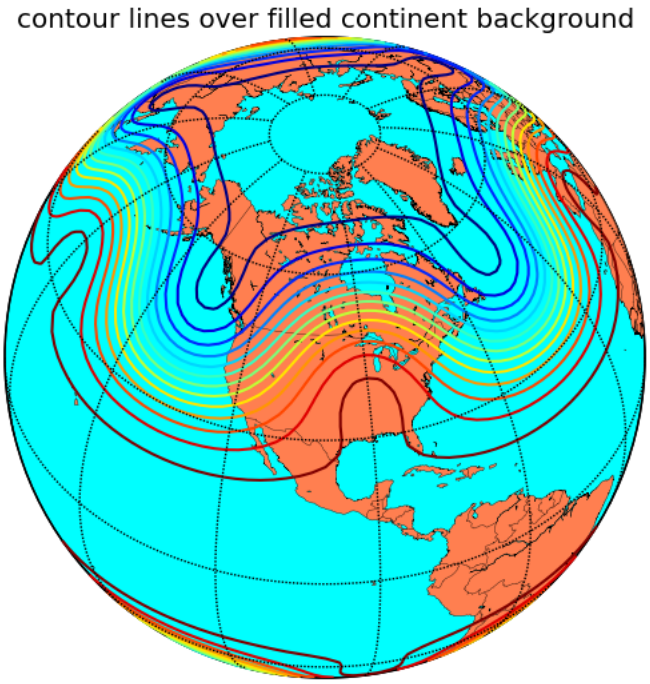
CHAPTER

TWENTYTWO

MAPPING TOOLKITS

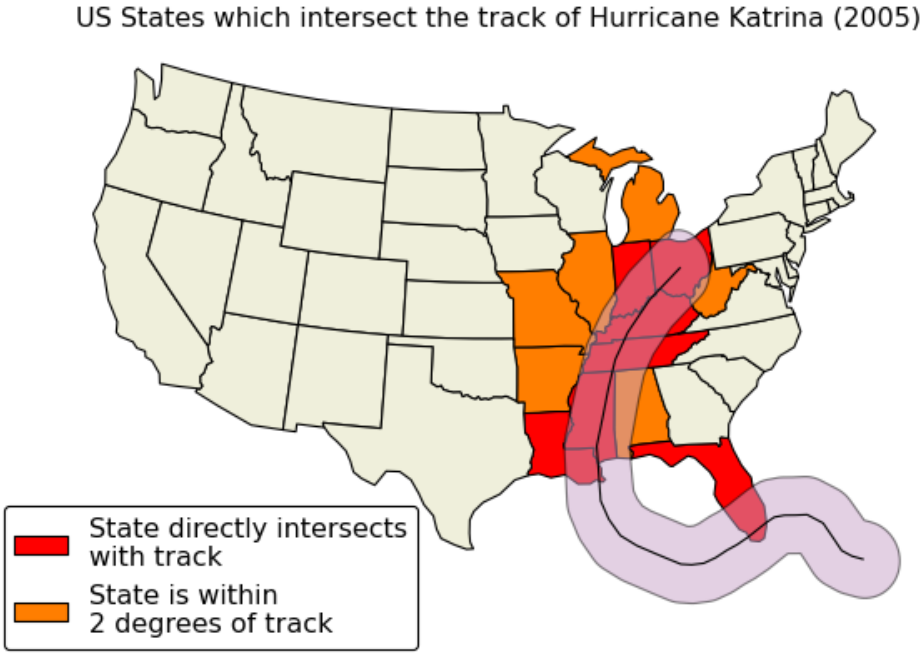
22.1 Basemap

Basemap plots data on map projections, with continental and political boundaries.



22.2 Cartopy

Cartopy builds on top of Matplotlib to provide object oriented map projection definitions and close integration with Shapely for powerful yet easy-to-use vector data processing tools. An example plot from the Cartopy gallery:


US States which intersect the track of Hurricane Katrina (2005)
State directly intersects with track
State is within 2 degrees of track

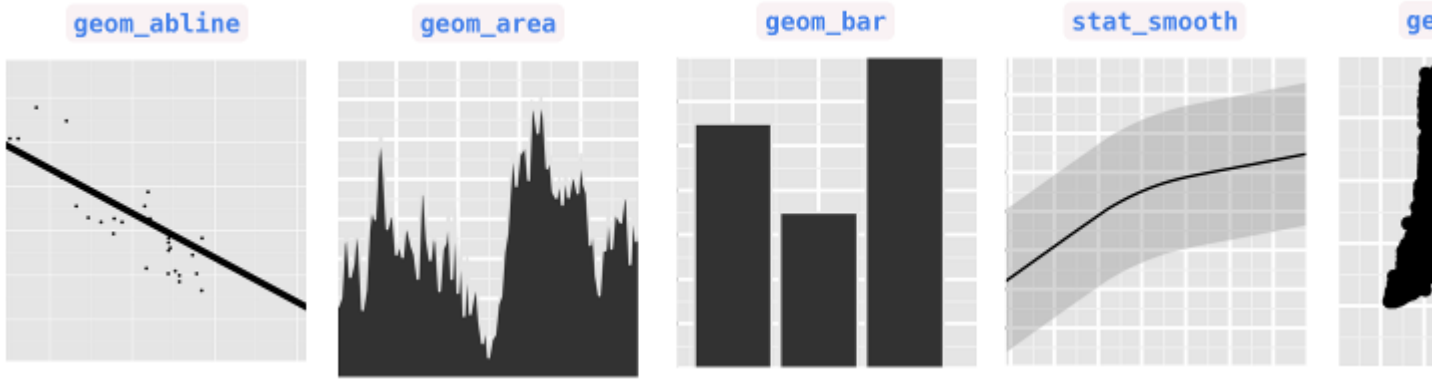
CHAPTER

TWENTYTHREE

DECLARATIVE LIBRARIES

23.1 ggplot

ggplot is a port of the R ggplot2 package to python based on Matplotlib.

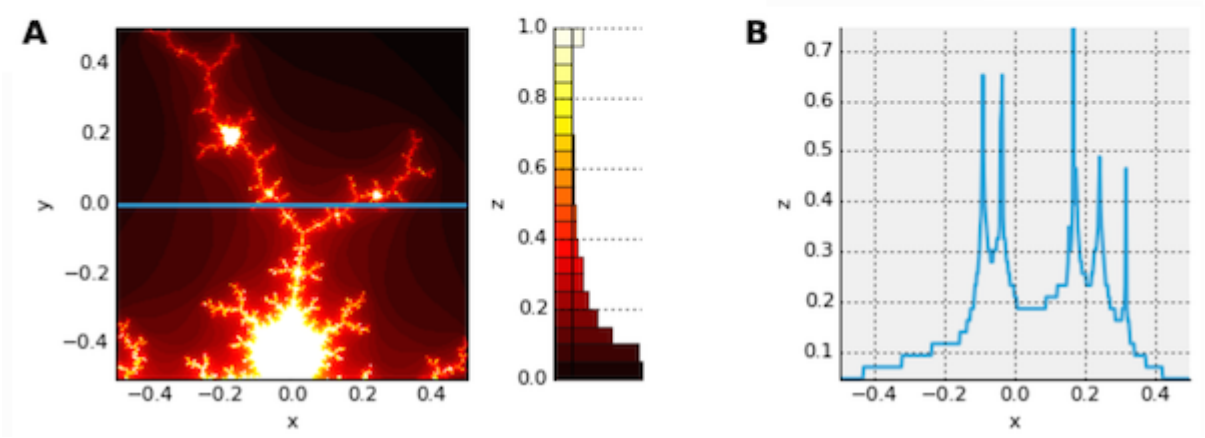


23.2 holoviews

holoviews makes it easier to visualize data interactively, especially in a Jupyter notebook, by providing a set of declarative plotting objects that store your data and associated metadata. Your data is then immediately visualizable alongside or overlaid with other data, either statically or with automatically provided widgets for parameter exploration.

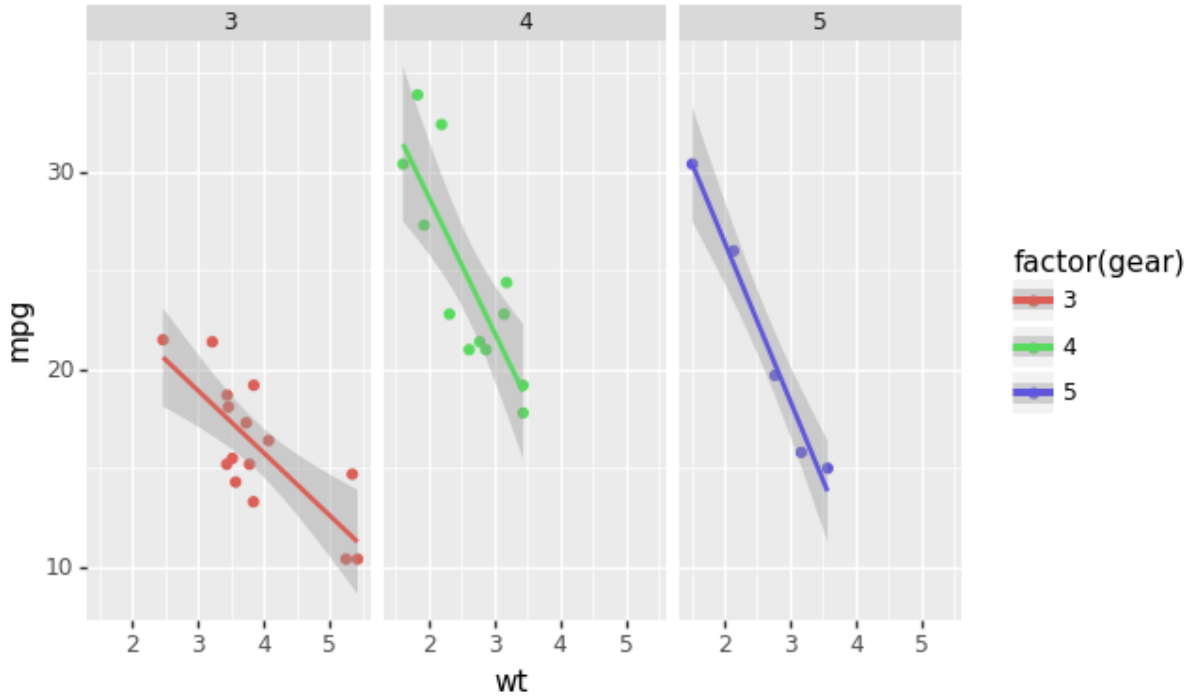
```
import numpy as np
import holoviews as hv
hv.notebook_extension('matplotlib')
fractal = hv.Image(np.load('mandelbrot.npy'))

((fractal * hv.HLine(y=0)).hist() + fractal.sample(y=0))
```



23.3 plotnine

plotnine implements a grammar of graphics, similar to R's ggplot2. The grammar allows users to compose plots by explicitly mapping data to the visual objects that make up the plot.



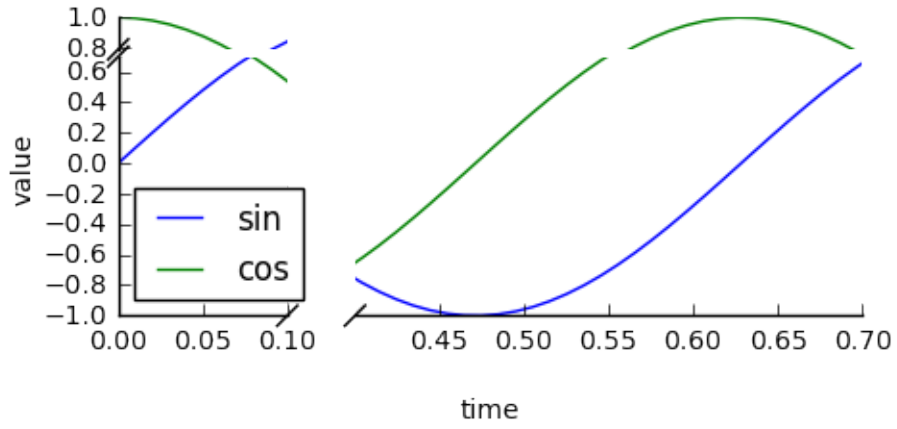
CHAPTER

TWENTYFOUR

SPECIALTY PLOTS

24.1 Broken Axes

brokenaxes supplies an axes class that can have a visual break to indicate a discontinuous range.



24.2 DeCiDa

DeCiDa is a library of functions and classes for electron device characterization, electronic circuit design and general data visualization and analysis.

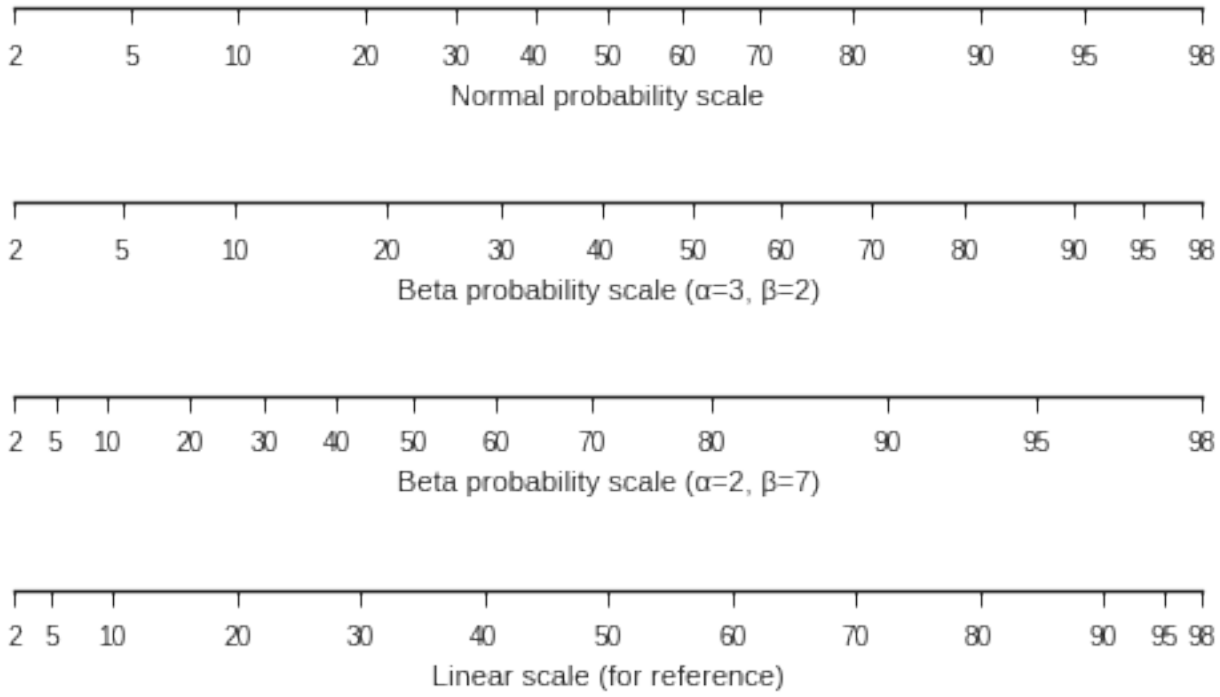
24.3 Matplotlib-Venn

Matplotlib-Venn provides a set of functions for plotting 2- and 3-set area-weighted (or unweighted) Venn diagrams.

24.4 mpl-probscale

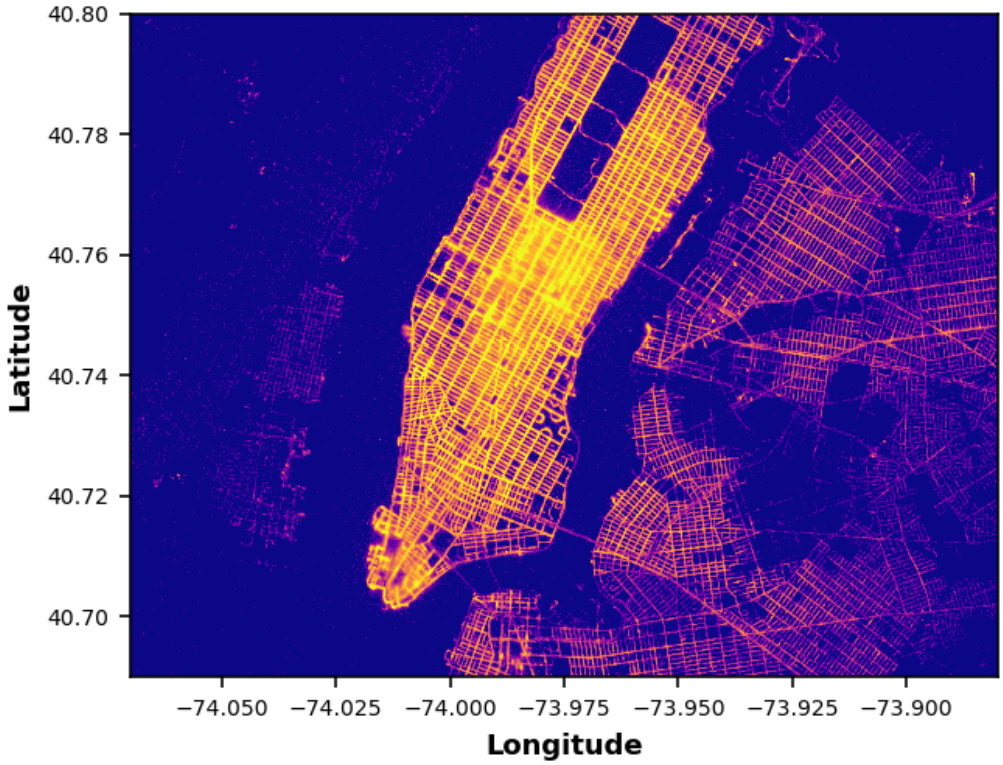
mpl-probscale is a small extension that allows Matplotlib users to specify probabilty scales. Simply importing the `probscale` module registers the scale with Matplotlib, making it accessible via e.g., `ax.`

`set_xscale('prob')` or `plt.yscale('prob')`.



24.5 mpl-scatter-density

mpl-scatter-density is a small package that makes it easy to make scatter plots of large numbers of points using a density map. The following example contains around 13 million points and the plotting (excluding reading in the data) took less than a second on an average laptop:



When used in interactive mode, the density map is downsampled on-the-fly while panning/zooming in order to provide a smooth interactive experience.

24.6 mplstereonet

mplstereonet provides stereonets for plotting and analyzing orientation data in Matplotlib.

24.7 Natgrid

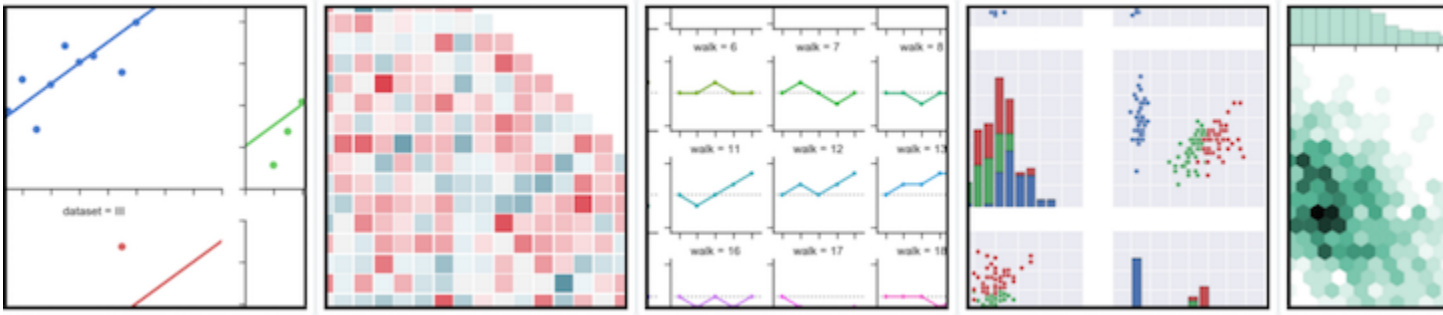
mpl_toolkits.natgrid is an interface to the natgrid C library for gridding irregularly spaced data.

24.8 pyUpSet

pyUpSet is a static Python implementation of the UpSet suite by Lex et al. to explore complex intersections of sets and data frames.

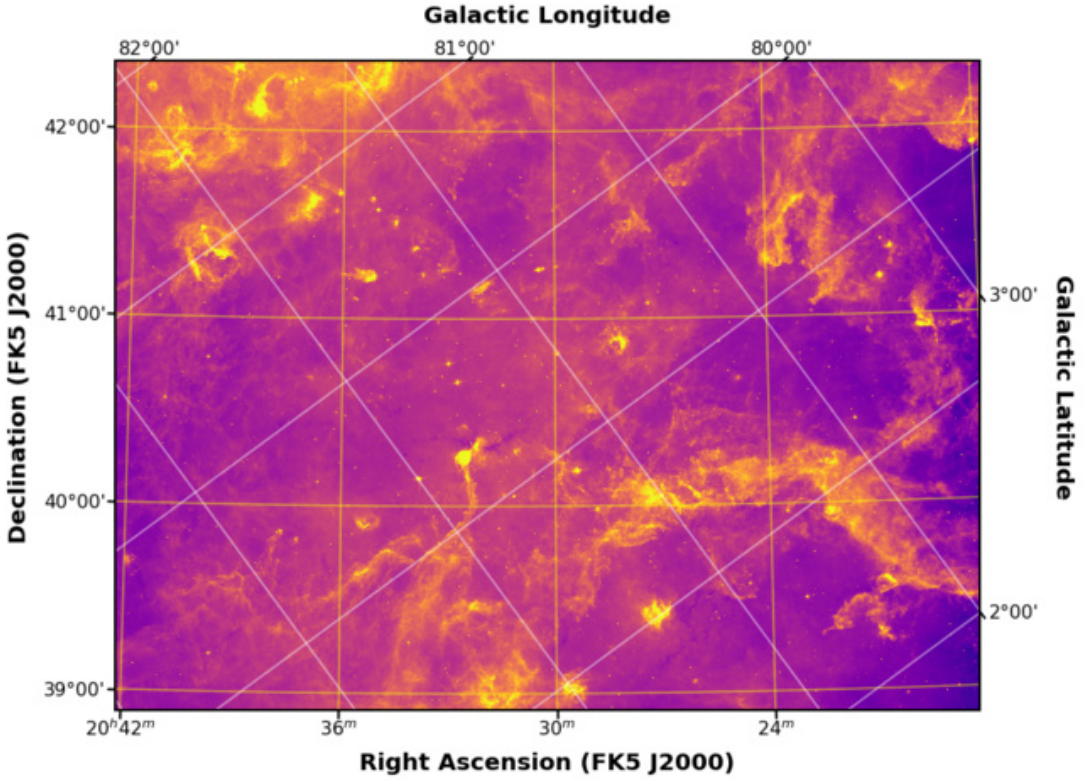
24.9 seaborn

seaborn is a high level interface for drawing statistical graphics with Matplotlib. It aims to make visualization a central part of exploring and understanding complex datasets.



24.10 WCSAxes

The Astropy core package includes a submodule called WCSAxes (available at astropy.visualization.wcsaxes) which adds Matplotlib projections for Astronomical image data. The following is an example of a plot made with WCSAxes which includes the original coordinate system of the image and an overlay of a different coordinate system:



24.11 Windrose

Windrose is a Python Matplotlib, Numpy library to manage wind data, draw windroses (also known as polar rose plots), draw probability density functions and fit Weibull distributions.

CHAPTER

TWENTYFIVE

INTERACTIVITY

25.1 mplcursors

mplcursors provides interactive data cursors for Matplotlib.

25.2 MplDataCursor

MplDataCursor is a toolkit written by Joe Kington to provide interactive "data cursors" (clickable annotation boxes) for Matplotlib.

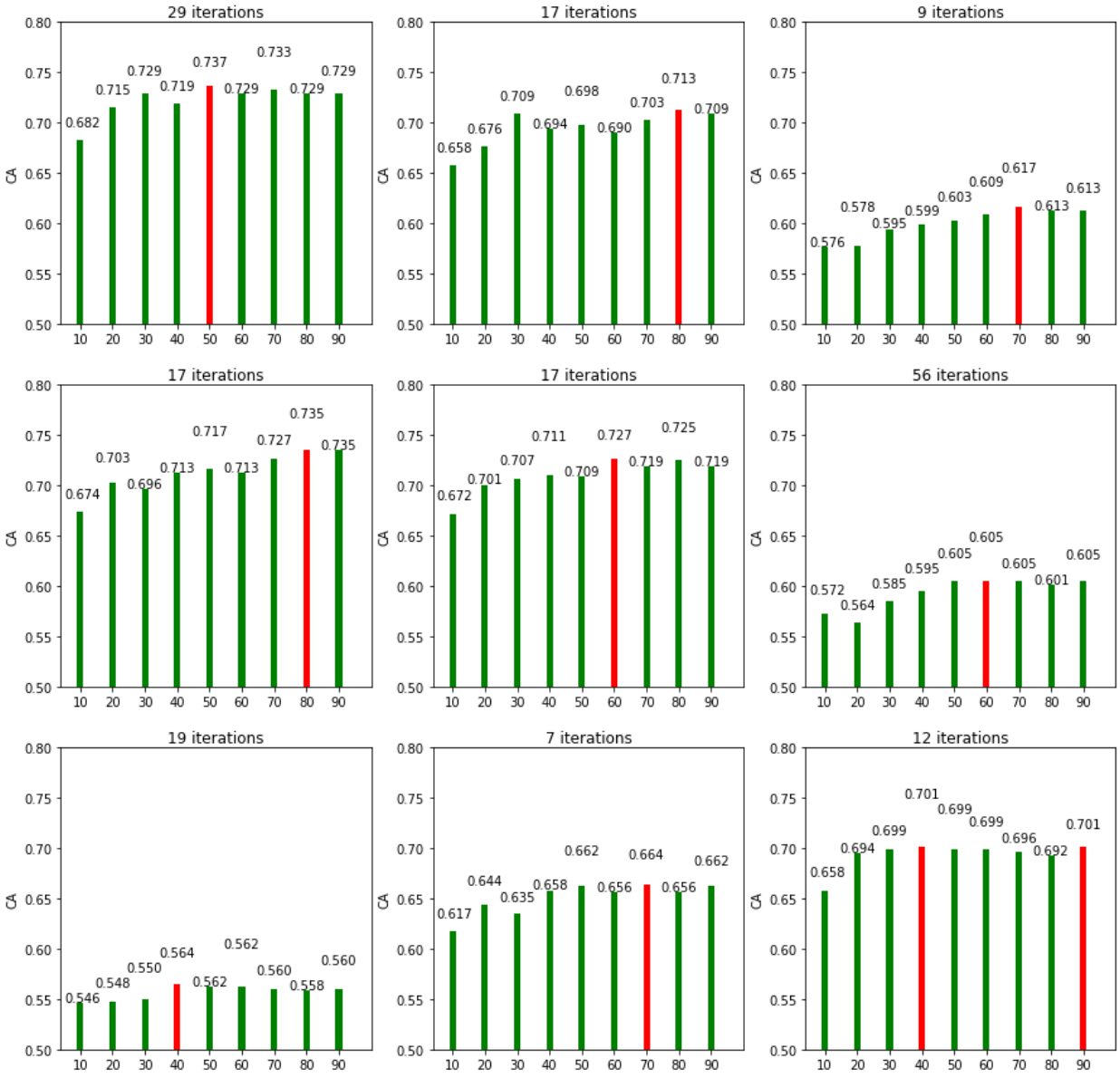
CHAPTER

TWENTYSIX

MISCELLANEOUS

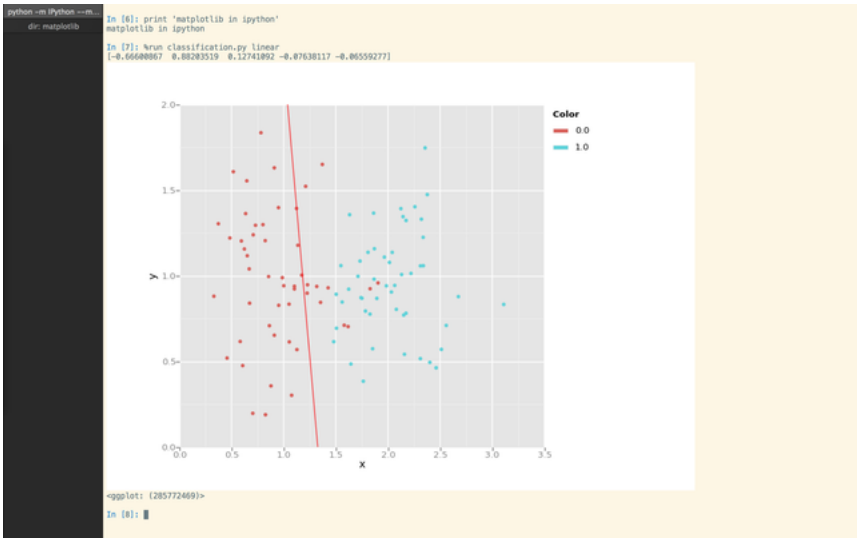
26.1 adjustText

adjustText is a small library for automatically adjusting text position in Matplotlib plots to minimize overlaps between them, specified points and other objects.



26.2 iTerm2 terminal backend

matplotlib_iterm2 is an external Matplotlib backend using the iTerm2 nightly build inline image display feature.

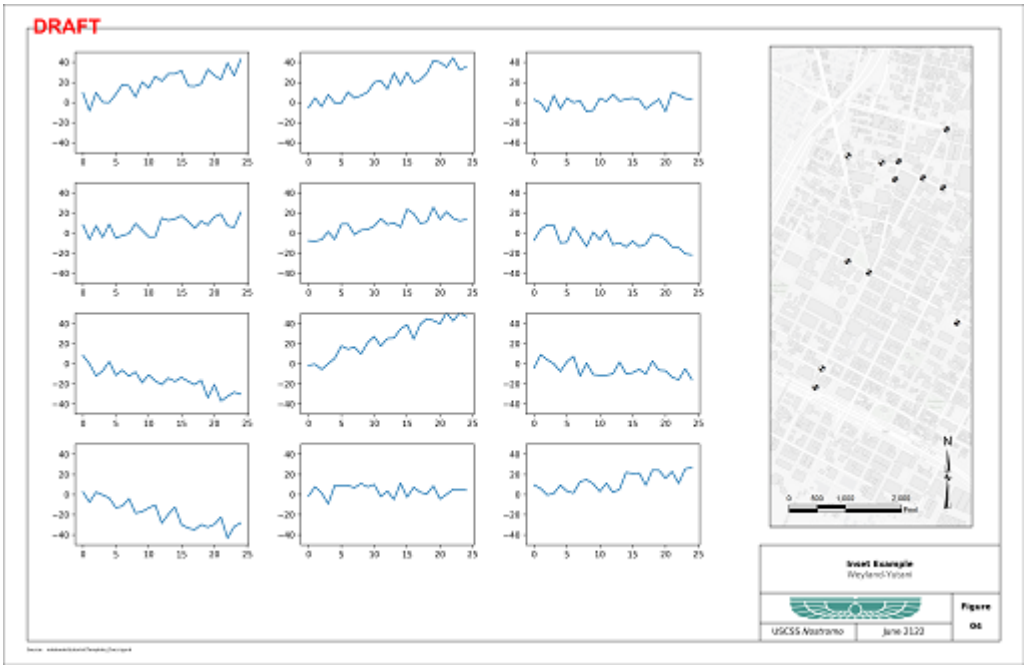


26.3 mplcairo

mplcairo is a cairo backend for Matplotlib, with faster and more accurate marker drawing, support for a wider selection of font formats and complex text layout, and various other features.

26.4 mpl-template

mpl-template provides a customizable way to add engineering figure elements such as a title block, border, and logo.



Part VI

The Matplotlib API

Below we describe several common approaches to plotting with Matplotlib.

Contents

- *The Pyplot API*
- *The Object-Oriented API*
- *Colors in Matplotlib*

CHAPTER

TWENTYSEVEN

THE PYPLOT API

The *matplotlib.pyplot* module contains functions that allow you to generate many kinds of plots quickly. For examples that showcase the use of the *matplotlib.pyplot* module, see the *Pyplot tutorial* or the pyplots_examples. We also recommend that you look into the object-oriented approach to plotting, described below.

matplotlib.pyplot.**plotting**()

Function	Description
acorr	Plot the autocorrelation of *x*.
angle_spectrum	Plot the angle spectrum.
annotate	Annotate the point `xy` with text `s`.
arrow	Add an arrow to the axes.
autoscale	Autoscale the axis view to the data (toggle).
axes	Add an axes to the current figure and make it the current axes.
axhline	Add a horizontal line across the axis.
axhspan	Add a horizontal span (rectangle) across the axis.
axis	Convenience method to get or set axis properties.
axvline	Add a vertical line across the axes.
axvspan	Add a vertical span (rectangle) across the axes.
bar	Make a bar plot.
barbs	Plot a 2-D field of barbs.
barh	Make a horizontal bar plot.
box	Turn the axes box on or off on the current axes.
boxplot	Make a box and whisker plot.
broken_barh	Plot a horizontal sequence of rectangles.
cla	Clear the current axes.
clabel	Label a contour plot.
clf	Clear the current figure.
clim	Set the color limits of the current image.
close	Close a figure window.
cohere	Plot the coherence between *x* and *y*.
colorbar	Add a colorbar to a plot.
contour	Plot contours.

Table 1 – continued from previous pag

Function	Description
contourf	Plot contours.
csd	Plot the cross-spectral density.
delaxes	Remove the given `Axes` *ax* from the current figure.
draw	Redraw the current figure.
errorbar	Plot y versus x as lines and/or markers with attached errorbars.
eventplot	Plot identical parallel lines at the given positions.
figimage	Add a non-resampled image to the figure.
figlegend	Place a legend in the figure.
fignum_exists	
figtext	Add text to figure.
figure	Creates a new figure.
fill	Plot filled polygons.
fill_between	Fill the area between two horizontal curves.
fill_betweenx	Fill the area between two vertical curves.
findobj	Find artist objects.
gca	Get the current *Axes* instance on the current figure matching the given keyword args,
gcf	Get a reference to the current figure.
gci	Get the current colorable artist.
get_figlabels	Return a list of existing figure labels.
get_fignums	Return a list of existing figure numbers.
grid	Turn the axes grids on or off.
hexbin	Make a hexagonal binning plot.
hist	Plot a histogram.
hist2d	Make a 2D histogram plot.
hlines	Plot horizontal lines at each *y* from *xmin* to *xmax*.
hold	
imread	Read an image from a file into an array.
imsave	Save an array as in image file.
imshow	Display an image on the axes.
install_repl_displayhook	Install a repl display hook so that any stale figure are automatically redrawn when co
ioff	Turn interactive mode off.
ion	Turn interactive mode on.
ishold	
isinteractive	Return status of interactive mode.
legend	Places a legend on the axes.
locator_params	Control behavior of tick locators.
loglog	Make a plot with log scaling on both the x and y axis.
magnitude_spectrum	Plot the magnitude spectrum.
margins	Set or retrieve autoscaling margins.
matshow	Display an array as a matrix in a new figure window.
minorticks_off	Remove minor ticks from the current plot.
minorticks_on	Display minor ticks on the current plot.
over	

Table 1 – continued from previous pag

Function	Description
pause	Pause for *interval* seconds.
pcolor	Create a pseudocolor plot with a non-regular rectangular grid.
pcolormesh	Create a pseudocolor plot with a non-regular rectangular grid.
phase_spectrum	Plot the phase spectrum.
pie	Plot a pie chart.
plot	Plot y versus x as lines and/or markers.
plot_date	Plot data that contains dates.
plotfile	Plot the data in a file.
polar	Make a polar plot.
psd	Plot the power spectral density.
quiver	Plot a 2-D field of arrows.
quiverkey	Add a key to a quiver plot.
rc	Set the current rc params.
rc_context	Return a context manager for managing rc settings.
rcdefaults	Restore the rc params from Matplotlib's internal defaults.
rgrids	Get or set the radial gridlines on a polar plot.
savefig	Save the current figure.
sca	Set the current Axes instance to *ax*.
scatter	A scatter plot of *y* vs *x* with varying marker size and/or color.
sci	Set the current image.
semilogx	Make a plot with log scaling on the x axis.
semilogy	Make a plot with log scaling on the y axis.
set_cmap	Set the default colormap.
setp	Set a property on an artist object.
show	Display a figure.
specgram	Plot a spectrogram.
spectral	Set the colormap to "spectral".
spy	Plot the sparsity pattern on a 2-D array.
stackplot	Draws a stacked area plot.
stem	Create a stem plot.
step	Make a step plot.
streamplot	Draws streamlines of a vector flow.
subplot	Return a subplot axes at the given grid position.
subplot2grid	Create an axis at specific location inside a regular grid.
subplot_tool	Launch a subplot tool window for a figure.
subplots	Create a figure and a set of subplots This utility wrapper makes it convenient to create
subplots_adjust	Tune the subplot layout.
suptitle	Add a centered title to the figure.
switch_backend	Switch the default backend.
table	Add a table to the current axes.
text	Add text to the axes.
thetagrids	Get or set the theta locations of the gridlines in a polar plot.
tick_params	Change the appearance of ticks, tick labels, and gridlines.

Table 1 – continued from previous pag

Function	Description
ticklabel_format	Change the *ScalarFormatter* used by default for linear axes.
tight_layout	Automatically adjust subplot parameters to give specified padding.
title	Set a title of the current axes.
tricontour	Draw contours on an unstructured triangular grid.
tricontourf	Draw contours on an unstructured triangular grid.
tripcolor	Create a pseudocolor plot of an unstructured triangular grid.
triplot	Draw a unstructured triangular grid as lines and/or markers.
twinx	Make a second axes that shares the *x*-axis.
twiny	Make a second axes that shares the *y*-axis.
uninstall_repl_displayhook	Uninstalls the matplotlib display hook.
violinplot	Make a violin plot.
vlines	Plot vertical lines.
xcorr	Plot the cross correlation between *x* and *y*.
xkcd	Turns on xkcd sketch-style drawing mode.
xlabel	Set the x-axis label of the current axes.
xlim	Get or set the x limits of the current axes.
xscale	Set the scaling of the x-axis.
xticks	Get or set the current tick locations and labels of the x-axis.
ylabel	Set the y-axis label of the current axes.
ylim	Get or set the y-limits of the current axes.
yscale	Set the scaling of the y-axis.
yticks	Get or set the current tick locations and labels of the y-axis.

CHAPTER

TWENTYEIGHT

THE OBJECT-ORIENTED API

Most of these functions also exist as methods in the *matplotlib.axes.Axes* class. You can use them with the "Object Oriented" approach to Matplotlib.

While it is easy to quickly generate plots with the *matplotlib.pyplot* module, we recommend using the object-oriented approach for more control and customization of your plots. See the methods in the *matplotlib.axes.Axes()* class for many of the same plotting functions. For examples of the OO approach to Matplotlib, see the API Examples.

CHAPTER

TWENTYNINE

COLORS IN MATPLOTLIB

There are many colormaps you can use to map data onto color values. Below we list several ways in which color can be utilized in Matplotlib.

For a more in-depth look at colormaps, see the *Colormaps in Matplotlib* tutorial.

`matplotlib.pyplot.`**`colormaps`**`()`

Matplotlib provides a number of colormaps, and others can be added using *`register_cmap()`*. This function documents the built-in colormaps, and will also return a list of all registered colormaps if called.

You can set the colormap for an image, pcolor, scatter, etc, using a keyword argument:

```
imshow(X, cmap=cm.hot)
```

or using the *`set_cmap()`* function:

```
imshow(X)
pyplot.set_cmap('hot')
pyplot.set_cmap('jet')
```

In interactive mode, *`set_cmap()`* will update the colormap post-hoc, allowing you to see which one works best for your data.

All built-in colormaps can be reversed by appending `_r`: For instance, `gray_r` is the reverse of `gray`.

There are several common color schemes used in visualization:

Sequential schemes for unipolar data that progresses from low to high

Diverging schemes for bipolar data that emphasizes positive or negative deviations from a central value

Cyclic schemes meant for plotting values that wrap around at the endpoints, such as phase angle, wind direction, or time of day

Qualitative schemes for nominal data that has no inherent ordering, where color is used only to distinguish categories

Matplotlib ships with 4 perceptually uniform color maps which are the recommended color maps for sequential data:

Colormap	Description
inferno	perceptually uniform shades of black-red-yellow
magma	perceptually uniform shades of black-red-white
plasma	perceptually uniform shades of blue-red-yellow
viridis	perceptually uniform shades of blue-green-yellow

The following colormaps are based on the ColorBrewer color specifications and designs developed by Cynthia Brewer:

ColorBrewer Diverging (luminance is highest at the midpoint, and decreases towards differently-colored endpoints):

Colormap	Description
BrBG	brown, white, blue-green
PiYG	pink, white, yellow-green
PRGn	purple, white, green
PuOr	orange, white, purple
RdBu	red, white, blue
RdGy	red, white, gray
RdYlBu	red, yellow, blue
RdYlGn	red, yellow, green
Spectral	red, orange, yellow, green, blue

ColorBrewer Sequential (luminance decreases monotonically):

Colormap	Description
Blues	white to dark blue
BuGn	white, light blue, dark green
BuPu	white, light blue, dark purple
GnBu	white, light green, dark blue
Greens	white to dark green
Greys	white to black (not linear)
Oranges	white, orange, dark brown
OrRd	white, orange, dark red
PuBu	white, light purple, dark blue
PuBuGn	white, light purple, dark green
PuRd	white, light purple, dark red
Purples	white to dark purple
RdPu	white, pink, dark purple
Reds	white to dark red
YlGn	light yellow, dark green
YlGnBu	light yellow, light green, dark blue
YlOrBr	light yellow, orange, dark brown
YlOrRd	light yellow, orange, dark red

ColorBrewer Qualitative:

(For plotting nominal data, `ListedColormap` is used, not `LinearSegmentedColormap`. Different sets of colors are recommended for different numbers of categories.)

- Accent
- Dark2
- Paired
- Pastel1
- Pastel2
- Set1
- Set2
- Set3

A set of colormaps derived from those of the same name provided with Matlab are also included:

Colormap	Description
autumn	sequential linearly-increasing shades of red-orange-yellow
bone	sequential increasing black-white color map with a tinge of blue, to emulate X-ray film
cool	linearly-decreasing shades of cyan-magenta
copper	sequential increasing shades of black-copper
flag	repetitive red-white-blue-black pattern (not cyclic at endpoints)
gray	sequential linearly-increasing black-to-white grayscale
hot	sequential black-red-yellow-white, to emulate blackbody radiation from an object at increasing temperatures
hsv	cyclic red-yellow-green-cyan-blue-magenta-red, formed by changing the hue component in the HSV color space
jet	a spectral map with dark endpoints, blue-cyan-yellow-red; based on a fluid-jet simulation by NCSA[1]
pink	sequential increasing pastel black-pink-white, meant for sepia tone colorization of photographs
prism	repetitive red-yellow-green-blue-purple-...-green pattern (not cyclic at endpoints)
spring	linearly-increasing shades of magenta-yellow
summer	sequential linearly-increasing shades of green-yellow
winter	linearly-increasing shades of blue-green

A set of palettes from the Yorick scientific visualisation package, an evolution of the GIST package, both by David H. Munro are included:

[1] Rainbow colormaps, `jet` in particular, are considered a poor choice for scientific visualization by many researchers: Rainbow Color Map (Still) Considered Harmful

Colormap	Description
gist_earth	mapmaker's colors from dark blue deep ocean to green lowlands to brown highlands to white mountains
gist_heat	sequential increasing black-red-orange-white, to emulate blackbody radiation from an iron bar as it grows hotter
gist_ncar	pseudo-spectral black-blue-green-yellow-red-purple-white colormap from National Center for Atmospheric Research[2]
gist_rainbow	runs through the colors in spectral order from red to violet at full saturation (like *hsv* but not cyclic)
gist_stern	"Stern special" color table from Interactive Data Language software

Other miscellaneous schemes:

Colormap	Description
afmhot	sequential black-orange-yellow-white blackbody spectrum, commonly used in atomic force microscopy
brg	blue-red-green
bwr	diverging blue-white-red
coolwarm	diverging blue-gray-red, meant to avoid issues with 3D shading, color blindness, and ordering of colors[3]
CMRmap	"Default colormaps on color images often reproduce to confusing grayscale images. The proposed colormap maintains an aesthetically pleasing color image that automatically reproduces to a monotonic grayscale with discrete, quantifiable saturation levels."[4]
cubehelix	Unlike most other color schemes cubehelix was designed by D.A. Green to be monotonically increasing in terms of perceived brightness. Also, when printed on a black and white postscript printer, the scheme results in a greyscale with monotonically increasing brightness. This color scheme is named cubehelix because the r,g,b values produced can be visualised as a squashed helix around the diagonal in the r,g,b color cube.
gnuplot	gnuplot's traditional pm3d scheme (black-blue-red-yellow)
gnuplot2	sequential color printable as gray (black-blue-violet-yellow-white)
ocean	green-blue-white
rainbow	spectral purple-blue-green-yellow-orange-red colormap with diverging luminance
seismic	diverging blue-white-red
nipy_spectral	black-purple-blue-green-yellow-red-white spectrum, originally from the Neuroimaging in Python project
terrain	mapmaker's colors, blue-green-yellow-brown-white, originally from IGOR Pro

[2] Resembles "BkBlAqGrYeOrReViWh200" from NCAR Command Language. See Color Table Gallery

The following colormaps are redundant and may be removed in future versions. It's recommended to use the names in the descriptions instead, which produce identical output:

Colormap	Description
gist_gray	identical to *gray*
gist_yarg	identical to *gray_r*
binary	identical to *gray_r*
spectral	identical to *nipy_spectral*[5]

[3] See Diverging Color Maps for Scientific Visualization by Kenneth Moreland.

[4] See A Color Map for Effective Black-and-White Rendering of Color-Scale Images by Carey Rappaport

[5] Changed to distinguish from ColorBrewer's *Spectral* map. `spectral()` still works, but `set_cmap('nipy_spectral')` is recommended for clarity.

CHAPTER

THIRTY

API CHANGES

Log of changes to Matplotlib that affect the outward-facing API. If updating Matplotlib breaks your scripts, this list may help you figure out what caused the breakage and how to fix it by updating your code.

For new features that were added to Matplotlib, please see *What's new in Matplotlib*.

30.1 Adding API change notes

Please place new portions of `api_changes.rst` in the `next_api_changes` directory.

When adding an entry please look at the currently existing files to see if you can extend any of them. If you create a file, name it `what_api_changes.rst` (ex `deprecated_rcparams.rst`) with contents following the form:

```
Brief description of change
---------------------------

Long description of change, justification, and work-arounds to
maintain old behavior (if any).
```

If you need more heading levels, please use ~~~~ and ++++.

30.2 API Changes in 2.2.0

30.2.1 New dependency

kiwisolver is now a required dependency to support the new constrained_layout, see *Constrained Layout Guide* for more details.

30.2.2 Deprecations

Classes, functions, and methods

The unused and untested `Artist.onRemove` and `Artist.hitlist` methods have been deprecated.

The now unused `mlab.less_simple_linear_interpolation` function is deprecated.

The unused `ContourLabeler.get_real_label_width` method is deprecated.

The unused `FigureManagerBase.show_popup` method is deprecated. This introduced in e945059b327d42a99938b939a1be867fa023e7ba in 2005 but never built out into any of the backends.

`backend_tkagg.AxisMenu` is deprecated, as it has become unused since the removal of "classic" toolbars.

Changed function signatures

kwarg `fig` to *GridSpec.get_subplot_params* is deprecated, use `figure` instead.

Using *pyplot.axes* with an *Axes* as argument is deprecated. This sets the current axes, i.e. it has the same effect as *pyplot.sca*. For clarity `plt.sca(ax)` should be preferred over `plt.axes(ax)`.

Using strings instead of booleans to control grid and tick visibility is deprecated. Using `"on"`, `"off"`, `"true"`, or `"false"` to control grid and tick visibility has been deprecated. Instead, use normal booleans (`True`/`False`) or boolean-likes. In the future, all non-empty strings may be interpreted as `True`.

When given 2D inputs with non-matching numbers of columns, *plot* currently cycles through the columns of the narrower input, until all the columns of the wider input have been plotted. This behavior is deprecated; in the future, only broadcasting (1 column to *n* columns) will be performed.

rcparams

The `rcParams["backend.qt4"]` and `rcParams["backend.qt5"]` rcParams were deprecated in version 2.2. In order to force the use of a specific Qt binding, either import that binding first, or set the `QT_API` environment variable.

Deprecation of the `nbagg.transparent` rcParam. To control transparency of figure patches in the nbagg (or any other) backend, directly set `figure.patch.facecolor`, or the `figure.facecolor` rcParam.

Deprecated `Axis.unit_data`

Use `Axis.units` (which has long existed) instead.

30.2.3 Removals

Function Signatures

Contouring no longer supports `legacy` corner masking. The deprecated `ContourSet.vmin` and `ContourSet.vmax` properties have been removed.

Passing `None` instead of `"none"` as format to *errorbar* is no longer supported.

The `bgcolor` keyword argument to `Axes` has been removed.

Modules, methods, and functions

The `matplotlib.finance`, `mpl_toolkits.exceltools` and `mpl_toolkits.gtktools` modules have been removed. `matplotlib.finance` remains available at https://github.com/matplotlib/mpl_finance.

The `mpl_toolkits.mplot3d.art3d.iscolor` function has been removed.

The `Axes.get_axis_bgcolor`, `Axes.set_axis_bgcolor`, `Bbox.update_from_data`, `Bbox.update_datalim_numerix`, `MaxNLocator.bin_boundaries` methods have been removed.

`mencoder` can no longer be used to encode animations.

The unused `FONT_SCALE` and `fontd` attributes of the `RendererSVG` class have been removed.

color maps

The `spectral` colormap has been removed. The `Vega*` colormaps, which were aliases for the `tab*` colormaps, have been removed.

rcparams

The following deprecated rcParams have been removed:

- `axes.color_cycle` (see `axes.prop_cycle`),
- `legend.isaxes`,
- `svg.embed_char_paths` (see `svg.fonttype`),
- `text.fontstyle`, `text.fontangle`, `text.fontvariant`, `text.fontweight`, `text.fontsize` (renamed to `text.style`, etc.),
- `tick.size` (renamed to `tick.major.size`).

30.2.4 Only accept string-like for Categorical input

Do not accept mixed string / float / int input, only strings are valid categoricals.

30.2.5 Removal of unused imports

Many unused imports were removed from the codebase. As a result, trying to import certain classes or functions from the "wrong" module (e.g. *Figure* from *matplotlib.backends.backend_agg* instead of *matplotlib.figure*) will now raise an `ImportError`.

30.2.6 `Axes3D.get_xlim`, `get_ylim` and `get_zlim` now return a tuple

They previously returned an array. Returning a tuple is consistent with the behavior for 2D axes.

30.2.7 Exception type changes

If `MovieWriterRegistry` can't find the requested `MovieWriter`, a more helpful `RuntimeError` message is now raised instead of the previously raised `KeyError`.

`auto_adjust_subplotpars` now raises `ValueError` instead of `RuntimeError` when sizes of input lists don't match

30.2.8 `Figure.set_figwidth` and `Figure.set_figheight` default forward to True

`matplotlib.Figure.set_figwidth` and `matplotlib.Figure.set_figheight` had the kwarg `forward=False` by default, but `Figure.set_size_inches` now defaults to `forward=True`. This makes these functions conistent.

30.2.9 Do not truncate svg sizes to nearest point

There is no reason to size the SVG out put in integer points, change to out putting floats for the *height*, *width*, and *viewBox* attributes of the *svg* element.

30.2.10 Fontsizes less than 1 pt are clipped to be 1 pt.

FreeType doesn't allow fonts to get smaller than 1 pt, so all Agg backends were silently rounding up to 1 pt. PDF (other vector backends?) were letting us write fonts that were less than 1 pt, but they could not be placed properly because position information comes from FreeType. This change makes it so no backends can use fonts smaller than 1 pt, consistent with FreeType and ensuring more consistent results across backends.

30.2.11 Changes to Qt backend class MRO

To support both Agg and cairo rendering for Qt backends all of the non-Agg specific code previously in `backend_qt5agg.FigureCanvasQTAggBase` has been moved to `backend_qt5.FigureCanvasQT` so it can be shared with the cairo implementation. The `FigureCanvasQTAggBase.paintEvent()`, `FigureCanvasQTAggBase.blit()`, and `FigureCanvasQTAggBase.print_figure()` methods have moved to `FigureCanvasQTAgg.paintEvent()`, `FigureCanvasQTAgg.blit()`, and `FigureCanvasQTAgg.print_figure()`. The first two methods assume that the instance is also a `QWidget` so to use `FigureCanvasQTAggBase` it was required to multiple inherit from a `QWidget` sub-class.

Having moved all of its methods either up or down the class hierarchy `FigureCanvasQTAggBase` has been deprecated. To do this with out warning and to preserve as much API as possible, `backend_qt5.FigureCanvasQTAggBase` now inherits from `backend_qt5.FigureCanvasQTAgg`.

The MRO for `FigureCanvasQTAgg` and `FigureCanvasQTAggBase` used to be

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
 matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
 matplotlib.backends.backend_agg.FigureCanvasAgg,
```

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```
 matplotlib.backends.backend_qt5.FigureCanvasQT,
 PyQt5.QtWidgets.QWidget,
 PyQt5.QtCore.QObject,
 sip.wrapper,
 PyQt5.QtGui.QPaintDevice,
 sip.simplewrapper,
 matplotlib.backend_bases.FigureCanvasBase,
 object]
```

and

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
 matplotlib.backends.backend_agg.FigureCanvasAgg,
 matplotlib.backend_bases.FigureCanvasBase,
 object]
```

respectively. They are now

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
 matplotlib.backends.backend_agg.FigureCanvasAgg,
 matplotlib.backends.backend_qt5.FigureCanvasQT,
 PyQt5.QtWidgets.QWidget,
 PyQt5.QtCore.QObject,
 sip.wrapper,
 PyQt5.QtGui.QPaintDevice,
 sip.simplewrapper,
 matplotlib.backend_bases.FigureCanvasBase,
 object]
```

and

```
[matplotlib.backends.backend_qt5agg.FigureCanvasQTAggBase,
 matplotlib.backends.backend_qt5agg.FigureCanvasQTAgg,
 matplotlib.backends.backend_agg.FigureCanvasAgg,
 matplotlib.backends.backend_qt5.FigureCanvasQT,
 PyQt5.QtWidgets.QWidget,
 PyQt5.QtCore.QObject,
 sip.wrapper,
 PyQt5.QtGui.QPaintDevice,
 sip.simplewrapper,
 matplotlib.backend_bases.FigureCanvasBase,
 object]
```

30.2.12 `Axes.imshow` clips RGB values to the valid range

When `Axes.imshow` is passed an RGB or RGBA value with out-of-range values, it now logs a warning and clips them to the valid range. The old behaviour, wrapping back in to the range, often hid outliers and made interpreting RGB images unreliable.

30.2.13 GTKAgg and GTKCairo backends deprecated

The GTKAgg and GTKCairo backends have been deprecated. These obsolete backends allow figures to be rendered via the GTK+ 2 toolkit. They are untested, known to be broken, will not work with Python 3, and their use has been discouraged for some time. Instead, use the `GTK3Agg` and `GTK3Cairo` backends for rendering to GTK+ 3 windows.

30.3 API Changes in 2.1.2

30.3.1 `Figure.legend` no longer checks for repeated lines to ignore

`matplotlib.Figure.legend` used to check if a line had the same label as an existing legend entry. If it also had the same line color or marker color legend didn't add a new entry for that line. However, the list of conditions was incomplete, didn't handle RGB tuples, didn't handle linewidths or linestyles etc.

This logic did not exist in `Axes.legend`. It was included (erroneously) in Matplotlib 2.1.1 when the legend argument parsing was unified [#9324](https://github.com/matplotlib/matplotlib/pull/9324). This change removes that check in `Axes.legend` again to restore the old behavior.

This logic has also been dropped from *`Figure.legend`*, where it was previously undocumented. Repeated lines with the same label will now each have an entry in the legend. If you do not want the duplicate entries, don't add a label to the line, or prepend the label with an underscore.

30.4 API Changes in 2.1.1

30.4.1 Default behavior of log scales reverted to clip <= 0 values

The change it 2.1.0 to mask in logscale by default had more disruptive changes than anticipated and has been reverted, however the clipping is now done in a way that fixes the issues that motivated changing the default behavior to `'mask'`.

As a side effect of this change, error bars which go negative now work as expected on log scales.

30.5 API Changes in 2.1.0

30.5.1 Default behavior of log scales changed to mask <= 0 values

Calling *`matplotlib.axes.Axes.set_xscale`* or *`matplotlib.axes.Axes.set_yscale`* now uses 'mask' as the default method to handle invalid values (as opposed to 'clip'). This means that any values <= 0 on a log scale will not be shown.

Previously they were clipped to a very small number and shown.

30.5.2 matplotlib.cbook.CallbackRegistry.process() suppresses exceptions by default

Matplotlib uses instances of *CallbackRegistry* as a bridge between user input event from the GUI and user callbacks. Previously, any exceptions raised in a user call back would bubble out of of the `process` method, which is typically in the GUI event loop. Most GUI frameworks simple print the traceback to the screen and continue as there is not always a clear method of getting the exception back to the user. However PyQt5 now exits the process when it receives an un-handled python exception in the event loop. Thus, *process()* now suppresses and prints tracebacks to stderr by default.

What *process()* does with exceptions is now user configurable via the `exception_handler` attribute and kwarg. To restore the previous behavior pass `None`

```
cb = CallbackRegistry(exception_handler=None)
```

A function which take and `Exception` as its only argument may also be passed

```
def maybe_reraise(exc):
    if isinstance(exc, RuntimeError):
        pass
    else:
        raise exc

cb = CallbackRegistry(exception_handler=maybe_reraise)
```

30.5.3 Improved toggling of the axes grids

The `g` key binding now switches the states of the `x` and `y` grids independently (by cycling through all four on/off combinations).

The new `G` key binding switches the states of the minor grids.

Both bindings are disabled if only a subset of the grid lines (in either direction) is visible, to avoid making irreversible changes to the figure.

30.5.4 Ticklabels are turned off instead of being invisible

Internally, the `Tick`'s `label1On()` attribute is now used to hide tick labels instead of setting the visibility on the tick label objects. This improves overall performance and fixes some issues. As a consequence, in case those labels ought to be shown, *tick_params()* needs to be used, e.g.

```
ax.tick_params(labelbottom=True)
```

30.5.5 Removal of warning on empty legends

`plt.legend` used to issue a warning when no labeled artist could be found. This warning has been removed.

30.5.6 More accurate legend autopositioning

Automatic positioning of legends now prefers using the area surrounded by a `Line2D` rather than placing the legend over the line itself.

30.5.7 Cleanup of stock sample data

The sample data of stocks has been cleaned up to remove redundancies and increase portability. The `AAPL.dat.gz`, `INTC.dat.gz` and `aapl.csv` files have been removed entirely and will also no longer be available from *matplotlib.cbook.get_sample_data*. If a CSV file is required, we suggest using the `msft.csv` that continues to be shipped in the sample data. If a NumPy binary file is acceptable, we suggest using one of the following two new files. The `aapl.npy.gz` and `goog.npy` files have been replaced by `aapl.npz` and `goog.npz`, wherein the first column's type has changed from `datetime.date` to `np.datetime64` for better portability across Python versions. Note that Matplotlib does not fully support `np.datetime64` as yet.

30.5.8 Updated qhull to 2015.2

The version of qhull shipped with Matplotlib, which is used for Delaunay triangulation, has been updated from version 2012.1 to 2015.2.

30.5.9 Improved Delaunay triangulations with large offsets

Delaunay triangulations now deal with large x,y offsets in a better way. This can cause minor changes to any triangulations calculated using Matplotlib, i.e. any use of *matplotlib.tri.Triangulation* that requests that a Delaunay triangulation is calculated, which includes *matplotlib.pyplot.tricontour*, *matplotlib.pyplot.tricontourf*, *matplotlib.pyplot.tripcolor*, *matplotlib.pyplot.triplot*, *matplotlib.mlab.griddata* and *mpl_toolkits.mplot3d.axes3d.Axes3D.plot_trisurf*.

30.5.10 Use `backports.functools_lru_cache` instead of `functools32`

It's better maintained and more widely used (by pylint, jaraco, etc).

30.5.11 `cbook.is_numlike` only performs an instance check

is_numlike() now only checks that its argument is an instance of `(numbers.Number, np.Number)`. In particular, this means that arrays are now not num-like.

30.5.12 Elliptical arcs now drawn between correct angles

The *matplotlib.patches.Arc* patch is now correctly drawn between the given angles.

Previously a circular arc was drawn and then stretched into an ellipse, so the resulting arc did not lie between *theta1* and *theta2*.

30.5.13 -d$backend no longer sets the backend

It is no longer possible to set the backend by passing `-d$backend` at the command line. Use the `MPLBACKEND` environment variable instead.

30.5.14 Path.intersects_bbox always treats the bounding box as filled

Previously, when `Path.intersects_bbox` was called with `filled` set to `False`, it would treat both the path and the bounding box as unfilled. This behavior was not well documented and it is usually not the desired behavior, since bounding boxes are used to represent more complex shapes located inside the bounding box. This behavior has now been changed: when `filled` is `False`, the path will be treated as unfilled, but the bounding box is still treated as filled. The old behavior was arguably an implementation bug.

When `Path.intersects_bbox` is called with `filled` set to `True` (the default value), there is no change in behavior. For those rare cases where `Path.intersects_bbox` was called with `filled` set to `False` and where the old behavior is actually desired, the suggested workaround is to call `Path.intersects_path` with a rectangle as the path:

```
from matplotlib.path import Path
from matplotlib.transforms import Bbox, BboxTransformTo
rect = Path.unit_rectangle().transformed(BboxTransformTo(bbox))
result = path.intersects_path(rect, filled=False)
```

30.5.15 WX no longer calls generates `IdleEvent` events or calls `idle_event`

Removed unused private method `_onIdle` from `FigureCanvasWx`.

The `IdleEvent` class and `FigureCanvasBase.idle_event` method will be removed in 2.2

30.5.16 Correct scaling of `magnitude_spectrum()`

The functions *matplotlib.mlab.magnitude_spectrum()* and *matplotlib.pyplot.magnitude_spectrum()* implicitly assumed the sum of windowing function values to be one. In Matplotlib and Numpy the standard windowing functions are scaled to have maximum value of one, which usually results in a sum of the order of n/2 for a n-point signal. Thus the amplitude scaling `magnitude_spectrum()` was off by that amount when using standard windowing functions (Bug 8417). Now the behavior is consistent with *matplotlib.pyplot.psd()* and `scipy.signal.welch()`. The following example demonstrates the new and old scaling:

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

tau, n = 10, 1024  # 10 second signal with 1024 points
```

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```
T = tau/n  # sampling interval
t = np.arange(n)*T

a = 4  # amplitude
x = a*np.sin(40*np.pi*t)  # 20 Hz sine with amplitude a

# New correct behavior: Amplitude at 20 Hz is a/2
plt.magnitude_spectrum(x, Fs=1/T, sides='onesided', scale='linear')

# Original behavior: Amplitude at 20 Hz is (a/2)*(n/2) for a Hanning window
w = np.hanning(n)  # default window is a Hanning window
plt.magnitude_spectrum(x*np.sum(w), Fs=1/T, sides='onesided', scale='linear')
```

30.5.17 Change to signatures of `bar()` & `barh()`

For 2.0 the *default value of *align** changed to `'center'`. However this caused the signature of *bar()* and *barh()* to be misleading as the first parameters were still *left* and *bottom* respectively:

```
bar(left, height, *, align='center', **kwargs)
barh(bottom, width, *, align='center', **kwargs)
```

despite behaving as the center in both cases. The methods now take `*args, **kwargs` as input and are documented to have the primary signatures of:

```
bar(x, height, *, align='center', **kwargs)
barh(y, width, *, align='center', **kwargs)
```

Passing *left* and *bottom* as keyword arguments to *bar()* and *barh()* respectively will warn. Support will be removed in Matplotlib 3.0.

30.5.18 Font cache as json

The font cache is now saved as json, rather than a pickle.

30.5.19 Invalid (Non-finite) Axis Limit Error

When using *set_xlim()* and *set_ylim()*, passing non-finite values now results in a `ValueError`. The previous behavior resulted in the limits being erroneously reset to `(-0.001, 0.001)`.

30.5.20 `scatter` and `Collection` offsets are no longer implicitly flattened

Collection (and thus both 2D *scatter* and 3D *scatter*) no longer implicitly flattens its offsets. As a consequence, `scatter`'s `x` and `y` arguments can no longer be 2+-dimensional arrays.

30.5.21 Deprecations

GraphicsContextBase's linestyle property.

The `GraphicsContextBase.get_linestyle` and `GraphicsContextBase.set_linestyle` methods, which had no effect, have been deprecated. All of the backends Matplotlib ships use `GraphicsContextBase.get_dashes` and `GraphicsContextBase.set_dashes` which are more general. Third-party backends should also migrate to the `*_dashes` methods.

NavigationToolbar2.dynamic_update

Use `draw_idle()` method on the `Canvas` instance instead.

Testing

`matplotlib.testing.noseclasses` is deprecated and will be removed in 2.3

EngFormatter *num* arg as string

Passing a string as *num* argument when calling an instance of *matplotlib.ticker.EngFormatter* is deprecated and will be removed in 2.3.

mpl_toolkits.axes_grid module

All functionally from `mpl_toolkits.axes_grid` can be found in either `mpl_toolkits.axes_grid1` or `mpl_toolkits.axisartist`. Axes classes from `mpl_toolkits.axes_grid` based on `Axis` from `mpl_toolkits.axisartist` can be found in `mpl_toolkits.axisartist`.

Axes collision in Figure.add_axes

Adding an axes instance to a figure by using the same arguments as for a previous axes instance currently reuses the earlier instance. This behavior has been deprecated in Matplotlib 2.1. In a future version, a *new* instance will always be created and returned. Meanwhile, in such a situation, a deprecation warning is raised by *AxesStack*.

This warning can be suppressed, and the future behavior ensured, by passing a *unique* label to each axes instance. See the docstring of *add_axes()* for more information.

Additional details on the rationale behind this deprecation can be found in #7377 and #9024.

Former validators for contour.negative_linestyle

The former public validation functions `validate_negative_linestyle` and `validate_negative_linestyle_legacy` will be deprecated in 2.1 and may be removed in 2.3. There are no public functions to replace them.

cbook

Many unused or near-unused *matplotlib.cbook* functions and classes have been deprecated: converter, tostr, todatetime, todate, tofloat, toint, unique, is_string_like, is_sequence_of_strings, is_scalar, Sorter, Xlator, soundex, Null, dict_delall, RingBuffer, get_split_ind, wrap, get_recursive_filelist, pieces, exception_to_str, allequal, alltrue, onetrue, allpairs, finddir, reverse_dict, restrict_dict, issubclass_safe, recursive_remove, unmasked_index_ranges.

30.5.22 Code Removal

qt4_compat.py

Moved to qt_compat.py. Renamed because it now handles Qt5 as well.

Previously Deprecated methods

The GraphicsContextBase.set_graylevel, FigureCanvasBase.onHilite and mpl_toolkits.axes_grid1.mpl_axes.Axes.toggle_axisline methods have been removed.

The ArtistInspector.findobj method, which was never working due to the lack of a get_children method, has been removed.

The deprecated point_in_path, get_path_extents, point_in_path_collection, path_intersects_path, convert_path_to_polygons, cleanup_path and clip_path_to_rect functions in the matplotlib.path module have been removed. Their functionality remains exposed as methods on the Path class.

The deprecated Artist.get_axes and Artist.set_axes methods have been removed

The matplotlib.backends.backend_ps.seq_allequal function has been removed. Use np.array_equal instead.

The deprecated matplotlib.rcsetup.validate_maskedarray, matplotlib.rcsetup.deprecate_savefig_extension and matplotlib.rcsetup.validate_tkpythoninspect functions, and associated savefig.extension and tk.pythoninspect rcparams entries have been removed.

The kwarg resolution of *matplotlib.projections.polar.PolarAxes* has been removed. It has deprecation with no effect from version 0.98.x.

Axes.set_aspect("normal")

Support for setting an Axes's aspect to "normal" has been removed, in favor of the synonym "auto".

shading kwarg to pcolor

The shading kwarg to *pcolor* has been removed. Set edgecolors appropriately instead.

Functions removed from the lines module

The *matplotlib.lines* module no longer imports the pts_to_prestep, pts_to_midstep and pts_to_poststep functions from *matplotlib.cbook*.

PDF backend functions

The methods embedTeXFont and tex_font_mapping of matplotlib.backqend_pdf.PdfFile have been removed. It is unlikely that external users would have called these methods, which are related to the font system internal to the PDF backend.

matplotlib.delaunay

Remove the delaunay triangulation code which is now handled by Qhull via *matplotlib.tri*.

30.6 API Changes in 2.0.1

30.6.1 Extensions to matplotlib.backend_bases.GraphicsContextBase

To better support controlling the color of hatches, the method *matplotlib.backend_bases.GraphicsContextBase.set_hatch_color* was added to the expected API of GraphicsContext classes. Calls to this method are currently wrapped with a try:...except Attribute: block to preserve back-compatibility with any third-party backends which do not extend *GraphicsContextBase*.

This value can be accessed in the backends via *matplotlib.backend_bases.GraphicsContextBase.get_hatch_color* (which was added in 2.0 see *Extension to matplotlib.backend_bases.GraphicsContextBase*) and should be used to color the hatches.

In the future there may also be hatch_linewidth and hatch_density related methods added. It is encouraged, but not required that third-party backends extend *GraphicsContextBase* to make adapting to these changes easier.

30.6.2 afm.get_fontconfig_fonts returns a list of paths and does not check for existence

afm.get_fontconfig_fonts used to return a set of paths encoded as a {key: 1, ...} dict, and checked for the existence of the paths. It now returns a list and dropped the existence check, as the same check is performed by the caller (afm.findSystemFonts) as well.

30.6.3 bar now returns rectangles of negative height or width if the corresponding input is negative

plt.bar used to normalize the coordinates of the rectangles that it created, to keep their height and width positives, even if the corresponding input was negative. This normalization has been removed to permit a simpler computation of the correct sticky_edges to use.

30.6.4 Do not clip line width when scaling dashes

The algorithm to scale dashes was changed to no longer clip the scaling factor: the dash patterns now continue to shrink at thin line widths. If the line width is smaller than the effective pixel size, this may result in dashed lines turning into solid gray-ish lines. This also required slightly tweaking the default patterns for '–', ':', and '.-' so that with the default line width the final patterns would not change.

There is no way to restore the old behavior.

30.6.5 Deprecate 'Vega' color maps

The "Vega" colormaps are deprecated in Matplotlib 2.0.1 and will be removed in Matplotlib 2.2. Use the "tab" colormaps instead: "tab10", "tab20", "tab20b", "tab20c".

30.7 API Changes in 2.0.0

30.7.1 Deprecation and removal

Color of Axes

The `axisbg` and `axis_bgcolor` properties on *Axes* have been deprecated in favor of `facecolor`.

GTK and GDK backends deprecated

The GDK and GTK backends have been deprecated. These obsolete backends allow figures to be rendered via the GDK API to files and GTK2 figures. They are untested and known to be broken, and their use has been discouraged for some time. Instead, use the `GTKAgg` and `GTKCairo` backends for rendering to GTK2 windows.

WX backend deprecated

The WX backend has been deprecated. It is untested, and its use has been discouraged for some time. Instead, use the `WXAgg` backend for rendering figures to WX windows.

CocoaAgg backend removed

The deprecated and not fully functional CocoaAgg backend has been removed.

`round` removed from TkAgg Backend

The TkAgg backend had its own implementation of the `round` function. This was unused internally and has been removed. Instead, use either the `round` builtin function or `numpy.round`.

'hold' functionality deprecated

The 'hold' keyword argument and all functions and methods related to it are deprecated, along with the 'axes.hold' `rcParams` entry. The behavior will remain consistent with the default `hold=True` state that has long been in place. Instead of using a function or keyword argument (`hold=False`) to change that behavior, explicitly clear the axes or figure as needed prior to subsequent plotting commands.

30.7.2 `Artist.update` has return value

The methods *matplotlib.artist.Artist.set*, `matplotlib.Artist.update`, and the function *matplotlib.artist.setp* now use a common codepath to look up how to update the given artist properties (either using the setter methods or an attribute/property).

The behavior of `matplotlib.Artist.update` is slightly changed to return a list of the values returned from the setter methods to avoid changing the API of `matplotlib.Artist.set` and *matplotlib.artist.setp*.

The keys passed into `matplotlib.Artist.update` are now converted to lower case before being processed, to match the behavior of `matplotlib.Artist.set` and *matplotlib.artist.setp*. This should not break any user code because there are no set methods with capitals in their names, but this puts a constraint on naming properties in the future.

30.7.3 `Legend` initializers gain `edgecolor` and `facecolor` kwargs

The *Legend* background patch (or 'frame') can have its `edgecolor` and `facecolor` determined by the corresponding keyword arguments to the *matplotlib.legend.Legend* initializer, or to any of the methods or functions that call that initializer. If left to their default values of `None`, their values will be taken from `matplotlib.rcParams`. The previously-existing `framealpha` kwarg still controls the alpha transparency of the patch.

30.7.4 Qualitative colormaps

Colorbrewer's qualitative/discrete colormaps ("Accent", "Dark2", "Paired", "Pastel1", "Pastel2", "Set1", "Set2", "Set3") are now implemented as `ListedColormap` instead of `LinearSegmentedColormap`.

To use these for images where categories are specified as integers, for instance, use:

```
plt.imshow(x, cmap='Dark2', norm=colors.NoNorm())
```

30.7.5 Change in the `draw_image` backend API

The `draw_image` method implemented by backends has changed its interface.

This change is only relevant if the backend declares that it is able to transform images by returning `True` from `option_scale_image`. See the `draw_image` docstring for more information.

30.7.6 matplotlib.ticker.LinearLocator algorithm update

The matplotlib.ticker.LinearLocator is used to define the range and location of axis ticks when the user wants an exact number of ticks. LinearLocator thus differs from the default locator MaxNLocator, for which the user specifies a maximum number of intervals rather than a precise number of ticks.

The view range algorithm in matplotlib.ticker.LinearLocator has been changed so that more convenient tick locations are chosen. The new algorithm returns a plot view range that is a multiple of the user-requested number of ticks. This ensures tick marks will be located at whole integers more consistently. For example, when both y-axes of a‘‘twinx‘‘ plot use matplotlib.ticker.LinearLocator with the same number of ticks, their y-tick locations and grid lines will coincide.

30.7.7 matplotlib.ticker.LogLocator gains numticks kwarg

The maximum number of ticks generated by the *LogLocator* can now be controlled explicitly via setting the new 'numticks' kwarg to an integer. By default the kwarg is None which internally sets it to the 'auto' string, triggering a new algorithm for adjusting the maximum according to the axis length relative to the ticklabel font size.

30.7.8 matplotlib.ticker.LogFormatter: two new kwargs

Previously, minor ticks on log-scaled axes were not labeled by default. An algorithm has been added to the *LogFormatter* to control the labeling of ticks between integer powers of the base. The algorithm uses two parameters supplied in a kwarg tuple named 'minor_thresholds'. See the docstring for further explanation.

To improve support for axes using SymmetricLogLocator, a 'linthresh' kwarg was added.

30.7.9 New defaults for 3D quiver function in mpl_toolkits.mplot3d.axes3d.py

Matplotlib has both a 2D and a 3D quiver function. These changes affect only the 3D function and make the default behavior of the 3D function match the 2D version. There are two changes:

1. The 3D quiver function previously normalized the arrows to be the same length, which makes it unusable for situations where the arrows should be different lengths and does not match the behavior of the 2D function. This normalization behavior is now controlled with the normalize keyword, which defaults to False.
2. The pivot keyword now defaults to tail instead of tip. This was done in order to match the default behavior of the 2D quiver function.

To obtain the previous behavior with the 3D quiver function, one can call the function with

```
ax.quiver(x, y, z, u, v, w, normalize=True, pivot='tip')
```

where "ax" is an Axes3d object created with something like

```
import mpl_toolkits.mplot3d.axes3d
ax = plt.sublot(111, projection='3d')
```

30.7.10 Stale figure behavior

Attempting to draw the figure will now mark it as not stale (independent if the draw succeeds). This change is to prevent repeatedly trying to re-draw a figure which is raising an error on draw. The previous behavior would only mark a figure as not stale after a full re-draw succeeded.

30.7.11 The spectral colormap is now nipy_spectral

The colormaps formerly known as `spectral` and `spectral_r` have been replaced by `nipy_spectral` and `nipy_spectral_r` since Matplotlib 1.3.0. Even though the colormap was deprecated in Matplotlib 1.3.0, it never raised a warning. As of Matplotlib 2.0.0, using the old names raises a deprecation warning. In the future, using the old names will raise an error.

30.7.12 Default install no longer includes test images

To reduce the size of wheels and source installs, the tests and baseline images are no longer included by default.

To restore installing the tests and images, use a `setup.cfg` with

```
[packages]
tests = True
toolkits_tests = True
```

in the source directory at build/install time.

30.8 Changes in 1.5.3

30.8.1 `ax.plot(..., marker=None)` gives default marker

Prior to 1.5.3 kwargs passed to `plot` were handled in two parts – default kwargs generated internal to `plot` (such as the cycled styles) and user supplied kwargs. The internally generated kwargs were passed to the `matplotlib.lines.Line2D.__init__` and the user kwargs were passed to `ln.set(**kwargs)` to update the artist after it was created. Now both sets of kwargs are merged and passed to `__init__`. This change was made to allow `None` to be passed in via the user kwargs to mean 'do the default thing' as is the convention through out mpl rather than raising an exception.

Unlike most *Line2D* setter methods *set_marker* did accept `None` as a valid input which was mapped to 'no marker'. Thus, by routing this `marker=None` through `__init__` rather than `set(...)` the meaning of `ax.plot(..., marker=None)` changed from 'no markers' to 'default markers from rcparams'.

This is change is only evident if `mpl.rcParams['lines.marker']` has a value other than `'None'` (which is string `'None'` which means 'no marker').

30.9 Changes in 1.5.2

30.9.1 Default Behavior Changes

Changed default `autorange` behavior in boxplots

Prior to v1.5.2, the whiskers of boxplots would extend to the minimum and maximum values if the quartiles were all equal (i.e., Q1 = median = Q3). This behavior has been disabled by default to restore consistency with other plotting packages.

To restore the old behavior, simply set `autorange=True` when calling `plt.boxplot`.

30.10 Changes in 1.5.0

30.10.1 Code Changes

Reversed `matplotlib.cbook.ls_mapper`, added `ls_mapper_r`

Formerly, `matplotlib.cbook.ls_mapper` was a dictionary with the long-form line-style names (`"solid"`) as keys and the short forms (`"-"`) as values. This long-to-short mapping is now done by `ls_mapper_r`, and the short-to-long mapping is done by the `ls_mapper`.

Prevent moving artists between Axes, Property-ify Artist.axes, deprecate Artist.{get,set}_axes

This was done to prevent an Artist that is already associated with an Axes from being moved/added to a different Axes. This was never supported as it causes havoc with the transform stack. The apparent support for this (as it did not raise an exception) was the source of multiple bug reports and questions on SO.

For almost all use-cases, the assignment of the axes to an artist should be taken care of by the axes as part of the `Axes.add_*` method, hence the deprecation of {get,set}_axes.

Removing the `set_axes` method will also remove the 'axes' line from the ACCEPTS kwarg tables (assuming that the removal date gets here before that gets overhauled).

Tightened input validation on 'pivot' kwarg to quiver

Tightened validation so that only {'tip', 'tail', 'mid', and 'middle'} (but any capitalization) are valid values for the 'pivot' kwarg in the `Quiver.__init__` (and hence `Axes.quiver` and `plt.quiver` which both fully delegate to `Quiver`). Previously any input matching 'mid.*' would be interpreted as 'middle', 'tip.*' as 'tip' and any string not matching one of those patterns as 'tail'.

The value of `Quiver.pivot` is normalized to be in the set {'tip', 'tail', 'middle'} in `Quiver.__init__`.

Reordered `Axes.get_children`

The artist order returned by `Axes.get_children` did not match the one used by `Axes.draw`. They now use the same order, as `Axes.draw` now calls `Axes.get_children`.

Changed behaviour of contour plots

The default behaviour of *contour()* and *contourf()* when using a masked array is now determined by the new keyword argument `corner_mask`, or if this is not specified then the new rcParam `contour.corner_mask` instead. The new default behaviour is equivalent to using `corner_mask=True`; the previous behaviour can be obtained using `corner_mask=False` or by changing the rcParam. The example http://matplotlib.org/examples/pylab_examples/contour_corner_mask.html demonstrates the difference. Use of the old contouring algorithm, which is obtained with `corner_mask='legacy'`, is now deprecated.

Contour labels may now appear in different places than in earlier versions of Matplotlib.

In addition, the keyword argument `nchunk` now applies to *contour()* as well as *contourf()*, and it subdivides the domain into subdomains of exactly `nchunk` by `nchunk` quads, whereas previously it was only roughly `nchunk` by `nchunk` quads.

The C/C++ object that performs contour calculations used to be stored in the public attribute QuadContourSet.Cntr, but is now stored in a private attribute and should not be accessed by end users.

Added set_params function to all Locator types

This was a bug fix targeted at making the api for Locators more consistent.

In the old behavior, only locators of type MaxNLocator have set_params() defined, causing its use on any other Locator to raise an AttributeError *(aside: set_params(args) is a function that sets the parameters of a Locator instance to be as specified within args)*. The fix involves moving set_params() to the Locator class such that all subtypes will have this function defined.

Since each of the Locator subtypes have their own modifiable parameters, a universal set_params() in Locator isn't ideal. Instead, a default no-operation function that raises a warning is implemented in Locator. Subtypes extending Locator will then override with their own implementations. Subtypes that do not have a need for set_params() will fall back onto their parent's implementation, which raises a warning as intended.

In the new behavior, Locator instances will not raise an AttributeError when set_params() is called. For Locators that do not implement set_params(), the default implementation in Locator is used.

Disallow `None` as x or y value in ax.plot

Do not allow `None` as a valid input for the `x` or `y` args in `ax.plot`. This may break some user code, but this was never officially supported (ex documented) and allowing `None` objects through can lead to confusing exceptions downstream.

To create an empty line use

```
ln1, = ax.plot([], [], ...)
ln2, = ax.plot([], ...)
```

In either case to update the data in the `Line2D` object you must update both the `x` and `y` data.

Removed `args` and `kwargs` from `MicrosecondLocator.__call__`

The call signature of `__call__()` has changed from `__call__(self, *args, **kwargs)` to `__call__(self)`. This is consistent with the superclass *Locator* and also all the other Locators derived from this superclass.

No `ValueError` for the MicrosecondLocator and YearLocator

The *MicrosecondLocator* and *YearLocator* objects when called will return an empty list if the axes have no data or the view has no interval. Previously, they raised a `ValueError`. This is consistent with all the Date Locators.

'OffsetBox.DrawingArea' respects the 'clip' keyword argument

The call signature was `OffsetBox.DrawingArea(..., clip=True)` but nothing was done with the `clip` argument. The object did not do any clipping regardless of that parameter. Now the object can and does clip the child `Artists` if they are set to be clipped.

You can turn off the clipping on a per-child basis using `child.set_clip_on(False)`.

Add salt to clipPath id

Add salt to the hash used to determine the id of the `clipPath` nodes. This is to avoid conflicts when two svg documents with the same clip path are included in the same document (see https://github.com/ipython/ipython/issues/8133 and https://github.com/matplotlib/matplotlib/issues/4349), however this means that the svg output is no longer deterministic if the same figure is saved twice. It is not expected that this will affect any users as the current ids are generated from an md5 hash of properties of the clip path and any user would have a very difficult time anticipating the value of the id.

Changed snap threshold for circle markers to inf

When drawing circle markers above some marker size (previously 6.0) the path used to generate the marker was snapped to pixel centers. However, this ends up distorting the marker away from a circle. By setting the snap threshold to inf snapping is never done on circles.

This change broke several tests, but is an improvement.

Preserve units with Text position

Previously the 'get_position' method on Text would strip away unit information even though the units were still present. There was no inherent need to do this, so it has been changed so that unit data (if present) will be preserved. Essentially a call to 'get_position' will return the exact value from a call to 'set_position'.

If you wish to get the old behaviour, then you can use the new method called 'get_unitless_position'.

New API for custom Axes view changes

Interactive pan and zoom were previously implemented using a Cartesian-specific algorithm that was not necessarily applicable to custom Axes. Three new private methods, `_get_view()`, `_set_view()`, and `_set_view_from_bbox()`, allow for custom *Axes* classes to override the pan and zoom algorithms. Implementors of custom *Axes* who override these methods may provide suitable behaviour for both pan and zoom as well as the view navigation buttons on the interactive toolbars.

30.10.2 MathTex visual changes

The spacing commands in mathtext have been changed to more closely match vanilla TeX.

Improved spacing in mathtext

The extra space that appeared after subscripts and superscripts has been removed.

No annotation coordinates wrap

In #2351 for 1.4.0 the behavior of ['axes points', 'axes pixel', 'figure points', 'figure pixel'] as coordinates was change to no longer wrap for negative values. In 1.4.3 this change was reverted for 'axes points' and 'axes pixel' and in addition caused 'axes fraction' to wrap. For 1.5 the behavior has been reverted to as it was in 1.4.0-1.4.2, no wrapping for any type of coordinate.

30.10.3 Deprecation

Deprecated `GraphicsContextBase.set_graylevel`

The `GraphicsContextBase.set_graylevel` function has been deprecated in 1.5 and will be removed in 1.6. It has been unused. The `GraphicsContextBase.set_foreground` could be used instead.

deprecated idle_event

The `idle_event` was broken or missing in most backends and causes spurious warnings in some cases, and its use in creating animations is now obsolete due to the animations module. Therefore code involving it has been removed from all but the wx backend (where it partially works), and its use is deprecated. The animations module may be used instead to create animations.

`color_cycle` deprecated

In light of the new property cycling feature, the Axes method *set_color_cycle* is now deprecated. Calling this method will replace the current property cycle with one that cycles just the given colors.

Similarly, the rc parameter *axes.color_cycle* is also deprecated in lieu of the new *axes.prop_cycle* parameter. Having both parameters in the same rc file is not recommended as the result cannot be predicted. For compatibility, setting *axes.color_cycle* will replace the cycler in *axes.prop_cycle* with a color cycle. Accessing *axes.color_cycle* will return just the color portion of the property cycle, if it exists.

Timeline for removal has not been set.

30.10.4 Bundled jquery

The version of jquery bundled with the webagg backend has been upgraded from 1.7.1 to 1.11.3. If you are using the version of jquery bundled with webagg you will need to update your html files as such

```
-    <script src="_static/jquery/js/jquery-1.7.1.min.js"></script>
+    <script src="_static/jquery/js/jquery-1.11.3.min.js"></script>
```

30.10.5 Code Removed

Removed `Image` from main namespace

`Image` was imported from PIL/pillow to test if PIL is available, but there is no reason to keep `Image` in the namespace once the availability has been determined.

Removed `lod` from Artist

Removed the method *set_lod* and all references to the attribute *_lod* as the are not used anywhere else in the code base. It appears to be a feature stub that was never built out.

Removed threading related classes from cbook

The classes `Scheduler`, `Timeout`, and `Idle` were in cbook, but are not used internally. They appear to be a prototype for the idle event system which was not working and has recently been pulled out.

Removed `Lena` images from sample_data

The `lena.png` and `lena.jpg` images have been removed from Matplotlib's sample_data directory. The images are also no longer available from *matplotlib.cbook.get_sample_data*. We suggest using `matplotlib.cbook.get_sample_data('grace_hopper.png')` or `matplotlib.cbook.get_sample_data('grace_hopper.jpg')` instead.

Legend

Removed handling of `loc` as a positional argument to `Legend`

Legend handlers

Remove code to allow legend handlers to be callable. They must now implement a method `legend_artist`.

Axis

Removed method `set_scale`. This is now handled via a private method which should not be used directly by users. It is called via `Axes.set_{x,y}scale` which takes care of ensuring the related changes are also made to the Axes object.

finance.py

Removed functions with ambiguous argument order from finance.py

Annotation

Removed `textcoords` and `xytext` proprieties from Annotation objects.

spinxext.ipython_*.py

Both `ipython_console_highlighting` and `ipython_directive` have been moved to `IPython`.

Change your import from 'matplotlib.sphinxext.ipython_directive' to 'IPython.sphinxext.ipython_directive' and from 'matplotlib.sphinxext.ipython_directive' to 'IPython.sphinxext.ipython_directive'

LineCollection.color

Deprecated in 2005, use `set_color`

remove `'faceted'` as a valid value for `shading` in `tri.tripcolor`

Use `edgecolor` instead. Added validation on `shading` to only be valid values.

Remove `faceted` kwarg from scatter

Remove support for the `faceted` kwarg. This was deprecated in d48b34288e9651ff95c3b8a071ef5ac5cf50bae7 (2008-04-18!) and replaced by `edgecolor`.

Remove `set_colorbar` method from `ScalarMappable`

Remove `set_colorbar` method, use `colorbar` attribute directly.

patheffects.svg

- remove `get_proxy_renderer` method from `AbstarctPathEffect` class
- remove `patch_alpha` and `offset_xy` from `SimplePatchShadow`

Remove `testing.image_util.py`

Contained only a no-longer used port of functionality from PIL

Remove `mlab.FIFOBuffer`

Not used internally and not part of core mission of mpl.

Remove `mlab.prepca`

Deprecated in 2009.

Remove `NavigationToolbar2QTAgg`

Added no functionality over the base `NavigationToolbar2Qt`

mpl.py

Remove the module `matplotlib.mpl`. Deprecated in 1.3 by PR #1670 and commit 78ce67d161625833cacff23cfe5d74920248c5b2

30.11 Changes in 1.4.x

30.11.1 Code changes

- A major refactoring of the axes module was made. The axes module has been split into smaller modules:
  - the `_base` module, which contains a new private _AxesBase class. This class contains all methods except plotting and labelling methods.
  - the `axes` module, which contains the Axes class. This class inherits from _AxesBase, and contains all plotting and labelling methods.

  - the `_subplot` module, with all the classes concerning subplotting.

There are a couple of things that do not exists in the `axes` module's namespace anymore. If you use them, you need to import them from their original location:

- math -> `import math`
- ma -> `from numpy import ma`
- cbook -> `from matplotlib import cbook`
- docstring -> `from matplotlib import docstring`
- is_sequence_of_strings -> `from matplotlib.cbook import is_sequence_of_strings`
- is_string_like -> `from matplotlib.cbook import is_string_like`
- iterable -> `from matplotlib.cbook import iterable`
- itertools -> `import itertools`
- martist -> `from matplotlib import artist as martist`
- matplotlib -> `import matplotlib`
- mcoll -> `from matplotlib import collections as mcoll`
- mcolors -> `from matplotlib import colors as mcolors`
- mcontour -> `from matplotlib import contour as mcontour`
- mpatches -> `from matplotlib import patches as mpatches`
- mpath -> `from matplotlib import path as mpath`
- mquiver -> `from matplotlib import quiver as mquiver`
- mstack -> `from matplotlib import stack as mstack`
- mstream -> `from matplotlib import stream as mstream`
- mtable -> `from matplotlib import table as mtable`
- As part of the refactoring to enable Qt5 support, the module `matplotlib.backends.qt4_compat` was renamed to `matplotlib.qt_compat`. `qt4_compat` is deprecated in 1.4 and will be removed in 1.5.
- The *errorbar()* method has been changed such that the upper and lower limits (*lolims*, *uplims*, *xlolims*, *xuplims*) now point in the correct direction.
- The *fmt* kwarg for `plot()` defaults.
- A bug has been fixed in the path effects rendering of fonts, which now means that the font size is consistent with non-path effect fonts. See https://github.com/matplotlib/matplotlib/issues/2889 for more detail.
- The Sphinx extensions `ipython_directive` and `ipython_console_highlighting` have been moved to the IPython project itself. While they remain in Matplotlib for this release, they have been deprecated. Update your extensions in `conf.py` to point to `IPython.sphinxext.ipython_directive` instead of `matplotlib.sphinxext.ipython_directive`.

- In `finance`, almost all functions have been deprecated and replaced with a pair of functions name `*_ochl` and `*_ohlc`. The former is the 'open-close-high-low' order of quotes used previously in this module, and the latter is the 'open-high-low-close' order that is standard in finance.
- For consistency the `face_alpha` keyword to *matplotlib.patheffects.SimplePatchShadow* has been deprecated in favour of the `alpha` keyword. Similarly, the keyword `offset_xy` is now named `offset` across all `_Base` has been renamed to *matplotlib.patheffects.AbstractPathEffect*. `matplotlib.patheffect.ProxyRenderer` has been renamed to *matplotlib.patheffects.PathEffectRenderer* and is now a full RendererBase subclass.
- The artist used to draw the outline of a `colorbar` has been changed from a *matplotlib.lines.Line2D* to *matplotlib.patches.Polygon*, thus `colorbar.ColorbarBase.outline` is now a *matplotlib.patches.Polygon* object.
- The legend handler interface has changed from a callable, to any object which implements the `legend_artists` method (a deprecation phase will see this interface be maintained for v1.4). See *Legend guide* for further details. Further legend changes include:
  - `matplotlib.axes.Axes._get_legend_handles()` now returns a generator of handles, rather than a list.
  - The *legend()* function's "loc" positional argument has been deprecated. Use the "loc" keyword instead.
- The rcParams `savefig.transparent` has been added to control default transparency when saving figures.
- Slightly refactored the `Annotation` family. The text location in `Annotation` is now handled entirely handled by the underlying `Text` object so `set_position` works as expected. The attributes `xytext` and `textcoords` have been deprecated in favor of `xyann` and `anncoords` so that `Annotation` and `AnnotaionBbox` can share a common sensibly named api for getting/setting the location of the text or box.
  - `xyann` -> set the location of the annotation
  - `xy` -> set where the arrow points to
  - `anncoords` -> set the units of the annotation location
  - `xycoords` -> set the units of the point location
  - `set_position()` -> `Annotation` only set location of annotation
- *matplotlib.mlab.specgram*, *matplotlib.mlab.psd*, *matplotlib.mlab.csd*, *matplotlib.mlab.cohere*, *matplotlib.mlab.cohere_pairs*, *matplotlib.pyplot.specgram*, *matplotlib.pyplot.psd*, *matplotlib.pyplot.csd*, and *matplotlib.pyplot.cohere* now raise ValueError where they previously raised AssertionError.
- For *matplotlib.mlab.psd*, *matplotlib.mlab.csd*, *matplotlib.mlab.cohere*, *matplotlib.mlab.cohere_pairs*, *matplotlib.pyplot.specgram*, *matplotlib.pyplot.psd*, *matplotlib.pyplot.csd*, and *matplotlib.pyplot.cohere*, in cases where a shape (n, 1) array is returned, this is now converted to a (n,) array. Previously, (n, m) arrays were averaged to an (n,) array, but (n, 1) arrays were returend unchanged. This change makes the dimensions consistent in both cases.

- Added the rcParam `axes.fromatter.useoffset` to control the default value of `useOffset` in `ticker.ScalarFormatter`
- Added `Formatter` sub-class `StrMethodFormatter` which does the exact same thing as `FormatStrFormatter`, but for new-style formatting strings.
- Deprecated `matplotlib.testing.image_util` and the only function within, `matplotlib.testing.image_util.autocontrast`. These will be removed completely in v1.5.0.
- The `fmt` argument of *plot_date()* has been changed from `bo` to just `o`, so color cycling can happen by default.
- Removed the class `FigureManagerQTAgg` and deprecated `NavigationToolbar2QTAgg` which will be removed in 1.5.
- Removed formerly public (non-prefixed) attributes `rect` and `drawRect` from `FigureCanvasQTAgg`; they were always an implementation detail of the (preserved) `drawRectangle()` function.
- The function signatures of `tight_bbox.adjust_bbox` and `tight_bbox.process_figure_for_rasterizing` have been changed. A new `fixed_dpi` parameter allows for overriding the `figure.dpi` setting instead of trying to deduce the intended behaviour from the file format.
- Added support for horizontal/vertical axes padding to `mpl_toolkits.axes_grid1.ImageGrid` — argument `axes_pad` can now be tuple-like if separate axis padding is required. The original behavior is preserved.
- Added support for skewed transforms to *matplotlib.transforms.Affine2D*, which can be created using the `skew` and `skew_deg` methods.
- Added clockwise parameter to control sectors direction in `axes.pie`
- In *matplotlib.lines.Line2D* the `markevery` functionality has been extended. Previously an integer start-index and stride-length could be specified using either a two-element-list or a two-element-tuple. Now this can only be done using a two-element-tuple. If a two-element-list is used then it will be treated as numpy fancy indexing and only the two markers corresponding to the given indexes will be shown.
- removed prop kwarg from *mpl_toolkits.axes_grid1.anchored_artists.AnchoredSizeBar* call. It was passed through to the base-class `__init__` and is only used for setting padding. Now `fontproperties` (which is what is really used to set the font properties of `AnchoredSizeBar`) is passed through in place of `prop`. If `fontpropreties` is not passed in, but `prop` is, then `prop` is used inplace of `fontpropreties`. If both are passed in, `prop` is silently ignored.
- The use of the index 0 in `plt.subplot` and related commands is deprecated. Due to a lack of validation calling `plt.subplots(2, 2, 0)` does not raise an exception, but puts an axes in the _last_ position. This is due to the indexing in subplot being 1-based (to mirror MATLAB) so before indexing into the `GridSpec` object used to determine where the axes should go, 1 is subtracted off. Passing in 0 results in passing -1 to `GridSpec` which results in getting the last position back. Even though this behavior is clearly wrong and not intended, we are going through a deprecation cycle in an abundance of caution that any users are exploiting this 'feature'. The use of 0 as an index will raise a warning in 1.4 and an exception in 1.5.
- Clipping is now off by default on offset boxes.

- Matplotlib now uses a less-aggressive call to `gc.collect(1)` when closing figures to avoid major delays with large numbers of user objects in memory.
- The default clip value of *all* pie artists now defaults to `False`.

30.11.2 Code removal

- Removed `mlab.levypdf`. The code raised a numpy error (and has for a long time) and was not the standard form of the Levy distribution. `scipy.stats.levy` should be used instead

30.12 Changes in 1.3.x

30.12.1 Changes in 1.3.1

It is rare that we make an API change in a bugfix release, however, for 1.3.1 since 1.3.0 the following change was made:

- `text.Text.cached` (used to cache font objects) has been made into a private variable. Among the obvious encapsulation benefit, this removes this confusing-looking member from the documentation.
- The method *hist()* now always returns bin occupancies as an array of type `float`. Previously, it was sometimes an array of type `int`, depending on the call.

30.12.2 Code removal

- The following items that were deprecated in version 1.2 or earlier have now been removed completely.
  - The Qt 3.x backends (`qt` and `qtagg`) have been removed in favor of the Qt 4.x backends (`qt4` and `qt4agg`).
  - The FltkAgg and Emf backends have been removed.
  - The `matplotlib.nxutils` module has been removed. Use the functionality on *matplotlib.path.Path.contains_point* and friends instead.
  - Instead of `axes.Axes.get_frame`, use `axes.Axes.patch`.
  - The following `kwargs` to the `legend` function have been renamed:
    - `pad` -> `borderpad`
    - `labelsep` -> `labelspacing`
    - `handlelen` -> `handlelength`
    - `handletextsep` -> `handletextpad`
    - `axespad` -> `borderaxespad`

    Related to this, the following rcParams have been removed:

    * legend.pad, legend.labelsep, legend.handlelen, legend.handletextsep and legend.axespad

  - For the hist function, instead of width, use rwidth (relative width).
  - On patches.Circle, the resolution kwarg has been removed. For a circle made up of line segments, use patches.CirclePolygon.
  - The printing functions in the Wx backend have been removed due to the burden of keeping them up-to-date.
  - mlab.liaupunov has been removed.
  - mlab.save, mlab.load, pylab.save and pylab.load have been removed. We recommend using numpy.savetxt and numpy.loadtxt instead.
  - widgets.HorizontalSpanSelector has been removed. Use widgets.SpanSelector instead.

30.12.3 Code deprecation

- The CocoaAgg backend has been deprecated, with the possibility for deletion or resurrection in a future release.
- The top-level functions in *matplotlib.path* that are implemented in C++ were never meant to be public. Instead, users should use the Pythonic wrappers for them in the path.Path and collections.Collection classes. Use the following mapping to update your code:
  - point_in_path -> path.Path.contains_point
  - get_path_extents -> path.Path.get_extents
  - point_in_path_collection -> collection.Collection.contains
  - path_in_path -> path.Path.contains_path
  - path_intersects_path -> path.Path.intersects_path
  - convert_path_to_polygons -> path.Path.to_polygons
  - cleanup_path -> path.Path.cleaned
  - points_in_path -> path.Path.contains_points
  - clip_path_to_rect -> path.Path.clip_to_bbox
- matplotlib.colors.normalize and matplotlib.colors.no_norm have been deprecated in favour of *matplotlib.colors.Normalize* and *matplotlib.colors.NoNorm* respectively.
- The ScalarMappable class' set_colorbar is now deprecated. Instead, the *matplotlib.cm.ScalarMappable.colorbar* attribute should be used. In previous Matplotlib versions this attribute was an undocumented tuple of (colorbar_instance, colorbar_axes) but is now just colorbar_instance. To get the colorbar axes it is possible to just use the *ax* attribute on a colorbar instance.

- The `mpl` module is now deprecated. Those who relied on this module should transition to simply using `import matplotlib as mpl`.

30.12.4 Code changes

- *Patch* now fully supports using RGBA values for its `facecolor` and `edgecolor` attributes, which enables faces and edges to have different alpha values. If the *Patch* object's `alpha` attribute is set to anything other than `None`, that value will override any alpha-channel value in both the face and edge colors. Previously, if *Patch* had `alpha=None`, the alpha component of `edgecolor` would be applied to both the edge and face.
- The optional `isRGB` argument to *set_foreground()* (and the other GraphicsContext classes that descend from it) has been renamed to `isRGBA`, and should now only be set to `True` if the `fg` color argument is known to be an RGBA tuple.
- For *Patch*, the `capstyle` used is now `butt`, to be consistent with the default for most other objects, and to avoid problems with non-solid `linestyle` appearing solid when using a large `linewidth`. Previously, *Patch* used `capstyle='projecting'`.
- `Path` objects can now be marked as `readonly` by passing `readonly=True` to its constructor. The built-in path singletons, obtained through `Path.unit*` class methods return readonly paths. If you have code that modified these, you will need to make a deepcopy first, using either:

```
import copy
path = copy.deepcopy(Path.unit_circle())

# or

path = Path.unit_circle().deepcopy()
```

  Deep copying a `Path` always creates an editable (i.e. non-readonly) `Path`.
- The list at `Path.NUM_VERTICES` was replaced by a dictionary mapping Path codes to the number of expected vertices at *NUM_VERTICES_FOR_CODE*.
- To support XKCD style plots, the `matplotlib.path.cleanup_path()` method's signature was updated to require a sketch argument. Users of `matplotlib.path.cleanup_path()` are encouraged to use the new *cleaned()* Path method.
- Data limits on a plot now start from a state of having "null" limits, rather than limits in the range (0, 1). This has an effect on artists that only control limits in one direction, such as `axvline` and `axhline`, since their limits will not longer also include the range (0, 1). This fixes some problems where the computed limits would be dependent on the order in which artists were added to the axes.
- Fixed a bug in setting the position for the right/top spine with data position type. Previously, it would draw the right or top spine at +1 data offset.
- In *FancyArrow*, the default arrow head width, `head_width`, has been made larger to produce a visible arrow head. The new value of this kwarg is `head_width = 20 * width`.
- It is now possible to provide `number of levels + 1` colors in the case of `extend='both'` for contourf (or just `number of levels` colors for an extend value `min` or `max`) such that the resulting

colormap's `set_under` and `set_over` are defined appropriately. Any other number of colors will continue to behave as before (if more colors are provided than levels, the colors will be unused). A similar change has been applied to contour, where `extend='both'` would expect `number of levels + 2` colors.

- A new keyword *extendrect* in *colorbar()* and *ColorbarBase* allows one to control the shape of colorbar extensions.
- The extension of *MultiCursor* to both vertical (default) and/or horizontal cursor implied that `self.line` is replaced by `self.vline` for vertical cursors lines and `self.hline` is added for the horizontal cursors lines.
- On POSIX platforms, the *report_memory()* function raises `NotImplementedError` instead of `OSError` if the **ps** command cannot be run.
- The `matplotlib.cbook.check_output()` function has been moved to `matplotlib.compat.subprocess()`.

30.12.5 Configuration and rcParams

- On Linux, the user-specific `matplotlibrc` configuration file is now located in `config/matplotlib/matplotlibrc` to conform to the XDG Base Directory Specification.
- The `font.*` rcParams now affect only text objects created after the rcParam has been set, and will not retroactively affect already existing text objects. This brings their behavior in line with most other rcParams.
- Removed call of *grid()* in *plotfile()*. To draw the axes grid, set the `axes.grid` rcParam to *True*, or explicitly call *grid()*.

30.13 Changes in 1.2.x

- The `classic` option of the rc parameter `toolbar` is deprecated and will be removed in the next release.
- The `isvector()` method has been removed since it is no longer functional.
- The `rasterization_zorder` property on *Axes* a zorder below which artists are rasterized. This has defaulted to -30000.0, but it now defaults to `None`, meaning no artists will be rasterized. In order to rasterize artists below a given zorder value, `set_rasterization_zorder` must be explicitly called.
- In *scatter()*, and `scatter`, when specifying a marker using a tuple, the angle is now specified in degrees, not radians.
- Using *twinx()* or *twiny()* no longer overrides the current locaters and formatters on the axes.
- In *contourf()*, the handling of the *extend* kwarg has changed. Formerly, the extended ranges were mapped after to 0, 1 after being normed, so that they always corresponded to the extreme values of the colormap. Now they are mapped outside this range so that they correspond to the special colormap values determined by the *set_under()* and *set_over()* methods, which default to the colormap end points.

- The new rc parameter `savefig.format` replaces `cairo.format` and `savefig.extension`, and sets the default file format used by *matplotlib.figure.Figure.savefig()*.
- In *pie()* and `pie()`, one can now set the radius of the pie; setting the *radius* to 'None' (the default value), will result in a pie with a radius of 1 as before.
- Use of `projection_factory()` is now deprecated in favour of axes class identification using *process_projection_requirements()* followed by direct axes class invocation (at the time of writing, functions which do this are: *add_axes()*, *add_subplot()* and *gca()*). Therefore:

```
key = figure._make_key(*args, **kwargs)
ispolar = kwargs.pop('polar', False)
projection = kwargs.pop('projection', None)
if ispolar:
    if projection is not None and projection != 'polar':
        raise ValueError('polar and projection args are inconsistent')
    projection = 'polar'
ax = projection_factory(projection, self, rect, **kwargs)
key = self._make_key(*args, **kwargs)

# is now

projection_class, kwargs, key = \
                    process_projection_requirements(self, *args, **kwargs)
ax = projection_class(self, rect, **kwargs)
```

  This change means that third party objects can expose themselves as Matplotlib axes by providing a `_as_mpl_axes` method. See *Developer's guide for creating scales and transformations* for more detail.

- A new keyword *extendfrac* in *colorbar()* and *ColorbarBase* allows one to control the size of the triangular minimum and maximum extensions on colorbars.
- A new keyword *capthick* in *errorbar()* has been added as an intuitive alias to the *markeredgewidth* and *mew* keyword arguments, which indirectly controlled the thickness of the caps on the errorbars. For backwards compatibility, specifying either of the original keyword arguments will override any value provided by *capthick*.
- Transform subclassing behaviour is now subtly changed. If your transform implements a non-affine transformation, then it should override the `transform_non_affine` method, rather than the generic `transform` method. Previously transforms would define `transform` and then copy the method into `transform_non_affine`:

```
class MyTransform(mtrans.Transform):
    def transform(self, xy):
        ...
    transform_non_affine = transform
```

  This approach will no longer function correctly and should be changed to:

```
class MyTransform(mtrans.Transform):
    def transform_non_affine(self, xy):
        ...
```

- Artists no longer have `x_isdata` or `y_isdata` attributes; instead any artist's transform can be interrogated with `artist_instance.get_transform().contains_branch(ax.transData)`
- Lines added to an axes now take into account their transform when updating the data and view limits. This means transforms can now be used as a pre-transform. For instance:

```
>>> import matplotlib.pyplot as plt
>>> import matplotlib.transforms as mtrans
>>> ax = plt.axes()
>>> ax.plot(range(10), transform=mtrans.Affine2D().scale(10) + ax.transData)
>>> print(ax.viewLim)
Bbox('array([[  0.,   0.],\n       [ 90.,  90.]])')
```

- One can now easily get a transform which goes from one transform's coordinate system to another, in an optimized way, using the new subtract method on a transform. For instance, to go from data coordinates to axes coordinates:

```
>>> import matplotlib.pyplot as plt
>>> ax = plt.axes()
>>> data2ax = ax.transData - ax.transAxes
>>> print(ax.transData.depth, ax.transAxes.depth)
3, 1
>>> print(data2ax.depth)
2
```

  for versions before 1.2 this could only be achieved in a sub-optimal way, using `ax.transData + ax.transAxes.inverted()` (depth is a new concept, but had it existed it would return 4 for this example).

- `twinx` and `twiny` now returns an instance of SubplotBase if parent axes is an instance of SubplotBase.
- All Qt3-based backends are now deprecated due to the lack of py3k bindings. Qt and QtAgg backends will continue to work in v1.2.x for py2.6 and py2.7. It is anticipated that the Qt3 support will be completely removed for the next release.
- `ColorConverter`, *Colormap* and *Normalize* now subclasses `object`
- ContourSet instances no longer have a `transform` attribute. Instead, access the transform with the `get_transform` method.

30.14 Changes in 1.1.x

- Added new *matplotlib.sankey.Sankey* for generating Sankey diagrams.
- In *imshow()*, setting *interpolation* to 'nearest' will now always mean that the nearest-neighbor interpolation is performed. If you want the no-op interpolation to be performed, choose 'none'.
- There were errors in how the tri-functions were handling input parameters that had to be fixed. If your tri-plots are not working correctly anymore, or you were working around apparent mistakes, please see issue #203 in the github tracker. When in doubt, use kwargs.

- The 'symlog' scale had some bad behavior in previous versions. This has now been fixed and users should now be able to use it without frustrations. The fixes did result in some minor changes in appearance for some users who may have been depending on the bad behavior.
- There is now a common set of markers for all plotting functions. Previously, some markers existed only for *scatter()* or just for *plot()*. This is now no longer the case. This merge did result in a conflict. The string 'd' now means "thin diamond" while 'D' will mean "regular diamond".

30.15 Changes beyond 0.99.x

- The default behavior of *matplotlib.axes.Axes.set_xlim()*, *matplotlib.axes.Axes.set_ylim()*, and *matplotlib.axes.Axes.axis()*, and their corresponding pyplot functions, has been changed: when view limits are set explicitly with one of these methods, autoscaling is turned off for the matching axis. A new *auto* kwarg is available to control this behavior. The limit kwargs have been renamed to *left* and *right* instead of *xmin* and *xmax*, and *bottom* and *top* instead of *ymin* and *ymax*. The old names may still be used, however.
- There are five new Axes methods with corresponding pyplot functions to facilitate autoscaling, tick location, and tick label formatting, and the general appearance of ticks and tick labels:
  - *matplotlib.axes.Axes.autoscale()* turns autoscaling on or off, and applies it.
  - *matplotlib.axes.Axes.margins()* sets margins used to autoscale the `matplotlib.axes.Axes.viewLim` based on the `matplotlib.axes.Axes.dataLim`.
  - *matplotlib.axes.Axes.locator_params()* allows one to adjust axes locator parameters such as *nbins*.
  - *matplotlib.axes.Axes.ticklabel_format()* is a convenience method for controlling the *matplotlib.ticker.ScalarFormatter* that is used by default with linear axes.
  - *matplotlib.axes.Axes.tick_params()* controls direction, size, visibility, and color of ticks and their labels.
- The *matplotlib.axes.Axes.bar()* method accepts a *error_kw* kwarg; it is a dictionary of kwargs to be passed to the errorbar function.
- The *matplotlib.axes.Axes.hist()* *color* kwarg now accepts a sequence of color specs to match a sequence of datasets.
- The *EllipseCollection* has been changed in two ways:
  - There is a new *units* option, 'xy', that scales the ellipse with the data units. This matches the :class:'~matplotlib.patches.Ellipse' scaling.
  - The *height* and *width* kwargs have been changed to specify the height and width, again for consistency with *Ellipse*, and to better match their names; previously they specified the half-height and half-width.
- There is a new rc parameter `axes.color_cycle`, and the color cycle is now independent of the rc parameter `lines.color`. `matplotlib.Axes.set_default_color_cycle()` is deprecated.

- You can now print several figures to one pdf file and modify the document information dictionary of a pdf file. See the docstrings of the class *matplotlib.backends.backend_pdf.PdfPages* for more information.
- Removed configobj and enthought.traits packages, which are only required by the experimental traited config and are somewhat out of date. If needed, install them independently.
- The new rc parameter `savefig.extension` sets the filename extension that is used by *matplotlib.figure.Figure.savefig()* if its *fname* argument lacks an extension.
- In an effort to simplify the backend API, all clipping rectangles and paths are now passed in using GraphicsContext objects, even on collections and images. Therefore:

```
draw_path_collection(self, master_transform, cliprect, clippath,
                     clippath_trans, paths, all_transforms, offsets,
                     offsetTrans, facecolors, edgecolors, linewidths,
                     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.

30.16 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.

30.17 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.

30.18 Changes for 0.98.1

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

30.19 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`)

30.19.1 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

30.20 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__

30.21 Changes for 0.91.1

30.22 Changes for 0.91.0

- Changed cbook.is_file_like() to cbook.is_writable_file_like() and corrected behavior.
- Added ax kwarg to pyplot.colorbar() and Figure.colorbar() so that one can specify the axes object from which space for the colorbar is to be taken, if one does not want to make the colorbar axes manually.
- Changed cbook.reversed() so it yields a tuple rather than a (index, tuple). This agrees with the python reversed builtin, and cbook only defines reversed if python doesn't provide the builtin.
- Made skiprows=1 the default on csv2rec()
- The gd and paint backends have been deleted.
- The errorbar method and function now accept additional kwargs so that upper and lower limits can be indicated by capping the bar with a caret instead of a straight line segment.
- The *matplotlib.dviread* file now has a parser for files like psfonts.map and pdftex.map, to map TeX font names to external files.

- The file *matplotlib.type1font* contains a new class for Type 1 fonts. Currently it simply reads pfa and pfb format files and stores the data in a way that is suitable for embedding in pdf files. In the future the class might actually parse the font to allow e.g., subsetting.
- matplotlib.FT2Font now supports FT_Attach_File(). In practice this can be used to read an afm file in addition to a pfa/pfb file, to get metrics and kerning information for a Type 1 font.
- The AFM class now supports querying CapHeight and stem widths. The get_name_char method now has an isord kwarg like get_width_char.
- Changed pcolor() default to shading='flat'; but as noted now in the docstring, it is preferable to simply use the 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, e.g., $\mathcal{R}$.
- 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.

30.23 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.
```

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```
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 (e.g., I added a default label
on this iteration) w/o having to change the tuple length and hence
the API of the client code every time 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 functions 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
```

30.24 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
```

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```
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
```

30.25 Changes for 0.87.7

```
Completely reworked the annotations API because I found the old
API cumbersome.  The new design is much more legible and easy to
read.  See matplotlib.text.Annotation and
examples/annotation_demo.py

markeredgecolor and markerfacecolor cannot be configured in
matplotlibrc any more. Instead, markers are generally colored
automatically based on the color of the line, unless marker colors
are explicitly set as kwargs - NN

Changed default comment character for load to '#' - JDH

math_parse_s_ft2font_svg from mathtext.py & mathtext2.py now returns
width, height, svg_elements. svg_elements is an instance of Bunch (
cmbook.py) and has the attributes svg_glyphs and svg_lines, which are both
lists.
```

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```
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.
```

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```
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.
```

30.26 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.
```

30.27 Changes for 0.85

```
Made xtick and ytick separate props in rc

made pos=None the default for tick formatters rather than 0 to
```

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```
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.
```

30.28 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
```

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```
from to_str.  Removed origin kwarg from backend.draw_image.
origin is handled entirely by the frontend now.
```

30.29 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.
  e.g., 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.
```

30.30 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. That's all good but I am confused over the use of linspace
      for the bin creation. I wouldn't have thought that it does
```

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```
    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)
```

30.31 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
```

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```
    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].
```

30.32 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
```

30.33 Changes for 0.73

```
- Removed deprecated ColormapJet and friends

- Removed all error handling from the verbose object

- figure num of zero is now allowed
```

30.34 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
```

30.35 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

```

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```
  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, e.g., (amin, amax, asum)
```

30.36 Changes for 0.70

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

Removed definct set_measurement in wx toolbar
```

30.37 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 axes.  If you
have code you are porting which called, e.g., figmanager.add_axes, you
can now simply do figmanager.canvas.figure.add_axes.
```

30.38 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.
```

30.39 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.  e.g.,

  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
```

30.40 Changes for 0.61

```
canvas.connect is now deprecated for event handling.  use
mpl_connect and mpl_disconnect instead.  The callback signature is
func(event) rather than func(widget, event)
```

30.41 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
```

30.42 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.
```

30.43 Changes for 0.54

30.43.1 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, e.g., 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, e.g., 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'$\rm{Histogram\ of\ IQ:}\ \mu=100,\ \sigma=15$')
```

30.43.2 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. e.g., 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 geometry and properties of the object. Now default values are added to the object when you call axes.add_line or axes.add_patch, so they are hidden from the user.

If you want to define a custom transformation on these objects, call o.set_transform(trans) where trans is a Transformation instance.

In prior versions of you wanted to add a custom line in data coords, you would have to do

l = Line2D(dpi, bbox, x, y, color = color, transx = transx, transy = transy,)

now all you need is

l = Line2D(x, y, color=color)

and the axes will set the transformation for you (unless you have set your own already, in which case it will eave it unchanged)

Transformations

The entire transformation architecture has been rewritten. Previously the x and y transformations where stored in the xaxis and yaxis instances. The problem with this approach is it only allows for separable transforms (where the x and y transformations don't depend on one another). But for cases like polar, they do. Now transformations operate on x,y together. There is a new base class matplotlib.transforms.Transformation and two concrete implementations, matplotlib.transforms.SeparableTransformation and matplotlib.transforms.Affine. The SeparableTransformation is constructed with the bounding box of the input (this determines the rectangular coordinate system of the input, i.e., the x and y view limits), the bounding box of the display, and possibly nonlinear transformations of x and y. The 2 most frequently used transformations, data coordinates -> display and axes coordinates -> display are available as ax.transData and ax.transAxes. See alignment_demo.py which uses axes coords.

Also, the transformations should be much faster now, for two reasons

- they are written entirely in extension code
- because they operate on x and y together, they can do the entire transformation in one loop. Earlier I did something along the lines of:

```
xt = sx*func(x) + tx
yt = sy*func(y) + ty
```

  Although this was done in numerix, it still involves 6 length(x) for-loops (the multiply, add, and function evaluation each for x and y). Now all of that is done in a single pass.

If you are using transformations and bounding boxes to get the cursor position in data coordinates, the method calls are a little different now. See the updated examples/coords_demo.py which shows you how to do this.

Likewise, if you are using the artist bounding boxes to pick items on the canvas with the GUI, the bbox methods are somewhat different. You will need to see the updated examples/object_picker.py.

See unit/transforms_unit.py for many examples using the new transformations.

30.44 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
```

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```
* 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.  e.g., 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 initialized with a
  FigureCanvas, not a Figure.  The examples embedding_in_gtk.py,
```

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```
  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.
```

30.45 Changes for 0.42

```
* Refactoring AxisText to be backend independent.  Text drawing and
  get_window_extent functionality will be moved to the Renderer.

* backend_bases.AxisTextBase is now text.Text module

* All the erase and reset functionality removed from AxisText - not
  needed with double buffered drawing.  Ditto with state change.
  Text instances have a get_prop_tup method that returns a hashable
  tuple of text properties which you can use to see if text props
  have changed, e.g., 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
```

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```
  matplotlib.matlab.get_current_fig_manager to allow user access to
  the GUI window attribute, e.g., figManager.window for GTK and
  figManager.frame for wx
```

30.46 Changes for 0.40

```
- Artist
    * __init__ takes a DPI instance and a Bound2D instance which is
      the bounding box of the artist in display coords
    * get_window_extent returns a Bound2D instance
    * set_size is removed; replaced by bbox and dpi
    * the clip_gc method is removed.  Artists now clip themselves with
      their box
    * added _clipOn boolean attribute.  If True, gc clip to bbox.

- AxisTextBase
    * Initialized with a transx, transy which are Transform instances
    * set_drawing_area removed
    * get_left_right and get_top_bottom are replaced by get_window_extent

- Line2D Patches now take transx, transy
    * Initialized with a transx, transy which are Transform instances

- Patches
   * Initialized with a transx, transy which are Transform instances

- FigureBase attributes dpi is a DPI instance rather than scalar and
  new attribute bbox is a Bound2D in display coords, and I got rid
  of the left, width, height, etc... attributes.  These are now
  accessible as, for example, bbox.x.min is left, bbox.x.interval()
  is width, bbox.y.max is top, etc...

- GcfBase attribute pagesize renamed to figsize

- Axes
    * removed figbg attribute
    * added fig instance to __init__
    * resizing is handled by figure call to resize.

- Subplot
    * added fig instance to __init__

- Renderer methods for patches now take gcEdge and gcFace instances.
  gcFace=None takes the place of filled=False

- True and False symbols provided by cbook in a python2.3 compatible
  way

- new module transforms supplies Bound1D, Bound2D and Transform
```

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```
  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

THIRTYONE

THE TOP LEVEL MATPLOTLIB MODULE

matplotlib.**use**(*arg*, *warn=True*, *force=False*)

Set the matplotlib backend to one of the known backends.

The argument is case-insensitive. *warn* specifies whether a warning should be issued if a backend has already been set up. *force* is an **experimental** flag that tells matplotlib to attempt to initialize a new backend by reloading the backend module.

Note: This function must be called *before* importing pyplot for the first time; or, if you are not using pyplot, it must be called before importing matplotlib.backends. If warn is True, a warning is issued if you try and call this after pylab or pyplot have been loaded. In certain black magic use cases, e.g. *pyplot.switch_backend()*, we are doing the reloading necessary to make the backend switch work (in some cases, e.g., pure image backends) so one can set warn=False to suppress the warnings.

To find out which backend is currently set, see *matplotlib.get_backend()*.

matplotlib.**get_backend**()

Return the name of the current backend.

matplotlib.**rcParams**

An instance of *RcParams* for handling default matplotlib values.

matplotlib.**rc_context**(*rc=None*, *fname=None*)

Return a context manager for managing rc settings.

This allows one to do:

```
with mpl.rc_context(fname='screen.rc'):
    plt.plot(x, a)
    with mpl.rc_context(fname='print.rc'):
        plt.plot(x, b)
    plt.plot(x, c)
```

The 'a' vs 'x' and 'c' vs 'x' plots would have settings from 'screen.rc', while the 'b' vs 'x' plot would have settings from 'print.rc'.

A dictionary can also be passed to the context manager:

```
with mpl.rc_context(rc={'text.usetex': True}, fname='screen.rc'):
    plt.plot(x, a)
```

The 'rc' dictionary takes precedence over the settings loaded from 'fname'. Passing a dictionary only is also valid. For example a common usage is:

```
with mpl.rc_context(rc={'interactive': False}):
    fig, ax = plt.subplots()
    ax.plot(range(3), range(3))
    fig.savefig('A.png', format='png')
    plt.close(fig)
```

matplotlib.**rc**(*group*, ***kwargs*)

Set the current rc params. Group is the grouping for the rc, e.g., 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, e.g., (*xtick*, *ytick*). *kwargs* is a dictionary attribute name/value pairs, e.g.,:

```
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. e.g., 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 `matplotlib.style.use('default')` or *`rcdefaults()`* to restore the default rc params after changes.

matplotlib.**rc_file**(*fname*)
Update rc params from file.

matplotlib.**rcdefaults**()
Restore the rc params from Matplotlib's internal defaults.

See also:

rc_file_defaults Restore the rc params from the rc file originally loaded by Matplotlib.

matplotlib.style.use Use a specific style file. Call `style.use('default')` to restore the default style.

matplotlib.**rc_file_defaults**()
Restore the rc params from the original rc file loaded by Matplotlib.

class matplotlib.**RcParams**(**args*, ***kwargs*)
A dictionary object including validation

validating functions are defined and associated with rc parameters in *matplotlib.rcsetup*

find_all(*pattern*)
Return the subset of this RcParams dictionary whose keys match, using `re.search()`, the given `pattern`.

Note: Changes to the returned dictionary are *not* propagated to the parent RcParams dictionary.

msg_backend_obsolete = 'The {} rcParam was deprecated in version 2.2. In order to force th

msg_depr = '%s is deprecated and replaced with %s; please use the latter.'

msg_depr_ignore = '%s is deprecated and ignored. Use %s instead.'

msg_depr_set = '%s is deprecated. Please remove it from your matplotlibrc and/or style fil

msg_obsolete = '%s is obsolete. Please remove it from your matplotlibrc and/or style files

validate = {'_internal.classic_mode': <function validate_bool at 0x7f2d1eb7d400>, 'agg.pa

matplotlib.**rc_params**(*fail_on_error=False*)
Return a *matplotlib.RcParams* instance from the default matplotlib rc file.

matplotlib.**rc_params_from_file**(*fname*, *fail_on_error=False*, *use_default_template=True*)
Return *matplotlib.RcParams* from the contents of the given file.

Parameters

fname [str] Name of file parsed for matplotlib settings.

fail_on_error [bool] If True, raise an error when the parser fails to convert a parameter.

use_default_template [bool] If True, initialize with default parameters before updating with those in the given file. If False, the configuration class only contains the parameters specified in the file. (Useful for updating dicts.)

matplotlib.**matplotlib_fname**()

Get the location of the config file.

The file location is determined in the following order

- `$PWD/matplotlibrc`
- `$MATPLOTLIBRC` if it is a file (or a named pipe, which can be created e.g. by process substitution)
- `$MATPLOTLIBRC/matplotlibrc`
- `$MPLCONFIGDIR/matplotlibrc`
- On Linux,
  - `$XDG_CONFIG_HOME/matplotlib/matplotlibrc` (if $XDG_CONFIG_HOME is defined)
  - or `$HOME/.config/matplotlib/matplotlibrc` (if $XDG_CONFIG_HOME is not defined)
- On other platforms,
  - `$HOME/.matplotlib/matplotlibrc` if `$HOME` is defined.
- Lastly, it looks in `$MATPLOTLIBDATA/matplotlibrc` for a system-defined copy.

matplotlib.**interactive**(*b*)

Set interactive mode to boolean b.

If b is True, then draw after every plotting command, e.g., after xlabel

matplotlib.**is_interactive**()

Return true if plot mode is interactive

CHAPTER

THIRTYTWO

AFM (ADOBE FONT METRICS INTERFACE)

32.1 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 this, it was decided not to go with them because they were either:

1. copyrighted or used a non-BSD compatible license
2. had too many dependencies and a free standing lib was needed
3. Did more than needed and it was easier to write afresh rather than figure out how to get just what was needed.

It is pretty easy to use, and requires only built-in python libs:

```
>>> from matplotlib import rcParams
>>> import os.path
>>> afm_fname = os.path.join(rcParams['datapath'],
...                          'fonts', 'afm', 'ptmr8a.afm')
>>>
>>> from matplotlib.afm import AFM
>>> with open(afm_fname, 'rb') as fh:
...     afm = AFM(fh)
>>> afm.string_width_height('What the heck?')
(6220.0, 694)
>>> 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]
```

class matplotlib.afm.**AFM**(*fh*)

Bases: object

Parse the AFM file in file object *fh*

family_name

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, e.g., 'Times'

get_fontname()
Return the font name, e.g., 'Times-Roman'

get_fullname()
Return the font full name, e.g., '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, i.e., ';' 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, e.g., '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.

matplotlib.afm.**parse_afm**(*fh*)

Parse the Adobe Font Metics file in file handle *fh*. Return value is a (*dhead*, *dcmetrics_ascii*, *dmetrics_name*, *dkernpairs*, *dcomposite*) tuple where *dhead* is a `_parse_header()` dict, *dcmetrics_ascii* and *dcmetrics_name* are the two resulting dicts from `_parse_char_metrics()`, *dkernpairs* is a `_parse_kern_pairs()` dict (possibly {}) and *dcomposite* is a `_parse_composites()` dict (possibly {})

CHAPTER

THIRTYTHREE

ANIMATION

Table of Contents

- *Animation*
- *Writer Classes*
- *Helper Classes*
- *Inheritance Diagrams*

33.1 Animation

The easiest way to make a live animation in matplotlib is to use one of the *Animation* classes.

FuncAnimation	Makes an animation by repeatedly calling a function `func`.
ArtistAnimation	Animation using a fixed set of `Artist` objects.

33.1.1 matplotlib.animation.FuncAnimation

class matplotlib.animation.**FuncAnimation**(*fig*, *func*, *frames=None*, *init_func=None*, *fargs=None*, *save_count=None*, ***kwargs*)

Bases: *matplotlib.animation.TimedAnimation*

Makes an animation by repeatedly calling a function `func`.

Parameters

fig [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

func [callable] The function to call at each frame. The first argument will be the next value in `frames`. Any additional positional arguments can be supplied via the `fargs` parameter.

The required signature is:

```
def func(frame, *fargs) -> iterable_of_artists:
```

frames [iterable, int, generator function, or None, optional] Source of data to pass `func` and each frame of the animation

If an iterable, then simply use the values provided. If the iterable has a length, it will override the `save_count` kwarg.

If an integer, then equivalent to passing `range(frames)`

If a generator function, then must have the signature:

```
def gen_function() -> obj:
```

If `None`, then equivalent to passing `itertools.count`.

In all of these cases, the values in *frames* is simply passed through to the user-supplied *func* and thus can be of any type.

init_func [callable, optional] A function used to draw a clear frame. If not given, the results of drawing from the first item in the frames sequence will be used. This function will be called once before the first frame.

If `blit == True`, `init_func` must return an iterable of artists to be re-drawn.

The required signature is:

```
def init_func() -> iterable_of_artists:
```

fargs [tuple or None, optional] Additional arguments to pass to each call to *func*.

save_count [int, optional] The number of values from *frames* to cache.

interval [number, optional] Delay between frames in milliseconds. Defaults to 200.

repeat_delay [number, optional] If the animation in repeated, adds a delay in milliseconds before repeating the animation. Defaults to `None`.

repeat [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to `True`.

blit [bool, optional] Controls whether blitting is used to optimize drawing. Defaults to `False`.

`new_frame_seq`()
Creates a new sequence of frame information.

`new_saved_frame_seq`()
Creates a new sequence of saved/cached frame information.

`save`(*filename*, *writer=None*, *fps=None*, *dpi=None*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*, *extra_anim=None*, *savefig_kwargs=None*)
Saves a movie file by drawing every frame.

Parameters

filename [str] The output filename, e.g., `mymovie.mp4`.

writer [*MovieWriter* or str, optional] A *MovieWriter* instance to use or a key that identifies a class to use, such as 'ffmpeg'. If `None`, defaults to `rcParams["animation.writer"]`.

fps [number, optional] Frames per second in the movie. Defaults to `None`, which will use the animation's specified interval to set the frames per second.

dpi [number, optional] Controls the dots per inch for the movie frames. This combined with the figure's size in inches controls the size of the movie. If `None`, defaults to `rcParams["savefig.dpi"]`.

codec [str, optional] The video codec to be used. Not all codecs are supported by a given *MovieWriter*. If `None`, default to `rcParams["animation.codec"]`.

bitrate [number, optional] Specifies the number of bits used per second in the compressed movie, in kilobits per second. A higher number means a higher quality movie, but at the cost of increased file size. If `None`, defaults to `rcParams["animation.bitrate"]`.

extra_args [list, optional] List of extra string arguments to be passed to the underlying movie utility. If `None`, defaults to `rcParams["animation.extra_args"]`.

metadata [Dict[str, str], optional] Dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

extra_anim [list, optional] Additional *Animation* objects that should be included in the saved movie file. These need to be from the same *matplotlib.figure.Figure* instance. Also, animation frames will just be simply combined, so there should be a 1:1 correspondence between the frames from the different animations.

savefig_kwargs [dict, optional] Is a dictionary containing keyword arguments to be passed on to the `savefig` command which is called repeatedly to save the individual frames.

Notes

fps, codec, bitrate, extra_args, metadata are used to construct a *MovieWriter* instance and can only be passed if `writer` is a string. If they are passed as non-`None` and `writer` is a *MovieWriter*, a `RuntimeError` will be raised.

`to_html5_video`(*embed_limit=None*)

Returns animation as an HTML5 video tag.

This saves the animation as an h264 video, encoded in base64 directly into the HTML5 video tag. This respects the rc parameters for the writer as well as the bitrate. This also makes use of the `interval` to control the speed, and uses the `repeat` parameter to decide whether to loop.

to_jshtml(*fps=None*, *embed_frames=True*, *default_mode=None*)
Generate HTML representation of the animation

Examples using matplotlib.animation.FuncAnimation

- *Animated line plot*
- *Decay*
- *Animated histogram*
- *Oscilloscope*
- *The Bayes update*
- *MATPLOTLIB UNCHAINED*
- *Animated 3D random walk*
- *The double pendulum problem*
- *Rain simulation*

33.1.2 matplotlib.animation.ArtistAnimation

class matplotlib.animation.**ArtistAnimation**(*fig*, *artists*, **args*, ***kwargs*)
Bases: *matplotlib.animation.TimedAnimation*

Animation using a fixed set of `Artist` objects.

Before creating an instance, all plotting should have taken place and the relevant artists saved.

Parameters

fig [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

artists [list] Each list entry a collection of artists that represent what needs to be enabled on each frame. These will be disabled for other frames.

interval [number, optional] Delay between frames in milliseconds. Defaults to 200.

repeat_delay [number, optional] If the animation in repeated, adds a delay in milliseconds before repeating the animation. Defaults to `None`.

repeat [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to `True`.

blit [bool, optional] Controls whether blitting is used to optimize drawing. Defaults to `False`.

new_frame_seq()
Creates a new sequence of frame information.

new_saved_frame_seq()
Creates a new sequence of saved/cached frame information.

save(*filename*, *writer=None*, *fps=None*, *dpi=None*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*, *extra_anim=None*, *savefig_kwargs=None*)
Saves a movie file by drawing every frame.

Parameters

filename [str] The output filename, e.g., `mymovie.mp4`.

writer [*MovieWriter* or str, optional] A *MovieWriter* instance to use or a key that identifies a class to use, such as 'ffmpeg'. If `None`, defaults to `rcParams["animation.writer"]`.

fps [number, optional] Frames per second in the movie. Defaults to `None`, which will use the animation's specified interval to set the frames per second.

dpi [number, optional] Controls the dots per inch for the movie frames. This combined with the figure's size in inches controls the size of the movie. If `None`, defaults to `rcParams["savefig.dpi"]`.

codec [str, optional] The video codec to be used. Not all codecs are supported by a given *MovieWriter*. If `None`, default to `rcParams["animation.codec"]`.

bitrate [number, optional] Specifies the number of bits used per second in the compressed movie, in kilobits per second. A higher number means a higher quality movie, but at the cost of increased file size. If `None`, defaults to `rcParams["animation.bitrate"]`.

extra_args [list, optional] List of extra string arguments to be passed to the underlying movie utility. If `None`, defaults to `rcParams["animation.extra_args"]`.

metadata [Dict[str, str], optional] Dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

extra_anim [list, optional] Additional *Animation* objects that should be included in the saved movie file. These need to be from the same *matplotlib.figure.Figure* instance. Also, animation frames will just be simply combined, so there should be a 1:1 correspondence between the frames from the different animations.

savefig_kwargs [dict, optional] Is a dictionary containing keyword arguments to be passed on to the `savefig` command which is called repeatedly to save the individual frames.

Notes

fps, codec, bitrate, extra_args, metadata are used to construct a *MovieWriter* instance and can only be passed if `writer` is a string. If they are passed as non-`None` and `writer` is a *MovieWriter*, a `RuntimeError` will be raised.

to_html5_video(*embed_limit=None*)
Returns animation as an HTML5 video tag.

This saves the animation as an h264 video, encoded in base64 directly into the HTML5 video tag. This respects the rc parameters for the writer as well as the bitrate. This also makes use of the `interval` to control the speed, and uses the `repeat` parameter to decide whether to loop.

to_jshtml(*fps=None*, *embed_frames=True*, *default_mode=None*)
Generate HTML representation of the animation

Examples using `matplotlib.animation.ArtistAnimation`

- *Animated image using a precomputed list of images*

In both cases it is critical to keep a reference to the instance object. The animation is advanced by a timer (typically from the host GUI framework) which the *Animation* object holds the only reference to. If you do not hold a reference to the *Animation* object, it (and hence the timers), will be garbage collected which will stop the animation.

To save an animation to disk use *Animation.save* or *Animation.to_html5_video*

See *Helper Classes* below for details about what movie formats are supported.

33.1.3 FuncAnimation

The inner workings of *FuncAnimation* is more-or-less:

```
for d in frames:
   artists = func(d, *fargs)
   fig.canvas.draw_idle()
   fig.canvas.start_event_loop(interval)
```

with details to handle 'blitting' (to dramatically improve the live performance), to be non-blocking, not repeatedly start/stop the GUI event loop, handle repeats, multiple animated axes, and easily save the animation to a movie file.

'Blitting' is a old technique in computer graphics. The general gist is to take an existing bit map (in our case a mostly rasterized figure) and then 'blit' one more artist on top. Thus, by managing a saved 'clean' bitmap, we can only re-draw the few artists that are changing at each frame and possibly save significant amounts of time. When using blitting (by passing `blit=True`) the core loop of *FuncAnimation* gets a bit more complicated

```
ax = fig.gca()

def update_blit(artists):
    fig.canvas.restore_region(bg_cache)
    for a in artists:
        a.axes.draw_artist(a)

    ax.figure.canvas.blit(ax.bbox)

artists = init_func()
```

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```
for a in artists:
   a.set_animated(True)

fig.canvas.draw()
bg_cache = fig.canvas.copy_from_bbox(ax.bbox)

for f in frames:
    artists = func(f, *fargs)
    update_blit(artists)
    fig.canvas.start_event_loop(interval)
```

This is of course leaving out many details (such as updating the background when the figure is resized or fully re-drawn). However, this hopefully minimalist example gives a sense of how `init_func` and `func` are used inside of *FuncAnimation* and the theory of how 'blitting' works.

The expected signature on `func` and `init_func` is very simple to keep *FuncAnimation* out of your book keeping and plotting logic, but this means that the callable objects you pass in must know what artists they should be working on. There are several approaches to handling this, of varying complexity and encapsulation. The simplest approach, which works quite well in the case of a script, is to define the artist at a global scope and let Python sort things out. For example

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

fig, ax = plt.subplots()
xdata, ydata = [], []
ln, = plt.plot([], [], 'ro', animated=True)

def init():
    ax.set_xlim(0, 2*np.pi)
    ax.set_ylim(-1, 1)
    return ln,

def update(frame):
    xdata.append(frame)
    ydata.append(np.sin(frame))
    ln.set_data(xdata, ydata)
    return ln,

ani = FuncAnimation(fig, update, frames=np.linspace(0, 2*np.pi, 128),
                    init_func=init, blit=True)
plt.show()
```

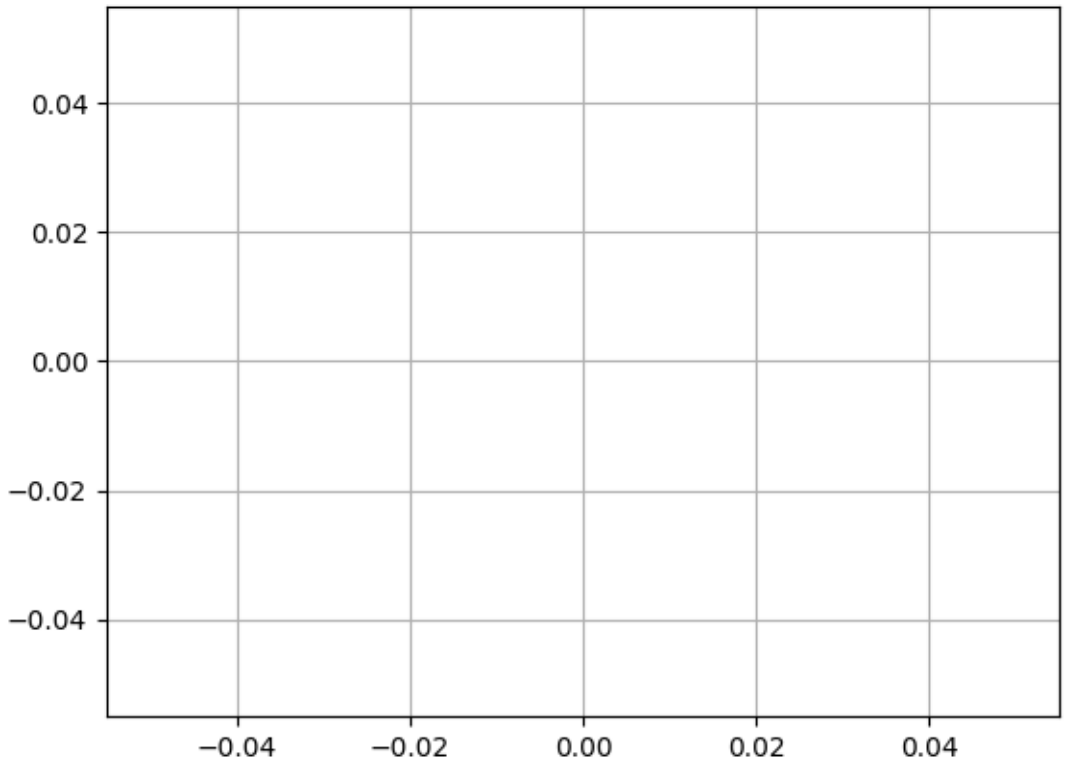
The second method is to us `functools.partial` to 'bind' artists to function. A third method is to use closures to build up the required artists and functions. A fourth method is to create a class.

Examples

Note: Click *here* to download the full example code

Decay

This example showcases: - using a generator to drive an animation, - changing axes limits during an animation.




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


def data_gen(t=0):
    cnt = 0
    while cnt < 1000:
        cnt += 1
        t += 0.1
        yield t, np.sin(2*np.pi*t) * np.exp(-t/10.)
```

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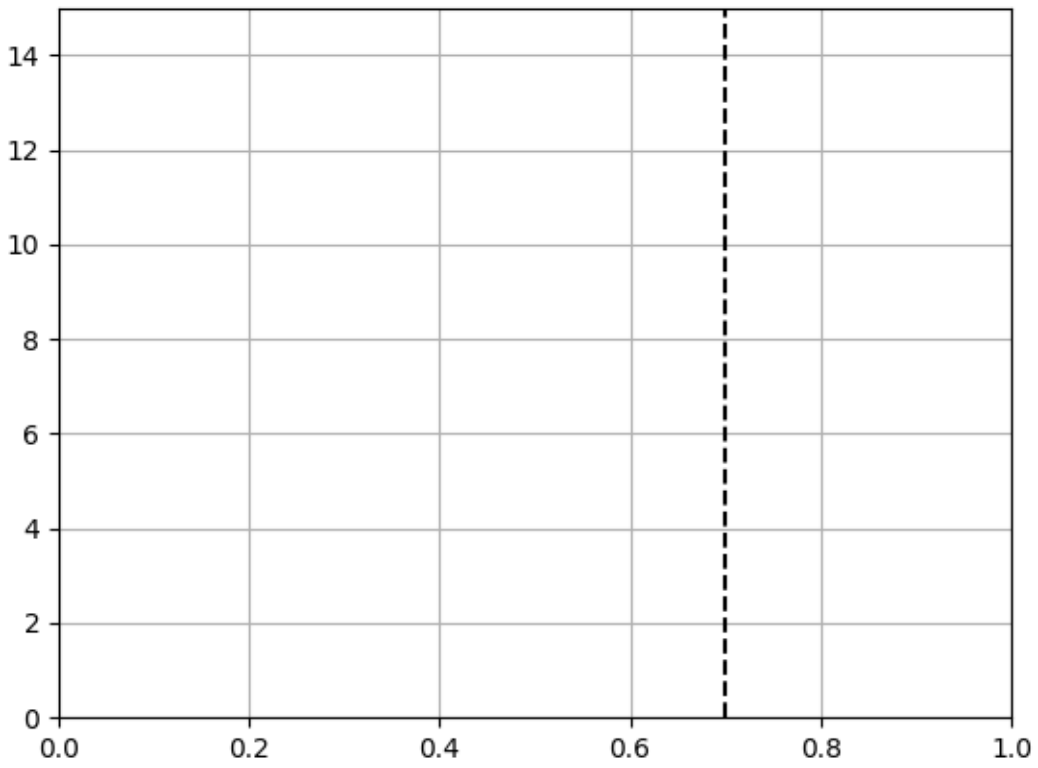
```
def init():
    ax.set_ylim(-1.1, 1.1)
    ax.set_xlim(0, 10)
    del xdata[:]
    del ydata[:]
    line.set_data(xdata, ydata)
    return line,

fig, ax = plt.subplots()
line, = ax.plot([], [], lw=2)
ax.grid()
xdata, ydata = [], []


def run(data):
    # update the data
    t, y = data
    xdata.append(t)
    ydata.append(y)
    xmin, xmax = ax.get_xlim()

    if t >= xmax:
        ax.set_xlim(xmin, 2*xmax)
        ax.figure.canvas.draw()
    line.set_data(xdata, ydata)

    return line,

ani = animation.FuncAnimation(fig, run, data_gen, blit=False, interval=10,
                              repeat=False, init_func=init)
plt.show()
```

Note: Click *here* to download the full example code

The Bayes update

This animation displays the posterior estimate updates as it is refitted when new data arrives. The vertical line represents the theoretical value to which the plotted distribution should converge.




```
import math

import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation


def beta_pdf(x, a, b):
    return (x**(a-1) * (1-x)**(b-1) * math.gamma(a + b)
            / (math.gamma(a) * math.gamma(b)))


class UpdateDist(object):
    def __init__(self, ax, prob=0.5):
        self.success = 0
        self.prob = prob
        self.line, = ax.plot([], [], 'k-')
        self.x = np.linspace(0, 1, 200)
        self.ax = ax

        # Set up plot parameters
        self.ax.set_xlim(0, 1)
        self.ax.set_ylim(0, 15)
```

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```
        self.ax.grid(True)

        # This vertical line represents the theoretical value, to
        # which the plotted distribution should converge.
        self.ax.axvline(prob, linestyle='--', color='black')

    def init(self):
        self.success = 0
        self.line.set_data([], [])
        return self.line,

    def __call__(self, i):
        # This way the plot can continuously run and we just keep
        # watching new realizations of the process
        if i == 0:
            return self.init()

        # Choose success based on exceed a threshold with a uniform pick
        if np.random.rand(1,) < self.prob:
            self.success += 1
        y = beta_pdf(self.x, self.success + 1, (i - self.success) + 1)
        self.line.set_data(self.x, y)
        return self.line,

# Fixing random state for reproducibility
np.random.seed(19680801)


fig, ax = plt.subplots()
ud = UpdateDist(ax, prob=0.7)
anim = FuncAnimation(fig, ud, frames=np.arange(100), init_func=ud.init,
                     interval=100, blit=True)
plt.show()
```

Note: Click *here* to download the full example code

The double pendulum problem

This animation illustrates the double pendulum problem.

Double pendulum formula translated from the C code at http://www.physics.usyd.edu.au/~wheat/dpend_html/solve_dpend.c

```
from numpy import sin, cos
import numpy as np
import matplotlib.pyplot as plt
import scipy.integrate as integrate
import matplotlib.animation as animation
```

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```
G = 9.8  # acceleration due to gravity, in m/s^2
L1 = 1.0  # length of pendulum 1 in m
L2 = 1.0  # length of pendulum 2 in m
M1 = 1.0  # mass of pendulum 1 in kg
M2 = 1.0  # mass of pendulum 2 in kg


def derivs(state, t):

    dydx = np.zeros_like(state)
    dydx[0] = state[1]

    del_ = state[2] - state[0]
    den1 = (M1 + M2)*L1 - M2*L1*cos(del_)*cos(del_)
    dydx[1] = (M2*L1*state[1]*state[1]*sin(del_)*cos(del_) +
               M2*G*sin(state[2])*cos(del_) +
               M2*L2*state[3]*state[3]*sin(del_) -
               (M1 + M2)*G*sin(state[0]))/den1

    dydx[2] = state[3]

    den2 = (L2/L1)*den1
    dydx[3] = (-M2*L2*state[3]*state[3]*sin(del_)*cos(del_) +
               (M1 + M2)*G*sin(state[0])*cos(del_) -
               (M1 + M2)*L1*state[1]*state[1]*sin(del_) -
               (M1 + M2)*G*sin(state[2]))/den2

    return dydx

# create a time array from 0..100 sampled at 0.05 second steps
dt = 0.05
t = np.arange(0.0, 20, dt)

# th1 and th2 are the initial angles (degrees)
# w10 and w20 are the initial angular velocities (degrees per second)
th1 = 120.0
w1 = 0.0
th2 = -10.0
w2 = 0.0

# initial state
state = np.radians([th1, w1, th2, w2])

# integrate your ODE using scipy.integrate.
y = integrate.odeint(derivs, state, t)

x1 = L1*sin(y[:, 0])
y1 = -L1*cos(y[:, 0])

x2 = L2*sin(y[:, 2]) + x1
y2 = -L2*cos(y[:, 2]) + y1
```

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```
fig = plt.figure()
ax = fig.add_subplot(111, autoscale_on=False, xlim=(-2, 2), ylim=(-2, 2))
ax.set_aspect('equal')
ax.grid()

line, = ax.plot([], [], 'o-', lw=2)
time_template = 'time = %.1fs'
time_text = ax.text(0.05, 0.9, '', transform=ax.transAxes)


def init():
    line.set_data([], [])
    time_text.set_text('')
    return line, time_text


def animate(i):
    thisx = [0, x1[i], x2[i]]
    thisy = [0, y1[i], y2[i]]

    line.set_data(thisx, thisy)
    time_text.set_text(time_template % (i*dt))
    return line, time_text

ani = animation.FuncAnimation(fig, animate, np.arange(1, len(y)),
                              interval=25, blit=True, init_func=init)

plt.show()
```

Note: Click *here* to download the full example code

Animated histogram

Use a path patch to draw a bunch of rectangles for an animated histogram.

```
import numpy as np

import matplotlib.pyplot as plt
import matplotlib.patches as patches
import matplotlib.path as path
import matplotlib.animation as animation

# Fixing random state for reproducibility
np.random.seed(19680801)

# histogram our data with numpy
data = np.random.randn(1000)
```

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```
n, bins = np.histogram(data, 100)

# 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
nrects = len(left)
```

Here comes the tricky part – we have to set up the vertex and path codes arrays using `plt.Path.MOVETO`, `plt.Path.LINETO` and `plt.Path.CLOSEPOLY` for each rect.

- We need 1 `MOVETO` per rectangle, which sets the initial point.
- We need 3 `LINETO`'s, which tell Matplotlib to draw lines from vertex 1 to vertex 2, v2 to v3, and v3 to v4.
- We then need one `CLOSEPOLY` which tells Matplotlib to draw a line from the v4 to our initial vertex (the `MOVETO` vertex), in order to close the polygon.

Note: The vertex for `CLOSEPOLY` is ignored, but we still need a placeholder in the `verts` array 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
```

To animate the histogram, we need an `animate` function, which generates a random set of numbers and updates the locations of the vertices for the histogram (in this case, only the heights of each rectangle). `patch` will eventually be a `Patch` object.

```
patch = None


def animate(i):
    # simulate new data coming in
    data = np.random.randn(1000)
    n, bins = np.histogram(data, 100)
    top = bottom + n
    verts[1::5, 1] = top
```

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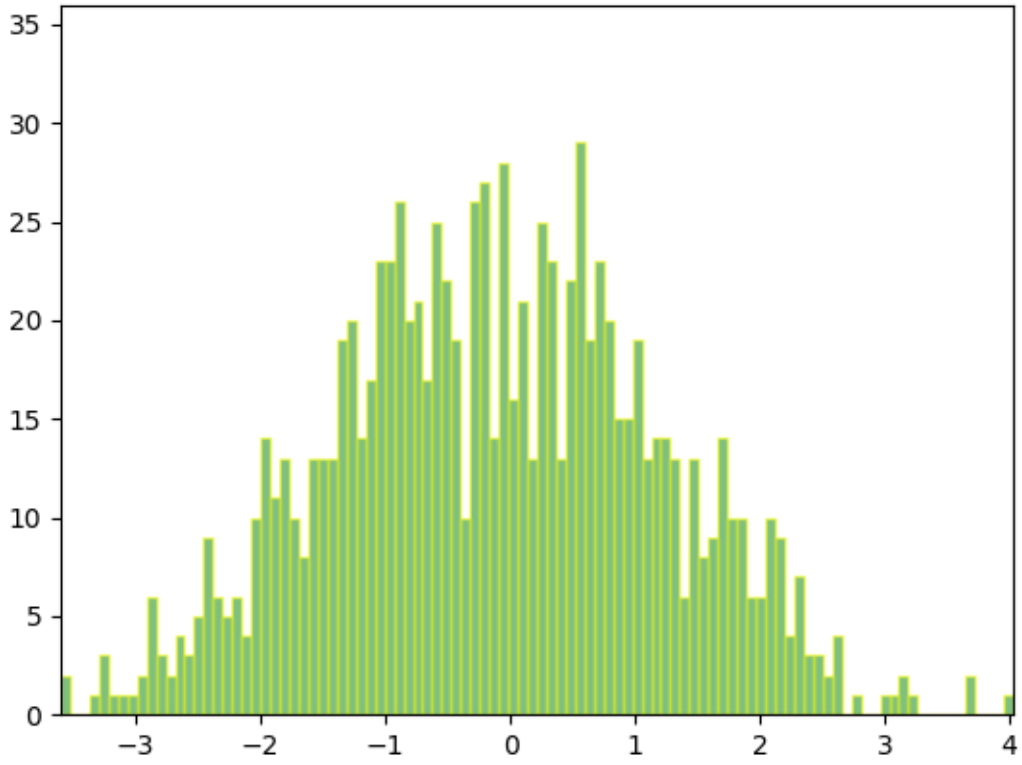
```
    verts[2::5, 1] = top
    return [patch, ]
```

And now we build the `Path` and `Patch` instances for the histogram using our vertices and codes. We add the patch to the `Axes` instance, and setup the `FuncAnimation` with our animate function.

```
fig, ax = plt.subplots()
barpath = path.Path(verts, codes)
patch = patches.PathPatch(
    barpath, facecolor='green', edgecolor='yellow', alpha=0.5)
ax.add_patch(patch)

ax.set_xlim(left[0], right[-1])
ax.set_ylim(bottom.min(), top.max())

ani = animation.FuncAnimation(fig, animate, 100, repeat=False, blit=True)
plt.show()
```



Note: Click *here* to download the full example code

Rain simulation

Simulates rain drops on a surface by animating the scale and opacity of 50 scatter points.

Author: Nicolas P. Rougier

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.animation import FuncAnimation

# Fixing random state for reproducibility
np.random.seed(19680801)
```

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```
# Create new Figure and an Axes which fills it.
fig = plt.figure(figsize=(7, 7))
ax = fig.add_axes([0, 0, 1, 1], frameon=False)
ax.set_xlim(0, 1), ax.set_xticks([])
ax.set_ylim(0, 1), ax.set_yticks([])

# Create rain data
n_drops = 50
rain_drops = np.zeros(n_drops, dtype=[('position', float, 2),
                                      ('size',     float, 1),
                                      ('growth',   float, 1),
                                      ('color',    float, 4)])

# Initialize the raindrops in random positions and with
# random growth rates.
rain_drops['position'] = np.random.uniform(0, 1, (n_drops, 2))
rain_drops['growth'] = np.random.uniform(50, 200, n_drops)

# Construct the scatter which we will update during animation
# as the raindrops develop.
scat = ax.scatter(rain_drops['position'][:, 0], rain_drops['position'][:, 1],
                  s=rain_drops['size'], lw=0.5, edgecolors=rain_drops['color'],
                  facecolors='none')


def update(frame_number):
    # Get an index which we can use to re-spawn the oldest raindrop.
    current_index = frame_number % n_drops

    # Make all colors more transparent as time progresses.
    rain_drops['color'][:, 3] -= 1.0/len(rain_drops)
    rain_drops['color'][:, 3] = np.clip(rain_drops['color'][:, 3], 0, 1)

    # Make all circles bigger.
    rain_drops['size'] += rain_drops['growth']

    # Pick a new position for oldest rain drop, resetting its size,
    # color and growth factor.
    rain_drops['position'][current_index] = np.random.uniform(0, 1, 2)
    rain_drops['size'][current_index] = 5
    rain_drops['color'][current_index] = (0, 0, 0, 1)
    rain_drops['growth'][current_index] = np.random.uniform(50, 200)

    # Update the scatter collection, with the new colors, sizes and positions.
    scat.set_edgecolors(rain_drops['color'])
    scat.set_sizes(rain_drops['size'])
    scat.set_offsets(rain_drops['position'])


# Construct the animation, using the update function as the animation director.
animation = FuncAnimation(fig, update, interval=10)
```

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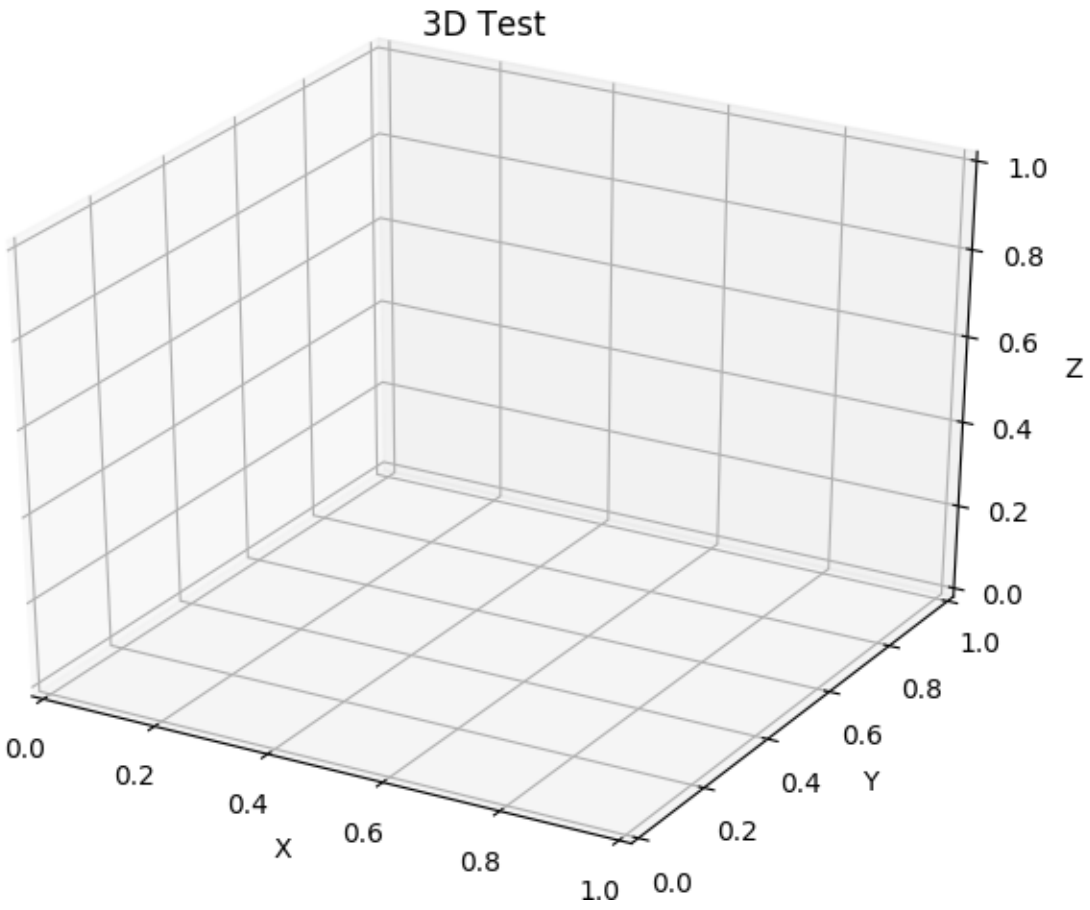
```
plt.show()
```

Note: Click *here* to download the full example code

Animated 3D random walk




```
import numpy as np
import matplotlib.pyplot as plt
import mpl_toolkits.mplot3d.axes3d as p3
import matplotlib.animation as animation

# Fixing random state for reproducibility
np.random.seed(19680801)


def Gen_RandLine(length, dims=2):
    """
    Create a line using a random walk algorithm
```

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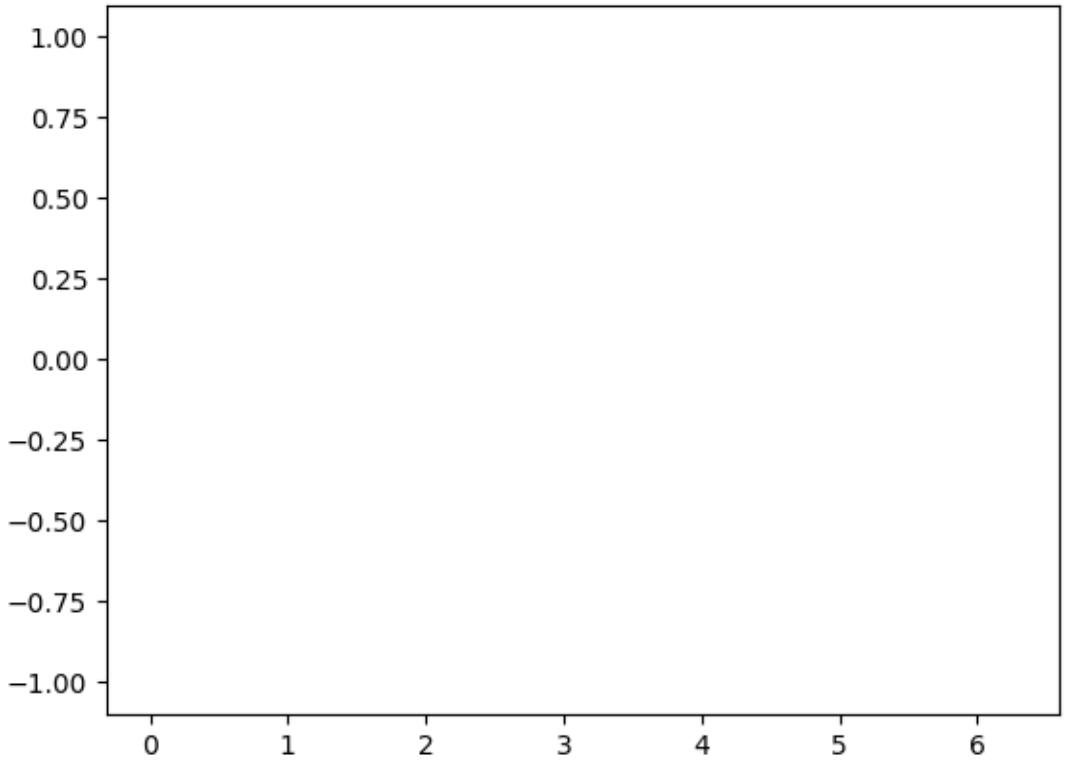
```
    length is the number of points for the line.
    dims is the number of dimensions the line has.
    """
    lineData = np.empty((dims, length))
    lineData[:, 0] = np.random.rand(dims)
    for index in range(1, length):
        # scaling the random numbers by 0.1 so
        # movement is small compared to position.
        # subtraction by 0.5 is to change the range to [-0.5, 0.5]
        # to allow a line to move backwards.
        step = ((np.random.rand(dims) - 0.5) * 0.1)
        lineData[:, index] = lineData[:, index - 1] + step

    return lineData


def update_lines(num, dataLines, lines):
    for line, data in zip(lines, dataLines):
        # NOTE: there is no .set_data() for 3 dim data...
        line.set_data(data[0:2, :num])
        line.set_3d_properties(data[2, :num])
    return lines

# Attaching 3D axis to the figure
fig = plt.figure()
ax = p3.Axes3D(fig)

# Fifty lines of random 3-D lines
data = [Gen_RandLine(25, 3) for index in range(50)]

# Creating fifty line objects.
# NOTE: Can't pass empty arrays into 3d version of plot()
lines = [ax.plot(dat[0, 0:1], dat[1, 0:1], dat[2, 0:1])[0] for dat in data]

# Setting the axes properties
ax.set_xlim3d([0.0, 1.0])
ax.set_xlabel('X')

ax.set_ylim3d([0.0, 1.0])
ax.set_ylabel('Y')

ax.set_zlim3d([0.0, 1.0])
ax.set_zlabel('Z')

ax.set_title('3D Test')

# Creating the Animation object
line_ani = animation.FuncAnimation(fig, update_lines, 25, fargs=(data, lines),
                                   interval=50, blit=False)

plt.show()
```

Note: Click *here* to download the full example code

Animated line plot




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

fig, ax = plt.subplots()

x = np.arange(0, 2*np.pi, 0.01)
line, = ax.plot(x, np.sin(x))


def init():  # only required for blitting to give a clean slate.
    line.set_ydata([np.nan] * len(x))
    return line,
```

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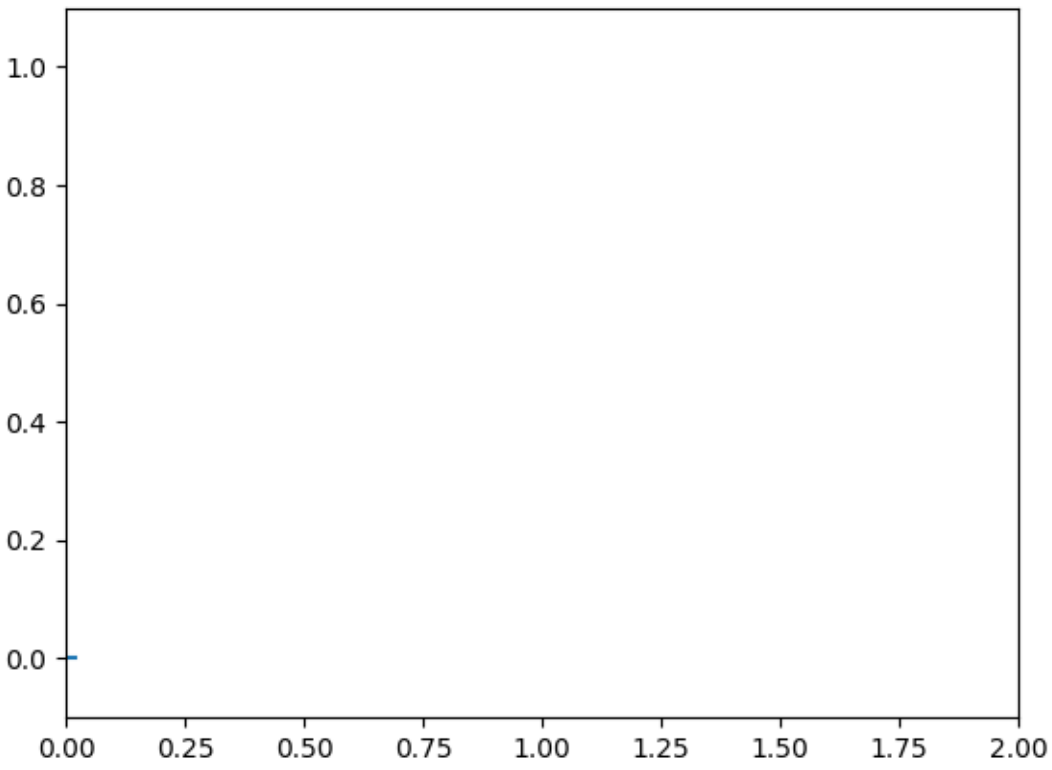
```
def animate(i):
    line.set_ydata(np.sin(x + i / 100))  # update the data.
    return line,


ani = animation.FuncAnimation(
    fig, animate, init_func=init, interval=2, blit=True, save_count=50)

# To save the animation, use e.g.
#
# ani.save("movie.mp4")
#
# or
#
# from matplotlib.animation import FFMpegWriter
# writer = FFMpegWriter(fps=15, metadata=dict(artist='Me'), bitrate=1800)
# ani.save("movie.mp4", writer=writer)

plt.show()
```

Note: Click *here* to download the full example code

Oscilloscope

Emulates an oscilloscope.




```
import numpy as np
from matplotlib.lines import Line2D
import matplotlib.pyplot as plt
import matplotlib.animation as animation


class Scope(object):
    def __init__(self, ax, maxt=2, dt=0.02):
        self.ax = ax
        self.dt = dt
        self.maxt = maxt
        self.tdata = [0]
        self.ydata = [0]
        self.line = Line2D(self.tdata, self.ydata)
        self.ax.add_line(self.line)
        self.ax.set_ylim(-.1, 1.1)
        self.ax.set_xlim(0, self.maxt)

    def update(self, y):
        lastt = self.tdata[-1]
        if lastt > self.tdata[0] + self.maxt:  # reset the arrays
            self.tdata = [self.tdata[-1]]
            self.ydata = [self.ydata[-1]]
```

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```
            self.ax.set_xlim(self.tdata[0], self.tdata[0] + self.maxt)
            self.ax.figure.canvas.draw()

        t = self.tdata[-1] + self.dt
        self.tdata.append(t)
        self.ydata.append(y)
        self.line.set_data(self.tdata, self.ydata)
        return self.line,


def emitter(p=0.03):
    'return a random value with probability p, else 0'
    while True:
        v = np.random.rand(1)
        if v > p:
            yield 0.
        else:
            yield np.random.rand(1)

# Fixing random state for reproducibility
np.random.seed(19680801)


fig, ax = plt.subplots()
scope = Scope(ax)

# pass a generator in "emitter" to produce data for the update func
ani = animation.FuncAnimation(fig, scope.update, emitter, interval=10,
                              blit=True)

plt.show()
```

Note: Click *here* to download the full example code

MATPLOTLIB UNCHAINED

Comparative path demonstration of frequency from a fake signal of a pulsar (mostly known because of the cover for Joy Division's Unknown Pleasures).

Author: Nicolas P. Rougier

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

# Fixing random state for reproducibility
np.random.seed(19680801)


# Create new Figure with black background
fig = plt.figure(figsize=(8, 8), facecolor='black')

# Add a subplot with no frame
ax = plt.subplot(111, frameon=False)
```

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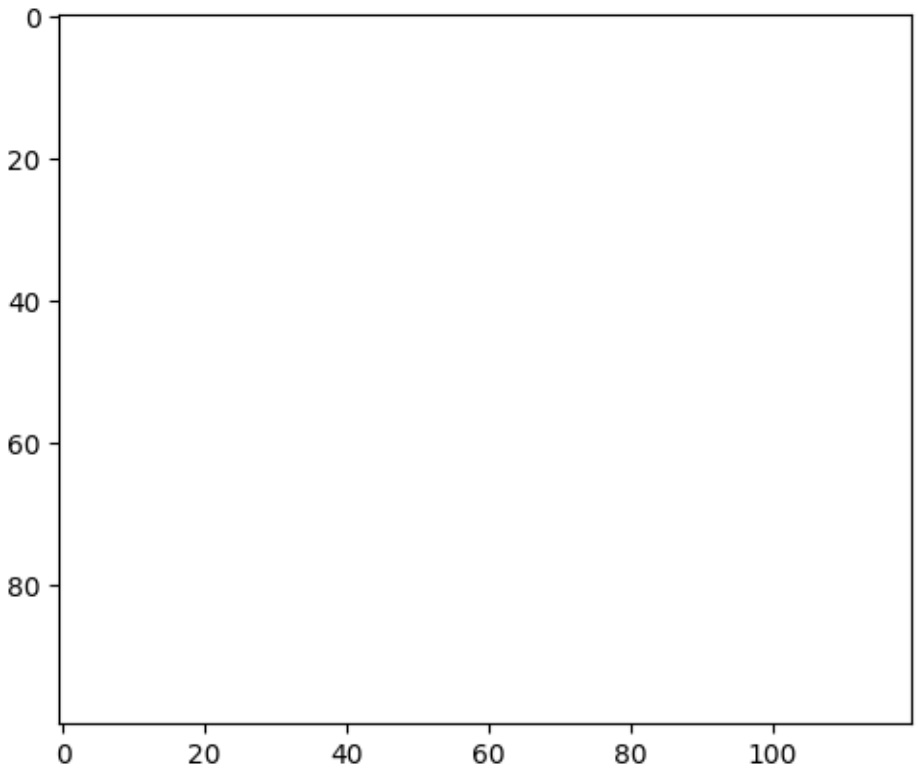
```
# Generate random data
data = np.random.uniform(0, 1, (64, 75))
X = np.linspace(-1, 1, data.shape[-1])
G = 1.5 * np.exp(-4 * X ** 2)

# Generate line plots
lines = []
for i in range(len(data)):
    # Small reduction of the X extents to get a cheap perspective effect
    xscale = 1 - i / 200.
    # Same for linewidth (thicker strokes on bottom)
    lw = 1.5 - i / 100.0
    line, = ax.plot(xscale * X, i + G * data[i], color="w", lw=lw)
    lines.append(line)

# Set y limit (or first line is cropped because of thickness)
ax.set_ylim(-1, 70)

# No ticks
ax.set_xticks([])
ax.set_yticks([])

# 2 part titles to get different font weights
ax.text(0.5, 1.0, "MATPLOTLIB ", transform=ax.transAxes,
        ha="right", va="bottom", color="w",
        family="sans-serif", fontweight="light", fontsize=16)
ax.text(0.5, 1.0, "UNCHAINED", transform=ax.transAxes,
        ha="left", va="bottom", color="w",
        family="sans-serif", fontweight="bold", fontsize=16)


def update(*args):
    # Shift all data to the right
    data[:, 1:] = data[:, :-1]

    # Fill-in new values
    data[:, 0] = np.random.uniform(0, 1, len(data))

    # Update data
    for i in range(len(data)):
        lines[i].set_ydata(i + G * data[i])

    # Return modified artists
    return lines

# Construct the animation, using the update function as the animation director.
anim = animation.FuncAnimation(fig, update, interval=10)
plt.show()
```

33.1.4 ArtistAnimation

Examples

Note: Click *here* to download the full example code

Animated image using a precomputed list of images




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

fig = plt.figure()


def f(x, y):
    return np.sin(x) + np.cos(y)
```

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```
x = np.linspace(0, 2 * np.pi, 120)
y = np.linspace(0, 2 * np.pi, 100).reshape(-1, 1)
# ims is a list of lists, each row is a list of artists to draw in the
# current frame; here we are just animating one artist, the image, in
# each frame
ims = []
for i in range(60):
    x += np.pi / 15.
    y += np.pi / 20.
    im = plt.imshow(f(x, y), animated=True)
    ims.append([im])

ani = animation.ArtistAnimation(fig, ims, interval=50, blit=True,
                                repeat_delay=1000)

# To save the animation, use e.g.
#
# ani.save("movie.mp4")
#
# or
#
# from matplotlib.animation import FFMpegWriter
# writer = FFMpegWriter(fps=15, metadata=dict(artist='Me'), bitrate=1800)
# ani.save("movie.mp4", writer=writer)

plt.show()
```

33.2 Writer Classes

The provided writers fall into a few broad categories.

The Pillow writer relies on the Pillow library to write the animation, keeping all data in memory.

PillowWriter

33.2.1 matplotlib.animation.PillowWriter

class matplotlib.animation.**PillowWriter**(**args*, ***kwargs*)

Bases: *matplotlib.animation.MovieWriter*

classmethod bin_path()

Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()

Clean-up and collect the process used to write the movie file.

finish()
Finish any processing for writing the movie.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure object that contains the information for frames

outfile [string] The filename of the resulting movie file

dpi [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

The pipe-based writers stream the captured frames over a pipe to an external process. The pipe-based variants tend to be more performant, but may not work on all systems.

FFMpegWriter	Pipe-based ffmpeg writer.
ImageMagickWriter	Pipe-based animated gif.
AVConvWriter	Pipe-based avconv writer.

33.2.2 matplotlib.animation.FFMpegWriter

class matplotlib.animation.**FFMpegWriter**(*fps=5*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*)
Bases: *matplotlib.animation.FFMpegBase*, *matplotlib.animation.MovieWriter*

Pipe-based ffmpeg writer.

Frames are streamed directly to ffmpeg via a pipe and written in a single pass.

Parameters

fps: int Framerate for movie.

codec: string or None, optional The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

bitrate: int or None, optional The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

extra_args: list of strings or None, optional A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

metadata: Dict[str, str] or None A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

args_key = 'animation.ffmpeg_args'

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

exec_key = 'animation.ffmpeg_path'

finish()
Finish any processing for writing the movie.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(_savefig_kwargs_**)**
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

output_args

saving(_fig_, _outfile_, _dpi_, _*args_, _**kwargs_**)**
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(_fig_, _outfile_, _dpi=None_**)**
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure object that contains the information for frames

outfile [string] The filename of the resulting movie file

dpi [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

Examples using `matplotlib.animation.FFMpegWriter`

- *Frame grabbing*

33.2.3 matplotlib.animation.ImageMagickWriter

class matplotlib.animation.**ImageMagickWriter**(*fps=5*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*)

Bases: *matplotlib.animation.ImageMagickBase*, *matplotlib.animation.MovieWriter*

Pipe-based animated gif.

Frames are streamed directly to ImageMagick via a pipe and written in a single pass.

Parameters

fps: int Framerate for movie.

codec: string or None, optional The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

bitrate: int or None, optional The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

extra_args: list of strings or None, optional A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

metadata: Dict[str, str] or None A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

args_key = 'animation.convert_args'

classmethod bin_path()

Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()

Clean-up and collect the process used to write the movie file.

delay

exec_key = 'animation.convert_path'

finish()
Finish any processing for writing the movie.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a ImageMagickWriter is actually available.

Done by first checking the windows registry (if applicable) and then running the commandline tool.

output_args

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure object that contains the information for frames

outfile [string] The filename of the resulting movie file

dpi [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

33.2.4 matplotlib.animation.AVConvWriter

class matplotlib.animation.**AVConvWriter**(*fps=5*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*)
Bases: *matplotlib.animation.AVConvBase*, *matplotlib.animation.FFMpegWriter*

Pipe-based avconv writer.

Frames are streamed directly to avconv via a pipe and written in a single pass.

Parameters

fps: int Framerate for movie.

codec: string or None, optional The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

bitrate: int or None, optional The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

extra_args: list of strings or None, optional A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

metadata: Dict[str, str] or None A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

args_key = 'animation.avconv_args'

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

exec_key = 'animation.avconv_path'

finish()
Finish any processing for writing the movie.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

output_args

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure object that contains the information for frames

outfile [string] The filename of the resulting movie file

dpi [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

The file-based writers save temporary files for each frame which are stitched into a single file at the end. Although slower, these writers can be easier to debug.

FFMpegFileWriter	File-based ffmpeg writer.
ImageMagickFileWriter	File-based animated gif writer.
AVConvFileWriter	File-based avconv writer.

33.2.5 matplotlib.animation.FFMpegFileWriter

class matplotlib.animation.**FFMpegFileWriter**(**args*, ***kwargs*)
Bases: *matplotlib.animation.FFMpegBase*, *matplotlib.animation.FileMovieWriter*

File-based ffmpeg writer.

Frames are written to temporary files on disk and then stitched together at the end.

args_key = 'animation.ffmpeg_args'

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

exec_key = 'animation.ffmpeg_path'

finish()
Finish any processing for writing the movie.

frame_format
Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame. All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

output_args

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*, *frame_prefix='_tmp'*, *clear_temp=True*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure to grab the rendered frames from.

outfile [str] The filename of the resulting movie file.

dpi [number, optional] The dpi of the output file. This, with the figure size, controls the size in pixels of the resulting movie file. Default is fig.dpi.

frame_prefix [str, optional] The filename prefix to use for temporary files. Defaults to `'_tmp'`.

clear_temp [bool, optional] If the temporary files should be deleted after stitching the final result. Setting this to `False` can be useful for debugging. Defaults to `True`.

supported_formats = ['png', 'jpeg', 'ppm', 'tiff', 'sgi', 'bmp', 'pbm', 'raw', 'rgba']

33.2.6 matplotlib.animation.ImageMagickFileWriter

class matplotlib.animation.**ImageMagickFileWriter**(**args*, ***kwargs*)
Bases: *matplotlib.animation.ImageMagickBase*, *matplotlib.animation.FileMovieWriter*

File-based animated gif writer.

Frames are written to temporary files on disk and then stitched together at the end.

args_key = 'animation.convert_args'

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

delay

exec_key = 'animation.convert_path'

finish()
Finish any processing for writing the movie.

frame_format
Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame. All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a ImageMagickWriter is actually available.

Done by first checking the windows registry (if applicable) and then running the commandline tool.

output_args

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*, *frame_prefix='_tmp'*, *clear_temp=True*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure to grab the rendered frames from.

outfile [str] The filename of the resulting movie file.

dpi [number, optional] The dpi of the output file. This, with the figure size, controls the size in pixels of the resulting movie file. Default is fig.dpi.

frame_prefix [str, optional] The filename prefix to use for temporary files. Defaults to `'_tmp'`.

clear_temp [bool, optional] If the temporary files should be deleted after stitching the final result. Setting this to `False` can be useful for debugging. Defaults to `True`.

supported_formats = ['png', 'jpeg', 'ppm', 'tiff', 'sgi', 'bmp', 'pbm', 'raw', 'rgba']

33.2.7 matplotlib.animation.AVConvFileWriter

class matplotlib.animation.**AVConvFileWriter**(**args*, ***kwargs*)

Bases: *matplotlib.animation.AVConvBase*, *matplotlib.animation.FFMpegFileWriter*

File-based avconv writer.

Frames are written to temporary files on disk and then stitched together at the end.

args_key = 'animation.avconv_args'

classmethod bin_path()

Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()

Clean-up and collect the process used to write the movie file.

exec_key = 'animation.avconv_path'

finish()

Finish any processing for writing the movie.

frame_format

Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.

frame_size

A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)

Grab the image information from the figure and save as a movie frame. All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()

Check to see if a MovieWriter subclass is actually available by running the commandline tool.

output_args

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)

Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*, *frame_prefix='_tmp'*, *clear_temp=True*)

Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure to grab the rendered frames from.

outfile [str] The filename of the resulting movie file.

dpi [number, optional] The dpi of the output file. This, with the figure size, controls the size in pixels of the resulting movie file. Default is fig.dpi.

frame_prefix [str, optional] The filename prefix to use for temporary files. Defaults to `'_tmp'`.

clear_temp [bool, optional] If the temporary files should be deleted after stitching the final result. Setting this to `False` can be useful for debugging. Defaults to `True`.

supported_formats = ['png', 'jpeg', 'ppm', 'tiff', 'sgi', 'bmp', 'pbm', 'raw', 'rgba']

Fundamentally, a *MovieWriter* provides a way to grab sequential frames from the same underlying *Figure* object. The base class *MovieWriter* implements 3 methods and a context manager. The only difference between the pipe-based and file-based writers is in the arguments to their respective `setup` methods.

The `setup()` method is used to prepare the writer (possibly opening a pipe), successive calls to `grab_frame()` capture a single frame at a time and `finish()` finalizes the movie and writes the output file to disk. For example

```
moviewriter = MovieWriter(...)
moviewriter.setup(fig=fig, 'my_movie.ext', dpi=100)
for j in range(n):
    update_figure(n)
    moviewriter.grab_frame()
moviewriter.finish()
```

If using the writer classes directly (not through *Animation.save*), it is strongly encouraged to use the *saving* context manager

```
with moviewriter.saving(fig, 'myfile.mp4', dpi=100):
    for j in range(n):
        update_figure(n)
        moviewriter.grab_frame()
```

to ensures that setup and cleanup are performed as necessary.

33.2.8 Examples

Note: Click *here* to download the full example code

Frame grabbing

Use a MovieWriter directly to grab individual frames and write them to a file. This avoids any event loop integration, and thus works even with the Agg backend. This is not recommended for use in an interactive

setting.

```
import numpy as np
import matplotlib
matplotlib.use("Agg")
import matplotlib.pyplot as plt
from matplotlib.animation import FFMpegWriter

# Fixing random state for reproducibility
np.random.seed(19680801)


metadata = dict(title='Movie Test', artist='Matplotlib',
                comment='Movie support!')
writer = FFMpegWriter(fps=15, metadata=metadata)

fig = plt.figure()
l, = plt.plot([], [], 'k-o')

plt.xlim(-5, 5)
plt.ylim(-5, 5)

x0, y0 = 0, 0

with writer.saving(fig, "writer_test.mp4", 100):
    for i in range(100):
        x0 += 0.1 * np.random.randn()
        y0 += 0.1 * np.random.randn()
        l.set_data(x0, y0)
        writer.grab_frame()
```

33.3 Helper Classes

33.3.1 Animation Base Classes

Animation	This class wraps the creation of an animation using matplotlib.
TimedAnimation	*Animation* subclass for time-based animation.

matplotlib.animation.Animation

class matplotlib.animation.**Animation**(*fig*, *event_source=None*, *blit=False*)

Bases: object

This class wraps the creation of an animation using matplotlib.

It is only a base class which should be subclassed to provide needed behavior.

This class is not typically used directly.

Parameters

fig [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

event_source [object, optional] A class that can run a callback when desired events are generated, as well as be stopped and started.

Examples include timers (see *TimedAnimation*) and file system notifications.

blit [bool, optional] controls whether blitting is used to optimize drawing. Defaults to `False`.

See also:

FuncAnimation, *ArtistAnimation*

new_frame_seq()
Creates a new sequence of frame information.

new_saved_frame_seq()
Creates a new sequence of saved/cached frame information.

save(*filename*, *writer=None*, *fps=None*, *dpi=None*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*, *extra_anim=None*, *savefig_kwargs=None*)
Saves a movie file by drawing every frame.

Parameters

filename [str] The output filename, e.g., `mymovie.mp4`.

writer [*MovieWriter* or str, optional] A *MovieWriter* instance to use or a key that identifies a class to use, such as 'ffmpeg'. If `None`, defaults to `rcParams["animation.writer"]`.

fps [number, optional] Frames per second in the movie. Defaults to `None`, which will use the animation's specified interval to set the frames per second.

dpi [number, optional] Controls the dots per inch for the movie frames. This combined with the figure's size in inches controls the size of the movie. If `None`, defaults to `rcParams["savefig.dpi"]`.

codec [str, optional] The video codec to be used. Not all codecs are supported by a given *MovieWriter*. If `None`, default to `rcParams["animation.codec"]`.

bitrate [number, optional] Specifies the number of bits used per second in the compressed movie, in kilobits per second. A higher number means a higher quality movie, but at the cost of increased file size. If `None`, defaults to `rcParams["animation.bitrate"]`.

extra_args [list, optional] List of extra string arguments to be passed to the underlying movie utility. If `None`, defaults to `rcParams["animation.extra_args"]`.

metadata [Dict[str, str], optional] Dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

extra_anim [list, optional] Additional *Animation* objects that should be included in the saved movie file. These need to be from the same *matplotlib.figure.Figure* instance. Also, animation frames will just be simply combined, so there should be a 1:1 correspondence between the frames from the different animations.

savefig_kwargs [dict, optional] Is a dictionary containing keyword arguments to be passed on to the `savefig` command which is called repeatedly to save the individual frames.

Notes

fps, codec, bitrate, extra_args, metadata are used to construct a *MovieWriter* instance and can only be passed if `writer` is a string. If they are passed as non-`None` and `writer` is a *MovieWriter*, a `RuntimeError` will be raised.

to_html5_video(*embed_limit=None*)
Returns animation as an HTML5 video tag.

This saves the animation as an h264 video, encoded in base64 directly into the HTML5 video tag. This respects the rc parameters for the writer as well as the bitrate. This also makes use of the `interval` to control the speed, and uses the `repeat` parameter to decide whether to loop.

to_jshtml(*fps=None*, *embed_frames=True*, *default_mode=None*)
Generate HTML representation of the animation

matplotlib.animation.TimedAnimation

class matplotlib.animation.**TimedAnimation**(*fig*, *interval=200*, *repeat_delay=None*, *repeat=True*, *event_source=None*, **args*, ***kwargs*)

Bases: *matplotlib.animation.Animation*

Animation subclass for time-based animation.

A new frame is drawn every *interval* milliseconds.

Parameters

fig [matplotlib.figure.Figure] The figure object that is used to get draw, resize, and any other needed events.

interval [number, optional] Delay between frames in milliseconds. Defaults to 200.

repeat_delay [number, optional] If the animation in repeated, adds a delay in milliseconds before repeating the animation. Defaults to `None`.

repeat [bool, optional] Controls whether the animation should repeat when the sequence of frames is completed. Defaults to `True`.

blit [bool, optional] Controls whether blitting is used to optimize drawing. Defaults to `False`.

new_frame_seq()
Creates a new sequence of frame information.

new_saved_frame_seq()
Creates a new sequence of saved/cached frame information.

save(*filename*, *writer=None*, *fps=None*, *dpi=None*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*, *extra_anim=None*, *savefig_kwargs=None*)
Saves a movie file by drawing every frame.

Parameters

filename [str] The output filename, e.g., `mymovie.mp4`.

writer [*MovieWriter* or str, optional] A *MovieWriter* instance to use or a key that identifies a class to use, such as 'ffmpeg'. If `None`, defaults to `rcParams["animation.writer"]`.

fps [number, optional] Frames per second in the movie. Defaults to `None`, which will use the animation's specified interval to set the frames per second.

dpi [number, optional] Controls the dots per inch for the movie frames. This combined with the figure's size in inches controls the size of the movie. If `None`, defaults to `rcParams["savefig.dpi"]`.

codec [str, optional] The video codec to be used. Not all codecs are supported by a given *MovieWriter*. If `None`, default to `rcParams["animation.codec"]`.

bitrate [number, optional] Specifies the number of bits used per second in the compressed movie, in kilobits per second. A higher number means a higher quality movie, but at the cost of increased file size. If `None`, defaults to `rcParams["animation.bitrate"]`.

extra_args [list, optional] List of extra string arguments to be passed to the underlying movie utility. If `None`, defaults to `rcParams["animation.extra_args"]`.

metadata [Dict[str, str], optional] Dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

extra_anim [list, optional] Additional *Animation* objects that should be included in the saved movie file. These need to be from the same *matplotlib.figure.Figure* instance. Also, animation frames will just be simply combined, so there should be a 1:1 correspondence between the frames from the different animations.

savefig_kwargs [dict, optional] Is a dictionary containing keyword arguments to be passed on to the `savefig` command which is called repeatedly to save the individual frames.

Notes

fps, codec, bitrate, extra_args, metadata are used to construct a *MovieWriter* instance and can only be passed if `writer` is a string. If they are passed as non-`None` and `writer` is a *MovieWriter*, a `RuntimeError` will be raised.

to_html5_video(*embed_limit=None*)
Returns animation as an HTML5 video tag.

This saves the animation as an h264 video, encoded in base64 directly into the HTML5 video tag. This respects the rc parameters for the writer as well as the bitrate. This also makes use of the `interval` to control the speed, and uses the `repeat` parameter to decide whether to loop.

to_jshtml(*fps=None*, *embed_frames=True*, *default_mode=None*)
Generate HTML representation of the animation

33.3.2 Writer Registry

A module-level registry is provided to map between the name of the writer and the class to allow a string to be passed to *Animation.save* instead of a writer instance.

MovieWriterRegistry	Registry of available writer classes by human readable name.

matplotlib.animation.MovieWriterRegistry

class matplotlib.animation.**MovieWriterRegistry**
Bases: `object`

Registry of available writer classes by human readable name.

ensure_not_dirty()
If dirty, reasks the writers if they are available

is_available(*name*)
Check if given writer is available by name.

Parameters

name [str]

Returns

available [bool]

list()
Get a list of available MovieWriters.

register(*name*)
Decorator for registering a class under a name.

Example use:

```
@registry.register(name)
class Foo:
    pass
```

reset_available_writers()
Reset the available state of all registered writers

set_dirty()
Sets a flag to re-setup the writers.

33.3.3 Writer Base Classes

To reduce code duplication base classes

AbstractMovieWriter	Abstract base class for writing movies.
MovieWriter	Base class for writing movies.
FileMovieWriter	*MovieWriter* for writing to individual files and stitching at the end.

matplotlib.animation.AbstractMovieWriter

class matplotlib.animation.**AbstractMovieWriter**
Bases: object

Abstract base class for writing movies. Fundamentally, what a MovieWriter does is provide is a way to grab frames by calling grab_frame().

setup() is called to start the process and finish() is called afterwards.

This class is set up to provide for writing movie frame data to a pipe. saving() is provided as a context manager to facilitate this process as:

```
with moviewriter.saving(fig, outfile='myfile.mp4', dpi=100):
    # Iterate over frames
    moviewriter.grab_frame(**savefig_kwargs)
```

The use of the context manager ensures that setup() and finish() are performed as necessary.

An instance of a concrete subclass of this class can be given as the `writer` argument of *Animation.save()*.

finish()
Finish any processing for writing the movie.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to `setup`.

setup(*fig*, *outfile*, *dpi=None*)
Perform setup for writing the movie file.

Parameters

fig: 'matplotlib.figure.Figure' instance The figure object that contains the information for frames

outfile: string The filename of the resulting movie file

dpi: int, optional The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is `fig.dpi`.

matplotlib.animation.MovieWriter

class matplotlib.animation.**MovieWriter**(*fps=5*, *codec=None*, *bitrate=None*, *extra_args=None*, *metadata=None*)
Bases: *matplotlib.animation.AbstractMovieWriter*

Base class for writing movies.

This class is set up to provide for writing movie frame data to a pipe. See examples for how to use these classes.

Attributes

frame_format [str] The format used in writing frame data, defaults to 'rgba'

fig [*Figure*] The figure to capture data from. This must be provided by the subclasses.

Parameters

fps: int Framerate for movie.

codec: string or None, optional The codec to use. If `None` (the default) the `animation.codec` rcParam is used.

bitrate: int or None, optional The bitrate for the saved movie file, which is one way to control the output file size and quality. The default value is `None`, which uses the `animation.bitrate` rcParam. A value of -1 implies that the bitrate should be determined automatically by the underlying utility.

extra_args: list of strings or None, optional A list of extra string arguments to be passed to the underlying movie utility. The default is `None`, which passes the additional arguments in the `animation.extra_args` rcParam.

metadata: Dict[str, str] or None A dictionary of keys and values for metadata to include in the output file. Some keys that may be of use include: title, artist, genre, subject, copyright, srcform, comment.

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

finish()
Finish any processing for writing the movie.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame.

All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure object that contains the information for frames

outfile [string] The filename of the resulting movie file

dpi [int, optional] The DPI (or resolution) for the file. This controls the size in pixels of the resulting movie file. Default is fig.dpi.

matplotlib.animation.FileMovieWriter

class matplotlib.animation.**FileMovieWriter**(**args*, ***kwargs*)
Bases: *matplotlib.animation.MovieWriter*

MovieWriter for writing to individual files and stitching at the end.

This must be sub-classed to be useful.

classmethod bin_path()
Returns the binary path to the commandline tool used by a specific subclass. This is a class method so that the tool can be looked for before making a particular MovieWriter subclass available.

cleanup()
Clean-up and collect the process used to write the movie file.

finish()
Finish any processing for writing the movie.

frame_format
Format (png, jpeg, etc.) to use for saving the frames, which can be decided by the individual subclasses.

frame_size
A tuple `(width, height)` in pixels of a movie frame.

grab_frame(***savefig_kwargs*)
Grab the image information from the figure and save as a movie frame. All keyword arguments in savefig_kwargs are passed on to the `savefig` command that saves the figure.

classmethod isAvailable()
Check to see if a MovieWriter subclass is actually available by running the commandline tool.

saving(*fig*, *outfile*, *dpi*, **args*, ***kwargs*)
Context manager to facilitate writing the movie file.

`*args, **kw` are any parameters that should be passed to *setup*.

setup(*fig*, *outfile*, *dpi=None*, *frame_prefix='_tmp'*, *clear_temp=True*)
Perform setup for writing the movie file.

Parameters

fig [matplotlib.figure.Figure] The figure to grab the rendered frames from.

outfile [str] The filename of the resulting movie file.

dpi [number, optional] The dpi of the output file. This, with the figure size, controls the size in pixels of the resulting movie file. Default is fig.dpi.

frame_prefix [str, optional] The filename prefix to use for temporary files. Defaults to `'_tmp'`.

clear_temp [bool, optional] If the temporary files should be deleted after stitching the final result. Setting this to `False` can be useful for debugging. Defaults to `True`.

and mixins

AVConvBase	Mixin class for avconv output.
FFMpegBase	Mixin class for FFMpeg output.
ImageMagickBase	Mixin class for ImageMagick output.

matplotlib.animation.AVConvBase

class matplotlib.animation.**AVConvBase**
Bases: *matplotlib.animation.FFMpegBase*

Mixin class for avconv output.

To be useful this must be multiply-inherited from with a `MovieWriterBase` sub-class.

args_key = 'animation.avconv_args'

exec_key = 'animation.avconv_path'

output_args

matplotlib.animation.FFMpegBase

class matplotlib.animation.**FFMpegBase**

Bases: `object`

Mixin class for FFMpeg output.

To be useful this must be multiply-inherited from with a `MovieWriterBase` sub-class.

args_key = 'animation.ffmpeg_args'

exec_key = 'animation.ffmpeg_path'

output_args

matplotlib.animation.ImageMagickBase

class matplotlib.animation.**ImageMagickBase**

Bases: `object`

Mixin class for ImageMagick output.

To be useful this must be multiply-inherited from with a `MovieWriterBase` sub-class.

args_key = 'animation.convert_args'

delay

exec_key = 'animation.convert_path'

classmethod isAvailable()

Check to see if a ImageMagickWriter is actually available.

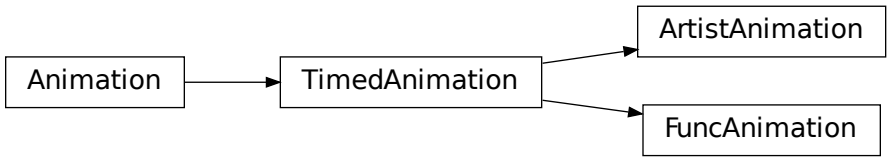
Done by first checking the windows registry (if applicable) and then running the commandline tool.

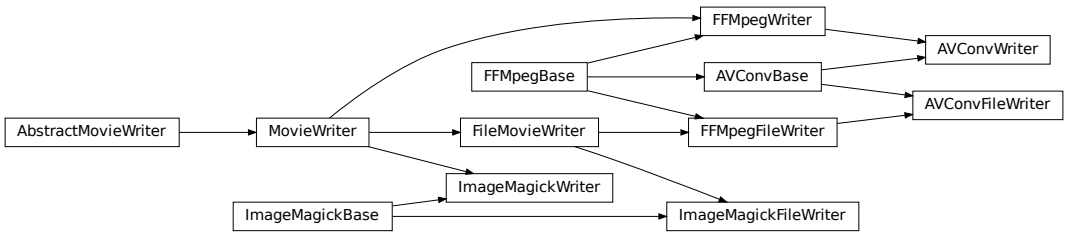
output_args

are provided.

See the source code for how to easily implement new *MovieWriter* classes.

33.4 Inheritance Diagrams

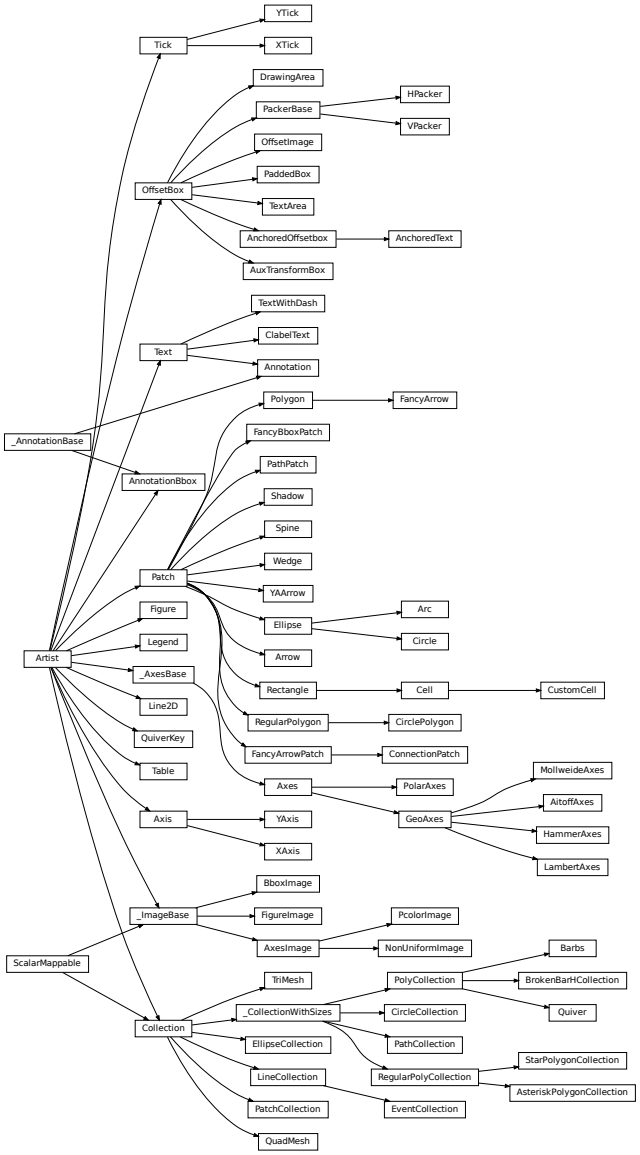




CHAPTER

THIRTYFOUR

ARTIST MODULE



34.1 Artist class

class matplotlib.artist.**Artist**

Abstract base class for someone who renders into a FigureCanvas.

34.1.1 Interactive

Artist.add_callback	Adds a callback function that will be called whenever one of the *Artist*'s properties changes.
Artist.format_cursor_data	Return *cursor data* string formatted.
Artist.get_contains	Return the _contains test used by the artist, or *None* for default.
Artist.get_cursor_data	Get the cursor data for a given event.
Artist.get_picker	Return the picker object used by this artist.
Artist.mouseover	
Artist.pchanged	Fire an event when property changed, calling all of the registered callbacks.
Artist.pick	Process pick event
Artist.pickable	Return *True* if *Artist* is pickable.
Artist.remove_callback	Remove a callback based on its *id*.
Artist.set_contains	Replace the contains test used by this artist.
Artist.set_picker	Set the epsilon for picking used by this artist
Artist.contains	Test whether the artist contains the mouse event.

matplotlib.artist.Artist.add_callback

Artist.**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.

matplotlib.artist.Artist.format_cursor_data

Artist.**format_cursor_data**(*data*)

Return *cursor data* string formatted.

matplotlib.artist.Artist.get_contains

Artist.**get_contains**()

Return the _contains test used by the artist, or *None* for default.

matplotlib.artist.Artist.get_cursor_data

Artist.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.artist.Artist.get_picker

Artist.**get_picker**()
Return the picker object used by this artist.

matplotlib.artist.Artist.mouseover

Artist.**mouseover**

matplotlib.artist.Artist.pchanged

Artist.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.artist.Artist.pick

Artist.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.artist.Artist.pickable

Artist.**pickable**()
Return *True* if *Artist* is pickable.

matplotlib.artist.Artist.remove_callback

Artist.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.artist.Artist.set_contains

Artist.**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.

Parameters

picker [callable]

matplotlib.artist.Artist.set_picker

Artist.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.artist.Artist.contains

Artist.**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.

34.1.2 Margins and Autoscaling

Artist.sticky_edges	x and y sticky edge lists.

matplotlib.artist.Artist.sticky_edges

Artist.**sticky_edges**
x and y sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

34.1.3 Clipping

Artist.get_clip_box	Return artist clipbox
Artist.get_clip_on	Return whether artist uses clipping
Artist.get_clip_path	Return artist clip path
Artist.set_clip_box	Set the artist's clip *Bbox*.
Artist.set_clip_on	Set whether artist uses clipping.
Artist.set_clip_path	Set the artist's clip path, which may be:

matplotlib.artist.Artist.get_clip_box

Artist.**get_clip_box**()
Return artist clipbox

matplotlib.artist.Artist.get_clip_on

Artist.**get_clip_on**()
Return whether artist uses clipping

matplotlib.artist.Artist.get_clip_path

Artist.**get_clip_path**()
Return artist clip path

matplotlib.artist.Artist.set_clip_box

Artist.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.artist.Artist.set_clip_on

Artist.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.artist.Artist.set_clip_path

Artist.**set_clip_path**(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

34.1.4 Bulk Properties

Artist.update	Update this artist's properties from the dictionary *prop*.
Artist.update_from	Copy properties from *other* to *self*.
Artist.properties	return a dictionary mapping property name -> value for all Artist props
Artist.set	A property batch setter.

matplotlib.artist.Artist.update

Artist.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.artist.Artist.update_from

Artist.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.artist.Artist.properties

Artist.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.artist.Artist.set

Artist.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

34.1.5 Drawing

Artist.draw	Derived classes drawing method
Artist.get_animated	Return the artist's animated state
Artist.set_animated	Set the artist's animation state.
Artist.get_agg_filter	Return filter function to be used for agg filter.
Artist.get_alpha	Return the alpha value used for blending - not supported on all backends
Artist.get_snap	Returns the snap setting which may be:
Artist.get_visible	Return the artist's visiblity
Artist.get_zorder	Return the artist's zorder.
Artist.set_agg_filter	Set the agg filter.
Artist.set_alpha	Set the alpha value used for blending - not supported on all backends.
Artist.set_sketch_params	Sets the sketch parameters.
Artist.set_snap	Sets the snap setting which may be:
Artist.get_rasterized	Return whether the artist is to be rasterized.
Artist.get_sketch_params	Returns the sketch parameters for the artist.
Artist.set_path_effects	Set the path effects.
Artist.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
Artist.zorder	
Artist.set_visible	Set the artist's visibility.

Continued on next page

Table 5 – continued from previous page

Artist.set_zorder	Set the zorder for the artist.
Artist.get_window_extent	Get the axes bounding box in display space.
Artist.get_path_effects	
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.

matplotlib.artist.Artist.draw

Artist.**draw**(*renderer*, **args*, ***kwargs*)
Derived classes drawing method

matplotlib.artist.Artist.get_animated

Artist.**get_animated**()
Return the artist's animated state

matplotlib.artist.Artist.set_animated

Artist.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.artist.Artist.get_agg_filter

Artist.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.artist.Artist.get_alpha

Artist.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.artist.Artist.get_snap

Artist.**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.

matplotlib.artist.Artist.get_visible

Artist.**get_visible**()
Return the artist's visiblity

matplotlib.artist.Artist.get_zorder

Artist.**get_zorder**()
Return the artist's zorder.

matplotlib.artist.Artist.set_agg_filter

Artist.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.artist.Artist.set_alpha

Artist.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.artist.Artist.set_sketch_params

Artist.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.artist.Artist.set_snap

Artist.**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.

Parameters

snap [bool or None]

matplotlib.artist.Artist.get_rasterized

Artist.**get_rasterized**()

Return whether the artist is to be rasterized.

matplotlib.artist.Artist.get_sketch_params

Artist.**get_sketch_params**()

Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.artist.Artist.set_path_effects

Artist.**set_path_effects**(*path_effects*)

Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.artist.Artist.set_rasterized

Artist.**set_rasterized**(*rasterized*)

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.artist.Artist.zorder

Artist.**zorder** = **0**

matplotlib.artist.Artist.set_visible

Artist.**set_visible**(*b*)

Set the artist's visibility.

Parameters

b [bool]

matplotlib.artist.Artist.set_zorder

Artist.**set_zorder**(*level*)

Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.artist.Artist.get_window_extent

Artist.**get_window_extent**(*renderer*)

Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.artist.Artist.get_path_effects

Artist.**get_path_effects**()

matplotlib.artist.Artist.get_transformed_clip_path_and_affine

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.

34.1.6 Figure and Axes

Artist.remove	Remove the artist from the figure if possible.
Artist.axes	The *Axes* instance the artist resides in, or *None*.
Artist.set_figure	Set the *Figure* instance the artist belongs to.
Artist.get_figure	Return the *Figure* instance the artist belongs to.

matplotlib.artist.Artist.remove

Artist.**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.

matplotlib.artist.Artist.axes

Artist.**axes**
The *Axes* instance the artist resides in, or *None*.

matplotlib.artist.Artist.set_figure

Artist.**set_figure**(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.artist.Artist.get_figure

Artist.**get_figure**()
Return the *Figure* instance the artist belongs to.

34.1.7 Children

Artist.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
Artist.findobj	Find artist objects.

matplotlib.artist.Artist.get_children

Artist.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.artist.Artist.findobj

Artist.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

34.1.8 Transform

Artist.set_transform	Set the artist transform.
Artist.get_transform	Return the *Transform* instance used by this artist.
Artist.is_transform_set	Returns *True* if *Artist* has a transform explicitly set.

matplotlib.artist.Artist.set_transform

Artist.**set_transform**(*t*)
Set the artist transform.

Parameters

t [*Transform*]

matplotlib.artist.Artist.get_transform

Artist.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.artist.Artist.is_transform_set

Artist.**is_transform_set**()
Returns *True* if *Artist* has a transform explicitly set.

34.1.9 Units

Artist.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
Artist.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
Artist.have_units	Return *True* if units are set on the *x* or *y* axes

matplotlib.artist.Artist.convert_xunits

Artist.**convert_xunits**(*x*)
For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.artist.Artist.convert_yunits

Artist.**convert_yunits**(*y*)
For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.artist.Artist.have_units

Artist.**have_units**()
Return *True* if units are set on the *x* or *y* axes

34.1.10 Metadata

Artist.get_gid	Returns the group id.
Artist.get_label	Get the label used for this artist in the legend.
Artist.set_gid	Sets the (group) id for the artist.
Artist.set_label	Set the label to *s* for auto legend.
Artist.get_url	Returns the url.
Artist.set_url	Sets the url for the artist.
Artist.aname	

matplotlib.artist.Artist.get_gid

Artist.**get_gid**()
Returns the group id.

matplotlib.artist.Artist.get_label

Artist.**get_label**()
Get the label used for this artist in the legend.

matplotlib.artist.Artist.set_gid

Artist.**set_gid**(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.artist.Artist.set_label

Artist.**set_label**(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

matplotlib.artist.Artist.get_url

Artist.**get_url**()
Returns the url.

matplotlib.artist.Artist.set_url

Artist.**set_url**(*url*)
Sets the url for the artist.

Parameters

url [str]

matplotlib.artist.Artist.aname

Artist.**aname** = **'Artist'**

34.1.11 Stale

Artist.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.artist.Artist.stale

Artist.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

34.2 Functions

allow_rasterization	Decorator for Artist.draw method.
get	Return the value of object's property.
getp	Return the value of object's property.
setp	Set a property on an artist object.
kwdoc	
ArtistInspector	A helper class to inspect an *Artist* and return information about it's settable properties and their current values.

34.2.1 matplotlib.artist.allow_rasterization

matplotlib.artist.**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-dependent renderer attributes or making other setup function calls, such as starting and flushing a mixed-mode renderer.

34.2.2 matplotlib.artist.get

matplotlib.artist.**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, e.g., 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

34.2.3 matplotlib.artist.getp

matplotlib.artist.**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, e.g., 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

34.2.4 matplotlib.artist.setp

matplotlib.artist.**setp**(*obj*, **args*, ***kwargs*)

Set a property on an artist object.

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
```

You may specify another output file to *setp* if `sys.stdout` is not acceptable for some reason using the `file` keyword-only argument:

```
>>> with fopen('output.log') as f:
>>>     setp(line, file=f)
```

setp() operates on a single instance or a iterable 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
```

34.2.5 matplotlib.artist.kwdoc

matplotlib.artist.**kwdoc**(*a*)

34.2.6 matplotlib.artist.ArtistInspector

class matplotlib.artist.**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 an iterable of *Artist*s. If an iterable 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.

__init__(*o*)

Initialize the artist inspector with an *Artist* or an iterable of *Artist*s. If an iterable 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.

Methods

__init__(o)	Initialize the artist inspector with an *Artist* or an iterable of *Artist*s.
aliased_name(s)	return 'PROPNAME or alias' if *s* has an alias, else return PROPNAME.
aliased_name_rest(s, target)	return 'PROPNAME or alias' if *s* has an alias, else return PROPNAME formatted for ReST
get_aliases()	Get a dict mapping *fullname* -> *alias* for each *alias* in the *ArtistInspector*.
get_setters()	Get the attribute strings with setters for object.
get_valid_values(attr)	Get the legal arguments for the setter associated with *attr*.
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, leadingspace])	If *prop* is *None*, return a list of strings of all settable properties and their valid values.
pprint_setters_rest([prop, leadingspace])	If *prop* is *None*, return a list of strings of all settable properties and their valid values.
properties()	return a dictionary mapping property name -> value

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'

get_aliases()
Get a dict mapping *fullname* -> *alias* for each *alias* in the *ArtistInspector*.

e.g., for lines:

```
{'markerfacecolor': 'mfc',
 'linewidth'      : 'lw',
}
```

get_setters()
Get the attribute strings with setters for object. e.g., 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" or ".. ACCEPTS":

e.g., for a line linestyle, return "[`'-'` | `'--'` | `'-.'` | `':'` | `'steps'` | `'None'`]"

is_alias(*o*)
Return *True* if method object *o* is an alias for another function.

pprint_getters()
Return the getters and actual values as list of strings.

pprint_setters(*prop=None*, *leadingspace=2*)
If *prop* is *None*, return a list of strings of all settable properties and their valid values.

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

pprint_setters_rest(*prop=None*, *leadingspace=4*)
If *prop* is *None*, return a list of strings of all settable properties and their valid values. Format the output for ReST

If *prop* is not *None*, it is a valid property name and that property will be returned as a string of property : valid values.

properties()
return a dictionary mapping property name -> value

CHAPTER

THIRTYFIVE

AXES CLASS

class matplotlib.axes.**Axes**(*fig*, *rect*, *facecolor=None*, *frameon=True*, *sharex=None*, *sharey=None*, *label=''*, *xscale=None*, *yscale=None*, ***kwargs*)

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.

Build an `Axes` instance in *Figure* *fig* with *rect=[left, bottom, width, height]* in *Figure* coordinates

Optional keyword arguments:

Keyword	Description
adjustable	['box' | 'datalim']
alpha	float: the alpha transparency (can be None)
anchor	**['C', 'SW', 'S', 'SE', 'E', 'NE', 'N',** 'NW', 'W']
aspect	['auto' | 'equal' | aspect_ratio]
autoscale_on	bool; whether to autoscale the *viewlim*
axisbelow	[bool | 'line'] draw the grids and ticks below or above most other artists, or below lines but above patches
cursor_props	a (*float*, *color*) tuple
figure	a `Figure` instance
frame_on	bool; whether to draw the axes frame
label	the axes label
navigate	bool
navigate_mode	['PAN' | 'ZOOM' | None] the navigation toolbar button status
position	[left, bottom, width, height] in class:`Figure` coords
sharex	an class:`Axes` instance to share the x-axis with
sharey	an class:`Axes` instance to share the y-axis with
title	the title string
visible	bool, whether the axes is visible
xlabel	the xlabel
xlim	(*xmin*, *xmax*) view limits
xscale	['linear' | 'log' | 'logit' | 'symlog']
xticklabels	sequence of strings
xticks	sequence of floats
ylabel	the ylabel strings
ylim	(*ymin*, *ymax*) view limits
yscale	['linear' | 'log' | 'logit' | 'symlog']
yticklabels	sequence of strings
yticks	sequence of floats

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35.1 Plotting

35.1.1 Basic

Axes.plot	Plot y versus x as lines and/or markers.
Axes.errorbar	Plot y versus x as lines and/or markers with attached errorbars.
Axes.scatter	A scatter plot of *y* vs *x* with varying marker size and/or color.
Axes.plot_date	Plot data that contains dates.
Axes.step	Make a step plot.
Axes.loglog	Make a plot with log scaling on both the x and y axis.
Axes.semilogx	Make a plot with log scaling on the x axis.
Axes.semilogy	Make a plot with log scaling on the y axis.
Axes.fill_between	Fill the area between two horizontal curves.
Axes.fill_betweenx	Fill the area between two vertical curves.
Axes.bar	Make a bar plot.
Axes.barh	Make a horizontal bar plot.
Axes.stem	Create a stem plot.
Axes.eventplot	Plot identical parallel lines at the given positions.
Axes.pie	Plot a pie chart.
Axes.stackplot	Draws a stacked area plot.
Axes.broken_barh	Plot a horizontal sequence of rectangles.
Axes.vlines	Plot vertical lines.
Axes.hlines	Plot horizontal lines at each *y* from *xmin* to *xmax*.
Axes.fill	Plot filled polygons.

matplotlib.axes.Axes.plot

`Axes.plot`(**args*, *data=None*, ***kwargs*)

Plot y versus x as lines and/or markers.

Call signatures:

```
plot([x], y, [fmt], data=None, **kwargs)
plot([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

The coordinates of the points or line nodes are given by *x*, *y*.

The optional parameter *fmt* is a convenient way for defining basic formatting like color, marker and linestyle. It's a shortcut string notation described in the *Notes* section below.

```
>>> 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
```

You can use *Line2D* properties as keyword arguments for more control on the appearance. Line properties and *fmt* can be mixed. The following two calls yield identical results:

```
>>> plot(x, y, 'go--', linewidth=2, markersize=12)
>>> plot(x, y, color='green', marker='o', linestyle='dashed',
        linewidth=2, markersize=12)
```

When conflicting with *fmt*, keyword arguments take precedence.

Plotting labelled data

There's a convenient way for plotting objects with labelled data (i.e. data that can be accessed by index `obj['y']`). Instead of giving the data in *x* and *y*, you can provide the object in the *data* parameter and just give the labels for *x* and *y*:

```
>>> plot('xlabel', 'ylabel', data=obj)
```

All indexable objects are supported. This could e.g. be a `dict`, a `pandas.DataFame` or a structured numpy array.

Plotting multiple sets of data

There are various ways to plot multiple sets of data.

- The most straight forward way is just to call *plot* multiple times. Example:

  ```
  >>> plot(x1, y1, 'bo')
  >>> plot(x2, y2, 'go')
  ```

- Alternatively, if your data is already a 2d array, you can pass it directly to *x*, *y*. A separate data set will be drawn for every column.

  Example: an array `a` where the first column represents the *x* values and the other columns are the *y* columns:

  ```
  >>> plot(a[0], a[1:])
  ```

- The third way is to specify multiple sets of *[x]*, *y*, *[fmt]* groups:

  ```
  >>> plot(x1, y1, 'g^', x2, y2, 'g-')
  ```

  In this case, any additional keyword argument applies to all datasets. Also this syntax cannot be combined with the *data* parameter.

By default, each line is assigned a different style specified by a 'style cycle'. The *fmt* and line property parameters are only necessary if you want explicit deviations from these defaults. Alternatively, you can also change the style cycle using the 'axes.prop_cycle' rcParam.

Parameters

x, y [array-like or scalar] The horizontal / vertical coordinates of the data points. *x* values are optional. If not given, they default to `[0, ..., N-1]`.

Commonly, these parameters are arrays of length N. However, scalars are supported as well (equivalent to an array with constant value).

The parameters can also be 2-dimensional. Then, the columns represent separate data sets.

fmt [str, optional] A format string, e.g. 'ro' for red circles. See the *Notes* section for a full description of the format strings.

Format strings are just an abbreviation for quickly setting basic line properties. All of these and more can also be controlled by keyword arguments.

data [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

Note: Technically there's a slight ambiguity in calls where the second label is a valid *fmt*. `plot('n', 'o', data=obj)` could be `plt(x, y)` or `plt(y, fmt)`. In such cases, the former interpretation is chosen, but a warning is issued. You may suppress the warning by adding an empty format string `plot('n', 'o', '', data=obj)`.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

scalex, scaley [bool, optional, default: True] These parameters determined if the view limits are adapted to the data limits. The values are passed on to *autoscale_view*.

****kwargs** [*Line2D* properties, optional] *kwargs* are used to specify properties like a line label (for auto legends), linewidth, antialiasing, marker face color. 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')
```

If you make multiple lines with one plot command, the kwargs apply to all those lines.

Here is a list of available *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance

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Table 2 – continued from previous page

Property	Description
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

scatter XY scatter plot with markers of variing size and/or color (sometimes also called bubble chart).

Notes

Format Strings

A format string consists of a part for color, marker and line:

```
fmt = '[color][marker][line]'
```

Each of them is optional. If not provided, the value from the style cycle is used. Exception: If `line` is given, but no `marker`, the data will be a line without markers.

Colors

The following color abbreviations are supported:

character	color
`'b'`	blue
`'g'`	green
`'r'`	red
`'c'`	cyan
`'m'`	magenta
`'y'`	yellow
`'k'`	black
`'w'`	white

If the color is the only part of the format string, you can additionally use any *matplotlib.colors* spec, e.g. full names (`'green'`) or hex strings (`'#008000'`).

Markers

character	description
'.'	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

Line Styles

character	description
'-'	solid line style
'--'	dashed line style
'-.'	dash-dot line style
':'	dotted line style

Example format strings:

```
'b'    # blue markers with default shape
'ro'   # red circles
'g-'   # green solid line
'--'   # dashed line with default color
'k^:'  # black triangle_up markers connected by a dotted line
```

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Examples using `matplotlib.axes.Axes.plot`

- sphx_glr_gallery_color_color_by_yvalue.py
- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_color_color_cycler.py
- sphx_glr_gallery_lines_bars_and_markers_simple_plot.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_shapes_and_collections_marker_path.py
- sphx_glr_gallery_pie_and_polar_charts_polar_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_legend.py

matplotlib.axes.Axes.errorbar

Axes.**errorbar**(*x*, *y*, *yerr=None*, *xerr=None*, *fmt=''*, *ecolor=None*, *elinewidth=None*, *capsize=None*, *barsabove=False*, *lolims=False*, *uplims=False*, *xlolims=False*, *xuplims=False*, *errorevery=1*, *capthick=None*, ***, *data=None*, ***kwargs*)

Plot y versus x as lines and/or markers with attached errorbars.

x, *y* define the data locations, *xerr*, *yerr* define the errorbar sizes. By default, this draws the data markers/lines as well the errorbars. Use fmt='none' to draw errorbars without any data markers.

Parameters

x, y [scalar or array-like] The data positions.

xerr, yerr [scalar or array-like, shape(N,) or shape(2,N), optional] The errorbar sizes:

- scalar: Symmetric +/- values for all data points.
- shape(N,): Symmetric +/-values for each data point.
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar.

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

fmt [plot format string, optional, default: ''] The format for the data points / data lines. See *plot* for details.

Use 'none' (case insensitive) to plot errorbars without any data markers.

ecolor [mpl color, optional, default: None] A matplotlib color arg which gives the color the errorbar lines. If None, use the color of the line connecting the markers.

elinewidth [scalar, optional, default: None] The linewidth of the errorbar lines. If None, the linewidth of the current style is used.

capsize [scalar, optional, default: None] The length of the error bar caps in points. If None, it will take the value from `rcParams["errorbar.capsize"]`.

capthick [scalar, optional, default: None] An alias to the keyword argument *markeredgewidth* (a.k.a. *mew*). This setting is a more sensible name for the property that controls the thickness of the error bar cap in points. For backwards compatibility, if *mew* or *markeredgewidth* are given, then they will over-ride *capthick*. This may change in future releases.

barsabove [bool, optional, default: False] If True, will plot the errorbars above the plot symbols. Default is below.

lolims, uplims, xlolims, xuplims [bool, optional, default: None] 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*. To use limits with inverted axes, *set_xlim()* or *set_ylim()* must be called before *errorbar()*.

errorevery [positive integer, optional, default: 1] Subsamples the errorbars. e.g., if errorevery=5, errorbars for every 5-th datapoint will be plotted. The data plot itself still shows all data points.

Returns

container [*ErrorbarContainer*] The container contains:

- plotline: *Line2D* instance of x, y plot markers and/or line.
- caplines: A tuple of *Line2D* instances of the error bar caps.
- barlinecols: A tuple of *LineCollection* with the horizontal and vertical error ranges.

Other Parameters

****kwargs :** All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)
errorbar(x, y, yerr, marker='s', mfc='red',
         mec='green', ms=20, mew=4)
```

where *mfc*, *mec*, *ms* and *mew* are aliases for the longer property names, *markerfacecolor*, *markeredgecolor*, *markersize* and *markeredgewidth*.

Valid kwargs for the marker properties are `Lines2D` properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance

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Table 3 – continued from previous page

Property	Description
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'xerr', 'y', 'yerr'.

matplotlib.axes.Axes.scatter

Axes.**scatter**(*x*, *y*, *s=None*, *c=None*, *marker=None*, *cmap=None*, *norm=None*, *vmin=None*, *vmax=None*, *alpha=None*, *linewidths=None*, *verts=None*, *edgecolors=None*, ***, *data=None*, ***kwargs*)

A scatter plot of *y* vs *x* with varying marker size and/or color.

Parameters

x, y [array_like, shape (n,)] The data positions.

s [scalar or array_like, shape (n,), optional] The marker size in points**2. Default is `rcParams['lines.markersize'] ** 2`.

c [color, sequence, or sequence of color, optional, default: 'b'] The marker color. Possible values:

- A single color format string.
- A sequence of color specifications of length n.
- A sequence of n numbers to be mapped to colors using *cmap* and *norm*.
- A 2-D array in which the rows are RGB or RGBA.

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. If you want to specify the same RGB or RGBA value for all points, use a 2-D array with a single row.

marker [*MarkerStyle*, optional, default: 'o'] The marker style. *marker* can be either an instance of the class or the text shorthand for a particular marker. See *markers* for more information marker styles.

cmap [*Colormap*, optional, default: None] A *Colormap* instance or registered colormap name. *cmap* is only used if *c* is an array of floats. If `None`, defaults to rc `image.cmap`.

norm [*Normalize*, optional, default: None] A *Normalize* instance is used to scale luminance data to 0, 1. *norm* is only used if *c* is an array of floats. If *None*, use the default *colors.Normalize*.

vmin, vmax [scalar, optional, default: None] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If None, the respective min and max of the color array is used. *vmin* and *vmax* are ignored if you pass a *norm* instance.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

linewidths [scalar or array_like, optional, default: None] The linewidth of the marker edges. Note: The default *edgecolors* is 'face'. You may want to change this as well. If *None*, defaults to rcParams `lines.linewidth`.

verts [sequence of (x, y), optional] If *marker* is *None*, these vertices will be used to construct the marker. The center of the marker is located at (0, 0) in normalized units. The overall marker is rescaled by *s*.

edgecolors [color or sequence of color, optional, default: 'face'] The edge color of the marker. Possible values:

- 'face': The edge color will always be the same as the face color.
- 'none': No patch boundary will be drawn.
- A matplotib color.

For non-filled markers, the *edgecolors* kwarg is ignored and forced to 'face' internally.

Returns

paths [*PathCollection*]

Other Parameters

****kwargs** [*Collection* properties]

See also:

plot To plot scatter plots when markers are identical in size and color.

Notes

- The *plot* function will be faster for scatterplots where markers don't vary in size or color.
- 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.
- Fundamentally, scatter works with 1-D arrays; *x*, *y*, *s*, and *c* may be input as 2-D arrays, but within scatter they will be flattened. The exception is *c*, which will be flattened only if its size matches the size of *x* and *y*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'c', 'color', 'edgecolors', 'facecolor', 'facecolors', 'linewidths', 's', 'x', 'y'.

Examples using `matplotlib.axes.Axes.scatter`

- sphx_glr_gallery_shapes_and_collections_scatter.py
- sphx_glr_gallery_pie_and_polar_charts_polar_scatter.py

matplotlib.axes.Axes.plot_date

Axes.**plot_date**(*x*, *y*, *fmt='o'*, *tz=None*, *xdate=True*, *ydate=False*, ***, *data=None*, ***kwargs*)

Plot data that contains dates.

Similar to *plot*, this plots *y* vs. *x* as lines or markers. However, the axis labels are formatted as dates depending on *xdate* and *ydate*.

Parameters

x, y [array-like] The coordinates of the data points. If *xdate* or *ydate* is *True*, the respective values *x* or *y* are interpreted as *Matplotlib dates*.

fmt [str, optional] The plot format string. For details, see the corresponding parameter in *plot*.

tz [[*None* | timezone string | `tzinfo` instance]] The time zone to use in labeling dates. If *None*, defaults to rcParam `timezone`.

xdate [bool, optional, default: True] If *True*, the *x*-axis will be interpreted as Matplotlib dates.

ydate [bool, optional, default: False] If *True*, the *y*-axis will be interpreted as Matplotlib dates.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object

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Table 4 – continued from previous page

Property	Description
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

matplotlib.dates Helper functions on dates.

matplotlib.dates.date2num Convert dates to num.

matplotlib.dates.num2date Convert num to dates.

matplotlib.dates.drange Create an equally spaced sequence of dates.

Notes

If you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to *plot_date*. *plot_date* will set the default tick locator to *AutoDateLocator* (if the tick locator is not already set to a *DateLocator* instance) and the default tick formatter to *AutoDateFormatter* (if the tick formatter is not already set to a *DateFormatter* instance).

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

matplotlib.axes.Axes.step

Axes.**step**(*x*, *y*, **args*, *data=None*, ***kwargs*)

Make a step plot.

Call signatures:

```
step(x, y, [fmt], *, data=None, where='pre', **kwargs)
step(x, y, [fmt], x2, y2, [fmt2], ..., *, where='pre', **kwargs)
```

This is just a thin wrapper around *plot* which changes some formatting options. Most of the concepts and parameters of plot can be used here as well.

Parameters

x [array_like] 1-D sequence of x positions. It is assumed, but not checked, that it is uniformly increasing.

y [array_like] 1-D sequence of y levels.

fmt [str, optional] A format string, e.g. 'g' for a green line. See *plot* for a more detailed description.

Note: While full format strings are accepted, it is recommended to only specify the color. Line styles are currently ignored (use the keyword argument *linestyle* instead). Markers are accepted and plotted on the given positions, however, this is a rarely needed feature for step plots.

data [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

where [{'pre', 'post', 'mid'}, optional, default 'pre'] Define where the steps should be placed:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** Additional parameters are the same as those for *plot*.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

matplotlib.axes.Axes.loglog

Axes.**loglog**(**args*, ***kwargs*)

Make a plot with log scaling on both the x and y axis.

Call signatures:

```
loglog([x], y, [fmt], data=None, **kwargs)
loglog([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes both the x-axis and the y-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basex/y*, *subsx/y* and *nonposx/y* control the x/y-axis properties. They are just forwarded to *Axes.set_xscale* and *Axes.set_yscale*.

Parameters

basex, basey [scalar, optional, default 10] Base of the x/y logarithm.

subsx, subsy [sequence, optional] The location of the minor x/y ticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_xscale* / *Axes.set_yscale* for details.

nonposx, nonposy [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in x or y can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by *plot*.

matplotlib.axes.Axes.semilogx

Axes.**semilogx**(**args*, ***kwargs*)

Make a plot with log scaling on the x axis.

Call signatures:

```
semilogx([x], y, [fmt], data=None, **kwargs)
semilogx([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the x-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basex*, *subsx* and *nonposx* control the x-axis properties. They are just forwarded to *Axes.set_xscale*.

Parameters

basex [scalar, optional, default 10] Base of the x logarithm.

subsx [array_like, optional] The location of the minor xticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_xscale* for details.

nonposx [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in x can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by *plot*.

matplotlib.axes.Axes.semilogy

`Axes.semilogy`(**args*, ***kwargs*)

Make a plot with log scaling on the y axis.

Call signatures:

```
semilogy([x], y, [fmt], data=None, **kwargs)
semilogy([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the y-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basey*, *subsy* and *nonposy* control the y-axis properties. They are just forwarded to *Axes.set_yscale*.

Parameters

basey [scalar, optional, default 10] Base of the y logarithm.

subsy [array_like, optional] The location of the minor yticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_yscale* for details.

nonposy [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in y can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by `plot`.

matplotlib.axes.Axes.fill_between

`Axes.fill_between`(*x*, *y1*, *y2=0*, *where=None*, *interpolate=False*, *step=None*, ***, *data=None*, ***kwargs*)

Fill the area between two horizontal curves.

The curves are defined by the points (*x*, *y1*) and (*x*, *y2*). This creates one or multiple polygons describing the filled area.

You may exclude some horizontal sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *x*.

Parameters

x [array (length N)] The x coordinates of the nodes defining the curves.

y1 [array (length N) or scalar] The y coordinates of the nodes defining the first curve.

y2 [array (length N) or scalar, optional, default: 0] The y coordinates of the nodes defining the second curve.

where [array of bool (length N), optional, default: None] Define *where* to exclude some horizontal regions from being filled. The filled regions are defined by the coordinates `x[where]`. More precisely, fill between `x[i]` and `x[i+1]` if `where[i] and where[i+1]`. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

interpolate [bool, optional] This option is only relvant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for *y1* > *y2* or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *x* array. Such a polygon cannot describe the above semantics close to the intersection. The x-sections containing the intersecion are simply clipped.

Setting *interpolate* to *True* will calculate the actual interscection point and extend the filled region up to this point.

step [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between *x*. The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

‘.PolyCollection‘ A *PolyCollection* containing the plotted polygons.

Other Parameters

****kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have vmin and vmax
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	[’/’ | ’\’ | ’|’ | ’-’ | ’+’ | ’x’ | ’o’ | ’O’ | ’.’ | ’*’]
joinstyle	unknown
label	object
linestyle or dashes or linestyles	[’solid’ | ’dashed’, ’dashdot’, ’dotted’ | (offset, on-off-dash-seq) | '-' | '--' | '-.' |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	[’screen’ | ’data’]
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

fill_betweenx Fill between two sets of x-values.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x', 'y1', 'y2'.

---

matplotlib.axes.Axes.fill_betweenx

Axes.**fill_betweenx**(*y*, *x1*, *x2=0*, *where=None*, *step=None*, *interpolate=False*, *, *data=None*, ***kwargs*)

Fill the area between two vertical curves.

The curves are defined by the points (*x1*, *y*) and (*x2*, *y*). This creates one or multiple polygons describing the filled area.

You may exclude some vertical sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *y*.

Parameters

y [array (length N)] The y coordinates of the nodes defining the curves.

x1 [array (length N) or scalar] The x coordinates of the nodes defining the first curve.

x2 [array (length N) or scalar, optional, default: 0] The x coordinates of the nodes defining the second curve.

where [array of bool (length N), optional, default: None] Define *where* to exclude some vertical regions from being filled. The filled regions are defined by the coordinates `y[where]`. More precisely, fill between `y[i]` and `y[i+1]` if `where[i] and where[i+1]`. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

interpolate [bool, optional] This option is only relvant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for *x1 > x2* or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *y* array. Such a polygon cannot describe the above semantics close to the intersection. The y-sections containing the intersecion are simply clipped.

Setting *interpolate* to *True* will calculate the actual interscection point and extend the filled region up to this point.

step [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between *y*. The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

'.PolyCollection' A *PolyCollection* containing the plotted polygons.

Other Parameters

****kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points

Table 6 – continued from previous page

Property	Description
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

fill_between Fill between two sets of y-values.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x1', 'x2', 'y'.

matplotlib.axes.Axes.bar

Axes.**bar**(**args*, *data=None*, ***kwargs*)

Make a bar plot.

Call signatures:

```
bar(x, height, *, align='center', **kwargs)
bar(x, height, width, *, align='center', **kwargs)
bar(x, height, width, bottom, *, align='center', **kwargs)
```

The bars are positioned at *x* with the given *align* ment. Their dimensions are given by *width* and *height*. The vertical baseline is *bottom* (default 0).

Each of *x*, *height*, *width*, and *bottom* may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

Parameters

x [sequence of scalars] The x coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

height [scalar or sequence of scalars] The height(s) of the bars.

width [scalar or array-like, optional] The width(s) of the bars (default: 0.8).

bottom [scalar or array-like, optional] The y coordinate(s) of the bars bases (default: 0).

align [{'center', 'edge'}, optional, default: 'center'] Alignment of the bars to the *x* coordinates:

- 'center': Center the base on the *x* positions.
- 'edge': Align the left edges of the bars with the *x* positions.

To align the bars on the right edge pass a negative *width* and `align='edge'`.

Returns

container [*BarContainer*] Container with all the bars and optionally errorbars.

Other Parameters

color [scalar or array-like, optional] The colors of the bar faces.

edgecolor [scalar or array-like, optional] The colors of the bar edges.

linewidth [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

tick_label [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

xerr, yerr [scalar or array-like of shape(N,) or shape(2,N), optional] If not *None*, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (Default)

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

ecolor [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

capsize [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

error_kw [dict, optional] Dictionary of kwargs to be passed to the *errorbar* method. Values of *ecolor* or *capsize* defined here take precedence over the independent kwargs.

log [bool, optional, default: False] If *True*, set the y-axis to be log scale.

orientation [{'vertical', 'horizontal'}, optional] *This is for internal use only.* Please use *barh* for horizontal bar plots. Default: 'vertical'.

See also:

barh Plot a horizontal bar plot.

Notes

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'bottom', 'color', 'ecolor', 'edgecolor', 'height', 'left', 'linewidth', 'tick_label', 'width', 'x', 'xerr', 'y', 'yerr'.
- All positional arguments.

Examples using `matplotlib.axes.Axes.bar`

- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_bar.py
- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py

matplotlib.axes.Axes.barh

`Axes.barh`(**args*, ***kwargs*)

Make a horizontal bar plot.

Call signatures:

```
bar(y, width, *, align='center', **kwargs)
bar(y, width, height, *, align='center', **kwargs)
bar(y, width, height, left, *, align='center', **kwargs)
```

The bars are positioned at *y* with the given *align*. Their dimensions are given by *width* and *height*. The horizontal baseline is *left* (default 0).

Each of *y*, *width*, *height*, and *left* may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

Parameters

y [scalar or array-like] The y coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

width [scalar or array-like] The width(s) of the bars.

height [sequence of scalars, optional, default: 0.8] The heights of the bars.

left [sequence of scalars] The x coordinates of the left sides of the bars (default: 0).

align [{'center', 'edge'}, optional, default: 'center'] Alignment of the base to the *y* coordinates*:

- 'center': Center the bars on the *y* positions.
- 'edge': Align the bottom edges of the bars with the *y* positions.

To align the bars on the top edge pass a negative *height* and `align='edge'`.

Returns

container [*BarContainer*] Container with all the bars and optionally errorbars.

Other Parameters

color [scalar or array-like, optional] The colors of the bar faces.

edgecolor [scalar or array-like, optional] The colors of the bar edges.

linewidth [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

tick_label [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

xerr, yerr [scalar or array-like of shape(N,) or shape(2,N), optional] If not `None`, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (default)

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

ecolor [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

capsize [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

error_kw [dict, optional] Dictionary of kwargs to be passed to the *errorbar* method. Values of *ecolor* or *capsize* defined here take precedence over the independent kwargs.

log [bool, optional, default: False] If `True`, set the x-axis to be log scale.

See also:

bar Plot a vertical bar plot.

Notes

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

matplotlib.axes.Axes.stem

`Axes.stem`(**args*, *data=None*, ***kwargs*)

Create a stem plot.

A stem plot plots vertical lines at each *x* location from the baseline to *y*, and places a marker there.

Call signature:

```
stem([x,] y, linefmt=None, markerfmt=None, basefmt=None)
```

The x-positions are optional. The formats may be provided either as positional or as keyword-arguments.

Parameters

x [array-like, optional] The x-positions of the stems. Default: (0, 1, ..., len(y) - 1).

y [array-like] The y-values of the stem heads.

linefmt [str, optional] A string defining the properties of the vertical lines. Usually, this will be a color or a color and a linestyle:

Character	Line Style
'-'	solid line
'--'	dashed line
'-.'	dash-dot line
':'	dotted line

Default: 'C0-', i.e. solid line with the first color of the color cycle.

Note: While it is technically possible to specify valid formats other than color or color and linestyle (e.g. 'rx' or '-.'), this is beyond the intention of the method and will most likely not result in a reasonable reasonable plot.

markerfmt [str, optional] A string defining the properties of the markers at the stem heads. Default: 'C0o', i.e. filled circles with the first color of the color cycle.

basefmt [str, optional] A format string defining the properties of the baseline.

Default: 'C3-' ('C2-' in classic mode).

bottom [float, optional, default: 0] The y-position of the baseline.

label [str, optional, default: None] The label to use for the stems in legends.

Returns

container [*StemContainer*] The container may be treated like a tuple (*markerline*, *stemlines*, *baseline*)

Other Parameters

****kwargs** No other parameters are supported. They are currently ignored silently for backward compatibility. This behavior is deprecated. Future versions will not accept any other parameters and will raise a TypeError instead.

Notes

See also:

The MATLAB function stem which inspired this method.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

matplotlib.axes.Axes.eventplot

`Axes.eventplot`(*positions*, *orientation='horizontal'*, *lineoffsets=1*, *linelengths=1*, *linewidths=None*, *colors=None*, *linestyles='solid'*, ***, *data=None*, ***kwargs*)

Plot identical parallel lines at the given positions.

positions should be a 1D or 2D array-like object, with each row corresponding to a row or column of lines.

This type of plot is commonly used in neuroscience for representing neural events, where it is usually called a spike raster, dot raster, or raster plot.

However, it is useful in any situation where you wish to show the timing or position of multiple sets of discrete events, such as the arrival times of people to a business on each day of the month or the date of hurricanes each year of the last century.

Parameters

positions [1D or 2D array-like object] Each value is an event. If *positions* is a 2D array-like, each row corresponds to a row or a column of lines (depending on the *orientation* parameter).

orientation [{'horizontal', 'vertical'}, optional] Controls the direction of the event collections:

- 'horizontal' : the lines are arranged horizontally in rows, and are vertical.
- 'vertical' : the lines are arranged vertically in columns, and are horizontal.

lineoffsets [scalar or sequence of scalars, optional, default: 1] The offset of the center of the lines from the origin, in the direction orthogonal to *orientation*.

linelengths [scalar or sequence of scalars, optional, default: 1] The total height of the lines (i.e. the lines stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

linewidths [scalar, scalar sequence or None, optional, default: None] The line width(s) of the event lines, in points. If it is None, defaults to its rcParams setting.

colors [color, sequence of colors or None, optional, default: None] The color(s) of the event lines. If it is None, defaults to its rcParams setting.

linestyles [str or tuple or a sequence of such values, optional] Default is 'solid'. Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '–', '-.', ':']. Dash tuples should be of the form:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

****kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.

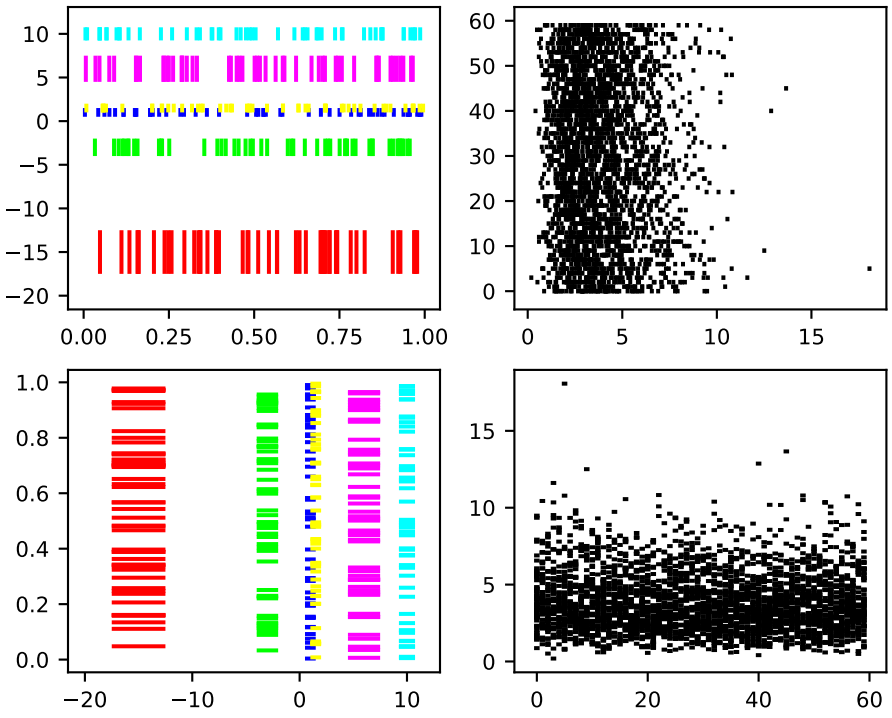
Returns

list [A list of *EventCollection* objects.] Contains the *EventCollection* that were added.

Notes

For *linelengths*, *linewidths*, *colors*, and *linestyles*, if only a single value is given, that value is applied to all lines. If an array-like is given, it must have the same length as *positions*, and each value will be applied to the corresponding row of the array.

Examples



Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'linelengths', 'lineoffsets', 'linestyles', 'linewidths', 'positions'.

matplotlib.axes.Axes.pie

`Axes.pie`(*x*, *explode=None*, *labels=None*, *colors=None*, *autopct=None*, *pctdistance=0.6*, *shadow=False*, *labeldistance=1.1*, *startangle=None*, *radius=None*, *counterclock=True*, *wedgeprops=None*, *textprops=None*, *center=(0, 0)*, *frame=False*, *rotatelabels=False*, ***, *data=None*)

Plot a pie chart.

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. The resulting pie will have an empty wedge of size `1 - sum(x)`.

The wedges are plotted counterclockwise, by default starting from the x-axis.

Parameters

x [array-like] The wedge sizes.

explode [array-like, optional, default: None] If not *None*, is a `len(x)` array which specifies the fraction of the radius with which to offset each wedge.

labels [list, optional, default: None] A sequence of strings providing the labels for each wedge

colors [array-like, optional, default: None] A sequence of matplotlib color args through which the pie chart will cycle. If *None*, will use the colors in the currently active cycle.

autopct [None (default), string, or function, optional] 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 [float, optional, default: 0.6] The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*.

shadow [bool, optional, default: False] Draw a shadow beneath the pie.

labeldistance [float, optional, default: 1.1] The radial distance at which the pie labels are drawn

startangle [float, optional, default: None] If not *None*, rotates the start of the pie chart by *angle* degrees counterclockwise from the x-axis.

radius [float, optional, default: None] The radius of the pie, if *radius* is *None* it will be set to 1.

counterclock [bool, optional, default: True] Specify fractions direction, clockwise or counterclockwise.

wedgeprops [dict, optional, default: None] Dict of arguments passed to the wedge objects making the pie. For example, you can pass in `wedgeprops = {'linewidth': 3}` to set the width of the wedge border lines equal to 3. For more details, look at the doc/arguments of the wedge object. By default `clip_on=False`.

textprops [dict, optional, default: None] Dict of arguments to pass to the text objects.

center [list of float, optional, default: (0, 0)] Center position of the chart. Takes value (0, 0) or is a sequence of 2 scalars.

frame [bool, optional, default: False] Plot axes frame with the chart if true.

rotatelabels [bool, optional, default: False] Rotate each label to the angle of the corresponding slice if true.

Returns

patches [list] A sequence of *matplotlib.patches.Wedge* instances

texts [list] A list of the label *matplotlib.text.Text* instances.

autotexts [list] A list of *Text* instances for the numeric labels. This will only be returned if the parameter *autopct* is not *None*.

Notes

The pie chart will probably look best if the figure and axes are square, or the Axes aspect is equal.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'explode', 'labels', 'x'.

Examples using `matplotlib.axes.Axes.pie`

- sphx_glr_gallery_pie_and_polar_charts_pie_features.py
- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py
- sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py

matplotlib.axes.Axes.stackplot

`Axes.stackplot`(*x*, **args*, *data=None*, ***kwargs*)

Draws a stacked area plot.

Parameters

x [1d array of dimension N]

y [2d array (dimension MxN), or sequence of 1d arrays (each dimension 1xN)] The data is assumed to be unstacked. Each of the following calls is legal:

```
stackplot(x, y)               # where y is MxN
stackplot(x, y1, y2, y3, y4)  # where y1, y2, y3, y4, are all 1xNm
```

baseline [['zero' | 'sym' | 'wiggle' | 'weighted_wiggle']] Method used to calculate the baseline:

- `'zero'`: Constant zero baseline, i.e. a simple stacked plot.
- `'sym'`: Symmetric around zero and is sometimes called 'ThemeRiver'.
- `'wiggle'`: Minimizes the sum of the squared slopes.
- `'weighted_wiggle'`: Does the same but weights to account for size of each layer. It is also called 'Streamgraph'-layout. More details can be found at http://leebyron.com/streamgraph/.

labels [Length N sequence of strings] Labels to assign to each data series.

colors [Length N sequence of colors] A list or tuple of colors. These will be cycled through and used to colour the stacked areas.

****kwargs :** All other keyword arguments are passed to *Axes.fill_between()*.

Returns

list [list of *PolyCollection*] A list of *PolyCollection* instances, one for each element in the stacked area plot.

matplotlib.axes.Axes.broken_barh

`Axes.`**broken_barh**(*xranges*, *yrange*, *, *data=None*, ***kwargs*)

Plot a horizontal sequence of rectangles.

A rectangle is drawn for each element of *xranges*. All rectangles have the same vertical position and size defined by *yrange*.

This is a convenience function for instantiating a *BrokenBarHCollection*, adding it to the axes and autoscaling the view.

Parameters

xranges [sequence of tuples (*xmin*, *xwidth*)] The x-positions and extends of the rectangles. For each tuple (*xmin*, *xwidth*) a rectangle is drawn from *xmin* to *xmin* + *xwidth*.

yranges [(*ymin*, *ymax*)] The y-position and extend for all the rectangles.

Returns

collection [A *BrokenBarHCollection*]

Other Parameters

****kwargs** [*BrokenBarHCollection* properties] Each *kwarg* can be either a single argument applying to all rectangles, e.g.:

```
facecolors='black'
```

or a sequence of arguments over which is cycled, e.g.:

```
facecolors=('black', 'blue')
```

would create interleaving black and blue rectangles.

Supported keywords:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)

Table 7 – continued from previous page

Property	Description
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

---

matplotlib.axes.Axes.vlines

`Axes.vlines`(*x*, *ymin*, *ymax*, *colors='k'*, *linestyles='solid'*, *label=''*, ***, *data=None*, ***kwargs*)

Plot vertical lines.

Plot vertical lines at each *x* from *ymin* to *ymax*.

Parameters

x [scalar or 1D array_like] x-indexes where to plot the lines.

ymin, ymax [scalar or 1D array_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

colors [array_like of colors, optional, default: 'k']

linestyles [['solid' | 'dashed' | 'dashdot' | 'dotted'], optional]

label [string, optional, default: '']

Returns

lines [*LineCollection*]

Other Parameters

****kwargs** [*LineCollection* properties.]

See also:

hlines horizontal lines

axvline vertical line across the axes

In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**: * All arguments with the following names: 'colors', 'x', 'ymax', 'ymin'.

matplotlib.axes.Axes.hlines

`Axes.hlines`(*y*, *xmin*, *xmax*, *colors='k'*, *linestyles='solid'*, *label=''*, *, *data=None*, ***kwargs*)

Plot horizontal lines at each *y* from *xmin* to *xmax*.

Parameters

y [scalar or sequence of scalar] y-indexes where to plot the lines.

xmin, xmax [scalar or 1D array_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

colors [array_like of colors, optional, default: 'k']

linestyles [['solid' | 'dashed' | 'dashdot' | 'dotted'], optional]

label [string, optional, default: '']

Returns

lines [*LineCollection*]

Other Parameters

****kwargs** [*LineCollection* properties.]

See also:

vlines vertical lines

axhline horizontal line across the axes

In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**: * All arguments with the following names: 'colors', 'xmax', 'xmin', 'y'.

Examples using `matplotlib.axes.Axes.hlines`

- sphx_glr_gallery_color_named_colors.py

matplotlib.axes.Axes.fill

`Axes.fill`(**args*, *data=None*, ***kwargs*)

Plot filled polygons.

Parameters

args [sequence of x, y, [color]] Each polygon is defined by the lists of *x* and *y* positions of its nodes, optionally followed by by a *color* specifier. See *matplotlib.colors* for supported color specifiers. The standard color cycle is used for polygons without a color specifier.

You can plot multiple polygons by providing multiple *x*, *y*, *[color]* groups.

For example, each of the following is legal:

```
ax.fill(x, y)                    # a polygon with default color
ax.fill(x, y, "b")               # a blue polygon
ax.fill(x, y, x2, y2)            # two polygons
ax.fill(x, y, "b", x2, y2, "r")  # a blue and a red polygon
```

Returns

a list of :class:'~matplotlib.patches.Polygon'

Other Parameters

****kwargs** [*Polygon* properties]

Notes

Use *fill_between()* if you would like to fill the region between two curves.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

35.1.2 Spans

Axes.axhline	Add a horizontal line across the axis.
Axes.axhspan	Add a horizontal span (rectangle) across the axis.
Axes.axvline	Add a vertical line across the axes.
Axes.axvspan	Add a vertical span (rectangle) across the axes.

matplotlib.axes.Axes.axhline

Axes.**axhline**(*y=0*, *xmin=0*, *xmax=1*, ***kwargs*)

Add a horizontal line across the axis.

Parameters

y [scalar, optional, default: 0] y position in data coordinates of the horizontal line.

xmin [scalar, optional, default: 0] Should be between 0 and 1, 0 being the far left of

the plot, 1 the far right of the plot.

xmax [scalar, optional, default: 1] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

Returns

line [*Line2D*]

Other Parameters

****kwargs :** Valid kwargs are *Line2D* properties, with the exception of 'transform':

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']

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Table 9 – continued from previous page

Property	Description
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

hlines Add horizontal lines in data coordinates.

axhspan Add a horizontal span (rectangle) across the axis.

Examples

- 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 middle half of the xrange:

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

Examples using `matplotlib.axes.Axes.axhline`

- sphx_glr_gallery_color_color_cycle_default.py

matplotlib.axes.Axes.axhspan

`Axes.`**`axhspan`**(*ymin*, *ymax*, *xmin=0*, *xmax=1*, ***kwargs*)

Add a horizontal span (rectangle) across the axis.

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, e.g., 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.

Parameters

ymin [float] Lower limit of the horizontal span in data units.

ymax [float] Upper limit of the horizontal span in data units.

xmin [float, optional, default: 0] Lower limit of the vertical span in axes (relative 0-1) units.

xmax [float, optional, default: 1] Upper limit of the vertical span in axes (relative 0-1) units.

Returns

Polygon [*Polygon*]

Other Parameters

****kwargs** [*Polygon* properties.]

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a Bbox instance
clip_on	bool
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a Figure instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | ':' | 'None' | ' ' | '']
linewidth or lw	float or None for default
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	Transform
url	a url string
visible	bool
zorder	float

See also:

axvspan Add a vertical span across the axes.

matplotlib.axes.Axes.axvline

Axes.**axvline**(*x=0*, *ymin=0*, *ymax=1*, ***kwargs*)

Add a vertical line across the axes.

Parameters

x [scalar, optional, default: 0] x position in data coordinates of the vertical line.

ymin [scalar, optional, default: 0] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

ymax [scalar, optional, default: 1] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

Returns

line [*Line2D*]

Other Parameters

****kwargs :** Valid kwargs are *Line2D* properties, with the exception of 'transform':

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None

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Table 10 – continued from previous page

Property	Description
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

vlines Add vertical lines in data coordinates.

axvspan Add a vertical span (rectangle) across the axis.

Examples

- 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 middle half of the yrange:

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

Examples using `matplotlib.axes.Axes.axvline`

- sphx_glr_gallery_color_color_cycle_default.py

matplotlib.axes.Axes.axvspan

`Axes.`**`axvspan`**(*xmin*, *xmax*, *ymin=0*, *ymax=1*, ***kwargs*)

Add a vertical span (rectangle) across the axes.

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, e.g., 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.

Parameters

xmin [scalar] Number indicating the first X-axis coordinate of the vertical span rectangle in data units.

xmax [scalar] Number indicating the second X-axis coordinate of the vertical span rectangle in data units.

ymin [scalar, optional] Number indicating the first Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 0.

ymax [scalar, optional] Number indicating the second Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 1.

Returns

rectangle [matplotlib.patches.Polygon] Vertical span (rectangle) from (xmin, ymin) to (xmax, ymax).

Other Parameters

****kwargs** Optional parameters are properties of the class matplotlib.patches.Polygon.

See also:

axhspan Add a horizontal span across the axes.

Examples

Draw a vertical, green, translucent rectangle from x = 1.25 to x = 1.55 that spans the yrange of the axes.

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

35.1.3 Spectral

Axes.acorr	Plot the autocorrelation of *x*.
Axes.angle_spectrum	Plot the angle spectrum.
Axes.cohere	Plot the coherence between *x* and *y*.
Axes.csd	Plot the cross-spectral density.
Axes.magnitude_spectrum	Plot the magnitude spectrum.
Axes.phase_spectrum	Plot the phase spectrum.
Axes.psd	Plot the power spectral density.
Axes.specgram	Plot a spectrogram.
Axes.xcorr	Plot the cross correlation between *x* and *y*.

matplotlib.axes.Axes.acorr

Axes.**acorr**(*x*, *, *data=None*, ***kwargs*)

Plot the autocorrelation of *x*.

Parameters

x [sequence of scalar]

hold [bool, optional, *deprecated*, default: True]

detrend [callable, optional, default: `mlab.detrend_none`] *x* is detrended by the *detrend* callable. Default is no normalization.

normed [bool, optional, default: True] If `True`, input vectors are normalised to unit length.

usevlines [bool, optional, default: True] If `True`, *Axes.vlines* is used to plot the vertical lines from the origin to the acorr. Otherwise, *Axes.plot* is used.

maxlags [integer, optional, default: 10] Number of lags to show. If `None`, will return all `2 * len(x) - 1` lags.

Returns

lags [array (lenth `2*maxlags+1`)] lag vector.

c [array (length `2*maxlags+1`)] auto correlation vector.

line [*LineCollection* or *Line2D*] *Artist* added to the axes of the correlation.

LineCollection if *usevlines* is True *Line2D* if *usevlines* is False

b [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False

Other Parameters

linestyle [*Line2D* prop, optional, default: None] Only used if usevlines is `False`.

marker [string, optional, default: 'o']

Notes

The cross correlation is performed with `numpy.correlate()` with `mode = 2`.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

---

matplotlib.axes.Axes.angle_spectrum

Axes.**angle_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, *, *data=None*, ***kwargs*)

Plot the angle spectrum.

Call signature:

```
angle_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
               pad_to=None, sides='default', **kwargs)
```

Compute the angle spectrum (wrapped phase spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

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

spectrum [1-D array] The values for the angle spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

magnitude_spectrum() *angle_spectrum()* plots the magnitudes of the corresponding frequen-

cies.

phase_spectrum() *phase_spectrum()* plots the unwrapped version of this function.

specgram() *specgram()* can plot the angle spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

---

matplotlib.axes.Axes.cohere

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

Plot the coherence between *x* and *y*.

Plot the coherence between *x* and *y*. Coherence is the normalized cross spectral density:

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

Parameters

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between blocks. The default value is 0 (no overlap).

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 return value is a tuple (*Cxy*, *f*), where *f* are the

frequencies of the coherence vector.

kwargs are applied to the lines.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']

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Table 13 – continued from previous page

Property	Description
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

References

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

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

---

matplotlib.axes.Axes.csd

Axes.**csd**(*x*, *y*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *return_line=None*, ***, *data=None*, ***kwargs*)

Plot the cross-spectral density.

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, return_line=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*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of x and y are averaged over each segment to compute P_{xy}, with a scaling to correct for power loss due to windowing.

If len(x) < *NFFT* or len(y) < *NFFT*, they will be zero padded to *NFFT*.

Parameters

x, y [1-D arrays or sequences] Arrays or sequences containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

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.

return_line [bool] Whether to include the line object plotted in the returned values. Default is False.

Returns

Pxy [1-D array] The values for the cross spectrum `P_{xy}` before scaling (complex valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxy*

line [a *Line2D* instance] The line created by this function. Only returned if *return_line* is True.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance

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Property	Description
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

psd() *psd()* is the equivalent to setting y=x.

Notes

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

References

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

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

matplotlib.axes.Axes.magnitude_spectrum

Axes.**magnitude_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, *scale=None*, *, *data=None*, **kwargs*)

Plot the magnitude spectrum.

Call signature:

```
magnitude_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
                   pad_to=None, sides='default', **kwargs)
```

Compute the magnitude spectrum of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

scale [['default' | 'linear' | 'dB']] The scaling of the values in the *spec*. 'linear' is no scaling. 'dB' returns the values in dB scale, i.e., the dB amplitude (20 * log10). 'default' is 'linear'.

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

spectrum [1-D array] The values for the magnitude spectrum before scaling (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance

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Table 15 – continued from previous page

Property	Description
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

psd() *psd()* plots the power spectral density.‘.

angle_spectrum() *angle_spectrum()* plots the angles of the corresponding frequencies.

phase_spectrum() *phase_spectrum()* plots the phase (unwrapped angle) of the corresponding frequencies.

specgram() *specgram()* can plot the magnitude spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: ’x’.

---

matplotlib.axes.Axes.phase_spectrum

Axes.**phase_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, ***, *data=None*, ***kwargs*)

Plot the phase spectrum.

Call signature:

```
phase_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
               pad_to=None, sides='default', **kwargs)
```

Compute the phase spectrum (unwrapped angle spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

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

spectrum [1-D array] The values for the phase spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance

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Table 16 – continued from previous page

Property	Description
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

magnitude_spectrum() *magnitude_spectrum()* plots the magnitudes of the corresponding frequencies.

angle_spectrum() *angle_spectrum()* plots the wrapped version of this function.

specgram() *specgram()* can plot the phase spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

---

matplotlib.axes.Axes.psd

Axes.**psd**(*x*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *return_line=None*, ***, *data=None*, ***kwargs*)

Plot the power spectral density.

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, return_line=None, **kwargs)
```

The power spectral density P_{xx} 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 P_{xx}, with a scaling to correct for power loss due to windowing.

If len(*x*) < *NFFT*, it will be zero padded to *NFFT*.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call detrend_mean(). 'linear' calls detrend_linear(). 'none' calls detrend_none().

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

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.

return_line [bool] Whether to include the line object plotted in the returned values. Default is False.

Returns

Pxx [1-D array] The values for the power spectrum P_{xx} before scaling (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxx*

line [a *Line2D* instance] The line created by this function. Only returned if *return_line* is True.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']

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Table 17 – continued from previous page

Property	Description
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

specgram() *specgram()* differs in the default overlap; in not returning the mean of the segment periodograms; in returning the times of the segments; and in plotting a colormap instead of a line.

magnitude_spectrum() *magnitude_spectrum()* plots the magnitude spectrum.

csd() *csd()* plots the spectral density between two signals.

Notes

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)

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

matplotlib.axes.Axes.specgram

Axes.**specgram**(*x*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *cmap=None*, *xextent=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *mode=None*, *scale=None*, *vmin=None*, *vmax=None*, ***, *data=None*, ***kwargs*)

Plot a spectrogram.

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, mode='default', scale='default',
         **kwargs)
```

Compute and plot a spectrogram of data in *x*. Data are split into *NFFT* length segments and the spectrum 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*. The spectrogram is plotted as a colormap (using imshow).

Parameters

x [1-D array or sequence] Array or sequence containing the data.

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

mode [['default' | 'psd' | 'magnitude' | 'angle' | 'phase']] What sort of spectrum to use. Default is 'psd', which takes the power spectral density. 'complex' returns the complex-valued frequency spectrum. 'magnitude' returns the magnitude spectrum. 'angle' returns the phase spectrum without unwrapping. 'phase' returns the phase spectrum with unwrapping.

noverlap [integer] The number of points of overlap between blocks. The default value is 128.

scale [['default' | 'linear' | 'dB']] The scaling of the values in the *spec*. 'linear' is no scaling. 'dB' returns the values in dB scale. When *mode* is 'psd', this is dB power (10 * log10). Otherwise this is dB amplitude (20 * log10). 'default' is 'dB' if *mode* is 'psd' or 'magnitude' and 'linear' otherwise. This must be 'linear' if *mode* is 'angle' or 'phase'.

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.

cmap : A *matplotlib.colors.Colormap* instance; if *None*, use default determined by rc

xextent [[None | (xmin, xmax)]] The image extent along the x-axis. The default sets *xmin* to the left border of the first bin (*spectrum* column) and *xmax* to the right border of the last bin. Note that for *noverlap>0* the width of the bins is smaller than those of the segments.

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

Returns

spectrum [2-D array] Columns are the periodograms of successive segments.

freqs [1-D array] The frequencies corresponding to the rows in *spectrum*.

t [1-D array] The times corresponding to midpoints of segments (i.e., the columns in *spectrum*).

im [instance of class *AxesImage*] The image created by imshow containing the spectrogram

See also:

psd() *psd()* differs in the default overlap; in returning the mean of the segment periodograms; in not returning times; and in generating a line plot instead of colormap.

magnitude_spectrum() A single spectrum, similar to having a single segment when *mode* is 'magnitude'. Plots a line instead of a colormap.

angle_spectrum() A single spectrum, similar to having a single segment when *mode* is 'angle'. Plots a line instead of a colormap.

phase_spectrum() A single spectrum, similar to having a single segment when *mode* is 'phase'. Plots a line instead of a colormap.

Notes

The parameters *detrend* and *scale_by_freq* do only apply when *mode* is set to 'psd'.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Examples using `matplotlib.axes.Axes.specgram`

- sphx_glr_gallery_images_contours_and_fields_specgram_demo.py

matplotlib.axes.Axes.xcorr

`Axes.xcorr`(*x*, *y*, *normed=True*, *detrend=<function detrend_none>*, *usevlines=True*, *maxlags=10*, ***, *data=None*, ***kwargs*)

Plot the cross correlation between *x* and *y*.

The correlation with lag k is defined as sum_n x[n+k] * conj(y[n]).

Parameters

x [sequence of scalars of length n]

y [sequence of scalars of length n]

hold [bool, optional, *deprecated*, default: True]

detrend [callable, optional, default: `mlab.detrend_none`] *x* is detrended by the *detrend* callable. Default is no normalization.

normed [bool, optional, default: True] If `True`, input vectors are normalised to unit length.

usevlines [bool, optional, default: True] If `True`, *Axes.vlines* is used to plot the vertical lines from the origin to the acorr. Otherwise, *Axes.plot* is used.

maxlags [int, optional] Number of lags to show. If None, will return all `2 * len(x) - 1` lags. Default is 10.

Returns

lags [array (lenth `2*maxlags+1`)] lag vector.

c [array (length `2*maxlags+1`)] auto correlation vector.

line [*LineCollection* or *Line2D*] *Artist* added to the axes of the correlation

LineCollection if *usevlines* is True *Line2D* if *usevlines* is False

b [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False

Other Parameters

linestyle [*Line2D* property, optional] Only used if usevlines is `False`.

marker [string, optional] Default is 'o'.

Notes

The cross correlation is performed with `numpy.correlate()` with `mode = 2`.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

35.1.4 Statistics

Axes.boxplot	Make a box and whisker plot.
Axes.violinplot	Make a violin plot.
Axes.violin	Drawing function for violin plots.
Axes.bxp	Drawing function for box and whisker plots.

matplotlib.axes.Axes.boxplot

Axes.**boxplot**(*x*, *notch=None*, *sym=None*, *vert=None*, *whis=None*, *positions=None*, *widths=None*, *patch_artist=None*, *bootstrap=None*, *usermedians=None*, *conf_intervals=None*, *meanline=None*, *showmeans=None*, *showcaps=None*, *showbox=None*, *showfliers=None*, *boxprops=None*, *labels=None*, *flierprops=None*, *medianprops=None*, *meanprops=None*, *capprops=None*, *whiskerprops=None*, *manage_xticks=True*, *autorange=False*, *zorder=None*, ***, *data=None*)

Make a box and whisker plot.

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.

Parameters

x [Array or a sequence of vectors.] The input data.

notch [bool, optional (False)] If `True`, will produce a notched box plot. Otherwise, a rectangular boxplot is produced. The notches represent the confidence interval (CI) around the median. See the entry for the `bootstrap` parameter for information regarding how the locations of the notches are computed.

Note: In cases where the values of the CI are less than the lower quartile or greater than the upper quartile, the notches will extend beyond the box, giving it a distinctive "flipped" appearance. This is expected behavior and consistent with other statistical visualization packages.

---

sym [str, optional] The default symbol for flier points. Enter an empty string (”) if you don’t want to show fliers. If `None`, then the fliers default to ’b+’ If you want more control use the flierprops kwarg.

vert [bool, optional (True)] If `True` (default), makes the boxes vertical. If `False`, everything is drawn horizontally.

whis [float, sequence, or string (default = 1.5)] As a float, determines the reach of the whiskers to the beyond the first and third quartiles. In other words, where IQR is the interquartile range (`Q3-Q1`), the upper whisker will extend to last datum less than `Q3 + whis*IQR`). Similarly, the lower whisker will extend to the first datum greater than `Q1 - whis*IQR`. Beyond the whiskers, data are considered outliers and are plotted as individual points. Set this to an unreasonably high value to force the whiskers to show the min and max values. Alternatively, set this to an ascending sequence of percentile (e.g., [5, 95]) to set the whiskers at specific percentiles of the data. Finally, `whis` can be the string `'range'` to force the whiskers to the min and max of the data.

bootstrap [int, optional] Specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If `bootstrap` is None, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall

and Stuart, 1967). Otherwise, bootstrap specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

usermedians [array-like, optional] An array or sequence whose first dimension (or length) is compatible with `x`. This overrides the medians computed by matplotlib for each element of `usermedians` that is not `None`. When an element of `usermedians` is None, the median will be computed by matplotlib as normal.

conf_intervals [array-like, optional] Array or sequence whose first dimension (or length) is compatible with `x` and whose second dimension is 2. When the an element of `conf_intervals` is not None, the notch locations computed by matplotlib are overridden (provided `notch` is `True`). When an element of `conf_intervals` is `None`, the notches are computed by the method specified by the other kwargs (e.g., `bootstrap`).

positions [array-like, optional] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions. Defaults to `range(1, N+1)` where N is the number of boxes to be drawn.

widths [scalar or array-like] Sets the width of each box either with a scalar or a sequence. The default is 0.5, or `0.15*(distance between extreme positions)`, if that is smaller.

patch_artist [bool, optional (False)] If `False` produces boxes with the Line2D artist. Otherwise, boxes and drawn with Patch artists.

labels [sequence, optional] Labels for each dataset. Length must be compatible with dimensions of `x`.

manage_xticks [bool, optional (True)] If the function should adjust the xlim and xtick locations.

autorange [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to `'range'` such that the whisker ends are at the minimum and maximum of the data.

meanline [bool, optional (False)] If `True` (and `showmeans` is `True`), will try to render the mean as a line spanning the full width of the box according to `meanprops` (see below). Not recommended if `shownotches` is also True. Otherwise, means will be shown as points.

zorder [scalar, optional (None)] Sets the zorder of the boxplot.

Returns

result [dict] A dictionary mapping each component of the boxplot to a list of the *matplotlib.lines.Line2D* instances created. That dictionary has the following keys (assuming vertical boxplots):

- `boxes`: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
- `medians`: horizontal lines at the median of each box.

- `whiskers`: the vertical lines extending to the most extreme, non-outlier data points.
- `caps`: the horizontal lines at the ends of the whiskers.
- `fliers`: points representing data that extend beyond the whiskers (fliers).
- `means`: points or lines representing the means.

Other Parameters

showcaps [bool, optional (True)] Show the caps on the ends of whiskers.

showbox [bool, optional (True)] Show the central box.

showfliers [bool, optional (True)] Show the outliers beyond the caps.

showmeans [bool, optional (False)] Show the arithmetic means.

capprops [dict, optional (None)] Specifies the style of the caps.

boxprops [dict, optional (None)] Specifies the style of the box.

whiskerprops [dict, optional (None)] Specifies the style of the whiskers.

flierprops [dict, optional (None)] Specifies the style of the fliers.

medianprops [dict, optional (None)] Specifies the style of the median.

meanprops [dict, optional (None)] Specifies the style of the mean.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

---

matplotlib.axes.Axes.violinplot

`Axes.violinplot`(*dataset*, *positions=None*, *vert=True*, *widths=0.5*, *showmeans=False*, *showextrema=True*, *showmedians=False*, *points=100*, *bw_method=None*, **, data=None*)

Make a violin plot.

Make a violin plot for each column of *dataset* or each vector in sequence *dataset*. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

Parameters

dataset [Array or a sequence of vectors.] The input data.

positions [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

vert [bool, default = True.] If true, creates a vertical violin plot. Otherwise, creates a horizontal violin plot.

widths [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

showmeans [bool, default = False] If `True`, will toggle rendering of the means.

showextrema [bool, default = True] If `True`, will toggle rendering of the extrema.

showmedians [bool, default = False] If `True`, will toggle rendering of the medians.

points [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimations at.

bw_method [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as `kde.factor`. If a callable, it should take a `GaussianKDE` instance as its only parameter and return a scalar. If None (default), 'scott' is used.

Returns

result [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- `bodies`: A list of the *matplotlib.collections.PolyCollection* instances containing the filled area of each violin.
- `cmeans`: A *matplotlib.collections.LineCollection* instance created to identify the mean values of each of the violin's distribution.
- `cmins`: A *matplotlib.collections.LineCollection* instance created to identify the bottom of each violin's distribution.
- `cmaxes`: A *matplotlib.collections.LineCollection* instance created to identify the top of each violin's distribution.
- `cbars`: A *matplotlib.collections.LineCollection* instance created to identify the centers of each violin's distribution.
- `cmedians`: A *matplotlib.collections.LineCollection* instance created to identify the median values of each of the violin's distribution.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'dataset'.

matplotlib.axes.Axes.violin

Axes.**violin**(*vpstats*, *positions=None*, *vert=True*, *widths=0.5*, *showmeans=False*, *showextrema=True*, *showmedians=False*)

Drawing function for violin plots.

Draw a violin plot for each column of `vpstats`. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

Parameters

vpstats [list of dicts] A list of dictionaries containing stats for each violin plot. Required keys are:

- `coords`: A list of scalars containing the coordinates that the violin's kernel density estimate were evaluated at.
- `vals`: A list of scalars containing the values of the kernel density estimate at each of the coordinates given in *coords*.
- `mean`: The mean value for this violin's dataset.
- `median`: The median value for this violin's dataset.
- `min`: The minimum value for this violin's dataset.
- `max`: The maximum value for this violin's dataset.

positions [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

vert [bool, default = True.] If true, plots the violins veritcally. Otherwise, plots the violins horizontally.

widths [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

showmeans [bool, default = False] If true, will toggle rendering of the means.

showextrema [bool, default = True] If true, will toggle rendering of the extrema.

showmedians [bool, default = False] If true, will toggle rendering of the medians.

Returns

result [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- `bodies`: A list of the *matplotlib.collections.PolyCollection* instances containing the filled area of each violin.
- `cmeans`: A *matplotlib.collections.LineCollection* instance created to identify the mean values of each of the violin's distribution.

- cmins: A *matplotlib.collections.LineCollection* instance created to identify the bottom of each violin's distribution.
- cmaxes: A *matplotlib.collections.LineCollection* instance created to identify the top of each violin's distribution.
- cbars: A *matplotlib.collections.LineCollection* instance created to identify the centers of each violin's distribution.
- cmedians: A *matplotlib.collections.LineCollection* instance created to identify the median values of each of the violin's distribution.

matplotlib.axes.Axes.bxp

Axes.**bxp**(*bxpstats*, *positions=None*, *widths=None*, *vert=True*, *patch_artist=False*, *shownotches=False*, *showmeans=False*, *showcaps=True*, *showbox=True*, *showfliers=True*, *boxprops=None*, *whiskerprops=None*, *flierprops=None*, *medianprops=None*, *capprops=None*, *meanprops=None*, *meanline=False*, *manage_xticks=True*, *zorder=None*)

Drawing function for box and whisker plots.

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.

Parameters

bxpstats [list of dicts] A list of dictionaries containing stats for each boxplot. Required keys are:

- med: The median (scalar float).
- q1: The first quartile (25th percentile) (scalar float).
- q3: The third quartile (75th percentile) (scalar float).
- whislo: Lower bound of the lower whisker (scalar float).
- whishi: Upper bound of the upper whisker (scalar float).

Optional keys are:

- mean: The mean (scalar float). Needed if showmeans=True.
- fliers: Data beyond the whiskers (sequence of floats). Needed if showfliers=True.
- cilo & cihi: Lower and upper confidence intervals about the median. Needed if shownotches=True.
- label: Name of the dataset (string). If available, this will be used a tick label for the boxplot

positions [array-like, default = [1, 2, ..., n]] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions.

widths [array-like, default = None] Either a scalar or a vector and sets the width of each box. The default is `0.15*(distance between extreme positions)`, clipped to no less than 0.15 and no more than 0.5.

vert [bool, default = False] If `True` (default), makes the boxes vertical. If `False`, makes horizontal boxes.

patch_artist [bool, default = False] If `False` produces boxes with the *Line2D* artist. If `True` produces boxes with the *Patch* artist.

shownotches [bool, default = False] If `False` (default), produces a rectangular box plot. If `True`, will produce a notched box plot

showmeans [bool, default = False] If `True`, will toggle on the rendering of the means

showcaps [bool, default = True] If `True`, will toggle on the rendering of the caps

showbox [bool, default = True] If `True`, will toggle on the rendering of the box

showfliers [bool, default = True] If `True`, will toggle on the rendering of the fliers

boxprops [dict or None (default)] If provided, will set the plotting style of the boxes

whiskerprops [dict or None (default)] If provided, will set the plotting style of the whiskers

capprops [dict or None (default)] If provided, will set the plotting style of the caps

flierprops [dict or None (default)] If provided will set the plotting style of the fliers

medianprops [dict or None (default)] If provided, will set the plotting style of the medians

meanprops [dict or None (default)] If provided, will set the plotting style of the means

meanline [bool, default = False] If `True` (and *showmeans* is `True`), will try to render the mean as a line spanning the full width of the box according to *meanprops*. Not recommended if *shownotches* is also True. Otherwise, means will be shown as points.

manage_xticks [bool, default = True] If the function should adjust the xlim and xtick locations.

zorder [scalar, default = None] The zorder of the resulting boxplot

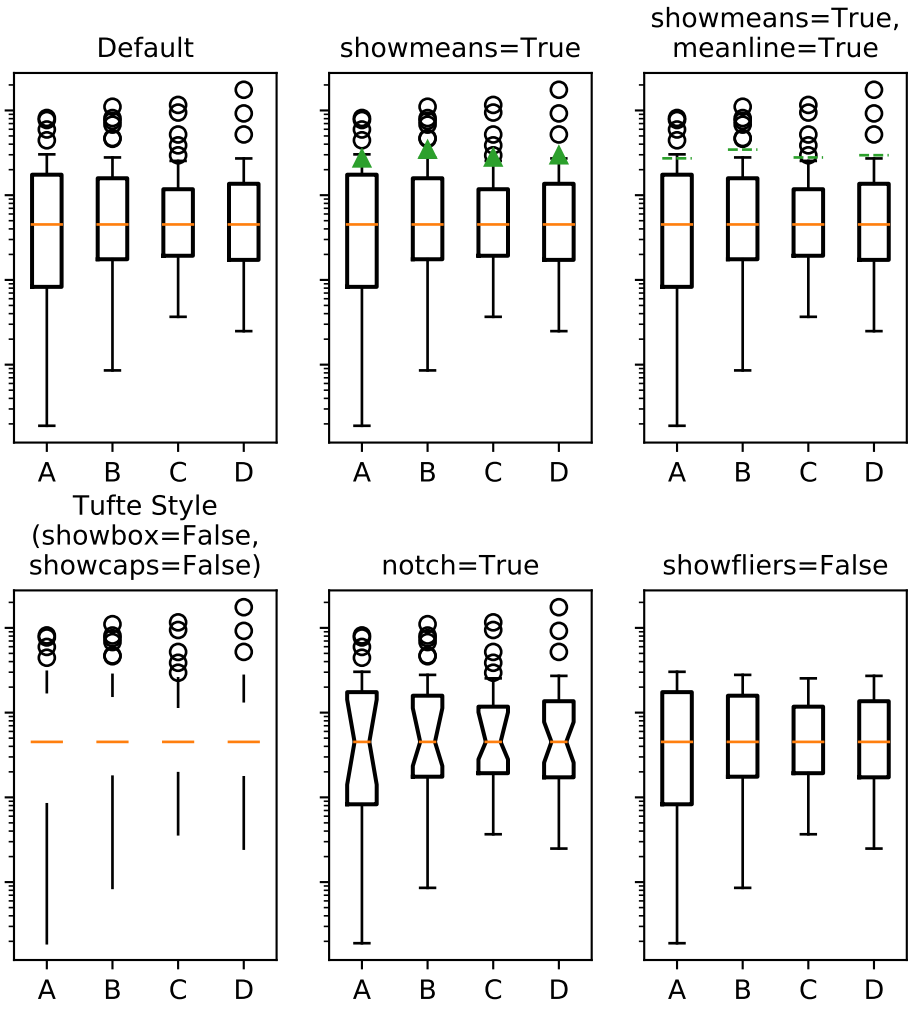
Returns

result [dict] A dictionary mapping each component of the boxplot to a list of the *matplotlib.lines.Line2D* instances created. That dictionary has the following keys (assuming vertical boxplots):

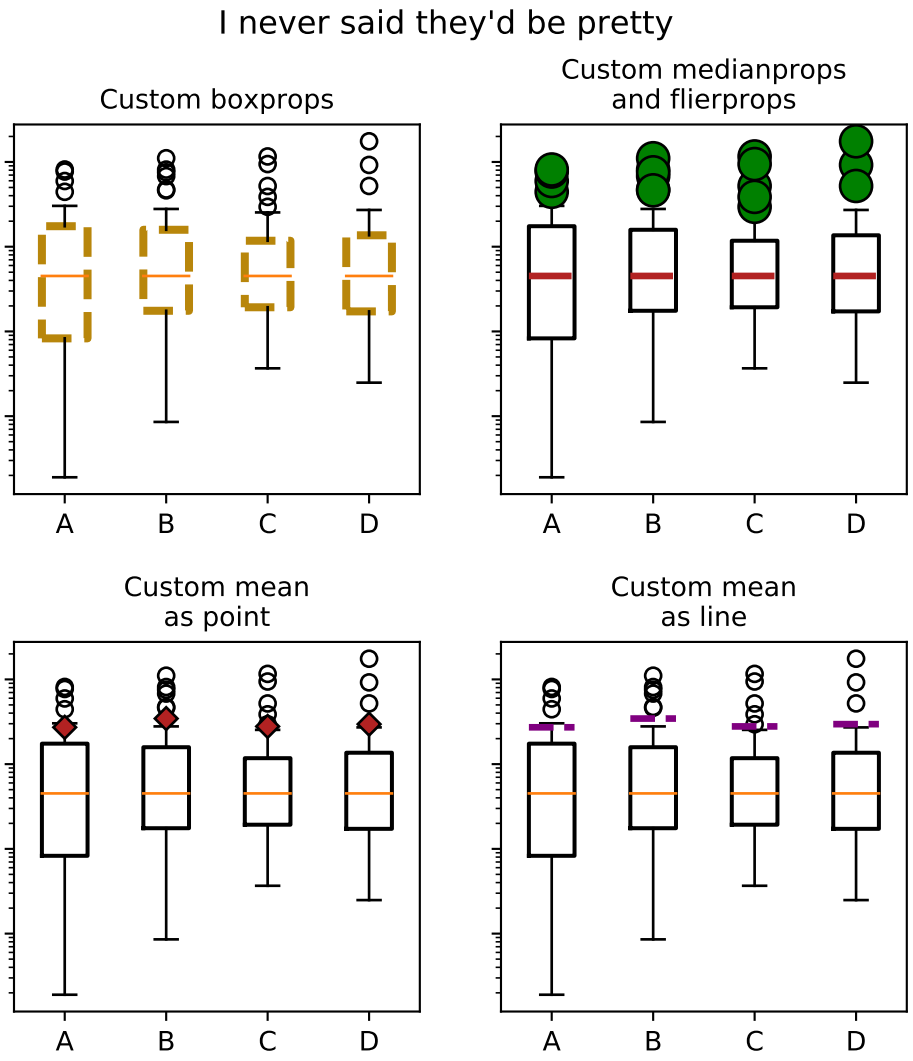
- `boxes`: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
- `medians`: horizontal lines at the median of each box.

- `whiskers`: the vertical lines extending to the most extreme, non-outlier data points.
- `caps`: the horizontal lines at the ends of the whiskers.
- `fliers`: points representing data that extend beyond the whiskers (fliers).
- `means`: points or lines representing the means.

Examples



35.1.5 Binned


I never said they'd be pretty
Custom boxprops
Custom medianprops
and flierprops
Custom mean
as point
Custom mean
as line
A
B
C
D

Axes.hexbin	Make a hexagonal binning plot.
Axes.hist	Plot a histogram.
Axes.hist2d	Make a 2D histogram plot.

matplotlib.axes.Axes.hexbin

Axes.**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='face'*, *reduce_C_function=<function mean>*, *mincnt=None*, *marginals=False*, ***, *data=None*, ***kwargs*)

Make a hexagonal binning plot.

Make a hexagonal binning plot of *x* versus *y*, where *x*, *y* are 1-D sequences of the same length, *N*. If *C* is *None* (the default), this is a histogram of the number of occurrences of the observations at (x[i],y[i]).

If *C* is specified, it specifies values at the coordinate (x[i],y[i]). These values are accumulated for each hexagonal bin and then reduced according to *reduce_C_function*, which defaults to numpy's mean function (np.mean). (If *C* is specified, it must also be a 1-D sequence of the same length as *x* and *y*.)

Parameters

x, y [array or masked array]

C [array or masked array, optional, default is *None*]

gridsize [int or (int, int), optional, default is 100] 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 [{'log'} or int or sequence, optional, default is *None*] 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'}, optional, default is 'linear'] Use a linear or log10 scale on the horizontal axis.

yscale [{'linear', 'log'}, optional, default is 'linear'] Use a linear or log10 scale on the vertical axis.

mincnt [int > 0, optional, default is *None*] If not *None*, only display cells with more than *mincnt* number of points in the cell

marginals [bool, optional, default is *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 [scalar, optional, default is *None*] The limits of the bins. The default assigns the limits based on *gridsize*, *x*, *y*, *xscale* and *yscale*.

If *xscale* or *yscale* is set to 'log', the limits are expected to be the exponent for a power of 10. E.g. for x-limits of 1 and 50 in 'linear' scale and y-limits of 10 and 1000 in 'log' scale, enter (1, 50, 1, 3).

Order of scalars is (left, right, bottom, top).

Returns

object 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*.

Other Parameters

cmap [object, optional, default is *None*] a *matplotlib.colors.Colormap* instance. If *None*, defaults to rc `image.cmap`.

norm [object, optional, default is *None*] *matplotlib.colors.Normalize* instance is used to scale luminance data to 0,1.

vmin, vmax [scalar, optional, default is *None*] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If *None*, the min and max of the color array *C* are used. Note if you pass a norm instance your settings for *vmin* and *vmax* will be ignored.

alpha [scalar between 0 and 1, optional, default is *None*] the alpha value for the patches

linewidths [scalar, optional, default is *None*] If *None*, defaults to 1.0.

edgecolors [{'face', 'none', *None*} or color, optional] If 'face' (the default), draws the edges in the same color as the fill color.

If 'none', no edge is drawn; this can sometimes lead to unsightly unpainted pixels between the hexagons.

If *None*, draws outlines in the default color.

If a matplotlib color arg, draws outlines in the specified color.

Notes

The standard descriptions of all the *Collection* parameters:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool

Table 20 – continued from previous page

Property	Description
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

matplotlib.axes.Axes.hist

Axes.**hist**(*x*, *bins=None*, *range=None*, *density=None*, *weights=None*, *cumulative=False*, *bottom=None*, *histtype='bar'*, *align='mid'*, *orientation='vertical'*, *rwidth=None*, *log=False*, *color=None*, *label=None*, *stacked=False*, *normed=None*, ***, *data=None*, ***kwargs*)

Plot a histogram.

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.

Parameters

x [(n,) array or sequence of (n,) arrays] Input values, this takes either a single array or a sequence of arrays which are not required to be of the same length

bins [integer or sequence or 'auto', optional] If an integer is given, `bins + 1` bin edges are calculated and returned, consistent with `numpy.histogram()`.

If `bins` is a sequence, gives bin edges, including left edge of first bin and right edge of last bin. In this case, `bins` is returned unmodified.

All but the last (righthand-most) bin is half-open. In other words, if `bins` is:

```
[1, 2, 3, 4]
```

then the first bin is `[1, 2)` (including 1, but excluding 2) and the second `[2, 3)`. The last bin, however, is `[3, 4]`, which *includes* 4.

Unequally spaced bins are supported if *bins* is a sequence.

If Numpy 1.11 is installed, may also be `'auto'`.

Default is taken from the rcParam `hist.bins`.

range [tuple or None, optional] 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.

Default is `None`

density [boolean, optional] If `True`, the first element of the return tuple will be the counts normalized to form a probability density, i.e., the area (or integral) under the histogram will sum to 1. This is achieved by dividing the count by the number of observations times the bin width and not dividing by the total number of observations. If *stacked* is also `True`, the sum of the histograms is normalized to 1.

Default is None for both *normed* and *density*. If either is set, then that value will be used. If neither are set, then the args will be treated as False.

If both *density* and *normed* are set an error is raised.

weights [(n,) array_like or None, optional] 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* or *density* is True, the weights are normalized, so that the integral of the density over the range remains 1.

Default is None

cumulative [boolean, optional] 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* or *density* 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* and/or *density* is also True, then the histogram is normalized such that the first bin equals 1.

Default is False

bottom [array_like, scalar, or None] Location of the bottom baseline of each bin. If a scalar, the base line for each bin is shifted by the same amount. If an array, each bin is shifted independently and the length of bottom must match the number of bins. If None, defaults to 0.

Default is None

histtype [{'bar', 'barstacked', 'step', 'stepfilled'}, optional] The type of histogram to draw.

- 'bar' is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- 'barstacked' is a bar-type histogram where multiple data are stacked on top of each other.
- 'step' generates a lineplot that is by default unfilled.
- 'stepfilled' generates a lineplot that is by default filled.

Default is 'bar'

align [{'left', 'mid', 'right'}, optional] 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.

Default is 'mid'

orientation [{'horizontal', 'vertical'}, optional] If 'horizontal', *barh* will be used for bar-type histograms and the *bottom* kwarg will be the left edges.

rwidth [scalar or None, optional] The relative width of the bars as a fraction of the bin width. If `None`, automatically compute the width.

Ignored if *histtype* is 'step' or 'stepfilled'.

Default is `None`

log [boolean, optional] 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.

Default is `False`

color [color or array_like of colors or None, optional] Color spec or sequence of color specs, one per dataset. Default (`None`) uses the standard line color sequence.

Default is `None`

label [string or None, optional] 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.

default is `None`

stacked [boolean, optional] If `True`, multiple data are stacked on top of each other If `False` multiple data are arranged side by side if histtype is 'bar' or on top of each other if histtype is 'step'

Default is `False`

normed [bool, optional] Deprecated; use the density keyword argument instead.

Returns

n [array or list of arrays] The values of the histogram bins. See *normed* or *density* and *weights* for a description of the possible semantics. If input *x* is an array, then this is an array of length *nbins*. If input is a sequence arrays `[data1, data2,. .]`, then this is a list of arrays with the values of the histograms for each of the arrays in the same order.

bins [array] The edges of the bins. Length nbins + 1 (nbins left edges and right edge of last bin). Always a single array even when multiple data sets are passed in.

patches [list or list of lists] Silent list of individual patches used to create the histogram or list of such list if multiple input datasets.

Other Parameters

****kwargs** [*Patch* properties]

See also:

hist2d 2D histograms

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x'.

Examples using `matplotlib.axes.Axes.hist`

- sphx_glr_gallery_statistics_histogram_features.py

matplotlib.axes.Axes.hist2d

`Axes.hist2d`(*x*, *y*, *bins=10*, *range=None*, *normed=False*, *weights=None*, *cmin=None*, *cmax=None*, ***, *data=None*, ***kwargs*)

Make a 2D histogram plot.

Parameters

x, y: array_like, shape (n,) Input values

bins: [None | int | [int, int] | array_like | [array, array]] The bin specification:

- If int, the number of bins for the two dimensions (nx=ny=bins).
- If `[int, int]`, the number of bins in each dimension (nx, ny = bins).
- If array_like, the bin edges for the two dimensions (x_edges=y_edges=bins).
- If `[array, array]`, the bin edges in each dimension (x_edges, y_edges = bins).

The default value is 10.

range [array_like shape(2, 2), optional, default: None] The leftmost and rightmost edges of the bins along each dimension (if not specified explicitly in the bins parameters): `[[xmin, xmax], [ymin, ymax]]`. All values outside of this range will be considered outliers and not tallied in the histogram.

normed [boolean, optional, default: False] Normalize histogram.

weights [array_like, shape (n,), optional, default: None] An array of values w_i weighing each sample (x_i, y_i).

cmin [scalar, optional, default: None] All bins that has count less than cmin will not be displayed and these count values in the return value count histogram will also be set to nan upon return

cmax [scalar, optional, default: None] All bins that has count more than cmax will not be displayed (set to none before passing to imshow) and these count values in the return value count histogram will also be set to nan upon return

Returns

h [2D array] The bi-dimensional histogram of samples x and y. Values in x are histogrammed along the first dimension and values in y are histogrammed along the second dimension.

xedges [1D array] The bin edges along the x axis.

yedges [1D array] The bin edges along the y axis.

image [AxesImage]

Other Parameters

cmap [Colormap or str, optional] A *colors.Colormap* instance. If not set, use rc settings.

norm [Normalize, optional] A *colors.Normalize* instance is used to scale luminance data to `[0, 1]`. If not set, defaults to *colors.Normalize()*.

vmin/vmax [None or scalar, optional] Arguments passed to the *Normalize* instance.

alpha [`0 <= scalar <= 1` or `None`, optional] The alpha blending value.

See also:

hist 1D histogram plotting

Notes

- Currently `hist2d` calculates it's own axis limits, and any limits previously set are ignored.
- Rendering the histogram with a logarithmic color scale is accomplished by passing a *colors.LogNorm* instance to the *norm* keyword argument. Likewise, power-law normalization (similar in effect to gamma correction) can be accomplished with *colors.PowerNorm*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x', 'y'.

35.1.6 Contours

Axes.clabel	Label a contour plot.
Axes.contour	Plot contours.
Axes.contourf	Plot contours.

matplotlib.axes.Axes.clabel

Axes.**clabel**(*CS*, **args*, ***kwargs*)

Label a contour plot.

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*.

Parameters

fontsize [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

colors : Color of each label

- 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 [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

inline_spacing [float, optional] 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 [string or dict, optional] A format string for the label. Default is '%1.3f'

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., fmt[level]=string), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

manual [bool or iterable, optional] 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).

manual can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

rightside_up [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

use_clabeltext [bool, optional] If `True`, `ClabelText` class (instead of `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. Default is `False`.

Examples using `matplotlib.axes.Axes.clabel`

- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py

matplotlib.axes.Axes.contour

`Axes.`**`contour`**(**args*, *data=None*, ***kwargs*)

Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **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.

Parameters

X, Y [array-like, optional] The coordinates of the values in *Z*.

X and *Y* must both be 2-D with the same shape as *Z* (e.g. created via `numpy.meshgrid()`), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

Z [array-like(N, M)] The height values over which the contour is drawn.

levels [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

Returns

:class:‘~matplotlib.contour.QuadContourSet‘

Other Parameters

corner_mask [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams['contour.corner_mask']`, which defaults to `True`.

colors [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

alpha [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

cmap [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

norm [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

vmin, vmax [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

origin [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of `Z[0, 0]`. This is only relevant, if *X*, *Y* are not given.

- *None*: `Z[0, 0]` is at X=0, Y=0 in the lower left corner.
- 'lower': `Z[0, 0]` is at X=0.5, Y=0.5 in the lower left corner.
- 'upper': `Z[0, 0]` is at X=N+0.5, Y=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`. Note: The value *None* in the rcParam is currently handled as 'lower'.

extent [(x0, x1, y0, y1), optional] 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 [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

extend [{'neither', 'both', 'min', 'max'}, optional] 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 [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

antialiased [bool, optinal] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

Nchunk [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

linewidths [float or sequence of float, optional] *Only applies to* *contour*.

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

linestyles [{*None*, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to* *contour*.

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

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.

hatches [List[str], optional] *Only applies to* `contourf`.

A list of cross hatch patterns to use on the filled areas. If None, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Notes

1. *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()*.
2. 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 using `matplotlib.axes.Axes.contour`

- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py

matplotlib.axes.Axes.contourf

`Axes.`**`contourf`**`(`*args*, *data=None*, ***kwargs*`)`

Plot contours.

Call signature:

```
contourf([X, Y,] Z, [levels], **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.

Parameters

X, Y [array-like, optional] The coordinates of the values in *Z*.

X and *Y* must both be 2-D with the same shape as *Z* (e.g. created via `numpy.meshgrid()`), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

Z [array-like(N, M)] The height values over which the contour is drawn.

levels [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

Returns

:class:‘~matplotlib.contour.QuadContourSet‘

Other Parameters

corner_mask [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams['contour.corner_mask']`, which defaults to `True`.

colors [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it’s repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

alpha [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

cmap [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

norm [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

vmin, vmax [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

origin [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of `Z[0, 0]`. This is only relevant, if *X*, *Y* are not given.

- *None*: `Z[0, 0]` is at X=0, Y=0 in the lower left corner.
- 'lower': `Z[0, 0]` is at X=0.5, Y=0.5 in the lower left corner.
- 'upper': `Z[0, 0]` is at X=N+0.5, Y=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`. Note: The value *None* in the rcParam is currently handled as 'lower'.

extent [(x0, x1, y0, y1), optional] 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 [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

extend [{'neither', 'both', 'min', 'max'}, optional] 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 [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

antialiased [bool, optinal] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

Nchunk [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

linewidths [float or sequence of float, optional] *Only applies to* `contour`.

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

linestyles [{*None*, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to* `contour`.

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

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.

hatches [List[str], optional] *Only applies to* `contourf`.

A list of cross hatch patterns to use on the filled areas. If None, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Notes

1. *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()*.
2. 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 using `matplotlib.axes.Axes.contourf`

- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py

- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py

35.1.7 Array

Axes.imshow	Display an image on the axes.
Axes.matshow	Plot the values of a 2D matrix or array as color-coded image.
Axes.pcolor	Create a pseudocolor plot with a non-regular rectangular grid.
Axes.pcolorfast	Create a pseudocolor plot with a non-regular rectangular grid.
Axes.pcolormesh	Create a pseudocolor plot with a non-regular rectangular grid.
Axes.spy	Plot the sparsity pattern on a 2-D array.

matplotlib.axes.Axes.imshow

Axes.**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*, ***, *data=None*, ***kwargs*)

Display an image on the axes.

Parameters

X [array_like, shape (n, m) or (n, m, 3) or (n, m, 4)] Display the image in `X` to current axes. `X` may be an array or a PIL image. If `X` is an array, it can have the following shapes and types:

- MxN – values to be mapped (float or int)
- MxNx3 – RGB (float or uint8)
- MxNx4 – RGBA (float or uint8)

MxN arrays are mapped to colors based on the `norm` (mapping scalar to scalar) and the `cmap` (mapping the normed scalar to a color).

Elements of RGB and RGBA arrays represent pixels of an MxN image. All values should be in the range [0 .. 1] for floats or [0 .. 255] for integers. Out-of-range values will be clipped to these bounds.

cmap [*Colormap*, optional, default: None] If None, default to rc `image.cmap` value. `cmap` is ignored if `X` is 3-D, directly specifying RGB(A) values.

aspect [['auto' | 'equal' | scalar], optional, default: None] 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 [string, optional, default: None] 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. If `interpolation` is 'none', then no interpolation is performed on the Agg, ps and pdf backends. Other backends will fall back to 'nearest'.

norm [*Normalize*, optional, default: None] A *Normalize* instance is used to scale a 2-D float `X` input to the (0, 1) range for input to the `cmap`. If `norm` is None, use the default func:`normalize`. If `norm` is an instance of *NoNorm*, `X` must be an array of integers that index directly into the lookup table of the `cmap`.

vmin, vmax [scalar, optional, default: None] `vmin` and `vmax` are used in conjunction with norm to normalize luminance data. Note if you pass a `norm` instance, your settings for `vmin` and `vmax` will be ignored.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque). The `alpha` argument is ignored for RGBA input data.

origin [['upper' | 'lower'], optional, default: None] 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 [scalars (left, right, bottom, top), optional, default: None] The location, in data-coordinates, of the lower-left and upper-right corners. If `None`, the image is positioned such that the pixel centers fall on zero-based (row, column) indices.

shape [scalars (columns, rows), optional, default: None] For raw buffer images

filternorm [scalar, optional, default: 1] 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 [scalar, optional, default: 4.0] The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: 'sinc', 'lanczos' or 'blackman'

Returns

image [*AxesImage*]

Other Parameters

****kwargs** [*Artist* properties.]

See also:

matshow Plot a matrix or an array as an image.

Notes

Unless *extent* is used, pixel centers will be located at integer coordinates. In other words: the origin will coincide with the center of pixel (0, 0).

Two typical representations are used for RGB images with an alpha channel:

- Straight (unassociated) alpha: R, G, and B channels represent the color of the pixel, disregarding its opacity.
- Premultiplied (associated) alpha: R, G, and B channels represent the color of the pixel, adjusted for its opacity by multiplication.

imshow expects RGB images adopting the straight (unassociated) alpha representation.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.axes.Axes.imshow`

- sphx_glr_gallery_color_colorbar_basics.py
- sphx_glr_gallery_color_colormap_reference.py
- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_images_contours_and_fields_barcode_demo.py
- sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py
- sphx_glr_gallery_images_contours_and_fields_layer_images.py
- sphx_glr_gallery_images_contours_and_fields_affine_image.py
- sphx_glr_gallery_images_contours_and_fields_shading_example.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py

matplotlib.axes.Axes.matshow

Axes.**matshow**(*Z*, ***kwargs*)

Plot the values of a 2D matrix or array as color-coded 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.

Parameters

Z [array-like(N, M)] The matrix to be displayed.

Returns

image [*AxesImage*]

Other Parameters

****kwargs** [*imshow* arguments]

See also:

imshow More general function to plot data on a 2D regular raster.

Notes

This is just a convenience function wrapping *imshow* to set useful defaults for a displaying a matrix. In particular:

- Set `origin='upper'`.
- Set `interpolation='nearest'`.
- Set `aspect='equal'`.
- Ticks are placed to the left and above.
- Ticks are formatted to show integer indices.

Examples using `matplotlib.axes.Axes.matshow`

- sphx_glr_gallery_images_contours_and_fields_matshow.py

matplotlib.axes.Axes.pcolor

Axes.**pcolor**(**args*, *data=None*, ***kwargs*)

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

X and *Y* can be used to specify the corners of the quadrilaterals.

Hint: `pcolor()` can be very slow for large arrays. In most cases you should use the the similar but much faster *pcolormesh* instead. See there for a discussion of the differences.

Parameters

C [array_like] A scalar 2-D array. The values will be color-mapped.

X, Y [array_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i,j]` has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
                      +--------+
                      | C[i,j] |
                      +--------+
   (X[i, j], Y[i, j])           (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of *X* and *Y* should be one greater than those of *C*. Alternatively, *X*, *Y* and *C* may have equal dimensions, in which case the last row and column of *C* will be ignored.

If *X* and/or *Y* are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

cmap [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

norm [*Normalize*, optional] The Normalize instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

vmin, vmax [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

edgecolors [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or '': No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

alpha [scalar, optional, default: None] The alpha blending value of the face color, between 0 (transparent) and 1 (opaque). Note: The edgecolor is currently not affected by this.

snap [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

Returns

collection [*matplotlib.collections.Collection*]

Other Parameters

antialiaseds [bool, optional, default: False] The default *antialiaseds* is False if the default *edgecolors*="none" is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of alpha. If *edgecolors* is not "none", then the default *antialiaseds* is taken from `rcParams["patch.antialiased"]`, which defaults to True. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

****kwargs :** Additionally, the following arguments are allowed. They are passed along to the *PolyCollection* constructor:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats

Table 23 – continued from previous page

Property	Description
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

pcolormesh for an explanation of the differences between pcolor and pcolormesh.

imshow If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

Notes

Masked arrays

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.

Grid orientation

The grid orientation follows the standard matrix convention: An array *C* with shape (nrows, ncolumns) is plotted with the column number as *X* and the row number as *Y*.

Handling of pcolor() end-cases

`pcolor()` displays all columns of *C* if *X* and *Y* are not specified, or if *X* and *Y* have one more column than *C*. If *X* and *Y* have the same number of columns as *C* then the last column of *C* is dropped. Similarly for the rows.

Note: This behavior is different from MATLAB's `pcolor()`, which always discards the last row and column of *C*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.axes.Axes.pcolor`

- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py

matplotlib.axes.Axes.pcolorfast

`Axes.pcolorfast`(**args*, *data=None*, ***kwargs*)

Create a pseudocolor plot with a non-regular rectangular grid.

Call signatures:

```
ax.pcolorfast(C, **kwargs)
ax.pcolorfast(xr, yr, C, **kwargs)
ax.pcolorfast(x, y, C, **kwargs)
ax.pcolorfast(X, Y, C, **kwargs)
```

This method is similar to ~.Axes.pcolor‘ and *pcolormesh*. It’s designed to provide the fastest pcolor-type plotting with the Agg backend. To achieve this, it uses different algorithms internally depending on the complexity of the input grid (regular rectangular, non-regular rectangular or arbitrary quadrilateral).

Warning: This method is experimental. Compared to *pcolor* or *pcolormesh* it has some limitations:

- It supports only flat shading (no outlines)
- It lacks support for log scaling of the axes.
- It does not have a have a pyplot wrapper.

Parameters

C [array-like(M, N)] A scalar 2D array. The values will be color-mapped. *C* may be a masked array.

x, y [tuple or array-like] *X* and *Y* are used to specify the coordinates of the quadilaterals. There are different ways to do this:

- Use tuples `xr=(xmin, xmax)` and `yr=(ymin, ymax)` to define a *uniform rectiangular grid*.

  The tuples define the outer edges of the grid. All individual quadrilaterals will be of the same size. This is the fastest version.

- Use 1D arrays *x*, *y* to specify a *non-uniform rectangular grid*.

  In this case *x* and *y* have to be monotonic 1D arrays of length *N+1* and *M+1*, specifying the x and y boundaries of the cells.

  The speed is intermediate. Note: The grid is checked, and if found to be uniform the fast version is used.

- Use 2D arrays *X*, *Y* if you need an *arbitrary quadrilateral grid* (i.e. if the quadrilaterals are not rectangular).

  In this case *X* and *Y* are 2D arrays with shape (M, N), specifying the x and y coordinates of the corners of the colored quadrilaterals. See *pcolormesh* for details.

  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.

Leaving out *x* and *y* defaults to `xr=(0, N)`, `yr=(0, M)`.

cmap [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

norm [*Normalize*, optional] The Normalize instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

vmin, vmax [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

snap [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

Returns

image [*AxesImage* or *PcolorImage* or *QuadMesh*] The return type depends on the type of grid:

- *AxesImage* for a regular rectangular grid.
- *PcolorImage* for a non-regular rectangular grid.
- *QuadMesh* for a non-rectangular grid.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.axes.Axes.pcolorfast`

- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py

matplotlib.axes.Axes.pcolormesh

Axes.**pcolormesh**(**args*, *data=None*, ***kwargs*)

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

X and *Y* can be used to specify the corners of the quadrilaterals.

Note: `pcolormesh()` is similar to *pcolor()*. It's much faster and preferred in most cases. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

Parameters

C [array_like] A scalar 2-D array. The values will be color-mapped.

X, Y [array_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i,j]` has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
                      +--------+
                      | C[i,j] |
                      +--------+
   (X[i, j], Y[i, j])           (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of *X* and *Y* should be one greater than those of *C*. Alternatively, *X*, *Y* and *C* may have equal dimensions, in which case the last row and column of *C* will be ignored.

If *X* and/or *Y* are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

cmap [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

norm [*Normalize*, optional] The Normalize instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

vmin, vmax [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

edgecolors [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or '': No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

shading [{'flat', 'gouraud'}, optional] The fill style, Possible values:

- 'flat': A solid color is used for each quad. The color of the quad (i, j), (i+1, j), (i, j+1), (i+1, j+1) is given by `C[i,j]`.
- 'gouraud': Each quad will be Gouraud shaded: The color of the corners (i', j') are given by `C[i',j']`. The color values of the area in between is interpolated from the corner values. When Gouraud shading is used, *edgecolors* is ignored.

snap [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

Returns

mesh [*matplotlib.collections.QuadMesh*]

Other Parameters

****kwargs** Additionally, the following arguments are allowed. They are passed along to the *QuadMesh* constructor:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string

Table 24 – continued from previous page

Property	Description
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

pcolor An alternative implementation with slightly different features. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

imshow If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

Notes

Masked arrays

C may be a masked array. If `C[i, j]` is masked, the corresponding quadrilateral will be transparent. Masking of *X* and *Y* is not supported. Use *pcolor* if you need this functionality.

Grid orientation

The grid orientation follows the standard matrix convention: An array *C* with shape (nrows, ncolumns) is plotted with the column number as *X* and the row number as *Y*.

Differences between pcolor() and pcolormesh()

Both methods are used to create a pseudocolor plot of a 2-D array using quadrilaterals.

The main difference lies in the created object and internal data handling: While *pcolor* returns a *PolyCollection*, *pcolormesh* returns a *QuadMesh*. The latter is more specialized for the given purpose and thus is faster. It should almost always be preferred.

There is also a slight difference in the handling of masked arrays. Both *pcolor* and *pcolormesh* support masked arrays for *C*. However, only *pcolor* supports masked arrays for *X* and *Y*. The reason lies in the internal handling of the masked values. *pcolor* leaves out the respective polygons from the PolyCollection. *pcolormesh* sets the facecolor of the masked elements to transparent. You can see the difference when using edgecolors. While all edges are drawn irrespective of masking in a QuadMesh, the edge between two adjacent masked quadrilaterals in *pcolor* is not drawn as the corresponding polygons do not exist in the PolyCollection.

Another difference is the support of Gouraud shading in *pcolormesh*, which is not available with *pcolor*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.axes.Axes.pcolormesh`

- sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py

matplotlib.axes.Axes.spy

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

Plot the sparsity pattern on a 2-D array.

`spy(Z)` plots the sparsity pattern of the 2-D array *Z*.

Parameters

Z [sparse array (n, m)] The array to be plotted.

precision [float, optional, default: 0] 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.

origin [["upper", "lower"], optional, default: "upper"] Place the [0,0] index of the array in the upper left or lower left corner of the axes.

aspect [['auto' | 'equal' | scalar], optional, default: "equal"] 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 'auto', changes the image aspect ratio to match that of the axes.

If None, default to rc `image.aspect` value.

Two plotting styles are available: image or marker. Both are available for full arrays, but only the marker style works for :class:‘scipy.sparse.spmatrix‘ instances.

If *marker* and *markersize* are *None*, an image will be returned and any remaining kwargs are passed to :func:‘~matplotlib.pyplot.imshow‘; else, a :class:‘~matplotlib.lines.Line2D‘ object will be returned with the value of marker determining the marker type, and any remaining kwargs passed to the :meth:‘~matplotlib.axes.Axes.plot‘ method.

If *marker* and *markersize* are *None*, useful kwargs include:

*** *cmap***

*** *alpha***

See also:

imshow for image options.

plot for plotting options

Examples using `matplotlib.axes.Axes.spy`

- sphx_glr_gallery_images_contours_and_fields_spy_demos.py

35.1.8 Unstructured Triangles

Axes.tripcolor	Create a pseudocolor plot of an unstructured triangular grid.
Axes.triplot	Draw a unstructured triangular grid as lines and/or markers.
Axes.tricontour	Draw contours on an unstructured triangular grid.
Axes.tricontourf	Draw contours on an unstructured triangular grid.

matplotlib.axes.Axes.tripcolor

`Axes.`**`tripcolor`**`(`*args*, ***kwargs*`)`

Create a pseudocolor plot of an unstructured triangular grid.

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where triangulation is a *matplotlib.tri.Triangulation* object, or

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

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

The next argument must be *C*, the array of color values, either one per point in the triangulation if color values are defined at points, or one per triangle in the triangulation if color values are defined at triangles. If there are the same number of points and triangles in the triangulation it is assumed that color values are defined at points; to force the use of color values at triangles use the kwarg `facecolors=C` instead of just `C`.

shading may be 'flat' (the default) or 'gouraud'. If *shading* is 'flat' and C values are defined at points, the color values used for each triangle are from the mean C of the triangle's three points. If *shading* is 'gouraud' then color values must be defined at points.

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

Examples using `matplotlib.axes.Axes.tripcolor`

- sphx_glr_gallery_images_contours_and_fields_tripcolor_demo.py

matplotlib.axes.Axes.triplot

Axes.**triplot**(**args*, ***kwargs*)

Draw a unstructured triangular grid as lines and/or markers.

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

where triangulation is a *matplotlib.tri.Triangulation* object, or

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

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

The remaining args and kwargs are the same as for *plot()*.

Return a list of 2 *Line2D* containing respectively:

- the lines plotted for triangles edges
- the markers plotted for triangles nodes

Examples using `matplotlib.axes.Axes.triplot`

- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
- sphx_glr_gallery_images_contours_and_fields_triplot_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py

matplotlib.axes.Axes.tricontour

Axes.**tricontour**(**args*, ***kwargs*)

Draw contours on an unstructured triangular grid. *tricontour()* and *tricontourf()* draw contour lines and filled contours, respectively. 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 *matplotlib.tri.Triangulation* object, or

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

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

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to *N+1* automatically chosen contour levels (*N* intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the (len(*V*)-1) regions between the values in *V*, which must be in increasing order.

```
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, in increasing order; e.g., 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: bool enable antialiasing

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 using `matplotlib.axes.Axes.tricontour`

- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py
- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py

matplotlib.axes.Axes.tricontourf

Axes.**tricontourf**(**args*, ***kwargs*)

Draw contours on an unstructured triangular grid. *tricontour()* and *tricontourf()* draw contour lines and filled contours, respectively. 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 *matplotlib.tri.Triangulation* object, or

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

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

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to *N+1* automatically chosen contour levels (*N* intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the (len(*V*)-1) regions between the values in *V*, which must be in increasing order.

```
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, in increasing order; e.g., 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: bool enable antialiasing

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 using `matplotlib.axes.Axes.tricontourf`

- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py

35.1.9 Text and Annotations

Axes.annotate	Annotate the point `xy` with text `s`.
Axes.text	Add text to the axes.
Axes.table	Add a table to the current axes.
Axes.arrow	Add an arrow to the axes.

matplotlib.axes.Axes.annotate

Axes.**annotate**(**args*, ***kwargs*)

Annotate the point `xy` with text `s`.

Additional kwargs are passed to *Text*.

Parameters

s [str] The text of the annotation

xy [iterable] Length 2 sequence specifying the *(x,y)* point to annotate

xytext [iterable, optional] Length 2 sequence specifying the *(x,y)* to place the text at. If None, defaults to `xy`.

xycoords [str, Artist, Transform, callable or tuple, optional] The coordinate system that `xy` is given in.

For a `str` the allowed values are:

Property	Description
'figure points'	points from the lower left of the figure
'figure pixels'	pixels from the lower left of the figure
'figure fraction'	fraction of figure from lower left
'axes points'	points from lower left corner of axes
'axes pixels'	pixels from lower left corner of axes
'axes fraction'	fraction of axes from lower left
'data'	use the coordinate system of the object being annotated (default)
'polar'	*(theta,r)* if not native 'data' coordinates

If a *Artist* object is passed in the units are fraction if it's bounding box.

If a *Transform* object is passed in use that to transform `xy` to screen coordinates

If a callable it must take a *RendererBase* object as input and return a *Transform* or *Bbox* object

If a `tuple` must be length 2 tuple of str, `Artist`, `Transform` or callable objects. The first transform is used for the *x* coordinate and the second for *y*.

See *Advanced Annotation* for more details.

Defaults to `'data'`

textcoords [str, `Artist`, `Transform`, callable or tuple, optional] The coordinate system that `xytext` is given, which may be different than the coordinate system used for `xy`.

All `xycoords` values are valid as well as the following strings:

Property	Description
'offset points'	offset (in points) from the *xy* value
'offset pixels'	offset (in pixels) from the *xy* value

defaults to the input of `xycoords`

arrowprops [dict, optional] If not None, properties used to draw a *FancyArrowPatch* arrow between `xy` and `xytext`.

If `arrowprops` does not contain the key `'arrowstyle'` the allowed keys are:

Key	Description
width	the width of the arrow in points
headwidth	the width of the base of the arrow head in points
headlength	the length of the arrow head in points
shrink	fraction of total length to 'shrink' from both ends
?	any key to *matplotlib.patches.FancyArrowPatch*

If the `arrowprops` contains the key `'arrowstyle'` the above keys are forbidden. The allowed values of `'arrowstyle'` are:

Name	Attrs
`'-'`	None
`'->'`	head_length=0.4,head_width=0.2
`'-['`	widthB=1.0,lengthB=0.2,angleB=None
`'|-|'`	widthA=1.0,widthB=1.0
`'-|>'`	head_length=0.4,head_width=0.2
`'<-'`	head_length=0.4,head_width=0.2
`'<->'`	head_length=0.4,head_width=0.2
`'<|-'`	head_length=0.4,head_width=0.2
`'<|-|>'`	head_length=0.4,head_width=0.2
`'fancy'`	head_length=0.4,head_width=0.4,tail_width=0.4
`'simple'`	head_length=0.5,head_width=0.5,tail_width=0.2
`'wedge'`	tail_width=0.3,shrink_factor=0.5

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*

Defaults to None

annotation_clip [bool, optional] Controls the visibility of the annotation when it goes outside the axes area.

If `True`, the annotation will only be drawn when the `xy` is inside the axes. If `False`, the annotation will always be drawn regardless of its position.

The default is `None`, which behave as `True` only if *xycoords* is "data".

Returns

Annotation

Examples using `matplotlib.axes.Axes.annotate`

- sphx_glr_gallery_shapes_and_collections_donut.py

matplotlib.axes.Axes.text

`Axes.text`(*x*, *y*, *s*, *fontdict=None*, *withdash=False*, ***kwargs*)

Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.

Parameters

x, y [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.

s [str] The text.

fontdict [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters.

withdash [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.

Returns

text [*Text*] The created *Text* instance.

Other Parameters

****kwargs** [*Text* properties.] Other miscellaneous text parameters.

Examples

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 (e.g., to set a background color) by using the keyword bbox. bbox is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

Examples using `matplotlib.axes.Axes.text`

- sphx_glr_gallery_color_named_colors.py

matplotlib.axes.Axes.table

Axes.**table**(***kwargs*)

Add a table to the current axes.

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)
```

Returns a *matplotlib.table.Table* instance. Either `cellText` or `cellColours` must be provided. 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
contains	a callable function
figure	a *Figure* instance
fontsize	a float in points
gid	an id string
label	object
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

matplotlib.axes.Axes.arrow

Axes.**arrow**(*x*, *y*, *dx*, *dy*, ***kwargs*)

Add an arrow to the axes.

This draws an arrow from `(x, y)` to `(x+dx, y+dy)`.

Parameters

x, y [float] The x/y-coordinate of the arrow base.

dx, dy [float] The length of the arrow along x/y-direction.

Returns

arrow [*FancyArrow*] The created *FancyArrow* object.

Other Parameters

****kwargs** Optional kwargs (inherited from *FancyArrow* patch) control the arrow construction and properties:

Constructor arguments

***width*: float (default: 0.001)** width of full arrow tail

***length_includes_head*: bool (default: False)** True if head is to be counted in calculating the length.

***head_width*: float or None (default: 3*width)** total width of the full arrow head

***head_length*: float or None (default: 1.5 * head_width)** length of arrow head

***shape*: ['full', 'left', 'right'] (default: 'full')** draw the left-half, right-half, or full arrow

***overhang*: float (default: 0)** fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

***head_starts_at_zero*: bool (default: False)** if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Other valid kwargs (inherited from :class:'Patch') are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | ':' | 'None' | ' ' | '']
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

Notes

The resulting arrow is affected by the axes aspect ratio and limits. This may produce an arrow whose head is not square with its stem. To create an arrow whose head is square with its stem, use *annotate()* for example:

```
>>> ax.annotate("", xy=(0.5, 0.5), xytext=(0, 0),
...             arrowprops=dict(arrowstyle="->"))
```

35.1.10 Fields

Axes.barbs	Plot a 2-D field of barbs.
Axes.quiver	Plot a 2-D field of arrows.
Axes.quiverkey	Add a key to a quiver plot.
Axes.streamplot	Draws streamlines of a vector flow.

matplotlib.axes.Axes.barbs

Axes.**barbs**(**args*, *data=None*, ***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 7.

***pivot*: ['tip' | 'middle' | float]** The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tip'. Can also be a number, which shifts the start of the barb that many points from the origin.

***barbcolor*: [color | color sequence]** Specifies the color all parts of the barb except any flags. This parameter is analogous 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 analogous 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.axes.Axes.barbs`

- sphx_glr_gallery_images_contours_and_fields_barb_demo.py

matplotlib.axes.Axes.quiver

Axes.**quiver**(**args*, *data=None*, ***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)
```

U and *V* are the arrow data, *X* and *Y* set the location of the arrows, and *C* sets the color of the arrows. These 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 and *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()`.

The default settings auto-scales the length of the arrows to a reasonable size. To change this behavior see the *scale* and *scale_units* kwargs.

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.

Parameters

X [1D or 2D array, sequence, optional] The x coordinates of the arrow locations

Y [1D or 2D array, sequence, optional] The y coordinates of the arrow locations

U [1D or 2D array or masked array, sequence] The x components of the arrow vectors

V [1D or 2D array or masked array, sequence] The y components of the arrow vectors

C [1D or 2D array, sequence, optional] The arrow colors

units [['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy']] The arrow dimensions (except for *length*) are measured in multiples of this unit.

'width' or 'height': the width or height of the axis

'dots' or 'inches': pixels or inches, based on the figure dpi

'x', 'y', or 'xy': respectively X, Y, or $\sqrt{X^2 + Y^2}$ in data units

The arrows scale differently depending on the units. For 'x' or 'y', the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For 'width or 'height', the arrow size increases with the width and height of the axes, respectively, when the window is resized; for 'dots' or 'inches', resizing does not change the arrows.

angles [['uv' | 'xy'], array, optional] Method for determining the angle of the arrows. Default is 'uv'.

'uv': the arrow axis aspect ratio is 1 so that if U*==*V the orientation of the arrow on the plot is 45 degrees counter-clockwise from the horizontal axis (positive to the right).

'xy': arrows point from (x,y) to (x+u, y+v). Use this for plotting a gradient field, for example.

Alternatively, arbitrary angles may be specified as an array of values in degrees, counter-clockwise from the horizontal axis.

Note: inverting a data axis will correspondingly invert the arrows only with `angles='xy'`.

scale [None, float, optional] Number of data units per arrow length unit, e.g., m/s per plot width; a smaller scale parameter makes the arrow longer. Default is *None*.

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 [['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy'], None, optional] If the *scale* kwarg is *None*, the arrow length unit. Default is *None*.

e.g. *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'/'height', then the vector will be half the width/height 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 [scalar, optional] 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, optional] Head width as multiple of shaft width, default is 3

headlength [scalar, optional] Head length as multiple of shaft width, default is 5

headaxislength [scalar, optional] Head length at shaft intersection, default is 4.5

minshaft [scalar, optional] 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, optional] 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' | 'mid' | 'middle' | 'tip'], optional] 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], optional] This is a synonym for the *PolyCollection* facecolor kwarg. If *C* has been set, *color* has no effect.

See also:

quiverkey Add a key to a quiver plot

Notes

Additional *PolyCollection* keyword arguments:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]

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Property	Description
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Examples using `matplotlib.axes.Axes.quiver`

- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py
- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py

matplotlib.axes.Axes.quiverkey

Axes.**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:

***angle* = 0** The angle of the key arrow. Measured in degrees anti-clockwise from the x-axis.

***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.

Examples using `matplotlib.axes.Axes.quiverkey`

- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py

matplotlib.axes.Axes.streamplot

`Axes.`**`streamplot`**(*x*, *y*, *u*, *v*, *density=1*, *linewidth=None*, *color=None*, *cmap=None*, *norm=None*, *arrowsize=1*, *arrowstyle='-|>'*, *minlength=0.1*, *transform=None*, *zorder=None*, *start_points=None*, *maxlength=4.0*, *integration_direction='both'*, ***, *data=None*)

Draws streamlines of a vector flow.

x*, *y [1d arrays] an *evenly spaced* grid.

u*, *v [2d arrays] x and y-velocities. Number of rows should match length of y, and the number of columns should match x.

density [float or 2-tuple] Controls the closeness of streamlines. When `density = 1`, the domain is divided into a 30x30 grid—*density* linearly scales this grid. Each cell in the grid can have, at most, one traversing streamline. For different densities in each direction, use [density_x, density_y].

linewidth [numeric or 2d array] vary linewidth when given a 2d array with the same shape as velocities.

color [matplotlib color code, or 2d array] Streamline color. When given an array with the same shape as velocities, *color* values are converted to colors using *cmap*.

cmap [`Colormap`] Colormap used to plot streamlines and arrows. Only necessary when using an array input for *color*.

norm [*Normalize*] Normalize object used to scale luminance data to 0, 1. If None, stretch (min, max) to (0, 1). Only necessary when *color* is an array.

arrowsize [float] Factor scale arrow size.

arrowstyle [str] Arrow style specification. See *FancyArrowPatch*.

minlength [float] Minimum length of streamline in axes coordinates.

***start_points*: Nx2 array** Coordinates of starting points for the streamlines. In data coordinates, the same as the `x` and `y` arrays.

zorder [int] any number

maxlength [float] Maximum length of streamline in axes coordinates.

integration_direction [['forward', 'backward', 'both']] Integrate the streamline in forward, backward or both directions.

Returns:

stream_container [StreamplotSet] Container object with attributes

- lines: *matplotlib.collections.LineCollection* of streamlines
- arrows: collection of *matplotlib.patches.FancyArrowPatch* objects representing arrows half-way along stream lines.

This container will probably change in the future to allow changes to the colormap, alpha, etc. for both lines and arrows, but these changes should be backward compatible.

Examples using `matplotlib.axes.Axes.streamplot`

- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py

35.2 Clearing

Axes.cla	Clear the current axes.
Axes.clear	Clear the axes.

35.2.1 matplotlib.axes.Axes.cla

`Axes.`**`cla`**`()`
Clear the current axes.

Examples using `matplotlib.axes.Axes.cla`

- sphx_glr_gallery_misc_custom_projection.py

35.2.2 matplotlib.axes.Axes.clear

Axes.**clear**()
Clear the axes.

35.3 Appearance

Axes.axis	Set axis properties.
Axes.set_axis_off	Turn off the axis.
Axes.set_axis_on	Turn on the axis.
Axes.set_frame_on	Set whether the axes rectangle patch is drawn.
Axes.get_frame_on	Get whether the axes rectangle patch is drawn.
Axes.set_axisbelow	Set whether axis ticks and gridlines are above or below most artists.
Axes.get_axisbelow	Get whether axis ticks and gridlines are above or below most artists.
Axes.grid	Turn the axes grids on or off.
Axes.get_facecolor	Get the Axes facecolor.
Axes.get_fc	Get the Axes facecolor.
Axes.set_facecolor	Set the Axes facecolor.
Axes.set_fc	Set the Axes facecolor.

35.3.1 matplotlib.axes.Axes.axis

Axes.**axis**(**v*, ***kwargs*)
Set axis properties.

Valid signatures:

```
xmin, xmax, ymin, ymax = axis()
xmin, xmax, ymin, ymax = axis(list_arg)
xmin, xmax, ymin, ymax = axis(string_arg)
xmin, xmax, ymin, ymax = axis(**kwargs)
```

Parameters

v [list of float or {'on', 'off', 'equal', 'tight', 'scaled', 'normal', 'auto', 'image', 'square'}] Optional positional argument

Axis data limits set from a list; or a command relating to axes:

Value	Description
'on'	Toggle axis lines and labels on
'off'	Toggle axis lines and labels off
'equal'	Equal scaling by changing limits
'scaled'	Equal scaling by changing box dimensions
'tight'	Limits set such that all data is shown
'auto'	Automatic scaling, fill rectangle with data
'normal'	Same as 'auto'; deprecated
'image'	'scaled' with axis limits equal to data limits
'square'	Square plot; similar to 'scaled', but initially forcing xmax-xmin = ymax-ymin

emit [bool, optional] Passed to set_{x,y}lim functions, if observers are notified of axis limit change

xmin, ymin, xmax, ymax [float, optional] The axis limits to be set

Returns

xmin, xmax, ymin, ymax [float] The axis limits

35.3.2 matplotlib.axes.Axes.set_axis_off

Axes.**set_axis_off**()
Turn off the axis.

Examples using matplotlib.axes.Axes.set_axis_off

- sphx_glr_gallery_color_colormap_reference.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py

35.3.3 matplotlib.axes.Axes.set_axis_on

Axes.**set_axis_on**()
Turn on the axis.

35.3.4 matplotlib.axes.Axes.set_frame_on

Axes.**set_frame_on**(*b*)
Set whether the axes rectangle patch is drawn.

Parameters

b [bool]

35.3.5 matplotlib.axes.Axes.get_frame_on

`Axes.get_frame_on()`
Get whether the axes rectangle patch is drawn.

35.3.6 matplotlib.axes.Axes.set_axisbelow

`Axes.set_axisbelow(b)`
Set whether axis ticks and gridlines are above or below most artists.

Parameters

b [bool or 'line']

35.3.7 matplotlib.axes.Axes.get_axisbelow

`Axes.get_axisbelow()`
Get whether axis ticks and gridlines are above or below most artists.

35.3.8 matplotlib.axes.Axes.grid

`Axes.grid(b=None, which='major', axis='both', **kwargs)`
Turn the axes grids on or off.

Set the axes grids on or off; *b* is a boolean.

If *b* is *None* and `len(kwargs)==0`, toggle the grid state. If *kwargs* are supplied, it is assumed that you want a grid and *b* is thus set to *True*.

which can be 'major' (default), 'minor', or 'both' to control whether major tick grids, minor tick grids, or both are affected.

axis can be 'both' (default), 'x', or 'y' to control which set of gridlines are drawn.

kwargs are used to set the grid line properties, e.g.,:

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

Valid *Line2D* kwargs are

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool

Co

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Property	Description
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

35.3.9 matplotlib.axes.Axes.get_facecolor

Axes.**get_facecolor**()
Get the Axes facecolor.

35.3.10 matplotlib.axes.Axes.get_fc

Axes.**get_fc**()
Get the Axes facecolor.

35.3.11 matplotlib.axes.Axes.set_facecolor

Axes.**set_facecolor**(*color*)
Set the Axes facecolor.

Parameters

color [color]

Examples using `matplotlib.axes.Axes.set_facecolor`

- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_color_color_cycle_default.py

35.3.12 matplotlib.axes.Axes.set_fc

Axes.**set_fc**(*color*)
Set the Axes facecolor.

Parameters

color [color]

35.4 Property cycle

Axes.set_prop_cycle	Set the property cycle of the Axes.
Axes.set_color_cycle	Deprecated since version 1.5.

35.4.1 matplotlib.axes.Axes.set_prop_cycle

Axes.**set_prop_cycle**(**args*, ***kwargs*)
Set the property cycle of the Axes.

The property cycle controls the style properties such as color, marker and linestyle of future plot commands. The style properties of data already added to the Axes are not modified.

Call signatures:

```
set_prop_cycle(cycler)
```

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```
set_prop_cycle(label=values[, label2=values2[, ...]])
set_prop_cycle(label, values)
```

Form 1 sets given `Cycler` object.

Form 2 creates a `Cycler` which cycles over one or more properties simultaneously and set it as the property cycle of the axes. If multiple properties are given, their value lists must have the same length. This is just a shortcut for explicitly creating a cycler and passing it to the function, i.e. it's short for `set_prop_cycle(cycler(label=values label2=values2, ...))`.

Form 3 creates a `Cycler` for a single property and set it as the property cycle of the axes. This form exists for compatibility with the original `cycler.cycler` interface. Its use is discouraged in favor of the kwarg form, i.e. `set_prop_cycle(label=values)`.

Parameters

cycler [Cycler] Set the given Cycler. *None* resets to the cycle defined by the current style.

label [str] The property key. Must be a valid *`Artist`* property. For example, 'color' or 'linestyle'. Aliases are allowed, such as 'c' for 'color' and 'lw' for 'linewidth'.

values [iterable] Finite-length iterable of the property values. These values are validated and will raise a ValueError if invalid.

See also:

`matplotlib.rcsetup.cycler` Convenience function for creating validated cyclers for properties.

`cycler.cycler` The original function for creating unvalidated cyclers.

Examples

Setting the property cycle for a single property:

```
>>> ax.set_prop_cycle(color=['red', 'green', 'blue'])
```

Setting the property cycle for simultaneously cycling over multiple properties (e.g. red circle, green plus, blue cross):

```
>>> ax.set_prop_cycle(color=['red', 'green', 'blue'],
...                   marker=['o', '+', 'x'])
```

Examples using `matplotlib.axes.Axes.set_prop_cycle`

- sphx_glr_gallery_color_color_cycler.py

35.4.2 matplotlib.axes.Axes.set_color_cycle

Axes.**set_color_cycle**(*clist*)

Deprecated since version 1.5: The set_color_cycle function was deprecated in version 1.5. Use *set_prop_cycle* instead.

Set the color cycle for any future plot commands on this Axes.

Parameters

clist A list of mpl color specifiers.

35.5 Axis / limits

Axes.get_xaxis	Return the XAxis instance.
Axes.get_yaxis	Return the YAxis instance.

35.5.1 matplotlib.axes.Axes.get_xaxis

Axes.**get_xaxis**()

Return the XAxis instance.

35.5.2 matplotlib.axes.Axes.get_yaxis

Axes.**get_yaxis**()

Return the YAxis instance.

35.5.3 Axis Limits and direction

Axes.invert_xaxis	Invert the x-axis.
Axes.xaxis_inverted	Return whether the x-axis is inverted.
Axes.invert_yaxis	Invert the y-axis.
Axes.yaxis_inverted	Return whether the y-axis is inverted.
Axes.set_xlim	Set the data limits for the x-axis
Axes.get_xlim	Get the x-axis range
Axes.set_ylim	Set the data limits for the y-axis
Axes.get_ylim	Get the y-axis range
Axes.update_datalim	Update the data lim bbox with seq of xy tups or equiv.
Axes.update_datalim_bounds	Update the datalim to include the given *Bbox bounds*
Axes.set_xbound	Set the lower and upper numerical bounds of the x-axis.

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Axes.get_xbound	Return the lower and upper x-axis bounds, in increasing order.
Axes.set_ybound	Set the lower and upper numerical bounds of the y-axis.
Axes.get_ybound	Return the lower and upper y-axis bounds, in increasing order.

matplotlib.axes.Axes.invert_xaxis

Axes.**invert_xaxis**()
Invert the x-axis.

matplotlib.axes.Axes.xaxis_inverted

Axes.**xaxis_inverted**()
Return whether the x-axis is inverted.

matplotlib.axes.Axes.invert_yaxis

Axes.**invert_yaxis**()
Invert the y-axis.

matplotlib.axes.Axes.yaxis_inverted

Axes.**yaxis_inverted**()
Return whether the y-axis is inverted.

matplotlib.axes.Axes.set_xlim

Axes.**set_xlim**(*left=None*, *right=None*, *emit=True*, *auto=False*, ***kw*)
Set the data limits for the x-axis

Parameters

left [scalar, optional] The left xlim (default: None, which leaves the left limit unchanged).

right [scalar, optional] The right xlim (default: None, which leaves the right limit unchanged).

emit [bool, optional] Whether to notify observers of limit change (default: True).

auto [bool or None, optional] Whether to turn on autoscaling of the x-axis. True turns on, False turns off (default action), None leaves unchanged.

xlimits [tuple, optional] The left and right xlims may be passed as the tuple (`left`, `right`) as the first positional argument (or as the `left` keyword argument).

Returns

xlimits [tuple] Returns the new x-axis limits as (`left`, `right`).

Notes

The `left` value may be greater than the `right` value, in which case the x-axis values will decrease from left to right.

Examples

```
>>> set_xlim(left, right)
>>> set_xlim((left, right))
>>> left, right = set_xlim(left, right)
```

One limit may be left unchanged.

```
>>> set_xlim(right=right_lim)
```

Limits may be passed in reverse order to flip the direction of the x-axis. For example, suppose `x` represents the number of years before present. The x-axis limits might be set like the following so 5000 years ago is on the left of the plot and the present is on the right.

```
>>> set_xlim(5000, 0)
```

Examples using `matplotlib.axes.Axes.set_xlim`

- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_misc_custom_projection.py

matplotlib.axes.Axes.get_xlim

`Axes.`**`get_xlim`**`()`

Get the x-axis range

Returns

xlimits [tuple] Returns the current x-axis limits as the tuple (`left`, `right`).

Notes

The x-axis may be inverted, in which case the `left` value will be greater than the `right` value.

matplotlib.axes.Axes.set_ylim

`Axes.set_ylim`(*bottom=None*, *top=None*, *emit=True*, *auto=False*, ***kw*)

Set the data limits for the y-axis

Parameters

bottom [scalar, optional] The bottom ylim (default: None, which leaves the bottom limit unchanged).

top [scalar, optional] The top ylim (default: None, which leaves the top limit unchanged).

emit [bool, optional] Whether to notify observers of limit change (default: True).

auto [bool or None, optional] Whether to turn on autoscaling of the y-axis. True turns on, False turns off (default action), None leaves unchanged.

ylimits [tuple, optional] The bottom and top yxlims may be passed as the tuple (`bottom`, `top`) as the first positional argument (or as the `bottom` keyword argument).

Returns

ylimits [tuple] Returns the new y-axis limits as (`bottom`, `top`).

Notes

The `bottom` value may be greater than the `top` value, in which case the y-axis values will decrease from bottom to top.

Examples

```
>>> set_ylim(bottom, top)
>>> set_ylim((bottom, top))
>>> bottom, top = set_ylim(bottom, top)
```

One limit may be left unchanged.

```
>>> set_ylim(top=top_lim)
```

Limits may be passed in reverse order to flip the direction of the y-axis. For example, suppose `y` represents depth of the ocean in m. The y-axis limits might be set like the following so 5000 m depth is at the bottom of the plot and the surface, 0 m, is at the top.

```
>>> set_ylim(5000, 0)
```

Examples using `matplotlib.axes.Axes.set_ylim`

- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_misc_custom_projection.py

matplotlib.axes.Axes.get_ylim

Axes.**get_ylim**()
Get the y-axis range

Returns

ylimits [tuple] Returns the current y-axis limits as the tuple (`bottom`, `top`).

Notes

The y-axis may be inverted, in which case the `bottom` value will be greater than the `top` value.

matplotlib.axes.Axes.update_datalim

Axes.**update_datalim**(*xys*, *updatex=True*, *updatey=True*)
Update the data lim bbox with seq of xy tups or equiv. 2-D array

matplotlib.axes.Axes.update_datalim_bounds

Axes.**update_datalim_bounds**(*bounds*)
Update the datalim to include the given *Bbox bounds*

matplotlib.axes.Axes.set_xbound

Axes.**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.

matplotlib.axes.Axes.get_xbound

Axes.**get_xbound**()
Return the lower and upper x-axis bounds, in increasing order.

matplotlib.axes.Axes.set_ybound

Axes.**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.

matplotlib.axes.Axes.get_ybound

Axes.**get_ybound**()

Return the lower and upper y-axis bounds, in increasing order.

35.5.4 Axis Labels, title, and legend

Axes.set_xlabel	Set the label for the x-axis.
Axes.get_xlabel	Get the xlabel text string.
Axes.set_ylabel	Set the label for the y-axis.
Axes.get_ylabel	Get the ylabel text string.
Axes.set_title	Set a title for the axes.
Axes.get_title	Get an axes title.
Axes.legend	Places a legend on the axes.
Axes.get_legend	Return the Legend instance, or None if no legend is defined.
Axes.get_legend_handles_labels	Return handles and labels for legend

matplotlib.axes.Axes.set_xlabel

Axes.**set_xlabel**(*xlabel*, *fontdict=None*, *labelpad=None*, ***kwargs*)

Set the label for the x-axis.

Parameters

xlabel [str] The label text.

labelpad [scalar, optional, default: None] Spacing in points between the label and the x-axis.

Other Parameters

****kwargs** [*Text* properties] *Text* properties control the appearance of the label.

See also:

text for information on how override and the optional args work

Examples using matplotlib.axes.Axes.set_xlabel

- sphx_glr_gallery_color_color_demo.py

- sphx_glr_gallery_statistics_histogram_features.py

matplotlib.axes.Axes.get_xlabel

Axes.**get_xlabel**()
Get the xlabel text string.

matplotlib.axes.Axes.set_ylabel

Axes.**set_ylabel**(*ylabel*, *fontdict=None*, *labelpad=None*, ***kwargs*)
Set the label for the y-axis.

Parameters

ylabel [str] The label text.

labelpad [scalar, optional, default: None] Spacing in points between the label and the y-axis.

Other Parameters

****kwargs** [*Text* properties] *Text* properties control the appearance of the label.

See also:

text for information on how override and the optional args work

Examples using matplotlib.axes.Axes.set_ylabel

- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_statistics_histogram_features.py

matplotlib.axes.Axes.get_ylabel

Axes.**get_ylabel**()
Get the ylabel text string.

matplotlib.axes.Axes.set_title

Axes.**set_title**(*label*, *fontdict=None*, *loc='center'*, *pad=None*, ***kwargs*)
Set a title for the axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

Parameters

label [str] Text to use for the title

fontdict [dict] A dictionary controlling the appearance of the title text, the default `fontdict` is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight' : rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

loc [{'center', 'left', 'right'}, str, optional] Which title to set, defaults to 'center'

pad [float] The offset of the title from the top of the axes, in points. Default is `None` to use rcParams['axes.titlepad'].

Returns

text [*Text*] The matplotlib text instance representing the title

Other Parameters

****kwargs** [*Text* properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

Examples using `matplotlib.axes.Axes.set_title`

- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_statistics_histogram_features.py
- sphx_glr_gallery_shapes_and_collections_donut.py

matplotlib.axes.Axes.get_title

`Axes.`**`get_title`**(*loc='center'*)

Get an axes title.

Get one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

Parameters

loc [{'center', 'left', 'right'}, str, optional] Which title to get, defaults to 'center'.

Returns

title [str] The title text string.

matplotlib.axes.Axes.legend

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

Places a legend on the axes.

Call signatures:

```
legend()
legend(labels)
legend(handles, labels)
```

The call signatures correspond to three different ways how to use this method.

1. Automatic detection of elements to be shown in the legend

The elements to be added to the legend are automatically determined, when you do not pass in any extra arguments.

In this case, the labels are taken from the artist. You can specify them either at artist creation or by calling the *set_label()* method on the artist:

```
line, = ax.plot([1, 2, 3], label='Inline label')
ax.legend()
```

or:

```
line.set_label('Label via method')
line, = ax.plot([1, 2, 3])
ax.legend()
```

Specific lines can be excluded from the automatic legend element selection by defining a label starting with an underscore. This is default for all artists, so calling *Axes.legend* without any arguments and without setting the labels manually will result in no legend being drawn.

2. Labeling existing plot elements

To make a legend for lines which already exist on the axes (via plot for instance), simply call this function with an iterable of strings, one for each legend item. For example:

```
ax.plot([1, 2, 3])
ax.legend(['A simple line'])
```

Note: This way of using is discouraged, because the relation between plot elements and labels is only implicit by their order and can easily be mixed up.

3. Explicitly defining the elements in the legend

For full control of which artists have a legend entry, it is possible to pass an iterable of legend artists followed by an iterable of legend labels respectively:

```
legend((line1, line2, line3), ('label1', 'label2', 'label3'))
```

Parameters

handles [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

labels [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

Returns

:class:‘matplotlib.legend.Legend‘ instance

Other Parameters

loc [int or string or pair of floats, default: ’upper right’] The location of the legend. Possible 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

Alternatively can be a 2-tuple giving `x, y` of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

bbox_to_anchor [*BboxBase* or pair of floats] Specify any arbitrary location for the legend in `bbox_transform` coordinates (default Axes coordinates).

For example, to put the legend’s upper right hand corner in the center of the axes the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

ncol [integer] The number of columns that the legend has. Default is 1.

prop [None or *matplotlib.font_manager.FontProperties* or dict] The font properties of the legend. If None (default), the current *matplotlib.rcParams* will be used.

fontsize [int or float or {’xx-small’, ’x-small’, ’small’, ’medium’, ’large’, ’x-large’, ’xx-large’}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

numpoints [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is None, which will take the value from rcParams["legend.numpoints"].

scatterpoints [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is None, which will take the value from rcParams["legend.scatterpoints"].

scatteryoffsets [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to [0.5]. Default is [0.375, 0.5, 0.3125].

markerscale [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is None, which will take the value from rcParams["legend.markerscale"].

markerfirst [bool] If *True*, legend marker is placed to the left of the legend label. If *False*, legend marker is placed to the right of the legend label. Default is *True*.

frameon [None or bool] Control whether the legend should be drawn on a patch (frame). Default is None, which will take the value from rcParams["legend.frameon"].

fancybox [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is None, which will take the value from rcParams["legend.fancybox"].

shadow [None or bool] Control whether to draw a shadow behind the legend. Default is None, which will take the value from rcParams["legend.shadow"].

framealpha [None or float] Control the alpha transparency of the legend's background. Default is None, which will take the value from rcParams["legend.framealpha"]. If shadow is activated and *framealpha* is None, the default value is ignored.

facecolor [None or "inherit" or a color spec] Control the legend's background color. Default is None, which will take the value from rcParams["legend.facecolor"]. If "inherit", it will take rcParams["axes.facecolor"].

edgecolor [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is None, which will take the value from rcParams["legend.edgecolor"] If "inherit", it will take rcParams["axes.edgecolor"].

mode [{"expand", None}] If mode is set to "expand" the legend will be horizontally expanded to fill the axes area (or bbox_to_anchor if defines the legend's size).

bbox_transform [None or *matplotlib.transforms.Transform*] The transform for the bounding box (bbox_to_anchor). For a value of None (default) the Axes' transAxes transform will be used.

title [str or None] The legend's title. Default is no title (None).

borderpad [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is None, which will take the value from

rcParams["legend.borderpad"].

labelspacing [float or None] The vertical space between the legend entries. Measured in font-size units. Default is None, which will take the value from rcParams["legend.labelspacing"].

handlelength [float or None] The length of the legend handles. Measured in font-size units. Default is None, which will take the value from rcParams["legend.handlelength"].

handletextpad [float or None] The pad between the legend handle and text. Measured in font-size units. Default is None, which will take the value from rcParams["legend.handletextpad"].

borderaxespad [float or None] The pad between the axes and legend border. Measured in font-size units. Default is None, which will take the value from rcParams["legend.borderaxespad"].

columnspacing [float or None] The spacing between columns. Measured in font-size units. Default is None, which will take the value from rcParams["legend.columnspacing"].

handler_map [dict or None] The custom dictionary mapping instances or types to a legend handler. This handler_map updates the default handler map found at *matplotlib.legend.Legend.get_legend_handler_map()*.

Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

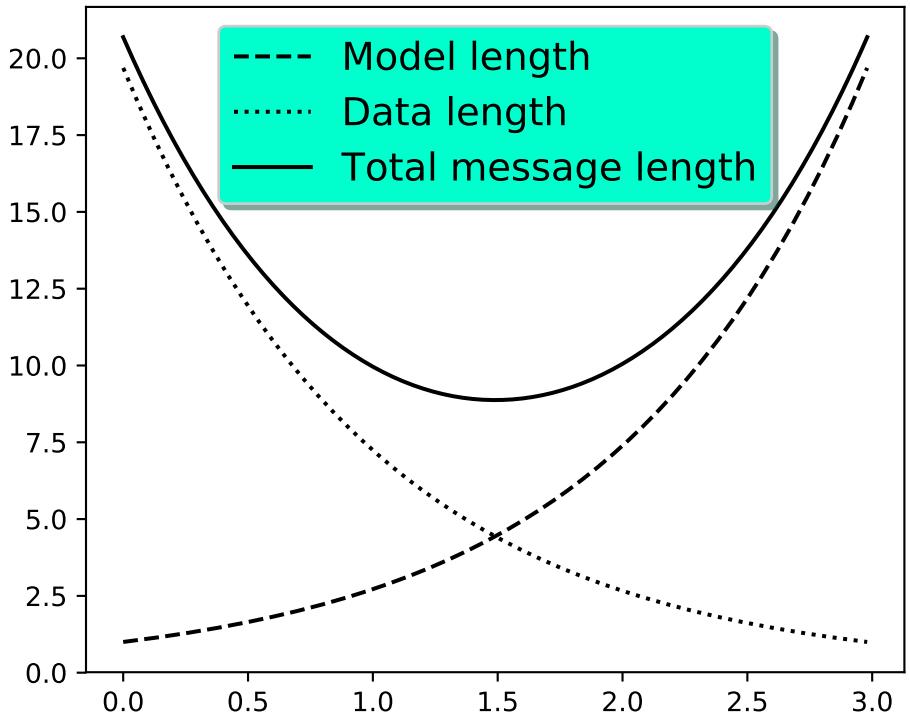
Examples

Examples using matplotlib.axes.Axes.legend

- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_pie_and_polar_charts_polar_legend.py
- sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py

matplotlib.axes.Axes.get_legend

Axes.**get_legend**()
Return the Legend instance, or None if no legend is defined.



matplotlib.axes.Axes.get_legend_handles_labels

Axes.**get_legend_handles_labels**(*legend_handler_map=None*)

Return handles and labels for legend

`ax.legend()` is equivalent to

```
h, l = ax.get_legend_handles_labels()
ax.legend(h, l)
```

35.5.5 Axis scales

Axes.set_xscale	Set the x-axis scale.
Axes.get_xscale	Return the xaxis scale string: linear, log, logit, symlog
Axes.set_yscale	Set the y-axis scale.
Axes.get_yscale	Return the yaxis scale string: linear, log, logit, symlog

matplotlib.axes.Axes.set_xscale

Axes.**set_xscale**(*value*, ***kwargs*)

Set the x-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

matplotlib.axes.Axes.set_yscale

Axes.**set_yscale**(*value*, ***kwargs*)
Set the y-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

See also:

matplotlib.scale.LinearScale linear transform

matplotlib.scale.LogTransform log transform

matplotlib.scale.SymmetricalLogTransform symlog transform

matplotlib.scale.LogisticTransform logit transform

Notes

Different kwargs are accepted, depending on the scale. See the *scale* module for more information.

matplotlib.axes.Axes.get_yscale

Axes.**get_yscale**()
Return the yaxis scale string: linear, log, logit, symlog

35.5.6 Autoscaling and margins

Axes.use_sticky_edges	When autoscaling, whether to obey all `Artist.sticky_edges`.
Axes.margins	Set or retrieve autoscaling margins.
Axes.set_xmargin	Set padding of X data limits prior to autoscaling.
Axes.set_ymargin	Set padding of Y data limits prior to autoscaling.
Axes.relim	Recompute the data limits based on current artists.
Axes.autoscale	Autoscale the axis view to the data (toggle).
Axes.autoscale_view	Autoscale the view limits using the data limits.
Axes.set_autoscale_on	Set whether autoscaling is applied on plot commands
Axes.get_autoscale_on	Get whether autoscaling is applied for both axes on plot commands
Axes.set_autoscalex_on	Set whether autoscaling for the x-axis is applied on plot commands
Axes.get_autoscalex_on	Get whether autoscaling for the x-axis is applied on plot commands

Continued on next page

Table 38 – continued from previous page

Axes.set_autoscaley_on	Set whether autoscaling for the y-axis is applied on plot commands
Axes.get_autoscaley_on	Get whether autoscaling for the y-axis is applied on plot commands

matplotlib.axes.Axes.use_sticky_edges

Axes.**use_sticky_edges**

When autoscaling, whether to obey all `Artist.sticky_edges`.

Default is `True`.

Setting this to `False` ensures that the specified margins will be applied, even if the plot includes an image, for example, which would otherwise force a view limit to coincide with its data limit.

The changing this property does not change the plot until *autoscale* or *autoscale_view* is called.

matplotlib.axes.Axes.margins

Axes.**margins**(**args*, ***kw*)

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 padding added to the end of each interval is *margin* times the data interval. The *margin* must be a float in the range [0, 1].

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.

matplotlib.axes.Axes.set_xmargin

Axes.**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. For example, if your data is in the range [0, 2], a factor of `m = 0.1` will result in a range [-0.2, 2.2].

Negative values -0.5 < m < 0 will result in clipping of the data range. I.e. for a data range [0, 2], a factor of `m = -0.1` will result in a range [0.2, 1.8].

Parameters

m [float greater than -0.5]

matplotlib.axes.Axes.set_ymargin

Axes.**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. For example, if your data is in the range [0, 2], a factor of `m = 0.1` will result in a range [-0.2, 2.2].

Negative values -0.5 < m < 0 will result in clipping of the data range. I.e. for a data range [0, 2], a factor of `m = -0.1` will result in a range [0.2, 1.8].

Parameters

m [float greater than -0.5]

matplotlib.axes.Axes.relim

Axes.**relim**(*visible_only=False*)

Recompute the data limits based on current artists. If you want to exclude invisible artists from the calculation, set `visible_only=True`

At present, *Collection* instances are not supported.

matplotlib.axes.Axes.autoscale

Axes.**autoscale**(*enable=True*, *axis='both'*, *tight=None*)

Autoscale the axis view to the data (toggle).

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.

Parameters

enable [bool or None, optional] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

axis [['both' | 'x' | 'y'], optional] which axis to operate on; default is 'both'

tight: bool or None, optional 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.

matplotlib.axes.Axes.autoscale_view

Axes.**autoscale_view**(*tight=None*, *scalex=True*, *scaley=True*)
Autoscale the view limits using the data limits.

You can selectively autoscale only a single axis, e.g., the xaxis by setting *scaley* to *False*. The autoscaling preserves any axis direction reversal that has already been done.

If *tight* is *False*, the axis major locator will be used to expand the view limits if rcParams['axes.autolimit_mode'] is 'round_numbers'. Note that any margins that are in effect will be applied first, regardless of whether *tight* is *True* or *False*. Specifying *tight* as *True* or *False* saves the setting as a private attribute of the Axes; specifying it as *None* (the default) applies the previously saved value.

The data limits are not updated automatically when artist data are changed after the artist has been added to an Axes instance. In that case, use *matplotlib.axes.Axes.relim()* prior to calling autoscale_view.

Examples using matplotlib.axes.Axes.autoscale_view

- sphx_glr_gallery_shapes_and_collections_ellipse_collection.py
- sphx_glr_gallery_shapes_and_collections_compound_path.py
- sphx_glr_gallery_shapes_and_collections_collections.py

matplotlib.axes.Axes.set_autoscale_on

Axes.**set_autoscale_on**(*b*)
Set whether autoscaling is applied on plot commands

Parameters

b [bool]

matplotlib.axes.Axes.get_autoscale_on

Axes.**get_autoscale_on**()
Get whether autoscaling is applied for both axes on plot commands

matplotlib.axes.Axes.set_autoscalex_on

Axes.**set_autoscalex_on**(*b*)
Set whether autoscaling for the x-axis is applied on plot commands

Parameters

b [bool]

matplotlib.axes.Axes.get_autoscalex_on

Axes.**get_autoscalex_on**()
Get whether autoscaling for the x-axis is applied on plot commands

matplotlib.axes.Axes.set_autoscaley_on

Axes.**set_autoscaley_on**(*b*)
Set whether autoscaling for the y-axis is applied on plot commands

Parameters

b [bool]

matplotlib.axes.Axes.get_autoscaley_on

Axes.**get_autoscaley_on**()
Get whether autoscaling for the y-axis is applied on plot commands

35.5.7 Aspect ratio

Axes.apply_aspect	Adjust the Axes for a specified data aspect ratio.
Axes.set_aspect	Set the aspect of the axis scaling, i.e.
Axes.get_aspect	
Axes.set_adjustable	Define which parameter the Axes will change to achieve a given aspect.
Axes.get_adjustable	

matplotlib.axes.Axes.apply_aspect

Axes.**apply_aspect**(*position=None*)
Adjust the Axes for a specified data aspect ratio.

Depending on *get_adjustable* this will modify either the Axes box (position) or the view limits. In the former case, *get_anchor* will affect the position.

See also:

matplotlib.axes.Axes.set_aspect for a description of aspect ratio handling.

matplotlib.axes.Axes.set_adjustable defining the parameter to adjust in order to meet the required aspect.

matplotlib.axes.Axes.set_anchor defining the position in case of extra space.

Notes

This is called automatically when each Axes is drawn. You may need to call it yourself if you need to update the Axes position and/or view limits before the Figure is drawn.

matplotlib.axes.Axes.set_aspect

`Axes.set_aspect`(*aspect*, *adjustable=None*, *anchor=None*, *share=False*)
Set the aspect of the axis scaling, i.e. the ratio of y-unit to x-unit.

Parameters

aspect [[’auto’ | ’equal’] or num] Possible values:

value	description
’auto’	automatic; fill the position rectangle with data
’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 [None or [’box’ | ’datalim’], optional] If not `None`, this defines which parameter will be adjusted to meet the required aspect. See *set_adjustable* for further details.

anchor [None or str or 2-tuple of float, optional] If not `None`, this defines where the Axes will be drawn if there is extra space due to aspect constraints. The most common way to to specify the anchor are abbreviations of cardinal directions:

value	description
’C’	centered
’SW’	lower left corner
’S’	middle of bottom edge
’SE’	lower right corner
etc.	

See *set_anchor* for further details.

share [bool, optional] If `True`, apply the settings to all shared Axes. Default is `False`.

See also:

matplotlib.axes.Axes.set_adjustable defining the parameter to adjust in order to meet the required aspect.

matplotlib.axes.Axes.set_anchor defining the position in case of extra space.

Examples using `matplotlib.axes.Axes.set_aspect`

- sphx_glr_gallery_shapes_and_collections_donut.py

matplotlib.axes.Axes.get_aspect

`Axes.get_aspect()`

matplotlib.axes.Axes.set_adjustable

`Axes.set_adjustable`(*adjustable*, *share=False*)

Define which parameter the Axes will change to achieve a given aspect.

Parameters

adjustable [['box' | 'datalim']] If 'box', change the physical dimensions of the Axes. If 'datalim', change the `x` or `y` data limits.

share [bool, optional] If `True`, apply the settings to all shared Axes. Default is `False`.

.. ACCEPTS: ['box' | 'datalim']

See also:

matplotlib.axes.Axes.set_aspect for a description of aspect handling.

Notes

Shared Axes (of which twinned Axes are a special case) impose restrictions on how aspect ratios can be imposed. For twinned Axes, use 'datalim'. For Axes that share both x and y, use 'box'. Otherwise, either 'datalim' or 'box' may be used. These limitations are partly a requirement to avoid over-specification, and partly a result of the particular implementation we are currently using, in which the adjustments for aspect ratios are done sequentially and independently on each Axes as it is drawn.

matplotlib.axes.Axes.get_adjustable

`Axes.get_adjustable()`

35.5.8 Ticks and tick labels

Axes.set_xticks	Set the x ticks with list of *ticks*
Axes.get_xticks	Return the x ticks as a list of locations
Axes.set_xticklabels	Set the x-tick labels with list of string labels.
Axes.get_xticklabels	Get the x tick labels as a list of *Text* instances.
Axes.get_xmajorticklabels	Get the major x tick labels.
Axes.get_xminorticklabels	Get the minor x tick labels.
Axes.get_xgridlines	Get the x grid lines as a list of `Line2D` instances.
Axes.get_xticklines	Get the x tick lines as a list of `Line2D` instances.
Axes.xaxis_date	Sets up x-axis ticks and labels that treat the x data as dates.
Axes.set_yticks	Set the y ticks with list of *ticks*
Axes.get_yticks	Return the y ticks as a list of locations
Axes.set_yticklabels	Set the y-tick labels with list of strings labels.
Axes.get_yticklabels	Get the y tick labels as a list of *Text* instances.
Axes.get_ymajorticklabels	Get the major y tick labels.
Axes.get_yminorticklabels	Get the minor y tick labels.
Axes.get_ygridlines	Get the y grid lines as a list of `Line2D` instances.
Axes.get_yticklines	Get the y tick lines as a list of `Line2D` instances.
Axes.yaxis_date	Sets up y-axis ticks and labels that treat the y data as dates.
Axes.minorticks_off	Remove minor ticks from the axes.
Axes.minorticks_on	Add autoscaling minor ticks to the axes.
Axes.ticklabel_format	Change the *ScalarFormatter* used by default for linear axes.
Axes.tick_params	Change the appearance of ticks, tick labels, and gridlines.
Axes.locator_params	Control behavior of tick locators.

matplotlib.axes.Axes.set_xticks

`Axes.`**`set_xticks`**(*ticks*, *minor=False*)

Set the x ticks with list of *ticks*

Parameters

ticks [list] List of x-axis tick locations.

minor [bool, optional] If `False` sets major ticks, if `True` sets minor ticks. Default is `False`.

matplotlib.axes.Axes.get_xticks

`Axes.`**`get_xticks`**(*minor=False*)

Return the x ticks as a list of locations

matplotlib.axes.Axes.set_xticklabels

Axes.**set_xticklabels**(*labels*, *fontdict=None*, *minor=False*, ***kwargs*)
Set the x-tick labels with list of string labels.

Parameters

labels [list of str] List of string labels.

fontdict [dict, optional] A dictionary controlling the appearance of the ticklabels. The default `fontdict` is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight': rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

minor [bool, optional] Whether to set the minor ticklabels rather than the major ones.

Returns

A list of '~.text.Text' instances.

Other Parameters

****kwargs** [*Text* properties.]

matplotlib.axes.Axes.get_xticklabels

Axes.**get_xticklabels**(*minor=False*, *which=None*)
Get the x tick labels as a list of *Text* instances.

Parameters

minor [bool, optional] If True return the minor ticklabels, else return the major ticklabels.

which [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

Returns

ret [list] List of *Text* instances.

matplotlib.axes.Axes.get_xmajorticklabels

Axes.**get_xmajorticklabels**()
Get the major x tick labels.

Returns

labels [list] List of *Text* instances

matplotlib.axes.Axes.get_xminorticklabels

Axes.**get_xminorticklabels**()
Get the minor x tick labels.

Returns

labels [list] List of *Text* instances

matplotlib.axes.Axes.get_xgridlines

Axes.**get_xgridlines**()
Get the x grid lines as a list of `Line2D` instances.

matplotlib.axes.Axes.get_xticklines

Axes.**get_xticklines**()
Get the x tick lines as a list of `Line2D` instances.

matplotlib.axes.Axes.xaxis_date

Axes.**xaxis_date**(*tz=None*)
Sets up x-axis ticks and labels that treat the x data as dates.

Parameters

tz [string or `tzinfo` instance, optional] Timezone string or timezone. Defaults to rc value.

matplotlib.axes.Axes.set_yticks

Axes.**set_yticks**(*ticks*, *minor=False*)
Set the y ticks with list of *ticks*

Parameters

ticks [sequence] List of y-axis tick locations

minor [bool, optional] If `False` sets major ticks, if `True` sets minor ticks. Default is `False`.

matplotlib.axes.Axes.get_yticks

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

matplotlib.axes.Axes.set_yticklabels

Axes.**set_yticklabels**(*labels*, *fontdict=None*, *minor=False*, ***kwargs*)
Set the y-tick labels with list of strings labels.

Parameters

labels [list of str] list of string labels

fontdict [dict, optional] A dictionary controlling the appearance of the ticklabels. The default `fontdict` is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight': rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

minor [bool, optional] Whether to set the minor ticklabels rather than the major ones.

Returns

A list of '~.text.Text' instances.

Other Parameters

****kwargs** [*Text* properties.]

matplotlib.axes.Axes.get_yticklabels

Axes.**get_yticklabels**(*minor=False*, *which=None*)
Get the y tick labels as a list of *Text* instances.

Parameters

minor [bool] If True return the minor ticklabels, else return the major ticklabels

which [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

Returns

ret [list] List of *Text* instances.

matplotlib.axes.Axes.get_ymajorticklabels

Axes.**get_ymajorticklabels**()
Get the major y tick labels.

Returns

labels [list] List of *Text* instances

matplotlib.axes.Axes.get_yminorticklabels

Axes.**get_yminorticklabels**()
Get the minor y tick labels.

Returns

labels [list] List of *Text* instances

matplotlib.axes.Axes.get_ygridlines

Axes.**get_ygridlines**()
Get the y grid lines as a list of Line2D instances.

matplotlib.axes.Axes.get_yticklines

Axes.**get_yticklines**()
Get the y tick lines as a list of Line2D instances.

matplotlib.axes.Axes.yaxis_date

Axes.**yaxis_date**(*tz=None*)
Sets up y-axis ticks and labels that treat the y data as dates.

Parameters

tz [string or tzinfo instance, optional] Timezone string or timezone. Defaults to rc value.

matplotlib.axes.Axes.minorticks_off

Axes.**minorticks_off**()
Remove minor ticks from the axes.

matplotlib.axes.Axes.minorticks_on

Axes.**minorticks_on**()
Add autoscaling minor ticks to the axes.

matplotlib.axes.Axes.ticklabel_format

Axes.**ticklabel_format**(***kwargs*)
Change 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	[bool | 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']
useLocale	If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the axes.formatter.use_locale rcparam.
useMathText	If True, render the offset and scientific notation in mathtext

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.

matplotlib.axes.Axes.tick_params

Axes.**tick_params**(*axis='both'*, ***kwargs*)

Change the appearance of ticks, tick labels, and gridlines.

Parameters

axis [{'x', 'y', 'both'}, optional] Which axis to apply the parameters to.

Other Parameters

axis [{'x', 'y', 'both'}] Axis on which to operate; default is 'both'.

reset [bool] 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 *which* ticks.

direction [{'in', 'out', 'inout'}] Puts ticks inside the axes, outside the axes, or both.

length [float] Tick length in points.

width [float] Tick width in points.

color [color] Tick color; accepts any mpl color spec.

pad [float] Distance in points between tick and label.

labelsize [float or str] Tick label font size in points or as a string (e.g., 'large').

labelcolor [color] Tick label color; mpl color spec.

colors [color] Changes the tick color and the label color to the same value: mpl color spec.

zorder [float] Tick and label zorder.

bottom, top, left, right [bool] Whether to draw the respective ticks.

labelbottom, labeltop, labelleft, labelright [bool] Whether to draw the respective tick labels.

labelrotation [float] Tick label rotation

grid_color [color] Changes the gridline color to the given mpl color spec.

grid_alpha [float] Transparency of gridlines: 0 (transparent) to 1 (opaque).

grid_linewidth [float] Width of gridlines in points.

grid_linestyle [string] Any valid *Line2D* line style spec.

Examples

Usage

```
ax.tick_params(direction='out', length=6, width=2, colors='r',
               grid_color='r', grid_alpha=0.5)
```

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. Gridlines will be red and translucent.

Examples using `matplotlib.axes.Axes.tick_params`

- sphx_glr_gallery_color_color_demo.py

matplotlib.axes.Axes.locator_params

`Axes.`**`locator_params`**(*axis='both'*, *tight=None*, ***kwargs*)

Control behavior of tick locators.

Parameters

axis [['both' | 'x' | 'y'], optional] The axis on which to operate.

tight [bool or None, optional] Parameter passed to *autoscale_view()*. Default is None, for no change.

Other Parameters

****kw :** 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,

:meth:‘autoscale_view‘ is called automatically after

the parameters are changed.

This presently works only for the

:class:‘~matplotlib.ticker.MaxNLocator‘ used

by default on linear axes, but it may be generalized.

35.6 Units

Axes.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
Axes.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
Axes.have_units	Return *True* if units are set on the *x* or *y* axes

35.6.1 matplotlib.axes.Axes.convert_xunits

Axes.**convert_xunits**(*x*)

For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

35.6.2 matplotlib.axes.Axes.convert_yunits

Axes.**convert_yunits**(*y*)

For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

35.6.3 matplotlib.axes.Axes.have_units

Axes.**have_units**()

Return *True* if units are set on the *x* or *y* axes

35.7 Adding Artists

Axes.add_artist	Add any *Artist* to the axes.
Axes.add_collection	Add a *Collection* instance to the axes.

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Axes.add_container	Add a *Container* instance to the axes.
Axes.add_image	Add a *AxesImage* to the axes.
Axes.add_line	Add a *Line2D* to the list of plot lines
Axes.add_patch	Add a *Patch* *p* to the list of axes patches; the clipbox will be set to the Axes clipping box.
Axes.add_table	Add a *Table* instance to the list of axes tables

35.7.1 matplotlib.axes.Axes.add_artist

Axes.**add_artist**(*a*)

Add any *Artist* to the axes.

Use *add_artist* only for artists for which there is no dedicated "add" method; and if necessary, use a method such as *update_datalim* to manually update the dataLim if the artist is to be included in autoscaling.

Returns the artist.

Examples using matplotlib.axes.Axes.add_artist

- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py

35.7.2 matplotlib.axes.Axes.add_collection

Axes.**add_collection**(*collection*, *autolim=True*)

Add a *Collection* instance to the axes.

Returns the collection.

Examples using matplotlib.axes.Axes.add_collection

- sphx_glr_gallery_shapes_and_collections_ellipse_collection.py
- sphx_glr_gallery_shapes_and_collections_line_collection.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_collections.py

35.7.3 matplotlib.axes.Axes.add_container

Axes.**add_container**(*container*)

Add a *Container* instance to the axes.

Returns the collection.

35.7.4 matplotlib.axes.Axes.add_image

Axes.**add_image**(*image*)
Add a *AxesImage* to the axes.

Returns the image.

35.7.5 matplotlib.axes.Axes.add_line

Axes.**add_line**(*line*)
Add a *Line2D* to the list of plot lines

Returns the line.

Examples using matplotlib.axes.Axes.add_line

- sphx_glr_gallery_shapes_and_collections_artist_reference.py

35.7.6 matplotlib.axes.Axes.add_patch

Axes.**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.

Examples using matplotlib.axes.Axes.add_patch

- sphx_glr_gallery_shapes_and_collections_compound_path.py
- sphx_glr_gallery_shapes_and_collections_path_patch.py
- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py

35.7.7 matplotlib.axes.Axes.add_table

Axes.**add_table**(*tab*)
Add a *Table* instance to the list of axes tables

Parameters

tab: ‘matplotlib.table.Table‘ Table instance

Returns

‘matplotlib.table.Table‘: the table.

35.8 Twinning

Axes.twinx	Create a twin Axes sharing the xaxis
Axes.twiny	Create a twin Axes sharing the yaxis
Axes.get_shared_x_axes	Return a reference to the shared axes Grouper object for x axes.
Axes.get_shared_y_axes	Return a reference to the shared axes Grouper object for y axes.

35.8.1 matplotlib.axes.Axes.twinx

Axes.**twinx**()

Create a twin Axes sharing the xaxis

Create a new Axes instance with an invisible x-axis and an independent y-axis positioned opposite to the original one (i.e. at right). The x-axis autoscale setting will be inherited from the original Axes. To ensure that the tick marks of both y-axes align, see *LinearLocator*

Returns

ax_twin [Axes] The newly created Axes instance

Notes

For those who are 'picking' artists while using twinx, pick events are only called for the artists in the top-most axes.

35.8.2 matplotlib.axes.Axes.twiny

Axes.**twiny**()

Create a twin Axes sharing the yaxis

Create a new Axes instance with an invisible y-axis and an independent x-axis positioned opposite to the original one (i.e. at top). The y-axis autoscale setting will be inherited from the original Axes. To ensure that the tick marks of both x-axes align, see *LinearLocator*

Returns

ax_twin [Axes] The newly created Axes instance

Notes

For those who are 'picking' artists while using twiny, pick events are only called for the artists in the top-most axes.

35.8.3 matplotlib.axes.Axes.get_shared_x_axes

Axes.**get_shared_x_axes**()
Return a reference to the shared axes Grouper object for x axes.

35.8.4 matplotlib.axes.Axes.get_shared_y_axes

Axes.**get_shared_y_axes**()
Return a reference to the shared axes Grouper object for y axes.

35.9 Axes Position

Axes.get_anchor	Get the anchor location.
Axes.set_anchor	Define the anchor location.
Axes.get_axes_locator	Return the axes_locator.
Axes.set_axes_locator	Set the axes locator.
Axes.reset_position	Reset the active position to the original position.
Axes.get_position	Get a copy of the axes rectangle as a *Bbox*.
Axes.set_position	Set the axes position.

35.9.1 matplotlib.axes.Axes.get_anchor

Axes.**get_anchor**()
Get the anchor location.

See also:

matplotlib.axes.Axes.set_anchor	for a description of the anchor.
matplotlib.axes.Axes.set_aspect	for a description of aspect handling.

35.9.2 matplotlib.axes.Axes.set_anchor

Axes.**set_anchor**(*anchor*, *share=False*)
Define the anchor location.

The actual drawing area (active position) of the Axes may be smaller than the Bbox (original position) when a fixed aspect is required. The anchor defines where the drawing area will be located within the available space.

Parameters

anchor [str or 2-tuple of floats] The anchor position may be either:

- a sequence (*cx*, *cy*). *cx* and *cy* may range from 0 to 1, where 0 is left or bottom and 1 is right or top.

- a string using cardinal directions as abbreviation:
  - 'C' for centered
  - 'S' (south) for bottom-center
  - 'SW' (south west) for bottom-left
  - etc.

  Here is an overview of the possible positions:

'NW'	'N'	'NE'
'W'	'C'	'E'
'SW'	'S'	'SE'

share [bool, optional] If `True`, apply the settings to all shared Axes. Default is `False`.

See also:

matplotlib.axes.Axes.set_aspect for a description of aspect handling.

35.9.3 matplotlib.axes.Axes.get_axes_locator

`Axes.`**`get_axes_locator`**`()`
Return the axes_locator.

35.9.4 matplotlib.axes.Axes.set_axes_locator

`Axes.`**`set_axes_locator`**`(`*locator*`)`
Set the axes locator.

Parameters

locator [callable] A locator function, which takes an axes and a renderer and returns a bbox.

35.9.5 matplotlib.axes.Axes.reset_position

`Axes.`**`reset_position`**`()`
Reset the active position to the original position.

This resets the a possible position change due to aspect constraints. For an explanation of the positions see *set_position*.

35.9.6 matplotlib.axes.Axes.get_position

Axes.**get_position**(*original=False*)

Get a copy of the axes rectangle as a *Bbox*.

Parameters

original [bool] If `True`, return the original position. Otherwise return the active position. For an explanation of the positions see *set_position*.

Returns

pos [*Bbox*]

Examples using `matplotlib.axes.Axes.get_position`

- sphx_glr_gallery_images_contours_and_fields_contour_demo.py

35.9.7 matplotlib.axes.Axes.set_position

Axes.**set_position**(*pos*, *which='both'*)

Set the axes position.

Axes have two position attributes. The 'original' position is the position allocated for the Axes. The 'active' position is the position the Axes is actually drawn at. These positions are usually the same unless a fixed aspect is set to the Axes. See *set_aspect* for details.

Parameters

pos [[left, bottom, width, height] or *Bbox*] The new position of the in *Figure* coordinates.

which [['both' | 'active' | 'original'], optional] Determines which position variables to change.

Examples using `matplotlib.axes.Axes.set_position`

- sphx_glr_gallery_images_contours_and_fields_contour_demo.py

35.10 Async/Event based

Axes.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
Axes.pchanged	Fire an event when property changed, calling all of the registered callbacks.

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Axes.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
Axes.remove_callback	Remove a callback based on its *id*.

35.10.1 matplotlib.axes.Axes.stale

`Axes.`**`stale`**

If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

35.10.2 matplotlib.axes.Axes.pchanged

`Axes.`**`pchanged`**`()`

Fire an event when property changed, calling all of the registered callbacks.

35.10.3 matplotlib.axes.Axes.add_callback

`Axes.`**`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.

35.10.4 matplotlib.axes.Axes.remove_callback

`Axes.`**`remove_callback`**`(`*`oid`*`)`

Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

35.11 Interactive

Axes.can_pan	Return *True* if this axes supports any pan/zoom button functionality.
Axes.can_zoom	Return *True* if this axes supports the zoom box button functionality.
Axes.get_navigate	Get whether the axes responds to navigation commands
Axes.set_navigate	Set whether the axes responds to navigation toolbar commands
Axes.get_navigate_mode	Get the navigation toolbar button status: 'PAN', 'ZOOM', or None

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Axes.set_navigate_mode	Set the navigation toolbar button status;
Axes.start_pan	Called when a pan operation has started.
Axes.drag_pan	Called when the mouse moves during a pan operation.
Axes.end_pan	Called when a pan operation completes (when the mouse button is up.)
Axes.format_coord	Return a format string formatting the *x*, *y* coord
Axes.format_cursor_data	Return *cursor data* string formatted.
Axes.format_xdata	Return *x* string formatted.
Axes.format_ydata	Return y string formatted.
Axes.mouseover	
Axes.in_axes	Return *True* if the given *mouseevent* (in display coords) is in the Axes
Axes.pick	Trigger pick event
Axes.pickable	Return *True* if `Artist` is pickable.
Axes.get_picker	Return the picker object used by this artist.
Axes.set_picker	Set the epsilon for picking used by this artist
Axes.set_contains	Replace the contains test used by this artist.
Axes.get_contains	Return the _contains test used by the artist, or *None* for default.
Axes.contains	Test whether the mouse event occurred in the axes.
Axes.contains_point	Returns *True* if the point (tuple of x,y) is inside the axes (the area defined by the its patch).
Axes.get_cursor_data	Get the cursor data for a given event.
Axes.get_cursor_props	Deprecated since version 2.1.
Axes.set_cursor_props	Deprecated since version 2.1.

35.11.1 matplotlib.axes.Axes.can_pan

Axes.**can_pan**()
Return *True* if this axes supports any pan/zoom button functionality.

35.11.2 matplotlib.axes.Axes.can_zoom

Axes.**can_zoom**()
Return *True* if this axes supports the zoom box button functionality.

35.11.3 matplotlib.axes.Axes.get_navigate

Axes.**get_navigate**()
Get whether the axes responds to navigation commands

35.11.4 matplotlib.axes.Axes.set_navigate

Axes.**set_navigate**(*b*)
Set whether the axes responds to navigation toolbar commands

Parameters

b [bool]

35.11.5 matplotlib.axes.Axes.get_navigate_mode

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

35.11.6 matplotlib.axes.Axes.set_navigate_mode

Axes.**set_navigate_mode**(*b*)
Set the navigation toolbar button status;

> **Warning:** this is not a user-API function.

35.11.7 matplotlib.axes.Axes.start_pan

Axes.**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.

35.11.8 matplotlib.axes.Axes.drag_pan

Axes.**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.

35.11.9 matplotlib.axes.Axes.end_pan

Axes.**end_pan**()
Called when a pan operation completes (when the mouse button is up.)

Note: Intended to be overridden by new projection types.

35.11.10 matplotlib.axes.Axes.format_coord

Axes.**format_coord**(*x*, *y*)
Return a format string formatting the *x*, *y* coord

35.11.11 matplotlib.axes.Axes.format_cursor_data

Axes.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

35.11.12 matplotlib.axes.Axes.format_xdata

Axes.**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

35.11.13 matplotlib.axes.Axes.format_ydata

Axes.**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

35.11.14 matplotlib.axes.Axes.mouseover

Axes.**mouseover**

35.11.15 matplotlib.axes.Axes.in_axes

Axes.**in_axes**(*mouseevent*)
Return *True* if the given *mouseevent* (in display coords) is in the Axes

35.11.16 matplotlib.axes.Axes.pick

Axes.**pick**(**args*)
Trigger pick event

Call signature:

```
pick(mouseevent)
```

each child artist will fire a pick event if mouseevent is over the artist and the artist has picker set

35.11.17 matplotlib.axes.Axes.pickable

Axes.**pickable**()
Return *True* if `Artist` is pickable.

35.11.18 matplotlib.axes.Axes.get_picker

Axes.**get_picker**()
Return the picker object used by this artist.

35.11.19 matplotlib.axes.Axes.set_picker

Axes.**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.

Parameters

picker [None or bool or float or callable]

35.11.20 matplotlib.axes.Axes.set_contains

Axes.**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.

Parameters

picker [callable]

35.11.21 matplotlib.axes.Axes.get_contains

Axes.**get_contains**()

Return the _contains test used by the artist, or *None* for default.

35.11.22 matplotlib.axes.Axes.contains

Axes.**contains**(*mouseevent*)

Test whether the mouse event occurred in the axes.

Returns *True* / *False*, {}

35.11.23 matplotlib.axes.Axes.contains_point

Axes.**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.

35.11.24 matplotlib.axes.Axes.get_cursor_data

Axes.**get_cursor_data**(*event*)

Get the cursor data for a given event.

35.11.25 matplotlib.axes.Axes.get_cursor_props

Axes.**get_cursor_props**()

Deprecated since version 2.1: The get_cursor_props function was deprecated in version 2.1.

Return the cursor propertiess as a (*linewidth*, *color*) tuple, where *linewidth* is a float and *color* is an RGBA tuple

35.11.26 matplotlib.axes.Axes.set_cursor_props

Axes.**set_cursor_props**(**args*)

Deprecated since version 2.1: The set_cursor_props function was deprecated in version 2.1.

Set the cursor property as

Call signature

```
ax.set_cursor_props(linewidth, color)
```

or:

```
ax.set_cursor_props((linewidth, color))
```

ACCEPTS: a (*float*, *color*) tuple

35.12 Children

Axes.get_children	return a list of child artists
Axes.get_images	return a list of Axes images contained by the Axes
Axes.get_lines	Return a list of lines contained by the Axes
Axes.findobj	Find artist objects.

35.12.1 matplotlib.axes.Axes.get_children

Axes.**get_children**()

return a list of child artists

35.12.2 matplotlib.axes.Axes.get_images

Axes.**get_images**()

return a list of Axes images contained by the Axes

35.12.3 matplotlib.axes.Axes.get_lines

Axes.**get_lines**()
Return a list of lines contained by the Axes

35.12.4 matplotlib.axes.Axes.findobj

Axes.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

35.13 Drawing

Axes.draw	Draw everything (plot lines, axes, labels)
Axes.draw_artist	This method can only be used after an initial draw which caches the renderer.
Axes.redraw_in_frame	This method can only be used after an initial draw which caches the renderer.
Axes.get_renderer_cache	
Axes.get_rasterization_zorder	Return the zorder value below which artists will be rasterized.
Axes.set_rasterization_zorder	**Parameters**
Axes.get_window_extent	get the axes bounding box in display space; *args* and *kwargs* are empty
Axes.get_tightbbox	Return the tight bounding box of the axes.

35.13.1 matplotlib.axes.Axes.draw

Axes.**draw**(*renderer=None*, *inframe=False*)
Draw everything (plot lines, axes, labels)

Examples using `matplotlib.axes.Axes.draw`

- sphx_glr_gallery_text_labels_and_annotations_usetex_baseline_test.py

35.13.2 matplotlib.axes.Axes.draw_artist

Axes.**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)

35.13.3 matplotlib.axes.Axes.redraw_in_frame

Axes.**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)

35.13.4 matplotlib.axes.Axes.get_renderer_cache

Axes.**get_renderer_cache**()

35.13.5 matplotlib.axes.Axes.get_rasterization_zorder

Axes.**get_rasterization_zorder**()
Return the zorder value below which artists will be rasterized.

35.13.6 matplotlib.axes.Axes.set_rasterization_zorder

Axes.**set_rasterization_zorder**(*z*)

Parameters

z [float or None] zorder below which artists are rasterized. `None` means that artists do not get rasterized based on zorder.

35.13.7 matplotlib.axes.Axes.get_window_extent

Axes.**get_window_extent**(**args*, ***kwargs*)
get the axes bounding box in display space; *args* and *kwargs* are empty

35.13.8 matplotlib.axes.Axes.get_tightbbox

Axes.**get_tightbbox**(*renderer*, *call_axes_locator=True*)
Return the tight bounding box of the axes. The dimension of the Bbox in canvas coordinate.

If *call_axes_locator* is *False*, it does not call the _axes_locator attribute, which is necessary to get the correct bounding box. `call_axes_locator==False` can be used if the caller is only intereted in the relative size of the tightbbox compared to the axes bbox.

35.14 Bulk property manipulation

Axes.set	A property batch setter.
Axes.update	Update this artist's properties from the dictionary *prop*.
Axes.properties	return a dictionary mapping property name -> value for all Artist props
Axes.update_from	Copy properties from *other* to *self*.

35.14.1 matplotlib.axes.Axes.set

Axes.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

Examples using matplotlib.axes.Axes.set

- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py

35.14.2 matplotlib.axes.Axes.update

Axes.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

35.14.3 matplotlib.axes.Axes.properties

Axes.**properties**()
return a dictionary mapping property name -> value for all Artist props

35.14.4 matplotlib.axes.Axes.update_from

Axes.**update_from**(*other*)
Copy properties from *other* to *self*.

35.15 General Artist Properties

Axes.set_agg_filter	Set the agg filter.
Axes.set_alpha	Set the alpha value used for blending - not supported on all backends.
Axes.set_animated	Set the artist's animation state.
Axes.set_clip_box	Set the artist's clip *Bbox*.

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Axes.set_clip_on	Set whether artist uses clipping.
Axes.set_clip_path	Set the artist's clip path, which may be:
Axes.set_gid	Sets the (group) id for the artist.
Axes.set_label	Set the label to *s* for auto legend.
Axes.set_path_effects	Set the path effects.
Axes.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
Axes.set_sketch_params	Sets the sketch parameters.
Axes.set_snap	Sets the snap setting which may be:
Axes.set_transform	Set the artist transform.
Axes.set_url	Sets the url for the artist.
Axes.set_visible	Set the artist's visibility.
Axes.set_zorder	Set the zorder for the artist.
Axes.get_agg_filter	Return filter function to be used for agg filter.
Axes.get_alpha	Return the alpha value used for blending - not supported on all backends
Axes.get_animated	Return the artist's animated state
Axes.get_clip_box	Return artist clipbox
Axes.get_clip_on	Return whether artist uses clipping
Axes.get_clip_path	Return artist clip path
Axes.get_gid	Returns the group id.
Axes.get_label	Get the label used for this artist in the legend.
Axes.get_path_effects	
Axes.get_rasterized	Return whether the artist is to be rasterized.
Axes.get_sketch_params	Returns the sketch parameters for the artist.
Axes.get_snap	Returns the snap setting which may be:
Axes.get_transform	Return the *Transform* instance used by this artist.
Axes.get_url	Returns the url.
Axes.get_visible	Return the artist's visiblity
Axes.get_zorder	Return the artist's zorder.
Axes.axes	The *Axes* instance the artist resides in, or *None*.
Axes.set_figure	Set the *Figure* for this *Axes*.
Axes.get_figure	Return the *Figure* instance the artist belongs to.

35.15.1 matplotlib.axes.Axes.set_agg_filter

Axes.**set_agg_filter**(*filter_func*)

Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

35.15.2 matplotlib.axes.Axes.set_alpha

Axes.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

35.15.3 matplotlib.axes.Axes.set_animated

Axes.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

35.15.4 matplotlib.axes.Axes.set_clip_box

Axes.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

35.15.5 matplotlib.axes.Axes.set_clip_on

Axes.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

35.15.6 matplotlib.axes.Axes.set_clip_path

Axes.**set_clip_path**(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

35.15.7 matplotlib.axes.Axes.set_gid

Axes.**set_gid**(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

35.15.8 matplotlib.axes.Axes.set_label

Axes.**set_label**(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling str (unicode on Py2).

35.15.9 matplotlib.axes.Axes.set_path_effects

Axes.**set_path_effects**(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

35.15.10 matplotlib.axes.Axes.set_rasterized

Axes.**set_rasterized**(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

35.15.11 matplotlib.axes.Axes.set_sketch_params

Axes.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

35.15.12 matplotlib.axes.Axes.set_snap

`Axes.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.

Parameters

snap [bool or None]

35.15.13 matplotlib.axes.Axes.set_transform

`Axes.set_transform(t)`

Set the artist transform.

Parameters

t [*Transform*]

35.15.14 matplotlib.axes.Axes.set_url

`Axes.set_url(url)`

Sets the url for the artist.

Parameters

url [str]

35.15.15 matplotlib.axes.Axes.set_visible

`Axes.set_visible(b)`

Set the artist's visibility.

Parameters

b [bool]

35.15.16 matplotlib.axes.Axes.set_zorder

Axes.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

35.15.17 matplotlib.axes.Axes.get_agg_filter

Axes.**get_agg_filter**()
Return filter function to be used for agg filter.

35.15.18 matplotlib.axes.Axes.get_alpha

Axes.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

35.15.19 matplotlib.axes.Axes.get_animated

Axes.**get_animated**()
Return the artist's animated state

35.15.20 matplotlib.axes.Axes.get_clip_box

Axes.**get_clip_box**()
Return artist clipbox

35.15.21 matplotlib.axes.Axes.get_clip_on

Axes.**get_clip_on**()
Return whether artist uses clipping

35.15.22 matplotlib.axes.Axes.get_clip_path

Axes.**get_clip_path**()
Return artist clip path

35.15.23 matplotlib.axes.Axes.get_gid

Axes.**get_gid**()
Returns the group id.

35.15.24 matplotlib.axes.Axes.get_label

Axes.**get_label**()
Get the label used for this artist in the legend.

35.15.25 matplotlib.axes.Axes.get_path_effects

Axes.**get_path_effects**()

35.15.26 matplotlib.axes.Axes.get_rasterized

Axes.**get_rasterized**()
Return whether the artist is to be rasterized.

35.15.27 matplotlib.axes.Axes.get_sketch_params

Axes.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

35.15.28 matplotlib.axes.Axes.get_snap

Axes.**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.

35.15.29 matplotlib.axes.Axes.get_transform

Axes.**get_transform**()
Return the *Transform* instance used by this artist.

35.15.30 matplotlib.axes.Axes.get_url

Axes.**get_url**()
Returns the url.

35.15.31 matplotlib.axes.Axes.get_visible

Axes.**get_visible**()
Return the artist's visiblity

35.15.32 matplotlib.axes.Axes.get_zorder

Axes.**get_zorder**()
Return the artist's zorder.

35.15.33 matplotlib.axes.Axes.axes

Axes.**axes**
The *Axes* instance the artist resides in, or *None*.

35.15.34 matplotlib.axes.Axes.set_figure

Axes.**set_figure**(*fig*)
Set the *Figure* for this *Axes*.

Parameters

fig [*Figure*]

35.15.35 matplotlib.axes.Axes.get_figure

Axes.**get_figure**()
Return the *Figure* instance the artist belongs to.

35.16 Artist Methods

Axes.remove	Remove the artist from the figure if possible.
Axes.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.

35.16.1 matplotlib.axes.Axes.remove

`Axes.`**`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.

35.16.2 matplotlib.axes.Axes.is_transform_set

`Axes.`**`is_transform_set`**`()`

Returns *True* if `Artist` has a transform explicitly set.

35.17 Projection

Methods used by *Axis* that must be overridden for non-rectilinear Axes.

Axes.name	
Axes.get_xaxis_transform	Get the transformation used for drawing x-axis labels, ticks and gridlines.
Axes.get_yaxis_transform	Get the transformation used for drawing y-axis labels, ticks and gridlines.
Axes.get_data_ratio	Returns the aspect ratio of the raw data.
Axes.get_data_ratio_log	Returns the aspect ratio of the raw data in log scale.
Axes.get_xaxis_text1_transform	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.
Axes.get_xaxis_text2_transform	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.
Axes.get_yaxis_text1_transform	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.

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Axes.get_yaxis_text2_transform	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.

35.17.1 matplotlib.axes.Axes.name

Axes.**name** = **'rectilinear'**

35.17.2 matplotlib.axes.Axes.get_xaxis_transform

Axes.**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.

35.17.3 matplotlib.axes.Axes.get_yaxis_transform

Axes.**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.

35.17.4 matplotlib.axes.Axes.get_data_ratio

Axes.**get_data_ratio**()

Returns the aspect ratio of the raw data.

This method is intended to be overridden by new projection types.

35.17.5 matplotlib.axes.Axes.get_data_ratio_log

Axes.**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.

35.17.6 matplotlib.axes.Axes.get_xaxis_text1_transform

Axes.**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.

35.17.7 matplotlib.axes.Axes.get_xaxis_text2_transform

Axes.**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.

35.17.8 matplotlib.axes.Axes.get_yaxis_text1_transform

Axes.**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.

35.17.9 matplotlib.axes.Axes.get_yaxis_text2_transform

Axes.**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.

35.18 Other

Axes.zorder	
Axes.aname	
Axes.get_default_bbox_extra_artists	
Axes.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.
Axes.has_data	Return *True* if any artists have been added to axes.
Axes.hold	Deprecated since version 2.0.
Axes.ishold	Deprecated since version 2.0.

35.18.1 matplotlib.axes.Axes.zorder

Axes.**zorder** = **0**

35.18.2 matplotlib.axes.Axes.aname

Axes.**aname** = **'Axes'**

35.18.3 matplotlib.axes.Axes.get_default_bbox_extra_artists

Axes.**get_default_bbox_extra_artists**()

35.18.4 matplotlib.axes.Axes.get_transformed_clip_path_and_affine

Axes.**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.

35.18.5 matplotlib.axes.Axes.has_data

Axes.**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.

35.18.6 matplotlib.axes.Axes.hold

Axes.**hold**(*b=None*)

Deprecated since version 2.0: axes.hold is deprecated. See the API Changes document (http://matplotlib.org/api/api_changes.html) for more details.

Set the hold state.

The `hold` mechanism is deprecated and will be removed in v3.0. The behavior will remain consistent with the long-time default value of True.

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

35.18.7 matplotlib.axes.Axes.ishold

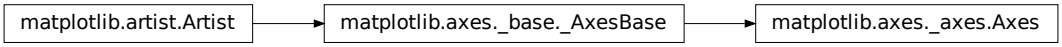
Axes.**ishold**()

Deprecated since version 2.0: The ishold function was deprecated in version 2.0.

return the HOLD status of the axes

The *hold* mechanism is deprecated and will be removed in v3.0.

35.19 Inheritance



CHAPTER

THIRTYSIX

AXIS AND TICK API

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  - *Interactive*
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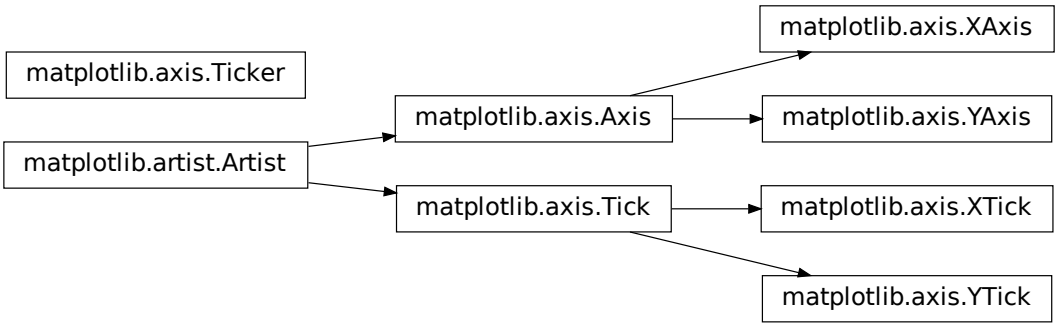
  - *Incremental navigation*
  - *YAxis Specific*
  - *XAxis Specific*
  - *Other*
  - *Discouraged*
- `Tick` *objects*
- *Common and inherited methods*
  - `XTick`
  - *YTick*
  - *YAxis*
  - *XAxis*
  - *Inherited from artist*
    - *Ticks*

* *Axis*

Classes for the ticks and x and y axis

36.1 Inheritance



36.2 `Axis` objects

class matplotlib.axis.**Axis**(*axes*, *pickradius=15*)

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

class matplotlib.axis.**XAxis**(*axes*, *pickradius=15*)

Init the axis with the parent Axes instance

class matplotlib.axis.**YAxis**(*axes*, *pickradius=15*)

Init the axis with the parent Axes instance

class matplotlib.axis.**Ticker**

Axis.cla	clear the current axis
Axis.get_scale	

36.2.1 matplotlib.axis.Axis.cla

Axis.**cla**()
clear the current axis

36.2.2 matplotlib.axis.Axis.get_scale

Axis.**get_scale**()

36.2.3 Formatters and Locators

Axis.get_major_formatter	Get the formatter of the major ticker
Axis.get_major_locator	Get the locator of the major ticker
Axis.get_minor_formatter	Get the formatter of the minor ticker
Axis.get_minor_locator	Get the locator of the minor ticker
Axis.set_major_formatter	Set the formatter of the major ticker
Axis.set_major_locator	Set the locator of the major ticker
Axis.set_minor_formatter	Set the formatter of the minor ticker
Axis.set_minor_locator	Set the locator of the minor ticker

matplotlib.axis.Axis.get_major_formatter

Axis.**get_major_formatter**()
Get the formatter of the major ticker

matplotlib.axis.Axis.get_major_locator

Axis.**get_major_locator**()
Get the locator of the major ticker

matplotlib.axis.Axis.get_minor_formatter

Axis.**get_minor_formatter**()
Get the formatter of the minor ticker

matplotlib.axis.Axis.get_minor_locator

Axis.**get_minor_locator**()
Get the locator of the minor ticker

matplotlib.axis.Axis.set_major_formatter

Axis.**set_major_formatter**(*formatter*)
Set the formatter of the major ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.Axis.set_major_locator

Axis.**set_major_locator**(*locator*)
Set the locator of the major ticker

ACCEPTS: a *Locator* instance

matplotlib.axis.Axis.set_minor_formatter

Axis.**set_minor_formatter**(*formatter*)
Set the formatter of the minor ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.Axis.set_minor_locator

Axis.**set_minor_locator**(*locator*)
Set the locator of the minor ticker

ACCEPTS: a *Locator* instance

36.2.4 Axis Label

Axis.set_label_coords	Set the coordinates of the label.
Axis.set_label_position	Set the label position (top or bottom)
Axis.set_label_text	Sets the text value of the axis label
Axis.get_label_position	Return the label position (top or bottom)
Axis.get_label_text	Get the text of the label

matplotlib.axis.Axis.set_label_coords

Axis.**set_label_coords**(*x*, *y*, *transform=None*)
Set the coordinates of the label. By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

matplotlib.axis.Axis.set_label_position

Axis.**set_label_position**(*position*)
Set the label position (top or bottom)

ACCEPTS: ['top' | 'bottom']

matplotlib.axis.Axis.set_label_text

Axis.**set_label_text**(*label*, *fontdict=None*, ***kwargs*)
Sets the text value of the axis label

ACCEPTS: A string value for the label

matplotlib.axis.Axis.get_label_position

Axis.**get_label_position**()
Return the label position (top or bottom)

matplotlib.axis.Axis.get_label_text

Axis.**get_label_text**()
Get the text of the label

36.2.5 Ticks, tick labels and Offset text

Axis.get_major_ticks	get the tick instances; grow as necessary
Axis.get_majorticklabels	Return a list of Text instances for the major ticklabels
Axis.get_majorticklines	Return the major tick lines as a list of Line2D instances
Axis.get_majorticklocs	Get the major tick locations in data coordinates as a numpy array
Axis.get_minor_ticks	get the minor tick instances; grow as necessary
Axis.get_minorticklabels	Return a list of Text instances for the minor ticklabels
Axis.get_minorticklines	Return the minor tick lines as a list of Line2D instances
Axis.get_minorticklocs	Get the minor tick locations in data coordinates as a numpy array
Axis.get_offset_text	Return the axis offsetText as a Text instance
Axis.get_tick_padding	
Axis.get_ticklabels	Get the tick labels as a list of *Text* instances.
Axis.get_ticklines	Return the tick lines as a list of Line2D instances

Continued on next page

Table 4 – continued from previous page

Axis.get_ticklocs	Get the tick locations in data coordinates as a numpy array
Axis.get_gridlines	Return the grid lines as a list of Line2D instance
Axis.grid	Set the axis grid on or off; b is a boolean.
Axis.iter_ticks	Iterate through all of the major and minor ticks.
Axis.set_tick_params	Set appearance parameters for ticks, ticklabels, and gridlines.
Axis.axis_date	Sets up x-axis ticks and labels that treat the x data as dates.

matplotlib.axis.Axis.get_major_ticks

Axis.**get_major_ticks**(*numticks=None*)
get the tick instances; grow as necessary

matplotlib.axis.Axis.get_majorticklabels

Axis.**get_majorticklabels**()
Return a list of Text instances for the major ticklabels

matplotlib.axis.Axis.get_majorticklines

Axis.**get_majorticklines**()
Return the major tick lines as a list of Line2D instances

matplotlib.axis.Axis.get_majorticklocs

Axis.**get_majorticklocs**()
Get the major tick locations in data coordinates as a numpy array

matplotlib.axis.Axis.get_minor_ticks

Axis.**get_minor_ticks**(*numticks=None*)
get the minor tick instances; grow as necessary

matplotlib.axis.Axis.get_minorticklabels

Axis.**get_minorticklabels**()
Return a list of Text instances for the minor ticklabels

matplotlib.axis.Axis.get_minorticklines

Axis.**get_minorticklines**()
Return the minor tick lines as a list of Line2D instances

matplotlib.axis.Axis.get_minorticklocs

Axis.**get_minorticklocs**()
Get the minor tick locations in data coordinates as a numpy array

matplotlib.axis.Axis.get_offset_text

Axis.**get_offset_text**()
Return the axis offsetText as a Text instance

matplotlib.axis.Axis.get_tick_padding

Axis.**get_tick_padding**()

matplotlib.axis.Axis.get_ticklabels

Axis.**get_ticklabels**(*minor=False*, *which=None*)
Get the tick labels as a list of *Text* instances.

Parameters

minor [bool] If True return the minor ticklabels, else return the major ticklabels

which [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

Returns

ret [list] List of *Text* instances.

matplotlib.axis.Axis.get_ticklines

Axis.**get_ticklines**(*minor=False*)
Return the tick lines as a list of Line2D instances

matplotlib.axis.Axis.get_ticklocs

Axis.**get_ticklocs**(*minor=False*)
Get the tick locations in data coordinates as a numpy array

matplotlib.axis.Axis.get_gridlines

Axis.**get_gridlines**()
Return the grid lines as a list of Line2D instance

matplotlib.axis.Axis.grid

Axis.**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, e.g.,

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

matplotlib.axis.Axis.iter_ticks

Axis.**iter_ticks**()
Iterate through all of the major and minor ticks.

matplotlib.axis.Axis.set_tick_params

Axis.**set_tick_params**(*which='major'*, *reset=False*, ***kw*)
Set appearance parameters for ticks, ticklabels, and gridlines.

For documentation of keyword arguments, see *matplotlib.axes.Axes.tick_params()*.

matplotlib.axis.Axis.axis_date

Axis.**axis_date**(*tz=None*)
Sets up x-axis ticks and labels that treat the x data as dates. *tz* is a `tzinfo` instance or a timezone string. This timezone is used to create date labels.

36.2.6 Data and view intervals

Axis.get_data_interval	return the Interval instance for this axis data limits
Axis.get_view_interval	return the Interval instance for this axis view limits
Axis.set_data_interval	set the axis data limits
Axis.set_view_interval	

matplotlib.axis.Axis.get_data_interval

Axis.**get_data_interval**()
return the Interval instance for this axis data limits

matplotlib.axis.Axis.get_view_interval

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

matplotlib.axis.Axis.set_data_interval

Axis.**set_data_interval**()
set the axis data limits

matplotlib.axis.Axis.set_view_interval

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

36.2.7 Rendering helpers

Axis.get_minpos	
Axis.get_tick_space	Return the estimated number of ticks that can fit on the axis.
Axis.get_ticklabel_extents	Get the extents of the tick labels on either side of the axes.
Axis.get_tightbbox	Return a bounding box that encloses the axis.

matplotlib.axis.Axis.get_minpos

Axis.**get_minpos**()

matplotlib.axis.Axis.get_tick_space

Axis.**get_tick_space**()
Return the estimated number of ticks that can fit on the axis.

matplotlib.axis.Axis.get_ticklabel_extents

Axis.**get_ticklabel_extents**(*renderer*)
Get the extents of the tick labels on either side of the axes.

matplotlib.axis.Axis.get_tightbbox

Axis.**get_tightbbox**(*renderer*)
Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and offsetText.

36.2.8 Interactive

Axis.get_pickradius	Return the depth of the axis used by the picker
Axis.set_pickradius	Set the depth of the axis used by the picker

matplotlib.axis.Axis.get_pickradius

Axis.**get_pickradius**()
Return the depth of the axis used by the picker

matplotlib.axis.Axis.set_pickradius

Axis.**set_pickradius**(*pickradius*)
Set the depth of the axis used by the picker

ACCEPTS: a distance in points

36.2.9 Units

Axis.convert_units	
Axis.set_units	set the units for axis
Axis.get_units	return the units for axis
Axis.update_units	introspect *data* for units converter and update the axis.converter instance if necessary.

matplotlib.axis.Axis.convert_units

Axis.**convert_units**(*x*)

matplotlib.axis.Axis.set_units

Axis.**set_units**(*u*)
set the units for axis

ACCEPTS: a units tag

matplotlib.axis.Axis.get_units

Axis.**get_units**()
return the units for axis

matplotlib.axis.Axis.update_units

Axis.**update_units**(*data*)
introspect *data* for units converter and update the axis.converter instance if necessary. Return *True* if *data* is registered for unit conversion.

36.2.10 Incremental navigation

Axis.pan	Pan *numsteps* (can be positive or negative)
Axis.zoom	Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

matplotlib.axis.Axis.pan

Axis.**pan**(*numsteps*)
Pan *numsteps* (can be positive or negative)

matplotlib.axis.Axis.zoom

Axis.**zoom**(*direction*)
Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

36.2.11 YAxis Specific

YAxis.axis_name	
YAxis.get_text_widths	
YAxis.get_ticks_position	Return the ticks position (left, right, both or unknown)
YAxis.set_offset_position	
YAxis.set_ticks_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.
YAxis.tick_left	Move ticks and ticklabels (if present) to the left of the axes.
YAxis.tick_right	Move ticks and ticklabels (if present) to the right of the axes.

matplotlib.axis.YAxis.axis_name

YAxis.**axis_name** = 'y'

matplotlib.axis.YAxis.get_text_widths

YAxis.**get_text_widths**(*renderer*)

matplotlib.axis.YAxis.get_ticks_position

YAxis.**get_ticks_position**()
Return the ticks position (left, right, both or unknown)

matplotlib.axis.YAxis.set_offset_position

YAxis.**set_offset_position**(*position*)

matplotlib.axis.YAxis.set_ticks_position

YAxis.**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']

matplotlib.axis.YAxis.tick_left

YAxis.**tick_left**()
Move ticks and ticklabels (if present) to the left of the axes.

matplotlib.axis.YAxis.tick_right

YAxis.**tick_right**()
Move ticks and ticklabels (if present) to the right of the axes.

36.2.12 XAxis Specific

XAxis.axis_name	
XAxis.get_text_heights	Returns the amount of space one should reserve for text above and below the axes.
XAxis.get_ticks_position	Return the ticks position (top, bottom, default or unknown)
XAxis.set_ticks_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.
XAxis.tick_bottom	Move ticks and ticklabels (if present) to the bottom of the axes.
XAxis.tick_top	Move ticks and ticklabels (if present) to the top of the axes.

matplotlib.axis.XAxis.axis_name

XAxis.**axis_name** = 'x'

matplotlib.axis.XAxis.get_text_heights

XAxis.**get_text_heights**(*renderer*)

Returns the amount of space one should reserve for text above and below the axes. Returns a tuple (above, below)

matplotlib.axis.XAxis.get_ticks_position

XAxis.**get_ticks_position**()

Return the ticks position (top, bottom, default or unknown)

matplotlib.axis.XAxis.set_ticks_position

XAxis.**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']

matplotlib.axis.XAxis.tick_bottom

XAxis.**tick_bottom**()

Move ticks and ticklabels (if present) to the bottom of the axes.

matplotlib.axis.XAxis.tick_top

XAxis.**tick_top**()
Move ticks and ticklabels (if present) to the top of the axes.

36.2.13 Other

Axis.OFFSETTEXTPAD	
Axis.limit_range_for_scale	
Axis.reset_ticks	Re-initialize the major and minor Tick lists.
Axis.set_default_intervals	set the default limits for the axis data and view interval if they are not mutated
Axis.get_smart_bounds	get whether the axis has smart bounds
Axis.set_smart_bounds	set the axis to have smart bounds

matplotlib.axis.Axis.OFFSETTEXTPAD

Axis.**OFFSETTEXTPAD** = 3

matplotlib.axis.Axis.limit_range_for_scale

Axis.**limit_range_for_scale**(*vmin*, *vmax*)

matplotlib.axis.Axis.reset_ticks

Axis.**reset_ticks**()
Re-initialize the major and minor Tick lists.

Each list starts with a single fresh Tick.

matplotlib.axis.Axis.set_default_intervals

Axis.**set_default_intervals**()
set the default limits for the axis data and view interval if they are not mutated

matplotlib.axis.Axis.get_smart_bounds

Axis.**get_smart_bounds**()
get whether the axis has smart bounds

matplotlib.axis.Axis.set_smart_bounds

Axis.**set_smart_bounds**(*value*)
set the axis to have smart bounds

36.2.14 Discouraged

These methods implicitly use *FixedLocator* and *FixedFormatter*. They can be convenient, but if not used together may de-couple your tick labels from your data.

Axis.set_ticklabels	Set the text values of the tick labels.
Axis.set_ticks	Set the locations of the tick marks from sequence ticks

matplotlib.axis.Axis.set_ticklabels

Axis.**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 or Text objects

matplotlib.axis.Axis.set_ticks

Axis.**set_ticks**(*ticks*, *minor=False*)
Set the locations of the tick marks from sequence ticks

ACCEPTS: sequence of floats

36.3 Tick objects

class matplotlib.axis.**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*, *labelrotation=0*, *grid_color=None*, *grid_linestyle=None*, *grid_linewidth=None*, *grid_alpha=None*, ***kw*)
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

Attributes

tick1line [Line2D]

tick2line [Line2D]

gridline [Line2D]

label1 [Text]

label2 [Text]

gridOn [bool] Determines whether to draw the tickline.

tick1On [bool] Determines whether to draw the first tickline.

tick2On [bool] Determines whether to draw the second tickline.

label1On [bool] Determines whether to draw the first tick label.

label2On [bool] Determines whether to draw the second 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

class matplotlib.axis.**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*, *labelrotation=0*, *grid_color=None*, *grid_linestyle=None*, *grid_linewidth=None*, *grid_alpha=None*, ***kw*)

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

class matplotlib.axis.**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*, *labelrotation=0*, *grid_color=None*, *grid_linestyle=None*, *grid_linewidth=None*, *grid_alpha=None*, ***kw*)

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

Tick.apply_tickdir	Calculate self._pad and self._tickmarkers
Tick.get_loc	Return the tick location (data coords) as a scalar
Tick.get_pad	Get the value of the tick label pad in points
Tick.get_pad_pixels	
Tick.get_tick_padding	Get the length of the tick outside of the axes.

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Table 14 – continued from previous page

Tick.get_tickdir	
Tick.get_view_interval	return the view Interval instance for the axis this tick is ticking
Tick.set_label1	Set the text of ticklabel
Tick.set_label2	Set the text of ticklabel2
Tick.set_pad	Set the tick label pad in points
Tick.update_position	Set the location of tick in data coords with scalar *loc*

36.3.1 matplotlib.axis.Tick.apply_tickdir

Tick.**apply_tickdir**(*tickdir*)
Calculate self._pad and self._tickmarkers

36.3.2 matplotlib.axis.Tick.get_loc

Tick.**get_loc**()
Return the tick location (data coords) as a scalar

36.3.3 matplotlib.axis.Tick.get_pad

Tick.**get_pad**()
Get the value of the tick label pad in points

36.3.4 matplotlib.axis.Tick.get_pad_pixels

Tick.**get_pad_pixels**()

36.3.5 matplotlib.axis.Tick.get_tick_padding

Tick.**get_tick_padding**()
Get the length of the tick outside of the axes.

36.3.6 matplotlib.axis.Tick.get_tickdir

Tick.**get_tickdir**()

36.3.7 matplotlib.axis.Tick.get_view_interval

Tick.**get_view_interval**()
return the view Interval instance for the axis this tick is ticking

36.3.8 matplotlib.axis.Tick.set_label1

Tick.**set_label1**(*s*)
Set the text of ticklabel

ACCEPTS: str

36.3.9 matplotlib.axis.Tick.set_label2

Tick.**set_label2**(*s*)
Set the text of ticklabel2

ACCEPTS: str

36.3.10 matplotlib.axis.Tick.set_pad

Tick.**set_pad**(*val*)
Set the tick label pad in points

ACCEPTS: float

36.3.11 matplotlib.axis.Tick.update_position

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

36.4 Common and inherited methods

36.4.1 XTick

XTick.apply_tickdir	Calculate self._pad and self._tickmarkers
XTick.get_loc	Return the tick location (data coords) as a scalar
XTick.get_pad	Get the value of the tick label pad in points
XTick.get_pad_pixels	
XTick.get_tick_padding	Get the length of the tick outside of the axes.
XTick.get_tickdir	
XTick.get_view_interval	return the Interval instance for this axis view limits
XTick.set_label1	Set the text of ticklabel

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Table 15 – continued from previous page

XTick.set_label2	Set the text of ticklabel2
XTick.set_pad	Set the tick label pad in points
XTick.update_position	Set the location of tick in data coords with scalar *loc*

matplotlib.axis.XTick.apply_tickdir

XTick.**apply_tickdir**(*tickdir*)
Calculate self._pad and self._tickmarkers

matplotlib.axis.XTick.get_loc

XTick.**get_loc**()
Return the tick location (data coords) as a scalar

matplotlib.axis.XTick.get_pad

XTick.**get_pad**()
Get the value of the tick label pad in points

matplotlib.axis.XTick.get_pad_pixels

XTick.**get_pad_pixels**()

matplotlib.axis.XTick.get_tick_padding

XTick.**get_tick_padding**()
Get the length of the tick outside of the axes.

matplotlib.axis.XTick.get_tickdir

XTick.**get_tickdir**()

matplotlib.axis.XTick.get_view_interval

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

matplotlib.axis.XTick.set_label1

XTick.**set_label1**(*s*)
Set the text of ticklabel

ACCEPTS: str

matplotlib.axis.XTick.set_label2

XTick.**set_label2**(*s*)
Set the text of ticklabel2

ACCEPTS: str

matplotlib.axis.XTick.set_pad

XTick.**set_pad**(*val*)
Set the tick label pad in points

ACCEPTS: float

matplotlib.axis.XTick.update_position

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

36.4.2 YTick

YTick.apply_tickdir	Calculate self._pad and self._tickmarkers
YTick.get_loc	Return the tick location (data coords) as a scalar
YTick.get_pad	Get the value of the tick label pad in points
YTick.get_pad_pixels	
YTick.get_tick_padding	Get the length of the tick outside of the axes.
YTick.get_tickdir	
YTick.get_view_interval	return the Interval instance for this axis view limits
YTick.set_label1	Set the text of ticklabel
YTick.set_label2	Set the text of ticklabel2
YTick.set_pad	Set the tick label pad in points
YTick.update_position	Set the location of tick in data coords with scalar *loc*

matplotlib.axis.YTick.apply_tickdir

YTick.**apply_tickdir**(*tickdir*)
Calculate self._pad and self._tickmarkers

matplotlib.axis.YTick.get_loc

YTick.**get_loc**()
Return the tick location (data coords) as a scalar

matplotlib.axis.YTick.get_pad

YTick.**get_pad**()
Get the value of the tick label pad in points

matplotlib.axis.YTick.get_pad_pixels

YTick.**get_pad_pixels**()

matplotlib.axis.YTick.get_tick_padding

YTick.**get_tick_padding**()
Get the length of the tick outside of the axes.

matplotlib.axis.YTick.get_tickdir

YTick.**get_tickdir**()

matplotlib.axis.YTick.get_view_interval

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

matplotlib.axis.YTick.set_label1

YTick.**set_label1**(*s*)
Set the text of ticklabel

ACCEPTS: str

matplotlib.axis.YTick.set_label2

YTick.**set_label2**(*s*)
Set the text of ticklabel2

ACCEPTS: str

matplotlib.axis.YTick.set_pad

YTick.**set_pad**(*val*)
Set the tick label pad in points

ACCEPTS: float

matplotlib.axis.YTick.update_position

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

36.4.3 YAxis

YAxis.OFFSETTEXTPAD	
YAxis.axis_date	Sets up x-axis ticks and labels that treat the x data as dates.
YAxis.cla	clear the current axis
YAxis.convert_units	
YAxis.get_data_interval	return the Interval instance for this axis data limits
YAxis.get_gridlines	Return the grid lines as a list of Line2D instance
YAxis.get_label_position	Return the label position (top or bottom)
YAxis.get_label_text	Get the text of the label
YAxis.get_major_formatter	Get the formatter of the major ticker
YAxis.get_major_locator	Get the locator of the major ticker
YAxis.get_major_ticks	get the tick instances; grow as necessary
YAxis.get_majorticklabels	Return a list of Text instances for the major ticklabels
YAxis.get_majorticklines	Return the major tick lines as a list of Line2D instances
YAxis.get_majorticklocs	Get the major tick locations in data coordinates as a numpy array
YAxis.get_minor_formatter	Get the formatter of the minor ticker
YAxis.get_minor_locator	Get the locator of the minor ticker
YAxis.get_minor_ticks	get the minor tick instances; grow as necessary
YAxis.get_minorticklabels	Return a list of Text instances for the minor ticklabels
YAxis.get_minorticklines	Return the minor tick lines as a list of Line2D instances
YAxis.get_minorticklocs	Get the minor tick locations in data coordinates as a numpy array
YAxis.get_minpos	
YAxis.get_offset_text	Return the axis offsetText as a Text instance
YAxis.get_pickradius	Return the depth of the axis used by the picker

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Table 17 – continued from previous page

YAxis.get_scale	
YAxis.get_smart_bounds	get whether the axis has smart bounds
YAxis.get_tick_padding	
YAxis.get_tick_space	Return the estimated number of ticks that can fit on the axis.
YAxis.get_ticklabel_extents	Get the extents of the tick labels on either side of the axes.
YAxis.get_ticklabels	Get the tick labels as a list of Text instances.
YAxis.get_ticklines	Return the tick lines as a list of Line2D instances
YAxis.get_ticklocs	Get the tick locations in data coordinates as a numpy array
YAxis.get_tightbbox	Return a bounding box that encloses the axis.
YAxis.get_units	return the units for axis
YAxis.get_view_interval	return the Interval instance for this axis view limits
YAxis.grid	Set the axis grid on or off; b is a boolean.
YAxis.iter_ticks	Iterate through all of the major and minor ticks.
YAxis.limit_range_for_scale	
YAxis.pan	Pan *numsteps* (can be positive or negative)
YAxis.reset_ticks	Re-initialize the major and minor Tick lists.
YAxis.set_data_interval	set the axis data limits
YAxis.set_default_intervals	set the default limits for the axis interval if they are not mutated
YAxis.set_label_coords	Set the coordinates of the label.
YAxis.set_label_position	Set the label position (left or right)
YAxis.set_label_text	Sets the text value of the axis label
YAxis.set_major_formatter	Set the formatter of the major ticker
YAxis.set_major_locator	Set the locator of the major ticker
YAxis.set_minor_formatter	Set the formatter of the minor ticker
YAxis.set_minor_locator	Set the locator of the minor ticker
YAxis.set_pickradius	Set the depth of the axis used by the picker
YAxis.set_smart_bounds	set the axis to have smart bounds
YAxis.set_tick_params	Set appearance parameters for ticks, ticklabels, and gridlines.
YAxis.set_ticklabels	Set the text values of the tick labels.
YAxis.set_ticks	Set the locations of the tick marks from sequence ticks
YAxis.set_units	set the units for axis
YAxis.set_view_interval	If *ignore* is *False*, the order of vmin, vmax does not matter; the original axis orientation will be preserved.
YAxis.update_units	introspect *data* for units converter and update the axis.converter instance if necessary.
YAxis.zoom	Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

matplotlib.axis.YAxis.OFFSETTEXTPAD

YAxis.**OFFSETTEXTPAD** = 3

matplotlib.axis.YAxis.axis_date

YAxis.**axis_date**(*tz=None*)
Sets up x-axis ticks and labels that treat the x data as dates. *tz* is a `tzinfo` instance or a timezone string. This timezone is used to create date labels.

matplotlib.axis.YAxis.cla

YAxis.**cla**()
clear the current axis

matplotlib.axis.YAxis.convert_units

YAxis.**convert_units**(*x*)

matplotlib.axis.YAxis.get_data_interval

YAxis.**get_data_interval**()
return the Interval instance for this axis data limits

matplotlib.axis.YAxis.get_gridlines

YAxis.**get_gridlines**()
Return the grid lines as a list of Line2D instance

matplotlib.axis.YAxis.get_label_position

YAxis.**get_label_position**()
Return the label position (top or bottom)

matplotlib.axis.YAxis.get_label_text

YAxis.**get_label_text**()
Get the text of the label

matplotlib.axis.YAxis.get_major_formatter

YAxis.**get_major_formatter**()
Get the formatter of the major ticker

matplotlib.axis.YAxis.get_major_locator

YAxis.**get_major_locator**()
Get the locator of the major ticker

matplotlib.axis.YAxis.get_major_ticks

YAxis.**get_major_ticks**(*numticks=None*)
get the tick instances; grow as necessary

matplotlib.axis.YAxis.get_majorticklabels

YAxis.**get_majorticklabels**()
Return a list of Text instances for the major ticklabels

matplotlib.axis.YAxis.get_majorticklines

YAxis.**get_majorticklines**()
Return the major tick lines as a list of Line2D instances

matplotlib.axis.YAxis.get_majorticklocs

YAxis.**get_majorticklocs**()
Get the major tick locations in data coordinates as a numpy array

matplotlib.axis.YAxis.get_minor_formatter

YAxis.**get_minor_formatter**()
Get the formatter of the minor ticker

matplotlib.axis.YAxis.get_minor_locator

YAxis.**get_minor_locator**()
Get the locator of the minor ticker

matplotlib.axis.YAxis.get_minor_ticks

YAxis.**get_minor_ticks**(*numticks=None*)
get the minor tick instances; grow as necessary

matplotlib.axis.YAxis.get_minorticklabels

YAxis.**get_minorticklabels**()
Return a list of Text instances for the minor ticklabels

matplotlib.axis.YAxis.get_minorticklines

YAxis.**get_minorticklines**()
Return the minor tick lines as a list of Line2D instances

matplotlib.axis.YAxis.get_minorticklocs

YAxis.**get_minorticklocs**()
Get the minor tick locations in data coordinates as a numpy array

matplotlib.axis.YAxis.get_minpos

YAxis.**get_minpos**()

matplotlib.axis.YAxis.get_offset_text

YAxis.**get_offset_text**()
Return the axis offsetText as a Text instance

matplotlib.axis.YAxis.get_pickradius

YAxis.**get_pickradius**()
Return the depth of the axis used by the picker

matplotlib.axis.YAxis.get_scale

YAxis.**get_scale**()

matplotlib.axis.YAxis.get_smart_bounds

YAxis.**get_smart_bounds**()
get whether the axis has smart bounds

matplotlib.axis.YAxis.get_tick_padding

YAxis.**get_tick_padding**()

matplotlib.axis.YAxis.get_tick_space

YAxis.**get_tick_space**()
Return the estimated number of ticks that can fit on the axis.

matplotlib.axis.YAxis.get_ticklabel_extents

YAxis.**get_ticklabel_extents**(*renderer*)
Get the extents of the tick labels on either side of the axes.

matplotlib.axis.YAxis.get_ticklabels

YAxis.**get_ticklabels**(*minor=False*, *which=None*)
Get the tick labels as a list of *Text* instances.

Parameters

minor [bool] If True return the minor ticklabels, else return the major ticklabels

which [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

Returns

ret [list] List of *Text* instances.

matplotlib.axis.YAxis.get_ticklines

YAxis.**get_ticklines**(*minor=False*)
Return the tick lines as a list of Line2D instances

matplotlib.axis.YAxis.get_ticklocs

YAxis.**get_ticklocs**(*minor=False*)
Get the tick locations in data coordinates as a numpy array

matplotlib.axis.YAxis.get_tightbbox

YAxis.**get_tightbbox**(*renderer*)
Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and offsetText.

matplotlib.axis.YAxis.get_units

YAxis.**get_units**()
return the units for axis

matplotlib.axis.YAxis.get_view_interval

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

matplotlib.axis.YAxis.grid

YAxis.**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, e.g.,

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

matplotlib.axis.YAxis.iter_ticks

YAxis.**iter_ticks**()
Iterate through all of the major and minor ticks.

matplotlib.axis.YAxis.limit_range_for_scale

YAxis.**limit_range_for_scale**(*vmin*, *vmax*)

matplotlib.axis.YAxis.pan

YAxis.**pan**(*numsteps*)
Pan *numsteps* (can be positive or negative)

matplotlib.axis.YAxis.reset_ticks

YAxis.**reset_ticks**()
Re-initialize the major and minor Tick lists.

Each list starts with a single fresh Tick.

matplotlib.axis.YAxis.set_data_interval

YAxis.**set_data_interval**(*vmin*, *vmax*, *ignore=False*)
set the axis data limits

matplotlib.axis.YAxis.set_default_intervals

YAxis.**set_default_intervals**()
set the default limits for the axis interval if they are not mutated

matplotlib.axis.YAxis.set_label_coords

YAxis.**set_label_coords**(*x*, *y*, *transform=None*)
Set the coordinates of the label. By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

matplotlib.axis.YAxis.set_label_position

YAxis.**set_label_position**(*position*)
Set the label position (left or right)

ACCEPTS: ['left' | 'right']

matplotlib.axis.YAxis.set_label_text

YAxis.**set_label_text**(*label*, *fontdict=None*, ***kwargs*)
Sets the text value of the axis label

ACCEPTS: A string value for the label

matplotlib.axis.YAxis.set_major_formatter

YAxis.**set_major_formatter**(*formatter*)
Set the formatter of the major ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.YAxis.set_major_locator

YAxis.**set_major_locator**(*locator*)
Set the locator of the major ticker

ACCEPTS: a *Locator* instance

matplotlib.axis.YAxis.set_minor_formatter

YAxis.**set_minor_formatter**(*formatter*)
Set the formatter of the minor ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.YAxis.set_minor_locator

YAxis.**set_minor_locator**(*locator*)
Set the locator of the minor ticker

ACCEPTS: a *Locator* instance

matplotlib.axis.YAxis.set_pickradius

YAxis.**set_pickradius**(*pickradius*)
Set the depth of the axis used by the picker

ACCEPTS: a distance in points

matplotlib.axis.YAxis.set_smart_bounds

YAxis.**set_smart_bounds**(*value*)
set the axis to have smart bounds

matplotlib.axis.YAxis.set_tick_params

YAxis.**set_tick_params**(*which='major'*, *reset=False*, ***kw*)
Set appearance parameters for ticks, ticklabels, and gridlines.

For documentation of keyword arguments, see *matplotlib.axes.Axes.tick_params()*.

matplotlib.axis.YAxis.set_ticklabels

YAxis.**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 or Text objects

matplotlib.axis.YAxis.set_ticks

YAxis.**set_ticks**(*ticks*, *minor=False*)

Set the locations of the tick marks from sequence ticks

ACCEPTS: sequence of floats

matplotlib.axis.YAxis.set_units

YAxis.**set_units**(*u*)

set the units for axis

ACCEPTS: a units tag

matplotlib.axis.YAxis.set_view_interval

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

If *ignore* is *False*, the order of vmin, vmax does not matter; the original axis orientation will be preserved. In addition, the view limits can be expanded, but will not be reduced. This method is for mpl internal use; for normal use, see *set_ylim()*.

matplotlib.axis.YAxis.update_units

YAxis.**update_units**(*data*)

introspect *data* for units converter and update the axis.converter instance if necessary. Return *True* if *data* is registered for unit conversion.

matplotlib.axis.YAxis.zoom

YAxis.**zoom**(*direction*)

Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

36.4.4 XAxis

XAxis.OFFSETTEXTPAD

Continued on next page

Table 18 – continued from previous page

XAxis.axis_date	Sets up x-axis ticks and labels that treat the x data as dates.
XAxis.cla	clear the current axis
XAxis.convert_units	
XAxis.get_data_interval	return the Interval instance for this axis data limits
XAxis.get_gridlines	Return the grid lines as a list of Line2D instance
XAxis.get_label_position	Return the label position (top or bottom)
XAxis.get_label_text	Get the text of the label
XAxis.get_major_formatter	Get the formatter of the major ticker
XAxis.get_major_locator	Get the locator of the major ticker
XAxis.get_major_ticks	get the tick instances; grow as necessary
XAxis.get_majorticklabels	Return a list of Text instances for the major ticklabels
XAxis.get_majorticklines	Return the major tick lines as a list of Line2D instances
XAxis.get_majorticklocs	Get the major tick locations in data coordinates as a numpy array
XAxis.get_minor_formatter	Get the formatter of the minor ticker
XAxis.get_minor_locator	Get the locator of the minor ticker
XAxis.get_minor_ticks	get the minor tick instances; grow as necessary
XAxis.get_minorticklabels	Return a list of Text instances for the minor ticklabels
XAxis.get_minorticklines	Return the minor tick lines as a list of Line2D instances
XAxis.get_minorticklocs	Get the minor tick locations in data coordinates as a numpy array
XAxis.get_minpos	
XAxis.get_offset_text	Return the axis offsetText as a Text instance
XAxis.get_pickradius	Return the depth of the axis used by the picker
XAxis.get_scale	
XAxis.get_smart_bounds	get whether the axis has smart bounds
XAxis.get_tick_padding	
XAxis.get_tick_space	Return the estimated number of ticks that can fit on the axis.
XAxis.get_ticklabel_extents	Get the extents of the tick labels on either side of the axes.
XAxis.get_ticklabels	Get the tick labels as a list of *Text* instances.
XAxis.get_ticklines	Return the tick lines as a list of Line2D instances
XAxis.get_ticklocs	Get the tick locations in data coordinates as a numpy array
XAxis.get_tightbbox	Return a bounding box that encloses the axis.
XAxis.get_units	return the units for axis
XAxis.get_view_interval	return the Interval instance for this axis view limits
XAxis.grid	Set the axis grid on or off; b is a boolean.
XAxis.iter_ticks	Iterate through all of the major and minor ticks.

Continued on next page

Table 18 – continued from previous page

XAxis.limit_range_for_scale	
XAxis.pan	Pan *numsteps* (can be positive or negative)
XAxis.reset_ticks	Re-initialize the major and minor Tick lists.
XAxis.set_data_interval	set the axis data limits
XAxis.set_default_intervals	set the default limits for the axis interval if they are not mutated
XAxis.set_label_coords	Set the coordinates of the label.
XAxis.set_label_position	Set the label position (top or bottom)
XAxis.set_label_text	Sets the text value of the axis label
XAxis.set_major_formatter	Set the formatter of the major ticker
XAxis.set_major_locator	Set the locator of the major ticker
XAxis.set_minor_formatter	Set the formatter of the minor ticker
XAxis.set_minor_locator	Set the locator of the minor ticker
XAxis.set_pickradius	Set the depth of the axis used by the picker
XAxis.set_smart_bounds	set the axis to have smart bounds
XAxis.set_tick_params	Set appearance parameters for ticks, ticklabels, and gridlines.
XAxis.set_ticklabels	Set the text values of the tick labels.
XAxis.set_ticks	Set the locations of the tick marks from sequence ticks
XAxis.set_units	set the units for axis
XAxis.set_view_interval	If *ignore* is *False*, the order of vmin, vmax does not matter; the original axis orientation will be preserved.
XAxis.update_units	introspect *data* for units converter and update the axis.converter instance if necessary.
XAxis.zoom	Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

matplotlib.axis.XAxis.OFFSETTEXTPAD

XAxis.**OFFSETTEXTPAD** = 3

matplotlib.axis.XAxis.axis_date

XAxis.**axis_date**(*tz=None*)

Sets up x-axis ticks and labels that treat the x data as dates. *tz* is a `tzinfo` instance or a timezone string. This timezone is used to create date labels.

matplotlib.axis.XAxis.cla

XAxis.**cla**()

clear the current axis

matplotlib.axis.XAxis.convert_units

XAxis.**convert_units**(*x*)

matplotlib.axis.XAxis.get_data_interval

XAxis.**get_data_interval**()
return the Interval instance for this axis data limits

matplotlib.axis.XAxis.get_gridlines

XAxis.**get_gridlines**()
Return the grid lines as a list of Line2D instance

matplotlib.axis.XAxis.get_label_position

XAxis.**get_label_position**()
Return the label position (top or bottom)

matplotlib.axis.XAxis.get_label_text

XAxis.**get_label_text**()
Get the text of the label

matplotlib.axis.XAxis.get_major_formatter

XAxis.**get_major_formatter**()
Get the formatter of the major ticker

matplotlib.axis.XAxis.get_major_locator

XAxis.**get_major_locator**()
Get the locator of the major ticker

matplotlib.axis.XAxis.get_major_ticks

XAxis.**get_major_ticks**(*numticks=None*)
get the tick instances; grow as necessary

matplotlib.axis.XAxis.get_majorticklabels

XAxis.**get_majorticklabels**()
Return a list of Text instances for the major ticklabels

matplotlib.axis.XAxis.get_majorticklines

XAxis.**get_majorticklines**()
Return the major tick lines as a list of Line2D instances

matplotlib.axis.XAxis.get_majorticklocs

XAxis.**get_majorticklocs**()
Get the major tick locations in data coordinates as a numpy array

matplotlib.axis.XAxis.get_minor_formatter

XAxis.**get_minor_formatter**()
Get the formatter of the minor ticker

matplotlib.axis.XAxis.get_minor_locator

XAxis.**get_minor_locator**()
Get the locator of the minor ticker

matplotlib.axis.XAxis.get_minor_ticks

XAxis.**get_minor_ticks**(*numticks=None*)
get the minor tick instances; grow as necessary

matplotlib.axis.XAxis.get_minorticklabels

XAxis.**get_minorticklabels**()
Return a list of Text instances for the minor ticklabels

matplotlib.axis.XAxis.get_minorticklines

XAxis.**get_minorticklines**()
Return the minor tick lines as a list of Line2D instances

matplotlib.axis.XAxis.get_minorticklocs

XAxis.**get_minorticklocs**()
Get the minor tick locations in data coordinates as a numpy array

matplotlib.axis.XAxis.get_minpos

XAxis.**get_minpos**()

matplotlib.axis.XAxis.get_offset_text

XAxis.**get_offset_text**()
Return the axis offsetText as a Text instance

matplotlib.axis.XAxis.get_pickradius

XAxis.**get_pickradius**()
Return the depth of the axis used by the picker

matplotlib.axis.XAxis.get_scale

XAxis.**get_scale**()

matplotlib.axis.XAxis.get_smart_bounds

XAxis.**get_smart_bounds**()
get whether the axis has smart bounds

matplotlib.axis.XAxis.get_tick_padding

XAxis.**get_tick_padding**()

matplotlib.axis.XAxis.get_tick_space

XAxis.**get_tick_space**()
Return the estimated number of ticks that can fit on the axis.

matplotlib.axis.XAxis.get_ticklabel_extents

XAxis.**get_ticklabel_extents**(*renderer*)
Get the extents of the tick labels on either side of the axes.

matplotlib.axis.XAxis.get_ticklabels

XAxis.**get_ticklabels**(*minor=False*, *which=None*)
Get the tick labels as a list of *Text* instances.

Parameters

minor [bool] If True return the minor ticklabels, else return the major ticklabels

which [None, ('minor', 'major', 'both')] Overrides `minor`.

Selects which ticklabels to return

Returns

ret [list] List of *Text* instances.

matplotlib.axis.XAxis.get_ticklines

XAxis.**get_ticklines**(*minor=False*)
Return the tick lines as a list of Line2D instances

matplotlib.axis.XAxis.get_ticklocs

XAxis.**get_ticklocs**(*minor=False*)
Get the tick locations in data coordinates as a numpy array

matplotlib.axis.XAxis.get_tightbbox

XAxis.**get_tightbbox**(*renderer*)
Return a bounding box that encloses the axis. It only accounts tick labels, axis label, and offsetText.

matplotlib.axis.XAxis.get_units

XAxis.**get_units**()
return the units for axis

matplotlib.axis.XAxis.get_view_interval

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

matplotlib.axis.XAxis.grid

XAxis.**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, e.g.,

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

matplotlib.axis.XAxis.iter_ticks

XAxis.**iter_ticks**()

Iterate through all of the major and minor ticks.

matplotlib.axis.XAxis.limit_range_for_scale

XAxis.**limit_range_for_scale**(*vmin*, *vmax*)

matplotlib.axis.XAxis.pan

XAxis.**pan**(*numsteps*)

Pan *numsteps* (can be positive or negative)

matplotlib.axis.XAxis.reset_ticks

XAxis.**reset_ticks**()

Re-initialize the major and minor Tick lists.

Each list starts with a single fresh Tick.

matplotlib.axis.XAxis.set_data_interval

XAxis.**set_data_interval**(*vmin*, *vmax*, *ignore=False*)

set the axis data limits

matplotlib.axis.XAxis.set_default_intervals

XAxis.**set_default_intervals**()

set the default limits for the axis interval if they are not mutated

matplotlib.axis.XAxis.set_label_coords

XAxis.**set_label_coords**(*x*, *y*, *transform=None*)

Set the coordinates of the label. By default, the x coordinate of the y label is determined by the tick label bounding boxes, but this can lead to poor alignment of multiple ylabels if there are multiple axes. Ditto for the y coordinate of the x label.

You can also specify the coordinate system of the label with the transform. If None, the default coordinate system will be the axes coordinate system (0,0) is (left,bottom), (0.5, 0.5) is middle, etc

matplotlib.axis.XAxis.set_label_position

XAxis.**set_label_position**(*position*)

Set the label position (top or bottom)

ACCEPTS: ['top' | 'bottom']

matplotlib.axis.XAxis.set_label_text

XAxis.**set_label_text**(*label*, *fontdict=None*, ***kwargs*)

Sets the text value of the axis label

ACCEPTS: A string value for the label

matplotlib.axis.XAxis.set_major_formatter

XAxis.**set_major_formatter**(*formatter*)

Set the formatter of the major ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.XAxis.set_major_locator

XAxis.**set_major_locator**(*locator*)

Set the locator of the major ticker

ACCEPTS: a *Locator* instance

matplotlib.axis.XAxis.set_minor_formatter

XAxis.**set_minor_formatter**(*formatter*)

Set the formatter of the minor ticker

ACCEPTS: A *Formatter* instance

matplotlib.axis.XAxis.set_minor_locator

XAxis.**set_minor_locator**(*locator*)
Set the locator of the minor ticker

ACCEPTS: a *Locator* instance

matplotlib.axis.XAxis.set_pickradius

XAxis.**set_pickradius**(*pickradius*)
Set the depth of the axis used by the picker

ACCEPTS: a distance in points

matplotlib.axis.XAxis.set_smart_bounds

XAxis.**set_smart_bounds**(*value*)
set the axis to have smart bounds

matplotlib.axis.XAxis.set_tick_params

XAxis.**set_tick_params**(*which='major'*, *reset=False*, ***kw*)
Set appearance parameters for ticks, ticklabels, and gridlines.

For documentation of keyword arguments, see *matplotlib.axes.Axes.tick_params()*.

matplotlib.axis.XAxis.set_ticklabels

XAxis.**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 or Text objects

matplotlib.axis.XAxis.set_ticks

XAxis.**set_ticks**(*ticks*, *minor=False*)
Set the locations of the tick marks from sequence ticks

ACCEPTS: sequence of floats

matplotlib.axis.XAxis.set_units

XAxis.**set_units**(*u*)
set the units for axis

ACCEPTS: a units tag

matplotlib.axis.XAxis.set_view_interval

XAxis.**set_view_interval**(*vmin*, *vmax*, *ignore=False*)
If *ignore* is *False*, the order of vmin, vmax does not matter; the original axis orientation will be preserved. In addition, the view limits can be expanded, but will not be reduced. This method is for mpl internal use; for normal use, see *set_xlim()*.

matplotlib.axis.XAxis.update_units

XAxis.**update_units**(*data*)
introspect *data* for units converter and update the axis.converter instance if necessary. Return *True* if *data* is registered for unit conversion.

matplotlib.axis.XAxis.zoom

XAxis.**zoom**(*direction*)
Zoom in/out on axis; if *direction* is >0 zoom in, else zoom out

36.4.5 Inherited from artist

Ticks

Tick.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
Tick.aname	
Tick.axes	The *Axes* instance the artist resides in, or *None*.
Tick.contains	Test whether the mouse event occurred in the Tick marks.
Tick.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
Tick.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
Tick.draw	Derived classes drawing method
Tick.findobj	Find artist objects.
Tick.format_cursor_data	Return *cursor data* string formatted.
Tick.get_agg_filter	Return filter function to be used for agg filter.

Continued on next page

Table 19 – continued from previous page

Tick.get_alpha	Return the alpha value used for blending - not supported on all backends
Tick.get_animated	Return the artist's animated state
Tick.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
Tick.get_clip_box	Return artist clipbox
Tick.get_clip_on	Return whether artist uses clipping
Tick.get_clip_path	Return artist clip path
Tick.get_contains	Return the _contains test used by the artist, or *None* for default.
Tick.get_cursor_data	Get the cursor data for a given event.
Tick.get_figure	Return the *Figure* instance the artist belongs to.
Tick.get_gid	Returns the group id.
Tick.get_label	Get the label used for this artist in the legend.
Tick.get_path_effects	
Tick.get_picker	Return the picker object used by this artist.
Tick.get_rasterized	Return whether the artist is to be rasterized.
Tick.get_sketch_params	Returns the sketch parameters for the artist.
Tick.get_snap	Returns the snap setting which may be:
Tick.get_transform	Return the *Transform* instance used by this artist.
Tick.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.
Tick.get_url	Returns the url.
Tick.get_visible	Return the artist's visiblity
Tick.get_window_extent	Get the axes bounding box in display space.
Tick.get_zorder	Return the artist's zorder.
Tick.have_units	Return *True* if units are set on the *x* or *y* axes
Tick.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
Tick.mouseover	
Tick.pchanged	Fire an event when property changed, calling all of the registered callbacks.
Tick.pick	Process pick event
Tick.pickable	Return *True* if `Artist` is pickable.
Tick.properties	return a dictionary mapping property name -> value for all Artist props
Tick.remove	Remove the artist from the figure if possible.
Tick.remove_callback	Remove a callback based on its *id*.
Tick.set	A property batch setter.
Tick.set_agg_filter	Set the agg filter.
Tick.set_alpha	Set the alpha value used for blending - not supported on all backends.
Tick.set_animated	Set the artist's animation state.
Tick.set_clip_box	Set the artist's clip *Bbox*.

Continued on next page

Table 19 – continued from previous page

Tick.set_clip_on	Set whether artist uses clipping.
Tick.set_clip_path	Set the artist's clip path, which may be:
Tick.set_contains	Replace the contains test used by this artist.
Tick.set_figure	Set the *Figure* instance the artist belongs to.
Tick.set_gid	Sets the (group) id for the artist.
Tick.set_label	Set the text of ticklabel
Tick.set_path_effects	Set the path effects.
Tick.set_picker	Set the epsilon for picking used by this artist
Tick.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
Tick.set_sketch_params	Sets the sketch parameters.
Tick.set_snap	Sets the snap setting which may be:
Tick.set_transform	Set the artist transform.
Tick.set_url	Sets the url for the artist.
Tick.set_visible	Set the artist's visibility.
Tick.set_zorder	Set the zorder for the artist.
Tick.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
Tick.update	Update this artist's properties from the dictionary *prop*.
Tick.update_from	Copy properties from *other* to *self*.
Tick.zorder	
XTick.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
XTick.aname	
XTick.axes	The *Axes* instance the artist resides in, or *None*.
XTick.contains	Test whether the mouse event occurred in the Tick marks.
XTick.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
XTick.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
XTick.draw	Derived classes drawing method
XTick.findobj	Find artist objects.
XTick.format_cursor_data	Return *cursor data* string formatted.
XTick.get_agg_filter	Return filter function to be used for agg filter.
XTick.get_alpha	Return the alpha value used for blending - not supported on all backends
XTick.get_animated	Return the artist's animated state
XTick.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
XTick.get_clip_box	Return artist clipbox
XTick.get_clip_on	Return whether artist uses clipping
XTick.get_clip_path	Return artist clip path

Continued on next page

Table 19 – continued from previous page

XTick.get_contains	Return the _contains test used by the artist, or *None* for default.
XTick.get_cursor_data	Get the cursor data for a given event.
XTick.get_figure	Return the *Figure* instance the artist belongs to.
XTick.get_gid	Returns the group id.
XTick.get_label	Get the label used for this artist in the legend.
XTick.get_path_effects	
XTick.get_picker	Return the picker object used by this artist.
XTick.get_rasterized	Return whether the artist is to be rasterized.
XTick.get_sketch_params	Returns the sketch parameters for the artist.
XTick.get_snap	Returns the snap setting which may be:
XTick.get_transform	Return the *Transform* instance used by this artist.
XTick.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.
XTick.get_url	Returns the url.
XTick.get_visible	Return the artist's visiblity
XTick.get_window_extent	Get the axes bounding box in display space.
XTick.get_zorder	Return the artist's zorder.
XTick.have_units	Return *True* if units are set on the *x* or *y* axes
XTick.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
XTick.mouseover	
XTick.pchanged	Fire an event when property changed, calling all of the registered callbacks.
XTick.pick	Process pick event
XTick.pickable	Return *True* if `Artist` is pickable.
XTick.properties	return a dictionary mapping property name -> value for all Artist props
XTick.remove	Remove the artist from the figure if possible.
XTick.remove_callback	Remove a callback based on its *id*.
XTick.set	A property batch setter.
XTick.set_agg_filter	Set the agg filter.
XTick.set_alpha	Set the alpha value used for blending - not supported on all backends.
XTick.set_animated	Set the artist's animation state.
XTick.set_clip_box	Set the artist's clip *Bbox*.
XTick.set_clip_on	Set whether artist uses clipping.
XTick.set_clip_path	Set the artist's clip path, which may be:
XTick.set_contains	Replace the contains test used by this artist.
XTick.set_figure	Set the *Figure* instance the artist belongs to.
XTick.set_gid	Sets the (group) id for the artist.
XTick.set_label	Set the text of ticklabel
XTick.set_path_effects	Set the path effects.

Continued on next page

Table 19 – continued from previous page

XTick.set_picker	Set the epsilon for picking used by this artist
XTick.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
XTick.set_sketch_params	Sets the sketch parameters.
XTick.set_snap	Sets the snap setting which may be:
XTick.set_transform	Set the artist transform.
XTick.set_url	Sets the url for the artist.
XTick.set_visible	Set the artist's visibility.
XTick.set_zorder	Set the zorder for the artist.
XTick.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
XTick.update	Update this artist's properties from the dictionary *prop*.
XTick.update_from	Copy properties from *other* to *self*.
XTick.zorder	
YTick.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
YTick.aname	
YTick.axes	The *Axes* instance the artist resides in, or *None*.
YTick.contains	Test whether the mouse event occurred in the Tick marks.
YTick.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
YTick.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
YTick.draw	Derived classes drawing method
YTick.findobj	Find artist objects.
YTick.format_cursor_data	Return *cursor data* string formatted.
YTick.get_agg_filter	Return filter function to be used for agg filter.
YTick.get_alpha	Return the alpha value used for blending - not supported on all backends
YTick.get_animated	Return the artist's animated state
YTick.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
YTick.get_clip_box	Return artist clipbox
YTick.get_clip_on	Return whether artist uses clipping
YTick.get_clip_path	Return artist clip path
YTick.get_contains	Return the _contains test used by the artist, or *None* for default.
YTick.get_cursor_data	Get the cursor data for a given event.
YTick.get_figure	Return the *Figure* instance the artist belongs to.
YTick.get_gid	Returns the group id.
YTick.get_label	Get the label used for this artist in the legend.
YTick.get_path_effects	
YTick.get_picker	Return the picker object used by this artist.

Continued on next page

Table 19 – continued from previous page

YTick.get_rasterized	Return whether the artist is to be rasterized.
YTick.get_sketch_params	Returns the sketch parameters for the artist.
YTick.get_snap	Returns the snap setting which may be:
YTick.get_transform	Return the Transform instance used by this artist.
YTick.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.
YTick.get_url	Returns the url.
YTick.get_visible	Return the artist's visiblity
YTick.get_window_extent	Get the axes bounding box in display space.
YTick.get_zorder	Return the artist's zorder.
YTick.have_units	Return *True* if units are set on the *x* or *y* axes
YTick.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
YTick.mouseover	
YTick.pchanged	Fire an event when property changed, calling all of the registered callbacks.
YTick.pick	Process pick event
YTick.pickable	Return *True* if `Artist` is pickable.
YTick.properties	return a dictionary mapping property name -> value for all Artist props
YTick.remove	Remove the artist from the figure if possible.
YTick.remove_callback	Remove a callback based on its *id*.
YTick.set	A property batch setter.
YTick.set_agg_filter	Set the agg filter.
YTick.set_alpha	Set the alpha value used for blending - not supported on all backends.
YTick.set_animated	Set the artist's animation state.
YTick.set_clip_box	Set the artist's clip Bbox.
YTick.set_clip_on	Set whether artist uses clipping.
YTick.set_clip_path	Set the artist's clip path, which may be:
YTick.set_contains	Replace the contains test used by this artist.
YTick.set_figure	Set the Figure instance the artist belongs to.
YTick.set_gid	Sets the (group) id for the artist.
YTick.set_label	Set the text of ticklabel
YTick.set_path_effects	Set the path effects.
YTick.set_picker	Set the epsilon for picking used by this artist
YTick.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
YTick.set_sketch_params	Sets the sketch parameters.
YTick.set_snap	Sets the snap setting which may be:
YTick.set_transform	Set the artist transform.
YTick.set_url	Sets the url for the artist.
YTick.set_visible	Set the artist's visibility.

Continued on next page

Table 19 – continued from previous page

YTick.set_zorder	Set the zorder for the artist.
YTick.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
YTick.update	Update this artist's properties from the dictionary *prop*.
YTick.update_from	Copy properties from *other* to *self*.
YTick.zorder	

matplotlib.axis.Tick.add_callback

Tick.**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.

matplotlib.axis.Tick.aname

Tick.**aname** = **'Artist'**

matplotlib.axis.Tick.axes

Tick.**axes**

The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.Tick.contains

Tick.**contains**(*mouseevent*)

Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

matplotlib.axis.Tick.convert_xunits

Tick.**convert_xunits**(*x*)

For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.Tick.convert_yunits

Tick.**convert_yunits**(*y*)

For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.Tick.draw

Tick.**draw**(*renderer*)
Derived classes drawing method

matplotlib.axis.Tick.findobj

Tick.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.Tick.format_cursor_data

Tick.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.Tick.get_agg_filter

Tick.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.Tick.get_alpha

Tick.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.Tick.get_animated

Tick.**get_animated**()
Return the artist's animated state

matplotlib.axis.Tick.get_children

Tick.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.Tick.get_clip_box

Tick.**get_clip_box**()
Return artist clipbox

matplotlib.axis.Tick.get_clip_on

Tick.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.Tick.get_clip_path

Tick.**get_clip_path**()
Return artist clip path

matplotlib.axis.Tick.get_contains

Tick.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.Tick.get_cursor_data

Tick.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.Tick.get_figure

Tick.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.Tick.get_gid

Tick.**get_gid**()
Returns the group id.

matplotlib.axis.Tick.get_label

Tick.**get_label**()
Get the label used for this artist in the legend.

matplotlib.axis.Tick.get_path_effects

Tick.**get_path_effects**()

matplotlib.axis.Tick.get_picker

Tick.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.Tick.get_rasterized

Tick.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.Tick.get_sketch_params

Tick.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.Tick.get_snap

Tick.**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.

matplotlib.axis.Tick.get_transform

Tick.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.Tick.get_transformed_clip_path_and_affine

Tick.**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.

matplotlib.axis.Tick.get_url

Tick.**get_url**()
Returns the url.

matplotlib.axis.Tick.get_visible

Tick.**get_visible**()
Return the artist's visiblity

matplotlib.axis.Tick.get_window_extent

Tick.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.Tick.get_zorder

Tick.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.Tick.have_units

Tick.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.Tick.is_transform_set

Tick.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.Tick.mouseover

Tick.**mouseover**

matplotlib.axis.Tick.pchanged

Tick.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.Tick.pick

Tick.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.Tick.pickable

Tick.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.Tick.properties

Tick.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.Tick.remove

Tick.**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.

matplotlib.axis.Tick.remove_callback

Tick.**remove_callback**(*oid*)

Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.Tick.set

Tick.**set**(***kwargs*)

A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.Tick.set_agg_filter

Tick.**set_agg_filter**(*filter_func*)

Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.Tick.set_alpha

Tick.**set_alpha**(*alpha*)

Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.Tick.set_animated

Tick.**set_animated**(*b*)

Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.Tick.set_clip_box

Tick.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.Tick.set_clip_on

Tick.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.Tick.set_clip_path

Tick.**set_clip_path**(*clippath*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.Tick.set_contains

Tick.**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.

Parameters

picker [callable]

matplotlib.axis.Tick.set_figure

Tick.**set_figure**(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.Tick.set_gid

Tick.**set_gid**(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.Tick.set_label

Tick.**set_label**(*s*)
Set the text of ticklabel

ACCEPTS: str

matplotlib.axis.Tick.set_path_effects

Tick.**set_path_effects**(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.Tick.set_picker

Tick.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.Tick.set_rasterized

`Tick.set_rasterized(`*rasterized*`)`

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.Tick.set_sketch_params

`Tick.set_sketch_params(`*scale=None*, *length=None*, *randomness=None*`)`

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.Tick.set_snap

`Tick.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.

Parameters

snap [bool or None]

matplotlib.axis.Tick.set_transform

Tick.**set_transform**(*t*)
Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.Tick.set_url

Tick.**set_url**(*url*)
Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.Tick.set_visible

Tick.**set_visible**(*b*)
Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.Tick.set_zorder

Tick.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.Tick.stale

Tick.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.Tick.update

Tick.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.Tick.update_from

Tick.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.Tick.zorder

Tick.**zorder** = **0**

matplotlib.axis.XTick.add_callback

XTick.**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.

matplotlib.axis.XTick.aname

XTick.**aname** = **'Artist'**

matplotlib.axis.XTick.axes

XTick.**axes**
The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.XTick.contains

XTick.**contains**(*mouseevent*)
Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

matplotlib.axis.XTick.convert_xunits

XTick.**convert_xunits**(*x*)
For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.XTick.convert_yunits

XTick.**convert_yunits**(*y*)
For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.XTick.draw

XTick.**draw**(*renderer*)
Derived classes drawing method

matplotlib.axis.XTick.findobj

XTick.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.XTick.format_cursor_data

XTick.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.XTick.get_agg_filter

XTick.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.XTick.get_alpha

XTick.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.XTick.get_animated

XTick.**get_animated**()
Return the artist's animated state

matplotlib.axis.XTick.get_children

XTick.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.XTick.get_clip_box

XTick.**get_clip_box**()
Return artist clipbox

matplotlib.axis.XTick.get_clip_on

XTick.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.XTick.get_clip_path

XTick.**get_clip_path**()
Return artist clip path

matplotlib.axis.XTick.get_contains

XTick.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.XTick.get_cursor_data

XTick.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.XTick.get_figure

XTick.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.XTick.get_gid

XTick.**get_gid**()
Returns the group id.

matplotlib.axis.XTick.get_label

XTick.**get_label**()
Get the label used for this artist in the legend.

matplotlib.axis.XTick.get_path_effects

XTick.**get_path_effects**()

matplotlib.axis.XTick.get_picker

XTick.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.XTick.get_rasterized

XTick.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.XTick.get_sketch_params

XTick.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.

- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.XTick.get_snap

XTick.**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.

matplotlib.axis.XTick.get_transform

XTick.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.XTick.get_transformed_clip_path_and_affine

XTick.**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.

matplotlib.axis.XTick.get_url

XTick.**get_url**()
Returns the url.

matplotlib.axis.XTick.get_visible

XTick.**get_visible**()
Return the artist's visiblity

matplotlib.axis.XTick.get_window_extent

XTick.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.XTick.get_zorder

XTick.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.XTick.have_units

XTick.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.XTick.is_transform_set

XTick.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.XTick.mouseover

XTick.**mouseover**

matplotlib.axis.XTick.pchanged

XTick.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.XTick.pick

XTick.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.XTick.pickable

XTick.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.XTick.properties

XTick.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.XTick.remove

XTick.**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.

matplotlib.axis.XTick.remove_callback

XTick.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.XTick.set

XTick.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.XTick.set_agg_filter

XTick.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.XTick.set_alpha

XTick.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.XTick.set_animated

XTick.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.XTick.set_clip_box

XTick.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.XTick.set_clip_on

XTick.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.XTick.set_clip_path

XTick.**set_clip_path**(*clippath*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.XTick.set_contains

XTick.**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.

Parameters

picker [callable]

matplotlib.axis.XTick.set_figure

XTick.**set_figure**(*fig*)

Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.XTick.set_gid

XTick.**set_gid**(*gid*)

Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.XTick.set_label

XTick.**set_label**(*s*)

Set the text of ticklabel

ACCEPTS: str

matplotlib.axis.XTick.set_path_effects

XTick.**set_path_effects**(*path_effects*)

Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.XTick.set_picker

XTick.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.XTick.set_rasterized

XTick.**set_rasterized**(*rasterized*)

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.XTick.set_sketch_params

XTick.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.XTick.set_snap

XTick.**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.

Parameters

snap [bool or None]

matplotlib.axis.XTick.set_transform

XTick.**set_transform**(*t*)

Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.XTick.set_url

XTick.**set_url**(*url*)

Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.XTick.set_visible

XTick.**set_visible**(*b*)

Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.XTick.set_zorder

XTick.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.XTick.stale

XTick.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.XTick.update

XTick.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.XTick.update_from

XTick.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.XTick.zorder

XTick.**zorder** = **0**

matplotlib.axis.YTick.add_callback

YTick.**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.

matplotlib.axis.YTick.aname

YTick.**aname** = **'Artist'**

matplotlib.axis.YTick.axes

YTick.**axes**
The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.YTick.contains

YTick.**contains**(*mouseevent*)
Test whether the mouse event occurred in the Tick marks.

This function always returns false. It is more useful to test if the axis as a whole contains the mouse rather than the set of tick marks.

matplotlib.axis.YTick.convert_xunits

YTick.**convert_xunits**(*x*)
For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.YTick.convert_yunits

YTick.**convert_yunits**(*y*)
For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.YTick.draw

YTick.**draw**(*renderer*)
Derived classes drawing method

matplotlib.axis.YTick.findobj

YTick.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.YTick.format_cursor_data

YTick.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.YTick.get_agg_filter

YTick.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.YTick.get_alpha

YTick.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.YTick.get_animated

YTick.**get_animated**()
Return the artist's animated state

matplotlib.axis.YTick.get_children

YTick.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.YTick.get_clip_box

YTick.**get_clip_box**()
Return artist clipbox

matplotlib.axis.YTick.get_clip_on

YTick.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.YTick.get_clip_path

YTick.**get_clip_path**()
Return artist clip path

matplotlib.axis.YTick.get_contains

YTick.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.YTick.get_cursor_data

YTick.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.YTick.get_figure

YTick.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.YTick.get_gid

YTick.**get_gid**()
Returns the group id.

matplotlib.axis.YTick.get_label

YTick.**get_label**()
Get the label used for this artist in the legend.

matplotlib.axis.YTick.get_path_effects

YTick.**get_path_effects**()

matplotlib.axis.YTick.get_picker

YTick.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.YTick.get_rasterized

YTick.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.YTick.get_sketch_params

YTick.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or None]

A 3-tuple with the following elements:

- scale: The amplitude of the wiggle perpendicular to the source line.
- length: The length of the wiggle along the line.
- randomness: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.YTick.get_snap

YTick.**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.

matplotlib.axis.YTick.get_transform

YTick.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.YTick.get_transformed_clip_path_and_affine

YTick.**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.

matplotlib.axis.YTick.get_url

YTick.**get_url**()
Returns the url.

matplotlib.axis.YTick.get_visible

YTick.**get_visible**()
Return the artist's visiblity

matplotlib.axis.YTick.get_window_extent

YTick.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.YTick.get_zorder

YTick.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.YTick.have_units

YTick.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.YTick.is_transform_set

YTick.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.YTick.mouseover

YTick.**mouseover**

matplotlib.axis.YTick.pchanged

YTick.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.YTick.pick

YTick.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.YTick.pickable

YTick.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.YTick.properties

YTick.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.YTick.remove

YTick.**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.

matplotlib.axis.YTick.remove_callback

YTick.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.YTick.set

YTick.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.YTick.set_agg_filter

YTick.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.YTick.set_alpha

YTick.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.YTick.set_animated

YTick.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.YTick.set_clip_box

YTick.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.YTick.set_clip_on

YTick.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.YTick.set_clip_path

YTick.**set_clip_path**(*clippath*, *transform=None*)

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.YTick.set_contains

YTick.**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.

Parameters

picker [callable]

matplotlib.axis.YTick.set_figure

YTick.**set_figure**(*fig*)

Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.YTick.set_gid

YTick.**set_gid**(*gid*)

Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.YTick.set_label

YTick.**set_label**(*s*)
Set the text of ticklabel

ACCEPTS: str

matplotlib.axis.YTick.set_path_effects

YTick.**set_path_effects**(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.YTick.set_picker

YTick.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.YTick.set_rasterized

YTick.**set_rasterized**(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.YTick.set_sketch_params

YTick.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.YTick.set_snap

YTick.**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.

Parameters

snap [bool or None]

matplotlib.axis.YTick.set_transform

YTick.**set_transform**(*t*)

Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.YTick.set_url

YTick.**set_url**(*url*)
Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.YTick.set_visible

YTick.**set_visible**(*b*)
Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.YTick.set_zorder

YTick.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.YTick.stale

YTick.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.YTick.update

YTick.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.YTick.update_from

YTick.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.YTick.zorder

YTick.**zorder** = **0**

Axis

Axis.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
Axis.aname	
Axis.axes	The *Axes* instance the artist resides in, or *None*.
Axis.contains	Test whether the artist contains the mouse event.
Axis.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
Axis.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
Axis.draw	Draw the axis lines, grid lines, tick lines and labels
Axis.findobj	Find artist objects.
Axis.format_cursor_data	Return *cursor data* string formatted.
Axis.get_agg_filter	Return filter function to be used for agg filter.
Axis.get_alpha	Return the alpha value used for blending - not supported on all backends
Axis.get_animated	Return the artist's animated state
Axis.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
Axis.get_clip_box	Return artist clipbox
Axis.get_clip_on	Return whether artist uses clipping
Axis.get_clip_path	Return artist clip path
Axis.get_contains	Return the _contains test used by the artist, or *None* for default.
Axis.get_cursor_data	Get the cursor data for a given event.
Axis.get_figure	Return the *Figure* instance the artist belongs to.
Axis.get_gid	Returns the group id.
Axis.get_label	Return the axis label as a Text instance
Axis.get_path_effects	
Axis.get_picker	Return the picker object used by this artist.
Axis.get_rasterized	Return whether the artist is to be rasterized.
Axis.get_sketch_params	Returns the sketch parameters for the artist.
Axis.get_snap	Returns the snap setting which may be:
Axis.get_transform	Return the *Transform* instance used by this artist.
Axis.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.
Axis.get_url	Returns the url.

Continued on next page

Table 20 – continued from previous page

Axis.get_visible	Return the artist's visiblity
Axis.get_window_extent	Get the axes bounding box in display space.
Axis.get_zorder	Return the artist's zorder.
Axis.have_units	Return *True* if units are set on the *x* or *y* axes
Axis.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
Axis.mouseover	
Axis.pchanged	Fire an event when property changed, calling all of the registered callbacks.
Axis.pick	Process pick event
Axis.pickable	Return *True* if `Artist` is pickable.
Axis.properties	return a dictionary mapping property name -> value for all Artist props
Axis.remove	Remove the artist from the figure if possible.
Axis.remove_callback	Remove a callback based on its *id*.
Axis.set	A property batch setter.
Axis.set_agg_filter	Set the agg filter.
Axis.set_alpha	Set the alpha value used for blending - not supported on all backends.
Axis.set_animated	Set the artist's animation state.
Axis.set_clip_box	Set the artist's clip *Bbox*.
Axis.set_clip_on	Set whether artist uses clipping.
Axis.set_clip_path	Set the artist's clip path, which may be:
Axis.set_contains	Replace the contains test used by this artist.
Axis.set_figure	Set the *Figure* instance the artist belongs to.
Axis.set_gid	Sets the (group) id for the artist.
Axis.set_label	Set the label to *s* for auto legend.
Axis.set_path_effects	Set the path effects.
Axis.set_picker	Set the epsilon for picking used by this artist
Axis.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
Axis.set_sketch_params	Sets the sketch parameters.
Axis.set_snap	Sets the snap setting which may be:
Axis.set_transform	Set the artist transform.
Axis.set_url	Sets the url for the artist.
Axis.set_visible	Set the artist's visibility.
Axis.set_zorder	Set the zorder for the artist.
Axis.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
Axis.update	Update this artist's properties from the dictionary *prop*.
Axis.update_from	Copy properties from *other* to *self*.
Axis.zorder	

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Table 20 – continued from previous page

XAxis.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
XAxis.aname	
XAxis.axes	The *Axes* instance the artist resides in, or *None*.
XAxis.contains	Test whether the mouse event occurred in the x axis.
XAxis.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type
XAxis.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
XAxis.draw	Draw the axis lines, grid lines, tick lines and labels
XAxis.findobj	Find artist objects.
XAxis.format_cursor_data	Return *cursor data* string formatted.
XAxis.get_agg_filter	Return filter function to be used for agg filter.
XAxis.get_alpha	Return the alpha value used for blending - not supported on all backends
XAxis.get_animated	Return the artist's animated state
XAxis.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
XAxis.get_clip_box	Return artist clipbox
XAxis.get_clip_on	Return whether artist uses clipping
XAxis.get_clip_path	Return artist clip path
XAxis.get_contains	Return the _contains test used by the artist, or *None* for default.
XAxis.get_cursor_data	Get the cursor data for a given event.
XAxis.get_figure	Return the *Figure* instance the artist belongs to.
XAxis.get_gid	Returns the group id.
XAxis.get_label	Return the axis label as a Text instance
XAxis.get_path_effects	
XAxis.get_picker	Return the picker object used by this artist.
XAxis.get_rasterized	Return whether the artist is to be rasterized.
XAxis.get_sketch_params	Returns the sketch parameters for the artist.
XAxis.get_snap	Returns the snap setting which may be:
XAxis.get_transform	Return the *Transform* instance used by this artist.
XAxis.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.
XAxis.get_url	Returns the url.
XAxis.get_visible	Return the artist's visiblity
XAxis.get_window_extent	Get the axes bounding box in display space.
XAxis.get_zorder	Return the artist's zorder.
XAxis.have_units	Return *True* if units are set on the *x* or *y* axes
XAxis.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
XAxis.mouseover	

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Table 20 – continued from previous page

XAxis.pchanged	Fire an event when property changed, calling all of the registered callbacks.
XAxis.pick	Process pick event
XAxis.pickable	Return *True* if `Artist` is pickable.
XAxis.properties	return a dictionary mapping property name -> value for all Artist props
XAxis.remove	Remove the artist from the figure if possible.
XAxis.remove_callback	Remove a callback based on its *id*.
XAxis.set	A property batch setter.
XAxis.set_agg_filter	Set the agg filter.
XAxis.set_alpha	Set the alpha value used for blending - not supported on all backends.
XAxis.set_animated	Set the artist's animation state.
XAxis.set_clip_box	Set the artist's clip *Bbox*.
XAxis.set_clip_on	Set whether artist uses clipping.
XAxis.set_clip_path	Set the artist's clip path, which may be:
XAxis.set_contains	Replace the contains test used by this artist.
XAxis.set_figure	Set the *Figure* instance the artist belongs to.
XAxis.set_gid	Sets the (group) id for the artist.
XAxis.set_label	Set the label to *s* for auto legend.
XAxis.set_path_effects	Set the path effects.
XAxis.set_picker	Set the epsilon for picking used by this artist
XAxis.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
XAxis.set_sketch_params	Sets the sketch parameters.
XAxis.set_snap	Sets the snap setting which may be:
XAxis.set_transform	Set the artist transform.
XAxis.set_url	Sets the url for the artist.
XAxis.set_visible	Set the artist's visibility.
XAxis.set_zorder	Set the zorder for the artist.
XAxis.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
XAxis.update	Update this artist's properties from the dictionary *prop*.
XAxis.update_from	Copy properties from *other* to *self*.
XAxis.zorder	
YAxis.add_callback	Adds a callback function that will be called whenever one of the `Artist`'s properties changes.
YAxis.aname	
YAxis.axes	The *Axes* instance the artist resides in, or *None*.
YAxis.contains	Test whether the mouse event occurred in the y axis.
YAxis.convert_xunits	For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

Continued on next page

Table 20 – continued from previous page

YAxis.convert_yunits	For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type
YAxis.draw	Draw the axis lines, grid lines, tick lines and labels
YAxis.findobj	Find artist objects.
YAxis.format_cursor_data	Return *cursor data* string formatted.
YAxis.get_agg_filter	Return filter function to be used for agg filter.
YAxis.get_alpha	Return the alpha value used for blending - not supported on all backends
YAxis.get_animated	Return the artist's animated state
YAxis.get_children	Return a list of the child `Artist`s this :class:`Artist` contains.
YAxis.get_clip_box	Return artist clipbox
YAxis.get_clip_on	Return whether artist uses clipping
YAxis.get_clip_path	Return artist clip path
YAxis.get_contains	Return the _contains test used by the artist, or *None* for default.
YAxis.get_cursor_data	Get the cursor data for a given event.
YAxis.get_figure	Return the *Figure* instance the artist belongs to.
YAxis.get_gid	Returns the group id.
YAxis.get_label	Return the axis label as a Text instance
YAxis.get_path_effects	
YAxis.get_picker	Return the picker object used by this artist.
YAxis.get_rasterized	Return whether the artist is to be rasterized.
YAxis.get_sketch_params	Returns the sketch parameters for the artist.
YAxis.get_snap	Returns the snap setting which may be:
YAxis.get_transform	Return the *Transform* instance used by this artist.
YAxis.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.
YAxis.get_url	Returns the url.
YAxis.get_visible	Return the artist's visiblity
YAxis.get_window_extent	Get the axes bounding box in display space.
YAxis.get_zorder	Return the artist's zorder.
YAxis.have_units	Return *True* if units are set on the *x* or *y* axes
YAxis.is_transform_set	Returns *True* if `Artist` has a transform explicitly set.
YAxis.mouseover	
YAxis.pchanged	Fire an event when property changed, calling all of the registered callbacks.
YAxis.pick	Process pick event
YAxis.pickable	Return *True* if `Artist` is pickable.
YAxis.properties	return a dictionary mapping property name -> value for all Artist props
YAxis.remove	Remove the artist from the figure if possible.
YAxis.remove_callback	Remove a callback based on its *id*.

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Table 20 – continued from previous page

YAxis.set	A property batch setter.
YAxis.set_agg_filter	Set the agg filter.
YAxis.set_alpha	Set the alpha value used for blending - not supported on all backends.
YAxis.set_animated	Set the artist's animation state.
YAxis.set_clip_box	Set the artist's clip Bbox.
YAxis.set_clip_on	Set whether artist uses clipping.
YAxis.set_clip_path	Set the artist's clip path, which may be:
YAxis.set_contains	Replace the contains test used by this artist.
YAxis.set_figure	Set the Figure instance the artist belongs to.
YAxis.set_gid	Sets the (group) id for the artist.
YAxis.set_label	Set the label to *s* for auto legend.
YAxis.set_path_effects	Set the path effects.
YAxis.set_picker	Set the epsilon for picking used by this artist
YAxis.set_rasterized	Force rasterized (bitmap) drawing in vector backend output.
YAxis.set_sketch_params	Sets the sketch parameters.
YAxis.set_snap	Sets the snap setting which may be:
YAxis.set_transform	Set the artist transform.
YAxis.set_url	Sets the url for the artist.
YAxis.set_visible	Set the artist's visibility.
YAxis.set_zorder	Set the zorder for the artist.
YAxis.stale	If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.
YAxis.update	Update this artist's properties from the dictionary *prop*.
YAxis.update_from	Copy properties from *other* to *self*.
YAxis.zorder	

matplotlib.axis.Axis.add_callback

Axis.**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.

matplotlib.axis.Axis.aname

Axis.**aname** = **'Artist'**

matplotlib.axis.Axis.axes

Axis.**axes**
The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.Axis.contains

Axis.**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.

matplotlib.axis.Axis.convert_xunits

Axis.**convert_xunits**(*x*)
For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.Axis.convert_yunits

Axis.**convert_yunits**(*y*)
For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.Axis.draw

Axis.**draw**(*renderer*, **args*, ***kwargs*)
Draw the axis lines, grid lines, tick lines and labels

matplotlib.axis.Axis.findobj

Axis.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.Axis.format_cursor_data

Axis.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.Axis.get_agg_filter

Axis.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.Axis.get_alpha

Axis.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.Axis.get_animated

Axis.**get_animated**()
Return the artist's animated state

matplotlib.axis.Axis.get_children

Axis.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.Axis.get_clip_box

Axis.**get_clip_box**()
Return artist clipbox

matplotlib.axis.Axis.get_clip_on

Axis.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.Axis.get_clip_path

Axis.**get_clip_path**()
Return artist clip path

matplotlib.axis.Axis.get_contains

Axis.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.Axis.get_cursor_data

Axis.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.Axis.get_figure

Axis.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.Axis.get_gid

Axis.**get_gid**()
Returns the group id.

matplotlib.axis.Axis.get_label

Axis.**get_label**()
Return the axis label as a Text instance

matplotlib.axis.Axis.get_path_effects

Axis.**get_path_effects**()

matplotlib.axis.Axis.get_picker

Axis.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.Axis.get_rasterized

Axis.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.Axis.get_sketch_params

Axis.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.Axis.get_snap

Axis.**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.

matplotlib.axis.Axis.get_transform

Axis.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.Axis.get_transformed_clip_path_and_affine

Axis.**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.

matplotlib.axis.Axis.get_url

Axis.**get_url**()
Returns the url.

matplotlib.axis.Axis.get_visible

Axis.**get_visible**()
Return the artist's visiblity

matplotlib.axis.Axis.get_window_extent

Axis.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.Axis.get_zorder

Axis.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.Axis.have_units

Axis.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.Axis.is_transform_set

Axis.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.Axis.mouseover

Axis.**mouseover**

matplotlib.axis.Axis.pchanged

Axis.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.Axis.pick

Axis.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.Axis.pickable

Axis.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.Axis.properties

Axis.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.Axis.remove

Axis.**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.

matplotlib.axis.Axis.remove_callback

Axis.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.Axis.set

Axis.**set**(**kwargs*)
A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.Axis.set_agg_filter

Axis.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.Axis.set_alpha

Axis.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.Axis.set_animated

Axis.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.Axis.set_clip_box

Axis.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.Axis.set_clip_on

Axis.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.Axis.set_clip_path

Axis.**set_clip_path**(*clippath*, *transform=None*)

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.Axis.set_contains

Axis.**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.

Parameters

picker [callable]

matplotlib.axis.Axis.set_figure

Axis.**set_figure**(*fig*)

Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.Axis.set_gid

Axis.**set_gid**(*gid*)

Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.Axis.set_label

Axis.**set_label**(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

matplotlib.axis.Axis.set_path_effects

Axis.**set_path_effects**(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.Axis.set_picker

Axis.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.Axis.set_rasterized

Axis.**set_rasterized**(*rasterized*)

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.Axis.set_sketch_params

Axis.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.Axis.set_snap

Axis.**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.

Parameters

snap [bool or None]

matplotlib.axis.Axis.set_transform

Axis.**set_transform**(*t*)

Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.Axis.set_url

Axis.**set_url**(*url*)
Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.Axis.set_visible

Axis.**set_visible**(*b*)
Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.Axis.set_zorder

Axis.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.Axis.stale

Axis.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.Axis.update

Axis.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.Axis.update_from

Axis.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.Axis.zorder

Axis.**zorder** = **0**

matplotlib.axis.XAxis.add_callback

XAxis.**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.

matplotlib.axis.XAxis.aname

XAxis.**aname** = **'Artist'**

matplotlib.axis.XAxis.axes

XAxis.**axes**

The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.XAxis.contains

XAxis.**contains**(*mouseevent*)

Test whether the mouse event occurred in the x axis.

matplotlib.axis.XAxis.convert_xunits

XAxis.**convert_xunits**(*x*)

For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.XAxis.convert_yunits

XAxis.**convert_yunits**(*y*)

For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.XAxis.draw

XAxis.**draw**(*renderer*, **args*, ***kwargs*)

Draw the axis lines, grid lines, tick lines and labels

matplotlib.axis.XAxis.findobj

XAxis.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.XAxis.format_cursor_data

XAxis.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.XAxis.get_agg_filter

XAxis.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.XAxis.get_alpha

XAxis.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.XAxis.get_animated

XAxis.**get_animated**()
Return the artist's animated state

matplotlib.axis.XAxis.get_children

XAxis.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.XAxis.get_clip_box

XAxis.**get_clip_box**()
Return artist clipbox

matplotlib.axis.XAxis.get_clip_on

XAxis.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.XAxis.get_clip_path

XAxis.**get_clip_path**()
Return artist clip path

matplotlib.axis.XAxis.get_contains

XAxis.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.XAxis.get_cursor_data

XAxis.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.XAxis.get_figure

XAxis.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.XAxis.get_gid

XAxis.**get_gid**()
Returns the group id.

matplotlib.axis.XAxis.get_label

XAxis.**get_label**()
Return the axis label as a Text instance

matplotlib.axis.XAxis.get_path_effects

XAxis.**get_path_effects**()

matplotlib.axis.XAxis.get_picker

XAxis.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.XAxis.get_rasterized

XAxis.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.XAxis.get_sketch_params

XAxis.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.XAxis.get_snap

XAxis.**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.

matplotlib.axis.XAxis.get_transform

XAxis.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.XAxis.get_transformed_clip_path_and_affine

XAxis.**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.

matplotlib.axis.XAxis.get_url

XAxis.**get_url**()
Returns the url.

matplotlib.axis.XAxis.get_visible

XAxis.**get_visible**()
Return the artist's visiblity

matplotlib.axis.XAxis.get_window_extent

XAxis.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.XAxis.get_zorder

XAxis.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.XAxis.have_units

XAxis.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.XAxis.is_transform_set

XAxis.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.XAxis.mouseover

XAxis.**mouseover**

matplotlib.axis.XAxis.pchanged

XAxis.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.XAxis.pick

XAxis.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.XAxis.pickable

XAxis.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.XAxis.properties

XAxis.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.XAxis.remove

XAxis.**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.

matplotlib.axis.XAxis.remove_callback

XAxis.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.XAxis.set

XAxis.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.XAxis.set_agg_filter

XAxis.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.XAxis.set_alpha

XAxis.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.XAxis.set_animated

XAxis.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.XAxis.set_clip_box

XAxis.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.XAxis.set_clip_on

XAxis.**set_clip_on**(*b*)

Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.XAxis.set_clip_path

XAxis.**set_clip_path**(*clippath*, *transform=None*)

Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.XAxis.set_contains

XAxis.**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.

Parameters

picker [callable]

matplotlib.axis.XAxis.set_figure

XAxis.**set_figure**(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.XAxis.set_gid

XAxis.**set_gid**(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.XAxis.set_label

XAxis.**set_label**(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

matplotlib.axis.XAxis.set_path_effects

XAxis.**set_path_effects**(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.XAxis.set_picker

XAxis.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.XAxis.set_rasterized

XAxis.**set_rasterized**(*rasterized*)

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.XAxis.set_sketch_params

XAxis.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.XAxis.set_snap

XAxis.**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.

Parameters

snap [bool or None]

matplotlib.axis.XAxis.set_transform

XAxis.**set_transform**(*t*)

Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.XAxis.set_url

XAxis.**set_url**(*url*)

Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.XAxis.set_visible

XAxis.**set_visible**(*b*)

Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.XAxis.set_zorder

XAxis.**set_zorder**(*level*)

Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.XAxis.stale

XAxis.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.XAxis.update

XAxis.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.XAxis.update_from

XAxis.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.XAxis.zorder

XAxis.**zorder = 0**

matplotlib.axis.YAxis.add_callback

YAxis.**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.

matplotlib.axis.YAxis.aname

YAxis.**aname = 'Artist'**

matplotlib.axis.YAxis.axes

YAxis.**axes**
The *Axes* instance the artist resides in, or *None*.

matplotlib.axis.YAxis.contains

YAxis.**contains**(*mouseevent*)
Test whether the mouse event occurred in the y axis.

Returns *True* | *False*

matplotlib.axis.YAxis.convert_xunits

YAxis.**convert_xunits**(*x*)
For artists in an axes, if the xaxis has units support, convert *x* using xaxis unit type

matplotlib.axis.YAxis.convert_yunits

YAxis.**convert_yunits**(*y*)
For artists in an axes, if the yaxis has units support, convert *y* using yaxis unit type

matplotlib.axis.YAxis.draw

YAxis.**draw**(*renderer*, **args*, ***kwargs*)
Draw the axis lines, grid lines, tick lines and labels

matplotlib.axis.YAxis.findobj

YAxis.**findobj**(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

matplotlib.axis.YAxis.format_cursor_data

YAxis.**format_cursor_data**(*data*)
Return *cursor data* string formatted.

matplotlib.axis.YAxis.get_agg_filter

YAxis.**get_agg_filter**()
Return filter function to be used for agg filter.

matplotlib.axis.YAxis.get_alpha

YAxis.**get_alpha**()
Return the alpha value used for blending - not supported on all backends

matplotlib.axis.YAxis.get_animated

YAxis.**get_animated**()
Return the artist's animated state

matplotlib.axis.YAxis.get_children

YAxis.**get_children**()
Return a list of the child `Artist`s this :class:`Artist` contains.

matplotlib.axis.YAxis.get_clip_box

YAxis.**get_clip_box**()
Return artist clipbox

matplotlib.axis.YAxis.get_clip_on

YAxis.**get_clip_on**()
Return whether artist uses clipping

matplotlib.axis.YAxis.get_clip_path

YAxis.**get_clip_path**()
Return artist clip path

matplotlib.axis.YAxis.get_contains

YAxis.**get_contains**()
Return the _contains test used by the artist, or *None* for default.

matplotlib.axis.YAxis.get_cursor_data

YAxis.**get_cursor_data**(*event*)
Get the cursor data for a given event.

matplotlib.axis.YAxis.get_figure

YAxis.**get_figure**()
Return the *Figure* instance the artist belongs to.

matplotlib.axis.YAxis.get_gid

YAxis.**get_gid**()
Returns the group id.

matplotlib.axis.YAxis.get_label

YAxis.**get_label**()
Return the axis label as a Text instance

matplotlib.axis.YAxis.get_path_effects

YAxis.**get_path_effects**()

matplotlib.axis.YAxis.get_picker

YAxis.**get_picker**()
Return the picker object used by this artist.

matplotlib.axis.YAxis.get_rasterized

YAxis.**get_rasterized**()
Return whether the artist is to be rasterized.

matplotlib.axis.YAxis.get_sketch_params

YAxis.**get_sketch_params**()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.

- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

matplotlib.axis.YAxis.get_snap

YAxis.**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.

matplotlib.axis.YAxis.get_transform

YAxis.**get_transform**()
Return the *Transform* instance used by this artist.

matplotlib.axis.YAxis.get_transformed_clip_path_and_affine

YAxis.**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.

matplotlib.axis.YAxis.get_url

YAxis.**get_url**()
Returns the url.

matplotlib.axis.YAxis.get_visible

YAxis.**get_visible**()
Return the artist's visiblity

matplotlib.axis.YAxis.get_window_extent

YAxis.**get_window_extent**(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

matplotlib.axis.YAxis.get_zorder

YAxis.**get_zorder**()
Return the artist's zorder.

matplotlib.axis.YAxis.have_units

YAxis.**have_units**()
Return *True* if units are set on the *x* or *y* axes

matplotlib.axis.YAxis.is_transform_set

YAxis.**is_transform_set**()
Returns *True* if `Artist` has a transform explicitly set.

matplotlib.axis.YAxis.mouseover

YAxis.**mouseover**

matplotlib.axis.YAxis.pchanged

YAxis.**pchanged**()
Fire an event when property changed, calling all of the registered callbacks.

matplotlib.axis.YAxis.pick

YAxis.**pick**(*mouseevent*)
Process pick event

each child artist will fire a pick event if *mouseevent* is over the artist and the artist has picker set

matplotlib.axis.YAxis.pickable

YAxis.**pickable**()
Return *True* if `Artist` is pickable.

matplotlib.axis.YAxis.properties

YAxis.**properties**()
return a dictionary mapping property name -> value for all Artist props

matplotlib.axis.YAxis.remove

YAxis.**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.

matplotlib.axis.YAxis.remove_callback

YAxis.**remove_callback**(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

matplotlib.axis.YAxis.set

YAxis.**set**(***kwargs*)
A property batch setter. Pass *kwargs* to set properties.

matplotlib.axis.YAxis.set_agg_filter

YAxis.**set_agg_filter**(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

matplotlib.axis.YAxis.set_alpha

YAxis.**set_alpha**(*alpha*)
Set the alpha value used for blending - not supported on all backends.

Parameters

alpha [float]

matplotlib.axis.YAxis.set_animated

YAxis.**set_animated**(*b*)
Set the artist's animation state.

Parameters

b [bool]

matplotlib.axis.YAxis.set_clip_box

YAxis.**set_clip_box**(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

matplotlib.axis.YAxis.set_clip_on

YAxis.**set_clip_on**(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

matplotlib.axis.YAxis.set_clip_path

YAxis.**set_clip_path**(*clippath*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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]

matplotlib.axis.YAxis.set_contains

YAxis.**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.

Parameters

picker [callable]

matplotlib.axis.YAxis.set_figure

YAxis.**set_figure**(*fig*)

Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

matplotlib.axis.YAxis.set_gid

YAxis.**set_gid**(*gid*)

Sets the (group) id for the artist.

Parameters

gid [str]

matplotlib.axis.YAxis.set_label

YAxis.**set_label**(*s*)

Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

matplotlib.axis.YAxis.set_path_effects

YAxis.**set_path_effects**(*path_effects*)

Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

matplotlib.axis.YAxis.set_picker

YAxis.**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.

Parameters

picker [None or bool or float or callable]

matplotlib.axis.YAxis.set_rasterized

YAxis.**set_rasterized**(*rasterized*)

Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

matplotlib.axis.YAxis.set_sketch_params

YAxis.**set_sketch_params**(*scale=None*, *length=None*, *randomness=None*)

Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

matplotlib.axis.YAxis.set_snap

YAxis.**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.

Parameters

snap [bool or None]

matplotlib.axis.YAxis.set_transform

YAxis.**set_transform**(*t*)

Set the artist transform.

Parameters

t [*Transform*]

matplotlib.axis.YAxis.set_url

YAxis.**set_url**(*url*)

Sets the url for the artist.

Parameters

url [str]

matplotlib.axis.YAxis.set_visible

YAxis.**set_visible**(*b*)

Set the artist's visibility.

Parameters

b [bool]

matplotlib.axis.YAxis.set_zorder

YAxis.**set_zorder**(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

matplotlib.axis.YAxis.stale

YAxis.**stale**
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

matplotlib.axis.YAxis.update

YAxis.**update**(*props*)
Update this artist's properties from the dictionary *prop*.

matplotlib.axis.YAxis.update_from

YAxis.**update_from**(*other*)
Copy properties from *other* to *self*.

matplotlib.axis.YAxis.zorder

YAxis.**zorder = 0**

CHAPTER

THIRTYSEVEN

BACKENDS

37.1 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 such as *KeyEvent* and *MouseEvent* store the meta data like keys and buttons pressed, x and y locations in pixel and *Axes* coordinates.

ShowBase The base class for the Show class of each interactive backend; the 'show' callable is then set to Show.__call__, inherited from ShowBase.

ToolContainerBase The base class for the Toolbar class of each interactive backend.

StatusbarBase The base class for the messaging area.

class matplotlib.backend_bases.**CloseEvent**(*name*, *canvas*, *guiEvent=None*)
Bases: *matplotlib.backend_bases.Event*

An event triggered by a figure being closed

class matplotlib.backend_bases.**DrawEvent**(*name*, *canvas*, *renderer*)
Bases: *matplotlib.backend_bases.Event*

An event triggered by a draw operation on the canvas

In most backends callbacks subscribed to this callback will be fired after the rendering is complete but before the screen is updated. Any extra artists drawn to the canvas's renderer will be reflected without an explicit call to `blit`.

> **Warning:** Calling `canvas.draw` and `canvas.blit` in these callbacks may not be safe with all backends and may cause infinite recursion.

In addition to the *Event* attributes, the following event attributes are defined:

Attributes

renderer [*RendererBase*] the renderer for the draw event

class matplotlib.backend_bases.**Event**(*name*, *canvas*, *guiEvent=None*)
Bases: object

A matplotlib event. Attach additional attributes as defined in *FigureCanvasBase.mpl_connect()*. The following attributes are defined and shown with their default values

Attributes

name [str] the event name

canvas [*FigureCanvasBase*] the backend-specific canvas instance generating the event

guiEvent the GUI event that triggered the matplotlib event

class matplotlib.backend_bases.**FigureCanvasBase**(*figure*)
Bases: object

The canvas the figure renders into.

Public attributes

Attributes

figure [*matplotlib.figure.Figure*] A high-level figure instance

blit(*bbox=None*)
Blit the canvas in bbox (default entire canvas).

button_press_event(*x*, *y*, *button*, *dblclick=False*, *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.

This method will call all functions connected to the 'button_release_event' with a *MouseEvent* instance.

Parameters

x [scalar] the canvas coordinates where 0=left

y [scalar] the canvas coordinates where 0=bottom

guiEvent the native UI event that generated the mpl event

close_event(*guiEvent=None*)
Pass a *CloseEvent* to all functions connected to `close_event`.

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*)
Pass a *DrawEvent* to all functions connected to `draw_event`.

draw_idle(**args*, ***kwargs*)
draw() only if idle; defaults to draw but backends can override

enter_notify_event(*guiEvent=None*, *xy=None*)
Backend derived classes should call this function when entering canvas

Parameters

guiEvent the native UI event that generated the mpl event

xy [tuple of 2 scalars] the coordinate location of the pointer when the canvas is entered

events = ['resize_event', 'draw_event', 'key_press_event', 'key_release_event', 'button_pr

filetypes = {'eps': 'Encapsulated Postscript', 'jpeg': 'Joint Photographic Experts Group

fixed_dpi = None

flush_events()
Flush the GUI events for the figure.

Interactive backends need to reimplement this method.

get_default_filename()
Return a string, which includes extension, suitable for use as a default filename.

classmethod get_default_filetype()
Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

classmethod get_supported_filetypes()
Return dict of savefig file formats supported by this backend

classmethod get_supported_filetypes_grouped()
Return a dict of savefig file formats supported by this backend, where the keys are a file type name, such as 'Joint Photographic Experts Group', and the values are a list of filename extensions used for that filetype, such as ['jpg', 'jpeg'].

get_width_height()
Return the figure width and height in points or pixels (depending on the backend), truncated to integers

get_window_title()
Get the title text of the window containing the figure. Return None if there is no window (e.g., a PS backend).

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*)
Deprecated since version 2.1: The idle_event function was deprecated in version 2.1.

Called when GUI is idle.

is_saving()
Returns whether the renderer is in the process of saving to a file, rather than rendering for an on-screen buffer.

key_press_event(*key*, *guiEvent=None*)
Pass a *KeyEvent* to all functions connected to `key_press_event`.

key_release_event(*key*, *guiEvent=None*)
Pass a *KeyEvent* to all functions connected to `key_release_event`.

leave_notify_event(*guiEvent=None*)
Backend derived classes should call this function when leaving canvas

Parameters

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.

This method will call all functions connected to the 'motion_notify_event' with a *MouseEvent* instance.

Parameters

x [scalar] the canvas coordinates where 0=left

y [scalar] the canvas coordinates where 0=bottom

guiEvent the native UI event that generated the mpl event

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()`.

Examples

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

Examples

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.

Other Parameters

interval [scalar] Timer interval in milliseconds

callbacks [List[Tuple[callable, Tuple, Dict]]] Sequence of (func, args, kwargs) where `func(*args, **kwargs)` will be executed by the timer every *interval*.

callbacks which return `False` or `0` will be removed from the timer.

Examples

```
>>> timer = fig.canvas.new_timer(callbacks=[(f1, (1, ), {'a': 3}),])
```

onRemove(*ev*)

Deprecated since version 2.2: The onRemove function was deprecated in version 2.2.

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_figure(*filename*, *dpi=None*, *facecolor=None*, *edgecolor=None*, *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.

Parameters

filename can also be a file object on image backends

orientation [{'landscape', 'portrait'}, optional] only currently applies to PostScript printing.

dpi [scalar, optional] the dots per inch to save the figure in; if None, use savefig.dpi

facecolor [color spec or None, optional] the facecolor of the figure; if None, defaults to savefig.facecolor

edgecolor [color spec or None, optional] the edgecolor of the figure; if None, defaults to savefig.edgecolor

format [str, optional] when set, forcibly set the file format to save to

bbox_inches [str or *Bbox*, optional] Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure. If None, use savefig.bbox

pad_inches [scalar, optional] Amount of padding around the figure when bbox_inches is 'tight'. If None, use savefig.pad_inches

bbox_extra_artists [list of *Artist*, optional] A list of extra artists that will be considered when the tight bbox is calculated.

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()
Pass a *ResizeEvent* to all functions connected to `resize_event`.

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 (e.g., a PS backend).

start_event_loop(*timeout=0*)
Start a blocking event loop.

Such an event loop is used by interactive functions, such as `ginput` and `waitforbuttonpress`, to wait for events.

The event loop blocks until a callback function triggers *stop_event_loop*, or *timeout* is reached.

If *timeout* is negative, never timeout.

Only interactive backends need to reimplement this method and it relies on *flush_events* being properly implemented.

Interactive backends should implement this in a more native way.

start_event_loop_default(*timeout=0*)
Deprecated since version 2.1: The start_event_loop_default function was deprecated in version 2.1.

Start a blocking event loop.

> Such an event loop is used by interactive functions, such as `ginput` and `waitforbuttonpress`, to wait for events.
>
> The event loop blocks until a callback function triggers *stop_event_loop*, or *timeout* is reached.
>
> If *timeout* is negative, never timeout.

Only interactive backends need to reimplement this method and it relies on *flush_events* being properly implemented.

Interactive backends should implement this in a more native way.

stop_event_loop()
Stop the current blocking event loop.

Interactive backends need to reimplement this to match *start_event_loop*

stop_event_loop_default()
Deprecated since version 2.1: The stop_event_loop_default function was deprecated in version 2.1.

Stop the current blocking event loop.

Interactive backends need to reimplement this to match *start_event_loop*

supports_blit = True

switch_backends(*FigureCanvasClass*)
Instantiate an instance of FigureCanvasClass

This is used for backend switching, e.g., to instantiate a FigureCanvasPS from a FigureCanvasGTK. Note, deep copying is not done, so any changes to one of the instances (e.g., setting figure size or line props), will be reflected in the other

class matplotlib.backend_bases.**FigureManagerBase**(*canvas*, *num*)
Bases: object

Helper class for pyplot mode, wraps everything up into a neat bundle

Attributes

canvas [*FigureCanvasBase*] The backend-specific canvas instance

num [int or str] The figure number

key_press_handler_id [int] The default key handler cid, when using the toolmanager. Can be used to disable default key press handling

```
figure.canvas.mpl_disconnect(
    figure.canvas.manager.key_press_handler_id)
```

destroy()

full_screen_toggle()

get_window_title()
Get the title text of the window containing the figure.

Return None for non-GUI (e.g., PS) backends.

key_press(*event*)
Implement the default mpl key bindings defined at *Navigation Keyboard Shortcuts*

resize(*w*, *h*)
"For GUI backends, resize the window (in pixels).

set_window_title(*title*)
Set the title text of the window containing the figure.

This has no effect for non-GUI (e.g., PS) backends.

show()
For GUI backends, show the figure window and redraw. For non-GUI backends, raise an exception to be caught by *show()*, for an optional warning.

show_popup(*msg*)
Deprecated since version 2.2: The show_popup function was deprecated in version 2.2.

Display message in a popup – GUI only.

class matplotlib.backend_bases.**GraphicsContextBase**
Bases: object

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_forced_alpha()
Return whether the value given by get_alpha() should be used to override any other alpha-channel values.

get_gid()
Return the object identifier if one is set, None otherwise.

get_hatch()
Gets the current hatch style

get_hatch_color()
Gets the color to use for hatching.

get_hatch_linewidth()
Gets the linewidth to use for hatching.

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()
Deprecated since version 2.1: The get_linestyle function was deprecated in version 2.1.

Return the linestyle: one of ('solid', 'dashed', 'dashdot', 'dotted').

get_linewidth()
Return the line width in points as a scalar

get_rgb()
returns a tuple of three or four floats from 0-1.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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. If `alpha=None` (the default), the alpha components of the foreground and fill colors will be used to set their respective transparencies (where applicable); otherwise, `alpha` will override them.

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.

Parameters

dash_offset [float] is the offset (usually 0).

dash_list [array_like] specifies the on-off sequence as points. `(None, None)` specifies a solid line

set_foreground(*fg*, *isRGBA=False*)
Set the foreground color. fg can be a MATLAB format string, a html hex color string, an rgb or rgba unit tuple, or a float between 0 and 1. In the latter case, grayscale is used.

If you know fg is rgba, set `isRGBA=True` for efficiency.

set_gid(*id*)
Sets the id.

set_hatch(*hatch*)
Sets the hatch style for filling

set_hatch_color(*hatch_color*)
sets the color to use for hatching.

set_joinstyle(*js*)
Set the join style to be one of ('miter', 'round', 'bevel')

set_linestyle(*style*)
Deprecated since version 2.1: The set_linestyle function was deprecated in version 2.1.

Set the linestyle to be one of ('solid', 'dashed', 'dashdot', 'dotted'). These are defined in the rcParams `lines.dashed_pattern`, `lines.dashdot_pattern` and `lines.dotted_pattern`. One may also specify customized dash styles by providing a tuple of (offset, dash pairs).

set_linewidth(*w*)
Set the linewidth in points

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16)

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 matplotlib.backend_bases.**IdleEvent**(***kwargs*)
Bases: *matplotlib.backend_bases.Event*

Deprecated since version 2.1: The IdleEvent class was deprecated in version 2.1.

An event triggered by the GUI backend when it is idle – useful for passive animation

class matplotlib.backend_bases.**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:

Notes

Modifier keys will be prefixed to the pressed key and will be in the order "ctrl", "alt", "super". The exception to this rule is when the pressed key is itself a modifier key, therefore "ctrl+alt" and "alt+control" can both be valid key values.

Examples

Usage:

```
def on_key(event):
    print('you pressed', event.key, event.xdata, event.ydata)

cid = fig.canvas.mpl_connect('key_press_event', on_key)
```

Attributes

key [None or str] the key(s) pressed. Could be **None**, a single case sensitive ascii character ("g", "G", "#", etc.), a special key ("control", "shift", "f1", "up", etc.) or a combination of the above (e.g., "ctrl+alt+g", "ctrl+alt+G").

class matplotlib.backend_bases.**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:

Attributes

x [scalar] x position - pixels from left of canvas

y [scalar] y position - pixels from bottom of canvas

inaxes [bool] the *Axes* instance if mouse is over axes

xdata [scalar] x coord of mouse in data coords

ydata [scalar] y coord of mouse in data coords

x, *y* in figure coords, 0,0 = bottom, left

inaxes = None

lastevent = None

x = None

xdata = None

y = None

ydata = None

class matplotlib.backend_bases.**MouseEvent**(*name*, *canvas*, *x*, *y*, *button=None*, *key=None*, *step=0*, *dblclick=False*, *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:

Examples

Usage:

```
def on_press(event):
    print('you pressed', event.button, event.xdata, event.ydata)

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

Attributes

button [None, scalar, or str] button pressed None, 1, 2, 3, 'up', 'down' (up and down are used for scroll events). Note that in the nbagg backend, both the middle and right clicks return 3 since right clicking will bring up the context menu in some browsers.

key [None, or str] the key depressed when the mouse event triggered (see *KeyEvent*)

step [scalar] number of scroll steps (positive for 'up', negative for 'down')

x, y in figure coords, 0,0 = bottom, left button pressed None, 1, 2, 3, 'up', 'down'

button = None

dblclick = None

inaxes = None

step = None

x = None

xdata = None

y = None

ydata = None

class matplotlib.backend_bases.**NavigationToolbar2**(*canvas*)

Bases: object

Base class for the navigation cursor, version 2

backends must implement a canvas that handles connections for 'button_press_event' and 'button_release_event'. See *FigureCanvasBase.mpl_connect()* for more information

They must also define

save_figure() save the current figure

set_cursor() if you want the pointer icon to change

_init_toolbar() create your toolbar widget

draw_rubberband() **(optional)** draw the zoom to rect "rubberband" rectangle

press() **(optional)** whenever a mouse button is pressed, you'll be notified with the event

release() **(optional)** whenever a mouse button is released, you'll be notified with the event

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*)
Callback for dragging in pan/zoom mode.

drag_zoom(*event*)
Callback for dragging 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.

Note that it is not guaranteed that `x0 <= x1` and `y0 <= y1`.

dynamic_update()
Deprecated since version 2.1: The dynamic_update function was deprecated in version 2.1. Use canvas.draw_idle instead.

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*)
Called whenever a mouse button is pressed.

press_pan(*event*)
Callback for mouse button press in pan/zoom mode.

press_zoom(*event*)
Callback for mouse button press in zoom to rect mode.

push_current()
Push the current view limits and position onto the stack.

release(*event*)
Callback for mouse button release.

release_pan(*event*)
Callback for mouse button release in pan/zoom mode.

release_zoom(*event*)
Callback for mouse button release in zoom to rect mode.

remove_rubberband()
Remove the rubberband.

save_figure(**args*)
Save the current figure.

set_cursor(*cursor*)
Set the current cursor to one of the `Cursors` enums values.

If required by the backend, this method should trigger an update in the backend event loop after the cursor is set, as this method may be called e.g. before a long-running task during which the GUI is not updated.

set_history_buttons()
Enable or disable the back/forward button.

set_message(*s*)
Display a message on toolbar or in status bar.

toolitems = (('Home', 'Reset original view', 'home', 'home'), ('Back', 'Back to previous v

update()
Reset the axes stack.

zoom(**args*)
Activate zoom to rect mode.

exception matplotlib.backend_bases.**NonGuiException**
Bases: `Exception`

class matplotlib.backend_bases.**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

Examples

Usage:

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

def on_pick(event):
    line = event.artist
    xdata, ydata = line.get_data()
    ind = event.ind
    print('on pick line:', np.array([xdata[ind], ydata[ind]]).T)

cid = fig.canvas.mpl_connect('pick_event', on_pick)
```

Attributes

mouseevent [*MouseEvent*] the mouse event that generated the pick

artist [*matplotlib.artist.Artist*] the picked artist

other extra class dependent attrs – e.g., a *Line2D* pick may define different extra attributes than a *PatchCollection* pick event

class matplotlib.backend_bases.**RendererBase**

Bases: object

An abstract base class to handle drawing/rendering operations.

The following methods must be implemented in the backend for full functionality (though just implementing *draw_path()* alone would give a highly capable backend):

- *draw_path()*
- *draw_image()*
- *draw_gouraud_triangle()*

The following methods *should* be implemented in the backend for optimization reasons:

- *draw_text()*
- *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.

Parameters

points [array_like, shape=(3, 2)] Array of (x, y) points for the triangle.

colors [array_like, shape=(3, 4)] RGBA colors for each point of the triangle.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_gouraud_triangles(*gc*, *triangles_array*, *colors_array*, *transform*)
Draws a series of Gouraud triangles.

Parameters

points [array_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

colors [array_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_image(*gc*, *x*, *y*, *im*, *transform=None*)
Draw an RGBA image.

Parameters

gc [*GraphicsContextBase*] a graphics context with clipping information.

x [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

y [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

im [array_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

transform [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option_scale_image()* returns `True`, an affine transformation *may* be passed to *draw_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override `x` and `y`, and has to be applied *before* translating the result by `x` and `y` (this can be accomplished by adding `x` and `y` to the translation vector defined by `transform`).

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.

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.

Parameters

gc [*GraphicsContextBase*] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

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*, *offset_position*)
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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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*, *edgecolors*)
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!'*, *mtext=None*)

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)
Draw the text instance

Parameters

gc [*GraphicsContextBase*] the graphics context

x [scalar] the x location of the text in display coords

y [scalar] the y location of the text baseline in display coords

s [str] the text string

prop [*matplotlib.font_manager.FontProperties*] font properties

angle [scalar] the rotation angle in degrees

mtext [*matplotlib.text.Text*] the original text object to be rendered

Notes

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 plotted 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, height, and descent (offset from the bottom to the baseline), 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 always want to rescale and composite raster images. (like SVG, PDF, or PS)

option_scale_image()
override this method for renderers that support arbitrary affine transformations in *draw_image()* (most vector backends).

points_to_pixels(*points*)
Convert points to display units

You need to override this function (unless your backend doesn't have a dpi, e.g., 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
```

Parameters

points [scalar or array_like] a float or a numpy array of float

Returns

Points converted to pixels

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 matplotlib.backend_bases.**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:

Attributes

width [scalar] width of the canvas in pixels

height [scalar] height of the canvas in pixels

class matplotlib.backend_bases.**ShowBase**
Bases: matplotlib.backend_bases._Backend

Simple base class to generate a show() callable in backends.

Subclass must override mainloop() method.

class matplotlib.backend_bases.**StatusbarBase**(*toolmanager*)
Bases: object

Base class for the statusbar

set_message(*s*)
Display a message on toolbar or in status bar

Parameters

s [str] Message text

class matplotlib.backend_bases.**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 [scalar] The time between timer events in milliseconds. Default is 1000 ms.

single_shot [bool] Boolean flag indicating whether this timer should operate as single shot (run once and then stop). Defaults to `False`.

callbacks [List[Tuple[callable, Tuple, Dict]]] Stores list of (func, args, kwargs) 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.

class matplotlib.backend_bases.**ToolContainerBase**(*toolmanager*)
Bases: `object`

Base class for all tool containers, e.g. toolbars.

Attributes

toolmanager [`ToolManager`] The tools with which this `ToolContainer` wants to communicate.

add_tool(*tool*, *group*, *position=-1*)
Adds a tool to this container

Parameters

tool [tool_like] The tool to add, see `ToolManager.get_tool`.

group [str] The name of the group to add this tool to.

position [int (optional)] The position within the group to place this tool. Defaults to end.

add_toolitem(*name*, *group*, *position*, *image*, *description*, *toggle*)
Add a toolitem to the container

This method must get implemented per backend

The callback associated with the button click event, must be **EXACTLY** `self.trigger_tool(name)`

Parameters

name [string] Name of the tool to add, this gets used as the tool's ID and as the default label of the buttons

group [String] Name of the group that this tool belongs to

position [Int] Position of the tool within its group, if -1 it goes at the End

image_file [String] Filename of the image for the button or `None`

description [String] Description of the tool, used for the tooltips

toggle [Bool]

- `True` : The button is a toggle (change the pressed/unpressed state between consecutive clicks)
- `False` : The button is a normal button (returns to unpressed state after release)

remove_toolitem(*name*)
Remove a toolitem from the `ToolContainer`

This method must get implemented per backend

Called when `ToolManager` emits a `tool_removed_event`

Parameters

name [string] Name of the tool to remove

toggle_toolitem(*name*, *toggled*)
Toggle the toolitem without firing event

Parameters

name [String] Id of the tool to toggle

toggled [bool] Whether to set this tool as toggled or not.

trigger_tool(*name*)
Trigger the tool

Parameters

name [String] Name (id) of the tool triggered from within the container

matplotlib.backend_bases.**get_registered_canvas_class**(*format*)
Return the registered default canvas for given file format. Handles deferred import of required backend.

matplotlib.backend_bases.**key_press_handler**(*event*, *canvas*, *toolbar=None*)
Implement the default mpl key bindings for the canvas and toolbar described at *Navigation Keyboard Shortcuts*

Parameters

event [*KeyEvent*] a key press/release event

canvas [*FigureCanvasBase*] the backend-specific canvas instance

toolbar [*NavigationToolbar2*] the navigation cursor toolbar

matplotlib.backend_bases.**register_backend**(*format*, *backend*, *description=None*)
Register a backend for saving to a given file format.

Parameters

format [str] File extension

backend [module string or canvas class] Backend for handling file output

description [str, optional] Description of the file type. Defaults to an empty string

37.2 matplotlib.backend_managers

ToolManager Class that makes the bridge between user interaction (key press, toolbar clicks, ..) and the actions in response to the user inputs.

class matplotlib.backend_managers.**ToolEvent**(*name*, *sender*, *tool*, *data=None*)
Bases: object

Event for tool manipulation (add/remove)

class matplotlib.backend_managers.**ToolManager**(*figure=None*)
Bases: object

Helper class that groups all the user interactions for a Figure

Attributes

figure: ‘Figure‘

keypresslock: ‘widgets.LockDraw‘ LockDraw object to know if the *canvas* key_press_event is locked

messagelock: 'widgets.LockDraw' `LockDraw` object to know if the message is available to write

`active_toggle`
Currently toggled tools

`add_tool`(*name*, *tool*, **args*, ***kwargs*)
Add *tool* to *ToolManager*

If successful adds a new event `tool_trigger_name` where **name** is the **name** of the tool, this event is fired everytime the tool is triggered.

Parameters

name [str] Name of the tool, treated as the ID, has to be unique

tool [class_like, i.e. str or type] Reference to find the class of the Tool to added.

See also:

matplotlib.backend_tools.ToolBase The base class for tools.

Notes

args and kwargs get passed directly to the tools constructor.

`canvas`
Canvas managed by FigureManager

`figure`
Figure that holds the canvas

`get_tool`(*name*, *warn=True*)
Return the tool object, also accepts the actual tool for convenience

Parameters

name [str, ToolBase] Name of the tool, or the tool itself

warn [bool, optional] If this method should give warnings.

`get_tool_keymap`(*name*)
Get the keymap associated with the specified tool

Parameters

name [string] Name of the Tool

Returns

list [list of keys associated with the Tool]

`message_event`(*message*, *sender=None*)
Emit a *ToolManagerMessageEvent*

`remove_tool`(*name*)
Remove tool from *ToolManager*

Parameters

name [string] Name of the Tool

`set_figure`(*figure*, *update_tools=True*)
Sets the figure to interact with the tools

Parameters

figure: 'Figure'

update_tools: bool Force tools to update figure

`toolmanager_connect`(*s*, *func*)
Connect event with string *s* to *func*.

Parameters

s [String] Name of the event

The following events are recognized

- 'tool_message_event'
- 'tool_removed_event'
- 'tool_added_event'

For every tool added a new event is created

- 'tool_trigger_TOOLNAME' Where TOOLNAME is the id of the tool.

func [function] Function to be called with signature def func(event)

`toolmanager_disconnect`(*cid*)
Disconnect callback id *cid*

Example usage:

```
cid = toolmanager.toolmanager_connect('tool_trigger_zoom',
                                      on_press)
#...later
toolmanager.toolmanager_disconnect(cid)
```

`tools`
Return the tools controlled by *ToolManager*

`trigger_tool`(*name*, *sender=None*, *canvasevent=None*, *data=None*)
Trigger a tool and emit the tool_trigger_[name] event

Parameters

name [string] Name of the tool

sender: object Object that wishes to trigger the tool

canvasevent [Event] Original Canvas event or None

data [Object] Extra data to pass to the tool when triggering

update_keymap(*name*, **keys*)

Set the keymap to associate with the specified tool

Parameters

name [string] Name of the Tool

keys [keys to associate with the Tool]

class matplotlib.backend_managers.**ToolManagerMessageEvent**(*name*, *sender*, *message*)

Bases: object

Event carrying messages from toolmanager

Messages usually get displayed to the user by the toolbar

class matplotlib.backend_managers.**ToolTriggerEvent**(*name*, *sender*, *tool*, *canvasevent=None*, *data=None*)

Bases: *matplotlib.backend_managers.ToolEvent*

Event to inform that a tool has been triggered

37.3 matplotlib.backends.backend_mixed

class matplotlib.backends.backend_mixed.**MixedModeRenderer**(*figure*, *width*, *height*, *dpi*, *vector_renderer*, *raster_renderer_class=None*, *bbox_inches_restore=None*)

Bases: object

A helper class to implement a renderer that switches between vector and raster drawing. An example may be a PDF writer, where most things are drawn with PDF vector commands, but some very complex objects, such as quad meshes, are rasterised and then output as images.

Parameters

figure [*matplotlib.figure.Figure*] The figure instance.

width [scalar] The width of the canvas in logical units

height [scalar] The height of the canvas in logical units

dpi [scalar] The dpi of the canvas

vector_renderer [*matplotlib.backend_bases.RendererBase*] An instance of a subclass of *RendererBase* that will be used for the vector drawing.

raster_renderer_class [*matplotlib.backend_bases.RendererBase*] The renderer class to use for the raster drawing. If not provided, this will use the Agg backend (which is currently the only viable option anyway.)

start_rasterizing()

Enter "raster" mode. All subsequent drawing commands (until stop_rasterizing is called) will be drawn with the raster backend.

If start_rasterizing is called multiple times before stop_rasterizing is called, this method has no effect.

stop_rasterizing()
Exit "raster" mode. All of the drawing that was done since the last start_rasterizing command will be copied to the vector backend by calling draw_image.

If stop_rasterizing is called multiple times before start_rasterizing is called, this method has no effect.

37.4 matplotlib.backend_tools

Abstract base classes define the primitives for Tools. These tools are used by *matplotlib.backend_managers.ToolManager*

ToolBase Simple stateless tool

ToolToggleBase Tool that has two states, only one Toggle tool can be active at any given time for the same *matplotlib.backend_managers.ToolManager*

class matplotlib.backend_tools.**AxisScaleBase**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolToggleBase*

Base Tool to toggle between linear and logarithmic

disable(*event*)
Disable the toggle tool

trigger call this method when `toggled` is True.

This can happen in different circumstances

- Click on the toolbar tool button
- Call to *matplotlib.backend_managers.ToolManager.trigger_tool*
- Another *ToolToggleBase* derived tool is triggered (from the same `ToolManager`)

enable(*event*)
Enable the toggle tool

trigger calls this method when `toggled` is False

trigger(*sender*, *event*, *data=None*)
Calls *enable* or *disable* based on `toggled` value

class matplotlib.backend_tools.**ConfigureSubplotsBase**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Base tool for the configuration of subplots

description = 'Configure subplots'

image = 'subplots'

class matplotlib.backend_tools.**Cursors**
Bases: object

Simple namespace for cursor reference

HAND = 0

MOVE = 3

POINTER = 1

SELECT_REGION = 2

WAIT = 4

class matplotlib.backend_tools.**RubberbandBase**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Draw and remove rubberband

draw_rubberband(**data*)
Draw rubberband

This method must get implemented per backend

remove_rubberband()
Remove rubberband

This method should get implemented per backend

trigger(*sender*, *event*, *data*)
Call *draw_rubberband* or *remove_rubberband* based on data

class matplotlib.backend_tools.**SaveFigureBase**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Base tool for figure saving

default_keymap = ['s', 'ctrl+s']

description = 'Save the figure'

image = 'filesave'

class matplotlib.backend_tools.**SetCursorBase**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolBase*

Change to the current cursor while inaxes

This tool, keeps track of all *ToolToggleBase* derived tools, and calls set_cursor when a tool gets triggered

set_cursor(*cursor*)
Set the cursor

This method has to be implemented per backend

set_figure(*figure*)
Assign a figure to the tool

Parameters

figure: 'Figure'

class matplotlib.backend_tools.**ToolBack**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ViewsPositionsBase*

Move back up the view lim stack

default_keymap = ['left', 'c', 'backspace']

description = 'Back to previous view'

image = 'back'

class matplotlib.backend_tools.**ToolBase**(*toolmanager*, *name*)
Bases: object

Base tool class

A base tool, only implements *trigger* method or not method at all. The tool is instantiated by *matplotlib.backend_managers.ToolManager*

Attributes

toolmanager: 'matplotlib.backend_managers.ToolManager' ToolManager that controls this Tool

figure: 'FigureCanvas' Figure instance that is affected by this Tool

name: String Used as **Id** of the tool, has to be unique among tools of the same ToolManager

canvas

default_keymap = None
Keymap to associate with this tool

String: List of comma separated keys that will be used to call this tool when the keypress event of *self.figure.canvas* is emitted

description = None
Description of the Tool

String: If the Tool is included in the Toolbar this text is used as a Tooltip

destroy()
Destroy the tool

This method is called when the tool is removed by *matplotlib.backend_managers.ToolManager.remove_tool*

figure

image = None
Filename of the image

String: Filename of the image to use in the toolbar. If None, the *name* is used as a label in the toolbar button

name
Tool Id

set_figure(*figure*)
Assign a figure to the tool

Parameters

figure: 'Figure'

toolmanager

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ToolCursorPosition**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolBase*

Send message with the current pointer position

This tool runs in the background reporting the position of the cursor

send_message(*event*)
Call *matplotlib.backend_managers.ToolManager.message_event*

set_figure(*figure*)
Assign a figure to the tool

Parameters

figure: 'Figure'

class matplotlib.backend_tools.**ToolEnableAllNavigation**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Tool to enable all axes for toolmanager interaction

default_keymap = ['a']

description = 'Enables all axes toolmanager'

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ToolEnableNavigation**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Tool to enable a specific axes for toolmanager interaction

default_keymap = (1, 2, 3, 4, 5, 6, 7, 8, 9)

description = 'Enables one axes toolmanager'

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ToolForward**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ViewsPositionsBase*

Move forward in the view lim stack

default_keymap = ['right', 'v']

description = 'Forward to next view'

image = 'forward'

class matplotlib.backend_tools.**ToolFullScreen**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolToggleBase*

Tool to toggle full screen

default_keymap = ['f', 'ctrl+f']

description = 'Toogle Fullscreen mode'

disable(*event*)
Disable the toggle tool

`trigger` call this method when `toggled` is True.

This can happen in different circumstances

- Click on the toolbar tool button
- Call to *matplotlib.backend_managers.ToolManager.trigger_tool*
- Another *ToolToggleBase* derived tool is triggered (from the same `ToolManager`)

enable(*event*)
Enable the toggle tool

`trigger` calls this method when `toggled` is False

class matplotlib.backend_tools.**ToolGrid**(*toolmanager*, *name*)
Bases: `matplotlib.backend_tools._ToolGridBase`

Tool to toggle the major grids of the figure

default_keymap = ['g']

description = 'Toogle major grids'

class matplotlib.backend_tools.**ToolHome**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ViewsPositionsBase*

Restore the original view lim

default_keymap = ['h', 'r', 'home']

description = 'Reset original view'

image = 'home'

class matplotlib.backend_tools.**ToolMinorGrid**(*toolmanager*, *name*)
Bases: `matplotlib.backend_tools._ToolGridBase`

Tool to toggle the major and minor grids of the figure

default_keymap = ['G']

description = 'Toogle major and minor grids'

class matplotlib.backend_tools.**ToolPan**(**args*)
Bases: *matplotlib.backend_tools.ZoomPanBase*

Pan axes with left mouse, zoom with right

cursor = 3

default_keymap = ['p']

description = 'Pan axes with left mouse, zoom with right'

image = 'move'

radio_group = 'default'

class matplotlib.backend_tools.**ToolQuit**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Tool to call the figure manager destroy method

default_keymap = ['ctrl+w', 'cmd+w', 'q']

description = 'Quit the figure'

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ToolQuitAll**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Tool to call the figure manager destroy method

default_keymap = ['W', 'cmd+W', 'Q']

description = 'Quit all figures'

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ToolToggleBase**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolBase*

Toggleable tool

Every time it is triggered, it switches between enable and disable

Parameters

``*args`` Variable length argument to be used by the Tool

``**kwargs`` *toggled* if present and True, sets the initial state of the Tool Arbitrary keyword arguments to be consumed by the Tool

cursor = None
Cursor to use when the tool is active

default_toggled = False
Default of toggled state

disable(*event=None*)
Disable the toggle tool

trigger call this method when *toggled* is True.

This can happen in different circumstances

- Click on the toolbar tool button
- Call to *matplotlib.backend_managers.ToolManager.trigger_tool*
- Another *ToolToggleBase* derived tool is triggered (from the same ToolManager)

enable(*event=None*)
Enable the toggle tool

trigger calls this method when *toggled* is False

radio_group = None
Attribute to group 'radio' like tools (mutually exclusive)

String that identifies the group or **None** if not belonging to a group

set_figure(*figure*)
Assign a figure to the tool

Parameters

figure: 'Figure'

toggled
State of the toggled tool

trigger(*sender*, *event*, *data=None*)
Calls *enable* or *disable* based on *toggled* value

class matplotlib.backend_tools.**ToolViewsPositions**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.ToolBase*

Auxiliary Tool to handle changes in views and positions

Runs in the background and should get used by all the tools that need to access the figure's history of views and positions, e.g.

- *ToolZoom*
- *ToolPan*
- *ToolHome*
- *ToolBack*
- *ToolForward*

add_figure(*figure*)
Add the current figure to the stack of views and positions

back()
Back one step in the stack of views and positions

clear(*figure*)
Reset the axes stack

forward()
Forward one step in the stack of views and positions

home()
Recall the first view and position from the stack

push_current(*figure=None*)
Push the current view limits and position onto their respective stacks

refresh_locators()
Redraw the canvases, update the locators

update_home_views(*figure=None*)
Make sure that self.home_views has an entry for all axes present in the figure

update_view()
Update the view limits and position for each axes from the current stack position. If any axes

are present in the figure that aren't in the current stack position, use the home view limits for those axes and don't update *any* positions.

class matplotlib.backend_tools.**ToolXScale**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.AxisScaleBase*

Tool to toggle between linear and logarithmic scales on the X axis

default_keymap = ['k', 'L']

description = 'Toogle Scale X axis'

set_scale(*ax*, *scale*)

class matplotlib.backend_tools.**ToolYScale**(**args*, ***kwargs*)
Bases: *matplotlib.backend_tools.AxisScaleBase*

Tool to toggle between linear and logarithmic scales on the Y axis

default_keymap = ['l']

description = 'Toogle Scale Y axis'

set_scale(*ax*, *scale*)

class matplotlib.backend_tools.**ToolZoom**(**args*)
Bases: *matplotlib.backend_tools.ZoomPanBase*

Zoom to rectangle

cursor = 2

default_keymap = ['o']

description = 'Zoom to rectangle'

image = 'zoom_to_rect'

radio_group = 'default'

class matplotlib.backend_tools.**ViewsPositionsBase**(*toolmanager*, *name*)
Bases: *matplotlib.backend_tools.ToolBase*

Base class for *ToolHome*, *ToolBack* and *ToolForward*

trigger(*sender*, *event*, *data=None*)
Called when this tool gets used

This method is called by *matplotlib.backend_managers.ToolManager.trigger_tool*

Parameters

event: 'Event' The Canvas event that caused this tool to be called

sender: object Object that requested the tool to be triggered

data: object Extra data

class matplotlib.backend_tools.**ZoomPanBase**(**args*)

Bases: *matplotlib.backend_tools.ToolToggleBase*

Base class for *ToolZoom* and *ToolPan*

disable(*event*)

Release the canvas and disconnect press/release events

enable(*event*)

Connect press/release events and lock the canvas

scroll_zoom(*event*)

trigger(*sender*, *event*, *data=None*)

Calls *enable* or *disable* based on `toggled` value

matplotlib.backend_tools.**add_tools_to_container**(*container, tools=[['navigation', ['home', 'back', 'forward']], ['zoompan', ['pan', 'zoom', 'subplots']], ['io', ['save']]]*)

Add multiple tools to the container.

Parameters

container: Container `backend_bases.ToolContainerBase` object that will get the tools added

tools [list, optional] List in the form [[group1, [tool1, tool2 ...]], [group2, [...]]] Where the tools given by tool1, and tool2 will display in group1. See `add_tool` for details.

matplotlib.backend_tools.**add_tools_to_manager**(*toolmanager*, *tools={'allnav': <class 'matplotlib.backend_tools.ToolEnableAllNavigation'>, 'back': <class 'matplotlib.backend_tools.ToolBack'>, 'cursor': 'ToolSetCursor', 'forward': <class 'matplotlib.backend_tools.ToolForward'>, 'fullscreen': <class 'matplotlib.backend_tools.ToolFullScreen'>, 'grid': <class 'matplotlib.backend_tools.ToolGrid'>, 'grid_minor': <class 'matplotlib.backend_tools.ToolMinorGrid'>, 'home': <class 'matplotlib.backend_tools.ToolHome'>, 'nav': <class 'matplotlib.backend_tools.ToolEnableNavigation'>, 'pan': <class 'matplotlib.backend_tools.ToolPan'>, 'position': <class 'matplotlib.backend_tools.ToolCursorPosition'>, 'quit': <class 'matplotlib.backend_tools.ToolQuit'>, 'quit_all': <class 'matplotlib.backend_tools.ToolQuitAll'>, 'rubberband': 'ToolRubberband', 'save': 'ToolSaveFigure', 'subplots': 'ToolConfigureSubplots', 'viewpos': <class 'matplotlib.backend_tools.ToolViewsPositions'>, 'xscale': <class 'matplotlib.backend_tools.ToolXScale'>, 'yscale': <class 'matplotlib.backend_tools.ToolYScale'>, 'zoom': <class 'matplotlib.backend_tools.ToolZoom'>}*)

Add multiple tools to `ToolManager`

Parameters

toolmanager: ToolManager `backend_managers.ToolManager` object that will get the tools added

tools [{str: class_like}, optional] The tools to add in a {name: tool} dict, see `add_tool` for more info.

matplotlib.backend_tools.**default_toolbar_tools = [['navigation', ['home', 'back', 'forward']],**

Default tools in the toolbar

matplotlib.backend_tools.**default_tools = {'allnav': <class 'matplotlib.backend_tools.ToolEnabl**
Default tools

37.5 matplotlib.backends.backend_agg

An agg http://antigrain.com/ backend

Features that are implemented

- capstyles and join styles
- dashes
- linewidth
- lines, rectangles, ellipses
- clipping to a rectangle
- output to RGBA and PNG, optionally JPEG and TIFF
- alpha blending
- DPI scaling properly - everything scales properly (dashes, linewidths, etc)
- draw polygon
- freetype2 w/ ft2font

TODO:

- integrate screen dpi w/ ppi and text

matplotlib.backends.backend_agg.**FigureCanvas**
alias of *matplotlib.backends.backend_agg.FigureCanvasAgg*

class matplotlib.backends.backend_agg.**FigureCanvasAgg**(*figure*)
Bases: *matplotlib.backend_bases.FigureCanvasBase*

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

Attributes

figure [*matplotlib.figure.Figure*] A high-level Figure instance

buffer_rgba()
Get the image as an RGBA byte string

draw must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

Returns

bytes

copy_from_bbox(*bbox*)

draw()
Draw the figure using the renderer

get_renderer(*cleared=False*)

print_jpeg(*filename_or_obj*, **args*, ***kwargs*)

Other Parameters

quality [int] The image quality, on a scale from 1 (worst) to 95 (best). The default is 95, if not given in the matplotlibrc file in the savefig.jpeg_quality parameter. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

optimize [bool] If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

progressive [bool] If present, indicates that this image should be stored as a progressive JPEG file.

print_jpg(*filename_or_obj*, **args*, ***kwargs*)

Other Parameters

quality [int] The image quality, on a scale from 1 (worst) to 95 (best). The default is 95, if not given in the matplotlibrc file in the savefig.jpeg_quality parameter. Values above 95 should be avoided; 100 completely disables the JPEG quantization stage.

optimize [bool] If present, indicates that the encoder should make an extra pass over the image in order to select optimal encoder settings.

progressive [bool] If present, indicates that this image should be stored as a progressive JPEG file.

print_png(*filename_or_obj*, **args*, ***kwargs*)

print_raw(*filename_or_obj*, **args*, ***kwargs*)

print_rgba(*filename_or_obj*, **args*, ***kwargs*)

print_tif(*filename_or_obj*, **args*, ***kwargs*)

print_tiff(*filename_or_obj*, **args*, ***kwargs*)

print_to_buffer()

restore_region(*region*, *bbox=None*, *xy=None*)

tostring_argb()
Get the image as an ARGB byte string

draw must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

Returns

bytes

tostring_rgb()
Get the image as an RGB byte string

draw must be called at least once before this function will work and to update the renderer for any subsequent changes to the Figure.

Returns

bytes

class matplotlib.backends.backend_agg.**RendererAgg**(*width*, *height*, *dpi*)
Bases: *matplotlib.backend_bases.RendererBase*

The renderer handles all the drawing primitives using a graphics context instance that controls the colors/styles

buffer_rgba()

clear()

debug
Deprecated since version 2.2: The debug function was deprecated in version 2.2.

draw_markers(**kl*, ***kw*)
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.

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.

Parameters

gc [GraphicsContextBase] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

draw_mathtext(*gc*, *x*, *y*, *s*, *prop*, *angle*)
Draw the math text using matplotlib.mathtext

draw_path(*gc*, *path*, *transform*, *rgbFace=None*)
Draw the path

draw_path_collection(**kl*, ***kw*)
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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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_tex(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath='TeX!'*, *mtext=None*)

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)
Render the text

get_canvas_width_height()
return the canvas width and height in display coords

get_text_width_height_descent(*s*, *prop*, *ismath*)
Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

lock = <unlocked _thread.RLock object owner=0 count=0>

option_image_nocomposite()
override this method for renderers that do not necessarily always want to rescale and composite raster images. (like SVG, PDF, or PS)

option_scale_image()
agg backend doesn't support arbitrary scaling of image.

points_to_pixels(*points*)
convert point measures to pixes using dpi and the pixels per inch of the display

restore_region(*region*, *bbox=None*, *xy=None*)
Restore the saved region. If bbox (instance of BboxBase, or its extents) is given, only the region specified by the bbox will be restored. *xy* (a tuple of two floasts) optionally specifies the new position (the LLC of the original region, not the LLC of the bbox) where the region will be restored.

```
>>> region = renderer.copy_from_bbox()
>>> x1, y1, x2, y2 = region.get_extents()
>>> renderer.restore_region(region, bbox=(x1+dx, y1, x2, y2),
...                         xy=(x1-dx, y1))
```

start_filter()
Start filtering. It simply create a new canvas (the old one is saved).

stop_filter(*post_processing*)
Save the plot in the current canvas as a image and apply the *post_processing* function.

def post_processing(image, dpi): # ny, nx, depth = image.shape # image (numpy array) has RGBA channels and has a depth of 4. ... # create a new_image (numpy array of 4 channels, size can be # different). The resulting image may have offsets from # lower-left corner of the original image return new_image, offset_x, offset_y

The saved renderer is restored and the returned image from post_processing is plotted (using draw_image) on it.

tostring_argb()

tostring_rgb()

tostring_rgba_minimized()

matplotlib.backends.backend_agg.**get_hinting_flag**()

37.6 matplotlib.backends.backend_cairo

37.6.1 A Cairo backend for matplotlib

Author Steve Chaplin and others

This backend depends on cairo, and either on cairocffi, or (Python 2 only) on pycairo.

class matplotlib.backends.backend_cairo.**ArrayWrapper**(*myarray*)
Bases: object

Thin wrapper around numpy ndarray to expose the interface expected by cairocffi. Basically replicates the array.array interface.

buffer_info()

matplotlib.backends.backend_cairo.**FigureCanvas**
alias of *matplotlib.backends.backend_cairo.FigureCanvasCairo*

class matplotlib.backends.backend_cairo.**FigureCanvasCairo**(*figure*)

Bases: *matplotlib.backend_bases.FigureCanvasBase*

print_pdf(*fobj*, **args*, ***kwargs*)

print_png(*fobj*, **args*, ***kwargs*)

print_ps(*fobj*, **args*, ***kwargs*)

print_svg(*fobj*, **args*, ***kwargs*)

print_svgz(*fobj*, **args*, ***kwargs*)

supports_blit = False

class matplotlib.backends.backend_cairo.**GraphicsContextCairo**(*renderer*)

Bases: *matplotlib.backend_bases.GraphicsContextBase*

get_rgb()

returns a tuple of three or four floats from 0-1.

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. If `alpha=None` (the default), the alpha components of the foreground and fill colors will be used to set their respective transparencies (where applicable); otherwise, `alpha` will override them.

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(*offset*, *dashes*)

Set the dash style for the gc.

Parameters

dash_offset [float] is the offset (usually 0).

dash_list [array_like] specifies the on-off sequence as points. `(None, None)` specifies a solid line

set_foreground(*fg*, *isRGBA=None*)
Set the foreground color. fg can be a MATLAB format string, a html hex color string, an rgb or rgba unit tuple, or a float between 0 and 1. In the latter case, grayscale is used.

If you know fg is rgba, set `isRGBA=True` for efficiency.

set_joinstyle(*js*)
Set the join style to be one of ('miter', 'round', 'bevel')

set_linewidth(*w*)
Set the linewidth in points

class matplotlib.backends.backend_cairo.**RendererCairo**(*dpi*)
Bases: *matplotlib.backend_bases.RendererBase*

static convert_path(*ctx*, *path*, *transform*, *clip=None*)

draw_image(*gc*, *x*, *y*, *im*)
Draw an RGBA image.

Parameters

gc [GraphicsContextBase] a graphics context with clipping information.

x [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

y [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

im [array_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

transform [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that `option_scale_image()` returns `True`, an affine transformation *may* be passed to *draw_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override `x` and `y`, and has to be applied *before* translating the result by `x` and `y` (this can be accomplished by adding `x` and `y` to the translation vector defined by `transform`).

draw_markers(*gc*, *marker_path*, *marker_trans*, *path*, *transform*, *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.

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.

Parameters

gc [GraphicsContextBase] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

draw_path(*gc*, *path*, *transform*, *rgbFace=None*)
Draws a *Path* instance using the given affine transform.

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)
Draw the text instance

Parameters

gc [GraphicsContextBase] the graphics context

x [scalar] the x location of the text in display coords

y [scalar] the y location of the text baseline in display coords

s [str] the text string

prop [*matplotlib.font_manager.FontProperties*] font properties

angle [scalar] the rotation angle in degrees

mtext [*matplotlib.text.Text*] the original text object to be rendered

Notes

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 plotted along with your text.

fontangles = {'italic': <MyCairoCffi name='mock.FONT_SLANT_ITALIC' id='139831684338520'>,

fontweights = {100: <MyCairoCffi name='mock.FONT_WEIGHT_NORMAL' id='139831685276504'>, 20

get_canvas_width_height()
return the canvas width and height in display coords

get_text_width_height_descent(*s*, *prop*, *ismath*)
Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

new_gc()
Return an instance of a GraphicsContextBase

points_to_pixels(*points*)

Convert points to display units

You need to override this function (unless your backend doesn't have a dpi, e.g., 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
```

Parameters

points [scalar or array_like] a float or a numpy array of float

Returns

Points converted to pixels

set_ctx_from_surface(*surface*)

set_width_height(*width*, *height*)

37.7 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.

37.8 matplotlib.backends.backend_gtkcairo

TODO We'll add this later, importing the gtk backends requires an active X-session, which is not compatible with cron jobs.

37.9 matplotlib.backends.backend_gtk3agg

TODO We'll add this later, importing the gtk3 backends requires an active X-session, which is not compatible with cron jobs.

37.10 matplotlib.backends.backend_gtk3cairo

TODO We'll add this later, importing the gtk3 backends requires an active X-session, which is not compatible with cron jobs.

37.11 matplotlib.backends.backend_nbagg

Interactive figures in the IPython notebook

class matplotlib.backends.backend_nbagg.**CommSocket**(*manager*)

Bases: object

Manages the Comm connection between IPython and the browser (client).

Comms are 2 way, with the CommSocket being able to publish a message via the send_json method, and handle a message with on_message. On the JS side figure.send_message and figure.ws.onmessage do the sending and receiving respectively.

is_open()

on_close()

on_message(*message*)

send_binary(*blob*)

send_json(*content*)

matplotlib.backends.backend_nbagg.**FigureCanvas**

alias of *matplotlib.backends.backend_nbagg.FigureCanvasNbAgg*

class matplotlib.backends.backend_nbagg.**FigureCanvasNbAgg**(**args*, ***kwargs*)

Bases: matplotlib.backends.backend_webagg_core.FigureCanvasWebAggCore

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.

Other Parameters

interval [scalar] Timer interval in milliseconds

callbacks [List[Tuple[callable, Tuple, Dict]]] Sequence of (func, args, kwargs) where `func(*args, **kwargs)` will be executed by the timer every *interval*.

callbacks which return `False` or `0` will be removed from the timer.

Examples

```
>>> timer = fig.canvas.new_timer(callbacks=[(f1, (1, ), {'a': 3}),])
```

matplotlib.backends.backend_nbagg.**FigureManager**

alias of *matplotlib.backends.backend_nbagg.FigureManagerNbAgg*

class matplotlib.backends.backend_nbagg.**FigureManagerNbAgg**(*canvas*, *num*)
Bases: matplotlib.backends.backend_webagg_core.FigureManagerWebAgg

ToolbarCls
alias of *NavigationIPy*

clearup_closed()
Clear up any closed Comms.

connected

destroy()

display_js()

classmethod get_javascript(*stream=None*)

remove_comm(*comm_id*)

reshow()
A special method to re-show the figure in the notebook.

show()
For GUI backends, show the figure window and redraw. For non-GUI backends, raise an exception to be caught by *show()*, for an optional warning.

class matplotlib.backends.backend_nbagg.**NavigationIPy**(*canvas*)
Bases: matplotlib.backends.backend_webagg_core.NavigationToolbar2WebAgg

toolitems = [('Home', 'Reset original view', 'fa fa-home icon-home', 'home'), ('Back', 'Ba

matplotlib.backends.backend_nbagg.**connection_info**()
Return a string showing the figure and connection status for the backend. This is intended as a diagnostic tool, and not for general use.

matplotlib.backends.backend_nbagg.**new_figure_manager_given_figure**(*num*, *figure*)
Create a new figure manager instance for the given figure.

matplotlib.backends.backend_nbagg.**show**(**args*, ***kwargs*)
Show all figures.

show blocks by calling `mainloop` if *block* is `True`, or if it is `None` and we are neither in IPython's `%pylab` mode, nor in `interactive` mode.

37.12 matplotlib.backends.backend_pdf

A PDF matplotlib backend Author: Jouni K Seppänen <jks@iki.fi>

matplotlib.backends.backend_pdf.**FigureCanvas**
alias of *matplotlib.backends.backend_pdf.FigureCanvasPdf*

class matplotlib.backends.backend_pdf.**FigureCanvasPdf**(*figure*)
Bases: *matplotlib.backend_bases.FigureCanvasBase*

The canvas the figure renders into. Calls the draw and print fig methods, creates the renderers, etc...

Attributes

figure [*matplotlib.figure.Figure*] A high-level Figure instance

draw()
Render the *Figure*.

filetypes = {'pdf': 'Portable Document Format'}

fixed_dpi = 72

get_default_filetype()
Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

print_pdf(*filename*, ***kwargs*)

matplotlib.backends.backend_pdf.**FigureManager**
alias of *matplotlib.backends.backend_pdf.FigureManagerPdf*

class matplotlib.backends.backend_pdf.**FigureManagerPdf**(*canvas*, *num*)
Bases: *matplotlib.backend_bases.FigureManagerBase*

class matplotlib.backends.backend_pdf.**GraphicsContextPdf**(*file*)
Bases: *matplotlib.backend_bases.GraphicsContextBase*

alpha_cmd(*alpha*, *forced*, *effective_alphas*)

capstyle_cmd(*style*)

capstyles = {'butt': 0, 'projecting': 2, 'round': 1}

clip_cmd(*cliprect*, *clippath*)
Set clip rectangle. Calls self.pop() and self.push().

commands = ((('_cliprect', '_clippath'), <function GraphicsContextPdf.clip_cmd>), (('_alph

copy_properties(*other*)
Copy properties of other into self.

dash_cmd(*dashes*)

delta(*other*)
Copy properties of other into self and return PDF commands needed to transform self into other.

fill(**args*)
Predicate: does the path need to be filled?

An optional argument can be used to specify an alternative _fillcolor, as needed by RendererPdf.draw_markers.

fillcolor_cmd(*rgb*)

finalize()
Make sure every pushed graphics state is popped.

hatch_cmd(*hatch*, *hatch_color*)

joinstyle_cmd(*style*)

joinstyles = {'bevel': 2, 'miter': 0, 'round': 1}

linewidth_cmd(*width*)

paint()
Return the appropriate pdf operator to cause the path to be stroked, filled, or both.

pop()

push()

rgb_cmd(*rgb*)

stroke()
Predicate: does the path need to be stroked (its outline drawn)? This tests for the various conditions that disable stroking the path, in which case it would presumably be filled.

class matplotlib.backends.backend_pdf.**Name**(*name*)
Bases: object

PDF name object.

static hexify(*match*)

name

pdfRepr()

class matplotlib.backends.backend_pdf.**Operator**(*op*)

Bases: object

PDF operator object.

op

pdfRepr()

class matplotlib.backends.backend_pdf.**PdfFile**(*filename*, *metadata=None*)

Bases: object

PDF file object.

addGouraudTriangles(*points*, *colors*)

alphaState(*alpha*)

Return name of an ExtGState that sets alpha to the given value.

beginStream(*id*, *len*, *extra=None*, *png=None*)

close()

Flush all buffers and free all resources.

createType1Descriptor(*t1font*, *fontfile*)

dviFontName(*dvifont*)

Given a dvi font object, return a name suitable for Op.selectfont. This registers the font information in self.dviFontInfo if not yet registered.

embedTTF(*filename*, *characters*)

Embed the TTF font from the named file into the document.

endStream()

finalize()

Write out the various deferred objects and the pdf end matter.

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 of the font.

hatchPattern(*hatch_style*)

imageObject(*image*)

Return name of an image XObject representing the given image.

markerObject(*path*, *trans*, *fill*, *stroke*, *lw*, *joinstyle*, *capstyle*)

Return name of a marker XObject representing the given path.

newPage(*width*, *height*)

newTextnote(*text, positionRect=[-100, -100, 0, 0]*)

output(**data*)

pathCollectionObject(*gc*, *path*, *trans*, *padding*, *filled*, *stroked*)

static pathOperations(*path*, *transform*, *clip=None*, *simplify=None*, *sketch=None*)

recordXref(*id*)

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.

texFontMap

write(*data*)

writeFonts()

writeGouraudTriangles()

writeHatches()

writeImages()

writeInfoDict()
Write out the info dictionary, checking it for good form

writeMarkers()

writeObject(*object*, *contents*)

writePath(*path*, *transform*, *clip=False*, *sketch=None*)

writePathCollectionTemplates()

writeTrailer()
Write out the PDF trailer.

writeXref()
Write out the xref table.

class matplotlib.backends.backend_pdf.**PdfPages**(*filename*, *keep_empty=True*, *metadata=None*)

Bases: object

A multi-page PDF file.

Notes

In reality *PdfPages* is a thin wrapper around *PdfFile*, in order to avoid confusion when using *savefig()* and forgetting the format argument.

Examples

```
>>> import matplotlib.pyplot as plt
>>> # Initialize:
>>> with PdfPages('foo.pdf') as pdf:
...     # As many times as you like, create a figure fig and save it:
...     fig = plt.figure()
...     pdf.savefig(fig)
...     # When no figure is specified the current figure is saved
...     pdf.savefig()
```

Create a new PdfPages object.

Parameters

filename [str] Plots using *PdfPages.savefig()* will be written to a file at this location. The file is opened at once and any older file with the same name is overwritten.

keep_empty [bool, optional] If set to False, then empty pdf files will be deleted automatically when closed.

metadata [dictionary, optional] Information dictionary object (see PDF reference section 10.2.1 'Document Information Dictionary'), e.g.: `{'Creator': 'My software', 'Author': 'Me', 'Title': 'Awesome fig'}`

The standard keys are `'Title'`, `'Author'`, `'Subject'`, `'Keywords'`, `'Creator'`, `'Producer'`, `'CreationDate'`, `'ModDate'`, and `'Trapped'`. Values have been predefined for `'Creator'`, `'Producer'` and `'CreationDate'`. They can be removed by setting them to `None`.

attach_note(*text, positionRect=[-100, -100, 0, 0]*)
Add a new text note to the page to be saved next. The optional positionRect specifies the position of the new note on the page. It is outside the page per default to make sure it is invisible on printouts.

close()
Finalize this object, making the underlying file a complete PDF file.

get_pagecount()
Returns the current number of pages in the multipage pdf file.

infodict()
Return a modifiable information dictionary object (see PDF reference section 10.2.1 'Document Information Dictionary').

keep_empty

savefig(*figure=None*, ***kwargs*)
Saves a *Figure* to this file as a new page.

Any other keyword arguments are passed to *savefig()*.

Parameters

figure [*Figure* or int, optional] Specifies what figure is saved to file. If not specified, the active figure is saved. If a *Figure* instance is provided, this figure is saved. If an int is specified, the figure instance to save is looked up by number.

class matplotlib.backends.backend_pdf.**Reference**(*id*)
Bases: object

PDF reference object. Use PdfFile.reserveObject() to create References.

pdfRepr()

write(*contents*, *file*)

class matplotlib.backends.backend_pdf.**RendererPdf**(*file*, *image_dpi*, *height*, *width*)
Bases: *matplotlib.backend_bases.RendererBase*

afm_font_cache = {}

check_gc(*gc*, *fillcolor=None*)

draw_gouraud_triangle(*gc*, *points*, *colors*, *trans*)
Draw a Gouraud-shaded triangle.

Parameters

points [array_like, shape=(3, 2)] Array of (x, y) points for the triangle.

colors [array_like, shape=(3, 4)] RGBA colors for each point of the triangle.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_gouraud_triangles(*gc*, *points*, *colors*, *trans*)
Draws a series of Gouraud triangles.

Parameters

points [array_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

colors [array_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_image(*gc*, *x*, *y*, *im*, *transform=None*)
Draw an RGBA image.

Parameters

gc [GraphicsContextBase] a graphics context with clipping information.

x [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

y [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

im [array_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

transform [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option_scale_image()* returns True, an affine transformation *may* be passed to *draw_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override x and y, and has to be applied *before* translating the result by x and y (this can be accomplished by adding x and y to the translation vector defined by transform).

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.

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.

Parameters

gc [GraphicsContextBase] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

draw_mathtext(*gc*, *x*, *y*, *s*, *prop*, *angle*)

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*, *offset_position*)
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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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_tex(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath='TeX!'*, *mtext=None*)

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)
Draw the text instance

Parameters

gc [GraphicsContextBase] the graphics context

x [scalar] the x location of the text in display coords

y [scalar] the y location of the text baseline in display coords

s [str] the text string

prop [*matplotlib.font_manager.FontProperties*] font properties

angle [scalar] the rotation angle in degrees

mtext [*matplotlib.text.Text*] the original text object to be rendered

Notes

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 plotted along with your text.

encode_string(*s*, *fonttype*)

finalize()

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_text_width_height_descent(*s*, *prop*, *ismath*)
Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

merge_used_characters(*other*)

new_gc()
Return an instance of a GraphicsContextBase

option_image_nocomposite()
return whether to generate a composite image from multiple images on a set of axes

option_scale_image()
pdf backend support arbitrary scaling of image.

track_characters(*font*, *s*)
Keeps track of which characters are required from each font.

class matplotlib.backends.backend_pdf.**Stream**(*id*, *len*, *file*, *extra=None*, *png=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; png: if the data is already png compressed, the decode parameters

compressobj

end()
Finalize stream.

extra

file

id

len

pdfFile

pos

write(*data*)
Write some data on the stream.

class matplotlib.backends.backend_pdf.**Verbatim**(*x*)
Bases: object

Store verbatim PDF command content for later inclusion in the stream.

pdfRepr()

matplotlib.backends.backend_pdf.**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.

matplotlib.backends.backend_pdf.**pdfRepr**(*obj*)
Map Python objects to PDF syntax.

37.13 matplotlib.backends.backend_pgf

matplotlib.backends.backend_pgf.**FigureCanvas**
alias of *matplotlib.backends.backend_pgf.FigureCanvasPgf*

class matplotlib.backends.backend_pgf.**FigureCanvasPgf**(*figure*)
Bases: *matplotlib.backend_bases.FigureCanvasBase*

filetypes = {'pdf': 'LaTeX compiled PGF picture', 'pgf': 'LaTeX PGF picture', 'png': 'P

get_default_filetype()
Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

get_renderer()

print_pdf(*fname_or_fh*, **args*, ***kwargs*)
Use LaTeX to compile a Pgf generated figure to PDF.

print_pgf(*fname_or_fh*, **args*, ***kwargs*)
Output pgf commands for drawing the figure so it can be included and rendered in latex documents.

print_png(*fname_or_fh*, **args*, ***kwargs*)
Use LaTeX to compile a pgf figure to pdf and convert it to png.

matplotlib.backends.backend_pgf.**FigureManager**
alias of *matplotlib.backends.backend_pgf.FigureManagerPgf*

class matplotlib.backends.backend_pgf.**FigureManagerPgf**(**args*)
Bases: *matplotlib.backend_bases.FigureManagerBase*

class matplotlib.backends.backend_pgf.**GraphicsContextPgf**
Bases: *matplotlib.backend_bases.GraphicsContextBase*

exception matplotlib.backends.backend_pgf.**LatexError**(*message*, *latex_output=''*)
Bases: Exception

class matplotlib.backends.backend_pgf.**LatexManager**
Bases: object

The LatexManager opens an instance of the LaTeX application for determining the metrics of text elements. The LaTeX environment can be modified by setting fonts and/or a custem preamble in the rc parameters.

get_width_height_descent(*text*, *prop*)
Get the width, total height and descent for a text typesetted by the current LaTeX environment.

class matplotlib.backends.backend_pgf.**LatexManagerFactory**
Bases: object

static get_latex_manager()

previous_instance = None

class matplotlib.backends.backend_pgf.**RendererPgf**(*figure*, *fh*, *dummy=False*)
Bases: *matplotlib.backend_bases.RendererBase*

Creates a new PGF renderer that translates any drawing instruction into text commands to be interpreted in a latex pgfpicture environment.

Attributes

figure [*matplotlib.figure.Figure*] Matplotlib figure to initialize height, width and dpi from.

fh [file-like] File handle for the output of the drawing commands.

draw_image(*gc*, *x*, *y*, *im*, *transform=None*)
Draw an RGBA image.

Parameters

gc [GraphicsContextBase] a graphics context with clipping information.

x [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

y [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

im [array_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

transform [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option_scale_image()* returns `True`, an affine transformation *may* be passed to *draw_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override `x` and `y`, and has to be applied *before* translating the result by `x` and `y` (this can be accomplished by adding `x` and `y` to the translation vector defined by `transform`).

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.

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.

Parameters

gc [`GraphicsContextBase`] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

draw_path(*gc*, *path*, *transform*, *rgbFace=None*)

Draws a *Path* instance using the given affine transform.

draw_tex(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath='TeX!'*, *mtext=None*)

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)

Draw the text instance

Parameters

gc [`GraphicsContextBase`] the graphics context

x [scalar] the x location of the text in display coords

y [scalar] the y location of the text baseline in display coords

s [str] the text string

prop [*matplotlib.font_manager.FontProperties*] font properties

angle [scalar] the rotation angle in degrees

mtext [*matplotlib.text.Text*] the original text object to be rendered

Notes

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 plotted 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_text_width_height_descent(*s*, *prop*, *ismath*)
Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

new_gc()
Return an instance of a GraphicsContextBase

option_image_nocomposite()
return whether to generate a composite image from multiple images on a set of axes

option_scale_image()
pgf backend supports affine transform of image.

points_to_pixels(*points*)
Convert points to display units

You need to override this function (unless your backend doesn't have a dpi, e.g., 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
```

Parameters

points [scalar or array_like] a float or a numpy array of float

Returns

Points converted to pixels

class matplotlib.backends.backend_pgf.**TmpDirCleaner**
Bases: object

static add(*tmpdir*)

static cleanup_remaining_tmpdirs()

remaining_tmpdirs = set()

matplotlib.backends.backend_pgf.**common_texification**(*text*)
Do some necessary and/or useful substitutions for texts to be included in LaTeX documents.

matplotlib.backends.backend_pgf.**get_fontspec**()
Build fontspec preamble from rc.

matplotlib.backends.backend_pgf.**get_preamble**()
Get LaTeX preamble from rc.

matplotlib.backends.backend_pgf.**get_texcommand**()
Get chosen TeX system from rc.

matplotlib.backends.backend_pgf.**make_pdf_to_png_converter**()
Returns a function that converts a pdf file to a png file.

matplotlib.backends.backend_pgf.**repl_escapetext**(*m*)

matplotlib.backends.backend_pgf.**repl_mathdefault**(*m*)

matplotlib.backends.backend_pgf.**writeln**(*fh*, *line*)

37.14 matplotlib.backends.backend_ps

A PostScript backend, which can produce both PostScript .ps and .eps

matplotlib.backends.backend_ps.**FigureCanvas**
alias of *matplotlib.backends.backend_ps.FigureCanvasPS*

class matplotlib.backends.backend_ps.**FigureCanvasPS**(*figure*)
Bases: *matplotlib.backend_bases.FigureCanvasBase*

draw()
Render the *Figure*.

filetypes = {'eps': 'Encapsulated Postscript', 'ps': 'Postscript'}

fixed_dpi = 72

get_default_filetype()
Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

print_eps(*outfile*, **args*, ***kwargs*)

print_ps(*outfile*, **args*, ***kwargs*)

matplotlib.backends.backend_ps.**FigureManager**
alias of *matplotlib.backends.backend_ps.FigureManagerPS*

class matplotlib.backends.backend_ps.**FigureManagerPS**(*canvas*, *num*)
Bases: *matplotlib.backend_bases.FigureManagerBase*

class matplotlib.backends.backend_ps.**GraphicsContextPS**
Bases: *matplotlib.backend_bases.GraphicsContextBase*

get_capstyle()
Return the capstyle as a string in ('butt', 'round', 'projecting')

get_joinstyle()
Return the line join style as one of ('miter', 'round', 'bevel')

shouldstroke()

class matplotlib.backends.backend_ps.**PsBackendHelper**
Bases: object

gs_exe
executable name of ghostscript.

gs_version
version of ghostscript.

supports_ps2write
True if the installed ghostscript supports ps2write device.

class matplotlib.backends.backend_ps.**RendererPS**(*width*, *height*, *pswriter*, *imagedpi=72*)
Bases: *matplotlib.backend_bases.RendererBase*

The renderer handles all the drawing primitives using a graphics context instance that controls the colors/styles.

Although postscript itself is dpi independent, we need to imform the image code about a requested dpi to generate high res images and them scale them before embeddin them

afmfontd = {}

create_hatch(*hatch*)

draw_gouraud_triangle(*gc*, *points*, *colors*, *trans*)
Draw a Gouraud-shaded triangle.

Parameters

points [array_like, shape=(3, 2)] Array of (x, y) points for the triangle.

colors [array_like, shape=(3, 4)] RGBA colors for each point of the triangle.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_gouraud_triangles(*gc*, *points*, *colors*, *trans*)
Draws a series of Gouraud triangles.

Parameters

points [array_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

colors [array_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_image(*gc*, *x*, *y*, *im*, *transform=None*)
Draw the Image instance into the current axes; x is the distance in pixels from the left hand side of the canvas and y is the distance from bottom

draw_markers(*gc*, *marker_path*, *marker_trans*, *path*, *trans*, *rgbFace=None*)
Draw the markers defined by path at each of the positions in x and y. path coordinates are points, x and y coords will be transformed by the transform

draw_mathtext(*gc*, *x*, *y*, *s*, *prop*, *angle*)
Draw the math text using matplotlib.mathtext

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*, *offset_position*)
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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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_tex(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath='TeX!'*, *mtext=None*)
draw a Text instance

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)
Draw a Text instance.

flipy()
return true if small y numbers are top for renderer

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_text_width_height_descent(*s*, *prop*, *ismath*)
get the width and height in display coords of the string s with FontPropertry prop

merge_used_characters(*other*)

new_gc()
Return an instance of a GraphicsContextBase

option_image_nocomposite()
return whether to generate a composite image from multiple images on a set of axes

option_scale_image()
ps backend support arbitrary scaling of image.

set_color(*r*, *g*, *b*, *store=1*)

set_font(*fontname*, *fontsize*, *store=1*)

set_linecap(*linecap*, *store=1*)

set_linedash(*offset*, *seq*, *store=1*)

set_linejoin(*linejoin*, *store=1*)

set_linewidth(*linewidth*, *store=1*)

track_characters(*font*, *s*)
Keeps track of which characters are required from each font.

matplotlib.backends.backend_ps.**convert_psfrags**(*tmpfile*, *psfrags*, *font_preamble*, *custom_preamble*, *paperWidth*, *paperHeight*, *orientation*)
When we want to use the LaTeX backend with postscript, we write PSFrag tags to a temporary postscript file, each one marking a position for LaTeX to render some text. convert_psfrags generates a LaTeX document containing the commands to convert those tags to text. LaTeX/dvips produces the postscript file that includes the actual text.

matplotlib.backends.backend_ps.**get_bbox**(*tmpfile*, *bbox*)
Use ghostscript's bbox device to find the center of the bounding box. Return an appropriately sized bbox centered around that point. A bit of a hack.

matplotlib.backends.backend_ps.**get_bbox_header**(*lbrt*, *rotated=False*)
return a postscript header stringfor the given bbox lbrt=(l, b, r, t). Optionally, return rotate command.

matplotlib.backends.backend_ps.**gs_distill**(*tmpfile*, *eps=False*, *ptype='letter'*, *bbox=None*, *rotated=False*)
Use ghostscript's pswrite or epswrite device to distill a file. This yields smaller files without illegal encapsulated postscript operators. The output is low-level, converting text to outlines.

matplotlib.backends.backend_ps.**pstoeps**(*tmpfile*, *bbox=None*, *rotated=False*)
Convert the postscript to encapsulated postscript. The bbox of the eps file will be replaced with the given *bbox* argument. If None, original bbox will be used.

matplotlib.backends.backend_ps.**quote_ps_string**(*s*)
Quote dangerous characters of S for use in a PostScript string constant.

matplotlib.backends.backend_ps.**xpdf_distill**(*tmpfile*, *eps=False*, *ptype='letter'*, *bbox=None*, *rotated=False*)
Use ghostscript's ps2pdf and xpdf's/poppler's pdftops to distill a file. This yields smaller files without illegal encapsulated postscript operators. This distiller is preferred, generating high-level postscript output that treats text as text.

37.15 matplotlib.backends.backend_qt4agg

NOTE Not included, to avoid adding a dependency to building the docs.

37.16 matplotlib.backends.backend_qt4cairo

NOTE Not included, to avoid adding a dependency to building the docs.

37.17 matplotlib.backends.backend_qt5agg

NOTE Not included, to avoid adding a dependency to building the docs.

37.18 matplotlib.backends.backend_qt5cairo

NOTE Not included, to avoid adding a dependency to building the docs.

37.19 matplotlib.backends.backend_svg

matplotlib.backends.backend_svg.**FigureCanvas**
alias of *matplotlib.backends.backend_svg.FigureCanvasSVG*

class matplotlib.backends.backend_svg.**FigureCanvasSVG**(*figure*)
Bases: *matplotlib.backend_bases.FigureCanvasBase*

filetypes = {'svg': 'Scalable Vector Graphics', 'svgz': 'Scalable Vector Graphics'}

fixed_dpi = 72

get_default_filetype()
Get the default savefig file format as specified in rcParam `savefig.format`. Returned string excludes period. Overridden in backends that only support a single file type.

print_svg(*filename*, **args*, ***kwargs*)

print_svgz(*filename*, **args*, ***kwargs*)

matplotlib.backends.backend_svg.**FigureManager**
alias of *matplotlib.backends.backend_svg.FigureManagerSVG*

class matplotlib.backends.backend_svg.**FigureManagerSVG**(*canvas*, *num*)
Bases: *matplotlib.backend_bases.FigureManagerBase*

class matplotlib.backends.backend_svg.**RendererSVG**(*width*, *height*, *svgwriter*, *basename=None*, *image_dpi=72*)
Bases: *matplotlib.backend_bases.RendererBase*

FONT_SCALE = 100.0

close_group(*s*)
Close a grouping element with label *s* Is only currently used by *backend_svg*

draw_gouraud_triangle(*gc*, *points*, *colors*, *trans*)
Draw a Gouraud-shaded triangle.

Parameters

points [array_like, shape=(3, 2)] Array of (x, y) points for the triangle.

colors [array_like, shape=(3, 4)] RGBA colors for each point of the triangle.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_gouraud_triangles(*gc*, *triangles_array*, *colors_array*, *transform*)
Draws a series of Gouraud triangles.

Parameters

points [array_like, shape=(N, 3, 2)] Array of *N* (x, y) points for the triangles.

colors [array_like, shape=(N, 3, 4)] Array of *N* RGBA colors for each point of the triangles.

transform [*matplotlib.transforms.Transform*] An affine transform to apply to the points.

draw_image(*gc*, *x*, *y*, *im*, *transform=None*)
Draw an RGBA image.

Parameters

gc [GraphicsContextBase] a graphics context with clipping information.

x [scalar] the distance in physical units (i.e., dots or pixels) from the left hand side of the canvas.

y [scalar] the distance in physical units (i.e., dots or pixels) from the bottom side of the canvas.

im [array_like, shape=(N, M, 4), dtype=np.uint8] An array of RGBA pixels.

transform [*matplotlib.transforms.Affine2DBase*] If and only if the concrete backend is written such that *option_scale_image()* returns True, an affine transformation *may* be passed to *draw_image()*. It takes the form of a *Affine2DBase* instance. The translation vector of the transformation is given in physical units (i.e., dots or pixels). Note that the transformation does not override x and y, and has to be applied *before* translating the result by x and y (this can be accomplished by adding x and y to the translation vector defined by transform).

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.

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.

Parameters

gc [GraphicsContextBase] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

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*, *offset_position*)
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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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_tex(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath='TeX!'*, *mtext=None*)

draw_text(*gc*, *x*, *y*, *s*, *prop*, *angle*, *ismath=False*, *mtext=None*)

Draw the text instance

Parameters

gc [`GraphicsContextBase`] the graphics context

x [scalar] the x location of the text in display coords

y [scalar] the y location of the text baseline in display coords

s [str] the text string

prop [*matplotlib.font_manager.FontProperties*] font properties

angle [scalar] the rotation angle in degrees

mtext [*matplotlib.text.Text*] the original text object to be rendered

Notes

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 plotted along with your text.

finalize()

flipy()

Return true if y small numbers are top for renderer Is used for drawing text (*matplotlib.text*) and images (*matplotlib.image*) only

fontd = {}

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_text_width_height_descent(*s*, *prop*, *ismath*)
Get the width, height, and descent (offset from the bottom to the baseline), in display coords, of the string *s* with *FontProperties* *prop*

open_group(*s*, *gid=None*)
Open a grouping element with label *s*. If *gid* is given, use *gid* as the id of the group.

option_image_nocomposite()
return whether to generate a composite image from multiple images on a set of axes

option_scale_image()
override this method for renderers that support arbitrary affine transformations in *draw_image()* (most vector backends).

class matplotlib.backends.backend_svg.**XMLWriter**(*file*)
Bases: object

close(*id*)

comment(*comment*)

data(*text*)

element(*tag*, *text=None*, *attrib={}*, ***extra*)

end(*tag=None*, *indent=True*)

flush()

start(*tag*, *attrib={}*, ***extra*)

matplotlib.backends.backend_svg.**escape_attrib**(*s*)

matplotlib.backends.backend_svg.**escape_cdata**(*s*)

matplotlib.backends.backend_svg.**escape_comment**(*s*)

matplotlib.backends.backend_svg.**generate_css**(*attrib={}*)

matplotlib.backends.backend_svg.**generate_transform**(*transform_list=[]*)

matplotlib.backends.backend_svg.**short_float_fmt**(*x*)
Create a short string representation of a float, which is %f formatting with trailing zeros and the decimal point removed.

37.20 matplotlib.backends.backend_tkagg

matplotlib.backends.backend_tkagg.**FigureCanvas**
alias of *matplotlib.backends.backend_tkagg.FigureCanvasTkAgg*

class matplotlib.backends.backend_tkagg.**FigureCanvasTkAgg**(*figure*, *master=None*, *resize_callback=None*)
Bases: *matplotlib.backends.backend_agg.FigureCanvasAgg*, matplotlib.backends._backend_tk.FigureCanvasTk

blit(*bbox=None*)
Blit the canvas in bbox (default entire canvas).

draw()
Draw the figure using the renderer

class matplotlib.backends.backend_tkagg.**FigureManagerTkAgg**(***kwargs*)
Bases: matplotlib.backends._backend_tk.FigureManagerTk

Deprecated since version 2.2: The FigureManagerTkAgg class was deprecated in version 2.2.

class matplotlib.backends.backend_tkagg.**NavigationToolbar2TkAgg**(***kwargs*)
Bases: matplotlib.backends._backend_tk.NavigationToolbar2Tk

Deprecated since version 2.2: The NavigationToolbar2TkAgg class was deprecated in version 2.2.

37.21 matplotlib.backends.backend_webagg

Note: The WebAgg backend is not documented here, in order to avoid adding Tornado to the doc build requirements.

37.22 matplotlib.backends.backend_wxagg

matplotlib.backends.backend_wxagg.**FigureCanvas**
alias of *matplotlib.backends.backend_wxagg.FigureCanvasWxAgg*

class matplotlib.backends.backend_wxagg.**FigureCanvasWxAgg**(*parent*, *id*, *figure*)
Bases: *matplotlib.backends.backend_agg.FigureCanvasAgg*, matplotlib.backends.backend_wx._FigureCanvasWxBase

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.

filetypes = {'eps': 'Encapsulated Postscript', 'jpeg': 'Joint Photographic Experts Group

class matplotlib.backends.backend_wxagg.**FigureFrameWxAgg**(*num*, *fig*)
Bases: matplotlib.backends.backend_wx.FigureFrameWx

get_canvas(*fig*)

class matplotlib.backends.backend_wxagg.**Toolbar**(***kwargs*)
Bases: matplotlib.backends.backend_wx.NavigationToolbar2Wx

Deprecated since version 2.2: The Toolbar class was deprecated in version 2.2. Use NavigationToolbar2WxAgg instead.

CHAPTER

THIRTYEIGHT

CBOOK

38.1 matplotlib.cbook

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

This module is safe to import from anywhere within matplotlib; it imports matplotlib only at runtime.

class matplotlib.cbook.**Bunch**(***kwds*)

Bases: object

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: https://code.activestate.com/recipes/121294/
```

class matplotlib.cbook.**CallbackRegistry**(*exception_handler=<function _exception_printer>*)

Bases: object

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

```
>>> def oneat(x):
...     print('eat', x)
>>> def ondrink(x):
...     print('drink', x)
```

```
>>> from matplotlib.cbook import CallbackRegistry
>>> callbacks = CallbackRegistry()
```

```
>>> id_eat = callbacks.connect('eat', oneat)
>>> id_drink = callbacks.connect('drink', ondrink)
```

```
>>> callbacks.process('drink', 123)
drink 123
>>> callbacks.process('eat', 456)
eat 456
>>> callbacks.process('be merry', 456) # nothing will be called
>>> callbacks.disconnect(id_eat)
>>> 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.

Parameters

exception_handler [callable, optional] If provided must have signature

```
def handler(exc: Exception) -> None:
```

If not None this function will be called with any `Exception` subclass raised by the callbacks in *`CallbackRegistry.process`*. The handler may either consume the exception or re-raise.

The callable must be pickle-able.

The default handler is

```
def h(exc):
    traceback.print_exc()
```

connect(*s*, *func*)
Register *func* to be called when signal *s* is generated.

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 matplotlib.cbook.**GetRealpathAndStat**
Bases: `object`

class matplotlib.cbook.**Grouper**(*init=()*)
Bases: `object`

This class provides a lightweight way to group arbitrary objects together into disjoint sets when a full-blown graph data structure would be overkill.

Objects can be joined using *join()*, tested for connectedness using *joined()*, and all disjoint sets can be retrieved by using the object as an iterator.

The objects being joined must be hashable and weak-referenceable.

For example:

```
>>> from matplotlib.cbook import Grouper
>>> class Foo(object):
...     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']
>>> grp = Grouper()
>>> grp.join(a, b)
>>> grp.join(b, c)
>>> grp.join(d, e)
>>> sorted(map(tuple, grp))
[(a, b, c), (d, e)]
>>> grp.joined(a, b)
True
>>> grp.joined(a, c)
True
>>> grp.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.

remove(*a*)

exception matplotlib.cbook.**IgnoredKeywordWarning**
Bases: UserWarning

A class for issuing warnings about keyword arguments that will be ignored by matplotlib

class matplotlib.cbook.**Locked**(*path*)
Bases: object

Context manager to handle locks.

Based on code from conda.

(c) 2012-2013 Continuum Analytics, Inc. / https://www.continuum.io/ All Rights Reserved

conda is distributed under the terms of the BSD 3-clause license. Consult LICENSE_CONDA or https://opensource.org/licenses/BSD-3-Clause.

LOCKFN = '.matplotlib_lock'

exception TimeoutError
Bases: RuntimeError

class matplotlib.cbook.**Null**(***kwargs*)
Bases: object

Deprecated since version 2.1: The Null class was deprecated in version 2.1.

Null objects always and reliably "do nothing."

class matplotlib.cbook.**RingBuffer**(***kwargs*)
Bases: object

Deprecated since version 2.1: The RingBuffer class was deprecated in version 2.1.

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 matplotlib.cbook.**Sorter**(***kwargs*)
Bases: object

Deprecated since version 2.1: sorted(..., key=itemgetter(...))

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 matplotlib.cbook.**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 matplotlib.cbook.**Xlator**(***kwargs*)

Bases: dict

Deprecated since version 2.1: The Xlator class was deprecated in version 2.1.

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.

matplotlib.cbook.**align_iterators**(*func*, **iterables*)

Deprecated since version 2.2: The align_iterators function was deprecated in version 2.2.

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

matplotlib.cbook.**allequal**(*seq*)

Deprecated since version 2.1: The allequal function was deprecated in version 2.1.

Return *True* if all elements of *seq* compare equal. If *seq* is 0 or 1 length, return *True*

matplotlib.cbook.**allpairs**(*x*)

Deprecated since version 2.1: The allpairs function was deprecated in version 2.1.

return all possible pairs in sequence *x*

matplotlib.cbook.**alltrue**(*seq*)

Deprecated since version 2.1: The alltrue function was deprecated in version 2.1.

Return *True* if all elements of *seq* evaluate to *True*. If *seq* is empty, return *False*.

matplotlib.cbook.**boxplot_stats**(*X*, *whis=1.5*, *bootstrap=None*, *labels=None*, *autorange=False*)

Returns list of dictionaries of statistics used to draw a series of box and whisker plots. The `Returns` section enumerates the required keys of the dictionary. Users can skip this function and pass a user-defined set of dictionaries to the new `axes.bxp` method instead of relying on MPL to do the calculations.

Parameters

X [array-like] Data that will be represented in the boxplots. Should have 2 or fewer dimensions.

whis [float, string, or sequence (default = 1.5)] As a float, determines the reach of the whiskers to the beyond the first and third quartiles. In other words, where IQR is the interquartile range (`Q3-Q1`), the upper whisker will extend to last datum less than `Q3 + whis*IQR`). Similarly, the lower whisker will extend to the first datum greater than `Q1 - whis*IQR`. Beyond the whiskers, data are considered outliers and are plotted as individual points. This can be set this to an ascending sequence of percentile (e.g., [5, 95]) to set the whiskers at specific percentiles of the data. Finally, `whis` can be the string `'range'` to force the whiskers to the minimum and maximum of the data. In the edge case that the 25th and 75th percentiles are equivalent, `whis` can be automatically set to `'range'` via the `autorange` option.

bootstrap [int, optional] Number of times the confidence intervals around the median should be bootstrapped (percentile method).

labels [array-like, optional] Labels for each dataset. Length must be compatible with dimensions of `X`.

autorange [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to `'range'` such that the

whisker ends are at the minimum and maximum of the data.

Returns

bxpstats [list of dict] A list of dictionaries containing the results for each column of data. Keys of each dictionary are the following:

Key	Value Description
label	tick label for the boxplot
mean	arithemetic mean value
med	50th percentile
q1	first quartile (25th percentile)
q3	third quartile (75th percentile)
cilo	lower notch around the median
cihi	upper notch around the median
whislo	end of the lower whisker
whishi	end of the upper whisker
fliers	outliers

Notes

Non-bootstrapping approach to confidence interval uses Gaussian- based asymptotic approximation:

$$\mathrm{med} \pm 1.57 \times \frac{\mathrm{iqr}}{\sqrt{N}} \tag{38.1}$$

General approach from: McGill, R., Tukey, J.W., and Larsen, W.A. (1978) "Variations of Boxplots", The American Statistician, 32:12-16.

matplotlib.cbook.**contiguous_regions**(*mask*)
Return a list of (ind0, ind1) such that mask[ind0:ind1].all() is True and we cover all such regions

class matplotlib.cbook.**converter**(***kwargs*)
Bases: object

Deprecated since version 2.1: The converter class was deprecated in version 2.1.

Base class for handling string -> python type with support for missing values

is_missing(*s*)

matplotlib.cbook.**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.

matplotlib.cbook.**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().

matplotlib.cbook.**dict_delall**(*d*, *keys*)

Deprecated since version 2.1: The dict_delall function was deprecated in version 2.1.

delete all of the *keys* from the `dict` *d*

matplotlib.cbook.**exception_to_str**(*s=None*)

Deprecated since version 2.1: The exception_to_str function was deprecated in version 2.1.

matplotlib.cbook.**file_requires_unicode**(*x*)

Returns `True` if the given writable file-like object requires Unicode to be written to it.

matplotlib.cbook.**finddir**(*o*, *match*, *case=False*)

Deprecated since version 2.1: The finddir function was deprecated in version 2.1.

return all attributes of *o* which match string in match. if case is True require an exact case match.

matplotlib.cbook.**flatten**(*seq*, *scalarp=<function is_scalar_or_string>*)

Returns a generator of flattened nested containers

For example:

```
>>> from matplotlib.cbook import flatten
>>> l = (('John', ['Hunter']), (1, 23), [[([42, (5, 23)], )]])
>>> print(list(flatten(l)))
['John', 'Hunter', 1, 23, 42, 5, 23]
```

By: Composite of Holger Krekel and Luther Blissett From: https://code.activestate.com/recipes/121294/ and Recipe 1.12 in cookbook

matplotlib.cbook.**get_label**(*y*, *default_name*)

matplotlib.cbook.**get_recursive_filelist**(*args*)

Deprecated since version 2.1: The get_recursive_filelist function was deprecated in version 2.1.

Recurse all the files and dirs in *args* ignoring symbolic links and return the files as a list of strings

matplotlib.cbook.**get_sample_data**(*fname*, *asfileobj=True*)

Return a sample data file. *fname* is a path relative to the `mpl-data/sample_data` directory. If *asfileobj* is `True` return a file object, otherwise just a file path.

Set the rc parameter examples.directory to the directory where we should look, if sample_data files are stored in a location different than default (which is 'mpl-data/sample_data' at the same level of 'matplotlib' Python module files).

If the filename ends in .gz, the file is implicitly ungzipped.

matplotlib.cbook.**get_split_ind**(*seq*, *N*)

Deprecated since version 2.1: The get_split_ind function was deprecated in version 2.1.

seq is a list of words. Return the index into seq such that:

```
len(' '.join(seq[:ind])<=N
```

.

matplotlib.cbook.**index_of**(*y*)

A helper function to get the index of an input to plot against if x values are not explicitly given.

Tries to get `y.index` (works if this is a pd.Series), if that fails, return np.arange(y.shape[0]).

This will be extended in the future to deal with more types of labeled data.

Parameters

y [scalar or array-like] The proposed y-value

Returns

x, y [ndarray] The x and y values to plot.

matplotlib.cbook.**is_hashable**(*obj*)

Returns true if *obj* can be hashed

matplotlib.cbook.**is_math_text**(*s*)

matplotlib.cbook.**is_numlike**(*obj*)

return true if *obj* looks like a number

matplotlib.cbook.**is_scalar**(*obj*)

Deprecated since version 2.1: The is_scalar function was deprecated in version 2.1.

return true if *obj* is not string like and is not iterable

matplotlib.cbook.**is_scalar_or_string**(*val*)

Return whether the given object is a scalar or string like.

matplotlib.cbook.**is_sequence_of_strings**(*obj*)
Deprecated since version 2.1: The is_sequence_of_strings function was deprecated in version 2.1.

Returns true if *obj* is iterable and contains strings

matplotlib.cbook.**is_string_like**(*obj*)
Deprecated since version 2.1: The is_string_like function was deprecated in version 2.1.

Return True if *obj* looks like a string

matplotlib.cbook.**is_writable_file_like**(*obj*)
return true if *obj* looks like a file object with a *write* method

matplotlib.cbook.**issubclass_safe**(*x*, *klass*)
Deprecated since version 2.1: The issubclass_safe function was deprecated in version 2.1.

return issubclass(x, klass) and return False on a TypeError

matplotlib.cbook.**iterable**(*obj*)
return true if *obj* is iterable

matplotlib.cbook.**listFiles**(*root*, *patterns='*'*, *recurse=1*, *return_folders=0*)
Recursively list files

from Parmar and Martelli in the Python Cookbook

matplotlib.cbook.**local_over_kwdict**(*local_var*, *kwargs*, **keys*)
Enforces the priority of a local variable over potentially conflicting argument(s) from a kwargs dict. The following possible output values are considered in order of priority:

local_var > kwargs[keys[0]] > ... > kwargs[keys[-1]]

The first of these whose value is not None will be returned. If all are None then None will be returned. Each key in keys will be removed from the kwargs dict in place.

Parameters

local_var: any object

The local variable (highest priority)

kwargs: dict Dictionary of keyword arguments; modified in place

keys: str(s) Name(s) of keyword arguments to process, in descending order of priority

Returns

out: any object Either local_var or one of kwargs[key] for key in keys

Raises

IgnoredKeywordWarning For each key in keys that is removed from kwargs but not used as the output value

class matplotlib.cbook.**maxdict**(*maxsize*)
Bases: dict

A dictionary with a maximum size; this doesn't override all the relevant methods to constrain the size, just setitem, so use with caution

matplotlib.cbook.**mkdirs**(*newdir*, *mode=511*)
make directory *newdir* recursively, and set *mode*. Equivalent to

```
> mkdir -p NEWDIR
> chmod MODE NEWDIR
```

matplotlib.cbook.**normalize_kwargs**(*kw*, *alias_mapping=None*, *required=()*, *forbidden=()*, *allowed=None*)
Helper function to normalize kwarg inputs

The order they are resolved are:

1. aliasing
2. required
3. forbidden
4. allowed

This order means that only the canonical names need appear in `allowed`, `forbidden`, `required`

Parameters

alias_mapping, dict, optional A mapping between a canonical name to a list of aliases, in order of precedence from lowest to highest.

If the canonical value is not in the list it is assumed to have the highest priority.

required [iterable, optional] A tuple of fields that must be in kwargs.

forbidden [iterable, optional] A list of keys which may not be in kwargs

allowed [tuple, optional] A tuple of allowed fields. If this not None, then raise if `kw` contains any keys not in the union of `required` and `allowed`. To allow only the required fields pass in `()` for `allowed`

Raises

TypeError To match what python raises if invalid args/kwargs are passed to a callable.

matplotlib.cbook.**onetrue**(*seq*)
Deprecated since version 2.1: The onetrue function was deprecated in version 2.1.

Return *True* if one element of *seq* is *True*. It *seq* is empty, return *False*.

matplotlib.cbook.**open_file_cm**(*path_or_file*, *mode='r'*, *encoding=None*)
Pass through file objects and context-manage `PathLike`s.

matplotlib.cbook.**pieces**(*seq*, *num=2*)
Deprecated since version 2.1: The pieces function was deprecated in version 2.1.

Break up the *seq* into *num* tuples

matplotlib.cbook.**print_cycles**(*objects*, *outstream=<_io.TextIOWrapper name='<stdout>' mode='w' encoding='UTF-8'>*, *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.

matplotlib.cbook.**pts_to_midstep**(*x*, **args*)

Convert continuous line to mid-steps.

Given a set of `N` points convert to `2N` points which when connected linearly give a step function which changes values at the middle of the intervals.

Parameters

x [array] The x location of the steps. May be empty.

y1, ..., yp [array] y arrays to be turned into steps; all must be the same length as `x`.

Returns

out [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out, y1_out, ..., yp_out`. If the input is length `N`, each of these arrays will be length `2N`.

Examples

>> x_s, y1_s, y2_s = pts_to_midstep(x, y1, y2)

matplotlib.cbook.**pts_to_poststep**(*x*, **args*)

Convert continuous line to post-steps.

Given a set of `N` points convert to `2N + 1` points, which when connected linearly give a step function which changes values at the end of the intervals.

Parameters

x [array] The x location of the steps. May be empty.

y1, ..., yp [array] y arrays to be turned into steps; all must be the same length as `x`.

Returns

out [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out, y1_out, ..., yp_out`. If the input is length `N`, each of these arrays will be length `2N + 1`. For `N=0`, the length will be 0.

Examples

>> x_s, y1_s, y2_s = pts_to_poststep(x, y1, y2)

matplotlib.cbook.**pts_to_prestep**(*x*, **args*)
Convert continuous line to pre-steps.

Given a set of N points, convert to 2N - 1 points, which when connected linearly give a step function which changes values at the beginning of the intervals.

Parameters

x [array] The x location of the steps. May be empty.

y1, ..., yp [array] y arrays to be turned into steps; all must be the same length as x.

Returns

out [array] The x and y values converted to steps in the same order as the input; can be unpacked as `x_out, y1_out, ..., yp_out`. If the input is length N, each of these arrays will be length 2N + 1. For N=0, the length will be 0.

Examples

>> x_s, y1_s, y2_s = pts_to_prestep(x, y1, y2)

matplotlib.cbook.**recursive_remove**(*path*)
Deprecated since version 2.1: The recursive_remove function was deprecated in version 2.1. Use shutil.rmtree instead.

matplotlib.cbook.**report_memory**(*i=0*)
return the memory consumed by process

matplotlib.cbook.**restrict_dict**(*d*, *keys*)
Deprecated since version 2.1: The restrict_dict function was deprecated in version 2.1.

Return a dictionary that contains those keys that appear in both d and keys, with values from d.

matplotlib.cbook.**reverse_dict**(*d*)
Deprecated since version 2.1: The reverse_dict function was deprecated in version 2.1.

reverse the dictionary – may lose data if values are not unique!

matplotlib.cbook.**safe_first_element**(*obj*)

matplotlib.cbook.**safe_masked_invalid**(*x*, *copy=False*)

matplotlib.cbook.**safezip**(**args*)
make sure *args* are equal len before zipping

matplotlib.cbook.**sanitize_sequence**(*data*)
Converts dictview object to list

class matplotlib.cbook.**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 given type

matplotlib.cbook.**simple_linear_interpolation**(*a*, *steps*)
Resample an array with `steps - 1` points between original point pairs.

Parameters

a [array, shape (n, ...)]

steps [int]

Returns

array, shape ``((n - 1) * steps + 1, ...)``

Along each column of *a*, ``(steps - 1)`` points are introduced between

each original values; the values are linearly interpolated.

matplotlib.cbook.**soundex**(*name*, *len=4*)
Deprecated since version 2.1: The soundex function was deprecated in version 2.1.

soundex module conforming to Odell-Russell algorithm

matplotlib.cbook.**strip_math**(*s*)
remove latex formatting from mathtext

matplotlib.cbook.**to_filehandle**(*fname*, *flag='rU'*, *return_opened=False*, *encoding=None*)
fname can be an `os.PathLike` 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 matplotlib.cbook.**todate**(***kwargs*)
Bases: *matplotlib.cbook.converter*

Deprecated since version 2.1: The todate class was deprecated in version 2.1.

convert to a date or None

class matplotlib.cbook.**todatetime**(***kwargs*)
Bases: *matplotlib.cbook.converter*

Deprecated since version 2.1: The todatetime class was deprecated in version 2.1.

convert to a datetime or None

class matplotlib.cbook.**tofloat**(***kwargs*)
Bases: *matplotlib.cbook.converter*

Deprecated since version 2.1: The tofloat class was deprecated in version 2.1.

convert to a float or None

class matplotlib.cbook.**toint**(***kwargs*)
Bases: *matplotlib.cbook.converter*

Deprecated since version 2.1: The toint class was deprecated in version 2.1.

convert to an int or None

class matplotlib.cbook.**tostr**(***kwargs*)
Bases: *matplotlib.cbook.converter*

Deprecated since version 2.1: The tostr class was deprecated in version 2.1.

convert to string or None

matplotlib.cbook.**unicode_safe**(*s*)

matplotlib.cbook.**unique**(*x*)

Deprecated since version 2.1: The unique function was deprecated in version 2.1.

Return a list of unique elements of *x*

matplotlib.cbook.**unmasked_index_ranges**(*mask*, *compressed=True*)

Deprecated since version 2.1: The unmasked_index_ranges function was deprecated in version 2.1.

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.

matplotlib.cbook.**violin_stats**(*X*, *method*, *points=100*)

Returns a list of dictionaries of data which can be used to draw a series of violin plots. See the `Returns` section below to view the required keys of the dictionary. Users can skip this function and pass a user-defined set of dictionaries to the `axes.vplot` method instead of using MPL to do the calculations.

Parameters

X [array-like] Sample data that will be used to produce the gaussian kernel density estimates. Must have 2 or fewer dimensions.

method [callable] The method used to calculate the kernel density estimate for each column of data. When called via `method(v, coords)`, it should return a vector of the values of the KDE evaluated at the values specified in coords.

points [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimates at.

Returns

A list of dictionaries containing the results for each column of data.

The dictionaries contain at least the following:

- coords: A list of scalars containing the coordinates this particular kernel density estimate was evaluated at.
- vals: A list of scalars containing the values of the kernel density estimate at each of the coordinates given in `coords`.
- mean: The mean value for this column of data.
- median: The median value for this column of data.
- min: The minimum value for this column of data.
- max: The maximum value for this column of data.

`matplotlib.cbook.`**`wrap`**`(`*prefix*, *text*, *cols*`)`

Deprecated since version 2.1: The wrap function was deprecated in version 2.1. Use textwrap.TextWrapper instead.

wrap *text* with *prefix* at length *cols*

CHAPTER

THIRTYNINE

CM (COLORMAP)

39.1 matplotlib.cm

Builtin colormaps, colormap handling utilities, and the *ScalarMappable* mixin.

See /gallery/color/colormap_reference for a list of builtin colormaps. See *Colormaps in Matplotlib* for an in-depth discussion of colormaps.

class matplotlib.cm.**ScalarMappable**(*norm=None*, *cmap=None*)

Bases: object

This is a mixin class to support scalar data to RGBA mapping. The ScalarMappable makes use of data normalization before returning RGBA colors from the given colormap.

Parameters

norm [*matplotlib.colors.Normalize* instance] The normalizing object which scales data, typically into the interval `[0, 1]`. If *None*, *norm* defaults to a *colors.Normalize* object which initializes its scaling based on the first data processed.

cmap [str or *Colormap* instance] The colormap used to map normalized data values to RGBA colors.

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

cmap = None

The Colormap instance of this ScalarMappable.

colorbar = None
The last colorbar associated with this ScalarMappable. May be None.

get_array()
Return the array

get_clim()
return the min, max of the color limits for image scaling

get_cmap()
return the colormap

norm = None
The Normalization instance of this ScalarMappable.

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

set_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

matplotlib.cm.**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 built-in colormaps.

If *name* is a *matplotlib.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.

matplotlib.cm.**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 *matplotlib.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 *LinearSegmentedColormap* initializer, and the resulting colormap is registered.

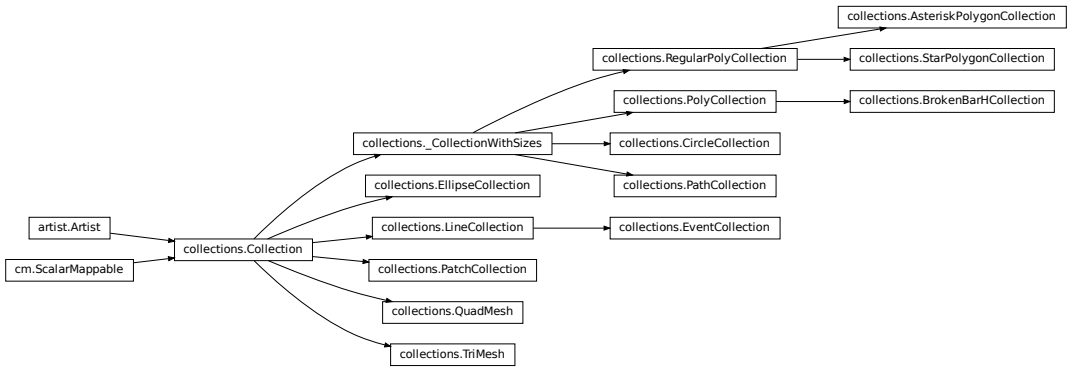
matplotlib.cm.**revcmap**(*data*)

Can only handle specification *data* in dictionary format.

CHAPTER

FORTY

COLLECTIONS



40.1 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 matplotlib.collections.**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,
    )
```

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.

add_checker(*checker*)

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes

The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_numsides()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_rotation()

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sizes(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_visible`(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

`stale`
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba`(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the

alpha kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**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.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The `Axes` instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all `Artist` instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure).

This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*verts*, *closed=True*)
This allows one to delay initialization of the vertices.

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sizes(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_verts(*verts*, *closed=True*)
This allows one to delay initialization of the vertices.

set_verts_and_codes(*verts*, *codes*)
This allows one to initialize vertices with path codes.

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

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.

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**CircleCollection**(*sizes*, ***kwargs*)
Bases: matplotlib.collections._CollectionWithSizes

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.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

set_hatch(*hatch*)
Set the hatching pattern

hatch can be one of:

```
/   - diagonal hatching
\   - back diagonal
```

(continues on next page)

(continued from previous page)

```
|   - 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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

`set_joinstyle`(*js*)

Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

`set_label`(*s*)

Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

`set_linestyle`(*ls*)

Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ ’-’, ’–’, ’-.’, ’:’} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is ’screen’ (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is ’data’, the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

`set_pickradius`(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

`set_rasterized`(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

`set_sizes`(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params`(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`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.

Parameters

snap [bool or None]

`set_transform`(*t*)
Set the artist transform.

Parameters

t [*Transform*]

`set_url`(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_visible`(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

`stale`
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**Collection**(*edgecolors=None*, *facecolors=None*, *linewidths=None*, *linestyles='solid'*, *capstyle=None*, *joinstyle=None*, *antialiaseds=None*, *offsets=None*, *transOffset=None*, *norm=None*, *cmap=None*, *pickradius=5.0*, *hatch=None*, *urls=None*, *offset_position='screen'*, *zorder=1*, ***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)]
```

Exceptions are *capstyle* and *joinstyle* properties, these can only be set globally for the whole collection.

Keyword arguments and default values:

- *edgecolors*: None
- *facecolors*: None
- *linewidths*: None
- *capstyle*: None
- *joinstyle*: None
- *antialiaseds*: None
- *offsets*: None
- *transOffset*: transforms.IdentityTransform()
- *offset_position*: 'screen' (default) or 'data'
- *norm*: None (optional for *matplotlib.cm.ScalarMappable*)
- *cmap*: None (optional for *matplotlib.cm.ScalarMappable*)
- *hatch*: None
- *zorder*: 1

offsets and *transOffset* are used to translate the patch after rendering (default no offsets). If offset_position is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

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 (i.e., 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

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.

add_checker(*checker*)
: Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is None, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**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.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure).

This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is

4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**EventCollection**(*positions*, *orientation=None*, *lineoffset=0*, *linelength=1*, *linewidth=None*, *color=None*, *linestyle='solid'*, *antialiased=None*, ***kwargs*)

Bases: *matplotlib.collections.LineCollection*

A collection of discrete events.

The events are given by a 1-dimensional array, usually the position of something along an axis, such as time or length. They do not have an amplitude and are displayed as vertical or horizontal parallel bars.

Parameters

positions [1D array-like object] Each value is an event.

orientation [{None, 'horizontal', 'vertical'}, optional] The orientation of the **collection** (the event bars are along the orthogonal direction). Defaults to 'horizontal' if not specified or None.

lineoffset [scalar, optional, default: 0] The offset of the center of the markers from the origin, in the direction orthogonal to *orientation*.

linelength [scalar, optional, default: 1] The total height of the marker (i.e. the marker stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

linewidth [scalar or None, optional, default: None] If it is None, defaults to its rcParams setting, in sequence form.

color [color, sequence of colors or None, optional, default: None] If it is None, defaults to its rcParams setting, in sequence form.

linestyle [str or tuple, optional, default: 'solid'] Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '–', '-.', ':']. Dash tuples should be of the form:

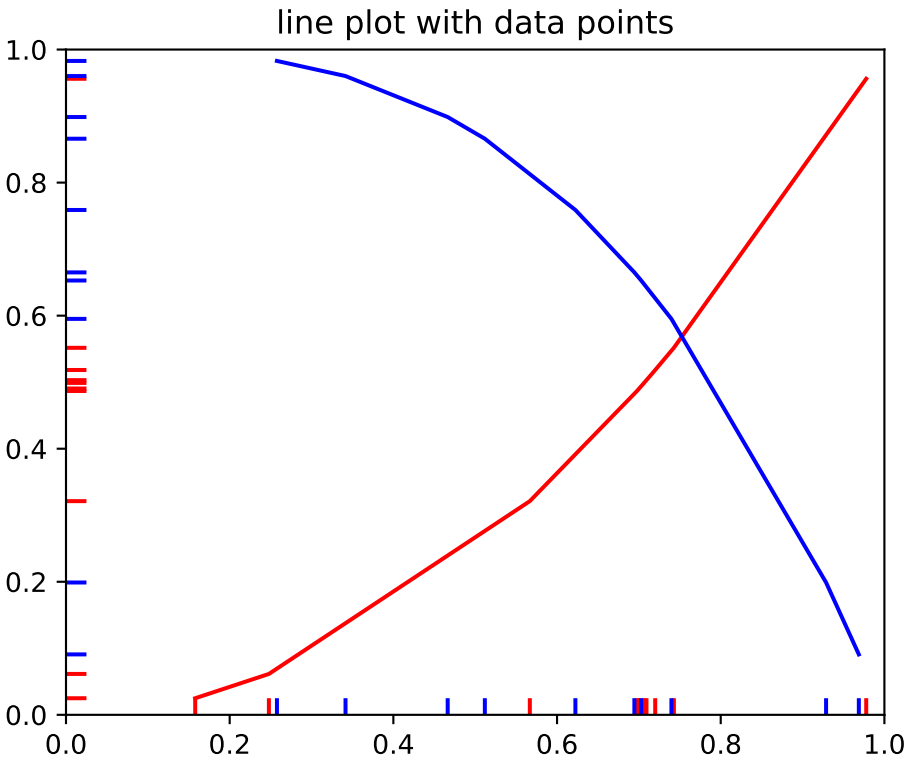
```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

antialiased [{None, 1, 2}, optional] If it is None, defaults to its rcParams setting, in sequence form.

****kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.

Examples



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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

add_positions(*position*)
add one or more events at the specified positions

aname = 'Artist'

append_positions(*position*)
add one or more events at the specified positions

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

axes
The Axes instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

extend_positions(*position*)
add one or more events at the specified positions

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all Artist instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_color()
get the color of the lines used to mark each event

get_colors()

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linelength()
get the length of the lines used to mark each event

get_lineoffset()
get the offset of the lines used to mark each event

get_linestyle()
get the style of the lines used to mark each event ['solid' | 'dashed' | 'dashdot' | 'dotted']

get_linestyles()

get_linewidth()
get the width of the lines used to mark each event

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_orientation()
get the orientation of the event line, may be: ['horizontal' | 'vertical']

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_positions()
return an array containing the floating-point values of the positions

get_rasterized()
Return whether the artist is to be rasterized.

get_segments()

Returns

segments [list] List of segments in the LineCollection. Each list item contains an array of vertices.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_horizontal()
True if the eventcollection is horizontal, False if vertical

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

set_color(*c*)
Set the color(s) of the LineCollection.

Parameters

c : Matplotlib color argument (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence.

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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linelength(*linelength*)
set the length of the lines used to mark each event

set_lineoffset(*lineoffset*)
set the offset of the lines used to mark each event

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

`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_norm`(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

`set_offset_position`(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`set_offsets`(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_orientation(*orientation=None*)
set the orientation of the event line ['horizontal' | 'vertical' | None] defaults to 'horizontal' if not specified or None

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*segments*)

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_positions(*positions*)
set the positions of the events to the specified value

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

`set_segments`(*segments*)

`set_sketch_params`(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`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.

Parameters

snap [bool or None]

`set_transform`(*t*)
Set the artist transform.

Parameters

t [*Transform*]

`set_url`(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_verts`(*segments*)

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

switch_orientation()
switch the orientation of the event line, either from vertical to horizontal or vice versus

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**LineCollection**(*segments*, *linewidths=None*, *colors=None*, *antialiaseds=None*, *linestyles='solid'*, *offsets=None*, *transOffset=None*, *norm=None*, *cmap=None*, *pickradius=5*, *zorder=2*, *facecolors='none'*, ***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.

Parameters

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 [sequence, optional] A sequence of RGBA tuples (e.g., arbitrary color strings, etc, not allowed).

antialiaseds [sequence, optional] A sequence of ones or zeros.

linestyles [string, tuple, optional] Either one of ['solid' | 'dashed' | 'dashdot' | 'dotted'], or a dash tuple. The dash tuple is:

```
(offset, onoffseq)
```

where `onoffseq` is an even length tuple of on and off ink in points.

norm [Normalize, optional] *Normalize* instance.

cmap [string or Colormap, optional] Colormap name or *Colormap* instance.

pickradius [float, optional] The tolerance in points for mouse clicks picking a line. Default is 5 pt.

zorder [int, optional] zorder of the LineCollection. Default is 2.

facecolors [optional] The facecolors of the LineCollection. Default is 'none'. Setting to a value other than 'none' will lead to a filled polygon being drawn between points on each line.

Notes

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.

The use of *ScalarMappable* is optional. If the *ScalarMappable* array `_A` is not None (i.e., a call to *set_array()* has been made), at draw time a call to scalar mappable will be made to set the colors.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_color()

get_colors()

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_segments()

Returns

segments [list] List of segments in the LineCollection. Each list item contains an array of vertices.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

set_color(*c*)
Set the color(s) of the LineCollection.

Parameters

c : Matplotlib color argument (all patches have same color), or a sequence or rgba tuples; if it is a sequence the patches will cycle through the sequence.

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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where onoffseq is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | ':' | 'None' | ' ' | '']

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*segments*)

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_segments(*segments*)

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_verts(*segments*)

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
x and y sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the x and y lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**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 (i.e., a call to set_array has been made), at draw time a call to scalar mappable will be made to set the face colors.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where onoffseq is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | ':' | 'None' | ' ' | '']

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*patches*)

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`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.

Parameters

snap [bool or None]

`set_transform`(*t*)

Set the artist transform.

Parameters

t [*Transform*]

`set_url`(*url*)

Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_visible`(*b*)

Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)

Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**PathCollection**(*paths*, *sizes=None*, ***kwargs*)

Bases: matplotlib.collections._CollectionWithSizes

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.

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.

add_checker(*checker*)

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes

The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

`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_norm`(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

`set_offset_position`(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

`set_offsets`(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*paths*)

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sizes(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

`stale`
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba`(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

`update`(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**PolyCollection**(*verts*, *sizes=None*, *closed=True*, ***kwargs*)
Bases: matplotlib.collections._CollectionWithSizes

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.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or None]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths(*verts*, *closed=True*)
This allows one to delay initialization of the vertices.

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sizes(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_verts`(*verts*, *closed=True*)
This allows one to delay initialization of the vertices.

`set_verts_and_codes`(*verts*, *codes*)
This allows one to initialize vertices with path codes.

`set_visible`(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

`stale`
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba`(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**QuadMesh**(*meshWidth*, *meshHeight*, *coordinates*, *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', or 'gouraud'

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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`.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

- None: return all objects contained in artist.
- function with signature `boolean = match(artist)` used to filter matches

- class instance: e.g., Line2D. Only return artists of class type.

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or None]

A 3-tuple with the following elements:

- scale: The amplitude of the wiggle perpendicular to the source line.
- length: The length of the wiggle along the line.
- randomness: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_visible`(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

`stale`
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

`sticky_edges`
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

`to_rgba`(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the

alpha kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**RegularPolyCollection**(*numsides*, *rotation=0*, *sizes=(1,)*, ***kwargs*)

Bases: matplotlib.collections._CollectionWithSizes

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,
    )
```

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all `Artist` instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_numsides()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_rotation()

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sizes(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`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.

Parameters

snap [bool or None]

`set_transform`(*t*)
Set the artist transform.

Parameters

t [*Transform*]

`set_url`(*url*)
Sets the url for the artist.

Parameters

url [str]

`set_urls`(*urls*)

Parameters

urls [List[str] or None]

`set_visible`(*b*)
Set the artist's visibility.

Parameters

b [bool]

`set_zorder`(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**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,
    )
```

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.

add_checker(*checker*)

Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_numsides()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_rotation()

get_sizes()
Returns the sizes of the elements in the collection. The value represents the 'area' of the element.

Returns

sizes [array] The 'area' of each element.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- `None`, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

`set_pickradius`(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

`set_rasterized`(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

`set_sizes`(*sizes*, *dpi=72.0*)
Set the sizes of each member of the collection.

Parameters

sizes [ndarray or None] The size to set for each element of the collection. The value is the 'area' of the element.

dpi [float] The dpi of the canvas. Defaults to 72.0.

`set_sketch_params`(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

`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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

class matplotlib.collections.**TriMesh**(*triangulation*, ***kwargs*)
Bases: *matplotlib.collections.Collection*

Class for the efficient drawing of a triangular mesh using Gouraud shading.

A triangular mesh is a *Triangulation* object.

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.

add_checker(*checker*)
Add an entry to a dictionary of boolean flags that are set to True when the mappable is changed.

aname = 'Artist'

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

axes
The *Axes* instance the artist resides in, or *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

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.

static convert_mesh_to_paths(*tri*)
Converts a given mesh into a sequence of *matplotlib.path.Path* objects for easier rendering by backends that do not directly support meshes.

This function is primarily of use to backend implementers.

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*)
Derived classes drawing method

findobj(*match=None*, *include_self=True*)
Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

format_cursor_data(*data*)
Return *cursor data* string formatted.

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_array()
Return the array

get_capstyle()

get_children()
Return a list of the child `Artist`s this :class:`Artist` contains.

get_clim()
return the min, max of the color limits for image scaling

get_clip_box()
Return artist clipbox

get_clip_on()
Return whether artist uses clipping

get_clip_path()
Return artist clip path

get_cmap()
return the colormap

get_contains()
Return the _contains test used by the artist, or *None* for default.

get_cursor_data(*event*)
Get the cursor data for a given event.

get_dashes()

get_datalim(*transData*)

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_figure()
Return the *Figure* instance the artist belongs to.

get_fill()
return whether fill is set

get_gid()
Returns the group id.

get_hatch()
Return the current hatching pattern.

get_joinstyle()

get_label()
Get the label used for this artist in the legend.

get_linestyle()

get_linestyles()

get_linewidth()

get_linewidths()

get_offset_position()
Returns how offsets are applied for the collection. If *offset_position* is 'screen', the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

get_offset_transform()

get_offsets()
Return the offsets for the collection.

get_path_effects()

get_paths()

get_picker()
Return the picker object used by this artist.

get_pickradius()

get_rasterized()
Return whether the artist is to be rasterized.

get_sketch_params()
Returns the sketch parameters for the artist.

Returns

sketch_params [tuple or `None`]

A 3-tuple with the following elements:

- `scale`: The amplitude of the wiggle perpendicular to the source line.
- `length`: The length of the wiggle along the line.
- `randomness`: The scale factor by which the length is shrunken or expanded.

May return 'None' if no sketch parameters were set.

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_transforms()

get_url()
Returns the url.

get_urls()

get_visible()
Return the artist's visiblity

get_window_extent(*renderer*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

get_zorder()
Return the artist's zorder.

have_units()
Return *True* if units are set on the *x* or *y* axes

hitlist(*event*)
Deprecated since version 2.2: The hitlist function was deprecated in version 2.2.

List the children of the artist which contain the mouse event *event*.

is_figure_set()
Deprecated since version 2.2: artist.figure is not None

Returns whether the artist is assigned to a *Figure*.

is_transform_set()
Returns *True* if `Artist` has a transform explicitly set.

mouseover

pchanged()
Fire an event when property changed, calling all of the registered callbacks.

pick(*mouseevent*)
Process pick event

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 property batch setter. Pass *kwargs* to set properties.

set_agg_filter(*filter_func*)
Set the agg filter.

Parameters

filter_func [callable] A filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array.

set_alpha(*alpha*)
Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_animated(*b*)
Set the artist's animation state.

Parameters

b [bool]

set_antialiased(*aa*)
Set the antialiasing state for rendering.

ACCEPTS: Boolean or sequence of booleans

set_antialiaseds(*aa*)
alias for set_antialiased

set_array(*A*)
Set the image array from numpy array *A*.

Parameters

A [ndarray]

set_capstyle(*cs*)
Set the capstyle for the collection. The capstyle can only be set globally for all elements in the collection

Parameters

cs [['butt' | 'round' | 'projecting']] The capstyle

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; may be overridden in methods that have `vmin` and `vmax` kwargs.

set_clip_box(*clipbox*)
Set the artist's clip *Bbox*.

Parameters

clipbox [*Bbox*]

set_clip_on(*b*)
Set whether artist uses clipping.

When False artists will be visible out side of the axes which can lead to unexpected results.

Parameters

b [bool]

set_clip_path(*path*, *transform=None*)
Set the artist's clip path, which may be:

- a *Patch* (or subclass) instance; or
- a *Path* instance, in which case a *Transform* instance, which will be applied to the path before using it for clipping, must be provided; or
- None, to remove a previously set 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_cmap(*cmap*)
set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

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_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.

Parameters

picker [callable]

set_dashes(*ls*)
alias for set_linestyle

set_edgecolor(*c*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*c*)
alias for set_edgecolor

set_facecolor(*c*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*c*)
alias for set_facecolor

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_gid(*gid*)
Sets the (group) id for the artist.

Parameters

gid [str]

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.

Unlike other properties such as linewidth and colors, hatching can only be specified for the collection as a whole, not separately for each member.

ACCEPTS: ['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']

set_joinstyle(*js*)
Set the joinstyle for the collection. The joinstyle can only be set globally for all elements in the collection.

Parameters

js [['miter' | 'round' | 'bevel']] The joinstyle

set_label(*s*)
Set the label to *s* for auto legend.

Parameters

s [object] *s* will be converted to a string by calling `str` (`unicode` on Py2).

set_linestyle(*ls*)
Set the linestyle(s) for the collection.

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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_norm(*norm*)
Set the normalization instance.

Parameters

norm [*Normalize*]

set_offset_position(*offset_position*)
Set how offsets are applied. If *offset_position* is 'screen' (default) the offset is applied after the master transform has been applied, that is, the offsets are in screen coordinates. If offset_position is 'data', the offset is applied before the master transform, i.e., the offsets are in data coordinates.

set_offsets(*offsets*)
Set the offsets for the collection. *offsets* can be a scalar or a sequence.

ACCEPTS: float or sequence of floats

set_path_effects(*path_effects*)
Set the path effects.

Parameters

path_effects [*AbstractPathEffect*]

set_paths()

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.

Parameters

picker [None or bool or float or callable]

set_pickradius(*pr*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, in points.

set_rasterized(*rasterized*)
Force rasterized (bitmap) drawing in vector backend output.

Defaults to None, which implies the backend's default behavior.

Parameters

rasterized [bool or None]

set_sketch_params(*scale=None*, *length=None*, *randomness=None*)
Sets the sketch parameters.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line, in pixels. If scale is `None`, or not provided, no sketch filter will be provided.

length [float, optional] The length of the wiggle along the line, in pixels (default 128.0)

randomness [float, optional] The scale factor by which the length is shrunken or expanded (default 16.0)

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.

Parameters

snap [bool or None]

set_transform(*t*)
Set the artist transform.

Parameters

t [*Transform*]

set_url(*url*)
Sets the url for the artist.

Parameters

url [str]

set_urls(*urls*)

Parameters

urls [List[str] or None]

set_visible(*b*)
Set the artist's visibility.

Parameters

b [bool]

set_zorder(*level*)
Set the zorder for the artist. Artists with lower zorder values are drawn first.

Parameters

level [float]

stale
If the artist is 'stale' and needs to be re-drawn for the output to match the internal state of the artist.

sticky_edges
`x` and `y` sticky edge lists.

When performing autoscaling, if a data limit coincides with a value in the corresponding sticky_edges list, then no margin will be added–the view limit "sticks" to the edge. A typical usecase is histograms, where one usually expects no margin on the bottom edge (0) of the histogram.

This attribute cannot be assigned to; however, the `x` and `y` lists can be modified in place as needed.

Examples

```
>>> artist.sticky_edges.x[:] = (xmin, xmax)
>>> artist.sticky_edges.y[:] = (ymin, ymax)
```

to_rgba(*x*, *alpha=None*, *bytes=False*, *norm=True*)
Return a normalized rgba array corresponding to *x*.

In the normal case, *x* is a 1-D or 2-D sequence of scalars, and the corresponding ndarray of rgba values will be returned, based on the norm and colormap set for this ScalarMappable.

There is one special case, for handling images that are already rgb or rgba, such as might have been read from an image file. If *x* is an ndarray with 3 dimensions, and the last dimension is either 3 or 4, then it will be treated as an rgb or rgba array, and no mapping will be done. The array can be uint8, or it can be floating point with values in the 0-1 range; otherwise a ValueError will be raised. If it is a masked array, the mask will be ignored. If the last dimension is 3, the *alpha* kwarg (defaulting to 1) will be used to fill in the transparency. If the last dimension is 4, the *alpha* kwarg is ignored; it does not replace the pre-existing alpha. A ValueError will be raised if the third dimension is other than 3 or 4.

In either case, if *bytes* is *False* (default), the rgba array will be floats in the 0-1 range; if it is *True*, the returned rgba array will be uint8 in the 0 to 255 range.

If norm is False, no normalization of the input data is performed, and it is assumed to be in the range (0-1).

update(*props*)
Update this artist's properties from the dictionary *prop*.

update_from(*other*)
copy properties from other to self

update_scalarmappable()
If the scalar mappable array is not none, update colors from scalar data

zorder = 0

CHAPTER

FORTYONE

COLORBAR

41.1 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 matplotlib.colorbar.**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*, *erase=True*)

Add the lines from a non-filled *ContourSet* to the colorbar.

Set *erase* to False if these lines should be added to any pre-existing lines.

on_mappable_changed(*mappable*)

Updates this colorbar to match the mappable's properties.

Typically this is automatically registered as an event handler by *colorbar_factory()* and should not be called manually.

remove()

Remove this colorbar from the figure. If the colorbar was created with `use_gridspec=True` then restore the gridspec to its previous value.

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 matplotlib.colorbar.**ColorbarBase**(*ax*, *cmap=None*, *norm=None*, *alpha=None*, *values=None*, *boundaries=None*, *orientation='vertical'*, *ticklocation='auto'*, *extend='neither'*, *spacing='uniform'*, *ticks=None*, *format=None*, *drawedges=False*, *filled=True*, *extendfrac=None*, *extendrect=False*, *label=''*)

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 public methods are *set_label()* and *add_lines()*.

Attributes

ax [Axes] The `Axes` instance in which the colorbar is drawn.

lines [list] A list of `LineCollection` if lines were drawn, otherwise an empty list.

dividers [LineCollection] A LineCollection if *drawedges* is `True`, otherwise `None`.

add_lines(*levels*, *colors*, *linewidths*, *erase=True*)
Draw lines on the colorbar.

colors and *linewidths* must be scalars or sequences the same length as *levels*.

Set *erase* to False to add lines without first removing any previously added lines.

ax = None
The axes that this colorbar lives in.

config_axis()

draw_all()
Calculate any free parameters based on the current cmap and norm, and do all the drawing.

get_ticks(*minor=False*)
Return the x ticks as a list of locations

n_rasterize = 50

remove()
Remove this colorbar from the figure

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.

Parameters

ticks [{None, sequence, *Locator* instance}] If None, a default Locator will be used.

update_ticks [{True, False}, optional] If True, tick locations are updated immediately. If False, use *update_ticks()* to manually update the ticks.

update_ticks()
Force the update of the ticks and ticklabels. This must be called whenever the tick locator and/or tick formatter changes.

class matplotlib.colorbar.**ColorbarPatch**(*ax*, *mappable*, ***kw*)
Bases: *matplotlib.colorbar.Colorbar*

A Colorbar which is created using *Patch* rather than the default `pcolor()`.

It uses a list of Patch instances instead of a *PatchCollection* because the latter does not allow the hatch pattern to vary among the members of the collection.

matplotlib.colorbar.**colorbar_factory**(*cax*, *mappable*, ***kwargs*)
Creates a colorbar on the given axes for the given mappable.

Typically, for automatic colorbar placement given only a mappable use *colorbar()*.

matplotlib.colorbar.**make_axes**(*parents*, *location=None*, *orientation=None*, *fraction=0.15*, *shrink=1.0*, *aspect=20*, ***kw*)
Resize and reposition parent axes, and return a child axes suitable for a colorbar.

Keyword arguments may include the following (with defaults):

location [[None|'left'|'right'|'top'|'bottom']] The position, relative to **parents**, where the colorbar axes should be created. If None, the value will either come from the given `orientation`, else it will default to 'right'.

orientation [[None|'vertical'|'horizontal']] The orientation of the colorbar. Typically, this keyword shouldn't be used, as it can be derived from the `location` keyword.

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 multiply the size of the colorbar
aspect	20; ratio of long to short dimensions
anchor	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
panchor	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

Returns (cax, kw), the child axes and the reduced kw dictionary to be passed when creating the colorbar instance.

`matplotlib.colorbar.`**`make_axes_gridspec`**(*parent*, ***kw*)

Resize and reposition a parent axes, and return a child axes suitable for a colorbar. This function is similar to make_axes. Prmary differences are

- *make_axes_gridspec* only handles the *orientation* keyword and cannot handle the "location" keyword.
- *make_axes_gridspec* should only be used with a subplot parent.
- ***make_axes*** **creates an instance of Axes.** ***make_axes_gridspec*** creates an instance of Subplot.
- ***make_axes*** **updates the position of the** parent. *make_axes_gridspec* replaces the grid_spec attribute of the parent with a new one.

While this function is meant to be compatible with *make_axes*, there could be some minor differences.

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 multiply the size of the colorbar
aspect	20; ratio of long to short dimensions
anchor	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
panchor	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

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

Returns (cax, kw), the child axes and the reduced kw dictionary to be passed when creating the colorbar instance.

CHAPTER

FORTYTWO

COLORS

For a visual representation of the Matplotlib colormaps, see:

- The color_examples examples for examples of controlling color with Matplotlib.
- The *Colors* tutorial for an in-depth guide on controlling color.

42.1 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 functions for checking whether an object can be interpreted as a color (*is_color_like()*), for converting such an object to an RGBA tuple (*to_rgba()*) or to an HTML-like hex string in the `#rrggbb` format (*to_hex()*), and a sequence of colors to an `(n, 4)` RGBA array (*to_rgba_array()*). Caching is used for efficiency.

Matplotlib recognizes the following formats to specify a color:

- an RGB or RGBA tuple of float values in `[0, 1]` (e.g., `(0.1, 0.2, 0.5)` or `(0.1, 0.2, 0.5, 0.3)`);
- a hex RGB or RGBA string (e.g., `'#0F0F0F'` or `'#0F0F0F0F'`);
- a string representation of a float value in `[0, 1]` inclusive for gray level (e.g., `'0.5'`);
- one of `{'b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'}`;
- a X11/CSS4 color name;
- a name from the xkcd color survey; prefixed with `'xkcd:'` (e.g., `'xkcd:sky blue'`);

- one of `{'tab:blue', 'tab:orange', 'tab:green', 'tab:red', 'tab:purple', 'tab:brown', 'tab:pink', 'tab:gray', 'tab:olive', 'tab:cyan'}` which are the Tableau Colors from the 'T10' categorical palette (which is the default color cycle);
- a "CN" color spec, i.e. `'C'` followed by a single digit, which is an index into the default property cycle (`matplotlib.rcParams['axes.prop_cycle']`); the indexing occurs at artist creation time and defaults to black if the cycle does not include color.

All string specifications of color, other than "CN", are case-insensitive.

42.1.1 Classes

BoundaryNorm(boundaries, ncolors[, clip])	Generate a colormap index based on discrete intervals.
Colormap(name[, N])	Baseclass for all scalar to RGBA mappings.
LightSource([azdeg, altdeg, hsv_min_val, ...])	Create a light source coming from the specified azimuth and elevation.
LinearSegmentedColormap(name, segmentdata[, ...])	Colormap objects based on lookup tables using linear segments.
ListedColormap(colors[, name, N])	Colormap object generated from a list of colors.
LogNorm([vmin, vmax, clip])	Normalize a given value to the 0-1 range on a log scale
NoNorm([vmin, vmax, clip])	Dummy replacement for Normalize, for the case where we want to use indices directly in a *ScalarMappable* .
Normalize([vmin, vmax, clip])	A class which, when called, can normalize data into the `[0.0, 1.0]` interval.
PowerNorm(gamma[, vmin, vmax, clip])	Normalize a given value to the `[0, 1]` interval with a power-law scaling.
SymLogNorm(linthresh[, linscale, vmin, ...])	The symmetrical logarithmic scale is logarithmic in both the positive and negative directions from the origin.

matplotlib.colors.BoundaryNorm

class matplotlib.colors.**BoundaryNorm**(*boundaries*, *ncolors*, *clip=False*)

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.

Parameters

boundaries [array-like] Monotonically increasing sequence of boundaries

ncolors [int] Number of colors in the colormap to be used

clip [bool, optional] If clip is `True`, out of range values are mapped to 0 if they are below `boundaries[0]` or mapped to ncolors - 1 if they are above `boundaries[-1]`.

If clip is `False`, out of range values are mapped to -1 if they are below `boundaries[0]` or mapped to ncolors if they are above `boundaries[-1]`. These are then converted to valid indices by `Colormap.__call__()`.

Notes

boundaries defines the edges of bins, and data falling within a bin is mapped to the color with the same index.

If the number of bins doesn't equal *ncolors*, the color is chosen by linear interpolation of the bin number onto color numbers.

inverse(*value*)

Raises

ValueError BoundaryNorm is not invertible, so calling this method will always raise an error

Examples using `matplotlib.colors.BoundaryNorm`

- sphx_glr_gallery_lines_bars_and_markers_multicolored_line.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_specialty_plots_leftventricle_bulleye.py
- sphx_glr_gallery_userdemo_colormap_normalizations_bounds.py
- sphx_glr_gallery_userdemo_colormap_normalizations.py
- *Customized Colorbars Tutorial*
- *Colormap Normalization*

matplotlib.colors.Colormap

class matplotlib.colors.**Colormap**(*name*, *N=256*)

Baseclass for all scalar to RGBA mappings.

Typically Colormap instances are used to convert data values (floats) from the interval `[0, 1]` to the RGBA color that the respective Colormap represents. For scaling of data into the `[0, 1]` interval

see *matplotlib.colors.Normalize*. It is worth noting that *matplotlib.cm.ScalarMappable* subclasses make heavy use of this `data->normalize->map-to-color` processing chain.

Parameters

name [str] The name of the colormap.

N [int] The number of rgb quantization levels.

colorbar_extend = None
When this colormap exists on a scalar mappable and colorbar_extend is not False, colorbar creation will pick up `colorbar_extend` as the default value for the `extend` keyword in the *matplotlib.colorbar.Colorbar* constructor.

is_gray()

reversed(*name=None*)
Make a reversed instance of the Colormap.

Note: Function not implemented for base class.

Parameters

name [str, optional] The name for the reversed colormap. If it's None the name will be the name of the parent colormap + "_r".

Notes

See *LinearSegmentedColormap.reversed()* and *ListedColormap.reversed()*

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

Examples using `matplotlib.colors.Colormap`

- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py

matplotlib.colors.LightSource

class matplotlib.colors.**LightSource**(*azdeg=315*, *altdeg=45*, *hsv_min_val=0*, *hsv_max_val=1*, *hsv_min_sat=1*, *hsv_max_sat=0*)
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 "shaded" rgb values for a data array. *shade_rgb()* can be used to combine an rgb image with The *shade_rgb()* The *hillshade()* produces an illumination map of a surface.

Specify the azimuth (measured clockwise from south) and altitude (measured up from the plane of the surface) of the light source in degrees.

Parameters

azdeg [number, optional] The azimuth (0-360, degrees clockwise from North) of the light source. Defaults to 315 degrees (from the northwest).

altdeg [number, optional] The altitude (0-90, degrees up from horizontal) of the light source. Defaults to 45 degrees from horizontal.

Notes

For backwards compatibility, the parameters *hsv_min_val*, *hsv_max_val*, *hsv_min_sat*, and *hsv_max_sat* may be supplied at initialization as well. However, these parameters will only be used if "blend_mode='hsv'" is passed into *shade()* or *shade_rgb()*. See the documentation for *blend_hsv()* for more details.

blend_hsv(*rgb*, *intensity*, *hsv_max_sat=None*, *hsv_max_val=None*, *hsv_min_val=None*, *hsv_min_sat=None*)

Take the input data array, convert to HSV values in the given colormap, then adjust those color values to give 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.

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).

Parameters

rgb [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

intensity [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

hsv_max_sat [number, optional] The maximum saturation value that the *intensity* map can shift the output image to. Defaults to 1.

hsv_min_sat [number, optional] The minimum saturation value that the *intensity* map can shift the output image to. Defaults to 0.

hsv_max_val [number, optional] The maximum value ("v" in "hsv") that the *intensity* map can shift the output image to. Defaults to 1.

hsv_min_val: number, optional The minimum value ("v" in "hsv") that the *intensity* map can shift the output image to. Defaults to 0.

Returns

rgb [ndarray] An MxNx3 RGB array representing the combined images.

`blend_overlay`(*rgb*, *intensity*)

Combines an rgb image with an intensity map using "overlay" blending.

Parameters

rgb [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

intensity [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

Returns

rgb [ndarray] An MxNx3 RGB array representing the combined images.

`blend_soft_light`(*rgb*, *intensity*)

Combines an rgb image with an intensity map using "soft light" blending. Uses the "pegtop" formula.

Parameters

rgb [ndarray] An MxNx3 RGB array of floats ranging from 0 to 1 (color image).

intensity [ndarray] An MxNx1 array of floats ranging from 0 to 1 (grayscale image).

Returns

rgb [ndarray] An MxNx3 RGB array representing the combined images.

`direction`

The unit vector direction towards the light source

`hillshade`(*elevation*, *vert_exag=1*, *dx=1*, *dy=1*, *fraction=1.0*)

Calculates the illumination intensity for a surface using the defined azimuth and elevation for the light source.

This computes the normal vectors for the surface, and then passes them on to *shade_normals*

Parameters

elevation [array-like] A 2d array (or equivalent) of the height values used to generate an illumination map

vert_exag [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topographic effects.

dx [number, optional] The x-spacing (columns) of the input *elevation* grid.

dy [number, optional] The y-spacing (rows) of the input *elevation* grid.

fraction [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full

illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

Returns

———-

intensity [ndarray] A 2d array of illumination values between 0-1, where 0 is completely in shadow and 1 is completely illuminated.

shade(*data*, *cmap*, *norm=None*, *blend_mode='overlay'*, *vmin=None*, *vmax=None*, *vert_exag=1*, *dx=1*, *dy=1*, *fraction=1*, ***kwargs*)

Combine colormapped data values with an illumination intensity map (a.k.a. "hillshade") of the values.

Parameters

data [array-like] A 2d array (or equivalent) of the height values used to generate a shaded map.

cmap [*Colormap* instance] The colormap used to color the *data* array. Note that this must be a *Colormap* instance. For example, rather than passing in `cmap='gist_earth'`, use `cmap=plt.get_cmap('gist_earth')` instead.

norm [*Normalize* instance, optional] The normalization used to scale values before colormapping. If None, the input will be linearly scaled between its min and max.

blend_mode [{'hsv', 'overlay', 'soft'} or callable, optional] The type of blending used to combine the colormapped data values with the illumination intensity. Default is "overlay". Note that for most topographic surfaces, "overlay" or "soft" appear more visually realistic. If a user-defined function is supplied, it is expected to combine an MxNx3 RGB array of floats (ranging 0 to 1) with an MxNx1 hillshade array (also 0 to 1). (Call signature `func(rgb, illum, **kwargs)`) Additional kwargs supplied to this function will be passed on to the *blend_mode* function.

vmin [scalar or None, optional] The minimum value used in colormapping *data*. If *None* the minimum value in *data* is used. If *norm* is specified, then this argument will be ignored.

vmax [scalar or None, optional] The maximum value used in colormapping *data*. If *None* the maximum value in *data* is used. If *norm* is specified, then this argument will be ignored.

vert_exag [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topography.

dx [number, optional] The x-spacing (columns) of the input *elevation* grid.

dy [number, optional] The y-spacing (rows) of the input *elevation* grid.

fraction [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

Additional kwargs are passed on to the *blend_mode* function.

Returns

rgba [ndarray] An MxNx4 array of floats ranging between 0-1.

`shade_normals`(*normals*, *fraction=1.0*)

Calculates the illumination intensity for the normal vectors of a surface using the defined azimuth and elevation for the light source.

Imagine an artificial sun placed at infinity in some azimuth and elevation position illuminating our surface. The parts of the surface that slope toward the sun should brighten while those sides facing away should become darker.

Parameters

fraction [number, optional] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

Returns

intensity [ndarray] A 2d array of illumination values between 0-1, where 0 is completely in shadow and 1 is completely illuminated.

`shade_rgb`(*rgb*, *elevation*, *fraction=1.0*, *blend_mode='hsv'*, *vert_exag=1*, *dx=1*, *dy=1*, ***kwargs*)

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.

Parameters

rgb [array-like] An MxNx3 RGB array, assumed to be in the range of 0 to 1.

elevation [array-like] A 2d array (or equivalent) of the height values used to generate a shaded map.

fraction [number] Increases or decreases the contrast of the hillshade. Values greater than one will cause intermediate values to move closer to full illumination or shadow (and clipping any values that move beyond 0 or 1). Note that this is not visually or mathematically the same as vertical exaggeration.

blend_mode [{'hsv', 'overlay', 'soft'} or callable, optional] The type of blending used to combine the colormapped data values with the illumination intensity. For backwards compatibility, this defaults to "hsv". Note that for most topographic surfaces, "overlay" or "soft" appear more visually realistic. If a user-defined function is supplied, it is expected to combine an MxNx3 RGB array of floats (ranging 0 to 1) with an MxNx1 hillshade array (also 0 to 1). (Call

signature `func(rgb, illum, **kwargs)`) Additional kwargs supplied to this function will be passed on to the *blend_mode* function.

vert_exag [number, optional] The amount to exaggerate the elevation values by when calculating illumination. This can be used either to correct for differences in units between the x-y coordinate system and the elevation coordinate system (e.g. decimal degrees vs meters) or to exaggerate or de-emphasize topography.

dx [number, optional] The x-spacing (columns) of the input *elevation* grid.

dy [number, optional] The y-spacing (rows) of the input *elevation* grid.

Additional kwargs are passed on to the *blend_mode* function.

Returns

shaded_rgb [ndarray] An MxNx3 array of floats ranging between 0-1.

Examples using `matplotlib.colors.LightSource`

- sphx_glr_gallery_images_contours_and_fields_shading_example.py
- sphx_glr_gallery_showcase_mandelbrot.py
- sphx_glr_gallery_frontpage_3D.py
- sphx_glr_gallery_misc_demo_agg_filter.py
- sphx_glr_gallery_mplot3d_custom_shaded_3d_surface.py
- sphx_glr_gallery_specialty_plots_advanced_hillshading.py
- sphx_glr_gallery_specialty_plots_topographic_hillshading.py

matplotlib.colors.LinearSegmentedColormap

class matplotlib.colors.**LinearSegmentedColormap**(*name*, *segmentdata*, *N=256*, *gamma=1.0*)

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. Entries for alpha are optional.

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)],
```

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```
        '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.

reversed(*name=None*)
Make a reversed instance of the Colormap.

Parameters

name [str, optional] The name for the reversed colormap. If it's None the name will be the name of the parent colormap + "_r".

Returns

LinearSegmentedColormap The reversed colormap.

set_gamma(*gamma*)
Set a new gamma value and regenerate color map.

Examples using matplotlib.colors.LinearSegmentedColormap

- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py

matplotlib.colors.ListedColormap

class matplotlib.colors.**ListedColormap**(*colors*, *name='from_list'*, *N=None*)

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 or Nx4 floating point array (*N* rgb or rgba 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.

reversed(*name=None*)

Make a reversed instance of the Colormap.

Parameters

name [str, optional] The name for the reversed colormap. If it's None the name will be the name of the parent colormap + "_r".

Returns

ListedColormap A reversed instance of the colormap.

Examples using matplotlib.colors.ListedColormap

- sphx_glr_gallery_lines_bars_and_markers_multicolored_line.py
- sphx_glr_gallery_specialty_plots_leftventricle_bulleye.py
- *Customized Colorbars Tutorial*

matplotlib.colors.LogNorm

class matplotlib.colors.**LogNorm**(*vmin=None*, *vmax=None*, *clip=False*)

Normalize a given value to the 0-1 range on a log scale

If *vmin* or *vmax* is not given, they are initialized from the minimum and maximum value respectively of the first input processed. That is, *__call__(A)* calls *autoscale_None(A)*. 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*)

Examples using `matplotlib.colors.LogNorm`

- sphx_glr_gallery_statistics_hist.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_userdemo_colormap_normalizations_lognorm.py
- sphx_glr_gallery_userdemo_colormap_normalizations.py
- *Colormap Normalization*

matplotlib.colors.NoNorm

class matplotlib.colors.**NoNorm**(*vmin=None*, *vmax=None*, *clip=False*)
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 initialized from the minimum and maximum value respectively of the first input processed. That is, *__call__(A)* calls *autoscale_None(A)*. 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*)

matplotlib.colors.Normalize

class matplotlib.colors.**Normalize**(*vmin=None*, *vmax=None*, *clip=False*)

A class which, when called, can normalize data into the `[0.0, 1.0]` interval.

If *vmin* or *vmax* is not given, they are initialized from the minimum and maximum value respectively of the first input processed. That is, *__call__(A)* calls *autoscale_None(A)*. If *clip* is *True* and the given value falls outside the range, the returned value will be 0 or 1, whichever is closer. Returns 0 if:

```
vmin==vmax
```

Works with scalars or arrays, including masked arrays. If *clip* is *True*, masked values are set to 1; otherwise they remain masked. Clipping silently defeats the purpose of setting the over, under, and masked colors in the colormap, so it is likely to lead to surprises; therefore the default is *clip = False*.

autoscale(*A*)

Set *vmin*, *vmax* to min, max of *A*.

autoscale_None(*A*)

autoscale only None-valued vmin or vmax.

inverse(*value*)

static process_value(*value*)

Homogenize the input *value* for easy and efficient normalization.

value can be a scalar or sequence.

Returns *result*, *is_scalar*, where *result* is a masked array matching *value*. Float dtypes are preserved; integer types with two bytes or smaller are converted to np.float32, and larger types are converted to np.float64. Preserving float32 when possible, and using in-place operations, can greatly improve speed for large arrays.

Experimental; we may want to add an option to force the use of float32.

scaled()

return true if vmin and vmax set

Examples using `matplotlib.colors.Normalize`

- sphx_glr_gallery_statistics_hist.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_specialty_plots_advanced_hillshading.py

- sphx_glr_gallery_specialty_plots_leftventricle_bulleye.py
- sphx_glr_gallery_userdemo_colormap_normalizations_custom.py
- sphx_glr_gallery_userdemo_colormap_normalizations.py
- *Constrained Layout Guide*
- *Customized Colorbars Tutorial*
- *Colormap Normalization*

matplotlib.colors.PowerNorm

class matplotlib.colors.**PowerNorm**(*gamma*, *vmin=None*, *vmax=None*, *clip=False*)

Normalize a given value to the `[0, 1]` interval with a power-law scaling. This will clip any negative data points to 0.

autoscale(*A*)

Set *vmin*, *vmax* to min, max of *A*.

autoscale_None(*A*)

autoscale only None-valued vmin or vmax.

inverse(*value*)

Examples using `matplotlib.colors.PowerNorm`

- sphx_glr_gallery_api_power_norm.py
- sphx_glr_gallery_showcase_mandelbrot.py
- sphx_glr_gallery_userdemo_colormap_normalizations_power.py
- sphx_glr_gallery_userdemo_colormap_normalizations.py
- *Colormap Normalization*

matplotlib.colors.SymLogNorm

class matplotlib.colors.**SymLogNorm**(*linthresh*, *linscale=1.0*, *vmin=None*, *vmax=None*, *clip=False*)

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*).

linthresh: The range within which the plot is linear (to avoid having the plot go to infinity around zero).

linscale: This allows the linear range (*-linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range. Defaults to 1.

autoscale(*A*)
Set *vmin*, *vmax* to min, max of *A*.

autoscale_None(*A*)
autoscale only None-valued vmin or vmax.

inverse(*value*)

Examples using `matplotlib.colors.SymLogNorm`

- sphx_glr_gallery_userdemo_colormap_normalizations_symlognorm.py
- sphx_glr_gallery_userdemo_colormap_normalizations.py
- *Colormap Normalization*

42.1.2 Functions

from_levels_and_colors(levels, colors[, extend])	A helper routine to generate a cmap and a norm instance which behave similar to contourf's levels and colors arguments.
hsv_to_rgb(hsv)	convert hsv values in a numpy array to rgb values all values assumed to be in range [0, 1]
rgb_to_hsv(arr)	convert float rgb values (in the range [0, 1]), in a numpy array to hsv values.
to_hex(c[, keep_alpha])	Convert *c* to a hex color.
to_rgb(c)	Convert *c* to an RGB color, silently dropping the alpha channel.
to_rgba(c[, alpha])	Convert *c* to an RGBA color.
to_rgba_array(c[, alpha])	Convert *c* to a (n, 4) array of RGBA colors.
is_color_like(c)	Return whether *c* can be interpreted as an RGB(A) color.
makeMappingArray(N, data[, gamma])	Create an *N* -element 1-d lookup table
get_named_colors_mapping()	Return the global mapping of names to named colors.

matplotlib.colors.from_levels_and_colors

matplotlib.colors.**from_levels_and_colors**(*levels*, *colors*, *extend='neither'*)
A helper routine to generate a cmap and a norm instance which behave similar to contourf's levels and colors arguments.

Parameters

levels [sequence of numbers] The quantization levels used to construct the *BoundaryNorm*. Values `v` are quantizized to level `i` if `lev[i] <= v < lev[i+1]`.

colors [sequence of colors] The fill color to use for each level. If `extend` is "neither" there must be `n_level - 1` colors. For an `extend` of "min" or "max" add one extra color, and for an `extend` of "both" add two colors.

extend [{'neither', 'min', 'max', 'both'}, optional] The behaviour when a value falls out of range of the given levels. See *contourf()* for details.

Returns

(cmap, norm) [tuple containing a *Colormap* and a *Normalize* instance]

matplotlib.colors.hsv_to_rgb

`matplotlib.colors.`**hsv_to_rgb**(*hsv*)

convert hsv values in a numpy array to rgb values all values assumed to be in range [0, 1]

Parameters

hsv [(..., 3) array-like] All values assumed to be in range [0, 1]

Returns

rgb [(..., 3) ndarray] Colors converted to RGB values in range [0, 1]

matplotlib.colors.rgb_to_hsv

`matplotlib.colors.`**rgb_to_hsv**(*arr*)

convert float rgb values (in the range [0, 1]), in a numpy array to hsv values.

Parameters

arr [(..., 3) array-like] All values must be in the range [0, 1]

Returns

hsv [(..., 3) ndarray] Colors converted to hsv values in range [0, 1]

Examples using `matplotlib.colors.rgb_to_hsv`

- sphx_glr_gallery_color_named_colors.py

matplotlib.colors.to_hex

`matplotlib.colors.`**to_hex**(*c*, *keep_alpha=False*)

Convert *c* to a hex color.

Uses the `#rrggbb` format if *keep_alpha* is False (the default), `#rrggbbaa` otherwise.

matplotlib.colors.to_rgb

`matplotlib.colors.`**`to_rgb`**(*c*)
Convert *c* to an RGB color, silently dropping the alpha channel.

matplotlib.colors.to_rgba

`matplotlib.colors.`**`to_rgba`**(*c*, *alpha=None*)
Convert *c* to an RGBA color.

Parameters

c [Matplotlib color]

alpha [scalar, optional] If *alpha* is not `None`, it forces the alpha value, except if *c* is `"none"` (case-insensitive), which always maps to `(0, 0, 0, 0)`.

Returns

tuple Tuple of `(r, g, b, a)` scalars.

Examples using `matplotlib.colors.to_rgba`

- sphx_glr_gallery_color_named_colors.py
- sphx_glr_gallery_shapes_and_collections_line_collection.py
- sphx_glr_gallery_shapes_and_collections_collections.py
- sphx_glr_gallery_event_handling_lasso_demo.py
- sphx_glr_gallery_mplot3d_polys3d.py
- sphx_glr_gallery_widgets_menu.py

matplotlib.colors.to_rgba_array

`matplotlib.colors.`**`to_rgba_array`**(*c*, *alpha=None*)
Convert *c* to a (n, 4) array of RGBA colors.

If *alpha* is not `None`, it forces the alpha value. If *c* is `"none"` (case-insensitive) or an empty list, an empty array is returned.

matplotlib.colors.is_color_like

`matplotlib.colors.`**`is_color_like`**(*c*)
Return whether *c* can be interpreted as an RGB(A) color.

matplotlib.colors.makeMappingArray

matplotlib.colors.**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.

matplotlib.colors.get_named_colors_mapping

matplotlib.colors.**get_named_colors_mapping**()

Return the global mapping of names to named colors.

CHAPTER

FORTYTHREE

CONTOUR

43.1 matplotlib.contour

These are classes to support contour plotting and labelling for the Axes class.

class matplotlib.contour.**ClabelText**(*x=0*, *y=0*, *text=''*, *color=None*, *verticalalignment='baseline'*, *horizontalalignment='left'*, *multialignment=None*, *fontproperties=None*, *rotation=None*, *linespacing=None*, *rotation_mode=None*, *usetex=None*, *wrap=False*, ***kwargs*)

Bases: *matplotlib.text.Text*

Unlike the ordinary text, the get_rotation returns an updated angle in the pixel coordinate assuming that the input rotation is an angle in data coordinate (or whatever transform set).

Create a *Text* instance at *x*, *y* with string *text*.

Valid kwargs are

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance
clip_on	bool
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 *Figure* instance
fontproperties or font_properties	a *matplotlib.font_manager.FontProperties* instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object

Table 1 – continued from

Property	Description
linespacing	float (multiple of font size)
multialignment or ma	[’left’ | ’right’ | ’center’]
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | ’vertical’ | ’horizontal’]
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | ’xx-small’ | ’x-small’ | ’small’ | ’medium’ | ’large’ | ’x-large’
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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*
url	a url string
usetex	bool or None
variant or fontvariant	[’normal’ | ’small-caps’]
verticalalignment or va	[’center’ | ’top’ | ’bottom’ | ’baseline’]
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | ’ultralight’ | ’light’ | ’normal’ | ’regular’ |
wrap	bool
x	float
y	float
zorder	float

get_rotation()
return the text angle as float in degrees

class matplotlib.contour.**ContourLabeler**
Bases: object

Mixin to provide labelling capability to *ContourSet*.

add_label(*x*, *y*, *rotation*, *lev*, *cvalue*)
Add contour label using *Text* class.

add_label_clabeltext(*x*, *y*, *rotation*, *lev*, *cvalue*)
Add contour label using *ClabelText* class.

add_label_near(*x*, *y*, *inline=True*, *inline_spacing=5*, *transform=None*)
Add a label near the point (x, y). If transform is None (default), (x, y) is in data coordinates; if transform is False, (x, y) is in display coordinates; otherwise, the specified transform will be used to translate (x, y) into display coordinates.

Parameters

x, y [float] The approximate location of the label.

inline [bool, optional, default: True] If *True* remove the segment of the contour beneath the label.

inline_spacing [int, optional, default: 5] Space in pixels to leave on each side of label when placing inline. This spacing will be exact for labels at locations where the contour is straight, less so for labels on curved contours.

`calc_label_rot_and_inline`(*slc*, *ind*, *lw*, *lc=None*, *spacing=5*)

This function calculates the appropriate label rotation given the linecontour coordinates in screen units, the index of the label location and the label width.

It will also break contour and calculate inlining if *lc* is not empty (lc defaults to the empty list if None). *spacing* is the space around the label in pixels to leave empty.

Do both of these tasks at once to avoid calculating path lengths multiple times, which is relatively costly.

The method used here involves calculating the path length along the contour in pixel coordinates and then looking approximately label width / 2 away from central point to determine rotation and then to break contour if desired.

`clabel`(**args*, ***kwargs*)

Label a contour plot.

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*.

Parameters

fontsize [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

colors : Color of each label

- 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 [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

inline_spacing [float, optional] 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 [string or dict, optional] A format string for the label. Default is '%1.3f'

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., fmt[level]=string), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

manual [bool or iterable, optional] 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).

manual can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

rightside_up [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

use_clabeltext [bool, optional] If `True`, *ClabelText* class (instead of `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. Default is `False`.

get_label_coords(*distances*, *XX*, *YY*, *ysize*, *lw*)
Return x, y, and the index of a label location.

Labels are plotted at a location with the smallest deviation of the contour from a straight line unless there is another label nearby, in which case the next best place on the contour is picked up. If all such candidates are rejected, the beginning of the contour is chosen.

get_label_width(*lev*, *fmt*, *fsize*)
Return the width of the label in points.

get_real_label_width(*lev*, *fmt*, *fsize*)
Deprecated since version 2.2: The get_real_label_width function was deprecated in version 2.2.

This computes actual onscreen label width. This uses some black magic to determine onscreen extent of non-drawn label. This magic may not be very robust.

This method is not being used, and may be modified or removed.

get_text(*lev*, *fmt*)
Get the text of the label.

labels(*inline*, *inline_spacing*)

locate_label(*linecontour*, *labelwidth*)
Find good place to draw a label (relatively flat part of the contour).

pop_label(*index=-1*)
Defaults to removing last label, but any index can be supplied

print_label(*linecontour*, *labelwidth*)
Return *False* if contours are too short for a label.

set_label_props(*label*, *text*, *color*)
Set the label properties - color, fontsize, text.

too_close(*x*, *y*, *lw*)
Return *True* if a label is already near this location.

class matplotlib.contour.**ContourSet**(*ax*, **args*, ***kwargs*)
Bases: *matplotlib.cm.ScalarMappable*, *matplotlib.contour.ContourLabeler*

Store a set of contour lines or filled regions.

User-callable method: *clabel*

Parameters

ax [*Axes*]

levels [[level0, level1, ..., leveln]] A list of floating point numbers indicating the contour levels.

allsegs [[level0segs, level1segs, ...]] List of all the polygon segments for all the *levels*. For contour lines `len(allsegs) == len(levels)`, and for filled contour regions `len(allsegs) = len(levels)-1`. The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

allkinds [None or [level0kinds, level1kinds, ...]] Optional list of all the polygon vertex kinds (code types), as described and used in Path. This is used to allow multiply- connected paths such as holes within filled polygons. If not None, `len(allkinds) == len(allsegs)`. The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If *allkinds* is not None, usually all polygons for a particular contour level are grouped together so that `level0segs = [polygon0]` and `level0kinds = [polygon0kinds]`.

kwargs : Keyword arguments are as described in the docstring of *contour*.

Attributes

ax: The axes object in which the contours are drawn.

collections: A silent_list of LineCollections or PolyCollections.

levels: Contour levels.

layers: Same as levels for line contours; half-way between levels for filled contours. See `_process_colors()`.

Draw contour lines or filled regions, depending on whether keyword arg *filled* is `False` (default) or `True`.

Call signature:

```
ContourSet(ax, levels, allsegs, [allkinds], **kwargs)
```

Parameters

ax : The *Axes* object to draw on.

levels [[level0, level1, ..., leveln]] A list of floating point numbers indicating the contour levels.

allsegs [[level0segs, level1segs, ...]] List of all the polygon segments for all the *levels*. For contour lines `len(allsegs) == len(levels)`, and for filled contour regions `len(allsegs) = len(levels)-1`. The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

allkinds [[level0kinds, level1kinds, ...], optional] Optional list of all the polygon vertex kinds (code types), as described and used in Path. This is used to allow multiply- connected paths such as holes within filled polygons. If not `None`, `len(allkinds) == len(allsegs)`. The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If *allkinds* is not `None`, usually all polygons for a particular contour level are grouped together so that `level0segs = [polygon0]` and `level0kinds = [polygon0kinds]`.

****kwargs** Keyword arguments are as described in the docstring of `contour`.

`changed`()
Call this whenever the mappable is changed to notify all the callbackSM listeners to the 'changed' signal

`find_nearest_contour`(*x*, *y*, *indices=None*, *pixel=True*)
Finds contour that is closest to a point. Defaults to measuring distance in pixels (screen space - useful for manual contour labeling), but this can be controlled via a keyword argument.

Returns a tuple containing the contour, segment, index of segment, x & y of segment point and distance to minimum point.

Optional keyword arguments:

***indices*:** Indexes of contour levels to consider when looking for nearest point. Defaults to using all levels.

***pixel*:** If *True*, measure distance in pixel space, if not, measure distance in axes space. Defaults to *True*.

get_alpha()
returns alpha to be applied to all ContourSet artists

get_transform()
Return the *Transform* instance used by this ContourSet.

legend_elements(*variable_name='x'*, *str_format=<class 'str'>*)
Return a list of artists and labels suitable for passing through to `plt.legend()` which represent this ContourSet.

The labels have the form "0 < x <= 1" stating the data ranges which the artists represent.

Parameters

variable_name [str] The string used inside the inequality used on the labels.

str_format [function: float -> str] Function used to format the numbers in the labels.

Returns

artists [List[*Artist*]] A list of the artists.

labels [List[str]] A list of the labels.

set_alpha(*alpha*)
Set the alpha blending value for all ContourSet artists. *alpha* must be between 0 (transparent) and 1 (opaque).

class matplotlib.contour.**QuadContourSet**(*ax*, **args*, ***kwargs*)
Bases: *matplotlib.contour.ContourSet*

Create and store a set of contour lines or filled regions.

User-callable method: `clabel`

Attributes

ax: The axes object in which the contours are drawn.

collections: A silent_list of LineCollections or PolyCollections.

levels: Contour levels.

layers: Same as levels for line contours; half-way between levels for filled contours. See `_process_colors()` method.

Draw contour lines or filled regions, depending on whether keyword arg *filled* is `False` (default) or `True`.

Call signature:

```
ContourSet(ax, levels, allsegs, [allkinds], **kwargs)
```

Parameters

ax : The *Axes* object to draw on.

levels [[level0, level1, ..., leveln]] A list of floating point numbers indicating the contour levels.

allsegs [[level0segs, level1segs, ...]] List of all the polygon segments for all the *levels*. For contour lines `len(allsegs) == len(levels)`, and for filled contour regions `len(allsegs) = len(levels)-1`. The lists should look like:

```
level0segs = [polygon0, polygon1, ...]
polygon0 = array_like [[x0,y0], [x1,y1], ...]
```

allkinds [[level0kinds, level1kinds, ...], optional] Optional list of all the polygon vertex kinds (code types), as described and used in Path. This is used to allow multiply- connected paths such as holes within filled polygons. If not `None`, `len(allkinds) == len(allsegs)`. The lists should look like:

```
level0kinds = [polygon0kinds, ...]
polygon0kinds = [vertexcode0, vertexcode1, ...]
```

If *allkinds* is not `None`, usually all polygons for a particular contour level are grouped together so that `level0segs = [polygon0]` and `level0kinds = [polygon0kinds]`.

****kwargs** Keyword arguments are as described in the docstring of `contour`.

CHAPTER

FORTYFOUR

CONTAINER

44.1 matplotlib.container

class matplotlib.container.**BarContainer**(*patches*, *errorbar=None*, ***kwargs*)

Bases: *matplotlib.container.Container*

Container for the artists of bar plots (e.g. created by *Axes.bar*).

The container can be treated as a tuple of the *patches* themselves. Additionally, you can access these and further parameters by the attributes.

Attributes

patches [list of *Rectangle*] The artists of the bars.

errorbar [None or *ErrorbarContainer*] A container for the error bar artists if error bars are present. *None* otherwise.

class matplotlib.container.**Container**(*kl*, *label=None*)

Bases: tuple

Base class for containers.

Containers are classes that collect semantically related Artists such as the bars of a bar plot.

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.

get_children()

get_label()

Get the label used for this artist in the legend.

pchanged()

Fire an event when property changed, calling all of the registered callbacks.

remove()

remove_callback(*oid*)
Remove a callback based on its *id*.

See also:

add_callback() For adding callbacks

set_label(*s*)
Set the label to *s* for auto legend.

ACCEPTS: string or anything printable with '%s' conversion.

set_remove_method(*f*)

class matplotlib.container.**ErrorbarContainer**(*lines*, *has_xerr=False*, *has_yerr=False*, ***kwargs*)
Bases: *matplotlib.container.Container*

Container for the artists of error bars (e.g. created by *Axes.errorbar*).

The container can be treated as the *lines* tuple itself. Additionally, you can access these and further parameters by the attributes.

Attributes

lines [tuple] Tuple of `(data_line, caplines, barlinecols)`.

- data_line : *Line2D* instance of x, y plot markers and/or line.
- caplines : tuple of *Line2D* instances of the error bar caps.
- barlinecols : list of *LineCollection* with the horizontal and vertical error ranges.

has_xerr, has_yerr [bool] `True` if the errorbar has x/y errors.

class matplotlib.container.**StemContainer**(*markerline_stemlines_baseline*, ***kwargs*)
Bases: *matplotlib.container.Container*

Container for the artists created in a *Axes.stem()* plot.

The container can be treated like a namedtuple `(markerline, stemlines, baseline)`.

Attributes

markerline [*Line2D*] The artist of the markers at the stem heads.

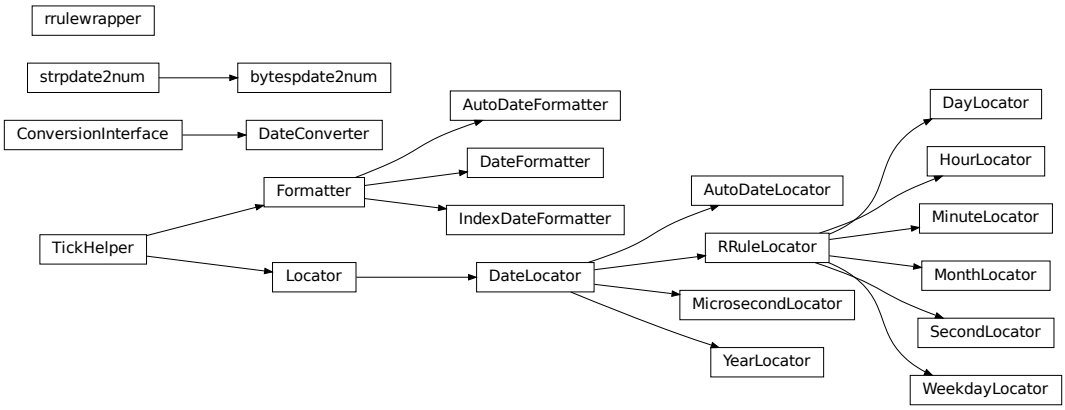
stemlines [list of *Line2D*] The artists of the vertical lines for all stems.

baseline [*Line2D*] The artist of the horizontal baseline.

CHAPTER

FORTYFIVE

DATES



45.1 matplotlib.dates

Matplotlib provides sophisticated date plotting capabilities, standing on the shoulders of python `datetime`, the add-on modules `pytz` and `dateutil`.

45.1.1 Matplotlib date format

Matplotlib represents dates using floating point numbers specifying the number of days since 0001-01-01 UTC, plus 1. For example, 0001-01-01, 06:00 is 1.25, not 0.25. Values < 1, i.e. dates before 0001-01-01 UTC are not supported.

There are a number of helper functions to convert between `datetime` objects and Matplotlib dates:

date2num	Convert datetime objects to Matplotlib dates.
num2date	Convert Matplotlib dates to `datetime` objects.

Continued on next page

Table 1 – continued from previous page

num2timedelta	Convert number of days to a `timedelta` object.
epoch2num	Convert an epoch or sequence of epochs to the new date format, that is days since 0001.
num2epoch	Convert days since 0001 to epoch.
mx2num	Convert mx `datetime` instance (or sequence of mx instances) to the new date format.
drange	Return a sequence of equally spaced Matplotlib dates.

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 [1]: date(2006, 4, 1).toordinal() - date(1, 1, 1).toordinal()
Out[1]: 732401
```

All the Matplotlib date converters, tickers and formatters are timezone aware. If no explicit timezone is provided, the rcParam `timezone` is assumend. 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.

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.

The dateutil module provides additional code to handle date ticking, making it easy to place ticks on any kinds of dates. See examples below.

45.1.2 Date tickers

Most of the date tickers can locate single or multiple values. For example:

```
# import constants for the days of the week
from matplotlib.dates import MO, TU, WE, TH, FR, SA, SU

# 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:

- *MicrosecondLocator*: locate microseconds
- *SecondLocator*: locate seconds
- *MinuteLocator*: locate minutes
- *HourLocator*: locate hours
- *DayLocator*: locate specified days of the month
- *WeekdayLocator*: Locate days of the week, e.g., MO, TU
- *MonthLocator*: locate months, e.g., 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 `dateutil.rrule` (dateutil) which allow almost arbitrary date tick specifications. See rrule example.
- *AutoDateLocator*: On autoscale, this class picks the best *DateLocator* (e.g., *RRuleLocator*) to set the view limits and the tick locations. If called with `interval_multiples=True` it will make ticks line up with sensible multiples of the tick intervals. E.g. if the interval is 4 hours, it will pick hours 0, 4, 8, etc as ticks. This behaviour is not guaranteed by default.

45.1.3 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.

`matplotlib.dates.`**date2num**(*d*)

Convert datetime objects to Matplotlib dates.

Parameters

d [`datetime.datetime` or `numpy.datetime64` or sequences of these]

Returns

float or sequence of floats Number of days (fraction part represents hours, minutes, seconds, ms) since 0001-01-01 00:00:00 UTC, plus one.

Notes

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.

matplotlib.dates.**num2date**(*x*, *tz=None*)
Convert Matplotlib dates to `datetime` objects.

Parameters

x [float or sequence of floats] Number of days (fraction part represents hours, minutes, seconds) since 0001-01-01 00:00:00 UTC, plus one.

tz [string, optional] Timezone of *x* (defaults to rcparams `timezone`).

Returns

'~datetime.datetime' or sequence of '~datetime.datetime' Dates are returned in timezone *tz*.

If *x* is a sequence, a sequence of `datetime` objects will be returned.

Notes

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.

matplotlib.dates.**num2timedelta**(*x*)
Convert number of days to a `timedelta` object.

If *x* is a sequence, a sequence of `timedelta` objects will be returned.

Parameters

x [float, sequence of floats] Number of days. The fraction part represents hours, minutes, seconds.

Returns

'datetime.timedelta' or list['datetime.timedelta']

matplotlib.dates.**drange**(*dstart*, *dend*, *delta*)
Return a sequence of equally spaced Matplotlib dates.

The dates start at *dstart* and reach up to, but not including *dend*. They are spaced by *delta*.

Parameters

dstart, dend [`datetime`] The date limits.

delta [`datetime.timedelta`] Spacing of the dates.

Returns

drange [numpy.array] A list floats representing Matplotlib dates.

matplotlib.dates.**epoch2num**(*e*)
Convert an epoch or sequence of epochs to the new date format, that is days since 0001.

matplotlib.dates.**num2epoch**(*d*)
Convert days since 0001 to epoch. *d* can be a number or sequence.

matplotlib.dates.**mx2num**(*mxdates*)
Convert mx datetime instance (or sequence of mx instances) to the new date format.

class matplotlib.dates.**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 a *strftime()* format string; *tz* is the** tzinfo instance.

illegal_s = re.compile('((^|[^%])(%%)*%s)')

set_tzinfo(*tz*)

strftime(*dt*, *fmt=None*)
Refer to documentation for datetime.datetime.strftime()

fmt is a datetime.datetime.strftime() format string.

Warning: For years before 1900, depending upon the current locale it is possible that the year displayed with %x might be incorrect. For years before 100, %y and %Y will yield zero-padded strings.

strftime_pre_1900(*dt*, *fmt=None*)
Call time.strftime for years before 1900 by rolling forward a multiple of 28 years.

fmt is a *strftime()* format string.

Dalke: I hope I did this math right. Every 28 years the calendar repeats, except through century leap years excepting the 400 year leap years. But only if you're using the Gregorian calendar.

class matplotlib.dates.**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 matplotlib.dates.**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 = {
    DAYS_PER_YEAR: rcParams['date.autoformat.year'],
    DAYS_PER_MONTH: rcParams['date.autoformat.month'],
    1.0: rcParams['date.autoformat.day'],
    1. / HOURS_PER_DAY: rcParams['date.autoformat.hour'],
    1. / (MINUTES_PER_DAY): rcParams['date.autoformat.minute'],
    1. / (SEC_PER_DAY): rcParams['date.autoformat.second'],
    1. / (MUSECONDS_PER_DAY): rcParams['date.autoformat.microsecond'],
    }
```

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:

```
>>> locator = AutoDateLocator()
>>> formatter = AutoDateFormatter(locator)
>>> formatter.scaled[1/(24.*60.)] = '%M:%S' # only show min and sec
```

A custom *FuncFormatter* can also be used. The following example shows how to use a custom format function to strip trailing zeros from decimal seconds and adds the date to the first ticklabel:

```
>>> def my_format_function(x, pos=None):
...     x = matplotlib.dates.num2date(x)
...     if pos == 0:
...         fmt = '%D %H:%M:%S.%f'
...     else:
...         fmt = '%H:%M:%S.%f'
...     label = x.strftime(fmt)
...     label = label.rstrip("0")
...     label = label.rstrip(".")
...     return label
>>> from matplotlib.ticker import FuncFormatter
>>> formatter.scaled[1/(24.*60.)] = FuncFormatter(my_format_function)
```

Autoformat the date labels. The default format is the one to use if none of the values in `self.scaled` are greater than the unit returned by `locator._get_unit()`.

class matplotlib.dates.**DateLocator**(*tz=None*)

Bases: *matplotlib.ticker.Locator*

Determines the tick locations when plotting dates.

This class is subclassed by other Locators and is not meant to be used on its own.

tz is a `tzinfo` instance.

datalim_to_dt()

Convert axis data interval to datetime objects.

hms0d = {'byhour': 0, 'byminute': 0, 'bysecond': 0}

nonsingular(*vmin*, *vmax*)
Given the proposed upper and lower extent, adjust the range if it is too close to being singular (i.e. a range of ~0).

set_tzinfo(*tz*)
Set time zone info.

viewlim_to_dt()
Converts the view interval to datetime objects.

class matplotlib.dates.**RRuleLocator**(*o*, *tz=None*)
Bases: *matplotlib.dates.DateLocator*

autoscale()
Set the view limits to include the data range.

static get_unit_generic(*freq*)

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.dates.**AutoDateLocator**(*tz=None*, *minticks=5*, *maxticks=None*, *interval_multiples=False*)
Bases: *matplotlib.dates.DateLocator*

On autoscale, this class picks the best *DateLocator* 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 *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, 20, 40, 50, 100, 200, 400, 500,
             1000, 2000, 4000, 5000, 10000],
  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],
  MICROSECONDLY: [1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000,
                  5000, 10000, 20000, 50000, 100000, 200000, 500000,
                  1000000],
  }
```

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.

nonsingular(*vmin*, *vmax*)
Given the proposed upper and lower extent, adjust the range if it is too close to being singular (i.e. a range of ~0).

refresh()
Refresh internal information based on current limits.

set_axis(*axis*)

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.dates.**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.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.dates.**MonthLocator**(*bymonth=None*, *bymonthday=1*, *interval=1*, *tz=None*)
Bases: *matplotlib.dates.RRuleLocator*

Make ticks on occurrences of each month, e.g., 1, 3, 12.

Mark every month in *bymonth*; *bymonth* can be an int or sequence. Default is `range(1,13)`, i.e. every month.

interval is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

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

Make ticks on occurrences of each weekday.

Mark every weekday in *byweekday*; *byweekday* can be a number or sequence.

Elements of *byweekday* must be one of MO, TU, WE, TH, FR, SA, SU, the constants from `dateutil.rrule`, which have been imported into the *matplotlib.dates* namespace.

interval specifies the number of weeks to skip. For example, `interval=2` plots every second week.

class matplotlib.dates.**DayLocator**(*bymonthday=None*, *interval=1*, *tz=None*)
Bases: *matplotlib.dates.RRuleLocator*

Make ticks on occurrences of each day of the month. For example, 1, 15, 30.

Mark every day in *bymonthday*; *bymonthday* can be an int or sequence.

Default is to tick every day of the month: `bymonthday=range(1,32)`

class matplotlib.dates.**HourLocator**(*byhour=None*, *interval=1*, *tz=None*)
Bases: *matplotlib.dates.RRuleLocator*

Make ticks on occurrences of each hour.

Mark every hour in *byhour*; *byhour* can be an int or sequence. Default is to tick every hour: `byhour=range(24)`

interval is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

class matplotlib.dates.**MinuteLocator**(*byminute=None*, *interval=1*, *tz=None*)
Bases: *matplotlib.dates.RRuleLocator*

Make ticks on occurrences of each minute.

Mark every minute in *byminute*; *byminute* can be an int or sequence. Default is to tick every minute: `byminute=range(60)`

interval is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

class matplotlib.dates.**SecondLocator**(*bysecond=None*, *interval=1*, *tz=None*)
Bases: *matplotlib.dates.RRuleLocator*

Make ticks on occurrences of each second.

Mark every second in *bysecond*; *bysecond* can be an int or sequence. Default is to tick every second: `bysecond = range(60)`

interval is the interval between each iteration. For example, if `interval=2`, mark every second occurrence.

class matplotlib.dates.**MicrosecondLocator**(*interval=1*, *tz=None*)
Bases: *matplotlib.dates.DateLocator*

Make ticks on regular intervals of one or more microsecond(s).

Note: Due to the floating point representation of time in days since 0001-01-01 UTC (plus 1), plotting data with microsecond time resolution does not work well with current dates.

If you want microsecond resolution time plots, it is strongly recommended to use floating point seconds, not datetime-like time representation.

If you really must use datetime.datetime() or similar and still need microsecond precision, your only chance is to use very early years; using year 0001 is recommended.

---

interval is the interval between each iteration. For example, if `interval=2`, mark every second microsecond.

set_axis(*axis*)

set_data_interval(*vmin*, *vmax*)

set_view_interval(*vmin*, *vmax*)

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.dates.**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`

That's the base of the rrule operation. It accepts all the keywords defined in the RFC as its constructor parameters (except byday, which was renamed to byweekday) and more. The constructor prototype is:

```
rrule(freq)
```

Where freq must be one of YEARLY, MONTHLY, WEEKLY, DAILY, HOURLY, MINUTELY, or SECONDLY.

Note: Per RFC section 3.3.10, recurrence instances falling on invalid dates and times are ignored rather than coerced:

> Recurrence rules may generate recurrence instances with an invalid date (e.g., February 30) or nonexistent local time (e.g., 1:30 AM on a day where the local time is moved forward by an hour at 1:00 AM). Such recurrence instances MUST be ignored and MUST NOT be counted as part of the recurrence set.

This can lead to possibly surprising behavior when, for example, the start date occurs at the end of the month:

```
>>> from dateutil.rrule import rrule, MONTHLY
>>> from datetime import datetime
>>> start_date = datetime(2014, 12, 31)
>>> list(rrule(freq=MONTHLY, count=4, dtstart=start_date))
...
```

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```
[datetime.datetime(2014, 12, 31, 0, 0),
 datetime.datetime(2015, 1, 31, 0, 0),
 datetime.datetime(2015, 3, 31, 0, 0),
 datetime.datetime(2015, 5, 31, 0, 0)]
```

Additionally, it supports the following keyword arguments:

Parameters

- **dtstart** – The recurrence start. Besides being the base for the recurrence, missing parameters in the final recurrence instances will also be extracted from this date. If not given, datetime.now() will be used instead.
- **interval** – The interval between each freq iteration. For example, when using YEARLY, an interval of 2 means once every two years, but with HOURLY, it means once every two hours. The default interval is 1.
- **wkst** – The week start day. Must be one of the MO, TU, WE constants, or an integer, specifying the first day of the week. This will affect recurrences based on weekly periods. The default week start is got from calendar.firstweekday(), and may be modified by calendar.setfirstweekday().
- **count** – How many occurrences will be generated.

  Note: As of version 2.5.0, the use of the `until` keyword together with the `count` keyword is deprecated per RFC-5545 Sec. 3.3.10.

- **until** – If given, this must be a datetime instance, that will specify the limit of the recurrence. The last recurrence in the rule is the greatest datetime that is less than or equal to the value specified in the `until` parameter.

  Note: As of version 2.5.0, the use of the `until` keyword together with the `count` keyword is deprecated per RFC-5545 Sec. 3.3.10.

- **bysetpos** – If given, it must be either an integer, or a sequence of integers, positive or negative. Each given integer will specify an occurrence number, corresponding to the nth occurrence of the rule inside the frequency period. For example, a bysetpos of -1 if combined with a MONTHLY frequency, and a byweekday of (MO, TU, WE, TH, FR), will result in the last work day of every month.
- **bymonth** – If given, it must be either an integer, or a sequence of integers, meaning the months to apply the recurrence to.
- **bymonthday** – If given, it must be either an integer, or a sequence of integers, meaning the month days to apply the recurrence to.
- **byyearday** – If given, it must be either an integer, or a sequence of integers, meaning the year days to apply the recurrence to.

- **byeaster** – If given, it must be either an integer, or a sequence of integers, positive or negative. Each integer will define an offset from the Easter Sunday. Passing the offset 0 to byeaster will yield the Easter Sunday itself. This is an extension to the RFC specification.
- **byweekno** – If given, it must be either an integer, or a sequence of integers, meaning the week numbers to apply the recurrence to. Week numbers have the meaning described in ISO8601, that is, the first week of the year is that containing at least four days of the new year.
- **byweekday** – If given, it must be either an integer (0 == MO), a sequence of integers, one of the weekday constants (MO, TU, etc), or a sequence of these constants. When given, these variables will define the weekdays where the recurrence will be applied. It's also possible to use an argument n for the weekday instances, which will mean the nth occurrence of this weekday in the period. For example, with MONTHLY, or with YEARLY and BYMONTH, using FR(+1) in byweekday will specify the first friday of the month where the recurrence happens. Notice that in the RFC documentation, this is specified as BYDAY, but was renamed to avoid the ambiguity of that keyword.
- **byhour** – If given, it must be either an integer, or a sequence of integers, meaning the hours to apply the recurrence to.
- **byminute** – If given, it must be either an integer, or a sequence of integers, meaning the minutes to apply the recurrence to.
- **bysecond** – If given, it must be either an integer, or a sequence of integers, meaning the seconds to apply the recurrence to.
- **cache** – If given, it must be a boolean value specifying to enable or disable caching of results. If you will use the same rrule instance multiple times, enabling caching will improve the performance considerably.

replace(***kwargs*)

Return new rrule with same attributes except for those attributes given new values by whichever keyword arguments are specified.

class matplotlib.dates.**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*)

Bases: object

The relativedelta type is based on the specification of the excellent work done by M.-A. Lemburg in his mx.DateTime extension. However, notice that this type does *NOT* implement the same algorithm as his work. Do *NOT* expect it to behave like mx.DateTime's counterpart.

There are two different ways to build a relativedelta instance. The first one is passing it two date/datetime classes:

```
relativedelta(datetime1, datetime2)
```

The second one is passing it any number of the following keyword arguments:

```
relativedelta(arg1=x,arg2=y,arg3=z...)

year, month, day, hour, minute, second, microsecond:
    Absolute information (argument is singular); adding or subtracting a
    relativedelta with absolute information does not perform an arithmetic
    operation, but rather REPLACES the corresponding value in the
    original datetime with the value(s) in relativedelta.

years, months, weeks, days, hours, minutes, seconds, microseconds:
    Relative information, may be negative (argument is plural); adding
    or subtracting a relativedelta with relative information performs
    the corresponding aritmetic operation on the original datetime value
    with the information in the relativedelta.

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. Notice that
    if the calculated date is already Monday, for example,
    using MO(1) or MO(-1) won't change the day.

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.
```

There are relative and absolute forms of the keyword arguments. The plural is relative, and the singular is absolute. For each argument in the order below, the absolute form is applied first (by setting each attribute to that value) and then the relative form (by adding the value to the attribute).

The order of attributes considered when this relativedelta is added to a datetime is:

1. Year
2. Month
3. Day
4. Hours
5. Minutes
6. Seconds
7. Microseconds

Finally, weekday is applied, using the rule described above.

For example

```
>>> dt = datetime(2018, 4, 9, 13, 37, 0)
>>> delta = relativedelta(hours=25, day=1, weekday=MO(1))
datetime(2018, 4, 2, 14, 37, 0)
```

First, the day is set to 1 (the first of the month), then 25 hours are added, to get to the 2nd day and 14th hour, finally the weekday is applied, but since the 2nd is already a Monday there is no effect.

normalized()

Return a version of this object represented entirely using integer values for the relative attributes.

```
>>> relativedelta(days=1.5, hours=2).normalized()
relativedelta(days=1, hours=14)
```

Returns Returns a `dateutil.relativedelta.relativedelta` object.

weeks

matplotlib.dates.**seconds**(*s*)

Return seconds as days.

matplotlib.dates.**minutes**(*m*)

Return minutes as days.

matplotlib.dates.**hours**(*h*)

Return hours as days.

matplotlib.dates.**weeks**(*w*)

Return weeks as days.

CHAPTER

FORTYSIX

DVIREAD

46.1 matplotlib.dviread

A 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:

```
with Dvi(filename, 72) as dvi:
    # iterate over pages:
    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 matplotlib.dviread.**Dvi**(*filename*, *dpi*)

Bases: object

A reader for a dvi ("device-independent") file, as produced by TeX. The current implementation can only iterate through pages in order, and does not even attempt to verify the postamble.

This class can be used as a context manager to close the underlying file upon exit. Pages can be read via iteration. Here is an overly simple way to extract text without trying to detect whitespace:

```
>>> with matplotlib.dviread.Dvi('input.dvi', 72) as dvi:
>>>     for page in dvi:
>>>         print(''.join(unichr(t.glyph) for t in page.text))
```

Read the data from the file named *filename* and convert TeX's internal units to units of *dpi* per inch. *dpi* only sets the units and does not limit the resolution. Use None to return TeX's internal units.

close()

Close the underlying file if it is open.

class matplotlib.dviread.**DviFont**(*scale*, *tfm*, *texname*, *vf*)

Bases: object

Encapsulation of a font that a DVI file can refer to.

This class 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).

Parameters

scale [float] Factor by which the font is scaled from its natural size.

tfm [Tfm] TeX font metrics for this font

texname [bytes] Name of the font as used internally by TeX and friends, as an ASCII bytestring. This is usually very different from any external font names, and `dviread.PsfontsMap` can be used to find the external name of the font.

vf [Vf] A TeX "virtual font" file, or None if this font is not virtual.

Attributes

texname [bytes]

size [float] Size of the font in Adobe points, converted from the slightly smaller TeX points.

widths [list] Widths of glyphs in glyph-space units, typically 1/1000ths of the point size.

size

texname

widths

class matplotlib.dviread.**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)
```

Parameters

filename [string or bytestring]

Attributes

encoding [list] List of character names

encoding

matplotlib.dviread.**PsFont**
alias of matplotlib.dviread.Font

class matplotlib.dviread.**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[b'ptmbo8r']
>>> entry.texname
b'ptmbo8r'
>>> entry.psname
b'Times-Bold'
>>> entry.encoding
'/usr/local/texlive/2008/texmf-dist/fonts/enc/dvips/base/8r.enc'
>>> entry.effects
{'slant': 0.16700000000000001}
>>> entry.filename
```

Parameters

filename [string or bytestring]

Notes

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`, or `dvipdfm.map`. The file `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 matplotlib.dviread.**Tfm**(*filename*)
Bases: object

A TeX Font Metric file.

This implementation covers only the bare minimum needed by the Dvi class.

Parameters

filename [string or bytestring]

Attributes

checksum [int] Used for verifying against the dvi file.

design_size [int] Design size of the font (unknown units)

width, height, depth [dict] Dimensions of each character, need to be scaled by the factor specified in the dvi file. These are dicts because indexing may not start from 0.

checksum

depth

design_size

height

width

class matplotlib.dviread.**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
```

Parameters

filename [string or bytestring]

Notes

The virtual font format is a derivative of dvi: http://mirrors.ctan.org/info/knuth/virtual-fonts This class reuses some of the machinery of *Dvi* but replaces the `_read` loop and dispatch mechanism.

matplotlib.dviread.**find_tex_file**(*filename*, *format=None*)

Find a file in the texmf tree.

Calls **kpsewhich** which is an interface to the kpathsea library *[1]*. Most existing TeX distributions on Unix-like systems use kpathsea. It is also available as part of MikTeX, a popular distribution on Windows.

Parameters

filename [string or bytestring]

format [string or bytestring] Used as the value of the `--format` option to **kpsewhich**. Could be e.g. 'tfm' or 'vf' to limit the search to that type of files.

References

[1]

`matplotlib.dviread.`**ord**(*x*)

CHAPTER

FORTYSEVEN

FIGURE

47.1 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.

47.1.1 Classes

AxesStack()	Specialization of the *Stack* to handle all tracking of *Axes* in a *Figure*.
Figure([figsize, dpi, facecolor, edgecolor, ...])	The top level container for all the plot elements.
SubplotParams([left, bottom, right, top, ...])	A class to hold the parameters for a subplot.

matplotlib.figure.AxesStack

class matplotlib.figure.**AxesStack**

Specialization of the *Stack* to handle all tracking of *Axes* in a *Figure*. This stack stores `key, (ind, axes)` pairs, where:

- **key** should be a hash of the args and kwargs used in generating the Axes.
- **ind** is a serial number for tracking the order in which axes were added.

The AxesStack is a callable, where `ax_stack()` returns the current axes. Alternatively the *current_key_axes()* will return the current key and associated axes.

add(*key*, *a*)

Add Axes *a*, with key *key*, to the stack, and return the stack.

If *key* is unhashable, replace it by a unique, arbitrary object.

If *a* is already on the stack, don't add it again, but return *None*.

as_list()

Return a list of the Axes instances that have been added to the figure

bubble(*a*)
Move the given axes, which must already exist in the stack, to the top.

current_key_axes()
Return a tuple of `(key, axes)` for the active axes.

If no axes exists on the stack, then returns `(None, None)`.

get(*key*)
Return the Axes instance that was added with *key*. If it is not present, return None.

remove(*a*)
Remove the axes from the stack.

matplotlib.figure.Figure

class matplotlib.figure.**Figure**(*figsize=None*, *dpi=None*, *facecolor=None*, *edgecolor=None*, *linewidth=0.0*, *frameon=None*, *subplotpars=None*, *tight_layout=None*, *constrained_layout=None*)
The top level container for all the plot elements.

The Figure instance supports callbacks through a *callbacks* attribute which is a *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.

Attributes

patch The *Rectangle* instance representing the figure patch.

suppressComposite For multiple figure images, the figure will make composite images depending on the renderer option_image_nocomposite function. If *suppressComposite* is a boolean, this will override the renderer.

Parameters

figsize [2-tuple of floats, default: `rcParams["figure.figsize"]`] Figure dimension `(width, height)` in inches.

dpi [float, default: `rcParams["figure.dpi"]`] Dots per inch.

facecolor [default: `rcParams["figure.facecolor"]`] The figure patch facecolor.

edgecolor [default: `rcParams["figure.edgecolor"]`] The figure patch edge color.

linewidth [float] The linewidth of the frame (i.e. the edge linewidth of the figure patch).

frameon [bool, default: `rcParams["figure.frameon"]`] If `False`, suppress drawing the figure frame.

subplotpars [*SubplotParams*] Subplot parameters. If not given, the default subplot parameters `rcParams["figure.subplot.*"]` are used.

tight_layout [bool or dict, default: `rcParams["figure.autolayout"]`] If `False` use *subplotpars*. If `True` adjust subplot parameters using *tight_layout* with default padding. When providing a dict containing the keys `pad`, `w_pad`, `h_pad`, and `rect`, the default *tight_layout* paddings will be overridden.

constrained_layout [bool] If `True` use constrained layout to adjust positioning of plot elements. Like `tight_layout`, but designed to be more flexible. See *Constrained Layout Guide* for examples. (Note: does not work with `subplot()` or `subplot2grid()`.) Defaults to `rcParams["figure.constrained_layout.use"]`.

add_axes(**args*, ***kwargs*)

Add an axes to the figure.

Call signature:

```
add_axes(rect, projection=None, polar=False, **kwargs)
```

Parameters

rect [sequence of float] The dimensions [left, bottom, width, height] of the new axes. All quantities are in fractions of figure width and height.

projection [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', rectilinear'}, optional] The projection type of the axes.

polar [boolean, optional] If True, equivalent to projection='polar'.

****kwargs** This method also takes the keyword arguments for *Axes*.

Returns

axes [Axes] The added axes.

Examples

Some simple examples:

```
rect = l, b, w, h
fig.add_axes(rect)
fig.add_axes(rect, frameon=False, facecolor='g')
fig.add_axes(rect, polar=True)
fig.add_axes(rect, projection='polar')
fig.add_axes(ax)
```

If the figure already has an axes with the same parameters, then it will simply make that axes current and return it. This behavior has been deprecated as of Matplotlib 2.1. Meanwhile, if you do not want this behavior (i.e., 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: if you want two axes that are otherwise identical to be added to the figure, make sure you give them unique labels:

```
fig.add_axes(rect, label='axes1')
fig.add_axes(rect, label='axes2')
```

In rare circumstances, add_axes may be called with a single argument, an Axes instance already created in the present figure but not in the figure's list of axes. For example, if an axes has been removed with *delaxes()*, it can be restored with:

```
fig.add_axes(ax)
```

In all cases, the *Axes* instance will be returned.

add_axobserver(*func*)
Whenever the axes state change, `func(self)` will be called.

add_subplot(**args*, ***kwargs*)
Add a subplot.

Call signatures:

```
add_subplot(nrows, ncols, index, **kwargs)
add_subplot(pos, **kwargs)
```

Parameters

***args** Either a 3-digit integer or three separate integers describing the position of the subplot. If the three integers are R, C, and P in order, the subplot will take the Pth position on a grid with R rows and C columns.

projection [{None, 'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', rectilinear'}, optional] The projection type of the axes.

polar [boolean, optional] If True, equivalent to projection='polar'.

****kwargs** This method also takes the keyword arguments for *Axes*.

Returns

axes [Axes] The axes of the subplot.

See also:

matplotlib.pyplot.subplot for an explanation of the args.

Notes

If the figure already has a subplot with key (*args*, *kwargs*) then it will simply make that subplot current and return it. This behavior is deprecated.

Examples

```
fig.add_subplot(111)

# equivalent but more general
fig.add_subplot(1, 1, 1)

# add subplot with red background
fig.add_subplot(212, facecolor='r')

# add a polar subplot
fig.add_subplot(111, projection='polar')

# add Subplot instance sub
fig.add_subplot(sub)
```

align_labels(*axs=None*)

Align the xlabels and ylabels of subplots with the same subplots row or column (respectively) if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

Parameters

axs [list of *Axes*] Optional list (or ndarray) of *Axes* to align the labels. Default is to align all axes on the figure.

See also:

matplotlib.figure.Figure.align_xlabels, *matplotlib.figure.Figure.align_ylabels*

align_xlabels(*axs=None*)

Align the ylabels of subplots in the same subplot column if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

If a label is on the bottom, it is aligned with labels on axes that also have their label on the bottom and that have the same bottom-most subplot row. If the label is on the top, it is aligned with labels on axes with the same top-most row.

Parameters

axs [list of *Axes*] Optional list of (or ndarray) *Axes* to align the xlabels. Default is to align all axes on the figure.

See also:

matplotlib.figure.Figure.align_ylabels, *matplotlib.figure.Figure.align_labels*

Notes

This assumes that `axs` are from the same *GridSpec*, so that their *SubplotSpec* positions correspond to figure positions.

Examples

Example with rotated xtick labels:

```
fig, axs = plt.subplots(1, 2)
for tick in axs[0].get_xticklabels():
    tick.set_rotation(55)
axs[0].set_xlabel('XLabel 0')
axs[1].set_xlabel('XLabel 1')
fig.align_xlabels()
```

align_ylabels(*axs=None*)

Align the ylabels of subplots in the same subplot column if label alignment is being done automatically (i.e. the label position is not manually set).

Alignment persists for draw events after this is called.

If a label is on the left, it is aligned with labels on axes that also have their label on the left and that have the same left-most subplot column. If the label is on the right, it is aligned with labels on axes with the same right-most column.

Parameters

axs [list of *Axes*] Optional list (or ndarray) of *Axes* to align the ylabels. Default is to align all axes on the figure.

See also:

matplotlib.figure.Figure.align_xlabels, *matplotlib.figure.Figure.align_labels*

Notes

This assumes that `axs` are from the same *GridSpec*, so that their *SubplotSpec* positions correspond to figure positions.

Examples

Example with large yticks labels:

```
fig, axs = plt.subplots(2, 1)
axs[0].plot(np.arange(0, 1000, 50))
axs[0].set_ylabel('YLabel 0')
```

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```
axs[1].set_ylabel('YLabel 1')
fig.align_ylabels()
```

autofmt_xdate(*bottom=0.2*, *rotation=30*, *ha='right'*, *which=None*)

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.

Parameters

bottom [scalar] The bottom of the subplots for *subplots_adjust()*.

rotation [angle in degrees] The rotation of the xtick labels.

ha [string] The horizontal alignment of the xticklabels.

which [{None, 'major', 'minor', 'both'}] Selects which ticklabels to rotate. Default is None which works the same as major.

axes

List of axes in the Figure. You can access the axes in the Figure through this list. Do not modify the list itself. Instead, use *add_axes*, `subplot` or *delaxes* to add or remove an axes.

clear(*keep_observers=False*)

Clear the figure – synonym for *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*, *use_gridspec=True*, ***kw*)

Create a colorbar for a ScalarMappable instance, *mappable*.

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)
```

Parameters

mappable : The `Image`, *ContourSet*, etc. to which the colorbar applies; this argument is mandatory for the Figure *colorbar()* method but optional for the pyplot *colorbar()* function, which sets the default to the current image.

cax [*Axes* object, optional] Axes into which the colorbar will be drawn.

ax [*Axes*, list of Axes, optional] Parent axes from which space for a new colorbar axes will be stolen. If a list of axes is given they will all be resized to make room for the colorbar axes.

use_gridspec [bool, optional] If *cax* is `None`, a new *cax* is created as an instance of Axes. If *ax* is an instance of Subplot and *use_gridspec* is `True`, *cax* is created as an instance of Subplot using the grid_spec module.

Returns

:class:'~matplotlib.colorbar.Colorbar' instance See also its base class, *ColorbarBase*. Call the *set_label()* method to label the colorbar.

Notes

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 multiply the size of the colorbar
aspect	20; ratio of long to short dimensions
anchor	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
panchor	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

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.
extendfrac	[*None* | 'auto' | length | lengths] If set to *None*, both the minimum and maximum triangular colorbar extensions with have a length of 5% of the interior colorbar length (this is the default setting). If set to 'auto', makes the triangular colorbar extensions the same lengths as the interior boxes (when *spacing* is set to 'uniform') or the same lengths as the respective adjacent interior boxes (when *spacing* is set to 'proportional'). If a scalar, indicates the length of both the minimum and maximum triangular colorbar extensions as a fraction of the interior colorbar length. A two-element sequence of fractions may also be given, indicating the lengths of the minimum and maximum colorbar extensions respectively as a fraction of the interior colorbar length.
extendrect	bool If *False* the minimum and maximum colorbar extensions will be triangular (the default). If *True* the extensions will be rectangular.
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	bool Whether to 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.

The *shrink* kwarg provides a simple way to scale the colorbar with respect to the axes. Note that if *cax* is specified it determines the size of the colorbar and *shrink* and *aspect* kwargs are

ignored.

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.

It is known that some vector graphics viewer (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers not matplotlib. As a workaround the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances. Particularly with semi transparent images (alpha < 1) and colorbar extensions and is not enabled by default see (issue #1188).

contains(*mouseevent*)
Test whether the mouse event occurred on the figure.

Returns

bool, {}

delaxes(*ax*)
Remove the *Axes* *ax* from the figure and update the current axes.

dpi
The resolution in dots per inch.

draw(*renderer*)
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.

execute_constrained_layout(*renderer=None*)
Use `layoutbox` to determine pos positions within axes.

See also *set_constrained_layout_pads*.

figimage(*X*, *xo=0*, *yo=0*, *alpha=None*, *norm=None*, *cmap=None*, *vmin=None*, *vmax=None*, *origin=None*, *resize=False*, ***kwargs*)
Add a non-resampled image to the figure.

The image is attached to the lower or upper left corner depending on *origin*.

Parameters

X The image data. This is an array of one of the following shapes:

- MxN: luminance (grayscale) values
- MxNx3: RGB values
- MxNx4: RGBA values

xo, yo [int] The *x*/*y* image offset in pixels.

alpha [None or float] The alpha blending value.

norm [*matplotlib.colors.Normalize*] A *Normalize* instance to map the luminance to the interval [0, 1].

cmap [str or *matplotlib.colors.Colormap*] The colormap to use. Default: `rcParams["image.cmap"]`.

vmin, vmax [scalar] If *norm* is not given, these values set the data limits for the colormap.

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 `rcParams["image.origin"]`.

resize [bool] If *True*, resize the figure to match the given image size.

Returns

:class:'matplotlib.image.FigureImage'

Other Parameters

****kwargs** Additional kwargs are *Artist* kwargs passed on to *FigureImage*.

Notes

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 extent [0,0,1,1].

Examples:

```
f = plt.figure()
nx = int(f.get_figwidth() * f.dpi)
ny = int(f.get_figheight() * f.dpi)
data = np.random.random((ny, nx))
f.figimage(data)
plt.show()
```

figurePatch

Deprecated since version 2.1: The figurePatch function was deprecated in version 2.1. Use `Figure.patch` instead.

gca(***kwargs*)

Get the current axes, creating one if necessary.

The following kwargs are supported for ensuring the returned axes adheres to the given projection etc., and for axes creation if the active axes does not exist:

Property	Description
`adjustable`	['box' | 'datalim']

Continued on next pag

Table 2 – continued from previous page

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) arra
alpha	float (0.0 transparent through 1.0 opaque)
anchor	['C' | 'SW' | 'S' | 'SE' | 'E' | 'NE' | 'N' | 'NW' | 'W']
animated	bool
aspect	unknown
autoscale_on	bool
autoscalex_on	bool
autoscaley_on	bool
axes_locator	a callable object which takes an axes instance and renderer and returns a bbox.
axisbelow	[bool | 'line']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
contains	a callable function
facecolor	color
fc	color
figure	*Figure*
frame_on	bool
gid	an id string
label	object
navigate	bool
navigate_mode	unknown
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	unknown
rasterization_zorder	float or None
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
title	unknown
transform	*Transform*
url	a url string
visible	bool
xbound	(lower: float, upper: float)
xlabel	unknown
xlim	(left: float, right: float)
xmargin	float greater than -0.5
xscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
xticklabels	list of string labels
xticks	list of tick locations.
ybound	(lower: float, upper: float)
ylabel	unknown
ylim	(bottom: float, top: float)

Continued on next pag

Table 2 – continued from previous page

Property	Description
ymargin	float greater than -0.5
yscale	['linear' | 'log' | 'symlog' | 'logit' | ...]
yticklabels	list of string labels
yticks	list of tick locations.
zorder	float

get_axes()
Return a list of axes in the Figure. You can access and modify the axes in the Figure through this list.

Do not modify the list itself. Instead, use *add_axes*, subplot or *delaxes* to add or remove an axes.

Note: This is equivalent to the property *axes*.

get_children()
Get a list of artists contained in the figure.

get_constrained_layout()
Return a boolean: True means constrained layout is being used.

See *Constrained Layout Guide*.

get_constrained_layout_pads(*relative=False*)
Get padding for constrained_layout.

Returns a list of w_pad, h_pad in inches and wspace and hspace as fractions of the subplot.

See *Constrained Layout Guide*.

Parameters

relative [boolean] If True, then convert from inches to figure relative.

get_default_bbox_extra_artists()

get_dpi()
Return the resolution in dots per inch 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 figure height as a float.

get_figwidth()
Return the figure width as a float.

get_frameon()
Return whether the figure frame will be drawn.

get_size_inches()
Returns the current size of the figure in inches.

Returns

size [ndarray] The size (width, height) of the figure in inches.

See also:

`matplotlib.Figure.set_size_inches`

get_tight_layout()
Return whether *tight_layout* is called when drawing.

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*)
Return the figure bounding box in display space. Arguments are ignored.

ginput(*n=1*, *timeout=30*, *show_clicks=True*, *mouse_add=1*, *mouse_pop=3*, *mouse_stop=2*)
Blocking call to interact with a figure.

Wait until the user clicks *n* times on the figure, and return the coordinates of each click in a list.

The buttons used for the various actions (adding points, removing points, terminating the inputs) can be overridden via the arguments *mouse_add*, *mouse_pop* and *mouse_stop*, that give the associated mouse button: 1 for left, 2 for middle, 3 for right.

Parameters

n [int, optional, default: 1] Number of mouse clicks to accumulate. If negative, accumulate clicks until the input is terminated manually.

timeout [scalar, optional, default: 30] Number of seconds to wait before timing out. If zero or negative will never timeout.

show_clicks [bool, optional, default: False] If True, show a red cross at the location of each click.

mouse_add [int, one of (1, 2, 3), optional, default: 1 (left click)] Mouse button used to add points.

mouse_pop [int, one of (1, 2, 3), optional, default: 3 (right click)] Mouse button used to remove the most recently added point.

mouse_stop [int, one of (1, 2, 3), optional, default: 2 (middle click)] Mouse button used to stop input.

Returns

points [list of tuples] A list of the clicked (x, y) coordinates.

Notes

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*)

Deprecated since version 2.0: The hold function was deprecated in version 2.0.

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

e.g.:

```
hold()      # toggle hold
hold(True)  # hold is on
hold(False) # hold is off
```

All "hold" machinery is deprecated.

init_layoutbox()

Initialize the layoutbox for use in constrained_layout.

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

Place a legend on the figure.

To make a legend from existing artists on every axes:

```
legend()
```

To make a legend for a list of lines and labels:

```
legend( (line1, line2, line3),
        ('label1', 'label2', 'label3'),
        loc='upper right')
```

These can also be specified by keyword:

```
legend(handles=(line1, line2, line3),
      labels=('label1', 'label2', 'label3'),
      loc='upper right')
```

Parameters

handles [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

labels [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

Returns

:class:‘matplotlib.legend.Legend‘ instance

Other Parameters

loc [int or string or pair of floats, default: ’upper right’] The location of the legend. Possible 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

Alternatively can be a 2-tuple giving `x, y` of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

bbox_to_anchor [*BboxBase* or pair of floats] Specify any arbitrary location for the legend in `bbox_transform` coordinates (default Axes coordinates).

For example, to put the legend’s upper right hand corner in the center of the axes the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

ncol [integer] The number of columns that the legend has. Default is 1.

prop [None or *matplotlib.font_manager.FontProperties* or dict] The font properties of the legend. If None (default), the current *matplotlib.rcParams* will be used.

fontsize [int or float or {’xx-small’, ’x-small’, ’small’, ’medium’, ’large’, ’x-large’, ’xx-large’}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

numpoints [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is `None`, which will take the value from `rcParams["legend.numpoints"]`.

scatterpoints [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.

scatteryoffsets [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to `[0.5]`. Default is `[0.375, 0.5, 0.3125]`.

markerscale [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.

markerfirst [bool] If *True*, legend marker is placed to the left of the legend label. If *False*, legend marker is placed to the right of the legend label. Default is *True*.

frameon [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.

fancybox [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.

shadow [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.

framealpha [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.

facecolor [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If `"inherit"`, it will take `rcParams["axes.facecolor"]`.

edgecolor [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]` If `"inherit"`, it will take `rcParams["axes.edgecolor"]`.

mode [{"expand", None}] If `mode` is set to `"expand"` the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).

bbox_transform [None or *matplotlib.transforms.Transform*] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.

title [str or None] The legend's title. Default is no title (`None`).

borderpad [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.

labelspacing [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

handlelength [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

handletextpad [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

borderaxespad [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

columnspacing [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

handler_map [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at *matplotlib.legend.Legend.get_legend_handler_map()*.

Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

savefig(*fname*, ***kwargs*)

Save the current figure.

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,
        frameon=None)
```

The output formats available depend on the backend being used.

Parameters

fname [str or file-like object] 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.format` is used.

If *fname* is not a string, remember to specify *format* to ensure that the correct backend is used.

Other Parameters

dpi [[*None* | scalar > 0 | 'figure']] The resolution in dots per inch. If *None* it will default to the value `savefig.dpi` in the matplotlibrc file. If 'figure' it will set the dpi to be the value of the figure.

facecolor [color spec or None, optional] the facecolor of the figure; if None, defaults to savefig.facecolor

edgecolor [color spec or None, optional] the edgecolor of the figure; if None, defaults to savefig.edgecolor

orientation [{'landscape', 'portrait'}] not supported on all backends; currently only on postscript output

papertype [str] One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.

format [str] One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

transparent [bool] 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.

frameon [bool] If *True*, the figure patch will be colored, if *False*, the figure background will be transparent. If not provided, the rcParam 'savefig.frameon' will be used.

bbox_inches [str or *Bbox*, optional] Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure. If None, use savefig.bbox

pad_inches [scalar, optional] Amount of padding around the figure when bbox_inches is 'tight'. If None, use savefig.pad_inches

bbox_extra_artists [list of *Artist*, optional] 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 that contains the figure

ACCEPTS: a FigureCanvas instance

`set_constrained_layout`(*constrained*)
Set whether `constrained_layout` is used upon drawing. If None, the rcParams['figure.constrained_layout.use'] value will be used.

When providing a dict containing the keys `w_pad`, `h_pad` the default `constrained_layout` paddings will be overridden. These pads are in inches and default to 3.0/72.0. `w_pad` is the width padding and `h_pad` is the height padding.

ACCEPTS: [True | False | dict | None]

See *Constrained Layout Guide*.

set_constrained_layout_pads(***kwargs*)
Set padding for `constrained_layout`. Note the kwargs can be passed as a dictionary `fig.set_constrained_layout(**paddict)`.

See *Constrained Layout Guide*.

Parameters

w_pad [scalar] Width padding in inches. This is the pad around axes and is meant to make sure there is enough room for fonts to look good. Defaults to 3 pts = 0.04167 inches

h_pad [scalar] Height padding in inches. Defaults to 3 pts.

wspace: scalar Width padding between subplots, expressed as a fraction of the subplot width. The total padding ends up being w_pad + wspace.

hspace: scalar Height padding between subplots, expressed as a fraction of the subplot width. The total padding ends up being h_pad + hspace.

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*, *forward=True*)
Set the height of the figure in inches.

ACCEPTS: float

set_figwidth(*val*, *forward=True*)
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(*w*, *h=None*, *forward=True*)
Set the figure size in inches (1in == 2.54cm)

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; e.g., you can resize the figure window from the shell

ACCEPTS: a w, h tuple with w, h in inches

See also:

`matplotlib.Figure.get_size_inches`

set_tight_layout(*tight*)

Set whether and how *tight_layout* is called when drawing.

Parameters

tight [bool or dict with keys "pad", "w_pad", "h_pad", "rect" or None] If a bool, sets whether to call *tight_layout* upon drawing. If `None`, use the `figure.autolayout` rcparam instead. If a dict, pass it as kwargs to *tight_layout*, overriding the default paddings.

show(*warn=True*)

If using a GUI backend with pyplot, display the figure window.

If the figure was not created using *figure()*, it will lack a *FigureManagerBase*, and will raise an AttributeError.

Parameters

warm [bool] If `True`, issue warning when called on a non-GUI backend

Notes

For non-GUI backends, this does nothing, in which case a warning will be issued if *warn* is `True` (default).

subplots(*nrows=1*, *ncols=1*, *sharex=False*, *sharey=False*, *squeeze=True*, *subplot_kw=None*, *gridspec_kw=None*)

Add a set of subplots to this figure.

Parameters

nrows, ncols [int, default: 1] Number of rows/cols of the subplot grid.

sharex, sharey [bool or {'none', 'all', 'row', 'col'}, default: False] Controls sharing of properties among x (`sharex`) or y (`sharey`) axes:

- True or 'all': x- or y-axis will be shared among all subplots.
- False or 'none': each subplot x- or y-axis will be independent.
- 'row': each subplot row will share an x- or y-axis.
- 'col': each subplot column will share an x- or y-axis.

When subplots have a shared x-axis along a column, only the x tick labels of the bottom subplot are created. Similarly, when subplots have a shared y-axis along a row, only the y tick labels of the first column subplot are created. To later turn other subplots' ticklabels on, use *tick_params()*.

squeeze [bool, optional, default: True]

- If True, extra dimensions are squeezed out from the returned array of Axes:
  - if only one subplot is constructed (nrows=ncols=1), the resulting single Axes object is returned as a scalar.
  - for Nx1 or 1xM subplots, the returned object is a 1D numpy object array of Axes objects.
  - 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 Axes object is always a 2D array containing Axes instances, even if it ends up being 1x1.

subplot_kw [dict, default: {}] Dict with keywords passed to the *add_subplot()* call used to create each subplots.

gridspec_kw [dict, default: {}] Dict with keywords passed to the *GridSpec* constructor used to create the grid the subplots are placed on.

Returns

ax [single Axes object or array of Axes objects] The added axes. The dimensions of the resulting array can be controlled with the squeeze keyword, see above.

See also:

pyplot.subplots pyplot API; docstring includes examples.

subplots_adjust(**args*, ***kwargs*)

Call signature:

```
subplots_adjust(left=None, bottom=None, right=None, top=None,
                    wspace=None, hspace=None)
```

Update the *SubplotParams* with *kwargs* (defaulting to rc when *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 the 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

If the `fontproperties` keyword argument is given then the rcParams defaults for `fontsize` (`figure.titlesize`) and `fontweight` (`figure.titleweight`) will be ignored in favour of the `FontProperties` defaults.

A *matplotlib.text.Text* instance is returned.

Example:

```
fig.suptitle('this is the figure title', fontsize=12)
```

text(*x*, *y*, *s*, **args*, ***kwargs*)

Add text to figure.

Call signature:

```
text(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	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance
clip_on	bool
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 *Figure* instance
fontproperties or font_properties	a *matplotlib.font_manager.FontProperties* instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object
linespacing	float (multiple of font size)
multialignment or ma	['left' | 'right' | 'center']
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large'

Table 3 – continued from

Property	Description
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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*
url	a url string
usetex	bool or None
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
wrap	bool
x	float
y	float
zorder	float

tight_layout(*renderer=None*, *pad=1.08*, *h_pad=None*, *w_pad=None*, *rect=None*)

Adjust subplot parameters to give specified padding.

Parameters

pad [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

h_pad, w_pad [float, optional] padding (height/width) between edges of adjacent subplots. Defaults to `pad_inches`.

rect [tuple (left, bottom, right, top), optional] a rectangle (left, bottom, right, top) in the normalized figure coordinate that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

waitforbuttonpress(*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.

Examples using `matplotlib.figure.Figure`

- sphx_glr_gallery_api_agg_oo_sgskip.py
- sphx_glr_gallery_subplots_axes_and_figures_custom_figure_class.py
- sphx_glr_gallery_images_contours_and_fields_figimage_demo.py

- sphx_glr_gallery_shapes_and_collections_collections.py
- sphx_glr_gallery_misc_webapp_demo_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_gtk3_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_gtk_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_gtk3_panzoom_sgskip.py
- sphx_glr_gallery_user_interfaces_mpl_with_glade_316_sgskip.py
- sphx_glr_gallery_user_interfaces_histogram_demo_canvasagg_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_gtk2_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_tk_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_wx2_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_wx5_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_qt_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_tk_canvas_sgskip.py
- sphx_glr_gallery_user_interfaces_wxcursor_demo_sgskip.py
- sphx_glr_gallery_user_interfaces_gtk_spreadsheet_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_wx4_sgskip.py
- sphx_glr_gallery_user_interfaces_mpl_with_glade_sgskip.py
- sphx_glr_gallery_user_interfaces_mathtext_wx_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_in_wx3_sgskip.py
- sphx_glr_gallery_user_interfaces_embedding_webagg_sgskip.py
- sphx_glr_gallery_user_interfaces_fourier_demo_wx_sgskip.py

matplotlib.figure.SubplotParams

class matplotlib.figure.**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 fractions of the figure width or height. Defaults are given by `rcParams["figure.subplot.[name]"]`.

Parameters

left [float] The left side of the subplots of the figure.

right [float] The right side of the subplots of the figure.

bottom [float] The bottom of the subplots of the figure.

top [float] The top of the subplots of the figure.

wspace [float] The amount of width reserved for space between subplots, expressed as a fraction of the average axis width.

hspace [float] The amount of height reserved for space between subplots, expressed as a fraction of the average axis height.

update(*left=None*, *bottom=None*, *right=None*, *top=None*, *wspace=None*, *hspace=None*)
Update the dimensions of the passed parameters. *None* means unchanged.

47.1.2 Functions

figaspect(arg)	Create a figure with specified aspect ratio.

matplotlib.figure.figaspect

matplotlib.figure.**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, e.g.,

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

FORTYEIGHT

FONT_MANAGER

48.1 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 matplotlib.font_manager.**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 matplotlib.font_manager.**FontManager**(*size=None*, *weight='normal'*)

Bases: object

On import, the *FontManager* singleton instance creates a list of TrueType fonts based on the font properties: name, style, variant, weight, stretch, and size. The *findfont()* method does a nearest neighbor search to find the font that most closely matches the specification. If no good enough match is found, a default font is returned.

findfont(*prop*, *fontext='ttf'*, *directory=None*, *fallback_to_default=True*, *rebuild_if_missing=True*)

Search the font list for the font that most closely matches the *FontProperties* *prop*.

findfont() performs a nearest neighbor search. Each font is given a similarity score to the target font properties. The first font with the highest score is returned. If no matches below a certain threshold are found, the default font (usually DejaVu 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 "DejaVu 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.

static 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 at the head of the list returns 0.0.

A match further down the list will return between 0 and 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 0.0 if both weight1 and weight 2 are given as strings and have the same value.

Otherwise, the result is the absolute value of the difference between the CSS numeric values of *weight1* and *weight2*, normalized between 0.05 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 matplotlib.font_manager.**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', a real font name or a list of real font names. Real font names are not supported when `text.usetex` is `True`.

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', a real font name or a list of real font names. Real font names are not supported when `text.usetex` is `True`.

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'

class matplotlib.font_manager.**JSONEncoder**(*, *skipkeys=False*, *ensure_ascii=True*, *check_circular=True*, *allow_nan=True*, *sort_keys=False*, *indent=None*, *separators=None*, *default=None*)

Bases: `json.encoder.JSONEncoder`

Constructor for JSONEncoder, with sensible defaults.

If skipkeys is false, then it is a TypeError to attempt encoding of keys that are not str, int, float or None. If skipkeys is True, such items are simply skipped.

If ensure_ascii is true, the output is guaranteed to be str objects with all incoming non-ASCII characters escaped. If ensure_ascii is false, the output can contain non-ASCII characters.

If check_circular is true, then lists, dicts, and custom encoded objects will be checked for circular references during encoding to prevent an infinite recursion (which would cause an OverflowError).

Otherwise, no such check takes place.

If allow_nan is true, then NaN, Infinity, and -Infinity will be encoded as such. This behavior is not JSON specification compliant, but is consistent with most JavaScript based encoders and decoders. Otherwise, it will be a ValueError to encode such floats.

If sort_keys is true, then the output of dictionaries will be sorted by key; this is useful for regression tests to ensure that JSON serializations can be compared on a day-to-day basis.

If indent is a non-negative integer, then JSON array elements and object members will be pretty-printed with that indent level. An indent level of 0 will only insert newlines. None is the most compact representation.

If specified, separators should be an (item_separator, key_separator) tuple. The default is (', ', ': ') if *indent* is `None` and (',', ': ') otherwise. To get the most compact JSON representation, you should specify (',', ':') to eliminate whitespace.

If specified, default is a function that gets called for objects that can't otherwise be serialized. It should return a JSON encodable version of the object or raise a `TypeError`.

default(*o*)

Implement this method in a subclass such that it returns a serializable object for `o`, or calls the base implementation (to raise a `TypeError`).

For example, to support arbitrary iterators, you could implement default like this:

```
def default(self, o):
    try:
        iterable = iter(o)
    except TypeError:
        pass
    else:
        return list(iterable)
    # Let the base class default method raise the TypeError
    return JSONEncoder.default(self, o)
```

matplotlib.font_manager.**OSXInstalledFonts**(*directories=None*, *fontext='ttf'*)

Get list of font files on OS X - ignores font suffix by default.

class matplotlib.font_manager.**TempCache**

Bases: `object`

A class to store temporary caches that are (a) not saved to disk and (b) invalidated whenever certain font-related rcParams—namely the family lookup lists—are changed or the font cache is reloaded. This avoids the expensive linear search through all fonts every time a font is looked up.

get(*prop*)

invalidating_rcparams = ('font.serif', 'font.sans-serif', 'font.cursive', 'font.fantasy',

make_rcparams_key()

set(*prop*, *value*)

matplotlib.font_manager.**afmFontProperty**(*fontpath*, *font*)
Extract information from an AFM font file.

Parameters

font [*AFM*] The AFM font file from which information will be extracted.

Returns

'FontEntry' The extracted font properties.

matplotlib.font_manager.**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.

matplotlib.font_manager.**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.

matplotlib.font_manager.**findfont**(*prop*, ***kw*)

matplotlib.font_manager.**get_font**(*filename*, *hinting_factor=None*)

matplotlib.font_manager.**get_fontconfig_fonts**(*fontext='ttf'*)
List the font filenames known to `fc-list` having the given extension.

matplotlib.font_manager.**get_fontext_synonyms**(*fontext*)
Return a list of file extensions extensions that are synonyms for the given file extension *fileext*.

matplotlib.font_manager.**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.

matplotlib.font_manager.**json_dump**(*data*, *filename*)
Dumps a data structure as JSON in the named file. Handles FontManager and its fields.

matplotlib.font_manager.**json_load**(*filename*)
Loads a data structure as JSON from the named file. Handles FontManager and its fields.

matplotlib.font_manager.**list_fonts**(*directory*, *extensions*)
Return a list of all fonts matching any of the extensions, possibly upper-cased, found recursively under the directory.

matplotlib.font_manager.**ttfFontProperty**(*font*)
Extract information from a TrueType font file.

Parameters

font [`FT2Font`] The TrueType font file from which information will be extracted.

Returns

'FontEntry' The extracted font properties.

matplotlib.font_manager.**ttfdict_to_fnames**(*d*)
Deprecated since version 2.1: The ttfdict_to_fnames function was deprecated in version 2.1.

flatten a ttfdict to all the filenames it contains

matplotlib.font_manager.**weight_as_number**(*weight*)
Deprecated since version 2.1: The weight_as_number function was deprecated in version 2.1.

Return the weight property as a numeric value. String values are converted to their corresponding numeric value.

matplotlib.font_manager.**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.

matplotlib.font_manager.**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'.

48.2 matplotlib.fontconfig_pattern

A module for parsing and generating fontconfig patterns.

See the fontconfig pattern specification for more information.

class matplotlib.fontconfig_pattern.**FontconfigPatternParser**
Bases: object

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.

matplotlib.fontconfig_pattern.**family_escape**(*$ self*, */*, *repl*, *string*, *count=0*)
Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

matplotlib.fontconfig_pattern.**family_unescape**(*$ self*, */*, *repl*, *string*, *count=0*)
Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

matplotlib.fontconfig_pattern.**generate_fontconfig_pattern**(*d*)
Given a dictionary of key/value pairs, generates a fontconfig pattern string.

matplotlib.fontconfig_pattern.**parse_fontconfig_pattern**

Parse the given fontconfig *pattern* and return a dictionary of key/value pairs useful for initializing a font_manager.FontProperties object.

matplotlib.fontconfig_pattern.**value_escape**(*$ self*, */*, *repl*, *string*, *count=0*)

Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

matplotlib.fontconfig_pattern.**value_unescape**(*$ self*, */*, *repl*, *string*, *count=0*)

Return the string obtained by replacing the leftmost non-overlapping occurrences of pattern in string by the replacement repl.

CHAPTER

FORTYNINE

GRIDSPEC

49.1 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*.

49.1.1 Classes

GridSpec(nrows, ncols[, figure, left, ...])	A class that specifies the geometry of the grid that a subplot will be placed.
SubplotSpec(gridspec, num1[, num2])	Specifies the location of the subplot in the given *GridSpec*.
GridSpecBase(nrows, ncols[, height_ratios, ...])	A base class of GridSpec that specifies the geometry of the grid that a subplot will be placed.
GridSpecFromSubplotSpec(nrows, ncols, ...[, ...])	GridSpec whose subplot layout parameters are inherited from the location specified by a given SubplotSpec.

matplotlib.gridspec.GridSpec

class matplotlib.gridspec.**GridSpec**(*nrows*, *ncols*, *figure=None*, *left=None*, *bottom=None*, *right=None*, *top=None*, *wspace=None*, *hspace=None*, *width_ratios=None*, *height_ratios=None*)

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.

Parameters

nrows [int] Number of rows in grid.

ncols [int] Number or columns in grid.

Notes

See *SubplotParams* for descriptions of the layout parameters.

get_subplot_params(*figure=None*, *fig=None*)
Return a dictionary of subplot layout parameters. The default parameters are from rcParams unless a figure attribute is set.

locally_modified_subplot_params()

tight_layout(*figure*, *renderer=None*, *pad=1.08*, *h_pad=None*, *w_pad=None*, *rect=None*)
Adjust subplot parameters to give specified padding.

Parameters

pad [float] Padding between the figure edge and the edges of subplots, as a fraction of the font-size.

h_pad, w_pad [float, optional] Padding (height/width) between edges of adjacent subplots. Defaults to `pad_inches`.

rect [tuple of 4 floats, optional] (left, bottom, right, top) rectangle in normalized figure coordinates that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

update(***kwargs*)
Update the current values. If any kwarg is None, default to the current value, if set, otherwise to rc.

Examples using `matplotlib.gridspec.GridSpec`

- sphx_glr_gallery_subplots_axes_and_figures_align_labels_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_lines_bars_and_markers_markevery_demo.py
- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py
- sphx_glr_gallery_pie_and_polar_charts_pie_demo2.py
- sphx_glr_gallery_userdemo_demo_gridspec05.py
- sphx_glr_gallery_userdemo_demo_gridspec02.py
- sphx_glr_gallery_userdemo_demo_gridspec03.py
- sphx_glr_gallery_userdemo_demo_gridspec04.py
- sphx_glr_gallery_userdemo_demo_gridspec06.py
- *Customizing Figure Layouts Using GridSpec and Other Functions*

- *Tight Layout guide*
- *origin and extent in imshow*
- *Constrained Layout Guide*

matplotlib.gridspec.SubplotSpec

class matplotlib.gridspec.**SubplotSpec**(*gridspec*, *num1*, *num2=None*)

Specifies the location of the subplot in the given `GridSpec`.

The subplot will occupy the num1-th cell of the given gridspec. If num2 is provided, the subplot will span between num1-th cell and num2-th cell.

The index starts from 0.

get_geometry()

Get the subplot geometry (`n_rows, n_cols, start, stop`).

start and stop are the index of the start and stop of the subplot.

get_gridspec()

get_position(*figure*, *return_all=False*)

Update the subplot position from `figure.subplotpars`.

get_rows_columns()

Get the subplot row and column numbers: (`n_rows, n_cols, row_start, row_stop, col_start, col_stop`)

get_topmost_subplotspec()

get the topmost SubplotSpec instance associated with the subplot

matplotlib.gridspec.GridSpecBase

class matplotlib.gridspec.**GridSpecBase**(*nrows*, *ncols*, *height_ratios=None*, *width_ratios=None*)

A base class of GridSpec that specifies the geometry of the grid that a subplot will be placed.

The number of rows and number of columns of the grid need to be set. Optionally, the ratio of heights and widths of rows and columns can be specified.

get_geometry()

get the geometry of the grid, e.g., 2,3

get_grid_positions(*fig*, *raw=False*)

return lists of bottom and top position of rows, left and right positions of columns.

If raw=True, then these are all in units relative to the container with no margins. (used for constrained_layout).

get_height_ratios()

get_subplot_params(*figure=None*, *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*)

matplotlib.gridspec.GridSpecFromSubplotSpec

class matplotlib.gridspec.**GridSpecFromSubplotSpec**(*nrows*, *ncols*, *subplot_spec*, *wspace=None*, *hspace=None*, *height_ratios=None*, *width_ratios=None*)

GridSpec whose subplot layout parameters are inherited from the location specified by a given SubplotSpec.

The number of rows and number of columns of the grid need to be set. An instance of SubplotSpec is also needed to be set from which the layout parameters will be inherited. The wspace and hspace of the layout can be optionally specified or the default values (from the figure or rcParams) will be used.

get_subplot_params(*figure=None*, *fig=None*)
Return a dictionary of subplot layout parameters.

get_topmost_subplotspec()
Get the topmost SubplotSpec instance associated with the subplot.

Examples using matplotlib.gridspec.GridSpecFromSubplotSpec

- sphx_glr_gallery_userdemo_demo_gridspec04.py
- sphx_glr_gallery_userdemo_demo_gridspec06.py
- *Customizing Figure Layouts Using GridSpec and Other Functions*
- *Constrained Layout Guide*

CHAPTER

FIFTY

IMAGE

50.1 matplotlib.image

The image module supports basic image loading, rescaling and display operations.

class matplotlib.image.**AxesImage**(*ax*, *cmap=None*, *norm=None*, *interpolation=None*, *origin=None*, *extent=None*, *filternorm=1*, *filterrad=4.0*, *resample=False*, ***kwargs*)

Bases: matplotlib.image._ImageBase

interpolation and cmap default to their rc settings

cmap is a colors.Colormap instance norm is a colors.Normalize instance to map luminance to 0-1

extent is data axes (left, right, bottom, top) for making image plots registered with data plots. Default is to label the pixel centers with the zero-based row and column indices.

Additional kwargs are matplotlib.artist properties

get_cursor_data(*event*)

Get the cursor data for a given event

get_extent()

Get the image extent: left, right, bottom, top

get_window_extent(*renderer=None*)

Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

make_image(*renderer*, *magnification=1.0*, *unsampled=False*)

set_extent(*extent*)

extent is data axes (left, right, bottom, top) for making image plots

This updates ax.dataLim, and, if autoscaling, sets viewLim to tightly fit the image, regardless of dataLim. Autoscaling state is not changed, so following this with ax.autoscale_view will redo the autoscaling in accord with dataLim.

class matplotlib.image.**BboxImage**(*bbox*, *cmap=None*, *norm=None*, *interpolation=None*, *origin=None*, *filternorm=1*, *filterrad=4.0*, *resample=False*, *interp_at_native=True*, ***kwargs*)

Bases: matplotlib.image._ImageBase

The Image class whose size is determined by the given bbox.

cmap is a colors.Colormap instance norm is a colors.Normalize instance to map luminance to 0-1

interp_at_native is a flag that determines whether or not interpolation should still be applied when the image is displayed at its native resolution. A common use case for this is when displaying an image for annotational purposes; it is treated similarly to Photoshop (interpolation is only used when displaying the image at non-native resolutions).

kwargs are an optional list of Artist keyword args

contains(*mouseevent*)
Test whether the mouse event occurred within the image.

get_transform()
Return the *Transform* instance used by this artist.

get_window_extent(*renderer=None*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

make_image(*renderer*, *magnification=1.0*, *unsampled=False*)

class matplotlib.image.**FigureImage**(*fig*, *cmap=None*, *norm=None*, *offsetx=0*, *offsety=0*, *origin=None*, ***kwargs*)

Bases: matplotlib.image._ImageBase

cmap is a colors.Colormap instance norm is a colors.Normalize instance to map luminance to 0-1

kwargs are an optional list of Artist keyword args

get_extent()
Get the image extent: left, right, bottom, top

make_image(*renderer*, *magnification=1.0*, *unsampled=False*)

set_data(*A*)
Set the image array.

zorder = 0

class matplotlib.image.NonUniformImage(*ax*, ***kwargs*)

Bases: *matplotlib.image.AxesImage*

kwargs are identical to those for AxesImage, except that 'nearest' and 'bilinear' are the only supported 'interpolation' options.

get_extent()

Get the image extent: left, right, bottom, top

make_image(*renderer*, *magnification=1.0*, *unsampled=False*)

set_array(**args*)

Retained for backwards compatibility - use set_data instead

ACCEPTS: numpy array A or PIL Image

set_cmap(*cmap*)

set the colormap for luminance data

ACCEPTS: a colormap or registered colormap name

set_data(*x*, *y*, *A*)

Set the grid for the pixel centers, and the pixel values.

***x* and *y* are monotonic 1-D ndarrays of lengths N and M,** respectively, specifying pixel centers

***A* is an (M,N) ndarray or masked array of values to be** colormapped, or a (M,N,3) RGB array, or a (M,N,4) RGBA array.

set_filternorm(*s*)

Set whether the resize filter norms the weights – see help for imshow

ACCEPTS: 0 or 1

set_filterrad(*s*)

Set the resize filter radius only applicable to some interpolation schemes – see help for imshow

ACCEPTS: positive float

set_interpolation(*s*)

Parameters

s [str, None] Either 'nearest', 'bilinear', or `None`.

set_norm(*norm*)

Set the normalization instance.

Parameters

norm [*Normalize*]

class matplotlib.image.**PcolorImage**(*ax*, *x=None*, *y=None*, *A=None*, *cmap=None*, *norm=None*, ***kwargs*)

Bases: matplotlib.image.AxesImage

Make a pcolor-style plot with an irregular rectangular grid.

This uses a variation of the original irregular image code, and it is used by pcolorfast for the corresponding grid type.

cmap defaults to its rc setting

cmap is a colors.Colormap instance norm is a colors.Normalize instance to map luminance to 0-1

Additional kwargs are matplotlib.artist properties

get_cursor_data(*event*)

Get the cursor data for a given event

make_image(*renderer*, *magnification=1.0*, *unsampled=False*)

set_array(**args*)

Retained for backwards compatibility - use set_data instead

ACCEPTS: numpy array A or PIL Image

set_data(*x*, *y*, *A*)

Set the grid for the rectangle boundaries, and the data values.

***x* and *y* are monotonic 1-D ndarrays of lengths N+1 and M+1,** respectively, specifying rectangle boundaries. If None, they will be created as uniform arrays from 0 through N and 0 through M, respectively.

***A* is an (M,N) ndarray or masked array of values to be** colormapped, or a (M,N,3) RGB array, or a (M,N,4) RGBA array.

matplotlib.image.**composite_images**(*images*, *renderer*, *magnification=1.0*)

Composite a number of RGBA images into one. The images are composited in the order in which they appear in the `images` list.

Parameters

images [list of Images] Each must have a `make_image` method. For each image, `can_composite` should return `True`, though this is not enforced by this function. Each image must have a purely affine transformation with no shear.

renderer [RendererBase instance]

magnification [float] The additional magnification to apply for the renderer in use.

Returns

tuple [image, offset_x, offset_y] Returns the tuple:

- image: A numpy array of the same type as the input images.
- offset_x, offset_y: The offset of the image (left, bottom) in the output figure.

matplotlib.image.**imread**(*fname*, *format=None*)

Read an image from a file into an array.

fname may be a string path, a valid URL, or a Python file-like object. If using a file object, it must be opened in binary mode.

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()*. Note, URL strings may not be compatible with PIL. Check the PIL documentation for more information.

matplotlib.image.**imsave**(*fname*, *arr*, *vmin=None*, *vmax=None*, *cmap=None*, *format=None*, *origin=None*, *dpi=100*)

Save an array as in image file.

The output formats available depend on the backend being used.

Parameters

fname [str or file-like] Path string 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 [array-like] An MxN (luminance), MxNx3 (RGB) or MxNx4 (RGBA) array.

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 [matplotlib.colors.Colormap, optional] For example, `cm.viridis`. If `None`, defaults to the `image.cmap` rcParam.

format [str] One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

origin [['upper' | 'lower']] Indicates whether the `(0, 0)` index of the array is in the upper left or lower left corner of the axes. Defaults to the `image.origin` rcParam.

dpi [int] The DPI to store in the metadata of the file. This does not affect the resolution of the output image.

matplotlib.image.**pil_to_array**(*pilImage*)

Load a PIL image and return it as a numpy array.

Grayscale images are returned as `(M, N)` arrays. RGB images are returned as `(M, N, 3)` arrays. RGBA images are returned as `(M, N, 4)` arrays.

matplotlib.image.**thumbnail**(*infile*, *thumbfile*, *scale=0.1*, *interpolation='bilinear'*, *preview=False*)

make a thumbnail of image in *infile* with output filename *thumbfile*.

infile **the image file – must be PNG or Pillow-readable if you** have Pillow installed

thumbfile the thumbnail filename

scale the scale factor for the thumbnail

interpolation the interpolation scheme used in the resampling

preview if True, the default backend (presumably a user interface backend) will be used which will cause a figure to be raised if `show()` is called. If it is False, a pure image backend will be used depending on the extension, 'png'->FigureCanvasAgg, 'pdf'->FigureCanvasPdf, 'svg'->FigureCanvasSVG

See examples/misc/image_thumbnail.py.

Return value is the figure instance containing the thumbnail

CHAPTER

FIFTYONE

LEGEND AND LEGEND_HANDLER

51.1 matplotlib.legend

The legend module defines the Legend class, which is responsible for drawing legends associated with axes and/or figures.

Important: It is unlikely that you would ever create a Legend instance manually. Most users would normally create a legend via the *legend()* function. For more details on legends there is also a *legend guide*.

The Legend class can be considered as a container of legend handles and legend texts. Creation of corresponding legend handles from the plot elements in the axes or figures (e.g., lines, patches, etc.) are specified by the handler map, which defines the mapping between the plot elements and the legend handlers to be used (the default legend handlers are defined in the *legend_handler* module). Note that not all kinds of artist are supported by the legend yet by default but it is possible to extend the legend handler's capabilities to support arbitrary objects. See the *legend guide* for more information.

class matplotlib.legend.**DraggableLegend**(*legend*, *use_blit=False*, *update='loc'*)

Bases: *matplotlib.offsetbox.DraggableOffsetBox*

Parameters

update [string] If "loc", update *loc* parameter of legend upon finalizing. If "bbox", update *bbox_to_anchor* parameter.

artist_picker(*legend*, *evt*)

finalize_offset()

class matplotlib.legend.**Legend**(*parent*, *handles*, *labels*, *loc=None*, *numpoints=None*, *markerscale=None*, *markerfirst=True*, *scatterpoints=None*, *scatteryoffsets=None*, *prop=None*, *fontsize=None*, *borderpad=None*, *labelspacing=None*, *handlelength=None*, *handleheight=None*, *handletextpad=None*, *borderaxespad=None*, *columnspacing=None*, *ncol=1*, *mode=None*, *fancybox=None*, *shadow=None*, *title=None*, *framealpha=None*, *edgecolor=None*, *facecolor=None*, *bbox_to_anchor=None*, *bbox_transform=None*, *frameon=None*, *handler_map=None*)

Bases: *matplotlib.artist.Artist*

Place a legend on the axes at location loc.

Parameters

parent [*Axes* or *Figure*] The artist that contains the legend.

handles [sequence of *Artist*] A list of Artists (lines, patches) to be added to the legend.

labels [sequence of strings] A list of labels to show next to the artists. The length of handles and labels should be the same. If they are not, they are truncated to the smaller of both lengths.

Other Parameters

loc [int or string or pair of floats, default: 'upper right'] The location of the legend. Possible 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

Alternatively can be a 2-tuple giving `x, y` of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

bbox_to_anchor [*BboxBase* or pair of floats] Specify any arbitrary location for the legend in `bbox_transform` coordinates (default Axes coordinates).

For example, to put the legend's upper right hand corner in the center of the axes the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

ncol [integer] The number of columns that the legend has. Default is 1.

prop [None or *matplotlib.font_manager.FontProperties* or dict] The font properties of the legend. If None (default), the current *matplotlib.rcParams* will be used.

fontsize [int or float or {'xx-small', 'x-small', 'small', 'medium', 'large', 'x-large', 'xx-large'}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

numpoints [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is `None`, which will take the value from `rcParams["legend.numpoints"]`.

scatterpoints [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.

scatteryoffsets [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to `[0.5]`. Default is `[0.375, 0.5, 0.3125]`.

markerscale [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.

markerfirst [bool] If *True*, legend marker is placed to the left of the legend label. If *False*, legend marker is placed to the right of the legend label. Default is *True*.

frameon [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.

fancybox [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.

shadow [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.

framealpha [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.

facecolor [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If `"inherit"`, it will take `rcParams["axes.facecolor"]`.

edgecolor [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]` If `"inherit"`, it will take `rcParams["axes.edgecolor"]`.

mode [{"expand", None}] If `mode` is set to `"expand"` the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).

bbox_transform [None or *matplotlib.transforms.Transform*] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.

title [str or None] The legend's title. Default is no title (`None`).

borderpad [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.

labelspacing [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

handlelength [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

handletextpad [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

borderaxespad [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

columnspacing [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

handler_map [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at *matplotlib.legend.Legend.get_legend_handler_map()*.

Notes

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.

```
codes = {'best':  0, 'center':  10, 'center left':  6, 'center right':  7, 'lower center':
```

contains(*event*)
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.

draggable(*state=None*, *use_blit=False*, *update='loc'*)
Set the draggable state – if state is

- None : toggle the current state
- True : turn draggable on
- False : turn draggable off

If draggable is on, you can drag the legend on the canvas with the mouse. The *DraggableLegend* helper instance is returned if draggable is on.

The update parameter control which parameter of the legend changes when dragged. If update is "loc", the *loc* parameter of the legend is changed. If "bbox", the *bbox_to_anchor* parameter is changed.

draw(*renderer*)
Draw everything that belongs to the legend.

draw_frame(*b*)
Set draw frame to b.

Parameters

b [bool]

get_bbox_to_anchor()
Return the bbox that the legend will be anchored to.

get_children()
Return a list of child artists.

classmethod get_default_handler_map()
A class method that returns the default handler map.

get_frame()
Return the *Rectangle* instances used to frame the legend.

get_frame_on()
Get whether the legend box patch is drawn.

static get_legend_handler(*legend_handler_map*, *orig_handle*)
Return a legend handler from *legend_handler_map* that corresponds to *orig_handler*.

legend_handler_map should be a dictionary object (that is returned by the get_legend_handler_map method).

It first checks if the *orig_handle* itself is a key in the *legend_hanler_map* and return the associated value. Otherwise, it checks for each of the classes in its method-resolution-order. If no matching key is found, it returns `None`.

get_legend_handler_map()
Return the handler map.

get_lines()
Return a list of *Line2D* instances in the legend.

get_patches()
Return a list of *Patch* instances in the legend.

get_texts()
Return a list of *Text* instances in the legend.

get_title()
Return the *Text* instance for the legend title.

get_window_extent(**args*, ***kwargs*)
Return extent of the legend.

set_bbox_to_anchor(*bbox*, *transform=None*)
Set the bbox that the legend will be anchored to.

bbox can be

- A *BboxBase* instance
- A tuple of `(left, bottom, width, height)` in the given transform (normalized axes coordinate if None)
- A tuple of `(left, bottom)` where the width and height will be assumed to be zero.

classmethod set_default_handler_map(*handler_map*)
A class method to set the default handler map.

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

Parameters

b [bool]

set_title(*title*, *prop=None*)
Set the legend title. Fontproperties can be optionally set with *prop* parameter.

classmethod update_default_handler_map(*handler_map*)
A class method to update the default handler map.

zorder = 5

51.2 matplotlib.legend_handler

This module defines default legend handlers.

It is strongly encouraged to have read the *legend guide* before this documentation.

Legend handlers are expected to be a callable object with a following signature.

```
legend_handler(legend, orig_handle, fontsize, handlebox)
```

Where *legend* is the legend itself, *orig_handle* is the original plot, *fontsize* is the fontsize in pixels, and *handlebox* is a OffsetBox instance. Within the call, you should create relevant artists (using relevant properties from the *legend* and/or *orig_handle*) and add them into the handlebox. The artists needs to be scaled according to the fontsize (note that the size is in pixel, i.e., this is dpi-scaled value).

This module includes definition of several legend handler classes derived from the base class (HandlerBase) with the following method:

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

class matplotlib.legend_handler.**HandlerBase**(*xpad=0.0*, *ypad=0.0*, *update_func=None*)

A Base class for default legend handlers.

The derived classes are meant to override *create_artists* method, which has a following signature.:

```
def create_artists(self, legend, orig_handle,
                   xdescent, ydescent, width, height, fontsize,
                   trans):
```

The overridden method needs to create artists of the given transform that fits in the given dimension (xdescent, ydescent, width, height) that are scaled by fontsize if necessary.

adjust_drawing_area(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

legend_artist(*legend*, *orig_handle*, *fontsize*, *handlebox*)

Return the artist that this HandlerBase generates for the given original artist/handle.

Parameters

legend [*matplotlib.legend.Legend* instance] The legend for which these legend artists are being created.

orig_handle [*matplotlib.artist.Artist* or similar] The object for which these legend artists are being created.

fontsize [float or int] The fontsize in pixels. The artists being created should be scaled according to the given fontsize.

handlebox [*matplotlib.offsetbox.OffsetBox* instance] The box which has been created to hold this legend entry's artists. Artists created in the *legend_artist* method must be added to this handlebox inside this method.

update_prop(*legend_handle*, *orig_handle*, *legend*)

class matplotlib.legend_handler.**HandlerCircleCollection**(*yoffsets=None*, *sizes=None*, ***kw*)

Handler for `CircleCollections`.

create_collection(*orig_handle*, *sizes*, *offsets*, *transOffset*)

class matplotlib.legend_handler.**HandlerErrorbar**(*xerr_size=0.5*, *yerr_size=None*, *marker_pad=0.3*, *numpoints=None*, ***kw*)

Handler for Errorbars.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

get_err_size(*legend*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

class matplotlib.legend_handler.**HandlerLine2D**(*marker_pad=0.3*, *numpoints=None*, ***kw*)

Handler for *Line2D* instances.

Parameters

marker_pad [float] Padding between points in legend entry.

numpoints [int] Number of points to show in legend entry.

Notes

Any other keyword arguments are given to *HandlerNpoints*.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

class matplotlib.legend_handler.**HandlerLineCollection**(*marker_pad=0.3*, *numpoints=None*, ***kw*)

Handler for *LineCollection* instances.

Parameters

marker_pad [float] Padding between points in legend entry.

numpoints [int] Number of points to show in legend entry.

Notes

Any other keyword arguments are given to *HandlerNpoints*.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

get_numpoints(*legend*)

class matplotlib.legend_handler.**HandlerNpoints**(*marker_pad=0.3*, *numpoints=None*, ***kw*)

A legend handler that shows *numpoints* points in the legend entry.

Parameters

marker_pad [float] Padding between points in legend entry.

numpoints [int] Number of points to show in legend entry.

Notes

Any other keyword arguments are given to *HandlerBase*.

get_numpoints(*legend*)

get_xdata(*legend*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

class matplotlib.legend_handler.**HandlerNpointsYoffsets**(*numpoints=None*, *yoffsets=None*, ***kw*)

A legend handler that shows *numpoints* in the legend, and allows them to be individually offest in the y-direction.

Parameters

numpoints [int] Number of points to show in legend entry.

yoffsets [array of floats] Length *numpoints* list of y offsets for each point in legend entry.

Notes

Any other keyword arguments are given to *HandlerNpoints*.

get_ydata(*legend*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

class matplotlib.legend_handler.**HandlerPatch**(*patch_func=None*, ***kw*)

Handler for *Patch* instances.

Parameters

patch_func [callable, optional] The function that creates the legend key artist. *patch_func* should have the signature:

```
def patch_func(legend=legend, orig_handle=orig_handle,
               xdescent=xdescent, ydescent=ydescent,
               width=width, height=height, fontsize=fontsize)
```

Subsequently the created artist will have its `update_prop` method called and the appropriate transform will be applied.

Notes

Any other keyword arguments are given to *HandlerBase*.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

class matplotlib.legend_handler.**HandlerPathCollection**(*yoffsets=None*, *sizes=None*, ***kw*)

Handler for PathCollections, which are used by *scatter*.

create_collection(*orig_handle*, *sizes*, *offsets*, *transOffset*)

class matplotlib.legend_handler.**HandlerPolyCollection**(*xpad=0.0*, *ypad=0.0*, *update_func=None*)

Handler for *PolyCollection* used in *fill_between* and *stackplot*.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

class matplotlib.legend_handler.**HandlerRegularPolyCollection**(*yoffsets=None*, *sizes=None*, ***kw*)

Handler for RegularPolyCollections.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

create_collection(*orig_handle*, *sizes*, *offsets*, *transOffset*)

get_numpoints(*legend*)

get_sizes(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

update_prop(*legend_handle*, *orig_handle*, *legend*)

class matplotlib.legend_handler.**HandlerStem**(*marker_pad=0.3*, *numpoints=None*, *bottom=None*, *yoffsets=None*, ***kw*)

Handler for plots produced by *stem*.

Parameters

marker_pad [float] Padding between points in legend entry. Default is 0.3.

numpoints [int, optional] Number of points to show in legend entry.

bottom [float, optional]

yoffsets [array of floats, optional] Length *numpoints* list of y offsets for each point in legend entry.

Notes

Any other keyword arguments are given to *HandlerNpointsYoffsets*.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

get_ydata(*legend*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*)

class matplotlib.legend_handler.**HandlerTuple**(*ndivide=1*, *pad=None*, ***kwargs*)

Handler for Tuple.

Additional kwargs are passed through to *HandlerBase*.

Parameters

ndivide [int, optional] The number of sections to divide the legend area into. If None, use the length of the input tuple. Default is 1.

pad [float, optional] If None, fall back to `legend.borderpad` as the default. In units of fraction of font size. Default is None.

create_artists(*legend*, *orig_handle*, *xdescent*, *ydescent*, *width*, *height*, *fontsize*, *trans*)

matplotlib.legend_handler.**update_from_first_child**(*tgt*, *src*)

CHAPTER

FIFTYTWO

LINES

52.1 matplotlib.lines

This module contains all the 2D line class which can draw with a variety of line styles, markers and colors.

52.1.1 Classes

Line2D(xdata, ydata[, linewidth, linestyle, ...])	A line - the line can have both a solid linestyle connecting all the vertices, and a marker at each vertex.
VertexSelector(line)	Manage the callbacks to maintain a list of selected vertices for *matplotlib.lines.Line2D*.

matplotlib.lines.Line2D

class matplotlib.lines.**Line2D**(*xdata*, *ydata*, *linewidth=None*, *linestyle=None*, *color=None*, *marker=None*, *markersize=None*, *markeredgewidth=None*, *markeredgecolor=None*, *markerfacecolor=None*, *markerfacecoloralt='none'*, *fillstyle=None*, *antialiased=None*, *dash_capstyle=None*, *solid_capstyle=None*, *dash_joinstyle=None*, *solid_joinstyle=None*, *pickradius=5*, *drawstyle=None*, *markevery=None*, ***kwargs*)

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, e.g., one can create "stepped" lines in various styles.

Create a *Line2D* instance with *x* and *y* data in sequences *xdata*, *ydata*.

The kwargs are *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool

Co

Table 2 – continued from previous page

Property	Description
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

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.

axes
The *Axes* instance the artist resides in, or *None*.

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(*renderer*)
draw the Line with `renderer` unless visibility is False

drawStyleKeys = ['default', 'steps-mid', 'steps-pre', 'steps-post', 'steps']

drawStyles = {'default': '_draw_lines', 'steps': '_draw_steps_pre', 'steps-mid': '_draw

fillStyles = ('full', 'left', 'right', 'bottom', 'top', 'none')

filled_markers = ('o', 'v', '^', '<', '>', '8', 's', 'p', '*', 'h', 'H', 'D', 'd', 'P', 'X

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 the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

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

lineStyles = {'': '_draw_nothing', ' ': '_draw_nothing', '-': '_draw_solid', '--': '_d

markers = {'.': 'point', ',': 'pixel', 'o': 'circle', 'v': 'triangle_down', '^': 'tri

recache(*always=False*)

recache_always()

set_aa(*val*)
alias for set_antialiased

set_antialiased(*b*)
Set whether to use antialiased rendering.

Parameters

b [bool]

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. 'none' means no filling; other options are for half-filled markers.

ACCEPTS: ['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']

set_linestyle(*ls*)
Set the linestyle of the line (also accepts drawstyles, e.g., `'steps--'`)

linestyle	description
`'-'` or `'solid'`	solid line
`'--'` or `'dashed'`	dashed line
`'-.'` or `'dashdot'`	dash-dotted line
`':'` or `'dotted'`	dotted line
`'None'`	draw nothing
`' '`	draw nothing
`''`	draw nothing

'steps' is equivalent to 'steps-pre' and is maintained for backward-compatibility.

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

See also:

set_drawstyle() To set the drawing style (stepping) of the plot.

Parameters

ls [{ `'-'`, `'--'`, `'-.'`, `':'`} and more see description] The line style.

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

ACCEPTS: *A valid marker style*

Parameters

marker: marker style See *markers* for full description of possible argument

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.

e.g., if `every=5`, every 5-th marker will be plotted.

ACCEPTS: [None | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]

Parameters

every: None | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float
Which markers to plot.

- every=None, every point will be plotted.
- every=N, every N-th marker will be plotted starting with marker 0.
- every=(start, N), every N-th marker, starting at point start, will be plotted.
- every=slice(start, end, N), every N-th marker, starting at point start, upto but not including point end, will be plotted.
- every=[i, j, m, n], only markers at points i, j, m, and n will be plotted.
- every=0.1, (i.e. a float) then markers will be spaced at approximately equal distances along the line; the distance along the line between markers is determined by multiplying the display-coordinate distance of the axes bounding-box diagonal by the value of every.
- every=(0.5, 0.1) (i.e. a length-2 tuple of float), the same functionality as every=0.1 is exhibited but the first marker will be 0.5 multiplied by the display-cordinate-diagonal-distance along the line.

Notes

Setting the markevery property will only show markers at actual data points. When using float arguments to set the markevery property on irregularly spaced data, the markers will likely not appear evenly spaced because the actual data points do not coincide with the theoretical spacing between markers.

When using a start offset to specify the first marker, the offset will be from the first data point which may be different from the first the visible data point if the plot is zoomed in.

If zooming in on a plot when using float arguments then the actual data points that have markers will change because the distance between markers is always determined from the display-coordinates axes-bounding-box-diagonal regardless of the actual axes data limits.

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*)
Set the pick radius used for containment tests.

Parameters

d [float] Pick radius, 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

validCap = ('butt', 'round', 'projecting')

validJoin = ('miter', 'round', 'bevel')

zorder = 2

Examples using `matplotlib.lines.Line2D`

- sphx_glr_gallery_api_line_with_text.py

- sphx_glr_gallery_pyplots_fig_x.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_text_labels_and_annotations_custom_legends.py
- sphx_glr_gallery_text_labels_and_annotations_legend_demo.py
- *Oscilloscope*
- sphx_glr_gallery_event_handling_pick_event_demo.py
- sphx_glr_gallery_event_handling_poly_editor.py
- sphx_glr_gallery_units_artist_tests.py
- *Legend guide*
- *Artist tutorial*

matplotlib.lines.VertexSelector

class matplotlib.lines.**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, ax = plt.subplots()
x, y = np.random.rand(2, 30)
line, = ax.plot(x, y, 'bs-', picker=5)

selector = HighlightSelected(line)
plt.show()
```

Initialize the class with a *matplotlib.lines.Line2D* instance. The line should already be added to some *matplotlib.axes.Axes* instance and should have the picker property set.

onpick(*event*)

When the line is picked, update the set of selected indices.

process_selected(*ind*, *xs*, *ys*)
Default "do nothing" implementation of the *process_selected()* method.

ind are the indices of the selected vertices. *xs* and *ys* are the coordinates of the selected vertices.

52.1.2 Functions

segment_hits(cx, cy, x, y, radius)	Determine if any line segments are within radius of a point.

matplotlib.lines.segment_hits

matplotlib.lines.**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.

CHAPTER

FIFTYTHREE

MARKERS

53.1 matplotlib.markers

This module contains functions to handle markers. Used by both the marker functionality of *plot* and *scatter*.

All possible markers are defined here:

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
"8"	octagon
"s"	square
"p"	pentagon
"P"	plus (filled)
"*"	star
"h"	hexagon1
"H"	hexagon2
"+"	plus
"x"	x
"X"	x (filled)
"D"	diamond
"d"	thin_diamond
"|"	vline
"_"	hline

Continued on next page

Table 1 – continued from previous page

marker	description
TICKLEFT	tickleft
TICKRIGHT	tickright
TICKUP	tickup
TICKDOWN	tickdown
CARETLEFT	caretleft (centered at tip)
CARETRIGHT	caretright (centered at tip)
CARETUP	caretup (centered at tip)
CARETDOWN	caretdown (centered at tip)
CARETLEFTBASE	caretleft (centered at base)
CARETRIGHTBASE	caretright (centered at base)
CARETUPBASE	caretup (centered at base)
"None", " " or ""	nothing
'$...$'	render the string using mathtext.
verts	a list of (x, y) pairs used for Path vertices. The center of the marker is located at (0,0) and the size is normalized.
path	a *Path* instance.
(numsides, style, angle)	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: **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

For backward compatibility, the form (verts, 0) is also accepted, but it is equivalent to just verts for giving a raw set of vertices that define the shape.

None is the default which means 'nothing', however this table is referred to from other docs for the valid inputs from marker inputs and in those cases None still means 'default'.

53.1.1 Classes

MarkerStyle([marker, fillstyle])

Parameters

matplotlib.markers.MarkerStyle

class matplotlib.markers.**MarkerStyle**(*marker=None*, *fillstyle=None*)

Parameters

marker [string or array_like, optional, default: None] See the descriptions of possible markers in the module docstring.

fillstyle [string, optional, default: 'full'] 'full', 'left", 'right', 'bottom', 'top', 'none'

Attributes

markers [list of known marks]

fillstyles [list of known fillstyles]

filled_markers [list of known filled markers.]

filled_markers = ('o', 'v', '^', '<', '>', '8', 's', 'p', '*', 'h', 'H', 'D', 'd', 'P', 'X

fillstyles = ('full', 'left', 'right', 'bottom', 'top', 'none')

get_alt_path()

get_alt_transform()

get_capstyle()

get_fillstyle()

get_joinstyle()

get_marker()

get_path()

get_snap_threshold()

get_transform()

is_filled()

```
markers = {'.':  'point', ',':  'pixel', 'o':  'circle', 'v':  'triangle_down', '^':  'tri
```

set_fillstyle(*fillstyle*)
Sets fillstyle

Parameters

fillstyle [string amongst known fillstyles]

set_marker(*marker*)

CHAPTER

FIFTYFOUR

MATHTEXT

54.1 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.

class matplotlib.mathtext.**Accent**(*c*, *state*, *math=True*)

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()

Grows one level larger. There is no limit to how big something can get.

render(*x*, *y*)

Render the character to the canvas.

shrink()

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.**AutoHeightChar**(*c*, *height*, *depth*, *state*, *always=False*, *factor=None*)

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 matplotlib.mathtext.**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 matplotlib.mathtext.**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.

alias = '\\]'

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.

target = ']'

class matplotlib.mathtext.Box(*width*, *height*, *depth*)
Bases: *matplotlib.mathtext.Node*

Represents any node with a physical location.

grow()
Grows one level larger. There is no limit to how big something can get.

render(*x1*, *y1*, *x2*, *y2*)

shrink()
Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.Char(*c*, *state*, *math=True*)
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()
Grows one level larger. There is no limit to how big something can get.

is_slanted()

render(*x*, *y*)
Render the character to the canvas

shrink()
Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.ComputerModernFontConstants
Bases: *matplotlib.mathtext.FontConstantsBase*

delta = 0.075

delta_integral = 0.3

delta_slanted = 0.3

script_space = 0.075

sub1 = 0.2

sub2 = 0.3

subdrop = 0.2

sup1 = 0.45

class matplotlib.mathtext.**DejaVuFonts**(**args*, ***kwargs*)
Bases: *matplotlib.mathtext.UnicodeFonts*

use_cmex = False

class matplotlib.mathtext.**DejaVuSansFontConstants**
Bases: *matplotlib.mathtext.FontConstantsBase*

class matplotlib.mathtext.**DejaVuSansFonts**(**args*, ***kwargs*)
Bases: *matplotlib.mathtext.DejaVuFonts*

A font handling class for the DejaVu Sans fonts

If a glyph is not found it will fallback to Stix Sans

class matplotlib.mathtext.**DejaVuSerifFontConstants**
Bases: *matplotlib.mathtext.FontConstantsBase*

class matplotlib.mathtext.**DejaVuSerifFonts**(**args*, ***kwargs*)
Bases: *matplotlib.mathtext.DejaVuFonts*

A font handling class for the DejaVu Serif fonts

If a glyph is not found it will fallback to Stix Serif

matplotlib.mathtext.**Error**(*msg*)
Helper class to raise parser errors.

class matplotlib.mathtext.**Fil**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**Fill**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**Filll**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**FontConstantsBase**
Bases: object

A set of constants that controls how certain things, such as sub- and superscripts are laid out. These are all metrics that can't be reliably retrieved from the font metrics in the font itself.

delta = 0.025

delta_integral = 0.1

delta_slanted = 0.2

script_space = 0.05

sub1 = 0.3

sub2 = 0.5

subdrop = 0.4

sup1 = 0.7

class matplotlib.mathtext.**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*, *math=True*)

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

math: whether sym is a math character

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 matplotlib.mathtext.**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()
Grows one level larger. There is no limit to how big something can get.

shrink()
Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.**GlueSpec**(*width=0.0*, *stretch=0.0*, *stretch_order=0*, *shrink=0.0*, *shrink_order=0*)
Bases: object

See *Glue*.

copy()

classmethod factory(*glue_type*)

class matplotlib.mathtext.**HCentered**(*elements*)
Bases: *matplotlib.mathtext.Hlist*

A convenience class to create an *Hlist* whose contents are centered within its enclosing box.

class matplotlib.mathtext.**Hbox**(*width*)
Bases: *matplotlib.mathtext.Box*

A box with only width (zero height and depth).

class matplotlib.mathtext.**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 matplotlib.mathtext.**Hrule**(*state*, *thickness=None*)

Bases: *matplotlib.mathtext.Rule*

Convenience class to create a horizontal rule.

class matplotlib.mathtext.**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.

depth = 0

grow()

Grows one level larger. There is no limit to how big something can get.

height = 0

shrink()

Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.**List**(*elements*)

Bases: *matplotlib.mathtext.Box*

A list of nodes (either horizontal or vertical).

grow()

Grows one level larger. There is no limit to how big something can get.

shrink()
Shrinks one level smaller. There are only three levels of sizes, after which things will no longer get smaller.

class matplotlib.mathtext.**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, e.g., 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, e.g., 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, e.g., 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, e.g., 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 matplotlib.mathtext.**MathTextWarning**
Bases: Warning

class matplotlib.mathtext.**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_rect_filled()*
- *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_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

set_canvas_size(*w*, *h*, *d*)
Dimension the drawing canvas

class matplotlib.mathtext.**MathtextBackendAgg**
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 the FreeType hinting type to use with this particular backend.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

set_canvas_size(*w*, *h*, *d*)
Dimension the drawing canvas

class matplotlib.mathtext.**MathtextBackendBitmap**
Bases: *matplotlib.mathtext.MathtextBackendAgg*

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

class matplotlib.mathtext.**MathtextBackendCairo**
Bases: *matplotlib.mathtext.MathtextBackend*

Store information to write a mathtext rendering to the Cairo backend.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

class matplotlib.mathtext.**MathtextBackendPath**
Bases: *matplotlib.mathtext.MathtextBackend*

Store information to write a mathtext rendering to the text path machinery.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

class matplotlib.mathtext.**MathtextBackendPdf**
Bases: *matplotlib.mathtext.MathtextBackend*

Store information to write a mathtext rendering to the PDF backend.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

class matplotlib.mathtext.**MathtextBackendPs**
Bases: *matplotlib.mathtext.MathtextBackend*

Store information to write a mathtext rendering to the PostScript backend.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

class matplotlib.mathtext.**MathtextBackendSvg**
Bases: *matplotlib.mathtext.MathtextBackend*

Store information to write a mathtext rendering to the SVG backend.

get_results(*box*, *used_characters*)
Return a backend-specific tuple to return to the backend after all processing is done.

render_glyph(*ox*, *oy*, *info*)
Draw a glyph described by *info* to the reference point (*ox*, *oy*).

render_rect_filled(*x1*, *y1*, *x2*, *y2*)
Draw a filled black rectangle from (*x1*, *y1*) to (*x2*, *y2*).

class matplotlib.mathtext.**NegFil**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**NegFill**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**NegFilll**
Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**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 matplotlib.mathtext.**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_delim(*s*, *loc*, *toks*)

binom(*s*, *loc*, *toks*)

c_over_c(*s*, *loc*, *toks*)

customspace(*s*, *loc*, *toks*)

dfrac(*s*, *loc*, *toks*)

end_group(*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_between_brackets(*s*, *loc*)

is_dropsub(*nucleus*)

is_overunder(*nucleus*)

is_slanted(*nucleus*)

main(*s*, *loc*, *toks*)

math(*s*, *loc*, *toks*)

math_string(*s*, *loc*, *toks*)

non_math(*s*, *loc*, *toks*)

operatorname(*s*, *loc*, *toks*)

overline(*s*, *loc*, *toks*)

parse(*s*, *fonts_object*, *fontsize*, *dpi*)
Parse expression *s* using the given *fonts_object* for output, at the given *fontsize* and *dpi*.

Returns the parse tree of *Node* instances.

pop_state()
Pop a *State* off of the stack.

push_state()
Push a new *State* onto the stack which is just a copy of the current state.

required_group(*s*, *loc*, *toks*)

simple_group(*s*, *loc*, *toks*)

snowflake(*s*, *loc*, *toks*)

space(*s*, *loc*, *toks*)

sqrt(*s*, *loc*, *toks*)

stackrel(*s*, *loc*, *toks*)

start_group(*s*, *loc*, *toks*)

subsuper(*s*, *loc*, *toks*)

symbol(*s*, *loc*, *toks*)

unknown_symbol(*s*, *loc*, *toks*)

class matplotlib.mathtext.**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 matplotlib.mathtext.**STIXFontConstants**

Bases: *matplotlib.mathtext.FontConstantsBase*

delta = 0.05

delta_integral = 0.3

delta_slanted = 0.3

script_space = 0.1

sub2 = 0.6

sup1 = 0.8

class matplotlib.mathtext.**STIXSansFontConstants**

Bases: *matplotlib.mathtext.FontConstantsBase*

delta_integral = 0.3

delta_slanted = 0.6

script_space = 0.05

sup1 = 0.8

class matplotlib.mathtext.**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 matplotlib.mathtext.**SsGlue**

Bases: *matplotlib.mathtext.Glue*

class matplotlib.mathtext.**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.

basepath = '/tmp/mpl_docs/lib/python3.6/site-packages/matplotlib/mpl-data/fonts/afm'

fontmap = {'cal': 'pzcmi8a', 'rm': 'pncr8a', 'tt': 'pcrr8a', 'it': 'pncri8a', 'sf': '

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_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_xheight(*font*, *fontsize*, *dpi*)
Get the xheight for the given *font* and *fontsize*.

class matplotlib.mathtext.**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.

cm_fallback = False

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.

use_cmex = False

class matplotlib.mathtext.**StixSansFonts**(**args*, ***kwargs*)
Bases: *matplotlib.mathtext.StixFonts*

A font handling class for the STIX fonts (that uses sans-serif characters by default).

class matplotlib.mathtext.**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 matplotlib.mathtext.**TruetypeFonts**(*default_font_prop*, *mathtext_backend*)
Bases: *matplotlib.mathtext.Fonts*

A generic base class for all font setups that use Truetype fonts (through FT2Font).

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_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_xheight(*fontname*, *fontsize*, *dpi*)
Get the xheight for the given *font* and *fontsize*.

class matplotlib.mathtext.**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*)
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.

use_cmex = True

class matplotlib.mathtext.**VCentered**(*elements*)
Bases: *matplotlib.mathtext.Hlist*

A convenience class to create a *Vlist* whose contents are centered within its enclosing box.

class matplotlib.mathtext.**Vbox**(*height*, *depth*)
Bases: *matplotlib.mathtext.Box*

A box with only height (zero width).

class matplotlib.mathtext.**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 matplotlib.mathtext.**Vrule**(*state*)

Bases: *matplotlib.mathtext.Rule*

Convenience class to create a vertical rule.

matplotlib.mathtext.**get_unicode_index**(*symbol*[, *bool*]) → 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'). If math is False, the current symbol should be treated as a non-math symbol.

matplotlib.mathtext.**math_to_image**(*s*, *filename_or_obj*, *prop=None*, *dpi=None*, *format=None*)

Given a math expression, renders it in a closely-clipped bounding box to an image file.

s A math expression. The math portion should be enclosed in dollar signs.

filename_or_obj A filepath or writable file-like object to write the image data to.

prop If provided, a FontProperties() object describing the size and style of the text.

dpi Override the output dpi, otherwise use the default associated with the output format.

format The output format, e.g., 'svg', 'pdf', 'ps' or 'png'. If not provided, will be deduced from the filename.

matplotlib.mathtext.**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

FIFTYFIVE

MLAB

55.1 matplotlib.mlab

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

55.1.1 MATLAB compatible functions

cohere() Coherence (normalized cross spectral density)

csd() Cross spectral density using Welch's average periodogram

detrend() Remove the mean or best fit line from an array

find() Return the indices where some condition is true; numpy.nonzero is similar but more general.

griddata() Interpolate irregularly distributed data to a regular grid.

prctile() Find the percentiles of a sequence

prepca() Principal Component Analysis

psd() Power spectral density using Welch's average periodogram

rk4() A 4th order runge kutta integrator for 1D or ND systems

specgram() Spectrogram (spectrum over segments of time)

55.1.2 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

complex_spectrum() Return the complex-valued frequency spectrum of a signal

magnitude_spectrum() Return the magnitude of the frequency spectrum of a signal

angle_spectrum() Return the angle (wrapped phase) of the frequency spectrum of a signal

phase_spectrum() Return the phase (unwrapped angle) of the frequency spectrum of a signal

detrend_mean() Remove the mean from a line.

demean() Remove the mean from a line. This function is the same as *detrend_mean()* except for the default *axis*.

detrend_linear() Remove the best fit line from a line.

detrend_none() Return the original line.

stride_windows() Get all windows in an array in a memory-efficient manner

stride_repeat() Repeat an array in a memory-efficient manner

apply_window() Apply a window along a given axis

55.1.3 record array helper functions

A collection of helper methods for numpyrecord arrays

See misc-examples-index

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),
```

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```
    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()
```

class matplotlib.mlab.**FormatBool**(***kwargs*)

Bases: *matplotlib.mlab.FormatObj*

Deprecated since version 2.2: The FormatBool class was deprecated in version 2.2.

fromstr(*s*)

toval(*x*)

class matplotlib.mlab.**FormatDate**(***kwargs*)

Bases: *matplotlib.mlab.FormatObj*

Deprecated since version 2.2: The FormatDate class was deprecated in version 2.2. Use date.strftime instead.

fromstr(*x*)

toval(*x*)

class matplotlib.mlab.**FormatDatetime**(***kwargs*)

Bases: *matplotlib.mlab.FormatDate*

Deprecated since version 2.2: The FormatDatetime class was deprecated in version 2.2. Use datetime.strftime instead.

fromstr(*x*)

class matplotlib.mlab.**FormatFloat**(***kwargs*)

Bases: *matplotlib.mlab.FormatFormatStr*

Deprecated since version 2.2: The FormatFloat class was deprecated in version 2.2.

fromstr(*s*)

toval(*x*)

class matplotlib.mlab.**FormatFormatStr**(***kwargs*)
Bases: *matplotlib.mlab.FormatObj*

Deprecated since version 2.2: The FormatFormatStr class was deprecated in version 2.2.

tostr(*x*)

class matplotlib.mlab.**FormatInt**(***kwargs*)
Bases: *matplotlib.mlab.FormatObj*

Deprecated since version 2.2: The FormatInt class was deprecated in version 2.2.

fromstr(*s*)

tostr(*x*)

toval(*x*)

class matplotlib.mlab.**FormatMillions**(***kwargs*)
Bases: *matplotlib.mlab.FormatFloat*

Deprecated since version 2.2: The FormatMillions class was deprecated in version 2.2.

class matplotlib.mlab.**FormatObj**(***kwargs*)
Bases: object

Deprecated since version 2.2: The FormatObj class was deprecated in version 2.2.

fromstr(*s*)

tostr(*x*)

toval(*x*)

class matplotlib.mlab.**FormatPercent**(***kwargs*)
Bases: *matplotlib.mlab.FormatFloat*

Deprecated since version 2.2: The FormatPercent class was deprecated in version 2.2.

class matplotlib.mlab.**FormatString**(***kwargs*)
Bases: *matplotlib.mlab.FormatObj*

Deprecated since version 2.2: The FormatString class was deprecated in version 2.2.

tostr(*x*)

class matplotlib.mlab.**FormatThousands**(***kwargs*)

Bases: *matplotlib.mlab.FormatFloat*

Deprecated since version 2.2: The FormatThousands class was deprecated in version 2.2.

class matplotlib.mlab.**GaussianKDE**(*dataset*, *bw_method=None*)

Bases: object

Representation of a kernel-density estimate using Gaussian kernels.

Parameters

dataset [array_like] Datapoints to estimate from. In case of univariate data this is a 1-D array, otherwise a 2-D array with shape (# of dims, # of data).

bw_method [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as `kde.factor`. If a callable, it should take a *GaussianKDE* instance as only parameter and return a scalar. If None (default), 'scott' is used.

Attributes

dataset [ndarray] The dataset with which `gaussian_kde` was initialized.

dim [int] Number of dimensions.

num_dp [int] Number of datapoints.

factor [float] The bandwidth factor, obtained from `kde.covariance_factor`, with which the covariance matrix is multiplied.

covariance [ndarray] The covariance matrix of `dataset`, scaled by the calculated bandwidth (`kde.factor`).

inv_cov [ndarray] The inverse of `covariance`.

Methods

kde.evaluate(points)	(ndarray) Evaluate the estimated pdf on a provided set of points.
kde(points)	(ndarray) Same as kde.evaluate(points)

covariance_factor()

evaluate(*points*)

Evaluate the estimated pdf on a set of points.

Parameters

points [(# of dimensions, # of points)-array] Alternatively, a (# of dimensions,) vector can be passed in and treated as a single point.

Returns

values [(# of points,)-array] The values at each point.

Raises

ValueError [if the dimensionality of the input points is different] than the dimensionality of the KDE.

scotts_factor()

silverman_factor()

class matplotlib.mlab.**PCA**(***kwargs*)

Bases: object

Deprecated since version 2.2: The PCA class was deprecated in version 2.2.

center(*x*)

center and optionally standardize 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

matplotlib.mlab.**amap**(*fn*, **args*)

Deprecated since version 2.2: The amap function was deprecated in version 2.2. Use numpy.array(list(map(...))) instead.

amap(function, sequence[, sequence, ...]) -> array.

Works like map(), but it returns an array. This is just a convenient shorthand for numpy.array(map(...)).

matplotlib.mlab.**angle_spectrum**(*x*, *Fs=None*, *window=None*, *pad_to=None*, *sides=None*)

Compute the angle of the frequency spectrum (wrapped phase spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

Returns

spectrum [1-D array] The values for the angle spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

See also:

complex_spectrum() This function returns the angle value of *complex_spectrum()*.

magnitude_spectrum() *angle_spectrum()* returns the magnitudes of the corresponding frequencies.

phase_spectrum() *phase_spectrum()* returns the unwrapped version of this function.

specgram() *specgram()* can return the angle spectrum of segments within the signal.

matplotlib.mlab.**apply_window**(*x*, *window*, *axis=0*, *return_window=None*)
Apply the given window to the given 1D or 2D array along the given axis.

Parameters

x [1D or 2D array or sequence] Array or sequence containing the data.

window [function or array.] Either a function to generate a window or an array with length *x*.shape[*axis*]

axis [integer] The axis over which to do the repetition. Must be 0 or 1. The default is 0

return_window [bool] If true, also return the 1D values of the window that was applied

matplotlib.mlab.**base_repr**(*number*, *base=2*, *padding=0*)
Deprecated since version 2.2: The base_repr function was deprecated in version 2.2.

Return the representation of a *number* in any given *base*.

matplotlib.mlab.**binary_repr**(*number*, *max_length=1025*)
Deprecated since version 2.2: The binary_repr function was deprecated in version 2.2.

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.

matplotlib.mlab.**bivariate_normal**(*X*, *Y*, *sigmax=1.0*, *sigmay=1.0*, *mux=0.0*, *muy=0.0*, *sigmaxy=0.0*)

Deprecated since version 2.2: The bivariate_normal function was deprecated in version 2.2.

Bivariate Gaussian distribution for equal shape *X*, *Y*.

See bivariate normal at mathworld.

matplotlib.mlab.**center_matrix**(*M*, *dim=0*)

Deprecated since version 2.2: The center_matrix function was deprecated in version 2.2.

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.)

matplotlib.mlab.**cohere**(*x*, *y*, *NFFT=256*, *Fs=2*, *detrend=<function detrend_none>*, *window=<function window_hanning>*, *noverlap=0*, *pad_to=None*, *sides='default'*, *scale_by_freq=None*)

The coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \tag{55.1}$$

Parameters

x, y Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between blocks. The default value is 0 (no overlap).

Returns

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(), *csd()*

matplotlib.mlab.**cohere_pairs**(*X*, *ij*, *NFFT=256*, *Fs=2*, *detrend=<function detrend_none>*, *window=<function window_hanning>*, *noverlap=0*, *preferSpeedOverMemory=True*, *progressCallback=<function donothing_callback>*, *returnPxx=False*)

Deprecated since version 2.2: scipy.signal.coherence

Compute the coherence and phase for all pairs *ij*, in *X*.

X is a *numSamples* * *numCols* array

ij is a list of tuples. Each tuple is a pair of indexes into the columns of X for which you want to compute coherence. For example, if *X* has 64 columns, and you want to compute all nonredundant pairs, define *ij* as:

```
ij = []
for i in range(64):
    for j in range(i+1,64):
        ij.append( (i,j) )
```

preferSpeedOverMemory is an optional bool. Defaults to true. If False, limits the caching by only making one, rather than two, complex cache arrays. This is useful if memory becomes critical. Even when *preferSpeedOverMemory* is False, *cohere_pairs()* will still give significant performance gains over calling *cohere()* for each pair, and will use 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 [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.

e.g., 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, :func:‘cohere_pairs‘ can be much more

efficient than just calling :func:‘cohere‘ for each pair, because

it caches most of the intensive computations. If :math:‘N‘ is the

number of pairs, this function is :math:‘O(N)‘ for most of the

heavy lifting, whereas calling cohere for each pair is

:math:‘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 :file:‘test/cohere_pairs_test.py‘ in the src tree for an

example script that shows that this :func:‘cohere_pairs‘ and

:func:‘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}.

matplotlib.mlab.**complex_spectrum**(*x*, *Fs=None*, *window=None*, *pad_to=None*, *sides=None*)

Compute the complex-valued frequency spectrum of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

Returns

spectrum [1-D array] The values for the complex spectrum (complex valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

See also:

magnitude_spectrum() *magnitude_spectrum()* returns the absolute value of this function.

angle_spectrum() *angle_spectrum()* returns the angle of this function.

phase_spectrum() *phase_spectrum()* returns the phase (unwrapped angle) of this function.

specgram() *specgram()* can return the complex spectrum of segments within the signal.

matplotlib.mlab.**contiguous_regions**(*mask*)

Deprecated since version 2.2: Moved to matplotlib.cbook

return a list of (ind0, ind1) such that mask[ind0:ind1].all() is True and we cover all such regions

matplotlib.mlab.**cross_from_above**(*x*, *threshold*)

Deprecated since version 2.2: The cross_from_above function was deprecated in version 2.2.

return the indices into *x* where *x* crosses some threshold from below, e.g., the i's where:

```
x[i-1]>threshold and x[i]<=threshold
```

See also:

cross_from_below()

matplotlib.mlab.**cross_from_below**(*x*, *threshold*)

Deprecated since version 2.2: The cross_from_below function was deprecated in version 2.2.

return the indices into *x* where *x* crosses some threshold from below, e.g., 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, ax = plt.subplots()
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()

matplotlib.mlab.**csd**(*x*, *y*, *NFFT=None*, *Fs=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*)

Compute the cross-spectral density.

Call signature:

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

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*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of x and y are averaged over each segment to compute P_{xy}, with a scaling to correct for power loss due to windowing.

If len(x) < *NFFT* or len(y) < *NFFT*, they will be zero padded to *NFFT*.

Parameters

x, y [1-D arrays or sequences] Arrays or sequences containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

Returns

Pxy [1-D array] The values for the cross spectrum `P_{xy}` before scaling (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxy*

See also:

psd() *psd()* is the equivalent to setting y=x.

References

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

`matplotlib.mlab.`**`csv2rec`**(*fname*, *comments='#'*, *skiprows=0*, *checkrows=0*, *delimiter=','*, *converterd=None*, *names=None*, *missing=''*, *missingd=None*, *use_mrecords=False*, *dayfirst=False*, *yearfirst=False*)

Deprecated since version 2.2: The csv2rec function was deprecated in version 2.2.

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, or *None* to switch off the removal of comments
- *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
- *dayfirst*: default is False so that MM-DD-YY has precedence over DD-MM-YY. See http://labix.org/python-dateutil#head-b95ce2094d189a89f80f5ae52a05b4ab7b41af47 for further information.
- *yearfirst*: default is False so that MM-DD-YY has precedence over YY-MM-DD. See http://labix.org/python-dateutil#head-b95ce2094d189a89f80f5ae52a05b4ab7b41af47 for further information.

If no rows are found, *None* is returned

matplotlib.mlab.**csvformat_factory**(*format*)

Deprecated since version 2.2: The csvformat_factory function was deprecated in version 2.2.

matplotlib.mlab.**demean**(*x*, *axis=0*)

Return x minus its mean along the specified axis.

Parameters

x [array or sequence] Array or sequence containing the data Can have any dimensionality

axis [integer] The axis along which to take the mean. See numpy.mean for a description of this argument.

See also:

`delinear()`

denone() delinear() and denone() are other detrend algorithms.

detrend_mean() This function is the same as *detrend_mean()* except for the default *axis*.

matplotlib.mlab.**detrend**(*x*, *key=None*, *axis=None*)
Return x with its trend removed.

Parameters

x [array or sequence] Array or sequence containing the data.

key [['default' | 'constant' | 'mean' | 'linear' | 'none'] or function] Specifies the detrend algorithm to use. 'default' is 'mean', which is the same as *detrend_mean()*. 'constant' is the same. 'linear' is the same as *detrend_linear()*. 'none' is the same as *detrend_none()*. The default is 'mean'. See the corresponding functions for more details regarding the algorithms. Can also be a function that carries out the detrend operation.

axis [integer] The axis along which to do the detrending.

See also:

detrend_mean() *detrend_mean()* implements the 'mean' algorithm.

detrend_linear() *detrend_linear()* implements the 'linear' algorithm.

detrend_none() *detrend_none()* implements the 'none' algorithm.

matplotlib.mlab.**detrend_linear**(*y*)
Return x minus best fit line; 'linear' detrending.

Parameters

y [0-D or 1-D array or sequence] Array or sequence containing the data

axis [integer] The axis along which to take the mean. See numpy.mean for a description of this argument.

See also:

delinear() This function is the same as delinear() except for the default *axis*.

detrend_mean()

detrend_none() *detrend_mean()* and *detrend_none()* are other detrend algorithms.

detrend() *detrend()* is a wrapper around all the detrend algorithms.

matplotlib.mlab.**detrend_mean**(*x*, *axis=None*)
Return x minus the mean(x).

Parameters

x [array or sequence] Array or sequence containing the data Can have any dimensionality

axis [integer] The axis along which to take the mean. See numpy.mean for a description of this argument.

See also:

demean() This function is the same as *demean()* except for the default *axis*.

detrend_linear()

detrend_none() *detrend_linear()* and *detrend_none()* are other detrend algorithms.

detrend() *detrend()* is a wrapper around all the detrend algorithms.

matplotlib.mlab.**detrend_none**(*x*, *axis=None*)

Return x: no detrending.

Parameters

x [any object] An object containing the data

axis [integer] This parameter is ignored. It is included for compatibility with detrend_mean

See also:

denone() This function is the same as denone() except for the default *axis*, which has no effect.

detrend_mean()

detrend_linear() *detrend_mean()* and *detrend_linear()* are other detrend algorithms.

detrend() *detrend()* is a wrapper around all the detrend algorithms.

matplotlib.mlab.**dist**(*x*, *y*)

Deprecated since version 2.2: numpy.hypot

Return the distance between two points.

matplotlib.mlab.**dist_point_to_segment**(*p*, *s0*, *s1*)

Deprecated since version 2.2: The dist_point_to_segment function was deprecated in version 2.2.

Get the distance of a point to a segment.

p, *s0*, *s1* are *xy* sequences

This algorithm from http://geomalgorithms.com/a02-_lines.html

matplotlib.mlab.**distances_along_curve**(*X*)

Deprecated since version 2.2: The distances_along_curve function was deprecated in version 2.2.

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.

matplotlib.mlab.**donothing_callback**(**args*)

Deprecated since version 2.2: The donothing_callback function was deprecated in version 2.2.

matplotlib.mlab.**entropy**(*y*, *bins*)

Deprecated since version 2.2: scipy.stats.entropy

Return the entropy of the data in *y* in units of nat.

$$-\sum p_i \ln(p_i) \tag{55.2}$$

where p_i is the probability of observing *y* in the ith 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) )
```

matplotlib.mlab.**exp_safe**(*x*)

Deprecated since version 2.2: numpy.exp

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.

matplotlib.mlab.**fftsurr**(*x*, *detrend=<function detrend_none>*, *window=<function window_none>*)

Deprecated since version 2.2: The fftsurr function was deprecated in version 2.2.

Compute an FFT phase randomized surrogate of *x*.

matplotlib.mlab.**find**(*condition*)

Deprecated since version 2.2: The find function was deprecated in version 2.2.

Return the indices where ravel(condition) is true

matplotlib.mlab.**frange**(*xini*, *xfin=None*, *delta=None*, ***kw*)

Deprecated since version 2.2: numpy.arange

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  ])
```

matplotlib.mlab.**get_formatd**(*r*, *formatd=None*)

Deprecated since version 2.2: The get_formatd function was deprecated in version 2.2.

build a formatd guaranteed to have a key for every dtype name

matplotlib.mlab.**get_sparse_matrix**(*M*, *N*, *frac=0.1*)

Deprecated since version 2.2: The get_sparse_matrix function was deprecated in version 2.2.

Return a *M* x *N* sparse matrix with *frac* elements randomly filled.

matplotlib.mlab.**get_xyz_where**(*Z*, *Cond*)

Deprecated since version 2.2: The get_xyz_where function was deprecated in version 2.2.

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.

matplotlib.mlab.**griddata**(*x*, *y*, *z*, *xi*, *yi*, *interp='nn'*)

Deprecated since version 2.2: The griddata function was deprecated in version 2.2. Use scipy.interpolate.griddata instead.

Interpolates from a nonuniformly spaced grid to some other grid.

Fits a surface of the form z = f(`x`, `y`) to the data in the (usually) nonuniformly spaced vectors (`x`, `y`, `z`), then interpolates this surface at the points specified by (`xi`, `yi`) to produce `zi`.

Parameters

x, y, z [1d array_like] Coordinates of grid points to interpolate from.

xi, yi [1d or 2d array_like] Coordinates of grid points to interpolate to.

interp [string key from {'nn', 'linear'}] Interpolation algorithm, either 'nn' for natural neighbor, or 'linear' for linear interpolation.

Returns

2d float array Array of values interpolated at (`xi`, `yi`) points. Array will be masked is any of (`xi`, `yi`) are outside the convex hull of (`x`, `y`).

Notes

If `interp` is 'nn' (the default), uses natural neighbor interpolation based on Delaunay triangulation. This option is only available if the mpl_toolkits.natgrid module is installed. This can be downloaded

from https://github.com/matplotlib/natgrid. The (xi, yi) grid must be regular and monotonically increasing in this case.

If interp is 'linear', linear interpolation is used via matplotlib.tri.LinearTriInterpolator.

Instead of using *griddata*, more flexible functionality and other interpolation options are available using a matplotlib.tri.Triangulation and a matplotlib.tri.TriInterpolator.

matplotlib.mlab.**identity**(*n*, *rank=2*, *dtype='l'*, *typecode=None*)

Deprecated since version 2.2: numpy.identity

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.

matplotlib.mlab.**inside_poly**(*points*, *verts*)

Deprecated since version 2.2: The inside_poly function was deprecated in version 2.2.

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.

matplotlib.mlab.**is_closed_polygon**(*X*)

Deprecated since version 2.2: The is_closed_polygon function was deprecated in version 2.2.

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.

matplotlib.mlab.**ispower2**(*n*)

Deprecated since version 2.2: The ispower2 function was deprecated in version 2.2.

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.

matplotlib.mlab.**isvector**(*X*)

Deprecated since version 2.2: The isvector function was deprecated in version 2.2.

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.

matplotlib.mlab.**l1norm**(*a*)

Deprecated since version 2.2: The l1norm function was deprecated in version 2.2. Use numpy.linalg.norm(a, ord=1) instead.

Return the *l1* norm of *a*, flattened out.

Implemented as a separate function (not a call to `norm()` for speed).

matplotlib.mlab.**l2norm**(*a*)

Deprecated since version 2.2: The l2norm function was deprecated in version 2.2. Use numpy.linalg.norm(a, ord=2) instead.

Return the *l2* norm of *a*, flattened out.

Implemented as a separate function (not a call to `norm()` for speed).

matplotlib.mlab.**less_simple_linear_interpolation**(*x*, *y*, *xi*, *extrap=False*)

Deprecated since version 2.2: The less_simple_linear_interpolation function was deprecated in version 2.2. Use numpy.interp instead.

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.

matplotlib.mlab.**log2**(*x*, *ln2=0.6931471805599453*)

Deprecated since version 2.2: numpy.log2

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.

matplotlib.mlab.**logspace**(*xmin*, *xmax*, *N*)

Deprecated since version 2.2: The logspace function was deprecated in version 2.2. Use numpy.logspace or numpy.geomspace instead.

Return N values logarithmically spaced between xmin and xmax.

matplotlib.mlab.**longest_contiguous_ones**(*x*)

Deprecated since version 2.2: The longest_contiguous_ones function was deprecated in version 2.2.

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.

matplotlib.mlab.**longest_ones**(*x*)

Deprecated since version 2.2: The longest_ones function was deprecated in version 2.2.

alias for longest_contiguous_ones

matplotlib.mlab.**magnitude_spectrum**(*x*, *Fs=None*, *window=None*, *pad_to=None*, *sides=None*)

Compute the magnitude (absolute value) of the frequency spectrum of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

Returns

spectrum [1-D array] The values for the magnitude spectrum (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

See also:

psd() *psd()* returns the power spectral density.

complex_spectrum() This function returns the absolute value of *complex_spectrum()*.

angle_spectrum() *angle_spectrum()* returns the angles of the corresponding frequencies.

phase_spectrum() *phase_spectrum()* returns the phase (unwrapped angle) of the corresponding frequencies.

specgram() *specgram()* can return the magnitude spectrum of segments within the signal.

matplotlib.mlab.**movavg**(*x*, *n*)

Deprecated since version 2.2: The movavg function was deprecated in version 2.2.

Compute the len(*n*) moving average of *x*.

matplotlib.mlab.**norm_flat**(*a*, *p=2*)

Deprecated since version 2.2: The norm_flat function was deprecated in version 2.2. Use numpy.linalg.norm(a.flat, ord=p) instead.

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.

matplotlib.mlab.**normpdf**(*x*, **args*)

Deprecated since version 2.2: scipy.stats.norm.pdf

Return the normal pdf evaluated at *x*; args provides *mu*, *sigma*

matplotlib.mlab.**offset_line**(*y*, *yerr*)

Deprecated since version 2.2: The offset_line function was deprecated in version 2.2.

Offsets an array *y* by +/- an error and returns a tuple (y - err, y + err).

The error term can be:

- A scalar. In this case, the returned tuple is obvious.
- A vector of the same length as *y*. The quantities y +/- err are computed component-wise.
- A tuple of length 2. In this case, yerr[0] is the error below *y* and yerr[1] is error above *y*. For example:

```
from pylab import *
x = linspace(0, 2*pi, num=100, endpoint=True)
y = sin(x)
y_minus, y_plus = mlab.offset_line(y, 0.1)
plot(x, y)
fill_between(x, ym, y2=yp)
show()
```

matplotlib.mlab.**path_length**(*X*)

Deprecated since version 2.2: The path_length function was deprecated in version 2.2.

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*).

matplotlib.mlab.**phase_spectrum**(*x*, *Fs=None*, *window=None*, *pad_to=None*, *sides=None*)

Compute the phase of the frequency spectrum (unwrapped angle spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

Returns

spectrum [1-D array] The values for the phase spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

See also:

complex_spectrum() This function returns the angle value of *complex_spectrum()*.

magnitude_spectrum() *magnitude_spectrum()* returns the magnitudes of the corresponding frequencies.

angle_spectrum() *angle_spectrum()* returns the wrapped version of this function.

specgram() *specgram()* can return the phase spectrum of segments within the signal.

matplotlib.mlab.**poly_below**(*xmin*, *xs*, *ys*)

Deprecated since version 2.2: The poly_below function was deprecated in version 2.2.

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()*, e.g.,:

```
xv, yv = poly_below(0, x, y)
ax.fill(xv, yv)
```

matplotlib.mlab.**poly_between**(*x*, *ylower*, *yupper*)

Deprecated since version 2.2: The poly_between function was deprecated in version 2.2.

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()*.

matplotlib.mlab.**prctile**(*x*, *p=(0.0*, *25.0*, *50.0*, *75.0*, *100.0)*)

Deprecated since version 2.2: numpy.percentile

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.

matplotlib.mlab.**prctile_rank**(*x*, *p*)

Deprecated since version 2.2: The prctile_rank function was deprecated in version 2.2.

Return the rank for each element in x, return the rank 0..len(p). e.g., 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.

matplotlib.mlab.**psd**(*x*, *NFFT=None*, *Fs=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*)

Compute the power spectral density.

Call signature:

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

The power spectral density P_{xx} 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 P_{xx}.

If len(x) < *NFFT*, it will be zero padded to *NFFT*.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

Returns

Pxx [1-D array] The values for the power spectrum `P_{xx}` (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxx*

See also:

specgram() *specgram()* differs in the default overlap; in not returning the mean of the segment periodograms; and in returning the times of the segments.

magnitude_spectrum() *magnitude_spectrum()* returns the magnitude spectrum.

csd() *csd()* returns the spectral density between two signals.

References

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

`matplotlib.mlab.`**`quad2cubic`**(*q0x*, *q0y*, *q1x*, *q1y*, *q2x*, *q2y*)

Deprecated since version 2.2: The quad2cubic function was deprecated in version 2.2.

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.

`matplotlib.mlab.`**`rec2csv`**(*r*, *fname*, *delimiter=', '*, *formatd=None*, *missing=''*, *missingd=None*, *withheader=True*)

Deprecated since version 2.2: The rec2csv function was deprecated in version 2.2. Use numpy.recarray.tofile instead.

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.

matplotlib.mlab.**rec2txt**(*r*, *header=None*, *padding=3*, *precision=3*, *fields=None*)

Deprecated since version 2.2: The rec2txt function was deprecated in version 2.2. Use numpy.recarray.tofile instead.

Returns a textual representation of a record array.

Parameters

r: numpy recarray

header: list 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 [list] 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'

Examples

For `precision=[0,2,3]`, the output is

```
ID    Price   Return
ABC   12.54    0.234
XYZ    6.32   -0.076
```

matplotlib.mlab.**rec_append_fields**(*rec*, *names*, *arrs*, *dtypes=None*)

Deprecated since version 2.2: The rec_append_fields function was deprecated in version 2.2.

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.

matplotlib.mlab.**rec_drop_fields**(*rec*, *names*)

Deprecated since version 2.2: The rec_drop_fields function was deprecated in version 2.2.

Return a new numpy record array with fields in *names* dropped.

matplotlib.mlab.**rec_groupby**(*r*, *groupby*, *stats*)

Deprecated since version 2.2: The rec_groupby function was deprecated in version 2.2.

r is a numpy record array

groupby is a sequence of record array attribute names that together form the grouping key. e.g., ('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 *groupby* argument, with the associated group values, and for each outname name in the *stats* argument, with the associated stat summary output.

matplotlib.mlab.**rec_join**(*key*, *r1*, *r2*, *jointype='inner'*, *defaults=None*, *r1postfix='1'*, *r2postfix='2'*)

Deprecated since version 2.2: The rec_join function was deprecated in version 2.2.

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*.

matplotlib.mlab.**rec_keep_fields**(*rec*, *names*)

Deprecated since version 2.2: The rec_keep_fields function was deprecated in version 2.2.

Return a new numpy record array with only fields listed in names

matplotlib.mlab.**rec_summarize**(*r*, *summaryfuncs*)

Deprecated since version 2.2: The rec_summarize function was deprecated in version 2.2.

r is a numpy record array

summaryfuncs is a list of (*attr*, *func*, *outname*) tuples which will apply *func* to 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*.

matplotlib.mlab.**recs_join**(*key*, *name*, *recs*, *jointype='outer'*, *missing=0.0*, *postfixes=None*)

Deprecated since version 2.2: The recs_join function was deprecated in version 2.2.

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.)
```

matplotlib.mlab.**rk4**(*derivs*, *y0*, *t*)

Deprecated since version 2.2: scipy.integrate.ode

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()`.

Parameters

y0 initial state vector

t sample times

derivs returns the derivative of the system and has the signature `dy = derivs(yi, ti)`

Examples

A 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)
```

A 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.

matplotlib.mlab.**rms_flat**(*a*)

Deprecated since version 2.2: The rms_flat function was deprecated in version 2.2.

Return the root mean square of all the elements of *a*, flattened out.

matplotlib.mlab.**safe_isinf**(*x*)
Deprecated since version 2.2: numpy.isinf

`numpy.isinf()` for arbitrary types

matplotlib.mlab.**safe_isnan**(*x*)
Deprecated since version 2.2: numpy.isnan

`numpy.isnan()` for arbitrary types

matplotlib.mlab.**segments_intersect**(*s1*, *s2*)
Deprecated since version 2.2: The segments_intersect function was deprecated in version 2.2.

Return *True* if *s1* and *s2* intersect. *s1* and *s2* are defined as:

```
s1: (x1, y1), (x2, y2)
s2: (x3, y3), (x4, y4)
```

matplotlib.mlab.**slopes**(*x*, *y*)
Deprecated since version 2.2: The slopes function was deprecated in version 2.2.

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)

matplotlib.mlab.**specgram**(*x*, *NFFT=None*, *Fs=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *mode=None*)
Compute a spectrogram.

Compute and plot a spectrogram of data in x. Data are split into NFFT length segments and the spectrum 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.

Parameters

x [array_like] 1-D array or sequence.

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call detrend_mean(). 'linear' calls detrend_linear(). 'none' calls detrend_none().

scale_by_freq [boolean, optional] 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.

noverlap [int, optional] The number of points of overlap between blocks. The default value is 128.

mode [str, optional]

What sort of spectrum to use, default is 'psd'.

'psd' Returns the power spectral density.

'complex' Returns the complex-valued frequency spectrum.

'magnitude' Returns the magnitude spectrum.

'angle' Returns the phase spectrum without unwrapping.

'phase' Returns the phase spectrum with unwrapping.

Returns

spectrum [array_like] 2-D array, columns are the periodograms of successive segments.

freqs [array_like] 1-D array, frequencies corresponding to the rows in *spectrum*.

t [array_like] 1-D array, the times corresponding to midpoints of segments (i.e the columns in *spectrum*).

See also:

psd differs in the overlap and in the return values.

complex_spectrum similar, but with complex valued frequencies.

magnitude_spectrum similar single segment when mode is 'magnitude'.

angle_spectrum similar to single segment when mode is 'angle'.

phase_spectrum similar to single segment when mode is 'phase'.

Notes

detrend and scale_by_freq only apply when *mode* is set to 'psd'.

matplotlib.mlab.**stineman_interp**(*xi*, *x*, *y*, *yp=None*)

Deprecated since version 2.2: The stineman_interp function was deprecated in version 2.2.

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

matplotlib.mlab.**stride_repeat**(*x*, *n*, *axis=0*)

Repeat the values in an array in a memory-efficient manner. Array x is stacked vertically n times.

> **Warning:** It is not safe to write to the output array. Multiple elements may point to the same piece of memory, so modifying one value may change others.

Parameters

x [1D array or sequence] Array or sequence containing the data.

n [integer] The number of time to repeat the array.

axis [integer] The axis along which the data will run.

References

stackoverflow: Repeat NumPy array without replicating data?

matplotlib.mlab.**stride_windows**(*x*, *n*, *noverlap=None*, *axis=0*)

Get all windows of x with length n as a single array, using strides to avoid data duplication.

> **Warning:** It is not safe to write to the output array. Multiple elements may point to the same piece of memory, so modifying one value may change others.

Parameters

x [1D array or sequence] Array or sequence containing the data.

n [integer] The number of data points in each window.

noverlap [integer] The overlap between adjacent windows. Default is 0 (no overlap)

axis [integer] The axis along which the windows will run.

References

stackoverflow: Rolling window for 1D arrays in Numpy? stackoverflow: Using strides for an efficient moving average filter

matplotlib.mlab.**vector_lengths**(*X*, *P=2.0*, *axis=None*)

Deprecated since version 2.2: The vector_lengths function was deprecated in version 2.2.

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*.

matplotlib.mlab.**window_hanning**(*x*)

Return x times the hanning window of len(x).

See also:

window_none() *window_none()* is another window algorithm.

matplotlib.mlab.**window_none**(*x*)

No window function; simply return x.

See also:

window_hanning() *window_hanning()* is another window algorithm.

CHAPTER

FIFTYSIX

OFFSETBOX

56.1 matplotlib.offsetbox

The OffsetBox is a simple container artist. The child artist are meant to be drawn at a relative position to its parent. The [VH]Packer, DrawingArea and TextArea are derived from the OffsetBox.

The [VH]Packer automatically adjust the relative postisions of their children, which should be instances of the OffsetBox. This is used to align similar artists together, e.g., in legend.

The DrawingArea can contain any Artist as a child. The DrawingArea has a fixed width and height. The position of children relative to the parent is fixed. The TextArea is contains a single Text instance. The width and height of the TextArea instance is the width and height of the its child text.

class matplotlib.offsetbox.**AnchoredOffsetbox**(*loc*, *pad=0.4*, *borderpad=0.5*, *child=None*, *prop=None*, *frameon=True*, *bbox_to_anchor=None*, *bbox_transform=None*, ***kwargs*)

Bases: *matplotlib.offsetbox.OffsetBox*

An offset box placed according to the legend location loc. AnchoredOffsetbox has a single child. When multiple children is needed, use other OffsetBox class to enclose them. By default, the offset box is anchored against its parent axes. You may explicitly specify the bbox_to_anchor.

loc is a string or an integer specifying the legend location. The valid location codes are:

```
'upper right'  : 1,
'upper left'   : 2,
'lower left'   : 3,
'lower right'  : 4,
'right'        : 5, (same as 'center right', for back-compatibility)
'center left'  : 6,
'center right' : 7,
'lower center' : 8,
'upper center' : 9,
'center'       : 10,
```

pad [pad around the child for drawing a frame. given in] fraction of fontsize.

borderpad : pad between offsetbox frame and the bbox_to_anchor,

child : OffsetBox instance that will be anchored.

prop : font property. This is only used as a reference for paddings.

frameon : draw a frame box if True.

bbox_to_anchor : bbox to anchor. Use self.axes.bbox if None.

bbox_transform : with which the bbox_to_anchor will be transformed.

codes = {'center': 10, 'center left': 6, 'center right': 7, 'lower center': 8, 'lower

draw(*renderer*)
draw the artist

get_bbox_to_anchor()
return the bbox that the legend will be anchored

get_child()
return the child

get_children()
return the list of children

get_extent(*renderer*)
return the extent of the artist. The extent of the child added with the pad is returned

get_window_extent(*renderer*)
get the bounding box in display space.

set_bbox_to_anchor(*bbox*, *transform=None*)
set the bbox that the child will be anchored.

bbox can be a Bbox instance, a list of [left, bottom, width, height], or a list of [left, bottom] where the width and height will be assumed to be zero. The bbox will be transformed to display coordinate by the given transform.

set_child(*child*)
set the child to be anchored

update_frame(*bbox*, *fontsize=None*)

zorder = 5

class matplotlib.offsetbox.**AnchoredText**(*s*, *loc*, *pad=0.4*, *borderpad=0.5*, *prop=None*, ***kwargs*)

Bases: matplotlib.offsetbox.AnchoredOffsetbox

AnchoredOffsetbox with Text.

Parameters

s [string] Text.

loc [str] Location code.

pad [float, optional] Pad between the text and the frame as fraction of the font size.

borderpad [float, optional] Pad between the frame and the axes (or *bbox_to_anchor*).

prop [*matplotlib.font_manager.FontProperties*] Font properties.

Notes

Other keyword parameters of *AnchoredOffsetbox* are also allowed.

class matplotlib.offsetbox.**AnnotationBbox**(*offsetbox*, *xy*, *xybox=None*, *xycoords='data'*, *boxcoords=None*, *frameon=True*, *pad=0.4*, *annotation_clip=None*, *box_alignment=(0.5, 0.5)*, *bboxprops=None*, *arrowprops=None*, *fontsize=None*, ***kwargs*)

Bases: *matplotlib.artist.Artist*, matplotlib.text._AnnotationBase

Annotation-like class, but with offsetbox instead of Text.

offsetbox : OffsetBox instance

xycoords [same as Annotation but can be a tuple of two] strings which are interpreted as x and y coordinates.

boxcoords [similar to textcoords as Annotation but can be a] tuple of two strings which are interpreted as x and y coordinates.

box_alignment [a tuple of two floats for a vertical and] horizontal alignment of the offset box w.r.t. the *boxcoords*. The lower-left corner is (0.0) and upper-right corner is (1.1).

other parameters are identical to that of Annotation.

anncoords

contains(*event*)
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.

draw(*renderer*)
Draw the Annotation object to the given *renderer*.

get_children()
Return a list of the child Artist`s this :class:`Artist contains.

get_fontsize(*s=None*)
return fontsize in points

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_fontsize(*s=None*)
set fontsize in points

update_positions(*renderer*)
Update the pixel positions of the annotated point and the text.

xyann

zorder = 3

class matplotlib.offsetbox.**AuxTransformBox**(*aux_transform*)
Bases: *matplotlib.offsetbox.OffsetBox*

Offset Box with the aux_transform . Its children will be transformed with the aux_transform first then will be offseted. The absolute coordinate of the aux_transform is meaning as it will be automatically adjust so that the left-lower corner of the bounding box of children will be set to (0,0) before the offset transform.

It is similar to drawing area, except that the extent of the box is not predetermined but calculated from the window extent of its children. Furthermore, the extent of the children will be calculated in the transformed coordinate.

add_artist(*a*)
Add any *Artist* to the container box

draw(*renderer*)
Draw the children

get_extent(*renderer*)
Return with, height, xdescent, ydescent of box

get_offset()
return offset of the container.

get_transform()
Return the *Transform* applied to the children

get_window_extent(*renderer*)
get the bounding box in display space.

set_offset(*xy*)
set offset of the container.

Accept : tuple of x,y coordinate in display units.

set_transform(*t*)
set_transform is ignored.

class matplotlib.offsetbox.**DraggableAnnotation**(*annotation*, *use_blit=False*)
Bases: *matplotlib.offsetbox.DraggableBase*

save_offset()

update_offset(*dx*, *dy*)

class matplotlib.offsetbox.**DraggableBase**(*ref_artist*, *use_blit=False*)
Bases: object

helper code for a draggable artist (legend, offsetbox) The derived class must override following two method.

def save_offset(self): pass

def update_offset(self, dx, dy): pass

save_offset is called when the object is picked for dragging and it is meant to save reference position of the artist.

***update_offset* is called during the dragging. dx and dy is the pixel** offset from the point where the mouse drag started.

Optionally you may override following two methods.

def artist_picker(self, artist, evt): return self.ref_artist.contains(evt)

def finalize_offset(self): pass

***artist_picker* is a picker method that will be** used. *finalize_offset* is called when the mouse is released. In current implementation of DraggableLegend and DraggableAnnotation, *update_offset* places the artists simply in display coordinates. And *finalize_offset* recalculate their position in the normalized axes coordinate and set a relavant attribute.

artist_picker(*artist*, *evt*)

disconnect()
disconnect the callbacks

finalize_offset()

on_motion(*evt*)

on_motion_blit(*evt*)

on_pick(*evt*)

on_release(*event*)

save_offset()

update_offset(*dx*, *dy*)

class matplotlib.offsetbox.**DraggableOffsetBox**(*ref_artist*, *offsetbox*, *use_blit=False*)

Bases: *matplotlib.offsetbox.DraggableBase*

get_loc_in_canvas()

save_offset()

update_offset(*dx*, *dy*)

class matplotlib.offsetbox.**DrawingArea**(*width*, *height*, *xdescent=0.0*, *ydescent=0.0*, *clip=False*)

Bases: *matplotlib.offsetbox.OffsetBox*

The DrawingArea can contain any Artist as a child. The DrawingArea has a fixed width and height. The position of children relative to the parent is fixed. The children can be clipped at the boundaries of the parent.

width, *height* : width and height of the container box. *xdescent*, *ydescent* : descent of the box in x- and y-direction. *clip* : Whether to clip the children

add_artist(*a*)
Add any *Artist* to the container box

clip_children
If the children of this DrawingArea should be clipped by DrawingArea bounding box.

draw(*renderer*)
Draw the children

get_extent(*renderer*)
Return with, height, xdescent, ydescent of box

get_offset()
return offset of the container.

get_transform()
Return the *Transform* applied to the children

get_window_extent(*renderer*)
get the bounding box in display space.

set_offset(*xy*)
set offset of the container.

Accept : tuple of x,y coordinate in display units.

set_transform(*t*)
set_transform is ignored.

class matplotlib.offsetbox.**HPacker**(*pad=None*, *sep=None*, *width=None*, *height=None*, *align='baseline'*, *mode='fixed'*, *children=None*)

Bases: *matplotlib.offsetbox.PackerBase*

The HPacker has its children packed horizontally. It automatically adjusts the relative positions of children at draw time.

Parameters

pad [float, optional] Boundary pad.

sep [float, optional] Spacing between items.

width [float, optional]

height [float, optional] Width and height of the container box, calculated if `None`.

align [str] Alignment of boxes.

mode [str] Packing mode.

Notes

pad and *sep* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

get_extent_offsets(*renderer*)
update offset of children and return the extents of the box

class matplotlib.offsetbox.**OffsetBox**(**args*, ***kwargs*)
Bases: *matplotlib.artist.Artist*

The OffsetBox is a simple container artist. The child artist are meant to be drawn at a relative position to its parent.

axes
The *Axes* instance the artist resides in, or *None*.

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.

draw(*renderer*)
Update the location of children if necessary and draw them to the given *renderer*.

get_children()
Return a list of artists it contains.

get_extent(*renderer*)
Return with, height, xdescent, ydescent of box

get_extent_offsets(*renderer*)

get_offset(*width*, *height*, *xdescent*, *ydescent*, *renderer*)
Get the offset

accepts extent of the box

get_visible_children()
Return a list of visible artists it contains.

get_window_extent(*renderer*)
get the bounding box in display space.

set_figure(*fig*)
Set the figure

accepts a class:*Figure* instance

set_height(*height*)
Set the height

accepts float

set_offset(*xy*)
Set the offset

accepts x, y, tuple, or a callable object.

set_width(*width*)
Set the width

accepts float

class matplotlib.offsetbox.**OffsetImage**(*arr*, *zoom=1*, *cmap=None*, *norm=None*, *interpolation=None*, *origin=None*, *filternorm=1*, *filterrad=4.0*, *resample=False*, *dpi_cor=True*, ***kwargs*)

Bases: *matplotlib.offsetbox.OffsetBox*

draw(*renderer*)
Draw the children

get_children()
Return a list of artists it contains.

get_data()

get_extent(*renderer*)
Return with, height, xdescent, ydescent of box

get_offset()
return offset of the container.

get_window_extent(*renderer*)
get the bounding box in display space.

get_zoom()

set_data(*arr*)

set_zoom(*zoom*)

class matplotlib.offsetbox.**PackerBase**(*pad=None*, *sep=None*, *width=None*, *height=None*, *align=None*, *mode=None*, *children=None*)

Bases: *matplotlib.offsetbox.OffsetBox*

Parameters

pad [float, optional] Boundary pad.

sep [float, optional] Spacing between items.

width [float, optional]

height [float, optional] Width and height of the container box, calculated if `None`.

align [str, optional] Alignment of boxes. Can be one of `top`, `bottom`, `left`, `right`, `center` and `baseline`

mode [str, optional] Packing mode.

Notes

pad and *sep* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

class matplotlib.offsetbox.**PaddedBox**(*child*, *pad=None*, *draw_frame=False*, *patch_attrs=None*)

Bases: *matplotlib.offsetbox.OffsetBox*

pad : boundary pad

Note: *pad* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

---

draw(*renderer*)

Update the location of children if necessary and draw them to the given *renderer*.

draw_frame(*renderer*)

get_extent_offsets(*renderer*)

update offset of childrens and return the extents of the box

update_frame(*bbox*, *fontsize=None*)

class matplotlib.offsetbox.**TextArea**(*s*, *textprops=None*, *multilinebaseline=None*, *minimumdescent=True*)

Bases: *matplotlib.offsetbox.OffsetBox*

The TextArea is contains a single Text instance. The text is placed at (0,0) with baseline+left alignment. The width and height of the TextArea instance is the width and height of the its child text.

Parameters

s [str] a string to be displayed.

textprops [*FontProperties*, optional]

multilinebaseline [bool, optional] If True, baseline for multiline text is adjusted so that it is (approximatedly) center-aligned with singleline text.

minimumdescent [bool, optional] If True, the box has a minimum descent of "p".

draw(*renderer*)
Draw the children

get_extent(*renderer*)
Return with, height, xdescent, ydescent of box

get_minimumdescent()
get minimumdescent.

get_multilinebaseline()
get multilinebaseline .

get_offset()
return offset of the container.

get_text()
Returns the string representation of this area's text

get_window_extent(*renderer*)
get the bounding box in display space.

set_minimumdescent(*t*)
Set minimumdescent .

If True, extent of the single line text is adjusted so that it has minimum descent of "p"

set_multilinebaseline(*t*)
Set multilinebaseline .

If True, baseline for multiline text is adjusted so that it is (approximatedly) center-aligned with singleline text.

set_offset(*xy*)
set offset of the container.

Accept : tuple of x,y coordinates in display units.

set_text(*s*)
Set the text of this area as a string.

set_transform(*t*)
set_transform is ignored.

class matplotlib.offsetbox.**VPacker**(*pad=None*, *sep=None*, *width=None*, *height=None*, *align='baseline'*, *mode='fixed'*, *children=None*)
Bases: *matplotlib.offsetbox.PackerBase*

The VPacker has its children packed vertically. It automatically adjust the relative positions of children in the drawing time.

Parameters

pad [float, optional] Boundary pad.

sep [float, optional] Spacing between items.

width [float, optional]

height [float, optional] width and height of the container box, calculated if `None`.

align [str, optional] Alignment of boxes.

mode [str, optional] Packing mode.

Notes

pad and *sep* need to given in points and will be scale with the renderer dpi, while *width* and *height* need to be in pixels.

get_extent_offsets(*renderer*)
update offset of childrens and return the extents of the box

matplotlib.offsetbox.**bbox_artist**(**args*, ***kwargs*)

CHAPTER

FIFTYSEVEN

PATCHES

57.1 matplotlib.patches

57.1.1 Classes

Arc(xy, width, height[, angle, theta1, theta2])	An elliptical arc.
Arrow(x, y, dx, dy[, width])	An arrow patch.
ArrowStyle	*ArrowStyle* is a container class which defines several arrowstyle classes, which is used to create an arrow path along a given path.
BoxStyle	*BoxStyle* is a container class which defines several boxstyle classes, which are used for *FancyBboxPatch*.
Circle(xy[, radius])	A circle patch.
CirclePolygon(xy[, radius, resolution])	A polygon-approximation of a circle patch.
ConnectionPatch(xyA, xyB, coordsA[, ...])	A *ConnectionPatch* class is to make connecting lines between two points (possibly in different axes).
ConnectionStyle	*ConnectionStyle* is a container class which defines several connectionstyle classes, which is used to create a path between two points.
Ellipse(xy, width, height[, angle])	A scale-free ellipse.
FancyArrow(x, y, dx, dy[, width, ...])	Like Arrow, but lets you set head width and head height independently.
FancyArrowPatch([posA, posB, path, ...])	A fancy arrow patch.
FancyBboxPatch(xy, width, height[, ...])	Draw a fancy box around a rectangle with lower left at *xy*=(*x*, *y*) with specified width and height.
Patch([edgecolor, facecolor, color, ...])	A patch is a 2D artist with a face color and an edge color.
PathPatch(path, **kwargs)	A general polycurve path patch.
Polygon(xy[, closed])	A general polygon patch.
Rectangle(xy, width, height[, angle])	Draw a rectangle with lower left at *xy* = (*x*, *y*) with specified *width*, *height* and rotation *angle*.

Continued on next page

Table 1 – continued from previous page

RegularPolygon(xy, numVertices[, radius, ...])	A regular polygon patch.
Shadow(patch, ox, oy[, props])	Create a shadow of the given *patch* offset by *ox*, *oy*.
Wedge(center, r, theta1, theta2[, width])	Wedge shaped patch.
YAArrow(figure, xytip, xybase[, width, ...])	Yet another arrow class.

matplotlib.patches.Arc

class matplotlib.patches.**Arc**(*xy*, *width*, *height*, *angle=0.0*, *theta1=0.0*, *theta2=360.0*, ***kwargs*)

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

draw(*renderer*)

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()*.

Examples using `matplotlib.patches.Arc`

- sphx_glr_gallery_units_ellipse_with_units.py

matplotlib.patches.Arrow

class matplotlib.patches.**Arrow**(*x*, *y*, *dx*, *dy*, *width=1.0*, ***kwargs*)

An arrow patch.

Draws an arrow from (*x*, *y*) to (*x* + *dx*, *y* + *dy*). The width of the arrow is scaled by *width*.

Parameters

x [scalar] x coordinate of the arrow tail

y [scalar] y coordinate of the arrow tail

dx [scalar] Arrow length in the x direction

dy [scalar] Arrow length in the y direction

width [scalar, optional (default: 1)] Scale factor for the width of the arrow. With a default value of 1, the tail width is 0.2 and head width is 0.6.

****kwargs :** Keyword arguments control the *Patch* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

See also:

FancyArrow Patch that allows independent control of the head and tail properties

`get_patch_transform()`

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate)

by 5.

get_path()
Return the path of this patch

Examples using matplotlib.patches.Arrow

- sphx_glr_gallery_shapes_and_collections_artist_reference.py

matplotlib.patches.ArrowStyle

class matplotlib.patches.**ArrowStyle**

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
Curve-FilledB	-|>	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
Curve-FilledA	<|-	head_length=0.4,head_width=0.2
Curve-FilledAB	<|-|>	head_length=0.4,head_width=0.2
BracketA	]-	widthA=1.0,lengthA=0.2,angleA=None
BracketAB	]-[	widthA=1.0,lengthA=0.2,angleA=None,widthB=1.0,lengthB=0.2,angleB=None
Fancy	fancy	head_length=0.4,head_width=0.4,tail_width=0.4
Simple	simple	head_length=0.5,head_width=0.5,tail_width=0.2
Wedge	wedge	tail_width=0.3,shrink_factor=0.5
BarAB	|-|	widthA=1.0,angleA=None,widthB=1.0,angleB=None

An instance of any arrow style class is a callable object, whose call signature is:

```
__call__(self, path, mutation_size, linewidth, aspect_ratio=1.)
```

and it returns a tuple of a `Path` instance and a boolean value. *path* is a `Path` instance along which the arrow will be drawn. *mutation_size* and *aspect_ratio* have the 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.

return the instance of the subclass with the given style name.

class BarAB(*widthA=1.0*, *angleA=None*, *widthB=1.0*, *angleB=None*)
An arrow with a bar(|) at both ends.

Parameters

widthA [float, optional, default] Width of the bracket

angleA [float, optional, default] Angle between the bracket and the line

widthB [float, optional, default] Width of the bracket

angleB [float, optional, default] Angle between the bracket and the line

class BracketA(*widthA=1.0*, *lengthA=0.2*, *angleA=None*)
An arrow with a bracket(]) at its end.

Parameters

widthA [float, optional, default] Width of the bracket

lengthA [float, optional, default] Length of the bracket

angleA [float, optional, default] Angle between the bracket and the line

class BracketAB(*widthA=1.0*, *lengthA=0.2*, *angleA=None*, *widthB=1.0*, *lengthB=0.2*, *angleB=None*)
An arrow with a bracket(]) at both ends.

Parameters

widthA [float, optional, default] Width of the bracket

lengthA [float, optional, default] Length of the bracket

angleA [float, optional, default] Angle between the bracket and the line

widthB [float, optional, default] Width of the bracket

lengthB [float, optional, default] Length of the bracket

angleB [float, optional, default] Angle between the bracket and the line

class BracketB(*widthB=1.0*, *lengthB=0.2*, *angleB=None*)
An arrow with a bracket([) at its end.

Parameters

widthB [float, optional, default] Width of the bracket

lengthB [float, optional, default] Length of the bracket

angleB [float, optional, default] Angle between the bracket and the line

`class Curve`
A simple curve without any arrow head.

`class CurveA`(*head_length=0.4*, *head_width=0.2*)
An arrow with a head at its begin point.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

`class CurveAB`(*head_length=0.4*, *head_width=0.2*)
An arrow with heads both at the begin and the end point.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

`class CurveB`(*head_length=0.4*, *head_width=0.2*)
An arrow with a head at its end point.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

`class CurveFilledA`(*head_length=0.4*, *head_width=0.2*)
An arrow with filled triangle head at the begin.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

`class CurveFilledAB`(*head_length=0.4*, *head_width=0.2*)
An arrow with filled triangle heads at both ends.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

`class CurveFilledB`(*head_length=0.4*, *head_width=0.2*)
An arrow with filled triangle head at the end.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

class Fancy(*head_length=0.4*, *head_width=0.4*, *tail_width=0.4*)
A fancy arrow. Only works with a quadratic bezier curve.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

tail_width [float, optional, default] Width of the arrow tail

transmute(*path*, *mutation_size*, *linewidth*)
The transmute method is the very core of the ArrowStyle class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the mutation_size, with which the arrow head etc. will be scaled. The linewidth may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a Path instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

class Simple(*head_length=0.5*, *head_width=0.5*, *tail_width=0.2*)
A simple arrow. Only works with a quadratic bezier curve.

Parameters

head_length [float, optional, default] Length of the arrow head

head_width [float, optional, default] Width of the arrow head

tail_width [float, optional, default] Width of the arrow tail

transmute(*path*, *mutation_size*, *linewidth*)
The transmute method is the very core of the ArrowStyle class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the mutation_size, with which the arrow head etc. will be scaled. The linewidth may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a Path instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

class Wedge(*tail_width=0.3*, *shrink_factor=0.5*)
Wedge(?) shape. Only works with a quadratic bezier curve. The begin point has a width of the tail_width and the end point has a width of 0. At the middle, the width is shrink_factor*tail_width.

Parameters

tail_width [float, optional, default] Width of the tail

shrink_factor [float, optional, default] Fraction of the arrow width at the middle point

transmute(*path*, *mutation_size*, *linewidth*)
The transmute method is the very core of the ArrowStyle class and must be overridden in the subclasses. It receives the path object along which the arrow will be drawn, and the mutation_size, with which the arrow head etc. will be scaled. The linewidth may be used to adjust the path so that it does not pass beyond the given points. It returns a tuple of a

Path instance and a boolean. The boolean value indicate whether the path can be filled or not. The return value can also be a list of paths and list of booleans of a same length.

matplotlib.patches.BoxStyle

class matplotlib.patches.**BoxStyle**

BoxStyle is a container class which defines several boxstyle classes, which are used for *FancyBboxPatch*.

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
Circle	`circle`	pad=0.3
DArrow	`darrow`	pad=0.3
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.

return the instance of the subclass with the given style name.

class **Circle**(*pad=0.3*)

A simple circle box.

Parameters

pad [float] The amount of padding around the original box.

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class DArrow(*pad=0.3*)
(Double) Arrow Box

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class LArrow(*pad=0.3*)
(left) Arrow Box

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class RArrow(*pad=0.3*)
(right) Arrow Box

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class Round(*pad=0.3*, *rounding_size=None*)
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*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class Round4(*pad=0.3*, *rounding_size=None*)
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*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class Roundtooth(*pad=0.3*, *tooth_size=None*)
A rounded tooth box.

pad amount of padding

tooth_size size of the sawtooth. pad* if None

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class Sawtooth(*pad=0.3*, *tooth_size=None*)
A sawtooth box.

pad amount of padding

tooth_size size of the sawtooth. pad* if None

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

class Square(*pad=0.3*)
A simple square box.

pad amount of padding

transmute(*x0*, *y0*, *width*, *height*, *mutation_size*)
The transmute method is a very core of the BboxTransmuter class and must be overridden in the subclasses. It receives the location and size of the rectangle, and the mutation_size, with which the amount of padding and etc. will be scaled. It returns a *Path* instance.

Examples using matplotlib.patches.BoxStyle

- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py

matplotlib.patches.Circle

class matplotlib.patches.**Circle**(*xy*, *radius=5*, ***kwargs*)
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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

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

Examples using `matplotlib.patches.Circle`

- sphx_glr_gallery_api_patch_collection.py
- sphx_glr_gallery_pyplots_whats_new_98_4_fancy.py
- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py
- sphx_glr_gallery_text_labels_and_annotations_fancyarrow_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_annotation_box.py
- sphx_glr_gallery_showcase_anatomy.py
- sphx_glr_gallery_axes_grid1_simple_anchored_artists.py
- sphx_glr_gallery_event_handling_looking_glass.py
- sphx_glr_gallery_misc_anchored_artists.py
- sphx_glr_gallery_misc_custom_projection.py
- sphx_glr_gallery_mplot3d_pathpatch3d.py
- sphx_glr_gallery_userdemo_anchored_box02.py
- *Legend guide*
- *Transformations Tutorial*

matplotlib.patches.CirclePolygon

class matplotlib.patches.**CirclePolygon**(*xy*, *radius=5*, *resolution=20*, ***kwargs*)

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a Bbox instance
clip_on	bool
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a Figure instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	Transform
url	a url string
visible	bool
zorder	float

matplotlib.patches.ConnectionPatch

class matplotlib.patches.**ConnectionPatch**(*xyA*, *xyB*, *coordsA*, *coordsB=None*, *axesA=None*, *axesB=None*, *arrowstyle='-'*, *arrow_transmuter=None*, *connectionstyle='arc3'*, *connector=None*, *patchA=None*, *patchB=None*, *shrinkA=0.0*, *shrinkB=0.0*, *mutation_scale=10.0*, *mutation_aspect=None*, *clip_on=False*, *dpi_cor=1.0*, ***kwargs*)

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"

Examples using matplotlib.patches.ConnectionPatch

- sphx_glr_gallery_userdemo_connect_simple01.py

matplotlib.patches.ConnectionStyle

class matplotlib.patches.**ConnectionStyle**

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.

return the instance of the subclass with the given style name.

class Angle(*angleA=90*, *angleB=0*, *rad=0.0*)

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*)

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*)

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*)

Creates a simple quadratic bezier curve between two points. The curve is created so that the middle control point (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=0.3*, *angle=None*)

A line with *angle* between A and B with *armA* and *armB*. One of the arms is extended so that they are connected in a right angle. The length of armA is determined by (*armA* + *fraction* x AB distance). Same for armB.

Parameters

armA [float] minimum length of armA

armB [float] minimum length of armB

fraction [float] a fraction of the distance between two points that will be added to armA and armB.

angle [float or None] angle of the connecting line (if None, parallel to A and B)

`connect`(*posA*, *posB*)

matplotlib.patches.Ellipse

class matplotlib.patches.**Ellipse**(*xy*, *width*, *height*, *angle=0.0*, ***kwargs*)

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_patch_transform()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the vertices of the rectangle

Examples using matplotlib.patches.Ellipse

- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py
- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_text_labels_and_annotations_annotation_demo.py
- sphx_glr_gallery_misc_anchored_artists.py
- sphx_glr_gallery_units_ellipse_with_units.py
- sphx_glr_gallery_userdemo_anchored_box03.py
- sphx_glr_gallery_userdemo_anchored_box04.py
- sphx_glr_gallery_userdemo_annotate_explain.py
- sphx_glr_gallery_userdemo_simple_annotate01.py
- *Legend guide*

matplotlib.patches.FancyArrow

class matplotlib.patches.**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*)

Like Arrow, but lets you set head width and head height independently.

Constructor arguments

***width*: float (default: 0.001)** width of full arrow tail

***length_includes_head*: bool (default: False)** True if head is to be counted in calculating the length.

***head_width*: float or None (default: 3*width)** total width of the full arrow head

***head_length*: float or None (default: 1.5 * head_width)** length of arrow head

***shape*: ['full', 'left', 'right'] (default: 'full')** draw the left-half, right-half, or full arrow

***overhang*: float (default: 0)** fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

***head_starts_at_zero*: bool (default: False)** if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Other valid kwargs (inherited from *Patch*) are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a Bbox instance
clip_on	bool
clip_path	[(Path, Transform) | Patch | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a Figure instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	Transform
url	a url string
visible	bool
zorder	float

matplotlib.patches.FancyArrowPatch

class matplotlib.patches.**FancyArrowPatch**(*posA=None*, *posB=None*, *path=None*, *arrowstyle='simple'*, *arrow_transmuter=None*, *connectionstyle='arc3'*, *connector=None*, *patchA=None*, *patchB=None*, *shrinkA=2*, *shrinkB=2*, *mutation_scale=1*, *mutation_aspect=None*, *dpi_cor=1*, ***kwargs*)

A fancy arrow patch. It draws an arrow using the `ArrowStyle`.

The head and tail positions are fixed at the specified start and end points of the arrow, but the size and shape (in display coordinates) of the arrow does not change when the axis is moved or zoomed.

If *posA* and *posB* are given, a path connecting two points is created according to *connectionstyle*. The path will be clipped with *patchA* and *patchB* and further shrunken by *shrinkA* and *shrinkB*. An arrow is drawn along this resulting path using the *arrowstyle* parameter.

Alternatively if *path* is provided, an arrow is drawn along this path and *patchA*, *patchB*, *shrinkA*, and *shrinkB* are ignored.

Parameters

posA, posB [None, tuple, optional (default: None)] (x,y) coordinates of arrow tail and arrow head respectively.

path [None, Path (default: None)] `matplotlib.path.Path` instance. If provided, an arrow is drawn along this path and *patchA*, *patchB*, *shrinkA*, and *shrinkB* are ignored.

arrowstyle [str or ArrowStyle, optional (default: 'simple')]

Describes how the fancy arrow will be drawn. It can be string of the available arrowstyle names, with optional comma-separated attributes, or an `ArrowStyle` instance. The optional attributes are meant to be scaled with the *mutation_scale*. The following arrow styles are available:

Class	Name	Attrs
Curve	-	None
CurveB	->	head_length=0.4,head_width=0.2
BracketB	-[	widthB=1.0,lengthB=0.2,angleB=None
Curve-FilledB	-|>	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
Curve-FilledA	<|-	head_length=0.4,head_width=0.2
Curve-FilledAB	<|-|>	head_length=0.4,head_width=0.2
BracketA	]-	widthA=1.0,lengthA=0.2,angleA=None
Brack-etAB	]-[	widthA=1.0,lengthA=0.2,angleA=None,widthB=1.0,lengthB=0.2,angleB=Non
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

arrow_transmuter : Ignored

connectionstyle [str, ConnectionStyle, or None, optional]

(default: 'arc3')

Describes how *posA* and *posB* are connected. It can be an instance of the *ConnectionStyle* class 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

connector : Ignored

patchA, patchB [None, Patch, optional (default: None)] Head and tail patch respectively. matplotlib.patch.Patch instance.

shrinkA, shrinkB [scalar, optional (default: 2)] Shrinking factor of the tail and head of the arrow respectively

mutation_scale [scalar, optional (default: 1)] Value with which attributes of *arrowstyle* (e.g., *head_length*) will be scaled.

mutation_aspect [None, scalar, optional (default: None)] 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.

dpi_cor [scalar, optional (default: 1)] dpi_cor is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

Notes

Valid kwargs are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

draw(*renderer*)
Draw the *Patch* to the given *renderer*.

get_arrowstyle()
Return the arrowstyle object.

get_connectionstyle()
Return the *ConnectionStyle* instance.

get_dpi_cor()

dpi_cor is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

Returns

dpi_cor [scalar]

`get_mutation_aspect`()
Return the aspect ratio of the bbox mutation.

`get_mutation_scale`()
Return the mutation scale.

Returns

scale [scalar]

`get_path`()
Return the path of the arrow in the data coordinates. Use get_path_in_displaycoord() method to retrieve the arrow path in display coordinates.

`get_path_in_displaycoord`()
Return the mutated path of the arrow in display coordinates.

`set_arrowstyle`(*arrowstyle=None*, ***kw*)
Set the arrow style. Old attributes are forgotten. Without arguments (or with `arrowstyle=None`) returns available box styles as a list of strings.

Parameters

arrowstyle [None, ArrowStyle, str, optional (default: None)] Can be a string with arrowstyle name with optional comma-separated attributes, e.g.:

```
set_arrowstyle("Fancy,head_length=0.2")
```

Alternatively attributes can be provided as keywords, e.g.:

```
set_arrowstyle("fancy", head_length=0.2)
```

`set_connectionstyle`(*connectionstyle*, ***kw*)
Set the connection style. Old attributes are forgotten.

Parameters

connectionstyle [None, ConnectionStyle instance, or string] Can be a string with connectionstyle name with optional comma-separated attributes, e.g.:

```
set_connectionstyle("arc,angleA=0,armA=30,rad=10")
```

Alternatively, the attributes can be provided as keywords, e.g.:

```
set_connectionstyle("arc", angleA=0,armA=30,rad=10)
```

Without any arguments (or with `connectionstyle=None`), return available styles as a list of strings.

set_dpi_cor(*dpi_cor*)
dpi_cor is currently used for linewidth-related things and shrink factor. Mutation scale is affected by this.

Parameters

dpi_cor [scalar]

set_mutation_aspect(*aspect*)
Set the aspect ratio of the bbox mutation.

Parameters

aspect [scalar]

set_mutation_scale(*scale*)
Set the mutation scale.

Parameters

scale [scalar]

set_patchA(*patchA*)
Set the tail patch.

Parameters

patchA [Patch] `matplotlib.patch.Patch` instance.

set_patchB(*patchB*)
Set the head patch.

Parameters

patchB [Patch] `matplotlib.patch.Patch` instance.

set_positions(*posA*, *posB*)
Set the begin and end positions of the connecting path.

Parameters

posA, posB [None, tuple] (x,y) coordinates of arrow tail and arrow head respectively. If `None` use current value.

matplotlib.patches.FancyBboxPatch

class matplotlib.patches.**FancyBboxPatch**(*xy*, *width*, *height*, *boxstyle='round'*, *bbox_transmuter=None*, *mutation_scale=1.0*, *mutation_aspect=None*, ***kwargs*)
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
Circle	`circle`	pad=0.3
DArrow	`darrow`	pad=0.3
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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

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.

The following boxstyles are available:

Class	Name	Attrs
Circle	`circle`	pad=0.3
DArrow	`darrow`	pad=0.3
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

ACCEPTS: ['circle' | 'darrow' | 'larrow' | 'rarrow' | 'round' | 'round4' | 'roundtooth' | 'sawtooth' | 'square']

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

Examples using matplotlib.patches.FancyBboxPatch

- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py

matplotlib.patches.Patch

class matplotlib.patches.**Patch**(*edgecolor=None*, *facecolor=None*, *color=None*, *linewidth=None*, *linestyle=None*, *antialiased=None*, *hatch=None*, *fill=True*, *capstyle=None*, *joinstyle=None*, ***kwargs*)
A patch is a 2D artist with a face color and an edge color.

If any of *edgecolor*, *facecolor*, *linewidth*, or *antialiased* are *None*, they default to their rc params setting.

The following kwarg properties are supported

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

contains(*mouseevent*, *radius=None*)

Test whether the mouse event occurred in the patch.

Returns T/F, {}

contains_point(*point*, *radius=None*)

Returns `True` if the given *point* is inside the path (transformed with its transform attribute).

radius allows the path to be made slightly larger or smaller.

contains_points(*points*, *radius=None*)

Returns a bool array which is `True` if the (closed) path contains the corresponding point. (transformed with its transform attribute).

points must be Nx2 array. *radius* allows the path to be made slightly larger or smaller.

draw(*renderer*)
Draw the *Patch* to the given *renderer*.

fill
return whether fill is set

get_aa()
Returns True if the *Patch* is to be drawn with antialiasing.

get_antialiased()
Returns True if the *Patch* is to be drawn with antialiasing.

get_capstyle()
Return the current capstyle

get_data_transform()
Return the *Transform* instance which maps data coordinates to physical coordinates.

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_joinstyle()
Return the current joinstyle

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()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the path of this patch

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*)
Get the axes bounding box in display space. Subclasses should override for inclusion in the bounding box "tight" calculation. Default is to return an empty bounding box at 0, 0.

Be careful when using this function, the results will not update if the artist window extent of the artist changes. The extent can change due to any changes in the transform stack, such as changing the axes limits, the figure size, or the canvas used (as is done when saving a figure). This can lead to unexpected behavior where interactive figures will look fine on the screen, but will save incorrectly.

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.

Parameters

b [bool or None]

set_capstyle(*s*)
Set the patch capstyle

ACCEPTS: ['butt' | 'round' | 'projecting']

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, None, 'none', or 'auto'

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.

Parameters

b [bool]

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_joinstyle(*s*)
Set the patch joinstyle

ACCEPTS: ['miter' | 'round' | 'bevel']

set_linestyle(*ls*)
Set the patch linestyle

linestyle	description
'-' or 'solid'	solid line
'--' or 'dashed'	dashed line
'-.' or 'dashdot'	dash-dotted line
':' or 'dotted'	dotted line

Alternatively a dash tuple of the following form can be provided:

```
(offset, onoffseq),
```

where `onoffseq` is an even length tuple of on and off ink in points.

ACCEPTS: ['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]

Parameters

ls [{ '-', '–', '-.', ':'} and more see description] The line style.

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

update_from(*other*)
Updates this *Patch* from the properties of *other*.

validCap = ('butt', 'round', 'projecting')

validJoin = ('miter', 'round', 'bevel')

zorder = 1

Examples using matplotlib.patches.Patch

- sphx_glr_gallery_text_labels_and_annotations_custom_legends.py
- *Legend guide*

matplotlib.patches.PathPatch

class matplotlib.patches.**PathPatch**(*path*, ***kwargs*)

A general polycurve path patch.

path is a *matplotlib.path.Path* object.

Valid kwargs are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

See also:

Patch For additional kwargs

get_path()
Return the path of this patch

Examples using matplotlib.patches.PathPatch

- sphx_glr_gallery_api_quad_bezier.py
- sphx_glr_gallery_api_histogram_path.py
- sphx_glr_gallery_pyplots_compound_path_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_shapes_and_collections_compound_path.py
- sphx_glr_gallery_shapes_and_collections_path_patch.py
- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_showcase_firefox.py
- *Animated histogram*
- sphx_glr_gallery_event_handling_path_editor.py
- sphx_glr_gallery_mplot3d_pathpatch3d.py
- *Path Tutorial*

matplotlib.patches.Polygon

class matplotlib.patches.**Polygon**(*xy*, *closed=True*, ***kwargs*)
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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

See also:

Patch For additional kwargs

`get_closed()`
Returns if the polygon is closed

Returns

closed [bool] If the path is closed

get_path()
Get the path of the polygon

Returns

path [Path] The *Path* object for the polygon

get_xy()
Get the vertices of the path

Returns

vertices [numpy array] The coordinates of the vertices as a Nx2 ndarray.

set_closed(*closed*)
Set if the polygon is closed

Parameters

closed [bool] True if the polygon is closed

set_xy(*xy*)
Set the vertices of the polygon

Parameters

xy [numpy array or iterable of pairs] The coordinates of the vertices as a Nx2 ndarray or iterable of pairs.

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.

Examples using matplotlib.patches.Polygon

- sphx_glr_gallery_api_patch_collection.py
- sphx_glr_gallery_statistics_boxplot_demo.py
- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_showcase_integral.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py
- sphx_glr_gallery_event_handling_poly_editor.py

matplotlib.patches.Rectangle

class matplotlib.patches.**Rectangle**(*xy*, *width*, *height*, *angle=0.0*, ***kwargs*)
Draw a rectangle with lower left at *xy* = (*x*, *y*) with specified *width*, *height* and rotation *angle*.

Parameters

xy: length-2 tuple The bottom and left rectangle coordinates

width: Rectangle width

height: Rectangle height

angle: float, optional rotation in degrees anti-clockwise about *xy* (default is 0.0)

fill: bool, optional Whether to fill the rectangle (default is `True`)

Notes

Valid kwargs are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_bbox()

get_height()
Return the height of the rectangle

get_patch_transform()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing

coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

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 height of the rectangle

set_width(*w*)
Set the width of the rectangle

set_x(*x*)
Set the left coord of the rectangle

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

xy
Return the left and bottom coords of the rectangle

Examples using `matplotlib.patches.Rectangle`

- sphx_glr_gallery_pyplots_text_layout.py
- sphx_glr_gallery_statistics_errorbars_and_boxes.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_event_handling_viewlims.py
- sphx_glr_gallery_event_handling_pick_event_demo.py
- sphx_glr_gallery_misc_anchored_artists.py

- sphx_glr_gallery_units_artist_tests.py
- sphx_glr_gallery_widgets_menu.py
- *Legend guide*
- *Transformations Tutorial*
- *Specifying Colors*
- *Text properties and layout*

matplotlib.patches.RegularPolygon

class matplotlib.patches.**RegularPolygon**(*xy*, *numVertices*, *radius=5*, *orientation=0*, ***kwargs*)

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_patch_transform()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the path of this patch

numvertices

orientation

radius

xy

Examples using matplotlib.patches.RegularPolygon

- sphx_glr_gallery_shapes_and_collections_artist_reference.py

matplotlib.patches.Shadow

class matplotlib.patches.**Shadow**(*patch*, *ox*, *oy*, *props=None*, ***kwargs*)

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

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

draw(*renderer*)

Draw the *Patch* to the given *renderer*.

get_patch_transform()

Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the path of this patch

Examples using matplotlib.patches.Shadow

- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_misc_svg_filter_pie.py

matplotlib.patches.Wedge

class matplotlib.patches.**Wedge**(*center*, *r*, *theta1*, *theta2*, *width=None*, ***kwargs*)
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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_path()
Return the path of this patch

set_center(*center*)

set_radius(*radius*)

set_theta1(*theta1*)

set_theta2(*theta2*)

set_width(*width*)

Examples using matplotlib.patches.Wedge

- sphx_glr_gallery_api_patch_collection.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py

matplotlib.patches.YAArrow

class matplotlib.patches.**YAArrow**(*figure*, *xytip*, *xybase*, *width=4*, *frac=0.1*, *headwidth=12*, ***kwargs*)

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

get_patch_transform()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the path of this patch

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*.

57.1.2 Functions

bbox_artist(artist, renderer[, props, fill])	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.
draw_bbox(bbox, renderer[, color, trans])	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.

matplotlib.patches.bbox_artist

matplotlib.patches.**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.

matplotlib.patches.draw_bbox

matplotlib.patches.**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.

CHAPTER

FIFTYEIGHT

PATH

58.1 matplotlib.path

A module for dealing with the polylines used throughout Matplotlib.

The primary class for polyline handling in Matplotlib is *Path*. Almost all vector drawing makes use of *Path*s somewhere in the drawing pipeline.

Whilst a *Path* instance itself cannot be drawn, some *Artist* subclasses, such as *PathPatch* and *PathCollection*, can be used for convenient *Path* visualisation.

class matplotlib.path.**Path**(*vertices*, *codes=None*, *_interpolation_steps=1*, *closed=False*, *readonly=False*)

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()* or *cleaned()* 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()*.

Some behavior of Path objects can be controlled by rcParams. See the rcParams whose keys contain 'path.'.

Note: 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.

Parameters

vertices [array_like] The `(n, 2)` float array, masked array or sequence of pairs representing the vertices of the path.

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()*.

codes [{None, array_like}, optional] n-length array integers representing the codes of the path. If not None, codes must be the same length as vertices. If None, *vertices* will be treated as a series of line segments.

_interpolation_steps [int, optional] 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.

closed [bool, optional] If *codes* is None and closed is True, vertices will be treated as line segments of a closed polygon.

readonly [bool, optional] Makes the path behave in an immutable way and sets the vertices and codes as read-only arrays.

CLOSEPOLY = 79

CURVE3 = 3

CURVE4 = 4

LINETO = 2

MOVETO = 1

NUM_VERTICES_FOR_CODE = {0: 1, 1: 1, 2: 1, 3: 2, 4: 3, 79: 1}

A dictionary mapping Path codes to the number of vertices that the code expects.

STOP = 0

classmethod arc(*theta1*, *theta2*, *n=None*, *is_wedge=False*)

Return an arc on the unit circle from angle *theta1* to angle *theta2* (in degrees).

theta2 is unwrapped to produce the shortest arc within 360 degrees. That is, if *theta2* > *theta1* + 360, the arc will be from *theta1* to *theta2* - 360 and not a full circle plus some extra overlap.

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.

classmethod circle(*center=(0.0, 0.0)*, *radius=1.0*, *readonly=False*)

Return a Path representing a circle of a given radius and center.

Parameters

center [pair of floats] The center of the circle. Default `(0, 0)`.

radius [float] The radius of the circle. Default is 1.

readonly [bool] Whether the created path should have the "readonly" argument set when creating the Path instance.

Notes

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.

cleaned(*transform=None*, *remove_nans=False*, *clip=None*, *quantize=False*, *simplify=False*, *curves=False*, *stroke_width=1.0*, *snap=False*, *sketch=None*)

Cleans up the path according to the parameters returning a new Path instance.

See also:

See *iter_segments()* for details of the keyword arguments.

Returns

Path instance with cleaned up vertices and codes.

clip_to_bbox(*bbox*, *inside=True*)

Clip the path to the given bounding box.

The path must be made up of one or more closed polygons. This algorithm will not behave correctly for unclosed paths.

If *inside* is `True`, clip to the inside of the box, otherwise to the outside of the box.

code_type
alias of numpy.uint8

codes
The list of codes in the *Path* as a 1-D numpy array. Each code is one of *STOP*, *MOVETO*, *LINETO*, *CURVE3*, *CURVE4* or *CLOSEPOLY*. For codes that correspond to more than one vertex (*CURVE3* and *CURVE4*), that code will be repeated so that the length of `self.vertices` and `self.codes` is always the same.

contains_path(*path*, *transform=None*)
Returns whether this (closed) path completely contains the given path.

If *transform* is not None, the path will be transformed before performing the test.

contains_point(*point*, *transform=None*, *radius=0.0*)
Returns whether the (closed) path contains the given point.

If *transform* is not None, the path will be transformed before performing the test.

radius allows the path to be made slightly larger or smaller.

contains_points(*points*, *transform=None*, *radius=0.0*)
Returns a bool array which is True if the (closed) path contains the corresponding point.

If *transform* is not None, the path will be transformed before performing the test.

radius allows the path to be made slightly larger or smaller.

copy()
Returns a shallow copy of the *Path*, which will share the vertices and codes with the source *Path*.

deepcopy(*memo=None*)
Returns a deepcopy of the *Path*. The *Path* will not be readonly, even if the source *Path* is.

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.

has_nonfinite
True if the vertices array has nonfinite values.

classmethod 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 the path completely encloses the bounding box, *intersects_bbox()* will return True.

The bounding box is always considered filled.

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*, *sketch=None*)
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.

Parameters

transform [None or *Transform* instance] If not None, the given affine transformation will be applied to the path.

remove_nans [{False, True}, optional] If True, will remove all NaNs from the path and insert MOVETO commands to skip over them.

clip [None or sequence, optional] If not None, must be a four-tuple (x1, y1, x2, y2) defining a rectangle in which to clip the path.

snap [None or bool, optional] If None, auto-snap to pixels, to reduce fuzziness of rectilinear lines. If True, force snapping, and if False, don't snap.

stroke_width [float, optional]

The width of the stroke being drawn. Needed as a hint for the snapping algorithm.

simplify [None or bool, optional]

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. See also the rcParams path.simplify and path.simplify_threshold.

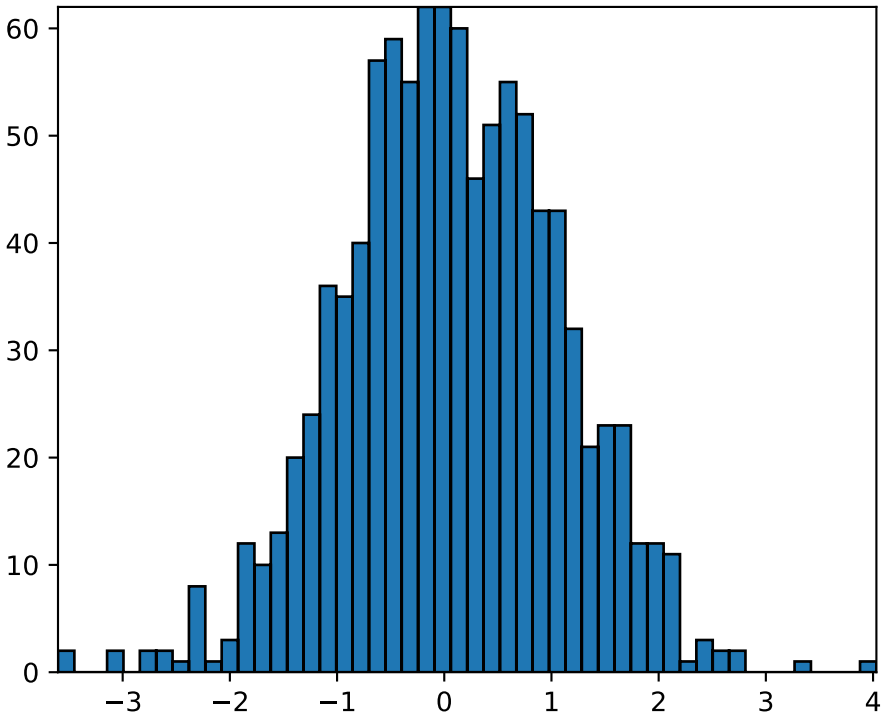
curves [{True, False}, optional] If True, curve segments will be returned as curve segments. If False, all curves will be converted to line segments.

sketch [None or sequence, optional] If not None, must be a 3-tuple of the form (scale, length, randomness), representing the sketch parameters.

classmethod make_compound_path(**args*)
Make a compound path from a list of Path objects.

classmethod make_compound_path_from_polys(*XY*)
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*

readonly
True if the *Path* is read-only.



should_simplify
: `True` if the vertices array should be simplified.

simplify_threshold
: The fraction of a pixel difference below which vertices will be simplified out.

to_polygons(*transform=None*, *width=0*, *height=0*, *closed_only=True*)
: Convert this path to a list of polygons or polylines. Each polygon/polyline 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.

  If *closed_only* is `True` (default), only closed polygons, with the last point being the same as the first point, will be returned. Any unclosed polylines in the path will be explicitly closed. If *closed_only* is `False`, any unclosed polygons in the path will be returned as unclosed polygons, and the closed polygons will be returned explicitly closed by setting the last point to the same as the first point.

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.

classmethod unit_circle()
Return the readonly *Path* of the unit circle.

For most cases, *Path.circle()* will be what you want.

classmethod unit_circle_righthalf()
Return 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.

classmethod unit_rectangle()
Return a *Path* instance of the unit rectangle from (0, 0) to (1, 1).

classmethod unit_regular_asterisk(*numVertices*)
Return a *Path* for a unit regular asterisk with the given numVertices and radius of 1.0, centered at (0, 0).

classmethod unit_regular_polygon(*numVertices*)
Return a *Path* instance for a unit regular polygon with the given *numVertices* and radius of 1.0, centered at (0, 0).

classmethod unit_regular_star(*numVertices*, *innerCircle=0.5*)
Return a *Path* for a unit regular star with the given numVertices and radius of 1.0, centered at (0, 0).

vertices
The list of vertices in the *Path* as an Nx2 numpy array.

classmethod wedge(*theta1*, *theta2*, *n=None*)
Return a wedge of the unit circle from angle *theta1* to angle *theta2* (in degrees).

theta2 is unwrapped to produce the shortest wedge within 360 degrees. That is, if *theta2* > *theta1* + 360, the wedge will be from *theta1* to *theta2* - 360 and not a full circle plus some extra overlap.

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*.

matplotlib.path.**get_path_collection_extents**(*master_transform*, *paths*, *transforms*, *offsets*, *offset_transform*)
Given a sequence of *Path* objects, *Transform* objects and offsets, as found in a *PathCollection*, returns the bounding box that encapsulates all of them.

master_transform is a global transformation to apply to all paths

paths is a sequence of *Path* instances.

transforms is a sequence of *Affine2D* instances.

offsets is a sequence of (x, y) offsets (or an Nx2 array)

offset_transform is a *Affine2D* to apply to the offsets before applying the offset to the path.

The way that *paths*, *transforms* and *offsets* are combined follows the same method as for collections. Each is iterated over independently, so if you have 3 paths, 2 transforms and 1 offset, their combinations are as follows:

(A, A, A), (B, B, A), (C, A, A)

matplotlib.path.**get_paths_extents**(*paths*, *transforms=[]*)

Given a sequence of *Path* objects and optional *Transform* objects, returns the bounding box that encapsulates all of them.

paths is a sequence of *Path* instances.

transforms is an optional sequence of *Affine2D* instances to apply to each path.

CHAPTER

FIFTYNINE

PATHEFFECTS

59.1 matplotlib.patheffects

Defines classes for path effects. The path effects are supported in *Text*, *Line2D* and *Patch*.

class matplotlib.patheffects.**AbstractPathEffect**(*offset=(0.0, 0.0)*)

Bases: object

A base class for path effects.

Subclasses should override the draw_path method to add effect functionality.

Parameters

offset [pair of floats] The offset to apply to the path, measured in points.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace=None*)

Derived should override this method. The arguments are the same as *matplotlib.backend_bases.RendererBase.draw_path()* except the first argument is a renderer.

class matplotlib.patheffects.**Normal**(*offset=(0.0, 0.0)*)

Bases: *matplotlib.patheffects.AbstractPathEffect*

The "identity" PathEffect.

The Normal PathEffect's sole purpose is to draw the original artist with no special path effect.

Parameters

offset [pair of floats] The offset to apply to the path, measured in points.

class matplotlib.patheffects.**PathEffectRenderer**(*path_effects*, *renderer*)

Bases: *matplotlib.backend_bases.RendererBase*

Implements a Renderer which contains another renderer.

This proxy then intercepts draw calls, calling the appropriate *AbstractPathEffect* draw method.

Note: Not all methods have been overridden on this RendererBase subclass. It may be necessary to add further methods to extend the PathEffects capabilities further.

Parameters

path_effects [iterable of *AbstractPathEffect*] The path effects which this renderer represents.

renderer [*matplotlib.backend_bases.RendererBase* instance]

copy_with_path_effect(*path_effects*)

draw_markers(*gc*, *marker_path*, *marker_trans*, *path*, **args*, ***kwargs*)

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.

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.

Parameters

gc [GraphicsContextBase] The graphics context

marker_trans [*matplotlib.transforms.Transform*] An affine transform applied to the marker.

trans [*matplotlib.transforms.Transform*] An affine transform applied to the path.

draw_path(*gc*, *tpath*, *affine*, *rgbFace=None*)

Draws a *Path* instance using the given affine transform.

draw_path_collection(*gc*, *master_transform*, *paths*, **args*, ***kwargs*)

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. *offset_position* may be either "screen" or "data" depending on the space that the offsets are in.

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.

new_gc()

Return an instance of a GraphicsContextBase

points_to_pixels(*points*)

Convert points to display units

You need to override this function (unless your backend doesn't have a dpi, e.g., 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
```

Parameters

points [scalar or array_like] a float or a numpy array of float

Returns

Points converted to pixels

class matplotlib.patheffects.**PathPatchEffect**(*offset=(0, 0)*, ***kwargs*)

Bases: *matplotlib.patheffects.AbstractPathEffect*

Draws a *PathPatch* instance whose Path comes from the original PathEffect artist.

Parameters

offset [pair of floats] The offset to apply to the path, in points.

****kwargs :** All keyword arguments are passed through to the *PathPatch* constructor. The properties which cannot be overridden are "path", "clip_box" "transform" and "clip_path".

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)

Derived should override this method. The arguments are the same as *matplotlib.backend_bases.RendererBase.draw_path()* except the first argument is a renderer.

class matplotlib.patheffects.**SimpleLineShadow**(*offset=(2, -2)*, *shadow_color='k'*, *alpha=0.3*, *rho=0.3*, ***kwargs*)

Bases: *matplotlib.patheffects.AbstractPathEffect*

A simple shadow via a line.

Parameters

offset [pair of floats] The offset to apply to the path, in points.

shadow_color [color] The shadow color. Default is black. A value of `None` takes the original artist's color with a scale factor of `rho`.

alpha [float] The alpha transparency of the created shadow patch. Default is 0.3.

rho [float] A scale factor to apply to the rgbFace color if `shadow_rgbFace` is `None`. Default is 0.3.

****kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)

Overrides the standard draw_path to add the shadow offset and necessary color changes for the shadow.

class matplotlib.patheffects.**SimplePatchShadow**(*offset=(2, -2)*, *shadow_rgbFace=None*, *alpha=None*, *rho=0.3*, ***kwargs*)

Bases: *matplotlib.patheffects.AbstractPathEffect*

A simple shadow via a filled patch.

Parameters

offset [pair of floats] The offset of the shadow in points.

shadow_rgbFace [color] The shadow color.

alpha [float] The alpha transparency of the created shadow patch. Default is 0.3. http://matplotlib.1069221.n5.nabble.com/path-effects-question-td27630.html

rho [float] A scale factor to apply to the rgbFace color if `shadow_rgbFace` is not specified. Default is 0.3.

****kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)
Overrides the standard draw_path to add the shadow offset and necessary color changes for the shadow.

class matplotlib.patheffects.**Stroke**(*offset=(0, 0)*, ***kwargs*)
Bases: *matplotlib.patheffects.AbstractPathEffect*

A line based PathEffect which re-draws a stroke.

The path will be stroked with its gc updated with the given keyword arguments, i.e., the keyword arguments should be valid gc parameter values.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)
draw the path with updated gc.

class matplotlib.patheffects.**withSimplePatchShadow**(*offset=(2, -2)*, *shadow_rgbFace=None*, *alpha=None*, *rho=0.3*, ***kwargs*)
Bases: *matplotlib.patheffects.SimplePatchShadow*

Adds a simple *SimplePatchShadow* and then draws the original Artist to avoid needing to call *Normal*.

Parameters

offset [pair of floats] The offset of the shadow in points.

shadow_rgbFace [color] The shadow color.

alpha [float] The alpha transparency of the created shadow patch. Default is 0.3. http://matplotlib.1069221.n5.nabble.com/path-effects-question-td27630.html

rho [float] A scale factor to apply to the rgbFace color if `shadow_rgbFace` is not specified. Default is 0.3.

****kwargs** Extra keywords are stored and passed through to `AbstractPathEffect._update_gc()`.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)
Overrides the standard draw_path to add the shadow offset and necessary color changes for the shadow.

class matplotlib.patheffects.**withStroke**(*offset=(0, 0)*, ***kwargs*)

Bases: *matplotlib.patheffects.Stroke*

Adds a simple *Stroke* and then draws the original Artist to avoid needing to call *Normal*.

The path will be stroked with its gc updated with the given keyword arguments, i.e., the keyword arguments should be valid gc parameter values.

draw_path(*renderer*, *gc*, *tpath*, *affine*, *rgbFace*)

draw the path with updated gc.

CHAPTER

SIXTY

PROJECTIONS

60.1 matplotlib.projections

class matplotlib.projections.**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).

matplotlib.projections.**get_projection_class**(*projection=None*)

Get a projection class from its name.

If *projection* is None, a standard rectilinear projection is returned.

matplotlib.projections.**get_projection_names**()

Get a list of acceptable projection names.

matplotlib.projections.**process_projection_requirements**(*figure*, **args*, ***kwargs*)

Handle the args/kwargs to for add_axes/add_subplot/gca, returning:

```
(axes_proj_class, proj_class_kwargs, proj_stack_key)
```

Which can be used for new axes initialization/identification.

Note: **kwargs** is modified in place.

matplotlib.projections.**register_projection**(*cls*)

60.2 matplotlib.projections.polar

class matplotlib.projections.polar.**InvertedPolarTransform**(*axis=None*, *use_rmin=True*, *_apply_theta_transforms=True*)

Bases: *matplotlib.transforms.Transform*

The inverse of the polar transform, mapping Cartesian coordinate space *x* and *y* back to *theta* and *r*.

input_dims = 2

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))`

is_separable = False

output_dims = 2

transform_non_affine(*xy*)

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class matplotlib.projections.polar.**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 the y limits (for the radius limits). The theta range is handled by the non-affine transform.

get_matrix()

Get the Affine transformation array for the affine part of this transform.

class matplotlib.projections.polar.**PolarAxes**(**args*, ***kwargs*)

Bases: `matplotlib.axes._axes.Axes`

A polar graph projection, where the input dimensions are *theta*, *r*.

Theta starts pointing east and goes anti-clockwise.

Build an `Axes` instance in `Figure` *fig* with *rect=[left, bottom, width, height]* in `Figure` coordinates

Optional keyword arguments:

Keyword	Description
adjustable	['box' | 'datalim']
alpha	float: the alpha transparency (can be None)
anchor	**['C', 'SW', 'S', 'SE', 'E', 'NE', 'N',** 'NW', 'W']
aspect	['auto' | 'equal' | aspect_ratio]
autoscale_on	bool; whether to autoscale the *viewlim*
axisbelow	[bool | 'line'] draw the grids and ticks below or above most other artists, or below lines but above patches
cursor_props	a (*float*, *color*) tuple
figure	a `Figure` instance
frame_on	bool; whether to draw the axes frame
label	the axes label
navigate	bool
navigate_mode	['PAN' | 'ZOOM' | None] the navigation toolbar button status
position	[left, bottom, width, height] in class:`Figure` coords
sharex	an class:`Axes` instance to share the x-axis with
sharey	an class:`Axes` instance to share the y-axis with
title	the title string
visible	bool, whether the axes is visible
xlabel	the xlabel
xlim	(*xmin*, *xmax*) view limits
xscale	['linear' | 'log' | 'logit' | 'symlog']
xticklabels	sequence of strings
xticks	sequence of floats
ylabel	the ylabel strings
ylim	(*ymin*, *ymax*) view limits
yscale	['linear' | 'log' | 'logit' | 'symlog']
yticklabels	sequence of strings
yticks	sequence of floats

class InvertedPolarTransform(*axis=None*, *use_rmin=True*, *_apply_theta_transforms=True*)

Bases: *matplotlib.transforms.Transform*

The inverse of the polar transform, mapping Cartesian coordinate space *x* and *y* back to *theta* and *r*.

input_dims = 2

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))`

is_separable = False

output_dims = 2

transform_non_affine(*xy*)
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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *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 the y limits (for the radius limits). The theta range is handled by the non-affine transform.

get_matrix()
Get the Affine transformation array for the affine part of this transform.

class PolarTransform(*axis=None*, *use_rmin=True*, *_apply_theta_transforms=True*)
Bases: *matplotlib.transforms.Transform*

The base polar transform. This handles projection *theta* and *r* into Cartesian coordinate space *x* and *y*, but does not perform the ultimate affine transformation into the correct position.

input_dims = 2

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))`

is_separable = False

output_dims = 2

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

transform_path_non_affine(*path*)
Returns a 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*, *axes=None*)
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.

autoscale()
autoscale the view limits

pan(*numsteps*)
Pan numticks (can be positive or negative)

refresh()
refresh internal information based on current lim

view_limits(*vmin*, *vmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

zoom(*direction*)
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

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.

class ThetaLocator(*base*)
Bases: *matplotlib.ticker.Locator*

Used to locate theta ticks.

This will work the same as the base locator except in the case that the view spans the entire circle. In such cases, the previously used default locations of every 45 degrees are returned.

autoscale()
autoscale the view limits

pan(*numsteps*)
Pan numticks (can be positive or negative)

refresh()
refresh internal information based on current lim

set_axis(*axis*)

view_limits(*vmin*, *vmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

zoom(*direction*)
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

can_pan()
Return *True* if this axes supports the pan/zoom button functionality.

For polar axes, this is slightly misleading. Both panning and zooming are performed by the same button. Panning is performed in azimuth while zooming is done along the radial.

can_zoom()
Return *True* if this axes supports the zoom box button functionality.

Polar axes do not support zoom boxes.

cla()
Clear the current axes.

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(**args*, ***kwargs*)
Draw everything (plot lines, axes, labels)

end_pan()
Called when a pan operation completes (when the mouse button is up.)

Note: Intended to be overridden by new projection types.

---

format_coord(*theta*, *r*)
Return a format string formatting the coordinate using Unicode characters.

get_data_ratio()
Return the aspect ratio of the data itself. For a polar plot, this should always be 1.0

get_rlabel_position()

Returns

float The theta position of the radius labels in degrees.

get_rmax()

get_rmin()

get_rorigin()

get_theta_direction()
Get the direction in which theta increases.

-1: Theta increases in the clockwise direction

1: Theta increases in the counterclockwise direction

get_theta_offset()
Get the offset for the location of 0 in radians.

get_thetamax()

get_thetamin()

get_xaxis_text1_transform(*pad*)

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*)

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_yaxis_text1_transform(*pad*)

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*)

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.

---

name = 'polar'

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

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	any matplotlib color
contains	a callable function

Table 1 – continued from

Property	Description
family or fontfamily or fontname or name	[FONTNAME | 'serif' | 'sans-serif' | 'cursive' | 'fantasy' | 'monospace']
figure	a *Figure* instance
fontproperties or font_properties	a *matplotlib.font_manager.FontProperties* instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object
linespacing	float (multiple of font size)
multialignment or ma	['left' | 'right' | 'center']
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large'
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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*
url	a url string
usetex	bool or None
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
wrap	bool
x	float
y	float
zorder	float

ACCEPTS: sequence of floats

set_rlabel_position(*value*)

Updates the theta position of the radius labels.

Parameters

value [number] The angular position of the radius labels in degrees.

set_rlim(**args*, ***kwargs*)

set_rmax(*rmax*)

set_rmin(*rmin*)

set_rorigin(*rorigin*)

set_rscale(**args*, ***kwargs*)

set_rticks(**args*, ***kwargs*)

set_theta_direction(*direction*)
Set the direction in which theta increases.

clockwise, -1: Theta increases in the clockwise direction

counterclockwise, anticlockwise, 1: Theta increases in the counterclockwise direction

set_theta_offset(*offset*)
Set the offset for the location of 0 in radians.

set_theta_zero_location(*loc*, *offset=0.0*)
Sets the location of theta's zero. (Calls set_theta_offset with the correct value in radians under the hood.)

loc [str] May be one of "N", "NW", "W", "SW", "S", "SE", "E", or "NE".

offset [float, optional] An offset in degrees to apply from the specified `loc`. **Note:** this offset is *always* applied counter-clockwise regardless of the direction setting.

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). e.g., 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance

Table 2 – continued from

Property	Description
clip_on	bool
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 Figure instance
fontproperties or font_properties	a matplotlib.font_manager.FontProperties instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object
linespacing	float (multiple of font size)
multialignment or ma	['left' | 'right' | 'center']
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large'
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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
url	a url string
usetex	bool or None
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
wrap	bool
x	float
y	float
zorder	float

ACCEPTS: sequence of floats

set_thetalim(**args*, ***kwargs*)

set_thetamax(*thetamax*)

set_thetamin(*thetamin*)

set_xscale(*scale*, **args*, ***kwargs*)
Set the x-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

See also:

matplotlib.scale.LinearScale linear transform

matplotlib.scale.LogTransform log transform

matplotlib.scale.SymmetricalLogTransform symlog transform

matplotlib.scale.LogisticTransform logit transform

Notes

Different kwargs are accepted, depending on the scale. See the *scale* module for more information.

set_yscale(**args*, ***kwargs*)
Set the y-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

See also:

matplotlib.scale.LinearScale linear transform

matplotlib.scale.LogTransform log transform

matplotlib.scale.SymmetricalLogTransform symlog transform

matplotlib.scale.LogisticTransform logit transform

Notes

Different kwargs are accepted, depending on the scale. See the *scale* module for more information.

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.

class matplotlib.projections.polar.**PolarTransform**(*axis=None*, *use_rmin=True*, *_apply_theta_transforms=True*)

Bases: *matplotlib.transforms.Transform*

The base polar transform. This handles projection *theta* and *r* into Cartesian coordinate space *x* and *y*, but does not perform the ultimate affine transformation into the correct position.

input_dims = 2

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))`

is_separable = False

output_dims = 2

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

transform_path_non_affine(*path*)

Returns a 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 matplotlib.projections.polar.**RadialAxis**(**args*, ***kwargs*)

Bases: *matplotlib.axis.YAxis*

A radial Axis.

This overrides certain properties of a `YAxis` to provide special-casing for a radial axis.

axis_name = 'radius'

cla()
clear the current axis

class matplotlib.projections.polar.**RadialLocator**(*base*, *axes=None*)
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.

autoscale()
autoscale the view limits

pan(*numsteps*)
Pan numticks (can be positive or negative)

refresh()
refresh internal information based on current lim

view_limits(*vmin*, *vmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

zoom(*direction*)
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

class matplotlib.projections.polar.**RadialTick**(*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*, *labelrotation=0*, *grid_color=None*, *grid_linestyle=None*, *grid_linewidth=None*, *grid_alpha=None*, ***kw*)
Bases: *matplotlib.axis.YTick*

A radial-axis tick.

This subclass of `YTick` provides radial ticks with some small modification to their re-positioning such that ticks are rotated based on axes limits. This results in ticks that are correctly perpendicular to the spine. Labels are also rotated to be perpendicular to the spine, when 'auto' rotation is enabled.

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

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

class matplotlib.projections.polar.**ThetaAxis**(*axes*, *pickradius=15*)
Bases: *matplotlib.axis.XAxis*

A theta Axis.

This overrides certain properties of an `XAxis` to provide special-casing for an angular axis.

Init the axis with the parent Axes instance

axis_name = 'theta'

cla()
clear the current axis

class matplotlib.projections.polar.**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.

class matplotlib.projections.polar.**ThetaLocator**(*base*)
Bases: *matplotlib.ticker.Locator*

Used to locate theta ticks.

This will work the same as the base locator except in the case that the view spans the entire circle. In such cases, the previously used default locations of every 45 degrees are returned.

autoscale()
autoscale the view limits

pan(*numsteps*)
Pan numticks (can be positive or negative)

refresh()
refresh internal information based on current lim

set_axis(*axis*)

view_limits(*vmin*, *vmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

zoom(*direction*)
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

class matplotlib.projections.polar.**ThetaTick**(*axes*, **args*, ***kwargs*)
Bases: *matplotlib.axis.XTick*

A theta-axis tick.

This subclass of `XTick` provides angular ticks with some small modification to their re-positioning such that ticks are rotated based on tick location. This results in ticks that are correctly perpendicular to the arc spine.

When 'auto' rotation is enabled, labels are also rotated to be parallel to the spine. The label padding is also applied here since it's not possible to use a generic axes transform to produce tick-specific padding.

update_position(*loc*)

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

CHAPTER

SIXTYONE

RCSETUP

61.1 matplotlib.rcsetup

The rcsetup module contains the default values and the validation code for customization using matplotlib's rc settings.

Each rc setting is assigned a default value and a function used to validate any attempted changes to that setting. The default values and validation functions are defined in the rcsetup module, and are used to construct the rcParams global object which stores the settings and is referenced throughout matplotlib.

These default values should be consistent with the default matplotlibrc file that actually reflects the values given here. Any additions or deletions to the parameter set listed here should also be visited to the `matplotlibrc.template` in matplotlib's root source directory.

class matplotlib.rcsetup.**ValidateInStrings**(*key*, *valid*, *ignorecase=False*)

Bases: object

valid is a list of legal strings

class matplotlib.rcsetup.**ValidateInterval**(*vmin*, *vmax*, *closedmin=True*, *closedmax=True*)

Bases: object

Value must be in interval

matplotlib.rcsetup.**cycler**(**args*, ***kwargs*)

Creates a Cycler object much like cycler.cycler(), but includes input validation.

Call signatures:

```
cycler(cycler)
cycler(label=values[, label2=values2[, ...]])
cycler(label, values)
```

Form 1 copies a given Cycler object.

Form 2 creates a Cycler which cycles over one or more properties simultaneously. If multiple properties are given, their value lists must have the same length.

Form 3 creates a Cycler for a single property. This form exists for compatibility with the original cycler. Its use is discouraged in favor of the kwarg form, i.e. `cycler(label=values)`.

Parameters

cycler [Cycler] Copy constructor for Cycler.

label [str] The property key. Must be a valid *Artist* property. For example, 'color' or 'linestyle'. Aliases are allowed, such as 'c' for 'color' and 'lw' for 'linewidth'.

values [iterable] Finite-length iterable of the property values. These values are validated and will raise a ValueError if invalid.

Returns

cycler [Cycler] A new Cycler for the given properties.

Examples

Creating a cycler for a single property:

```
>>> c = cycler(color=['red', 'green', 'blue'])
```

Creating a cycler for simultaneously cycling over multiple properties (e.g. red circle, green plus, blue cross):

```
>>> c = cycler(color=['red', 'green', 'blue'],
...            marker=['o', '+', 'x'])
```

matplotlib.rcsetup.**deprecate_axes_hold**(*value*)

matplotlib.rcsetup.**update_savefig_format**(*value*)

matplotlib.rcsetup.**validate_animation_writer_path**(*p*)

matplotlib.rcsetup.**validate_any**(*s*)

matplotlib.rcsetup.**validate_anylist**(*s*)

matplotlib.rcsetup.**validate_aspect**(*s*)

matplotlib.rcsetup.**validate_axisbelow**(*s*)

matplotlib.rcsetup.**validate_backend**(*s*)

matplotlib.rcsetup.**validate_bbox**(*s*)

matplotlib.rcsetup.**validate_bool**(*b*)
Convert b to a boolean or raise

matplotlib.rcsetup.**validate_bool_maybe_none**(*b*)
Convert b to a boolean or raise

matplotlib.rcsetup.**validate_capstylelist**(*s*)

matplotlib.rcsetup.**validate_color**(*s*)
return a valid color arg

matplotlib.rcsetup.**validate_color_for_prop_cycle**(*s*)

matplotlib.rcsetup.**validate_color_or_auto**(*s*)

matplotlib.rcsetup.**validate_color_or_inherit**(*s*)
return a valid color arg

matplotlib.rcsetup.**validate_colorlist**(*s*)
return a list of colorspecs

matplotlib.rcsetup.**validate_cycler**(*s*)
return a Cycler object from a string repr or the object itself

matplotlib.rcsetup.**validate_dashlist**(*s*)

matplotlib.rcsetup.**validate_dpi**(*s*)
confirm s is string 'figure' or convert s to float or raise

matplotlib.rcsetup.**validate_fillstylelist**(*s*)

matplotlib.rcsetup.**validate_float**(*s*)
convert s to float or raise

matplotlib.rcsetup.**validate_float_or_None**(*s*)
convert s to float, None or raise

matplotlib.rcsetup.**validate_floatlist**(*s*)
convert s to float or raise

matplotlib.rcsetup.**validate_font_properties**(*s*)

matplotlib.rcsetup.**validate_fontsize**(*s*)

matplotlib.rcsetup.**validate_fontsizelist**(*s*)

matplotlib.rcsetup.**validate_fonttype**(*s*)
confirm that this is a Postscript of PDF font type that we know how to convert to

matplotlib.rcsetup.**validate_hatch**(*s*)
Validate a hatch pattern. A hatch pattern string can have any sequence of the following characters: `\ / | - + * . x o O`.

matplotlib.rcsetup.**validate_hatchlist**(*s*)
Validate a hatch pattern. A hatch pattern string can have any sequence of the following characters: \ / | - + * . x o O.

matplotlib.rcsetup.**validate_hinting**(*s*)

matplotlib.rcsetup.**validate_hist_bins**(*s*)

matplotlib.rcsetup.**validate_int**(*s*)
convert s to int or raise

matplotlib.rcsetup.**validate_int_or_None**(*s*)
if not None, tries to validate as an int

matplotlib.rcsetup.**validate_joinstylelist**(*s*)

matplotlib.rcsetup.**validate_negative_linestyle**(*s*)
Deprecated since version 2.1: The validate_negative_linestyle function was deprecated in version 2.1. See 'validate_negative_linestyle_legacy' deprecation warning for more information.

matplotlib.rcsetup.**validate_negative_linestyle_legacy**(*s*)
Deprecated since version 2.1: The validate_negative_linestyle_legacy function was deprecated in version 2.1. The 'contour.negative_linestyle' rcParam now follows the same validation as the other rcParams that are related to line style.

class matplotlib.rcsetup.**validate_nseq_float**(*n=None*, *allow_none=False*)
Bases: object

class matplotlib.rcsetup.**validate_nseq_int**(*n=None*)
Bases: object

matplotlib.rcsetup.**validate_path_exists**(*s*)
If s is a path, return s, else False

matplotlib.rcsetup.**validate_ps_distiller**(*s*)

matplotlib.rcsetup.**validate_qt4**(*s*)

matplotlib.rcsetup.**validate_qt5**(*s*)

matplotlib.rcsetup.**validate_sketch**(*s*)

matplotlib.rcsetup.**validate_string**(*s*)

matplotlib.rcsetup.**validate_string_or_None**(*s*)
convert s to string or raise

matplotlib.rcsetup.**validate_stringlist**(*s*)
return a list

matplotlib.rcsetup.**validate_svg_fonttype**(*s*)

matplotlib.rcsetup.**validate_toolbar**(*s*)

matplotlib.rcsetup.**validate_webagg_address**(*s*)

matplotlib.rcsetup.**validate_whiskers**(*s*)

CHAPTER

SIXTYTWO

SANKEY

62.1 matplotlib.sankey

Module for creating Sankey diagrams using matplotlib

class matplotlib.sankey.**Sankey**(*ax=None*, *scale=1.0*, *unit=''*, *format='%G'*, *gap=0.25*, *radius=0.1*, *shoulder=0.03*, *offset=0.15*, *head_angle=100*, *margin=0.4*, *tolerance=1e-06*, ***kwargs*)

Bases: object

Sankey diagram in matplotlib

Sankey diagrams are a specific type of flow diagram, in which the width of the arrows is shown proportionally to the flow quantity. They are typically used to visualize energy or material or cost transfers between processes. Wikipedia (6/1/2011)

Create a new Sankey instance.

Optional keyword arguments:

Field	Description
ax	axes onto which the data should be plotted If *ax* isn't provided, new axes will be created.
scale	scaling factor for the flows *scale* sizes the width of the paths in order to maintain proper layout. The same scale is applied to all subdiagrams. The value should be chosen such that the product of the scale and the sum of the inputs is approximately 1.0 (and the product of the scale and the sum of the outputs is approximately -1.0).
unit	string representing the physical unit associated with the flow quantities If *unit* is None, then none of the quantities are labeled.
format	a Python number formatting string to be used in labeling the flow as a quantity (i.e., a number times a unit, where the unit is given)
gap	space between paths that break in/break away to/from the top or bottom
radius	inner radius of the vertical paths
shoulder	size of the shoulders of output arrowS
offset	text offset (from the dip or tip of the arrow)
head_angle	angle of the arrow heads (and negative of the angle of the tails) [deg]
margin	minimum space between Sankey outlines and the edge of the plot area
tolerance	acceptable maximum of the magnitude of the sum of flows The magnitude of the sum of connected flows cannot be greater than *tolerance*.

The optional arguments listed above are applied to all subdiagrams so that there is consistent alignment and formatting.

If `Sankey` is instantiated with any keyword arguments other than those explicitly listed above (`**kwargs`), they will be passed to `add()`, which will create the first subdiagram.

In order to draw a complex Sankey diagram, create an instance of `Sankey` by calling it without any kwargs:

```
sankey = Sankey()
```

Then add simple Sankey sub-diagrams:

```
sankey.add() # 1
sankey.add() # 2
#...
sankey.add() # n
```

Finally, create the full diagram:

```
sankey.finish()
```

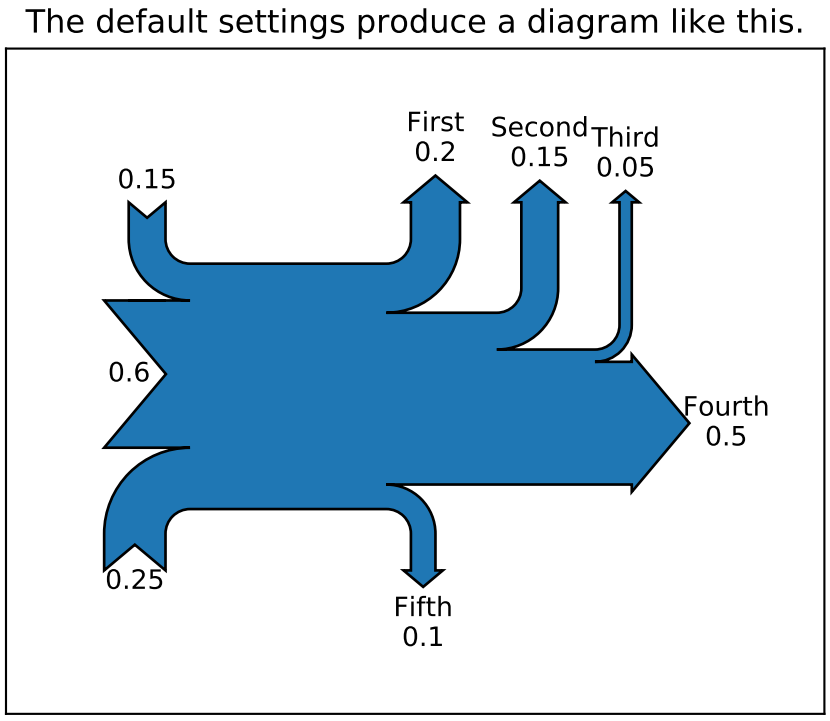
Or, instead, simply daisy-chain those calls:

```
Sankey().add().add...  .add().finish()
```

See also:

add() finish()

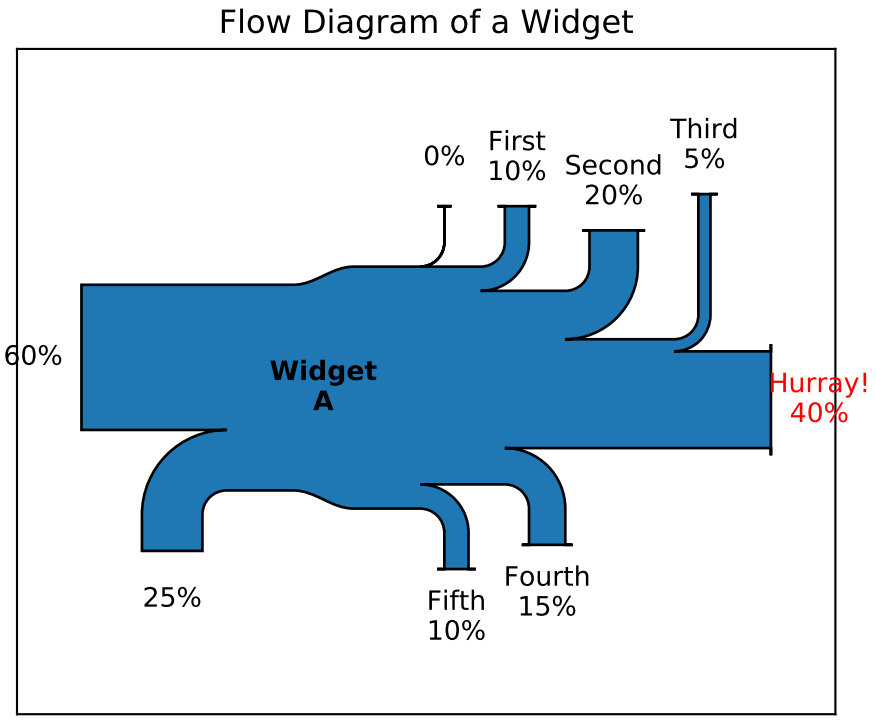
Examples:



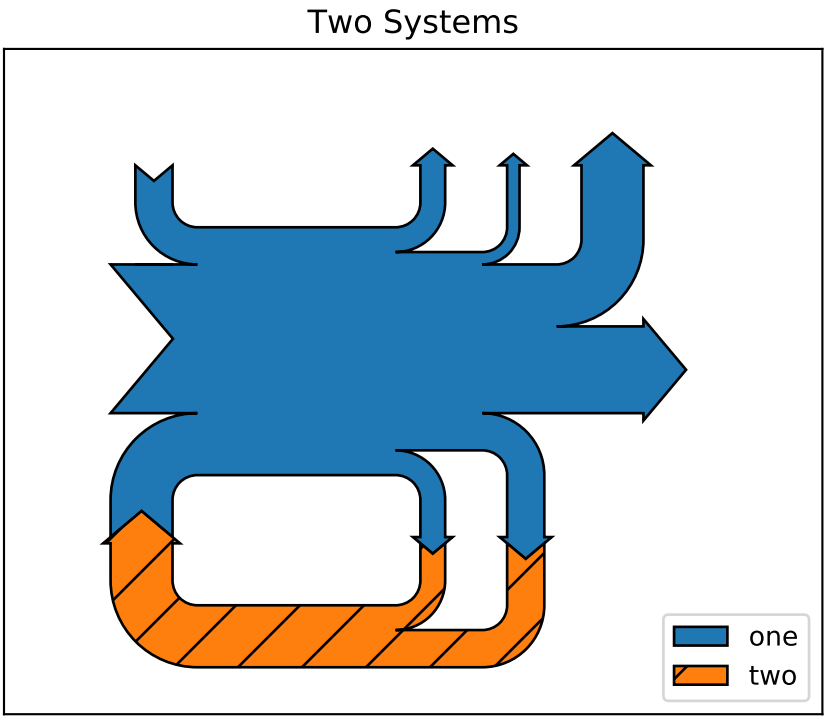
add(*patchlabel=''*, *flows=None*, *orientations=None*, *labels=''*, *trunklength=1.0*, *pathlengths=0.25*, *prior=None*, *connect=(0, 0)*, *rotation=0*, ***kwargs*)
Add a simple Sankey diagram with flows at the same hierarchical level.

Return value is the instance of *Sankey*.

Optional keyword arguments:



Keyword	Description
patchlabel	label to be placed at the center of the diagram Note: *label* (not *patchlabel*) will be passed to the patch through `**kwargs` and can be used to create an entry in the legend.
flows	array of flow values By convention, inputs are positive and outputs are negative.
orientations	list of orientations of the paths Valid values are 1 (from/to the top), 0 (from/to the left or right), or -1 (from/to the bottom). If *orientations* == 0, inputs will break in from the left and outputs will break away to the right.
labels	list of specifications of the labels for the flows Each value may be *None* (no labels), '' (just label the quantities), or a labeling string. If a single value is provided, it will be applied to all flows. If an entry is a non-empty string, then the quantity for the corresponding flow will be shown below the string. However, if the *unit* of the main diagram is None, then quantities are never shown, regardless of the value of this argument.
trunklength	length between the bases of the input and output groups
pathlengths	list of lengths of the arrows before break-in or after break-away If a single value is given, then it will be applied to the first (inside) paths on the top and bottom, and the length of all other arrows will be justified accordingly. The *pathlengths* are not applied to the horizontal inputs and outputs.
prior	index of the prior diagram to which this diagram should be connected
connect	a (prior, this) tuple indexing the flow of the prior diagram and the flow of this diagram which should be connected If this is the first diagram or *prior* is



Valid kwargs are *matplotlib.patches.PathPatch()* arguments:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

As examples, `fill=False` and `label='A legend entry'`. By default, `facecolor='#bfd1d4'` (light blue) and `linewidth=0.5`.

The indexing parameters (*prior* and *connect*) are zero-based.

The flows are placed along the top of the diagram from the inside out in order of their index within the *flows* list or array. They are placed along the sides of the diagram from the top down and along the bottom from the outside in.

If the sum of the inputs and outputs is nonzero, the discrepancy will appear as a cubic Bezier

curve along the top and bottom edges of the trunk.

See also:

finish()

finish()

Adjust the axes and return a list of information about the Sankey subdiagram(s).

Return value is a list of subdiagrams represented with the following fields:

Field	Description
patch	Sankey outline (an instance of `PathPatch`)
flows	values of the flows (positive for input, negative for output)
angles	list of angles of the arrows [deg/90] For example, if the diagram has not been rotated, an input to the top side will have an angle of 3 (DOWN), and an output from the top side will have an angle of 1 (UP). If a flow has been skipped (because its magnitude is less than *tolerance*), then its angle will be *None*.
tips	array in which each row is an [x, y] pair indicating the positions of the tips (or "dips") of the flow paths If the magnitude of a flow is less the *tolerance* for the instance of *Sankey*, the flow is skipped and its tip will be at the center of the diagram.
text	*Text* instance for the label of the diagram
texts	list of *Text* instances for the labels of flows

See also:

add()

CHAPTER

SIXTYTHREE

SCALE

63.1 matplotlib.scale

class matplotlib.scale.**InvertedLog10Transform**(*shorthand_name=None*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

Creates a new TransformNode.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

base = 10.0

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))`

class matplotlib.scale.**InvertedLog2Transform**(*shorthand_name=None*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

Creates a new TransformNode.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

base = 2.0

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))`

class matplotlib.scale.**InvertedLogTransform**(*base*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

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))`

class matplotlib.scale.**InvertedLogTransformBase**(*shorthand_name=None*)

Bases: *matplotlib.transforms.Transform*

Creates a new `TransformNode`.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

has_inverse = True

input_dims = 1

is_separable = True

output_dims = 1

transform_non_affine(*a*)

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class matplotlib.scale.**InvertedNaturalLogTransform**(*shorthand_name=None*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

Creates a new `TransformNode`.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

base = 2.718281828459045

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))`

class matplotlib.scale.**InvertedSymmetricalLogTransform**(*base*, *linthresh*, *linscale*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))`

is_separable = True

output_dims = 1

transform_non_affine(*a*)
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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class matplotlib.scale.**LinearScale**(*axis*, ***kwargs*)
Bases: *matplotlib.scale.ScaleBase*

The default linear scale.

get_transform()
The transform for linear scaling is just the *IdentityTransform*.

name = 'linear'

set_default_locators_and_formatters(*axis*)
Set the locators and formatters to reasonable defaults for linear scaling.

class matplotlib.scale.**Log10Transform**(*nonpos='clip'*)
Bases: *matplotlib.scale.LogTransformBase*

base = 10.0

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))`

class matplotlib.scale.**Log2Transform**(*nonpos='clip'*)
Bases: *matplotlib.scale.LogTransformBase*

base = 2.0

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))`

class matplotlib.scale.**LogScale**(*axis*, ***kwargs*)
Bases: *matplotlib.scale.ScaleBase*

A standard logarithmic scale. Care is taken so non-positive values are not plotted.

For computational efficiency (to push as much as possible to Numpy C code in the common cases), this scale provides different transforms depending on the base of the logarithm:

- base 10 (*Log10Transform*)
- base 2 (*Log2Transform*)
- base e (*NaturalLogTransform*)
- arbitrary base (*LogTransform*)

***basex/basey*:** The base of the logarithm

***nonposx/nonposy*: ['mask' | 'clip']** non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

class InvertedLog10Transform(*shorthand_name=None*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

Creates a new `TransformNode`.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

base = 10.0

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))`

class InvertedLog2Transform(*shorthand_name=None*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

Creates a new `TransformNode`.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

base = 2.0

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))`

class InvertedLogTransform(*base*)

Bases: *matplotlib.scale.InvertedLogTransformBase*

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))

class InvertedNaturalLogTransform(*shorthand_name=None*)
Bases: matplotlib.scale.InvertedLogTransformBase

Creates a new TransformNode.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of str(transform) when DEBUG=True.

base = 2.718281828459045

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))

class Log10Transform(*nonpos='clip'*)
Bases: matplotlib.scale.LogTransformBase

base = 10.0

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))

class Log2Transform(*nonpos='clip'*)
Bases: matplotlib.scale.LogTransformBase

base = 2.0

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))

class LogTransform(*base*, *nonpos='clip'*)
Bases: matplotlib.scale.LogTransformBase

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))`

class LogTransformBase(*nonpos='clip'*)

Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

is_separable = True

output_dims = 1

transform_non_affine(*a*)

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class NaturalLogTransform(*nonpos='clip'*)

Bases: *matplotlib.scale.LogTransformBase*

base = 2.718281828459045

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))`

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.

name = 'log'

set_default_locators_and_formatters(*axis*)
Set the locators and formatters to specialized versions for log scaling.

class matplotlib.scale.**LogTransform**(*base*, *nonpos='clip'*)
Bases: *matplotlib.scale.LogTransformBase*

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))`

class matplotlib.scale.**LogTransformBase**(*nonpos='clip'*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

is_separable = True

output_dims = 1

transform_non_affine(*a*)
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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class matplotlib.scale.**LogisticTransform**(*nonpos='mask'*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))

is_separable = True

output_dims = 1

transform_non_affine(*a*)
logistic transform (base 10)

class matplotlib.scale.**LogitScale**(*axis*, *nonpos='mask'*)
Bases: *matplotlib.scale.ScaleBase*

Logit scale for data between zero and one, both excluded.

This scale is similar to a log scale close to zero and to one, and almost linear around 0.5. It maps the interval]0, 1[onto]-infty, +infty[.

***nonpos*: ['mask' | 'clip']** values beyond]0, 1[can be masked as invalid, or clipped to a number very close to 0 or 1

get_transform()
Return a *LogitTransform* instance.

limit_range_for_scale(*vmin*, *vmax*, *minpos*)
Limit the domain to values between 0 and 1 (excluded).

name = 'logit'

set_default_locators_and_formatters(*axis*)
Set the *Locator* and *Formatter* objects on the given axis to match this scale.

class matplotlib.scale.**LogitTransform**(*nonpos='mask'*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))

is_separable = True

output_dims = 1

transform_non_affine(*a*)
logit transform (base 10), masked or clipped

class matplotlib.scale.**NaturalLogTransform**(*nonpos='clip'*)
Bases: *matplotlib.scale.LogTransformBase*

base = 2.718281828459045

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))`

class matplotlib.scale.**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()*
- *set_default_locators_and_formatters()*

And optionally:

- *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 matplotlib.scale.**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*:** A single float which defines the range (-*x*, *x*), within which the plot is linear. This avoids having the plot go to infinity around zero.

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

***linscalex/linscaley*:** This allows the linear range (*-linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

class InvertedSymmetricalLogTransform(*base*, *linthresh*, *linscale*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))`

is_separable = True

output_dims = 1

transform_non_affine(*a*)
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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class SymmetricalLogTransform(*base*, *linthresh*, *linscale*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))`

is_separable = True

output_dims = 1

transform_non_affine(*a*)
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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

get_transform()
Return a *SymmetricalLogTransform* instance.

name = 'symlog'

set_default_locators_and_formatters(*axis*)
Set the locators and formatters to specialized versions for symmetrical log scaling.

class matplotlib.scale.**SymmetricalLogTransform**(*base*, *linthresh*, *linscale*)
Bases: *matplotlib.transforms.Transform*

has_inverse = True

input_dims = 1

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))`

is_separable = True

output_dims = 1

transform_non_affine(*a*)

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

matplotlib.scale.**get_scale_docs**()

Helper function for generating docstrings related to scales.

matplotlib.scale.**get_scale_names**()

matplotlib.scale.**register_scale**(*scale_class*)

Register a new kind of scale.

scale_class must be a subclass of *ScaleBase*.

matplotlib.scale.**scale_factory**(*scale*, *axis*, ***kwargs*)

Return a scale class by name.

ACCEPTS: [linear | log | logit | symlog]

CHAPTER

SIXTYFOUR

SPINES

64.1 matplotlib.spines

class matplotlib.spines.**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:*set_position* for more information.

The default position is `('outward',0)`.

Spines are subclasses of class:*Patch*, and inherit much of their behavior.

Spines draw a line, a circle, or an arc depending if function:*set_patch_line*, function:*set_patch_circle*, or function:*set_patch_arc* 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

classmethod arc_spine(*axes*, *spine_type*, *center*, *radius*, *theta1*, *theta2*, ***kwargs*)
(classmethod) Returns an arc *Spine*.

classmethod circular_spine(*axes*, *center*, *radius*, ***kwargs*)
(staticmethod) Returns a circular *Spine*.

cla()
Clear the current spine

draw(*renderer*)

Draw the Patch to the given *renderer*.

get_bounds()
Get the bounds of the spine.

get_patch_transform()
Return the *Transform* instance which takes patch coordinates to data coordinates.

For example, one may define a patch of a circle which represents a radius of 5 by providing coordinates for a unit circle, and a transform which scales the coordinates (the patch coordinate) by 5.

get_path()
Return the path of this patch

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.

classmethod 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_arc(*center*, *radius*, *theta1*, *theta2*)
set the spine to be arc-like

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

SIXTYFIVE

STYLE

65.1 matplotlib.style

matplotlib.style.**context**(*style*, *after_reset=False*)
Context manager for using style settings temporarily.

Parameters

style [str, dict, or list] A style specification. Valid options are:

str	The name of a style or a path/URL to a style file. For a list of available style names, see `style.available`.
dict	Dictionary with valid key/value pairs for *matplotlib.rcParams*.
list	A list of style specifiers (str or dict) applied from first to last in the list.

after_reset [bool] If True, apply style after resetting settings to their defaults; otherwise, apply style on top of the current settings.

matplotlib.style.**reload_library**()
Reload style library.

matplotlib.style.**use**(*style*)
Use matplotlib style settings from a style specification.

The style name of 'default' is reserved for reverting back to the default style settings.

Parameters

style [str, dict, or list] A style specification. Valid options are:

str	The name of a style or a path/URL to a style file. For a list of available style names, see `style.available`.
dict	Dictionary with valid key/value pairs for *matplotlib.rcParams*.
list	A list of style specifiers (str or dict) applied from first to last in the list.

matplotlib.style.**library**
Dictionary of available styles

matplotlib.style.**available**
List of available styles

CHAPTER

SIXTYSIX

TABLE

66.1 matplotlib.table

Place a table below the x-axis at location loc.

The table consists of a grid of cells.

The grid need not be rectangular and can have holes.

Cells are added by specifying their row and column.

For the purposes of positioning the cell at (0, 0) is assumed to be at the top left and the cell at (max_row, max_col) is assumed to be at bottom right.

You can add additional cells outside this range to have convenient ways of positioning more interesting grids.

Author : John Gill <jng@europe.renre.com> Copyright : 2004 John Gill and John Hunter License : matplotlib license

class matplotlib.table.**Cell**(*xy*, *width*, *height*, *edgecolor='k'*, *facecolor='w'*, *fill=True*, *text=''*, *loc=None*, *fontproperties=None*)

Bases: *matplotlib.patches.Rectangle*

A cell is a Rectangle with some associated text.

PAD = 0.1

auto_set_font_size(*renderer*)
Shrink font size until text fits.

draw(*renderer*)
Draw the Patch to the given *renderer*.

get_fontsize()
Return the cell fontsize

get_required_width(*renderer*)
Get width required for this cell.

get_text()
Return the cell Text intance

get_text_bounds(*renderer*)
Get text bounds in axes co-ordinates.

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

set_fontsize(*size*)

set_text_props(***kwargs*)
update the text properties with kwargs

set_transform(*trans*)
Set the artist transform.

Parameters

t [*Transform*]

class matplotlib.table.**CustomCell**(**args*, ***kwargs*)
Bases: *matplotlib.table.Cell*

A subclass of Cell where the sides may be visibly toggled.

get_path()
Return a path where the edges specified by _visible_edges are drawn

visible_edges

class matplotlib.table.**Table**(*ax*, *loc=None*, *bbox=None*, ***kwargs*)
Bases: *matplotlib.artist.Artist*

Create a table of cells.

Table can have (optional) row and column headers.

Each entry in the table can be either text or patches.

Column widths and row heights for the table can be specified.

Return value is a sequence of text, line and patch instances that make up the table

AXESPAD = 0.02

FONTSIZE = 10

add_cell(*row*, *col*, **args*, ***kwargs*)
Add a cell to the table.

Parameters

row [int] Row index

col [int] Column index

Returns

'CustomCell': Automatically created cell

auto_set_column_width(*col*)

Given column indexs in either List, Tuple or int. Will be able to automatically set the columns into optimal sizes.

Here is the example of the input, which triger automatic adjustment on columns to optimal size by given index numbers. -1: the row labling 0: the 1st column 1: the 2nd column

Args: col(List): list of indexs >>>table.auto_set_column_width([-1,0,1])

col(Tuple): tuple of indexs >>>table.auto_set_column_width((-1,0,1))

col(int): index integer >>>table.auto_set_column_width(-1) >>>table.auto_set_column_width(0) >>>table.auto_set_column_width(1)

auto_set_font_size(*value=True*)

Automatically set font size.

codes = {'best': 0, 'bottom': 17, 'bottom left': 12, 'bottom right': 13, 'center': 9,

contains(*mouseevent*)

Test whether the mouse event occurred in the table.

Returns T/F, {}

draw(*renderer*)

Derived classes drawing method

edges

get_celld()

return a dict of cells in the table

get_child_artists()

Return the Artists contained by the table

get_children()

Return the Artists contained by the table

get_window_extent(*renderer*)

Return the bounding box of the table in window coords

scale(*xscale*, *yscale*)

Scale column widths by xscale and row heights by yscale.

set_fontsize(*size*)

Set the fontsize of the cell text

ACCEPTS: a float in points

matplotlib.table.**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*, *edges='closed'*)

Factory function to generate a Table instance.

Thanks to John Gill for providing the class and table.

CHAPTER

SIXTYSEVEN

TEXT

67.1 matplotlib.text

Classes for including text in a figure.

class matplotlib.text.**Annotation**(*s*, *xy*, *xytext=None*, *xycoords='data'*, *textcoords=None*, *arrowprops=None*, *annotation_clip=None*, ***kwargs*)

Bases: *matplotlib.text.Text*, matplotlib.text._AnnotationBase

Annotate the point `xy` with text `s`.

Additional kwargs are passed to *Text*.

Parameters

s [str] The text of the annotation

xy [iterable] Length 2 sequence specifying the *(x,y)* point to annotate

xytext [iterable, optional] Length 2 sequence specifying the *(x,y)* to place the text at. If None, defaults to `xy`.

xycoords [str, Artist, Transform, callable or tuple, optional] The coordinate system that `xy` is given in.

For a `str` the allowed values are:

Property	Description
'figure points'	points from the lower left of the figure
'figure pixels'	pixels from the lower left of the figure
'figure fraction'	fraction of figure from lower left
'axes points'	points from lower left corner of axes
'axes pixels'	pixels from lower left corner of axes
'axes fraction'	fraction of axes from lower left
'data'	use the coordinate system of the object being annotated (default)
'polar'	*(theta,r)* if not native 'data' coordinates

If a *Artist* object is passed in the units are fraction if it's bounding box.

If a *Transform* object is passed in use that to transform `xy` to screen coordinates

If a callable it must take a *RendererBase* object as input and return a *Transform* or *Bbox* object

If a `tuple` must be length 2 tuple of str, `Artist`, `Transform` or callable objects. The first transform is used for the *x* coordinate and the second for *y*.

See *Advanced Annotation* for more details.

Defaults to `'data'`

textcoords [str, `Artist`, `Transform`, callable or tuple, optional] The coordinate system that `xytext` is given, which may be different than the coordinate system used for `xy`.

All `xycoords` values are valid as well as the following strings:

Property	Description
'offset points'	offset (in points) from the *xy* value
'offset pixels'	offset (in pixels) from the *xy* value

defaults to the input of `xycoords`

arrowprops [dict, optional] If not None, properties used to draw a *FancyArrowPatch* arrow between `xy` and `xytext`.

If `arrowprops` does not contain the key `'arrowstyle'` the allowed keys are:

Key	Description
width	the width of the arrow in points
headwidth	the width of the base of the arrow head in points
headlength	the length of the arrow head in points
shrink	fraction of total length to 'shrink' from both ends
?	any key to *matplotlib.patches.FancyArrowPatch*

If the `arrowprops` contains the key `'arrowstyle'` the above keys are forbidden. The allowed values of `'arrowstyle'` are:

Name	Attrs
'-'	None
'->'	head_length=0.4,head_width=0.2
'-['	widthB=1.0,lengthB=0.2,angleB=None
'|-|'	widthA=1.0,widthB=1.0
'-|>'	head_length=0.4,head_width=0.2
'<-'	head_length=0.4,head_width=0.2
'<->'	head_length=0.4,head_width=0.2
'<|-'	head_length=0.4,head_width=0.2
'<|-|>'	head_length=0.4,head_width=0.2
'fancy'	head_length=0.4,head_width=0.4,tail_width=0.4
'simple'	head_length=0.5,head_width=0.5,tail_width=0.2
'wedge'	tail_width=0.3,shrink_factor=0.5

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*

Defaults to None

annotation_clip [bool, optional] Controls the visibility of the annotation when it goes outside the axes area.

If `True`, the annotation will only be drawn when the `xy` is inside the axes. If `False`, the annotation will always be drawn regardless of its position.

The default is `None`, which behave as `True` only if *xycoords* is "data".

Returns

Annotation

anncoords

contains(*event*)

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(*renderer*)
Draw the *Annotation* object to the given *renderer*.

get_window_extent(*renderer=None*)
Return a *Bbox* object bounding the text and arrow annotation, in display units.

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. The *dpi* used defaults to self.figure.dpi; the renderer dpi is irrelevant.

set_figure(*fig*)
Set the *Figure* instance the artist belongs to.

Parameters

fig [*Figure*]

update_positions(*renderer*)
"Update the pixel positions of the annotated point and the text.

xyann

class matplotlib.text.**OffsetFrom**(*artist*, *ref_coord*, *unit='points'*)
Bases: object

Callable helper class for working with *Annotation*

Parameters

artist [Artist, BboxBase, or Transform] The object to compute the offset from.

ref_coord [length 2 sequence] If artist is an Artist or BboxBase, this values is the location to of the offset origin in fractions of the artist bounding box.

If artist is a transform, the offset origin is the transform applied to this value.

unit [{'points, 'pixels'}] The screen units to use (pixels or points) for the offset input.

get_unit()
The unit for input to the transform used by __call__

set_unit(*unit*)
The unit for input to the transform used by __call__

Parameters

unit [{'points', 'pixels'}]

class matplotlib.text.**Text**(*x=0*, *y=0*, *text=''*, *color=None*, *verticalalignment='baseline'*, *horizontalalignment='left'*, *multialignment=None*, *fontproperties=None*, *rotation=None*, *linespacing=None*, *rotation_mode=None*, *usetex=None*, *wrap=False*, ***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	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance
clip_on	bool
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 *Figure* instance
fontproperties or font_properties	a *matplotlib.font_manager.FontProperties* instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object
linespacing	float (multiple of font size)
multialignment or ma	['left' | 'right' | 'center']
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large'
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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*
url	a url string
usetex	bool or None
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
wrap	bool
x	float

Table 1 – continued from

Property	Description
y	float
zorder	float

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(*renderer*)
Draws the *Text* object to the given *renderer*.

get_bbox_patch()
Return the bbox Patch object. Returns None if 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_position()
Return the position of the text as a tuple (*x*, *y*)

get_prop_tup(*renderer=None*)
Return a hashable tuple of properties.

Not intended to be human readable, but useful for backends who want to cache derived information about text (e.g., 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_unitless_position()
Return the unitless position of the text as a tuple (*x*, *y*)

get_usetex()
Return whether this *Text* object uses TeX for rendering.

If the user has not manually set this value, it defaults to `rcParams["text.usetex"]`.

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.

get_wrap()
Returns the wrapping state for the text.

static is_math_text(*s*, *usetex=None*)
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 FancyBboxPatch, e.g., facecolor='red', alpha=0.5.

t.set_bbox(dict(facecolor='red', alpha=0.5))

The default boxstyle is 'square'. The mutation scale of the FancyBboxPatch is set to the fontsize.

ACCEPTS: FancyBboxPatch prop dict

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.

When False, artists will be visible outside of the axes, which can lead to unexpected results.

Parameters

b [bool]

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_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_multialignment

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_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.

Parameters

m [None or "default" or "anchor"] If None or "default", the text will be first rotated, then aligned according to their horizontal and vertical alignments. If "anchor", then alignment occurs before rotation.

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_usetex(*usetex*)

Parameters

usetex [bool or None] Whether to render using TeX, None means to use rcParams["text.usetex"].

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_wrap(*wrap*)
Sets the wrapping state for the text.

Parameters

wrap [bool]

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(*kwargs*)
Update properties from a dictionary.

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

zorder = 3

class matplotlib.text.**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(*renderer=None*)
Return a hashable tuple of properties.

Not intended to be human readable, but useful for backends who want to cache derived information about text (e.g., layouts) and need to know if the text has changed.

get_unitless_position()
Return the unitless position of the text as a tuple (*x*, *y*)

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.

matplotlib.text.**get_rotation**(*rotation*)
Return the text angle as float. The returned angle is between 0 and 360 deg.

rotation may be 'horizontal', 'vertical', or a numeric value in degrees.

CHAPTER

SIXTYEIGHT

TICKER

68.1 matplotlib.ticker

68.1.1 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.

Default Formatter

The default formatter identifies when the x-data being plotted is a small range on top of a large off set. To reduce the chances that the ticklabels overlap the ticks are labeled as deltas from a fixed offset. For example:

```
ax.plot(np.arange(2000, 2010), range(10))
```

will have tick of 0-9 with an offset of +2e3. If this is not desired turn off the use of the offset on the default formatter:

```
ax.get_xaxis().get_major_formatter().set_useOffset(False)
```

set the rcParam `axes.formatter.useoffset=False` to turn it off globally, or set a different formatter.

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*. It is initialized with a base, e.g., 10, and it picks axis limits and ticks that are multiples of that base.

The Locator subclasses defined here are

AutoLocator *MaxNLocator* with simple defaults. This is the default tick locator for most plotting.

MaxNLocator Finds up to a max number of intervals with ticks at nice locations.

LinearLocator Space ticks evenly from min to max.

LogLocator Space ticks logarithmically from min to max.

MultipleLocator Ticks and range are a multiple of base; either integer or float.

FixedLocator Tick locations are fixed.

IndexLocator Locator for index plots (e.g., where `x = range(len(y))`).

NullLocator No ticks.

SymmetricalLogLocator Locator for use with with the symlog norm; works like *LogLocator* for the part outside of the threshold and adds 0 if inside the limits.

LogitLocator Locator for logit scaling.

OldAutoLocator Choose a *MultipleLocator* and dynamically reassign it for intelligent ticking during navigation.

AutoMinorLocator Locator for minor ticks when the axis is linear and the major ticks are uniformly spaced. Subdivides the major tick interval into a specified number of minor intervals, defaulting to 4 or 5 depending on the major interval.

There are a number of locators specialized for date locations - see the `dates` module.

You can define your own locator by deriving from Locator. You must override the `__call__` method, which returns a sequence of locations, and you will probably want to override the autoscale method to set the view limits from the data limits.

If you want to override the default locator, use one of the above or a custom locator and pass it to the x or y axis instance. The relevant methods are:

```
ax.xaxis.set_major_locator(xmajor_locator)
ax.xaxis.set_minor_locator(xminor_locator)
ax.yaxis.set_major_locator(ymajor_locator)
ax.yaxis.set_minor_locator(yminor_locator)
```

The default minor locator is *NullLocator*, i.e., 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.

StrMethodFormatter Use string `format` method.

FormatStrFormatter Use an old-style sprintf format string.

ScalarFormatter Default formatter for scalars: autopick the format string.

LogFormatter Formatter for log axes.

LogFormatterExponent Format values for log axis using `exponent = log_base(value)`.

LogFormatterMathtext Format values for log axis using `exponent = log_base(value)` using Math text.

LogFormatterSciNotation Format values for log axis using scientific notation.

LogitFormatter Probability formatter.

EngFormatter Format labels in engineering notation

PercentFormatter Format labels as a percentage

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(xmajor_formatter)
ax.xaxis.set_minor_formatter(xminor_formatter)
ax.yaxis.set_major_formatter(ymajor_formatter)
ax.yaxis.set_minor_formatter(ymajor_formatter)
```

See /gallery/ticks_and_spines/major_minor_demo for an example of setting major and minor ticks. See the *matplotlib.dates* module for more information and examples of using date locators and formatters.

class matplotlib.ticker.**TickHelper**

Bases: object

axis = None

create_dummy_axis(***kwargs*)

set_axis(*axis*)

set_bounds(*vmin*, *vmax*)

set_data_interval(*vmin*, *vmax*)

set_view_interval(*vmin*, *vmax*)

class matplotlib.ticker.**Formatter**

Bases: *matplotlib.ticker.TickHelper*

Create a string based on a tick value and location.

fix_minus(*s*)
Some classes may want to replace a hyphen for minus with the proper unicode symbol (U+2212) for typographical correctness. The default is to not replace it.

Note, if you use this method, e.g., in *format_data()* or call, you probably don't want to use it for *format_data_short()* since the toolbar uses this for interactive coord reporting and I doubt we can expect GUIs across platforms will handle the unicode correctly. So for now the classes that override *fix_minus()* should have an explicit *format_data_short()* method

format_data(*value*)
Returns the full string representation of the value with the position unspecified.

format_data_short(*value*)
Return a short string version of the tick value.

Defaults to the position-independent long value.

get_offset()

locs = []

set_locs(*locs*)

class matplotlib.ticker.**FixedFormatter**(*seq*)
Bases: *matplotlib.ticker.Formatter*

Return fixed strings for tick labels based only on position, not value.

Set the sequence of strings that will be used for labels.

get_offset()

set_offset_string(*ofs*)

class matplotlib.ticker.**NullFormatter**
Bases: *matplotlib.ticker.Formatter*

Always return the empty string.

class matplotlib.ticker.**FuncFormatter**(*func*)
Bases: *matplotlib.ticker.Formatter*

Use a user-defined function for formatting.

The function should take in two inputs (a tick value `x` and a position `pos`), and return a string containing the corresponding tick label.

class matplotlib.ticker.**FormatStrFormatter**(*fmt*)
Bases: *matplotlib.ticker.Formatter*

Use an old-style ('%' operator) format string to format the tick.

The format string should have a single variable format (%) in it. It will be applied to the value (not the position) of the tick.

class matplotlib.ticker.**StrMethodFormatter**(*fmt*)

Bases: *matplotlib.ticker.Formatter*

Use a new-style format string (as used by `str.format()`) to format the tick.

The field used for the value must be labeled `x` and the field used for the position must be labeled `pos`.

class matplotlib.ticker.**ScalarFormatter**(*useOffset=None*, *useMathText=None*, *useLocale=None*)

Bases: *matplotlib.ticker.Formatter*

Format tick values as a number.

Tick value is interpreted as 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*)

Replace hyphens with a unicode minus.

format_data(*value*)

Return a formatted string representation of a number.

format_data_short(*value*)

Return a short formatted string representation of a number.

get_offset()

Return scientific notation, plus offset.

get_useLocale()

get_useMathText()

get_useOffset()

pprint_val(*x*)

set_locs(*locs*)

Set the locations of the ticks.

set_powerlimits(*lims*)

Sets size thresholds for scientific notation.

Parameters

lims [(min_exp, max_exp)] A tuple containing the powers of 10 that determine the switchover threshold. Numbers below `10**min_exp` and above `10**max_exp` will be displayed in scientific notation.

For example, `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.

.. seealso:: Method :meth:'set_scientific'

`set_scientific`(*b*)
Turn scientific notation on or off.

See also:

Method *set_powerlimits()*

`set_useLocale`(*val*)

`set_useMathText`(*val*)

`set_useOffset`(*val*)

`useLocale`

`useMathText`

`useOffset`

`class matplotlib.ticker.LogFormatter`(*base=10.0*, *labelOnlyBase=False*, *minor_thresholds=None*, *linthresh=None*)
Bases: *matplotlib.ticker.Formatter*

Base class for formatting ticks on a log or symlog scale.

It may be instantiated directly, or subclassed.

Parameters

base [float, optional, default: 10.] Base of the logarithm used in all calculations.

labelOnlyBase [bool, optional, default: False] If True, label ticks only at integer powers of base. This is normally True for major ticks and False for minor ticks.

minor_thresholds [(subset, all), optional, default: (1, 0.4)] If labelOnlyBase is False, these two numbers control the labeling of ticks that are not at integer powers of base; normally these are the minor ticks. The controlling parameter is the log of the axis data range. In the typical case where base is 10 it is the number of decades spanned by the axis, so we can call it 'numdec'. If `numdec <= all`, all minor ticks will be labeled. If `all < numdec <= subset`, then only a subset of minor ticks will be labeled, so as to avoid crowding. If `numdec > subset` then no minor ticks will be labeled.

linthresh [None or float, optional, default: None] If a symmetric log scale is in use, its `linthresh` parameter must be supplied here.

Notes

The *set_locs* method must be called to enable the subsetting logic controlled by the `minor_thresholds` parameter.

In some cases such as the colorbar, there is no distinction between major and minor ticks; the tick locations might be set manually, or by a locator that puts ticks at integer powers of base and at intermediate locations. For this situation, disable the minor_thresholds logic by using `minor_thresholds=(np.inf, np.inf)`, so that all ticks will be labeled.

To disable labeling of minor ticks when 'labelOnlyBase' is False, use `minor_thresholds=(0, 0)`. This is the default for the "classic" style.

Examples

To label a subset of minor ticks when the view limits span up to 2 decades, and all of the ticks when zoomed in to 0.5 decades or less, use `minor_thresholds=(2, 0.5)`.

To label all minor ticks when the view limits span up to 1.5 decades, use `minor_thresholds=(1.5, 1.5)`.

base(*base*)
Change the *base* for labeling.

> **Warning:** Should always match the base used for *LogLocator*

format_data(*value*)
Returns the full string representation of the value with the position unspecified.

format_data_short(*value*)
Return a short formatted string representation of a number.

label_minor(*labelOnlyBase*)
Switch minor tick labeling on or off.

Parameters

labelOnlyBase [bool] If True, label ticks only at integer powers of base.

pprint_val(*x*, *d*)

set_locs(*locs=None*)
Use axis view limits to control which ticks are labeled.

The *locs* parameter is ignored in the present algorithm.

class matplotlib.ticker.**LogFormatterExponent**(*base=10.0*, *labelOnlyBase=False*, *minor_thresholds=None*, *linthresh=None*)
Bases: *matplotlib.ticker.LogFormatter*

Format values for log axis using `exponent = log_base(value)`.

class matplotlib.ticker.**LogFormatterMathtext**(*base=10.0*, *labelOnlyBase=False*, *minor_thresholds=None*, *linthresh=None*)

Bases: *matplotlib.ticker.LogFormatter*

Format values for log axis using `exponent = log_base(value)`.

class matplotlib.ticker.**IndexFormatter**(*labels*)

Bases: *matplotlib.ticker.Formatter*

Format the position x to the nearest i-th label where i=int(x+0.5)

class matplotlib.ticker.**LogFormatterSciNotation**(*base=10.0*, *labelOnlyBase=False*, *minor_thresholds=None*, *linthresh=None*)

Bases: *matplotlib.ticker.LogFormatterMathtext*

Format values following scientific notation in a logarithmic axis.

class matplotlib.ticker.**LogitFormatter**

Bases: *matplotlib.ticker.Formatter*

Probability formatter (using Math text).

format_data_short(*value*)

return a short formatted string representation of a number

class matplotlib.ticker.**EngFormatter**(*unit=''*, *places=None*, *sep=' '*)

Bases: *matplotlib.ticker.Formatter*

Formats axis values using engineering prefixes to represent powers of 1000, plus a specified unit, e.g., 10 MHz instead of 1e7.

Parameters

unit [str (default: "")] Unit symbol to use, suitable for use with single-letter representations of powers of 1000. For example, 'Hz' or 'm'.

places [int (default: None)] Precision with which to display the number, specified in digits after the decimal point (there will be between one and three digits before the decimal point). If it is None, the formatting falls back to the floating point format '%g', which displays up to 6 *significant* digits, i.e. the equivalent value for *places* varies between 0 and 5 (inclusive).

sep [str (default: " ")] Separator used between the value and the prefix/unit. For example, one get '3.14 mV' if `sep` is " " (default) and '3.14mV' if `sep` is "". Besides the default behavior, some other useful options may be:

- `sep=""` to append directly the prefix/unit to the value;
- `sep="\N{THIN SPACE}"` (U+2009);
- `sep="\N{NARROW NO-BREAK SPACE}"` (U+202F);
- `sep="\N{NO-BREAK SPACE}"` (U+00A0).

ENG_PREFIXES = {-24: 'y', -21: 'z', -18: 'a', -15: 'f', -12: 'p', -9: 'n', -6: 'μ',

format_eng(*num*)

Formats a number in engineering notation, appending a letter representing the power of 1000 of the original number. Some examples:

```
>>> format_eng(0)       # for self.places = 0
'0'
```

```
>>> format_eng(1000000) # for self.places = 1
'1.0 M'
```

```
>>> format_eng("-1e-6") # for self.places = 2
u'-1.00 μ'
```

`num` may be a numeric value or a string that can be converted to a numeric value with `float(num)`.

class matplotlib.ticker.**PercentFormatter**(*xmax=100*, *decimals=None*, *symbol='%'*, *is_latex=False*)

Bases: *matplotlib.ticker.Formatter*

Format numbers as a percentage.

Parameters

xmax [float] Determines how the number is converted into a percentage. *xmax* is the data value that corresponds to 100%. Percentages are computed as `x / xmax * 100`. So if the data is already scaled to be percentages, *xmax* will be 100. Another common situation is where `xmax` is 1.0.

decimals [None or int] The number of decimal places to place after the point. If *None* (the default), the number will be computed automatically.

symbol [string or None] A string that will be appended to the label. It may be *None* or empty to indicate that no symbol should be used. LaTeX special characters are escaped in *symbol* whenever latex mode is enabled, unless *is_latex* is *True*.

is_latex [bool] If *False*, reserved LaTeX characters in *symbol* will be escaped.

convert_to_pct(*x*)

format_pct(*x*, *display_range*)

Formats the number as a percentage number with the correct number of decimals and adds the percent symbol, if any.

If `self.decimals` is `None`, the number of digits after the decimal point is set based on the `display_range` of the axis as follows:

display_range	decimals	sample
>50	0	`x = 34.5` => 35%
>5	1	`x = 34.5` => 34.5%
>0.5	2	`x = 34.5` => 34.50%
...	...	...

This method will not be very good for tiny axis ranges or extremely large ones. It assumes that the values on the chart are percentages displayed on a reasonable scale.

symbol
The configured percent symbol as a string.

If LaTeX is enabled via `rcParams["text.usetex"]`, the special characters `{'#', '$', '%', '&', '~', '_', '^', '\', '{', '}'}` are automatically escaped in the string.

class matplotlib.ticker.**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

MAXTICKS = 1000

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

set_params(***kwargs*)
Do nothing, and rase a warning. Any locator class not supporting the set_params() function will call this.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*vmin*, *vmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

zoom(*direction*)
Zoom in/out on axis; if direction is >0 zoom in, else zoom out

class matplotlib.ticker.**IndexLocator**(*base*, *offset*)

Bases: *matplotlib.ticker.Locator*

Place a tick on every multiple of some base number of points plotted, e.g., on every 5th point. It is assumed that you are doing index plotting; i.e., 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

set_params(*base=None*, *offset=None*)

Set parameters within this locator

tick_values(*vmin*, *vmax*)

Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.ticker.**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.

set_params(*nbins=None*)

Set parameters within this locator.

tick_values(*vmin*, *vmax*)

" Return the locations of the ticks.

Note: Because the values are fixed, vmin and vmax are not used in this method.

---

class matplotlib.ticker.**NullLocator**

Bases: *matplotlib.ticker.Locator*

No ticks

tick_values(*vmin*, *vmax*)

" Return the locations of the ticks.

Note: Because the values are Null, vmin and vmax are not used in this method.

---

class matplotlib.ticker.**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

set_params(*numticks=None*, *presets=None*)

Set parameters within this locator.

tick_values(*vmin*, *vmax*)

Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*vmin*, *vmax*)

Try to choose the view limits intelligently

class matplotlib.ticker.**LogLocator**(*base=10.0*, *subs=(1.0,)*, *numdecs=4*, *numticks=None*)

Bases: *matplotlib.ticker.Locator*

Determine the tick locations for log axes

Place ticks on the locations : subs[j] * base**i

Parameters

subs [None, string, or sequence of float, optional, default (1.0,)] Gives the multiples of integer powers of the base at which to place ticks. The default places ticks only at integer powers of the base. The permitted string values are `'auto'` and `'all'`, both of which use an algorithm based on the axis view limits to determine whether and how to put ticks between integer powers of the base. With `'auto'`, ticks are placed only between integer powers; with `'all'`, the integer powers are included. A value of None is equivalent to `'auto'`.

base(*base*)

set the base of the log scaling (major tick every base**i, i integer)

nonsingular(*vmin*, *vmax*)

set_params(*base=None*, *subs=None*, *numdecs=None*, *numticks=None*)

Set parameters within this locator.

subs(*subs*)
set the minor ticks for the log scaling every base**i*subs[j]

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*vmin*, *vmax*)
Try to choose the view limits intelligently

class matplotlib.ticker.**AutoLocator**
Bases: *matplotlib.ticker.MaxNLocator*

Dynamically find major tick positions. This is actually a subclass of *MaxNLocator*, with parameters *nbins = 'auto'* and *steps = [1, 2, 2.5, 5, 10]*.

To know the values of the non-public parameters, please have a look to the defaults of *MaxNLocator*.

class matplotlib.ticker.**MultipleLocator**(*base=1.0*)
Bases: *matplotlib.ticker.Locator*

Set a tick on every integer that is multiple of base in the view interval

set_params(*base*)
Set parameters within this locator.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*dmin*, *dmax*)
Set the view limits to the nearest multiples of base that contain the data

class matplotlib.ticker.**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. If the string `'auto'`, the number of bins will be automatically determined based on the length of the axis.

steps Sequence of nice numbers starting with 1 and ending with 10; e.g., [1, 2, 4, 5, 10], where the values are acceptable tick multiples. i.e. for the example, 20, 40, 60 would be an acceptable set of ticks, as would 0.4, 0.6, 0.8, because they are multiples of 2. However, 30, 60, 90 would not be allowed because 3 does not appear in the list of steps.

integer If True, ticks will take only integer values, provided at least `min_n_ticks` integers are found within the view limits.

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, primarily when `rcParams["axes.autolimit_mode"]` is `'round_numbers'`. 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.

min_n_ticks Relax `nbins` and `integer` constraints if necessary to obtain this minimum number of ticks.

default_params = {'integer': False, 'min_n_ticks': 2, 'nbins': 10, 'prune': None, 'ste

set_params(***kwargs*)
Set parameters within this locator.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*dmin*, *dmax*)
select a scale for the range from vmin to vmax

Normally this method is overridden by subclasses to change locator behaviour.

class matplotlib.ticker.**AutoMinorLocator**(*n=None*)
Bases: *matplotlib.ticker.Locator*

Dynamically find minor tick positions based on the positions of major ticks. The scale must be linear with major ticks evenly spaced.

n is the number of subdivisions of the interval between major ticks; e.g., n=2 will place a single minor tick midway between major ticks.

If *n* is omitted or None, it will be set to 5 or 4.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

class matplotlib.ticker.**SymmetricalLogLocator**(*transform=None*, *subs=None*, *linthresh=None*, *base=None*)
Bases: *matplotlib.ticker.Locator*

Determine the tick locations for symmetric log axes

place ticks on the location= base**i*subs[j]

set_params(*subs=None*, *numticks=None*)
Set parameters within this locator.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

---

view_limits(*vmin*, *vmax*)
Try to choose the view limits intelligently

class matplotlib.ticker.**LogitLocator**(*minor=False*)
Bases: *matplotlib.ticker.Locator*

Determine the tick locations for logit axes

place ticks on the logit locations

nonsingular(*vmin*, *vmax*)

set_params(*minor=None*)
Set parameters within this locator.

tick_values(*vmin*, *vmax*)
Return the values of the located ticks given **vmin** and **vmax**.

Note: To get tick locations with the vmin and vmax values defined automatically for the associated `axis` simply call the Locator instance:

```
>>> print((type(loc)))
<type 'Locator'>
>>> print((loc()))
[1, 2, 3, 4]
```

CHAPTER

SIXTYNINE

TIGHT_LAYOUT

69.1 matplotlib.tight_layout

This module provides routines to adjust subplot params so that subplots are nicely fit in the figure. In doing so, only axis labels, tick labels, axes titles and offsetboxes that are anchored to axes are currently considered.

Internally, it assumes that the margins (left_margin, etc.) which are differences between ax.get_tightbbox and ax.bbox are independent of axes position. This may fail if Axes.adjustable is datalim. Also, This will fail for some cases (for example, left or right margin is affected by xlabel).

matplotlib.tight_layout.**auto_adjust_subplotpars**(*fig*, *renderer*, *nrows_ncols*, *num1num2_list*, *subplot_list*, *ax_bbox_list=None*, *pad=1.08*, *h_pad=None*, *w_pad=None*, *rect=None*)

Return a dict of subplot parameters to adjust spacing between subplots.

Note that this function ignores geometry information of subplot itself, but uses what is given by the *nrows_ncols* and *num1num2_list* parameters. Also, the results could be incorrect if some subplots have `adjustable=datalim`.

Parameters

nrows_ncols [Tuple[int, int]] Number of rows and number of columns of the grid.

num1num2_list [List[int]] List of numbers specifying the area occupied by the subplot

subplot_list [list of subplots] List of subplots that will be used to calculate optimal subplot_params.

pad [float] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

h_pad, w_pad [float] Padding (height/width) between edges of adjacent subplots, as a fraction of the font size. Defaults to *pad*.

rect [Tuple[float, float, float, float]] [left, bottom, right, top] in normalized (0, 1) figure coordinates.

matplotlib.tight_layout.**get_renderer**(*fig*)

matplotlib.tight_layout.**get_subplotspec_list**(*axes_list*, *grid_spec=None*)

Return a list of subplotspec from the given list of axes.

For an instance of axes that does not support subplotspec, None is inserted in the list.

If grid_spec is given, None is inserted for those not from the given grid_spec.

matplotlib.tight_layout.**get_tight_layout_figure**(*fig*, *axes_list*, *subplotspec_list*, *renderer*, *pad=1.08*, *h_pad=None*, *w_pad=None*, *rect=None*)

Return subplot parameters for tight-layouted-figure with specified padding.

Parameters

fig [Figure]

axes_list [list of Axes]

subplotspec_list [list of *SubplotSpec*] The subplotspecs of each axes.

renderer [renderer]

pad [float] Padding between the figure edge and the edges of subplots, as a fraction of the font size.

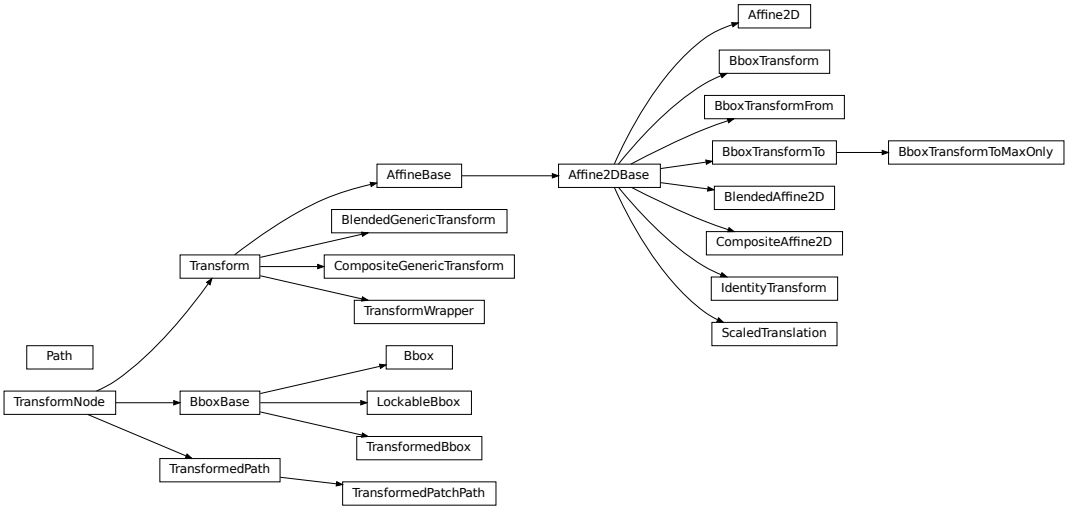
h_pad, w_pad [float] Padding (height/width) between edges of adjacent subplots. Defaults to *pad_inches*.

rect [Tuple[float, float, float, float], optional] (left, bottom, right, top) rectangle in normalized figure coordinates that the whole subplots area (including labels) will fit into. Defaults to using the entire figure.

CHAPTER

SEVENTY

WORKING WITH TRANSFORMATIONS

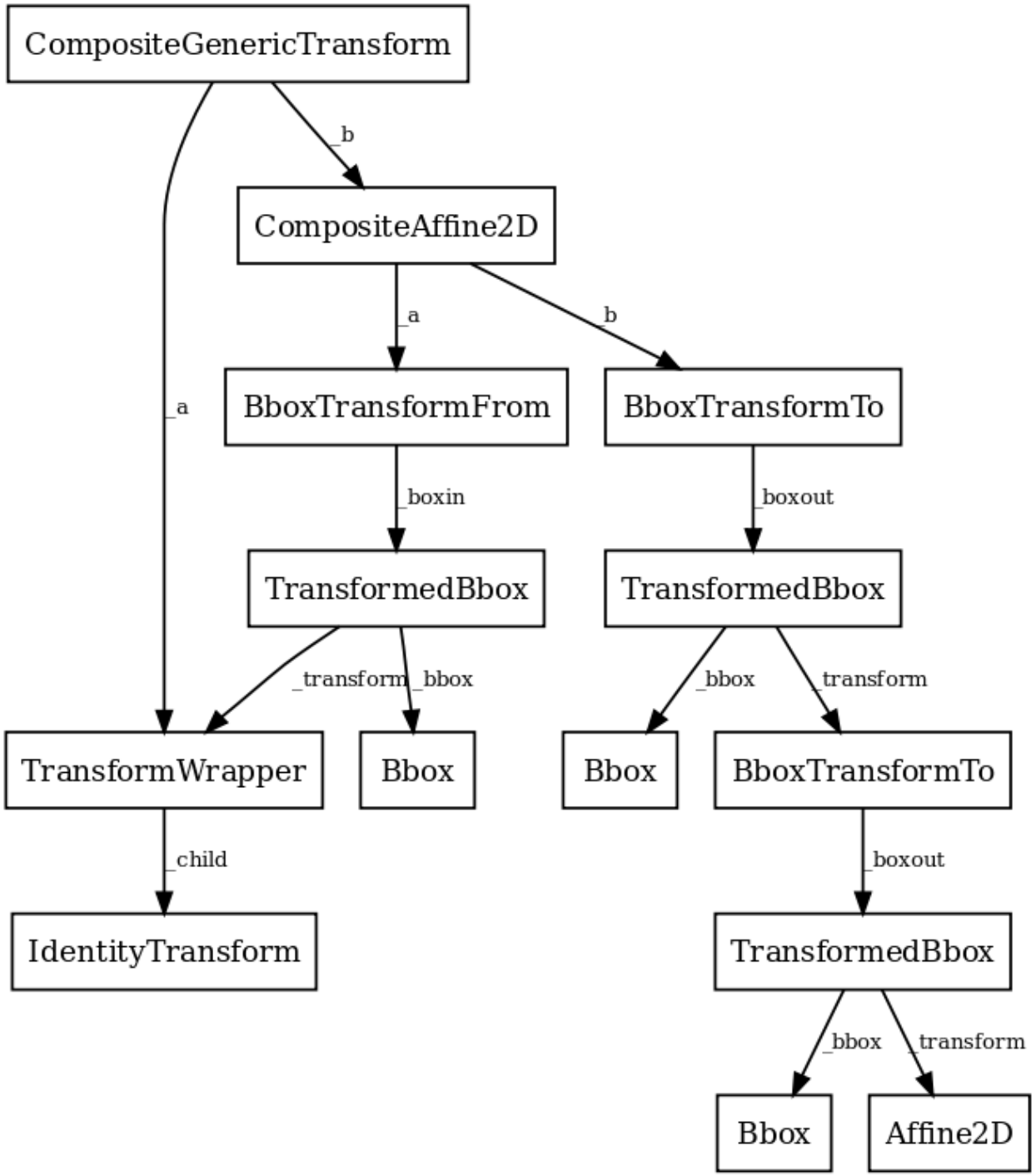


70.1 matplotlib.transforms

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 matplotlib.transforms.**Affine2D**(*matrix=None*, ***kwargs*)

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.

is_separable

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
```

.

skew(*xShear*, *yShear*)
Adds a skew in place.

xShear and *yShear* are the shear angles along the *x*- and *y*-axes, respectively, in radians.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate_deg()*, *translate()* and *scale()*.

skew_deg(*xShear*, *yShear*)
Adds a skew in place.

xShear and *yShear* are the shear angles along the *x*- and *y*-axes, respectively, in degrees.

Returns *self*, so this method can easily be chained with more calls to *rotate()*, *rotate_deg()*, *translate()* and *scale()*.

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 matplotlib.transforms.**Affine2DBase**(**args*, ***kwargs*)
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.

has_inverse = True

input_dims = 2

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))`

is_separable

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
```

output_dims = 2

to_values()
Return the values of the matrix as a sequence (a,b,c,d,e,f)

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *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 matplotlib.transforms.**AffineBase**(**args*, ***kwargs*)
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.

is_affine = True

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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

transform_path(*path*)
Returns a transformed 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 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 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 matplotlib.transforms.**Bbox**(*points*, ***kwargs*)
Bases: *matplotlib.transforms.BboxBase*

A mutable bounding box.

Parameters

points [ndarray] A 2x2 numpy array of the form `[[x0, y0], [x1, y1]]`.

Notes

If you need to create a *Bbox* object from another form of data, consider the static methods *unit()*, *from_bounds()* and *from_extents()*.

bounds
Returns (*x0*, *y0*, `width`, `height`).

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_xy()*.

value [bool]

- When `True`, subsequent calls to *update_from_data_xy()* will ignore the existing bounds of the *Bbox*.
- When `False`, subsequent calls to *update_from_data_xy()* will include the existing bounds of the *Bbox*.

intervalx
intervalx is the pair of *x* coordinates that define the bounding box. It is not guaranteed to be sorted from left to right.

intervaly
intervaly is the pair of *y* coordinates that define the bounding box. It is not guaranteed to be sorted from bottom to top.

minpos

minposx

minposy

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.

static null()
(staticmethod) Create a new null *Bbox* from (inf, inf) to (-inf, -inf).

p0
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
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`.

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_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.

Parameters

xy [ndarray] A numpy array of 2D points.

ignore [bool, optional]

- 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, updatey [bool, optional] When `True`, update the x/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.

Parameters

path [*Path*]

ignore [bool, optional]

- 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, updatey [bool, optional] When `True`, update the x/y values.

x0
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
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`.

y0
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
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`.

class matplotlib.transforms.**BboxBase**(*shorthand_name=None*)
Bases: *matplotlib.transforms.TransformNode*

This is the base class of all bounding boxes, and provides read-only access to its data. A mutable bounding box is provided by the *Bbox* class.

The canonical representation is as two points, with no restrictions on their ordering. Convenience properties are provided to get the left, bottom, right and top edges and width and height, but these are not stored explicitly.

Creates a new *TransformNode*.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

anchored(*c*, *container=None*)

Return a copy of the *Bbox*, shifted to position *c* within a container.

Parameters

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.

container [Bbox, optional] The box within which the *Bbox* is positioned; it defaults to the initial *Bbox*.

bounds

Returns (*x0*, *y0*, *width*, *height*).

coefs = {'C': (0.5, 0.5), 'E': (1.0, 0.5), 'N': (0.5, 1.0), 'NE': (1.0, 1.0), 'NW': (0, 1.

contains(*x*, *y*)

Returns whether `(x, y)` is in the bounding box or on its edge.

containsx(*x*)

Returns whether *x* is in the closed (*x0*, *x1*) interval.

containsy(*y*)

Returns whether *y* is in the closed (*y0*, *y1*) interval.

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*. Any vertices with a non-finite x or y value are ignored.

Parameters

vertices [Nx2 Numpy array.]

count_overlaps(*bboxes*)
Count the number of bounding boxes that overlap this one.

Parameters

bboxes [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
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 whether `x, y` is in the bounding box, but not on its edge.

fully_containsx(*x*)
Returns whether *x* is in the open (*x0*, *x1*) interval.

fully_containsy(*y*)
Returns whether *y* is in the open (*y0*, *y1*) interval.

fully_overlaps(*other*)
Returns whether this bounding box overlaps with the other bounding box, not including the edges.

Parameters

other [BboxBase]

get_points()

height
The height of the bounding box. It may be negative if *y1* < *y0*.

static intersection(*bbox1*, *bbox2*)
Return the intersection of the two bboxes or None if they do not intersect.

intervalx
intervalx is the pair of *x* coordinates that define the bounding box. It is not guaranteed to be sorted from left to right.

intervaly
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_affine = True

is_bbox = True

is_unit()
Returns True if the *Bbox* is the unit bounding box from (0, 0) to (1, 1).

max
max is the top-right corner of the bounding box.

min
min is the bottom-left corner of the bounding box.

overlaps(*other*)
Returns whether this bounding box overlaps with the other bounding box.

Parameters

other [BboxBase]

p0
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
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
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
The width of the bounding box. It may be negative if *x1* < *x0*.

x0
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
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
xmax is the right edge of the bounding box.

xmin
xmin is the left edge of the bounding box.

y0
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
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
ymax is the top edge of the bounding box.

ymin
ymin is the bottom edge of the bounding box.

class matplotlib.transforms.**BboxTransform**(*boxin*, *boxout*, ***kwargs*)
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 Affine transformation array for the affine part of this transform.

is_separable = True

class matplotlib.transforms.**BboxTransformFrom**(*boxin*, ***kwargs*)
Bases: *matplotlib.transforms.Affine2DBase*

BboxTransformFrom linearly transforms points from a given *Bbox* to the unit bounding box.

get_matrix()
Get the Affine transformation array for the affine part of this transform.

is_separable = True

class matplotlib.transforms.**BboxTransformTo**(*boxout*, ***kwargs*)
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 Affine transformation array for the affine part of this transform.

is_separable = True

class matplotlib.transforms.**BboxTransformToMaxOnly**(*boxout*, ***kwargs*)
Bases: *matplotlib.transforms.BboxTransformTo*

BboxTransformTo is a transformation that linearly transforms points from the unit bounding box to a given *Bbox* with a fixed upper left of (0, 0).

Create a new *BboxTransformTo* that linearly transforms points from the unit bounding box to *boxout*.

get_matrix()
Get the Affine transformation array for the affine part of this transform.

class matplotlib.transforms.**BlendedAffine2D**(*x_transform*, *y_transform*, ***kwargs*)
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.

contains_branch_seperately(*transform*)
Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes' data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

get_matrix()
Get the Affine transformation array for the affine part of this transform.

is_separable = True

class matplotlib.transforms.**BlendedGenericTransform**(*x_transform*, *y_transform*, ***kwargs*)
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.

contains_branch(*other*)
Return whether the given transform is a sub-tree of this transform.

This routine uses transform equality to identify sub-trees, therefore in many situations it is object id which will be used.

For the case where the given transform represents the whole of this transform, returns True.

contains_branch_seperately(*transform*)
Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes' data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

depth
Returns the number of transforms which have been chained together to form this Transform instance.

Note: For the special case of a Composite transform, the maximum depth of the two is returned.

---

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.

has_inverse

input_dims = 2

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))`

is_affine

is_separable = True

output_dims = 2

pass_through = True

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

class matplotlib.transforms.**CompositeAffine2D**(*a*, *b*, ***kwargs*)
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.

depth
Returns the number of transforms which have been chained together to form this Transform instance.

Note: For the special case of a Composite transform, the maximum depth of the two is returned.

---

get_matrix()
Get the Affine transformation array for the affine part of this transform.

class matplotlib.transforms.**CompositeGenericTransform**(*a*, *b*, ***kwargs*)
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.

depth
Returns the number of transforms which have been chained together to form this Transform instance.

Note: For the special case of a Composite transform, the maximum depth of the two is returned.

---

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.

has_inverse

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))`

is_affine

is_separable

pass_through = True

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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

transform_path_non_affine(*path*)
Returns a 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(value`

class matplotlib.transforms.**IdentityTransform**(**args*, ***kwargs*)
Bases: *matplotlib.transforms.Affine2DBase*

A special class that does one 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 Affine transformation array for 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 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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `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`).

Alternatively, accepts a numpy array of length `input_dims` and returns a numpy array of length `output_dims`.

transform_path(*path*)
Returns a 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 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 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 matplotlib.transforms.**LockableBbox**(*bbox*, *x0=None*, *y0=None*, *x1=None*, *y1=None*, ***kwargs*)

Bases: *matplotlib.transforms.BboxBase*

A *Bbox* where some elements may be locked at certain values.

When the child bounding box changes, the bounds of this bbox will update accordingly with the exception of the locked elements.

Parameters

bbox [Bbox] The child bounding box to wrap.

x0 [float or None] The locked value for x0, or None to leave unlocked.

y0 [float or None] The locked value for y0, or None to leave unlocked.

x1 [float or None] The locked value for x1, or None to leave unlocked.

y1 [float or None] The locked value for y1, or None to leave unlocked.

get_points()
Get the points of the bounding box directly as a numpy array of the form: `[[x0, y0], [x1, y1]]`.

locked_x0
float or None: The value used for the locked x0.

locked_x1
float or None: The value used for the locked x1.

locked_y0
float or None: The value used for the locked y0.

locked_y1
float or None: The value used for the locked y1.

class matplotlib.transforms.**ScaledTranslation**(*xt*, *yt*, *scale_trans*, ***kwargs*)

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 Affine transformation array for the affine part of this transform.

class matplotlib.transforms.**Transform**(*shorthand_name=None*)

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* is True)

If the transform needs to do something non-standard with *matplotlib.path.Path* objects, such as adding curves where there were once line segments, it should override:

- *transform_path()*

Creates a new *TransformNode*.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

contains_branch(*other*)

Return whether the given transform is a sub-tree of this transform.

This routine uses transform equality to identify sub-trees, therefore in many situations it is object id which will be used.

For the case where the given transform represents the whole of this transform, returns True.

contains_branch_seperately(*other_transform*)

Returns whether the given branch is a sub-tree of this transform on each separate dimension.

A common use for this method is to identify if a transform is a blended transform containing an axes' data transform. e.g.:

```
x_isdata, y_isdata = trans.contains_branch_seperately(ax.transData)
```

depth
Returns the number of transforms which have been chained together to form this Transform instance.

Note: For the special case of a Composite transform, the maximum depth of the two is returned.

---

get_affine()
Get the affine part of this transform.

get_matrix()
Get the Affine transformation array for the affine part of this transform.

has_inverse = False
True if this transform has a corresponding inverse transform.

input_dims = None
The number of input dimensions of this transform. Must be overridden (with integers) in the subclass.

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))`

is_separable = False
True if this transform is separable in the x- and y- dimensions.

output_dims = None
The number of output dimensions of this transform. Must be overridden (with integers) in the subclass.

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

transform_angles(*angles*, *pts*, *radians=False*, *pushoff=1e-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_bbox(*bbox*)

Transform the given bounding box.

Note, for smarter transforms including caching (a common requirement for matplotlib figures), see *TransformedBbox*.

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*).

Alternatively, accepts a numpy array of length *input_dims* and returns a numpy array of length *output_dims*.

transform_path(*path*)

Returns a transformed 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 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 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 matplotlib.transforms.**TransformNode**(*shorthand_name=None*)
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*.

Parameters

shorthand_name [str] A string representing the "name" of the transform. The name carries no significance other than to improve the readability of `str(transform)` when DEBUG=True.

INVALID = 3

INVALID_AFFINE = 2

INVALID_NON_AFFINE = 1

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 triggers an invalidation of its ancestors. Should be called any time the transform changes.

is_affine = False

is_bbox = False

pass_through = False
If pass_through is True, all ancestors will always be invalidated, even if 'self' is already invalid.

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 matplotlib.transforms.**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.

has_inverse

is_affine

is_separable

pass_through = True

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 matplotlib.transforms.**TransformedBbox**(*bbox*, *transform*, ***kwargs*)

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.

Parameters

bbox [*Bbox*]

transform [*Transform*]

get_points()

Get the points of the bounding box directly as a numpy array of the form: `[[x0, y0], [x1, y1]]`.

class matplotlib.transforms.**TransformedPatchPath**(*patch*)

Bases: *matplotlib.transforms.TransformedPath*

A *TransformedPatchPath* caches a non-affine transformed copy of the Patch. This cached copy is automatically updated when the non-affine part of the transform or the patch changes.

Create a new *TransformedPatchPath* from the given Patch.

class matplotlib.transforms.**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.

Note: Paths are considered immutable by this class. Any update to the path's vertices/codes will not trigger a transform recomputation.

Create a new *TransformedPath* from the given *Path* and *Transform*.

get_affine()

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.

matplotlib.transforms.**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.

matplotlib.transforms.**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
```

matplotlib.transforms.**interval_contains**(*interval*, *val*)
Check, inclusively, whether an interval includes a given value.

Parameters

interval [sequence of scalar] A 2-length sequence, endpoints that define the interval.

val [scalar] Value to check is within interval.

Returns

bool Returns true if given val is within the interval.

matplotlib.transforms.**interval_contains_open**(*interval*, *val*)
Check, excluding endpoints, whether an interval includes a given value.

Parameters

interval [sequence of scalar] A 2-length sequence, endpoints that define the interval.

val [scalar] Value to check is within interval.

Returns

bool Returns true if given val is within the interval.

matplotlib.transforms.**nonsingular**(*vmin*, *vmax*, *expander=0.001*, *tiny=1e-15*, *increasing=True*)
Modify the endpoints of a range as needed to avoid singularities.

Parameters

vmin, vmax [float] The initial endpoints.

expander [float, optional, default: 0.001] Fractional amount by which *vmin* and *vmax* are expanded if the original interval is too small, based on *tiny*.

tiny [float, optional, default: 1e-15] Threshold for the ratio of the interval to the maximum absolute value of its endpoints. If the interval is smaller than this, it will be expanded. This value should be around 1e-15 or larger; otherwise the interval will be approaching the double precision resolution limit.

increasing [bool, optional, default: True] If True, swap *vmin*, *vmax* if *vmin* > *vmax*.

Returns

vmin, vmax [float] Endpoints, expanded and/or swapped if necessary. If either input is inf or NaN, or if both inputs are 0 or very close to zero, it returns *-expander*, *expander*.

matplotlib.transforms.**offset_copy**(*trans*, *fig=None*, *x=0.0*, *y=0.0*, *units='inches'*)
Return a new transform with an added offset.

Parameters

trans [*Transform* instance] Any transform, to which offset will be applied.

fig [*Figure*, optional, default: None] Current figure. It can be None if *units* are 'dots'.

x, y [float, optional, default: 0.0] Specifies the offset to apply.

units [{'inches', 'points', 'dots'}, optional] Units of the offset.

Returns

trans [*Transform* instance] Transform with applied offset.

CHAPTER

SEVENTYONE

TRIANGULAR GRIDS

71.1 matplotlib.tri

Unstructured triangular grid functions.

class matplotlib.tri.**Triangulation**(*x*, *y*, *triangles=None*, *mask=None*)

An unstructured triangular grid consisting of npoints points and ntri triangles. The triangles can either be specified by the user or automatically generated using a Delaunay triangulation.

Parameters

x, y [array_like of shape (npoints)] Coordinates of grid points.

triangles [integer array_like of shape (ntri, 3), optional] For each triangle, the indices of the three points that make up the triangle, ordered in an anticlockwise manner. If not specified, the Delaunay triangulation is calculated.

mask [boolean array_like of shape (ntri), optional] Which triangles are masked out.

Notes

For a Triangulation to be valid it must not have duplicate points, triangles formed from colinear points, or overlapping triangles.

Attributes

'edges'

'neighbors'

is_delaunay [bool] Whether the Triangulation is a calculated Delaunay triangulation (where `triangles` was not specified) or not.

calculate_plane_coefficients(*z*)

Calculate plane equation coefficients for all unmasked triangles from the point (x,y) coordinates and specified z-array of shape (npoints). Returned array has shape (npoints,3) and allows z-value at (x,y) position in triangle tri to be calculated using z = array[tri,0]*x + array[tri,1]*y + array[tri,2].

edges
Return integer array of shape (nedges,2) containing all edges of non-masked triangles.

Each edge is the start point index and end point index. Each edge (start,end and end,start) appears only once.

get_cpp_triangulation()

static get_from_args_and_kwargs(**args*, ***kwargs*)
Return a Triangulation object from the args and kwargs, and the remaining args and kwargs with the consumed values removed.

There are two alternatives: either the first argument is a Triangulation object, in which case it is returned, or the args and kwargs are sufficient to create a new Triangulation to return. In the latter case, see Triangulation.__init__ for the possible args and kwargs.

get_masked_triangles()
Return an array of triangles that are not masked.

get_trifinder()
Return the default *matplotlib.tri.TriFinder* of this triangulation, creating it if necessary. This allows the same TriFinder object to be easily shared.

neighbors
Return integer array of shape (ntri,3) containing neighbor triangles.

For each triangle, the indices of the three triangles that share the same edges, or -1 if there is no such neighboring triangle. neighbors[i,j] is the triangle that is the neighbor to the edge from point index triangles[i,j] to point index triangles[i,(j+1)%3].

set_mask(*mask*)
Set or clear the mask array. This is either None, or a boolean array of shape (ntri).

class matplotlib.tri.**TriFinder**(*triangulation*)
Abstract base class for classes used to find the triangles of a Triangulation in which (x,y) points lie.

Rather than instantiate an object of a class derived from TriFinder, it is usually better to use the function *matplotlib.tri.Triangulation.get_trifinder()*.

Derived classes implement __call__(x,y) where x,y are array_like point coordinates of the same shape.

class matplotlib.tri.**TrapezoidMapTriFinder**(*triangulation*)
Bases: matplotlib.tri.trifinder.TriFinder

TriFinder class implemented using the trapezoid map algorithm from the book "Computational Geometry, Algorithms and Applications", second edition, by M. de Berg, M. van Kreveld, M. Overmars and O. Schwarzkopf.

The triangulation must be valid, i.e. it must not have duplicate points, triangles formed from colinear points, or overlapping triangles. The algorithm has some tolerance to triangles formed from colinear points, but this should not be relied upon.

class matplotlib.tri.**TriInterpolator**(*triangulation*, *z*, *trifinder=None*)
Abstract base class for classes used to perform interpolation on triangular grids.

Derived classes implement the following methods:

- `__call__(x, y)` , where x, y are array_like point coordinates of the same shape, and that returns a masked array of the same shape containing the interpolated z-values.
- `gradient(x, y)` , where x, y are array_like point coordinates of the same shape, and that returns a list of 2 masked arrays of the same shape containing the 2 derivatives of the interpolator (derivatives of interpolated z values with respect to x and y).

class matplotlib.tri.**LinearTriInterpolator**(*triangulation*, *z*, *trifinder=None*)

Bases: matplotlib.tri.triinterpolate.TriInterpolator

A LinearTriInterpolator performs linear interpolation on a triangular grid.

Each triangle is represented by a plane so that an interpolated value at point (x,y) lies on the plane of the triangle containing (x,y). Interpolated values are therefore continuous across the triangulation, but their first derivatives are discontinuous at edges between triangles.

Parameters

triangulation [*Triangulation* object] The triangulation to interpolate over.

z [array_like of shape (npoints,)] Array of values, defined at grid points, to interpolate between.

trifinder [*TriFinder* object, optional] If this is not specified, the Triangulation's default TriFinder will be used by calling *matplotlib.tri.Triangulation.get_trifinder()*.

Methods

'__call__' (x, y)	(Returns interpolated values at x,y points)
'gradient' (x, y)	(Returns interpolated derivatives at x,y points)

gradient(*x*, *y*)

Returns a list of 2 masked arrays containing interpolated derivatives at the specified x,y points.

Parameters

x, y [array-like] x and y coordinates of the same shape and any number of dimensions.

Returns

dzdx, dzdy [np.ma.array] 2 masked arrays of the same shape as *x* and *y* ; values corresponding to (x,y) points outside of the triangulation are masked out. The first returned array contains the values of $\frac{\partial z}{\partial x}$ and the second those of $\frac{\partial z}{\partial y}$.

class matplotlib.tri.**CubicTriInterpolator**(*triangulation*, *z*, *kind='min_E'*, *trifinder=None*, *dz=None*)

Bases: matplotlib.tri.triinterpolate.TriInterpolator

A CubicTriInterpolator performs cubic interpolation on triangular grids.

In one-dimension - on a segment - a cubic interpolating function is defined by the values of the function and its derivative at both ends. This is almost the same in 2-d inside a triangle, except that the values of the function and its 2 derivatives have to be defined at each triangle node.

The CubicTriInterpolator takes the value of the function at each node - provided by the user - and internally computes the value of the derivatives, resulting in a smooth interpolation. (As a special feature, the user can also impose the value of the derivatives at each node, but this is not supposed to be the common usage.)

Parameters

triangulation [*Triangulation* object] The triangulation to interpolate over.

z [array_like of shape (npoints,)] Array of values, defined at grid points, to interpolate between.

kind [{'min_E', 'geom', 'user'}, optional] Choice of the smoothing algorithm, in order to compute the interpolant derivatives (defaults to 'min_E'):

- if 'min_E': (default) The derivatives at each node is computed to minimize a bending energy.
- if 'geom': The derivatives at each node is computed as a weighted average of relevant triangle normals. To be used for speed optimization (large grids).
- if 'user': The user provides the argument `dz`, no computation is hence needed.

trifinder [*TriFinder* object, optional] If not specified, the Triangulation's default TriFinder will be used by calling *matplotlib.tri.Triangulation.get_trifinder()*.

dz [tuple of array_likes (dzdx, dzdy), optional] Used only if *kind* ='user'. In this case *dz* must be provided as (dzdx, dzdy) where dzdx, dzdy are arrays of the same shape as *z* and are the interpolant first derivatives at the *triangulation* points.

Notes

This note is a bit technical and details the way a *CubicTriInterpolator* computes a cubic interpolation.

The interpolation is based on a Clough-Tocher subdivision scheme of the *triangulation* mesh (to make it clearer, each triangle of the grid will be divided in 3 child-triangles, and on each child triangle the interpolated function is a cubic polynomial of the 2 coordinates). This technique originates from FEM (Finite Element Method) analysis; the element used is a reduced Hsieh-Clough-Tocher (HCT) element. Its shape functions are described in *[1]*. The assembled function is guaranteed to be C1-smooth, i.e. it is continuous and its first derivatives are also continuous (this is easy to show inside the triangles but is also true when crossing the edges).

In the default case (*kind* ='min_E'), the interpolant minimizes a curvature energy on the functional space generated by the HCT element shape functions - with imposed values but arbitrary derivatives at each node. The minimized functional is the integral of the so-called total curvature (implementation based on an algorithm from *[2]* - PCG sparse solver):

$$E(z) = \frac{1}{2}\int_{\Omega}\left(\left(\frac{\partial^2 z}{\partial x^2}\right)^2 + \left(\frac{\partial^2 z}{\partial y^2}\right)^2 + 2\left(\frac{\partial^2 z}{\partial y \partial x}\right)^2\right) dx\, dy \tag{71.1}$$

If the case *kind* ='geom' is chosen by the user, a simple geometric approximation is used (weighted average of the triangle normal vectors), which could improve speed on very large grids.

References

[1], *[2]*

Methods

'__call__' (x, y)	(Returns interpolated values at x,y points)
'gradient' (x, y)	(Returns interpolated derivatives at x,y points)

`gradient`(*x*, *y*)

Returns a list of 2 masked arrays containing interpolated derivatives at the specified x,y points.

Parameters

x, y [array-like] x and y coordinates of the same shape and any number of dimensions.

Returns

dzdx, dzdy [np.ma.array] 2 masked arrays of the same shape as *x* and *y* ; values corresponding to (x,y) points outside of the triangulation are masked out. The first returned array contains the values of $\frac{\partial z}{\partial x}$ and the second those of $\frac{\partial z}{\partial y}$.

`class matplotlib.tri.TriRefiner`(*triangulation*)

Abstract base class for classes implementing mesh refinement.

A TriRefiner encapsulates a Triangulation object and provides tools for mesh refinement and interpolation.

Derived classes must implements:

- `refine_triangulation(return_tri_index=False, **kwargs)` , where the optional keyword arguments *kwargs* are defined in each TriRefiner concrete implementation, and which returns :
  - a refined triangulation
  - optionally (depending on *return_tri_index*), for each point of the refined triangulation: the index of the initial triangulation triangle to which it belongs.
- `refine_field(z, triinterpolator=None, **kwargs)` , where:
  - *z* array of field values (to refine) defined at the base triangulation nodes

- *triinterpolator* is a *TriInterpolator* (optional)
- the other optional keyword arguments *kwargs* are defined in each TriRefiner concrete implementation

and which returns (as a tuple) a refined triangular mesh and the interpolated values of the field at the refined triangulation nodes.

class matplotlib.tri.**UniformTriRefiner**(*triangulation*)

Bases: matplotlib.tri.trirefine.TriRefiner

Uniform mesh refinement by recursive subdivisions.

Parameters

triangulation [*Triangulation*] The encapsulated triangulation (to be refined)

refine_field(*z*, *triinterpolator=None*, *subdiv=3*)

Refines a field defined on the encapsulated triangulation.

Returns *refi_tri* (refined triangulation), *refi_z* (interpolated values of the field at the node of the refined triangulation).

Parameters

z [1d-array-like of length n_points] Values of the field to refine, defined at the nodes of the encapsulated triangulation. (n_points is the number of points in the initial triangulation)

triinterpolator [*TriInterpolator*, optional] Interpolator used for field interpolation. If not specified, a *CubicTriInterpolator* will be used.

subdiv [integer, optional] Recursion level for the subdivision. Defaults to 3. Each triangle will be divided into 4**subdiv child triangles.

Returns

refi_tri [*Triangulation* object] The returned refined triangulation

refi_z [1d array of length: *refi_tri* node count.] The returned interpolated field (at *refi_tri* nodes)

refine_triangulation(*return_tri_index=False*, *subdiv=3*)

Computes an uniformly refined triangulation *refi_triangulation* of the encapsulated triangulation.

This function refines the encapsulated triangulation by splitting each father triangle into 4 child sub-triangles built on the edges midside nodes, recursively (level of recursion *subdiv*). In the end, each triangle is hence divided into 4**subdiv child triangles. The default value for *subdiv* is 3 resulting in 64 refined subtriangles for each triangle of the initial triangulation.

Parameters

return_tri_index [boolean, optional] Boolean indicating whether an index table indicating the father triangle index of each point will be returned. Default value False.

subdiv [integer, optional] Recursion level for the subdivision. Defaults value 3. Each triangle will be divided into `4**subdiv` child triangles.

Returns

refi_triangulation [*Triangulation*] The returned refined triangulation

found_index [array-like of integers] Index of the initial triangulation containing triangle, for each point of *refi_triangulation*. Returned only if *return_tri_index* is set to True.

class matplotlib.tri.**TriAnalyzer**(*triangulation*)

Define basic tools for triangular mesh analysis and improvement.

A TriAnalizer encapsulates a *Triangulation* object and provides basic tools for mesh analysis and mesh improvement.

Parameters

triangulation [*Triangulation* object] The encapsulated triangulation to analyze.

Attributes

'scale_factors'

circle_ratios(*rescale=True*)

Returns a measure of the triangulation triangles flatness.

The ratio of the incircle radius over the circumcircle radius is a widely used indicator of a triangle flatness. It is always <= `0.5` and == `0.5` only for equilateral triangles. Circle ratios below 0.01 denote very flat triangles.

To avoid unduly low values due to a difference of scale between the 2 axis, the triangular mesh can first be rescaled to fit inside a unit square with *scale_factors* (Only if *rescale* is True, which is its default value).

Parameters

rescale [boolean, optional] If True, a rescaling will be internally performed (based on *scale_factors*, so that the (unmasked) triangles fit exactly inside a unit square mesh. Default is True.

Returns

circle_ratios [masked array] Ratio of the incircle radius over the circumcircle radius, for each 'rescaled' triangle of the encapsulated triangulation. Values corresponding to masked triangles are masked out.

get_flat_tri_mask(*min_circle_ratio=0.01*, *rescale=True*)

Eliminates excessively flat border triangles from the triangulation.

Returns a mask *new_mask* which allows to clean the encapsulated triangulation from its border-located flat triangles (according to their *circle_ratios()*). This mask is meant to be subsequently applied to the triangulation using *matplotlib.tri.Triangulation.set_mask()* . *new_mask* is an extension of the initial triangulation mask in the sense that an initially masked triangle will remain masked.

The *new_mask* array is computed recursively ; at each step flat triangles are removed only if they share a side with the current mesh border. Thus no new holes in the triangulated domain will be created.

Parameters

min_circle_ratio [float, optional] Border triangles with incircle/circumcircle radii ratio r/R will be removed if r/R < *min_circle_ratio*. Default value: 0.01

rescale [boolean, optional] If True, a rescaling will first be internally performed (based on `scale_factors`), so that the (unmasked) triangles fit exactly inside a unit square mesh. This rescaling accounts for the difference of scale which might exist between the 2 axis. Default (and recommended) value is True.

Returns

new_mask [array-like of booleans] Mask to apply to encapsulated triangulation. All the initially masked triangles remain masked in the *new_mask*.

Notes

The rationale behind this function is that a Delaunay triangulation - of an unstructured set of points - sometimes contains almost flat triangles at its border, leading to artifacts in plots (especially for high-resolution contouring). Masked with computed *new_mask*, the encapsulated triangulation would contain no more unmasked border triangles with a circle ratio below *min_circle_ratio*, thus improving the mesh quality for subsequent plots or interpolation.

`scale_factors`

Factors to rescale the triangulation into a unit square.

Returns *k*, tuple of 2 scale factors.

Returns

k [tuple of 2 floats (kx, ky)] Tuple of floats that would rescale the triangulation : `[triangulation.x * kx, triangulation.y * ky]` fits exactly inside a unit square.

CHAPTER

SEVENTYTWO

TYPE1FONT

72.1 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 matplotlib.type1font.**Type1Font**(*input*)

Bases: object

A class representing a Type-1 font, for use by backends.

Attributes

parts [tuple] A 3-tuple of the cleartext part, the encrypted part, and the finale of zeros.

prop [Dict[str, Any]] 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.

matplotlib.type1font.**ord**(*x*)

CHAPTER

SEVENTYTHREE

UNITS

73.1 matplotlib.units

The classes here provide support for using custom classes with Matplotlib, e.g., those that do not expose the array interface but know how to convert themselves to arrays. It also supports classes with units and units conversion. Use cases include converters for custom objects, e.g., 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 the register with the Registry converter dictionary and a *ConversionInterface*. For example, here is a complete implementation which supports plotting with native datetime objects:

```
import matplotlib.units as units
import matplotlib.dates as dates
import matplotlib.ticker as ticker
import datetime

class DateConverter(units.ConversionInterface):

    @staticmethod
    def convert(value, unit, axis):
        'Convert a datetime 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 the Matplotlib units registry.
units.registry[datetime.date] = DateConverter()
```

class matplotlib.units.**AxisInfo**(*majloc=None*, *minloc=None*, *majfmt=None*, *minfmt=None*, *label=None*, *default_limits=None*)

Bases: object

Information to support default axis labeling, tick labeling, and default limits. An instance of this class must be returned by *ConversionInterface.axisinfo()*.

Parameters

majloc, minloc [Locator, optional] Tick locators for the major and minor ticks.

majfmt, minfmt [Formatter, optional] Tick formatters for the major and minor ticks.

label [str, optional] The default axis label.

default_limits [optional] The default min and max limits of the axis if no data has been plotted.

Notes

If any of the above are None, the axis will simply use the default value.

class matplotlib.units.**ConversionInterface**

Bases: object

The minimal interface for a converter to take custom data types (or sequences) and convert them to values Matplotlib can use.

static axisinfo(*unit*, *axis*)

Return an AxisInfo instance for the axis with the specified units.

static convert(*obj*, *unit*, *axis*)

Convert *obj* using *unit* for the specified *axis*. If *obj* is a sequence, return the converted sequence. The output must be a sequence of scalars that can be used by the numpy array layer.

static default_units(*x*, *axis*)

Return the default unit for *x* or None for the given axis.

static is_numlike(*x*)

The Matplotlib datalim, autoscaling, locators etc work with scalars which are the units converted to floats given the current unit. The converter may be passed these floats, or arrays of them, even when units are set.

class matplotlib.units.**Registry**

Bases: dict

A register that maps types to conversion interfaces.

get_converter(*x*)

Get the converter for data that has the same type as *x*. If no converters are registered for *x*, returns None.

CHAPTER

SEVENTYFOUR

WIDGETS

74.1 matplotlib.widgets

74.1.1 GUI neutral widgets

Widgets that are designed to work for any of the GUI backends. All of these widgets require you to predefine a *matplotlib.axes.Axes* instance and pass that as the first arg. matplotlib doesn't try to be too smart with respect to layout – you will have to figure out how wide and tall you want your Axes to be to accommodate your widget.

class matplotlib.widgets.**AxesWidget**(*ax*)

Bases: *matplotlib.widgets.Widget*

Widget that is connected to a single *Axes*.

To guarantee that the widget remains responsive and not garbage-collected, a reference to the object should be maintained by the user.

This is necessary because the callback registry maintains only weak-refs to the functions, which are member functions of the widget. If there are no references to the widget object it may be garbage collected which will disconnect the callbacks.

Attributes:

ax [*Axes*] The parent axes for the widget

canvas [*FigureCanvasBase* subclass] The parent figure canvas for the widget.

active [bool] If False, the widget does not respond to events.

connect_event(*event*, *callback*)

Connect callback with an event.

This should be used in lieu of `figure.canvas.mpl_connect` since this function stores callback ids for later clean up.

disconnect_events()

Disconnect all events created by this widget.

class matplotlib.widgets.**Button**(*ax*, *label*, *image=None*, *color='0.85'*, *hovercolor='0.95'*)

Bases: *matplotlib.widgets.AxesWidget*

A GUI neutral button.

For the button to remain responsive you must keep a reference to it. Call *on_clicked()* to connect to the button.

Attributes

ax : The *matplotlib.axes.Axes* the button renders into.

label : A *matplotlib.text.Text* instance.

color : The color of the button when not hovering.

hovercolor : The color of the button when hovering.

Parameters

ax [matplotlib.axes.Axes] The *matplotlib.axes.Axes* instance the button will be placed into.

label [str] The button text. Accepts string.

image [array, mpl image, Pillow Image] The image to place in the button, if not *None*. Can be any legal arg to imshow (numpy array, matplotlib Image instance, or Pillow Image).

color [color] The color of the button when not activated

hovercolor [color] The color of the button when the mouse is over it

`disconnect`(*cid*)
remove the observer with connection id *cid*

`on_clicked`(*func*)
When the button is clicked, call this *func* with event.

A connection id is returned. It can be used to disconnect the button from its callback.

`class matplotlib.widgets.CheckButtons`(*ax*, *labels*, *actives*)
Bases: *matplotlib.widgets.AxesWidget*

A GUI neutral set of check buttons.

For the check buttons to remain responsive you must keep a reference to this object.

The following attributes are exposed

ax The *matplotlib.axes.Axes* instance the buttons are located in

labels List of *matplotlib.text.Text* instances

lines List of (line1, line2) tuples for the x's in the check boxes. These lines exist for each box, but have `set_visible(False)` when its box is not checked.

rectangles List of *matplotlib.patches.Rectangle* instances

Connect to the CheckButtons with the *on_clicked()* method

Add check buttons to *matplotlib.axes.Axes* instance *ax*

labels A len(buttons) list of labels as strings

actives

A len(buttons) list of booleans indicating whether the button is active

`disconnect`(*cid*)
remove the observer with connection id *cid*

`get_status`()
returns a tuple of the status (True/False) of all of the check buttons

`on_clicked`(*func*)
When the button is clicked, call *func* with button label

A connection id is returned which can be used to disconnect

`set_active`(*index*)
Directly (de)activate a check button by index.

***index* is an index into the original label list** that this object was constructed with. Raises ValueError if *index* is invalid.

Callbacks will be triggered if `eventson` is True.

`class matplotlib.widgets.Cursor`(*ax*, *horizOn=True*, *vertOn=True*, *useblit=False*, ***lineprops*)
Bases: *matplotlib.widgets.AxesWidget*

A horizontal and vertical line that spans the axes and moves with the pointer. You can turn off the hline or vline respectively with the following attributes:

horizOn Controls the visibility of the horizontal line

vertOn Controls the visibility of the horizontal line

and the visibility of the cursor itself with the *visible* attribute.

For the cursor to remain responsive you must keep a reference to it.

Add a cursor to *ax*. If `useblit=True`, use the backend-dependent blitting features for faster updates. *lineprops* is a dictionary of line properties.

`clear`(*event*)
clear the cursor

`onmove`(*event*)
on mouse motion draw the cursor if visible

`class matplotlib.widgets.EllipseSelector`(*ax*, *onselect*, *drawtype='box'*, *minspanx=None*, *minspany=None*, *useblit=False*, *lineprops=None*, *rectprops=None*, *spancoords='data'*, *button=None*, *maxdist=10*, *marker_props=None*, *interactive=False*, *state_modifier_keys=None*)
Bases: *matplotlib.widgets.RectangleSelector*

Select an elliptical region of an axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
from matplotlib.widgets import  EllipseSelector
from pylab import *

def onselect(eclick, erelease):
  'eclick and erelease are matplotlib events at press and release'
  print(' startposition : (%f, %f)' % (eclick.xdata, eclick.ydata))
  print(' endposition   : (%f, %f)' % (erelease.xdata, erelease.ydata))
  print(' used button   : ', eclick.button)

def toggle_selector(event):
    print(' Key pressed.')
    if event.key in ['Q', 'q'] and toggle_selector.ES.active:
        print(' EllipseSelector deactivated.')
        toggle_selector.RS.set_active(False)
    if event.key in ['A', 'a'] and not toggle_selector.ES.active:
        print(' EllipseSelector activated.')
        toggle_selector.ES.set_active(True)

x = arange(100)/(99.0)
y = sin(x)
fig = figure
ax = subplot(111)
ax.plot(x,y)

toggle_selector.ES = EllipseSelector(ax, onselect, drawtype='line')
connect('key_press_event', toggle_selector)
show()
```

Create a selector in *ax*. When a selection is made, clear the span and call onselect with:

```
onselect(pos_1, pos_2)
```

and clear the drawn box/line. The `pos_1` and `pos_2` are arrays of length 2 containing the x- and y-coordinate.

If *minspanx* is not *None* then events smaller than *minspanx* in x direction are ignored (it's the same for y).

The rectangle is drawn with *rectprops*; default:

```
rectprops = dict(facecolor='red', edgecolor = 'black',
                 alpha=0.2, fill=True)
```

The line is drawn with *lineprops*; default:

```
lineprops = dict(color='black', linestyle='-',
                 linewidth = 2, alpha=0.5)
```

Use *drawtype* if you want the mouse to draw a line, a box or nothing between click and actual position by setting

drawtype = 'line', drawtype='box' or drawtype = 'none'. Drawing a line would result in a line from vertex A to vertex C in a rectangle ABCD.

spancoords is one of 'data' or 'pixels'. If 'data', *minspanx* and *minspanx* will be interpreted in the same coordinates as the x and y axis. If 'pixels', they are in pixels.

button is a list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is *None*, which does not limit which button can be used.

Note, typically: 1 = left mouse button 2 = center mouse button (scroll wheel) 3 = right mouse button

interactive will draw a set of handles and allow you interact with the widget after it is drawn.

state_modifier_keys are keyboard modifiers that affect the behavior of the widget.

The defaults are: dict(move=' ', clear='escape', square='shift', center='ctrl')

Keyboard modifiers, which: 'move': Move the existing shape. 'clear': Clear the current shape. 'square': Makes the shape square. 'center': Make the initial point the center of the shape. 'square' and 'center' can be combined.

draw_shape(*extents*)

class matplotlib.widgets.**Lasso**(*ax*, *xy*, *callback=None*, *useblit=True*)

Bases: *matplotlib.widgets.AxesWidget*

Selection curve of an arbitrary shape.

The selected path can be used in conjunction with *contains_point()* to select data points from an image.

Unlike *LassoSelector*, this must be initialized with a starting point xy, and the *Lasso* events are destroyed upon release.

Parameters

ax [*Axes*] The parent axes for the widget.

xy [array] Coordinates of the start of the lasso.

callback [callable] Whenever the lasso is released, the callback function is called and passed the vertices of the selected path.

onmove(*event*)

onrelease(*event*)

class matplotlib.widgets.**LassoSelector**(*ax*, *onselect=None*, *useblit=True*, *lineprops=None*, *button=None*)

Bases: matplotlib.widgets._SelectorWidget

Selection curve of an arbitrary shape.

For the selector to remain responsive you must keep a reference to it.

The selected path can be used in conjunction with *contains_point* to select data points from an image.

In contrast to *Lasso*, *LassoSelector* is written with an interface similar to *RectangleSelector* and *SpanSelector*, and will continue to interact with the axes until disconnected.

Example usage:

```
ax = subplot(111)
ax.plot(x,y)

def onselect(verts):
    print(verts)
lasso = LassoSelector(ax, onselect)
```

Parameters

ax [*Axes*] The parent axes for the widget.

onselect [function] Whenever the lasso is released, the *onselect* function is called and passed the vertices of the selected path.

button [List[Int], optional] A list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is `None`, which does not limit which button can be used.

Note, typically:

- 1 = left mouse button
- 2 = center mouse button (scroll wheel)
- 3 = right mouse button

onpress(*event*)

onrelease(*event*)

class matplotlib.widgets.**LockDraw**

Bases: `object`

Some widgets, like the cursor, draw onto the canvas, and this is not desirable under all circumstances, like when the toolbar is in zoom-to-rect mode and drawing a rectangle. The module level "lock" allows someone to grab the lock and prevent other widgets from drawing. Use `matplotlib.widgets.lock(someobj)` to prevent other widgets from drawing while you're interacting with the canvas.

available(*o*)
drawing is available to *o*

isowner(*o*)
Return True if *o* owns this lock

locked()
Return True if the lock is currently held by an owner

release(*o*)
release the lock

class matplotlib.widgets.**MultiCursor**(*canvas*, *axes*, *useblit=True*, *horizOn=False*, *vertOn=True*, ***lineprops*)
Bases: *matplotlib.widgets.Widget*

Provide a vertical (default) and/or horizontal line cursor shared between multiple axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
from matplotlib.widgets import MultiCursor
from pylab import figure, show, np

t = np.arange(0.0, 2.0, 0.01)
s1 = np.sin(2*np.pi*t)
s2 = np.sin(4*np.pi*t)
fig = figure()
ax1 = fig.add_subplot(211)
ax1.plot(t, s1)

ax2 = fig.add_subplot(212, sharex=ax1)
ax2.plot(t, s2)

multi = MultiCursor(fig.canvas, (ax1, ax2), color='r', lw=1,
                    horizOn=False, vertOn=True)
show()
```

clear(*event*)
clear the cursor

connect()
connect events

disconnect()
disconnect events

onmove(*event*)

class matplotlib.widgets.**PolygonSelector**(*ax*, *onselect*, *useblit=False*, *lineprops=None*, *markerprops=None*, *vertex_select_radius=15*)
Bases: matplotlib.widgets._SelectorWidget

Select a polygon region of an axes.

Place vertices with each mouse click, and make the selection by completing the polygon (clicking on the first vertex). Hold the *ctrl* key and click and drag a vertex to reposition it (the *ctrl* key is not necessary if the polygon has already been completed). Hold the *shift* key and click and drag anywhere in the axes to move all vertices. Press the *esc* key to start a new polygon.

For the selector to remain responsive you must keep a reference to it.

Parameters

ax [*Axes*] The parent axes for the widget.

onselect [function] When a polygon is completed or modified after completion, the `onselect` function is called and passed a list of the vertices as `(xdata, ydata)` tuples.

useblit [bool, optional]

lineprops [dict, optional] The line for the sides of the polygon is drawn with the properties given by `lineprops`. The default is `dict(color='k', linestyle='-', linewidth=2, alpha=0.5)`.

markerprops [dict, optional] The markers for the vertices of the polygon are drawn with the properties given by `markerprops`. The default is `dict(marker='o', markersize=7, mec='k', mfc='k', alpha=0.5)`.

vertex_select_radius [float, optional] A vertex is selected (to complete the polygon or to move a vertex) if the mouse click is within `vertex_select_radius` pixels of the vertex. The default radius is 15 pixels.

Examples

/gallery/widgets/polygon_selector_demo

onmove(*event*)
Cursor move event handler and validator

verts
Get the polygon vertices.

Returns

list A list of the vertices of the polygon as `(xdata, ydata)` tuples.

class matplotlib.widgets.**RadioButtons**(*ax*, *labels*, *active=0*, *activecolor='blue'*)
Bases: *matplotlib.widgets.AxesWidget*

A GUI neutral radio button.

For the buttons to remain responsive you must keep a reference to this object.

The following attributes are exposed:

ax The *matplotlib.axes.Axes* instance the buttons are in

activecolor The color of the button when clicked

labels A list of *matplotlib.text.Text* instances

circles A list of *matplotlib.patches.Circle* instances

value_selected A string listing the current value selected

Connect to the RadioButtons with the *on_clicked()* method

Add radio buttons to *matplotlib.axes.Axes* instance *ax*

labels A len(buttons) list of labels as strings

active The index into labels for the button that is active

activecolor The color of the button when clicked

disconnect(*cid*)
remove the observer with connection id *cid*

on_clicked(*func*)
When the button is clicked, call *func* with button label

A connection id is returned which can be used to disconnect

set_active(*index*)
Trigger which radio button to make active.

***index* is an index into the original label list** that this object was constructed with. Raise ValueError if the index is invalid.

Callbacks will be triggered if `eventson` is True.

class matplotlib.widgets.**RectangleSelector**(*ax*, *onselect*, *drawtype='box'*, *minspanx=None*, *minspany=None*, *useblit=False*, *lineprops=None*, *rectprops=None*, *spancoords='data'*, *button=None*, *maxdist=10*, *marker_props=None*, *interactive=False*, *state_modifier_keys=None*)

Bases: `matplotlib.widgets._SelectorWidget`

Select a rectangular region of an axes.

For the cursor to remain responsive you must keep a reference to it.

Example usage:

```
from matplotlib.widgets import  RectangleSelector
from pylab import *

def onselect(eclick, erelease):
  'eclick and erelease are matplotlib events at press and release'
  print(' startposition : (%f, %f)' % (eclick.xdata, eclick.ydata))
  print(' endposition   : (%f, %f)' % (erelease.xdata, erelease.ydata))
  print(' used button   : ', eclick.button)

def toggle_selector(event):
    print(' Key pressed.')
    if event.key in ['Q', 'q'] and toggle_selector.RS.active:
        print(' RectangleSelector deactivated.')
        toggle_selector.RS.set_active(False)
    if event.key in ['A', 'a'] and not toggle_selector.RS.active:
```

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```
        print(' RectangleSelector activated.')
        toggle_selector.RS.set_active(True)

x = arange(100)/(99.0)
y = sin(x)
fig = figure
ax = subplot(111)
ax.plot(x,y)

toggle_selector.RS = RectangleSelector(ax, onselect, drawtype='line')
connect('key_press_event', toggle_selector)
show()
```

Create a selector in *ax*. When a selection is made, clear the span and call onselect with:

```
onselect(pos_1, pos_2)
```

and clear the drawn box/line. The `pos_1` and `pos_2` are arrays of length 2 containing the x- and y-coordinate.

If *minspanx* is not *None* then events smaller than *minspanx* in x direction are ignored (it's the same for y).

The rectangle is drawn with *rectprops*; default:

```
rectprops = dict(facecolor='red', edgecolor = 'black',
                 alpha=0.2, fill=True)
```

The line is drawn with *lineprops*; default:

```
lineprops = dict(color='black', linestyle='-',
                 linewidth = 2, alpha=0.5)
```

Use *drawtype* if you want the mouse to draw a line, a box or nothing between click and actual position by setting

`drawtype = 'line'`, `drawtype='box'` or `drawtype = 'none'`. Drawing a line would result in a line from vertex A to vertex C in a rectangle ABCD.

spancoords is one of 'data' or 'pixels'. If 'data', *minspanx* and *minspanx* will be interpreted in the same coordinates as the x and y axis. If 'pixels', they are in pixels.

button is a list of integers indicating which mouse buttons should be used for rectangle selection. You can also specify a single integer if only a single button is desired. Default is *None*, which does not limit which button can be used.

Note, typically: 1 = left mouse button 2 = center mouse button (scroll wheel) 3 = right mouse button

interactive will draw a set of handles and allow you interact with the widget after it is drawn.

state_modifier_keys are keyboard modifiers that affect the behavior of the widget.

The defaults are: dict(move=' ', clear='escape', square='shift', center='ctrl')

Keyboard modifiers, which: 'move': Move the existing shape. 'clear': Clear the current shape. 'square': Makes the shape square. 'center': Make the initial point the center of the shape. 'square' and 'center' can be combined.

center
Center of rectangle

corners
Corners of rectangle from lower left, moving clockwise.

draw_shape(*extents*)

edge_centers
Midpoint of rectangle edges from left, moving clockwise.

extents
Return (xmin, xmax, ymin, ymax).

geometry
Returns numpy.ndarray of shape (2,5) containing x (`RectangleSelector.geometry[1,:]`) and y (`RectangleSelector.geometry[0,:]`) coordinates of the four corners of the rectangle starting and ending in the top left corner.

class matplotlib.widgets.**Slider**(*ax*, *label*, *valmin*, *valmax*, *valinit=0.5*, *valfmt='%1.2f'*, *closedmin=True*, *closedmax=True*, *slidermin=None*, *slidermax=None*, *dragging=True*, *valstep=None*, ***kwargs*)

Bases: *matplotlib.widgets.AxesWidget*

A slider representing a floating point range.

Create a slider from *valmin* to *valmax* in axes *ax*. For the slider to remain responsive you must maintain a reference to it. Call *on_changed()* to connect to the slider event.

Attributes

val [float] Slider value.

Parameters

ax [Axes] The Axes to put the slider in.

label [str] Slider label.

valmin [float] The minimum value of the slider.

valmax [float] The maximum value of the slider.

valinit [float, optional, default: 0.5] The slider initial position.

valfmt [str, optional, default: "%1.2f"] Used to format the slider value, fprint format string.

closedmin [bool, optional, default: True] Indicate whether the slider interval is closed on the bottom.

closedmax [bool, optional, default: True] Indicate whether the slider interval is closed on the top.

slidermin [Slider, optional, default: None] Do not allow the current slider to have a value less than the value of the Slider `slidermin`.

slidermax [Slider, optional, default: None] Do not allow the current slider to have a value greater than the value of the Slider `slidermax`.

dragging [bool, optional, default: True] If True the slider can be dragged by the mouse.

valstep [float, optional, default: None] If given, the slider will snap to multiples of `valstep`.

Notes

Additional kwargs are passed on to `self.poly` which is the *Rectangle* that draws the slider knob. See the *Rectangle* documentation for valid property names (e.g., `facecolor`, `edgecolor`, `alpha`).

`disconnect`(*cid*)
Remove the observer with connection id *cid*

Parameters

cid [int] Connection id of the observer to be removed

`on_changed`(*func*)
When the slider value is changed call *func* with the new slider value

Parameters

func [callable] Function to call when slider is changed. The function must accept a single float as its arguments.

Returns

cid [int] Connection id (which can be used to disconnect *func*)

`reset`()
Reset the slider to the initial value

`set_val`(*val*)
Set slider value to *val*

Parameters

val [float]

`class matplotlib.widgets.SpanSelector`(*ax*, *onselect*, *direction*, *minspan=None*, *useblit=False*, *rectprops=None*, *onmove_callback=None*, *span_stays=False*, *button=None*)
Bases: `matplotlib.widgets._SelectorWidget`

Visually select a min/max range on a single axis and call a function with those values.

To guarantee that the selector remains responsive, keep a reference to it.

In order to turn off the SpanSelector, set `span_selector.active=False`. To turn it back on, set `span_selector.active=True`.

Parameters

ax [*matplotlib.axes.Axes* object]

onselect [func(min, max), min/max are floats]

direction ["horizontal" or "vertical"] The axis along which to draw the span selector

minspan [float, default is None] If selection is less than *minspan*, do not call *onselect*

useblit [bool, default is False] If True, use the backend-dependent blitting features for faster canvas updates.

rectprops [dict, default is None] Dictionary of *matplotlib.patches.Patch* properties

onmove_callback [func(min, max), min/max are floats, default is None] Called on mouse move while the span is being selected

span_stays [bool, default is False] If True, the span stays visible after the mouse is released

button [int or list of ints]

Determines which mouse buttons activate the span selector 1 = left mouse button

2 = center mouse button (scroll wheel)

3 = right mouse button

Examples

```
>>> import matplotlib.pyplot as plt
>>> import matplotlib.widgets as mwidgets
>>> fig, ax = plt.subplots()
>>> ax.plot([1, 2, 3], [10, 50, 100])
>>> def onselect(vmin, vmax):
        print(vmin, vmax)
>>> rectprops = dict(facecolor='blue', alpha=0.5)
>>> span = mwidgets.SpanSelector(ax, onselect, 'horizontal',
                                 rectprops=rectprops)
>>> fig.show()
```

See also: /gallery/widgets/span_selector

ignore(*event*)

return *True* if *event* should be ignored

new_axes(*ax*)
Set SpanSelector to operate on a new Axes

class matplotlib.widgets.**SubplotTool**(*targetfig*, *toolfig*)
Bases: *matplotlib.widgets.Widget*

A tool to adjust the subplot params of a *matplotlib.figure.Figure*.

targetfig The figure instance to adjust.

toolfig The figure instance to embed the subplot tool into. If *None*, a default figure will be created. If you are using this from the GUI

funcbottom(*val*)

funchspace(*val*)

funcleft(*val*)

funcright(*val*)

functop(*val*)

funcwspace(*val*)

class matplotlib.widgets.**TextBox**(*ax*, *label*, *initial=''*, *color='.95'*, *hovercolor='1'*, *label_pad=0.01*)
Bases: *matplotlib.widgets.AxesWidget*

A GUI neutral text input box.

For the text box to remain responsive you must keep a reference to it.

The following attributes are accessible:

ax The *matplotlib.axes.Axes* the button renders into.

label A *matplotlib.text.Text* instance.

color The color of the text box when not hovering.

hovercolor The color of the text box when hovering.

Call *on_text_change()* to be updated whenever the text changes.

Call *on_submit()* to be updated whenever the user hits enter or leaves the text entry field.

Parameters

ax [matplotlib.axes.Axes] The *matplotlib.axes.Axes* instance the button will be placed into.

label [str] Label for this text box. Accepts string.

initial [str] Initial value in the text box

color [color] The color of the box

hovercolor [color] The color of the box when the mouse is over it

label_pad [float] the distance between the label and the right side of the textbox

begin_typing(*x*)

disconnect(*cid*)
remove the observer with connection id *cid*

on_submit(*func*)
When the user hits enter or leaves the submision box, call this *func* with event.

A connection id is returned which can be used to disconnect.

on_text_change(*func*)
When the text changes, call this *func* with event.

A connection id is returned which can be used to disconnect.

position_cursor(*x*)

set_val(*val*)

stop_typing()

class matplotlib.widgets.**ToolHandles**(*ax*, *x*, *y*, *marker='o'*, *marker_props=None*, *useblit=True*)

Bases: object

Control handles for canvas tools.

Parameters

ax [*matplotlib.axes.Axes*] Matplotlib axes where tool handles are displayed.

x, y [1D arrays] Coordinates of control handles.

marker [str] Shape of marker used to display handle. See *matplotlib.pyplot.plot*.

marker_props [dict] Additional marker properties. See *matplotlib.lines.Line2D*.

closest(*x*, *y*)
Return index and pixel distance to closest index.

set_animated(*val*)

set_data(*pts*, *y=None*)
Set x and y positions of handles

set_visible(*val*)

x

y

class matplotlib.widgets.**Widget**

Bases: object

Abstract base class for GUI neutral widgets

active

Is the widget active?

drawon = True

eventson = True

get_active()

Get whether the widget is active.

ignore(*event*)

Return True if event should be ignored.

This method (or a version of it) should be called at the beginning of any event callback.

set_active(*active*)

Set whether the widget is active.

pyplot	*matplotlib.pyplot* is a state-based interface to matplotlib.

CHAPTER

SEVENTYFIVE

MATPLOTLIB.PYPLOT

matplotlib.pyplot is a state-based interface to matplotlib. It provides a MATLAB-like way of plotting.

pyplot is mainly intended for interactive plots and simple cases of programmatic plot generation:

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

x = np.arange(0, 5, 0.1)
y = np.sin(x)
plt.plot(x, y)
```

The object-oriented API is recommended for more complex plots.

75.1 Functions

acorr(x[, hold, data])	Plot the autocorrelation of *x*.
angle_spectrum(x[, Fs, Fc, window, pad_to, ...])	Plot the angle spectrum.
annotate(*args, **kwargs)	Annotate the point `xy` with text `s`.
arrow(x, y, dx, dy[, hold])	Add an arrow to the axes.
autoscale([enable, axis, tight])	Autoscale the axis view to the data (toggle).
autumn()	Set the colormap to "autumn".
axes([arg])	Add an axes to the current figure and make it the current axes.
axhline([y, xmin, xmax, hold])	Add a horizontal line across the axis.
axhspan(ymin, ymax[, xmin, xmax, hold])	Add a horizontal span (rectangle) across the axis.
axis(*v, **kwargs)	Convenience method to get or set axis properties.
axvline([x, ymin, ymax, hold])	Add a vertical line across the axes.
axvspan(xmin, xmax[, ymin, ymax, hold])	Add a vertical span (rectangle) across the axes.
bar(*args, **kwargs)	Make a bar plot.
barbs(*args, **kw)	Plot a 2-D field of barbs.
barh(*args, **kwargs)	Make a horizontal bar plot.
bone()	Set the colormap to "bone".
box([on])	Turn the axes box on or off on the current axes.

Continued on next page

Table 1 – continued from previous page

boxplot(x[, notch, sym, vert, whis, ...])	Make a box and whisker plot.
broken_barh(xranges, yrange[, hold, data])	Plot a horizontal sequence of rectangles.
cla()	Clear the current axes.
clabel(CS, *args, **kwargs)	Label a contour plot.
clf()	Clear the current figure.
clim([vmin, vmax])	Set the color limits of the current image.
close(*args)	Close a figure window.
cohere(x, y[, NFFT, Fs, Fc, detrend, ...])	Plot the coherence between *x* and *y*.
colorbar([mappable, cax, ax])	Add a colorbar to a plot.
colors()	Deprecated since version 2.1.
connect(s, func)	Connect event with string *s* to *func*.
contour(*args, **kwargs)	Plot contours.
contourf(*args, **kwargs)	Plot contours.
cool()	Set the colormap to "cool".
copper()	Set the colormap to "copper".
csd(x, y[, NFFT, Fs, Fc, detrend, window, ...])	Plot the cross-spectral density.
delaxes([ax])	Remove the given `Axes` *ax* from the current figure.
disconnect(cid)	Disconnect callback id cid
draw()	Redraw the current figure.
errorbar(x, y[, yerr, xerr, fmt, ecolor, ...])	Plot y versus x as lines and/or markers with attached errorbars.
eventplot(positions[, orientation, ...])	Plot identical parallel lines at the given positions.
figimage(*args, **kwargs)	Add a non-resampled image to the figure.
figlegend(*args, **kwargs)	Place a legend in the figure.
fignum_exists(num)	
figtext(*args, **kwargs)	Add text to figure.
figure([num, figsize, dpi, facecolor, ...])	Creates a new figure.
fill(*args, **kwargs)	Plot filled polygons.
fill_between(x, y1[, y2, where, ...])	Fill the area between two horizontal curves.
fill_betweenx(y, x1[, x2, where, step, ...])	Fill the area between two vertical curves.
findobj([o, match, include_self])	Find artist objects.
flag()	Set the colormap to "flag".
gca(**kwargs)	Get the current `Axes` instance on the current figure matching the given keyword args, or create one.
gcf()	Get a reference to the current figure.
gci()	Get the current colorable artist.
get_current_fig_manager()	
get_figlabels()	Return a list of existing figure labels.
get_fignums()	Return a list of existing figure numbers.
get_plot_commands()	Get a sorted list of all of the plotting commands.
ginput(*args, **kwargs)	Blocking call to interact with a figure.
gray()	Set the colormap to "gray".
grid([b, which, axis])	Turn the axes grids on or off.

Continued on next page

Table 1 – continued from previous page

hexbin(x, y[, C, gridsize, bins, xscale, ...])	Make a hexagonal binning plot.
hist(x[, bins, range, density, weights, ...])	Plot a histogram.
hist2d(x, y[, bins, range, normed, weights, ...])	Make a 2D histogram plot.
hlines(y, xmin, xmax[, colors, linestyles, ...])	Plot horizontal lines at each *y* from *xmin* to *xmax*.
hold([b])	Deprecated since version 2.0.
hot()	Set the colormap to "hot".
hsv()	Set the colormap to "hsv".
imread(*args, **kwargs)	Read an image from a file into an array.
imsave(*args, **kwargs)	Save an array as in image file.
imshow(X[, cmap, norm, aspect, ...])	Display an image on the axes.
inferno()	Set the colormap to "inferno".
install_repl_displayhook()	Install a repl display hook so that any stale figure are automatically redrawn when control is returned to the repl.
ioff()	Turn interactive mode off.
ion()	Turn interactive mode on.
ishold()	Deprecated since version 2.0.
isinteractive()	Return status of interactive mode.
jet()	Set the colormap to "jet".
legend(*args, **kwargs)	Places a legend on the axes.
locator_params([axis, tight])	Control behavior of tick locators.
loglog(*args, **kwargs)	Make a plot with log scaling on both the x and y axis.
magma()	Set the colormap to "magma".
magnitude_spectrum(x[, Fs, Fc, window, ...])	Plot the magnitude spectrum.
margins(*args, **kw)	Set or retrieve autoscaling margins.
matshow(A[, fignum])	Display an array as a matrix in a new figure window.
minorticks_off()	Remove minor ticks from the current plot.
minorticks_on()	Display minor ticks on the current plot.
nipy_spectral()	Set the colormap to "nipy_spectral".
over(func, *args, **kwargs)	Deprecated since version 2.0.
pause(interval)	Pause for *interval* seconds.
pcolor(*args, **kwargs)	Create a pseudocolor plot with a non-regular rectangular grid.
pcolormesh(*args, **kwargs)	Create a pseudocolor plot with a non-regular rectangular grid.
phase_spectrum(x[, Fs, Fc, window, pad_to, ...])	Plot the phase spectrum.
pie(x[, explode, labels, colors, autopct, ...])	Plot a pie chart.
pink()	Set the colormap to "pink".
plasma()	Set the colormap to "plasma".
plot(*args, **kwargs)	Plot y versus x as lines and/or markers.

Continued on next page

Table 1 – continued from previous page

plot_date(x, y[, fmt, tz, xdate, ydate, ...])	Plot data that contains dates.
plotfile(fname[, cols, plotfuncs, comments, ...])	Plot the data in a file.
polar(*args, **kwargs)	Make a polar plot.
prism()	Set the colormap to "prism".
psd(x[, NFFT, Fs, Fc, detrend, window, ...])	Plot the power spectral density.
quiver(*args, **kw)	Plot a 2-D field of arrows.
quiverkey(*args, **kw)	Add a key to a quiver plot.
rc(*args, **kwargs)	Set the current rc params.
rc_context([rc, fname])	Return a context manager for managing rc settings.
rcdefaults()	Restore the rc params from Matplotlib's internal defaults.
rgrids(*args, **kwargs)	Get or set the radial gridlines on a polar plot.
savefig(*args, **kwargs)	Save the current figure.
sca(ax)	Set the current Axes instance to *ax*.
scatter(x, y[, s, c, marker, cmap, norm, ...])	A scatter plot of *y* vs *x* with varying marker size and/or color.
sci(im)	Set the current image.
semilogx(*args, **kwargs)	Make a plot with log scaling on the x axis.
semilogy(*args, **kwargs)	Make a plot with log scaling on the y axis.
set_cmap(cmap)	Set the default colormap.
setp(*args, **kwargs)	Set a property on an artist object.
show(*args, **kw)	Display a figure.
specgram(x[, NFFT, Fs, Fc, detrend, window, ...])	Plot a spectrogram.
spectral()	Set the colormap to "spectral".
spring()	Set the colormap to "spring".
spy(Z[, precision, marker, markersize, aspect])	Plot the sparsity pattern on a 2-D array.
stackplot(x, *args, **kwargs)	Draws a stacked area plot.
stem(*args, **kwargs)	Create a stem plot.
step(x, y, *args, **kwargs)	Make a step plot.
streamplot(x, y, u, v[, density, linewidth, ...])	Draws streamlines of a vector flow.
subplot(*args, **kwargs)	Return a subplot axes at the given grid position.
subplot2grid(shape, loc[, rowspan, colspan, fig])	Create an axis at specific location inside a regular grid.
subplot_tool([targetfig])	Launch a subplot tool window for a figure.
subplots([nrows, ncols, sharex, sharey, ...])	Create a figure and a set of subplots
subplots_adjust(*args, **kwargs)	Tune the subplot layout.
summer()	Set the colormap to "summer".
suptitle(*args, **kwargs)	Add a centered title to the figure.
switch_backend(newbackend)	Switch the default backend.
table(**kwargs)	Add a table to the current axes.
text(x, y, s[, fontdict, withdash])	Add text to the axes.
thetagrids(*args, **kwargs)	Get or set the theta locations of the gridlines in a polar plot.

Continued on next page

Table 1 – continued from previous page

tick_params([axis])	Change the appearance of ticks, tick labels, and gridlines.
ticklabel_format(**kwargs)	Change the ScalarFormatter used by default for linear axes.
tight_layout([pad, h_pad, w_pad, rect])	Automatically adjust subplot parameters to give specified padding.
title(s, *args, **kwargs)	Set a title of the current axes.
tricontour(*args, **kwargs)	Draw contours on an unstructured triangular grid.
tricontourf(*args, **kwargs)	Draw contours on an unstructured triangular grid.
tripcolor(*args, **kwargs)	Create a pseudocolor plot of an unstructured triangular grid.
triplot(*args, **kwargs)	Draw a unstructured triangular grid as lines and/or markers.
twinx([ax])	Make a second axes that shares the *x*-axis.
twiny([ax])	Make a second axes that shares the *y*-axis.
uninstall_repl_displayhook()	Uninstalls the matplotlib display hook.
violinplot(dataset[, positions, vert, ...])	Make a violin plot.
viridis()	Set the colormap to "viridis".
vlines(x, ymin, ymax[, colors, linestyles, ...])	Plot vertical lines.
waitforbuttonpress(*args, **kwargs)	Blocking call to interact with the figure.
winter()	Set the colormap to "winter".
xcorr(x, y[, normed, detrend, usevlines, ...])	Plot the cross correlation between *x* and *y*.
xkcd([scale, length, randomness])	Turns on xkcd sketch-style drawing mode.This will only have effect on things drawn after this function is called..
xlabel(s, *args, **kwargs)	Set the x-axis label of the current axes.
xlim(*args, **kwargs)	Get or set the x limits of the current axes.
xscale(*args, **kwargs)	Set the scaling of the x-axis.
xticks(*args, **kwargs)	Get or set the current tick locations and labels of the x-axis.
ylabel(s, *args, **kwargs)	Set the y-axis label of the current axes.
ylim(*args, **kwargs)	Get or set the y-limits of the current axes.
yscale(*args, **kwargs)	Set the scaling of the y-axis.
yticks(*args, **kwargs)	Get or set the current tick locations and labels of the y-axis.

75.1.1 matplotlib.pyplot.acorr

matplotlib.pyplot.**acorr**(*x*, *hold=None*, *data=None*, ***kwargs*)

Plot the autocorrelation of *x*.

Parameters

x [sequence of scalar]

hold [bool, optional, *deprecated*, default: True]

detrend [callable, optional, default: `mlab.detrend_none`] *x* is detrended by the

detrend callable. Default is no normalization.

normed [bool, optional, default: True] If `True`, input vectors are normalised to unit length.

usevlines [bool, optional, default: True] If `True`, `Axes.vlines` is used to plot the vertical lines from the origin to the acorr. Otherwise, `Axes.plot` is used.

maxlags [integer, optional, default: 10] Number of lags to show. If `None`, will return all `2 * len(x) - 1` lags.

Returns

lags [array (lenth `2*maxlags+1`)] lag vector.

c [array (length `2*maxlags+1`)] auto correlation vector.

line [*LineCollection* or *Line2D*] *Artist* added to the axes of the correlation.

LineCollection if *usevlines* is True *Line2D* if *usevlines* is False

b [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False

Other Parameters

linestyle [*Line2D* prop, optional, default: None] Only used if usevlines is `False`.

marker [string, optional, default: 'o']

Notes

The cross correlation is performed with `numpy.correlate()` with `mode = 2`.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

75.1.2 matplotlib.pyplot.angle_spectrum

matplotlib.pyplot.**angle_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, *hold=None*, *data=None*, ***kwargs*)

Plot the angle spectrum.

Call signature:

```
angle_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
               pad_to=None, sides='default', **kwargs)
```

Compute the angle spectrum (wrapped phase spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

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

spectrum [1-D array] The values for the angle spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color or c	any matplotlib color
contains	a callable function
dash_capstyle	['butt' | 'round' | 'projecting']

Co

Table 2 – continued from previous page

Property	Description
dash_joinstyle	['miter' | 'round' | 'bevel']
dashes	sequence of on/off ink in points
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

magnitude_spectrum() *angle_spectrum()* plots the magnitudes of the corresponding frequencies.

phase_spectrum() *phase_spectrum()* plots the unwrapped version of this function.

specgram() *specgram()* can plot the angle spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

75.1.3 matplotlib.pyplot.annotate

matplotlib.pyplot.**annotate**(**args*, ***kwargs*)

Annotate the point `xy` with text `s`.

Additional kwargs are passed to *Text*.

Parameters

s [str] The text of the annotation

xy [iterable] Length 2 sequence specifying the *(x,y)* point to annotate

xytext [iterable, optional] Length 2 sequence specifying the *(x,y)* to place the text at. If None, defaults to `xy`.

xycoords [str, Artist, Transform, callable or tuple, optional] The coordinate system that `xy` is given in.

For a `str` the allowed values are:

Property	Description
'figure points'	points from the lower left of the figure
'figure pixels'	pixels from the lower left of the figure
'figure fraction'	fraction of figure from lower left
'axes points'	points from lower left corner of axes
'axes pixels'	pixels from lower left corner of axes
'axes fraction'	fraction of axes from lower left
'data'	use the coordinate system of the object being annotated (default)
'polar'	*(theta,r)* if not native 'data' coordinates

If a *Artist* object is passed in the units are fraction if it's bounding box.

If a *Transform* object is passed in use that to transform `xy` to screen coordinates

If a callable it must take a *RendererBase* object as input and return a *Transform* or *Bbox* object

If a `tuple` must be length 2 tuple of str, `Artist`, `Transform` or callable objects. The first transform is used for the *x* coordinate and the second for *y*.

See *Advanced Annotation* for more details.

Defaults to `'data'`

textcoords [str, `Artist`, `Transform`, callable or tuple, optional] The coordinate system that `xytext` is given, which may be different than the coordinate system used for `xy`.

All `xycoords` values are valid as well as the following strings:

Property	Description
'offset points'	offset (in points) from the *xy* value
'offset pixels'	offset (in pixels) from the *xy* value

defaults to the input of `xycoords`

arrowprops [dict, optional] If not None, properties used to draw a *FancyArrowPatch* arrow between `xy` and `xytext`.

If `arrowprops` does not contain the key `'arrowstyle'` the allowed keys are:

Key	Description
width	the width of the arrow in points
headwidth	the width of the base of the arrow head in points
headlength	the length of the arrow head in points
shrink	fraction of total length to 'shrink' from both ends
?	any key to *matplotlib.patches.FancyArrowPatch*

If the `arrowprops` contains the key `'arrowstyle'` the above keys are forbidden. The allowed values of `'arrowstyle'` are:

Name	Attrs
`'-'`	None
`'->'`	head_length=0.4,head_width=0.2
`'-['`	widthB=1.0,lengthB=0.2,angleB=None
`'|-|'`	widthA=1.0,widthB=1.0
`'-|>'`	head_length=0.4,head_width=0.2
`'<-'`	head_length=0.4,head_width=0.2
`'<->'`	head_length=0.4,head_width=0.2
`'<|-'`	head_length=0.4,head_width=0.2
`'<|-|>'`	head_length=0.4,head_width=0.2
`'fancy'`	head_length=0.4,head_width=0.4,tail_width=0.4
`'simple'`	head_length=0.5,head_width=0.5,tail_width=0.2
`'wedge'`	tail_width=0.3,shrink_factor=0.5

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*

Defaults to None

annotation_clip [bool, optional] Controls the visibility of the annotation when it goes outside the axes area.

If `True`, the annotation will only be drawn when the `xy` is inside the axes. If `False`, the annotation will always be drawn regardless of its position.

The default is `None`, which behave as `True` only if *xycoords* is "data".

Returns

Annotation

Examples using `matplotlib.pyplot.annotate`

- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py
- sphx_glr_gallery_showcase_xkcd.py
- *Pyplot tutorial*

75.1.4 matplotlib.pyplot.arrow

`matplotlib.pyplot.`**`arrow`**(*x*, *y*, *dx*, *dy*, *hold=None*, ***kwargs*)

Add an arrow to the axes.

This draws an arrow from `(x, y)` to `(x+dx, y+dy)`.

Parameters

x, y [float] The x/y-coordinate of the arrow base.

dx, dy [float] The length of the arrow along x/y-direction.

Returns

arrow [*FancyArrow*] The created *FancyArrow* object.

Other Parameters

****kwargs** Optional kwargs (inherited from *FancyArrow* patch) control the arrow construction and properties:

Constructor arguments

***width*: float (default: 0.001)** width of full arrow tail

***length_includes_head*: bool (default: False)** True if head is to be counted in calculating the length.

***head_width*: float or None (default: 3*width)** total width of the full arrow head

***head_length*: float or None (default: 1.5 * head_width)** length of arrow head

***shape*: ['full', 'left', 'right'] (default: 'full')** draw the left-half, right-half, or full arrow

***overhang*: float (default: 0)** fraction that the arrow is swept back (0 overhang means triangular shape). Can be negative or greater than one.

***head_starts_at_zero*: bool (default: False)** if True, the head starts being drawn at coordinate 0 instead of ending at coordinate 0.

Other valid kwargs (inherited from :class:'Patch') are:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

Notes

The resulting arrow is affected by the axes aspect ratio and limits. This may produce an arrow whose head is not square with its stem. To create an arrow whose head is square with its stem, use *annotate()* for example:

```
>>> ax.annotate("", xy=(0.5, 0.5), xytext=(0, 0),
...             arrowprops=dict(arrowstyle="->"))
```

Examples using `matplotlib.pyplot.arrow`

- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py

75.1.5 matplotlib.pyplot.autoscale

`matplotlib.pyplot.`**`autoscale`**(*enable=True*, *axis='both'*, *tight=None*)

Autoscale the axis view to the data (toggle).

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.

Parameters

enable [bool or None, optional] True (default) turns autoscaling on, False turns it off. None leaves the autoscaling state unchanged.

axis [['both' | 'x' | 'y'], optional] which axis to operate on; default is 'both'

tight: bool or None, optional 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.

75.1.6 matplotlib.pyplot.autumn

`matplotlib.pyplot.`**`autumn`**()

Set the colormap to "autumn".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.7 matplotlib.pyplot.axes

`matplotlib.pyplot.`**`axes`**(*arg=None*, ***kwargs*)

Add an axes to the current figure and make it the current axes.

Parameters

arg [None or 4-tuple or Axes] The exact behavior of this function depends on the type:

- *None*: A new full window axes is added using `subplot(111, **kwargs)`
- 4-tuple of floats *rect* = `[left, bottom, width, height]`. A new axes is added with dimensions *rect* in normalized (0, 1) units using *add_axes* on the current figure.
- *Axes*: This is equivalent to *pyplot.sca*. It sets the current axes to *arg*. Note: This implicitly changes the current figure to the parent of *arg*.

Note: The use of an Axes as an argument is deprecated and will be removed in v3.0. Please use *pyplot.sca* instead.

Returns

axes [Axes] The created or activated axes.

Other Parameters

****kwargs :** For allowed keyword arguments see *pyplot.subplot* and *Figure.add_axes* respectively. Some common keyword arguments are listed below:

kwarg	Accepts	Description
facecolor	color	the axes background color
frameon	bool	whether to display the frame
sharex	otherax	share x-axis with *otherax*
sharey	otherax	share y-axis with *otherax*
polar	bool	whether to use polar axes
aspect	[str | num]	['equal', 'auto'] or a number. If a number, the ratio of y-unit/x-unit in screen-space. See also *set_aspect*.

Examples

Creating a new full window axes:

```
>>> plt.axes()
```

Creating a new axes with specified dimensions and some kwargs:

```
>>> plt.axes((left, bottom, width, height), facecolor='w')
```

Examples using `matplotlib.pyplot.axes`

- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_hist.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_simple_demo.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py
- sphx_glr_gallery_axes_grid1_demo_axes_hbox_divider.py
- sphx_glr_gallery_axes_grid1_make_room_for_ylabel_using_axesgrid.py

- sphx_glr_gallery_event_handling_lasso_demo.py
- sphx_glr_gallery_misc_tight_bbox_test.py
- sphx_glr_gallery_widgets_textbox.py
- sphx_glr_gallery_widgets_check_buttons.py
- sphx_glr_gallery_widgets_buttons.py
- sphx_glr_gallery_widgets_radio_buttons.py
- sphx_glr_gallery_widgets_slider_demo.py

75.1.8 matplotlib.pyplot.axhline

matplotlib.pyplot.**axhline**(*y=0*, *xmin=0*, *xmax=1*, *hold=None*, ***kwargs*)

Add a horizontal line across the axis.

Parameters

y [scalar, optional, default: 0] y position in data coordinates of the horizontal line.

xmin [scalar, optional, default: 0] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

xmax [scalar, optional, default: 1] Should be between 0 and 1, 0 being the far left of the plot, 1 the far right of the plot.

Returns

line [*Line2D*]

Other Parameters

****kwargs :** Valid kwargs are *Line2D* properties, with the exception of 'transform':

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance

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Table 3 – continued from previous page

Property	Description
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

hlines Add horizontal lines in data coordinates.

axhspan Add a horizontal span (rectangle) across the axis.

Examples

- 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 middle half of the xrange:

```
>>> axhline(y=.5, xmin=0.25, xmax=0.75)
```

Examples using `matplotlib.pyplot.axhline`

- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py
- sphx_glr_gallery_color_color_cycle_default.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_misc_zorder_demo.py

75.1.9 matplotlib.pyplot.axhspan

`matplotlib.pyplot.`**`axhspan`**(*ymin*, *ymax*, *xmin=0*, *xmax=1*, *hold=None*, ***kwargs*)

Add a horizontal span (rectangle) across the axis.

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, e.g., 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.

Parameters

ymin [float] Lower limit of the horizontal span in data units.

ymax [float] Upper limit of the horizontal span in data units.

xmin [float, optional, default: 0] Lower limit of the vertical span in axes (relative 0-1) units.

xmax [float, optional, default: 1] Upper limit of the vertical span in axes (relative 0-1) units.

Returns

Polygon [*Polygon*]

Other Parameters

****kwargs** [*Polygon* properties.]

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

See also:

axvspan Add a vertical span across the axes.

Examples using `matplotlib.pyplot.axhspan`

- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py

75.1.10 matplotlib.pyplot.axis

matplotlib.pyplot.**axis**(**v*, ***kwargs*)

Convenience method to get or set axis properties.

Calling with no arguments:

```
>>> 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.

```
>>> axis('square')
```

changes the limit ranges (*xmax-xmin*) and (*ymax-ymin*) of the *x* and *y* axes to be the same, and have the same scaling, resulting in a square plot.

The xmin, xmax, ymin, ymax tuple is returned

See also:

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

Examples using `matplotlib.pyplot.axis`

- sphx_glr_gallery_pyplots_pyplot_formatstr.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_text_labels_and_annotations_autowrap.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_font_table_ttf_sgskip.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo_kw.py
- sphx_glr_gallery_text_labels_and_annotations_text_alignment.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_contour_manual.py
- sphx_glr_gallery_misc_cursor_demo_sgskip.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- sphx_glr_gallery_widgets_slider_demo.py
- *Pyplot tutorial*

75.1.11 matplotlib.pyplot.axvline

`matplotlib.pyplot.`**`axvline`**(*x=0*, *ymin=0*, *ymax=1*, *hold=None*, ***kwargs*)

Add a vertical line across the axes.

Parameters

x [scalar, optional, default: 0] x position in data coordinates of the vertical line.

ymin [scalar, optional, default: 0] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

ymax [scalar, optional, default: 1] Should be between 0 and 1, 0 being the bottom of the plot, 1 the top of the plot.

Returns

line [*Line2D*]

Other Parameters

****kwargs :** Valid kwargs are *Line2D* properties, with the exception of 'transform':

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance

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Property	Description
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

vlines Add vertical lines in data coordinates.

axvspan Add a vertical span (rectangle) across the axis.

Examples

- 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 middle half of the yrange:

```
>>> axvline(x=.5, ymin=0.25, ymax=0.75)
```

Examples using `matplotlib.pyplot.axvline`

- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py
- sphx_glr_gallery_color_color_cycle_default.py

75.1.12 matplotlib.pyplot.axvspan

`matplotlib.pyplot.`**`axvspan`**(*xmin*, *xmax*, *ymin=0*, *ymax=1*, *hold=None*, ***kwargs*)

Add a vertical span (rectangle) across the axes.

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, e.g., 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.

Parameters

xmin [scalar] Number indicating the first X-axis coordinate of the vertical span rectangle in data units.

xmax [scalar] Number indicating the second X-axis coordinate of the vertical span rectangle in data units.

ymin [scalar, optional] Number indicating the first Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 0.

ymax [scalar, optional] Number indicating the second Y-axis coordinate of the vertical span rectangle in relative Y-axis units (0-1). Default to 1.

Returns

rectangle [matplotlib.patches.Polygon] Vertical span (rectangle) from (xmin, ymin) to (xmax, ymax).

Other Parameters

****kwargs** Optional parameters are properties of the class matplotlib.patches.Polygon.

See also:

axhspan Add a horizontal span across the axes.

Examples

Draw a vertical, green, translucent rectangle from x = 1.25 to x = 1.55 that spans the yrange of the axes.

```
>>> axvspan(1.25, 1.55, facecolor='g', alpha=0.5)
```

Examples using `matplotlib.pyplot.axvspan`

- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py

75.1.13 matplotlib.pyplot.bar

matplotlib.pyplot.**bar**(**args*, ***kwargs*)

Make a bar plot.

Call signatures:

```
bar(x, height, *, align='center', **kwargs)
bar(x, height, width, *, align='center', **kwargs)
bar(x, height, width, bottom, *, align='center', **kwargs)
```

The bars are positioned at *x* with the given *align* ment. Their dimensions are given by *width* and *height*. The vertical baseline is *bottom* (default 0).

Each of *x*, *height*, *width*, and *bottom* may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

Parameters

x [sequence of scalars] The x coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

height [scalar or sequence of scalars] The height(s) of the bars.

width [scalar or array-like, optional] The width(s) of the bars (default: 0.8).

bottom [scalar or array-like, optional] The y coordinate(s) of the bars bases (default: 0).

align [{'center', 'edge'}, optional, default: 'center'] Alignment of the bars to the *x* coordinates:

- 'center': Center the base on the *x* positions.
- 'edge': Align the left edges of the bars with the *x* positions.

To align the bars on the right edge pass a negative *width* and `align='edge'`.

Returns

container [*BarContainer*] Container with all the bars and optionally errorbars.

Other Parameters

color [scalar or array-like, optional] The colors of the bar faces.

edgecolor [scalar or array-like, optional] The colors of the bar edges.

linewidth [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

tick_label [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

xerr, yerr [scalar or array-like of shape(N,) or shape(2,N), optional] If not *None*, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (Default)

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

ecolor [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

capsize [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

error_kw [dict, optional] Dictionary of kwargs to be passed to the *errorbar* method. Values of *ecolor* or *capsize* defined here take precedence over the independent kwargs.

log [bool, optional, default: False] If *True*, set the y-axis to be log scale.

orientation [{'vertical', 'horizontal'}, optional] *This is for internal use only.* Please use *barh* for horizontal bar plots. Default: 'vertical'.

See also:

barh Plot a horizontal bar plot.

Notes

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'bottom', 'color', 'ecolor', 'edgecolor', 'height', 'left', 'linewidth', 'tick_label', 'width', 'x', 'xerr', 'y', 'yerr'.
- All positional arguments.

Examples using `matplotlib.pyplot.bar`

- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_bar.py
- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py
- sphx_glr_gallery_misc_table_demo.py
- sphx_glr_gallery_specialty_plots_system_monitor.py
- sphx_glr_gallery_ticks_and_spines_custom_ticker1.py
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75.1.14 matplotlib.pyplot.barbs

matplotlib.pyplot.**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 7.

***pivot*: ['tip' | 'middle' | float]** The part of the arrow that is at the grid point; the arrow rotates about this point, hence the name *pivot*. Default is 'tip'. Can also be a number, which shifts the start of the barb that many points from the origin.

***barbcolor*: [color | color sequence]** Specifies the color all parts of the barb except any flags. This parameter is analogous 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 analogous 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)

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Property	Description
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.pyplot.barbs`

- sphx_glr_gallery_images_contours_and_fields_barb_demo.py

75.1.15 matplotlib.pyplot.barh

`matplotlib.pyplot.`**barh**(**args*, ***kwargs*)

Make a horizontal bar plot.

Call signatures:

```
bar(y, width, *, align='center', **kwargs)
bar(y, width, height, *, align='center', **kwargs)
bar(y, width, height, left, *, align='center', **kwargs)
```

The bars are positioned at *y* with the given *align*. Their dimensions are given by *width* and *height*. The horizontal baseline is *left* (default 0).

Each of *y*, *width*, *height*, and *left* may either be a scalar applying to all bars, or it may be a sequence of length N providing a separate value for each bar.

Parameters

y [scalar or array-like] The y coordinates of the bars. See also *align* for the alignment of the bars to the coordinates.

width [scalar or array-like] The width(s) of the bars.

height [sequence of scalars, optional, default: 0.8] The heights of the bars.

left [sequence of scalars] The x coordinates of the left sides of the bars (default: 0).

align [{'center', 'edge'}, optional, default: 'center'] Alignment of the base to the *y* coordinates*:

- 'center': Center the bars on the *y* positions.
- 'edge': Align the bottom edges of the bars with the *y* positions.

To align the bars on the top edge pass a negative *height* and `align='edge'`.

Returns

container [*BarContainer*] Container with all the bars and optionally errorbars.

Other Parameters

color [scalar or array-like, optional] The colors of the bar faces.

edgecolor [scalar or array-like, optional] The colors of the bar edges.

linewidth [scalar or array-like, optional] Width of the bar edge(s). If 0, don't draw edges.

tick_label [string or array-like, optional] The tick labels of the bars. Default: None (Use default numeric labels.)

xerr, yerr [scalar or array-like of shape(N,) or shape(2,N), optional] If not `None`, add horizontal / vertical errorbars to the bar tips. The values are +/- sizes relative to the data:

- scalar: symmetric +/- values for all bars
- shape(N,): symmetric +/- values for each bar
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar. (default)

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

ecolor [scalar or array-like, optional, default: 'black'] The line color of the errorbars.

capsize [scalar, optional] The length of the error bar caps in points. Default: None, which will take the value from `rcParams["errorbar.capsize"]`.

error_kw [dict, optional] Dictionary of kwargs to be passed to the *errorbar* method. Values of *ecolor* or *capsize* defined here take precedence over the independent kwargs.

log [bool, optional, default: False] If `True`, set the x-axis to be log scale.

See also:

bar Plot a vertical bar plot.

Notes

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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float or None
animated	bool
antialiased or aa	bool or None
capstyle	['butt' | 'round' | 'projecting']
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
color	matplotlib color spec
contains	a callable function
edgecolor or ec	mpl color spec, None, 'none', or 'auto'
facecolor or fc	mpl color spec, or None for default, or 'none' for no color
figure	a *Figure* instance
fill	bool
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	['miter' | 'round' | 'bevel']
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `':'` | `'None'` | `' '` | `''`]
linewidth or lw	float or None for default
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
visible	bool
zorder	float

75.1.16 matplotlib.pyplot.bone

matplotlib.pyplot.**bone**()
Set the colormap to "bone".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.17 matplotlib.pyplot.box

matplotlib.pyplot.**box**(*on=None*)

Turn the axes box on or off on the current axes.

Parameters

on [bool or None] The new `Axes` box state. If `None`, toggle the state.

See also:

matplotlib.axes.Axes.set_frame_on(), *matplotlib.axes.Axes.get_frame_on()*

75.1.18 matplotlib.pyplot.boxplot

matplotlib.pyplot.**boxplot**(*x*, *notch=None*, *sym=None*, *vert=None*, *whis=None*, *positions=None*, *widths=None*, *patch_artist=None*, *bootstrap=None*, *usermedians=None*, *conf_intervals=None*, *meanline=None*, *showmeans=None*, *showcaps=None*, *showbox=None*, *showfliers=None*, *boxprops=None*, *labels=None*, *flierprops=None*, *medianprops=None*, *meanprops=None*, *capprops=None*, *whiskerprops=None*, *manage_xticks=True*, *autorange=False*, *zorder=None*, *hold=None*, *data=None*)

Make a box and whisker plot.

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.

Parameters

x [Array or a sequence of vectors.] The input data.

notch [bool, optional (False)] If `True`, will produce a notched box plot. Otherwise, a rectangular boxplot is produced. The notches represent the confidence interval (CI) around the median. See the entry for the `bootstrap` parameter for information regarding how the locations of the notches are computed.

Note: In cases where the values of the CI are less than the lower quartile or greater than the upper quartile, the notches will extend beyond the box, giving it a distinctive "flipped" appearance. This is expected behavior and consistent with other statistical visualization packages.

---

sym [str, optional] The default symbol for flier points. Enter an empty string (”) if you don’t want to show fliers. If `None`, then the fliers default to ’b+’ If you want more control use the flierprops kwarg.

vert [bool, optional (True)] If `True` (default), makes the boxes vertical. If `False`, everything is drawn horizontally.

whis [float, sequence, or string (default = 1.5)] As a float, determines the reach of the whiskers to the beyond the first and third quartiles. In other words, where IQR is the interquartile range (`Q3-Q1`), the upper whisker will extend to last datum less than `Q3 + whis*IQR`). Similarly, the lower whisker will extend to the first datum greater than `Q1 - whis*IQR`. Beyond the whiskers, data are considered outliers and are plotted as individual points. Set this to an unreasonably high value to force the whiskers to show the min and max values. Alternatively, set this to an ascending sequence of percentile (e.g., [5, 95]) to set the whiskers at specific percentiles of the data. Finally, `whis` can be the string `'range'` to force the whiskers to the min and max of the data.

bootstrap [int, optional] Specifies whether to bootstrap the confidence intervals around the median for notched boxplots. If `bootstrap` is None, no bootstrapping is performed, and notches are calculated using a Gaussian-based asymptotic approximation (see McGill, R., Tukey, J.W., and Larsen, W.A., 1978, and Kendall and Stuart, 1967). Otherwise, bootstrap specifies the number of times to bootstrap the median to determine its 95% confidence intervals. Values between 1000 and 10000 are recommended.

usermedians [array-like, optional] An array or sequence whose first dimension (or length) is compatible with `x`. This overrides the medians computed by matplotlib for each element of `usermedians` that is not `None`. When an element of `usermedians` is None, the median will be computed by matplotlib as normal.

conf_intervals [array-like, optional] Array or sequence whose first dimension (or length) is compatible with `x` and whose second dimension is 2. When the an element of `conf_intervals` is not None, the notch locations computed by matplotlib are overridden (provided `notch` is `True`). When an element of `conf_intervals` is `None`, the notches are computed by the method specified by the other kwargs (e.g., `bootstrap`).

positions [array-like, optional] Sets the positions of the boxes. The ticks and limits are automatically set to match the positions. Defaults to `range(1, N+1)` where N is the number of boxes to be drawn.

widths [scalar or array-like] Sets the width of each box either with a scalar or a sequence. The default is 0.5, or `0.15*(distance between extreme positions)`, if that is smaller.

patch_artist [bool, optional (False)] If `False` produces boxes with the Line2D artist. Otherwise, boxes and drawn with Patch artists.

labels [sequence, optional] Labels for each dataset. Length must be compatible with dimensions of `x`.

manage_xticks [bool, optional (True)] If the function should adjust the xlim and xtick locations.

autorange [bool, optional (False)] When `True` and the data are distributed such that the 25th and 75th percentiles are equal, `whis` is set to `'range'` such that the

whisker ends are at the minimum and maximum of the data.

meanline [bool, optional (False)] If `True` (and `showmeans` is `True`), will try to render the mean as a line spanning the full width of the box according to `meanprops` (see below). Not recommended if `shownotches` is also True. Otherwise, means will be shown as points.

zorder [scalar, optional (None)] Sets the zorder of the boxplot.

Returns

result [dict] A dictionary mapping each component of the boxplot to a list of the *matplotlib.lines.Line2D* instances created. That dictionary has the following keys (assuming vertical boxplots):

- `boxes`: the main body of the boxplot showing the quartiles and the median's confidence intervals if enabled.
- `medians`: horizontal lines at the median of each box.
- `whiskers`: the vertical lines extending to the most extreme, non-outlier data points.
- `caps`: the horizontal lines at the ends of the whiskers.
- `fliers`: points representing data that extend beyond the whiskers (fliers).
- `means`: points or lines representing the means.

Other Parameters

showcaps [bool, optional (True)] Show the caps on the ends of whiskers.

showbox [bool, optional (True)] Show the central box.

showfliers [bool, optional (True)] Show the outliers beyond the caps.

showmeans [bool, optional (False)] Show the arithmetic means.

capprops [dict, optional (None)] Specifies the style of the caps.

boxprops [dict, optional (None)] Specifies the style of the box.

whiskerprops [dict, optional (None)] Specifies the style of the whiskers.

flierprops [dict, optional (None)] Specifies the style of the fliers.

medianprops [dict, optional (None)] Specifies the style of the median.

meanprops [dict, optional (None)] Specifies the style of the mean.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

75.1.19 matplotlib.pyplot.broken_barh

matplotlib.pyplot.**broken_barh**(*xranges*, *yrange*, *hold=None*, *data=None*, ***kwargs*)

Plot a horizontal sequence of rectangles.

A rectangle is drawn for each element of *xranges*. All rectangles have the same vertical position and size defined by *yrange*.

This is a convenience function for instantiating a *BrokenBarHCollection*, adding it to the axes and autoscaling the view.

Parameters

xranges [sequence of tuples (*xmin*, *xwidth*)] The x-positions and extends of the rectangles. For each tuple (*xmin*, *xwidth*) a rectangle is drawn from *xmin* to *xmin* + *xwidth*.

yranges [(*ymin*, *ymax*)] The y-position and extend for all the rectangles.

Returns

collection [A *BrokenBarHCollection*]

Other Parameters

****kwargs** [*BrokenBarHCollection* properties] Each *kwarg* can be either a single argument applying to all rectangles, e.g.:

```
facecolors='black'
```

or a sequence of arguments over which is cycled, e.g.:

```
facecolors=('black', 'blue')
```

would create interleaving black and blue rectangles.

Supported keywords:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have vmin and vmax
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]

Table 6 – continued from previous page

Property	Description
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

75.1.20 matplotlib.pyplot.cla

matplotlib.pyplot.**cla**()
Clear the current axes.

75.1.21 matplotlib.pyplot.clabel

matplotlib.pyplot.**clabel**(*CS*, **args*, ***kwargs*)

Label a contour plot.

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*.

Parameters

fontsize [string or float, optional] Size in points or relative size e.g., 'smaller', 'x-large'. See `Text.set_size` for accepted string values.

colors : Color of each label

- 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 [bool, optional] If `True` the underlying contour is removed where the label is placed. Default is `True`.

inline_spacing [float, optional] 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 [string or dict, optional] A format string for the label. Default is '%1.3f'

Alternatively, this can be a dictionary matching contour levels with arbitrary strings to use for each contour level (i.e., fmt[level]=string), or it can be any callable, such as a *Formatter* instance, that returns a string when called with a numeric contour level.

manual [bool or iterable, optional] 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).

manual can also be an iterable object of x,y tuples. Contour labels will be created as if mouse is clicked at each x,y positions.

rightside_up [bool, optional] If `True`, label rotations will always be plus or minus 90 degrees from level. Default is `True`.

use_clabeltext [bool, optional] If `True`, `ClabelText` class (instead of `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. Default is `False`.

Examples using `matplotlib.pyplot.clabel`

- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py

75.1.22 matplotlib.pyplot.clf

`matplotlib.pyplot.`**`clf`**`()`
Clear the current figure.

Examples using `matplotlib.pyplot.clf`

- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py

75.1.23 matplotlib.pyplot.clim

`matplotlib.pyplot.`**`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)
```

75.1.24 matplotlib.pyplot.close

matplotlib.pyplot.**close**(**args*)

Close a figure window.

`close()` by itself closes the current figure

`close(fig)` closes the *Figure* instance *fig*

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

`close(name)` where *name* is a string, closes figure with that label

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

Examples using `matplotlib.pyplot.close`

- sphx_glr_gallery_subplots_axes_and_figures_subplots_demo.py
- sphx_glr_gallery_event_handling_pipong.py
- sphx_glr_gallery_misc_multipage_pdf.py
- sphx_glr_gallery_misc_multiprocess_sgskip.py
- *Tight Layout guide*

75.1.25 matplotlib.pyplot.cohere

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

Plot the coherence between *x* and *y*.

Plot the coherence between *x* and *y*. Coherence is the normalized cross spectral density:

$$C_{xy} = \frac{|P_{xy}|^2}{P_{xx}P_{yy}} \tag{75.1}$$

Parameters

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between blocks. The default value is 0 (no overlap).

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 return value is a tuple (*Cxy*, *f*), where *f* are the

frequencies of the coherence vector.

kwargs are applied to the lines.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)

Co

Table 7 – continued from previous page

Property	Description
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

References

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

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

75.1.26 matplotlib.pyplot.colorbar

matplotlib.pyplot.**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)
```

Parameters

mappable : The Image, *ContourSet*, etc. to which the colorbar applies; this argument is mandatory for the Figure *colorbar()* method but optional for the pyplot *colorbar()* function, which sets the default to the current image.

cax [*Axes* object, optional] Axes into which the colorbar will be drawn.

ax [*Axes*, list of Axes, optional] Parent axes from which space for a new colorbar axes will be stolen. If a list of axes is given they will all be resized to make room for the colorbar axes.

use_gridspec [bool, optional] If *cax* is None, a new *cax* is created as an instance of Axes. If *ax* is an instance of Subplot and *use_gridspec* is True, *cax* is created as an instance of Subplot using the grid_spec module.

Returns

:class:'~matplotlib.colorbar.Colorbar' instance See also its base class, *ColorbarBase*. Call the *set_label()* method to label the colorbar.

Notes

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 multiply the size of the colorbar
aspect	20; ratio of long to short dimensions
anchor	(0.0, 0.5) if vertical; (0.5, 1.0) if horizontal; the anchor point of the colorbar axes
panchor	(1.0, 0.5) if vertical; (0.5, 0.0) if horizontal; the anchor point of the colorbar parent axes. If False, the parent axes' anchor will be unchanged

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.
extendfrac	[*None* | 'auto' | length | lengths] If set to *None*, both the minimum and maximum triangular colorbar extensions with have a length of 5% of the interior colorbar length (this is the default setting). If set to 'auto', makes the triangular colorbar extensions the same lengths as the interior boxes (when *spacing* is set to 'uniform') or the same lengths as the respective adjacent interior boxes (when *spacing* is set to 'proportional'). If a scalar, indicates the length of both the minimum and maximum triangular colorbar extensions as a fraction of the interior colorbar length. A two-element sequence of fractions may also be given, indicating the lengths of the minimum and maximum colorbar extensions respectively as a fraction of the interior colorbar length.
extendrect	bool If *False* the minimum and maximum colorbar extensions will be triangular (the default). If *True* the extensions will be rectangular.
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	bool Whether to 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.

The *shrink* kwarg provides a simple way to scale the colorbar with respect to the axes. Note that if *cax* is specified it determines the size of the colorbar and *shrink* and *aspect* kwargs are ignored.

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.

It is known that some vector graphics viewer (svg and pdf) renders white gaps between segments of the colorbar. This is due to bugs in the viewers not matplotlib. As a workaround the colorbar can be rendered with overlapping segments:

```
cbar = colorbar()
cbar.solids.set_edgecolor("face")
draw()
```

However this has negative consequences in other circumstances. Particularly with semi transparent images (alpha < 1) and colorbar extensions and is not enabled by default see (issue #1188).

Examples using `matplotlib.pyplot.colorbar`

- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_color_colorbar_basics.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py
- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_shapes_and_collections_ellipse_collection.py
- sphx_glr_gallery_shapes_and_collections_line_collection.py
- sphx_glr_gallery_axes_grid1_simple_colorbar.py
- sphx_glr_gallery_axes_grid1_demo_colorbar_with_inset_locator.py
- sphx_glr_gallery_axes_grid1_demo_axes_divider.py
- sphx_glr_gallery_misc_contour_manual.py
- *Image tutorial*
- *Tight Layout guide*

75.1.27 matplotlib.pyplot.colors

matplotlib.pyplot.**colors**()

Deprecated since version 2.1: The colors function was deprecated in version 2.1.

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 built-in 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, facecolor=(0.1843, 0.3098, 0.3098))
```

Here is an example that creates a pale turquoise title:

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

75.1.28 matplotlib.pyplot.connect

matplotlib.pyplot.**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()`.

Examples

Usage:

```
def on_press(event):
    print('you pressed', event.button, event.xdata, event.ydata)

cid = canvas.mpl_connect('button_press_event', on_press)
```

Examples using `matplotlib.pyplot.connect`

- sphx_glr_gallery_event_handling_coords_demo.py
- sphx_glr_gallery_misc_cursor_demo_sgskip.py
- sphx_glr_gallery_user_interfaces_pylab_with_gtk_sgskip.py
- sphx_glr_gallery_widgets_rectangle_selector.py

75.1.29 matplotlib.pyplot.contour

matplotlib.pyplot.**contour**(**args*, ***kwargs*)

Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **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.

Parameters

X, Y [array-like, optional] The coordinates of the values in *Z*.

X and *Y* must both be 2-D with the same shape as *Z* (e.g. created via numpy.meshgrid()), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

Z [array-like(N, M)] The height values over which the contour is drawn.

levels [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

Returns

:class:‘~matplotlib.contour.QuadContourSet‘

Other Parameters

corner_mask [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams['contour.corner_mask']`, which defaults to `True`.

colors [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it’s repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut

does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

alpha [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

cmap [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

norm [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

vmin, vmax [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

origin [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of `Z[0, 0]`. This is only relevant, if *X*, *Y* are not given.

- *None*: `Z[0, 0]` is at X=0, Y=0 in the lower left corner.
- 'lower': `Z[0, 0]` is at X=0.5, Y=0.5 in the lower left corner.
- 'upper': `Z[0, 0]` is at X=N+0.5, Y=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`. Note: The value *None* in the rcParam is currently handled as 'lower'.

extent [(x0, x1, y0, y1), optional] 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 [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

extend [{'neither', 'both', 'min', 'max'}, optional] 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 [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

antialiased [bool, optinal] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

Nchunk [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

linewidths [float or sequence of float, optional] *Only applies to* *contour*.

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

linestyles [{*None*, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to* *contour*.

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

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.

hatches [List[str], optional] *Only applies to* *contourf*.

A list of cross hatch patterns to use on the filled areas. If None, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Notes

1. *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()*.
2. 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 using `matplotlib.pyplot.contour`

- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py

75.1.30 matplotlib.pyplot.contourf

matplotlib.pyplot.**contourf**(**args*, ***kwargs*)

Plot contours.

Call signature:

```
contour([X, Y,] Z, [levels], **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.

Parameters

X, Y [array-like, optional] The coordinates of the values in *Z*.

X and *Y* must both be 2-D with the same shape as *Z* (e.g. created via `numpy.meshgrid()`), or they must both be 1-D such that `len(X) == M` is the number of columns in *Z* and `len(Y) == N` is the number of rows in *Z*.

If not given, they are assumed to be integer indices, i.e. `X = range(M)`, `Y = range(N)`.

Z [array-like(N, M)] The height values over which the contour is drawn.

levels [int or array-like, optional] Determines the number and positions of the contour lines / regions.

If an int *n*, use *n* data intervals; i.e. draw *n+1* contour lines. The level heights are automatically chosen.

If array-like, draw contour lines at the specified levels. The values must be in increasing order.

Returns

:class:‘~matplotlib.contour.QuadContourSet‘

Other Parameters

corner_mask [bool, optional] Enable/disable corner masking, which only has an effect if *Z* is a masked array. If `False`, any quad touching a masked point is masked out. If `True`, only the triangular corners of quads nearest those points are always masked out, other triangular corners comprising three unmasked points are contoured as usual.

Defaults to `rcParams['contour.corner_mask']`, which defaults to `True`.

colors [color string or sequence of colors, optional] The colors of the levels, i.e. the lines for *contour* and the areas for *contourf*.

The sequence is cycled for the levels in ascending order. If the sequence is shorter than the number of levels, it's repeated.

As a shortcut, single color strings may be used in place of one-element lists, i.e. `'red'` instead of `['red']` to color all levels with the same color. This shortcut does only work for color strings, not for other ways of specifying colors.

By default (value *None*), the colormap specified by *cmap* will be used.

alpha [float, optional] The alpha blending value, between 0 (transparent) and 1 (opaque).

cmap [str or *Colormap*, optional] A *Colormap* instance or registered colormap name. The colormap maps the level values to colors. Defaults to `rcParams["image.cmap"]`.

If given, *colors* take precedence over *cmap*.

norm [*Normalize*, optional] If a colormap is used, the *Normalize* instance scales the level values to the canonical colormap range [0, 1] for mapping to colors. If not given, the default linear scaling is used.

vmin, vmax [float, optional] If not *None*, either or both of these values will be supplied to the *Normalize* instance, overriding the default color scaling based on *levels*.

origin [{*None*, 'upper', 'lower', 'image'}, optional] Determines the orientation and exact position of *Z* by specifying the position of `Z[0, 0]`. This is only relevant, if *X*, *Y* are not given.

- *None*: `Z[0, 0]` is at X=0, Y=0 in the lower left corner.
- 'lower': `Z[0, 0]` is at X=0.5, Y=0.5 in the lower left corner.
- 'upper': `Z[0, 0]` is at X=N+0.5, Y=0.5 in the upper left corner.
- 'image': Use the value from `rcParams["image.origin"]`. Note: The value *None* in the rcParam is currently handled as 'lower'.

extent [(x0, x1, y0, y1), optional] 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 [ticker.Locator subclass, optional] The locator is used to determine the contour levels if they are not given explicitly via *levels*. Defaults to *MaxNLocator*.

extend [{'neither', 'both', 'min', 'max'}, optional] 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 [registered units, optional] Override axis units by specifying an instance of a *matplotlib.units.ConversionInterface*.

antialiased [bool, optinal] Enable antialiasing, overriding the defaults. For filled contours, the default is *True*. For line contours, it is taken from `rcParams["lines.antialiased"]`.

Nchunk [int >= 0, optional] If 0, no subdivision of the domain. Specify a positive integer to divide the domain into subdomains of *nchunk* by *nchunk* quads. Chunking reduces the maximum length of polygons generated by the contouring algorithm which reduces the rendering workload passed on to the backend and also requires slightly less RAM. It can however introduce rendering artifacts at chunk boundaries depending on the backend, the *antialiased* flag and value of *alpha*.

linewidths [float or sequence of float, optional] *Only applies to* *contour*.

The line width of the contour lines.

If a number, all levels will be plotted with this linewidth.

If a sequence, the levels in ascending order will be plotted with the linewidths in the order specified.

Defaults to `rcParams["lines.linewidth"]`.

linestyles [{*None*, 'solid', 'dashed', 'dashdot', 'dotted'}, optional] *Only applies to* *contour*.

If *linestyles* is *None*, the default is 'solid' unless the lines are monochrome. In that case, negative contours will take their linestyle from `rcParams["contour.negative_linestyle"]` setting.

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.

hatches [List[str], optional] *Only applies to* *contourf*.

A list of cross hatch patterns to use on the filled areas. If None, no hatching will be added to the contour. Hatching is supported in the PostScript, PDF, SVG and Agg backends only.

Notes

1. *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()*.
2. 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 using `matplotlib.pyplot.contourf`

- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py

75.1.31 matplotlib.pyplot.cool

matplotlib.pyplot.**cool**()
Set the colormap to "cool".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.32 matplotlib.pyplot.copper

matplotlib.pyplot.**copper**()
Set the colormap to "copper".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.33 matplotlib.pyplot.csd

matplotlib.pyplot.**csd**(*x*, *y*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *return_line=None*, *hold=None*, *data=None*, ***kwargs*)

Plot the cross-spectral density.

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, return_line=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*. *noverlap* gives the length of the overlap between segments. The product of the direct FFTs of x and y are averaged over each segment to compute P_{xy}, with a scaling to correct for power loss due to windowing.

If len(x) < *NFFT* or len(y) < *NFFT*, they will be zero padded to *NFFT*.

Parameters

x, y [1-D arrays or sequences] Arrays or sequences containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

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.

return_line [bool] Whether to include the line object plotted in the returned values. Default is False.

Returns

Pxy [1-D array] The values for the cross spectrum `P_{xy}` before scaling (complex valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxy*

line [a *Line2D* instance] The line created by this function. Only returned if *return_line* is True.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance

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Table 8 – continued from previous page

Property	Description
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

psd() *psd()* is the equivalent to setting y=x.

Notes

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

References

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

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

75.1.34 matplotlib.pyplot.delaxes

matplotlib.pyplot.**delaxes**(*ax=None*)

Remove the given `Axes` *ax* from the current figure. If *ax* is *None*, the current axes is removed. A KeyError is raised if the axes doesn't exist.

75.1.35 matplotlib.pyplot.disconnect

matplotlib.pyplot.**disconnect**(*cid*)

Disconnect callback id cid

Examples

Usage:

```
cid = canvas.mpl_connect('button_press_event', on_press)
#...later
canvas.mpl_disconnect(cid)
```

Examples using `matplotlib.pyplot.disconnect`

- sphx_glr_gallery_event_handling_coords_demo.py

75.1.36 matplotlib.pyplot.draw

matplotlib.pyplot.**draw**()

Redraw the current figure.

This is used to update a figure that has been altered, but not automatically re-drawn. If interactive mode is on (*ion()*), this should be only rarely needed, but there may be ways to modify the state of a figure without marking it as `stale`. Please report these cases as bugs.

A more object-oriented alternative, given any *Figure* instance, `fig`, that was created using a *pyplot* function, is:

```
fig.canvas.draw_idle()
```

Examples using `matplotlib.pyplot.draw`

- sphx_glr_gallery_pyplots_whats_new_99_axes_grid.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py

- sphx_glr_gallery_text_labels_and_annotations_fancytextbox_demo.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_fancyarrow_demo.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_baseline_test.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_axes_grid1_simple_axisline4.py
- sphx_glr_gallery_axes_grid1_simple_axesgrid2.py
- sphx_glr_gallery_axes_grid1_demo_colorbar_with_inset_locator.py
- sphx_glr_gallery_axes_grid1_parasite_simple2.py
- sphx_glr_gallery_axes_grid1_scatter_hist_locatable_axes.py
- sphx_glr_gallery_axes_grid1_demo_edge_colorbar.py
- sphx_glr_gallery_axes_grid1_demo_axes_divider.py
- sphx_glr_gallery_axes_grid1_demo_axes_grid2.py
- sphx_glr_gallery_axes_grid1_demo_axes_grid.py
- sphx_glr_gallery_axisartist_demo_parasite_axes2.py
- sphx_glr_gallery_axisartist_demo_curvelinear_grid.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_cursor_demo_sgskip.py
- sphx_glr_gallery_misc_anchored_artists.py
- sphx_glr_gallery_mplot3d_rotate_axes3d.py
- sphx_glr_gallery_scales_aspect_loglog.py
- sphx_glr_gallery_widgets_textbox.py
- sphx_glr_gallery_widgets_check_buttons.py
- sphx_glr_gallery_widgets_buttons.py
- sphx_glr_gallery_widgets_radio_buttons.py

75.1.37 matplotlib.pyplot.errorbar

matplotlib.pyplot.**errorbar**(*x*, *y*, *yerr=None*, *xerr=None*, *fmt=''*, *ecolor=None*, *elinewidth=None*, *capsize=None*, *barsabove=False*, *lolims=False*, *uplims=False*, *xlolims=False*, *xuplims=False*, *errorevery=1*, *capthick=None*, *hold=None*, *data=None*, ***kwargs*)

Plot y versus x as lines and/or markers with attached errorbars.

x, *y* define the data locations, *xerr*, *yerr* define the errorbar sizes. By default, this draws the data markers/lines as well the errorbars. Use fmt='none' to draw errorbars without any data markers.

Parameters

x, y [scalar or array-like] The data positions.

xerr, yerr [scalar or array-like, shape(N,) or shape(2,N), optional] The errorbar sizes:

- scalar: Symmetric +/- values for all data points.
- shape(N,): Symmetric +/-values for each data point.
- **shape(2,N): Separate - and + values for each bar. First row** contains the lower errors, the second row contains the upper errors.
- *None*: No errorbar.

See /gallery/statistics/errorbar_features for an example on the usage of `xerr` and `yerr`.

fmt [plot format string, optional, default: ''] The format for the data points / data lines. See *plot* for details.

Use 'none' (case insensitive) to plot errorbars without any data markers.

ecolor [mpl color, optional, default: None] A matplotlib color arg which gives the color the errorbar lines. If None, use the color of the line connecting the markers.

elinewidth [scalar, optional, default: None] The linewidth of the errorbar lines. If None, the linewidth of the current style is used.

capsize [scalar, optional, default: None] The length of the error bar caps in points. If None, it will take the value from `rcParams["errorbar.capsize"]`.

capthick [scalar, optional, default: None] An alias to the keyword argument *markeredgewidth* (a.k.a. *mew*). This setting is a more sensible name for the property that controls the thickness of the error bar cap in points. For backwards compatibility, if *mew* or *markeredgewidth* are given, then they will over-ride *capthick*. This may change in future releases.

barsabove [bool, optional, default: False] If True, will plot the errorbars above the plot symbols. Default is below.

lolims, uplims, xlolims, xuplims [bool, optional, default: None] 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*. To use limits with inverted axes, `set_xlim()` or `set_ylim()` must be called before *errorbar()*.

errorevery [positive integer, optional, default: 1] Subsamples the errorbars. e.g., if errorevery=5, errorbars for every 5-th datapoint will be plotted. The data plot itself still shows all data points.

Returns

container [*ErrorbarContainer*] The container contains:

- plotline: *Line2D* instance of x, y plot markers and/or line.
- caplines: A tuple of *Line2D* instances of the error bar caps.
- barlinecols: A tuple of *LineCollection* with the horizontal and vertical error ranges.

Other Parameters

****kwargs :** All other keyword arguments are passed on to the plot command for the markers. For example, this code makes big red squares with thick green edges:

```
x,y,yerr = rand(3,10)
errorbar(x, y, yerr, marker='s', mfc='red',
         mec='green', ms=20, mew=4)
```

where *mfc*, *mec*, *ms* and *mew* are aliases for the longer property names, *markerfacecolor*, *markeredgecolor*, *markersize* and *markeredgewidth*.

Valid kwargs for the marker properties are `Lines2D` properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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

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Table 9 – continued from previous page

Property	Description
markevery	[None | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'xerr', 'y', 'yerr'.

Examples using `matplotlib.pyplot.errorbar`

- sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py

75.1.38 matplotlib.pyplot.eventplot

`matplotlib.pyplot.`**`eventplot`**(*positions*, *orientation='horizontal'*, *lineoffsets=1*, *linelengths=1*, *linewidths=None*, *colors=None*, *linestyles='solid'*, *hold=None*, *data=None*, ***kwargs*)

Plot identical parallel lines at the given positions.

positions should be a 1D or 2D array-like object, with each row corresponding to a row or column of lines.

This type of plot is commonly used in neuroscience for representing neural events, where it is usually called a spike raster, dot raster, or raster plot.

However, it is useful in any situation where you wish to show the timing or position of multiple sets of discrete events, such as the arrival times of people to a business on each day of the month or the date of hurricanes each year of the last century.

Parameters

positions [1D or 2D array-like object] Each value is an event. If *positions* is a 2D array-like, each row corresponds to a row or a column of lines (depending on the *orientation* parameter).

orientation [{'horizontal', 'vertical'}, optional] Controls the direction of the event collections:

- 'horizontal' : the lines are arranged horizontally in rows, and are vertical.
- 'vertical' : the lines are arranged vertically in columns, and are horizontal.

lineoffsets [scalar or sequence of scalars, optional, default: 1] The offset of the center of the lines from the origin, in the direction orthogonal to *orientation*.

linelengths [scalar or sequence of scalars, optional, default: 1] The total height of the lines (i.e. the lines stretches from `lineoffset - linelength/2` to `lineoffset + linelength/2`).

linewidths [scalar, scalar sequence or None, optional, default: None] The line width(s) of the event lines, in points. If it is None, defaults to its rcParams setting.

colors [color, sequence of colors or None, optional, default: None] The color(s) of the event lines. If it is None, defaults to its rcParams setting.

linestyles [str or tuple or a sequence of such values, optional] Default is 'solid'. Valid strings are ['solid', 'dashed', 'dashdot', 'dotted', '-', '–', '-.', ':']. Dash tuples should be of the form:

```
(offset, onoffseq),
```

where *onoffseq* is an even length tuple of on and off ink in points.

****kwargs** [optional] Other keyword arguments are line collection properties. See *LineCollection* for a list of the valid properties.

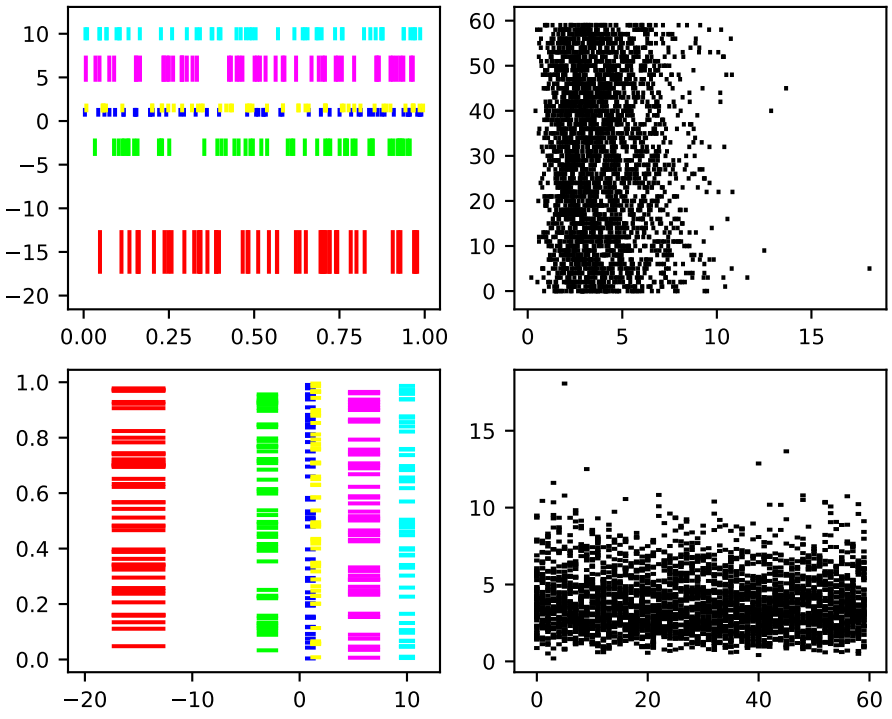
Returns

list [A list of *EventCollection* objects.] Contains the *EventCollection* that were added.

Notes

For *linelengths*, *linewidths*, *colors*, and *linestyles*, if only a single value is given, that value is applied to all lines. If an array-like is given, it must have the same length as *positions*, and each value will be applied to the corresponding row of the array.

Examples



Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'linelengths', 'lineoffsets', 'linestyles', 'linewidths', 'positions'.

75.1.39 matplotlib.pyplot.figimage

`matplotlib.pyplot.`**`figimage`**(**args*, ***kwargs*)

Add a non-resampled image to the figure.

The image is attached to the lower or upper left corner depending on *origin*.

Parameters

X The image data. This is an array of one of the following shapes:

- MxN: luminance (grayscale) values
- MxNx3: RGB values
- MxNx4: RGBA values

xo, yo [int] The *x*/*y* image offset in pixels.

alpha [None or float] The alpha blending value.

norm [*matplotlib.colors.Normalize*] A *Normalize* instance to map the luminance to the interval [0, 1].

cmap [str or *matplotlib.colors.Colormap*] The colormap to use. Default: `rcParams["image.cmap"]`.

vmin, vmax [scalar] If *norm* is not given, these values set the data limits for the colormap.

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 `rcParams["image.origin"]`.

resize [bool] If *True*, resize the figure to match the given image size.

Returns

:class:'matplotlib.image.FigureImage'

Other Parameters

****kwargs** Additional kwargs are *Artist* kwargs passed on to *FigureImage*.

Notes

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 extent [0,0,1,1].

Examples:

```
f = plt.figure()
nx = int(f.get_figwidth() * f.dpi)
ny = int(f.get_figheight() * f.dpi)
data = np.random.random((ny, nx))
f.figimage(data)
plt.show()
```

Examples using `matplotlib.pyplot.figimage`

- sphx_glr_gallery_images_contours_and_fields_figimage_demo.py

75.1.40 matplotlib.pyplot.figlegend

matplotlib.pyplot.**figlegend**(**args*, ***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.

Examples

To make a legend from existing artists on every axes:

```
figlegend()
```

To make a legend for a list of lines and labels:

```
figlegend( (line1, line2, line3),
           ('label1', 'label2', 'label3'),
           'upper right' )
```

See also:

legend()

75.1.41 matplotlib.pyplot.fignum_exists

matplotlib.pyplot.**fignum_exists**(*num*)

75.1.42 matplotlib.pyplot.figtext

matplotlib.pyplot.**figtext**(**args*, ***kwargs*)

Add text to figure.

Call signature:

```
text(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	a filter function, which takes a (m, n, 3) float array and a dpi value, and retur
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
backgroundcolor	any matplotlib color
bbox	FancyBboxPatch prop dict
clip_box	a *matplotlib.transforms.Bbox* instance
clip_on	bool

Table 10 – continued from

Property	Description
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 *Figure* instance
fontproperties or font_properties	a *matplotlib.font_manager.FontProperties* instance
gid	an id string
horizontalalignment or ha	['center' | 'right' | 'left']
label	object
linespacing	float (multiple of font size)
multialignment or ma	['left' | 'right' | 'center']
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
position	(x,y)
rasterized	bool or None
rotation	[angle in degrees | 'vertical' | 'horizontal']
rotation_mode	[None | "default" | "anchor"]
size or fontsize	[size in points | 'xx-small' | 'x-small' | 'small' | 'medium' | 'large' | 'x-large'
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
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*
url	a url string
usetex	bool or None
variant or fontvariant	['normal' | 'small-caps']
verticalalignment or va	['center' | 'top' | 'bottom' | 'baseline']
visible	bool
weight or fontweight	[a numeric value in range 0-1000 | 'ultralight' | 'light' | 'normal' | 'regular' |
wrap	bool
x	float
y	float
zorder	float

Examples using `matplotlib.pyplot.figtext`

- sphx_glr_gallery_showcase_integral.py

75.1.43 matplotlib.pyplot.figure

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

Creates a new figure.

Parameters

num [integer or string, optional, default: none] If not provided, a new figure will be created, and the figure number will be incremented. The figure objects holds this number in a `number` attribute. If num is provided, and a figure with this id already exists, make it active, and returns a reference to it. If this figure does not exists, create it and returns it. If num is a string, the window title will be set to this figure's `num`.

figsize [tuple of integers, optional, default: None] width, height in inches. If not provided, defaults to rc figure.figsize.

dpi [integer, optional, default: None] resolution of the figure. If not provided, defaults to rc figure.dpi.

facecolor : the background color. If not provided, defaults to rc figure.facecolor.

edgecolor : the border color. If not provided, defaults to rc figure.edgecolor.

frameon [bool, optional, default: True] If False, suppress drawing the figure frame.

FigureClass [class derived from matplotlib.figure.Figure] Optionally use a custom Figure instance.

clear [bool, optional, default: False] If True and the figure already exists, then it is cleared.

Returns

figure [Figure] The Figure instance returned will also be passed to new_figure_manager in the backends, which allows to hook custom Figure classes into the pylab interface. Additional kwargs will be passed to the figure init function.

Notes

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.

rcParams defines the default values, which can be modified in the matplotlibrc file

Examples using `matplotlib.pyplot.figure`

- sphx_glr_gallery_api_mathtext_asarray.py
- sphx_glr_gallery_api_sankey_links.py

- sphx_glr_gallery_api_sankey_basics.py
- sphx_glr_gallery_api_logos2.py
- sphx_glr_gallery_api_sankey_rankine.py
- sphx_glr_gallery_api_skewt.py
- sphx_glr_gallery_pyplots_fig_x.py
- sphx_glr_gallery_pyplots_pyplot_two_subplots.py
- sphx_glr_gallery_pyplots_whats_new_99_mplot3d.py
- sphx_glr_gallery_pyplots_fig_axes_labels_simple.py
- sphx_glr_gallery_pyplots_fig_axes_customize_simple.py
- sphx_glr_gallery_pyplots_annotation_polar.py
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- sphx_glr_gallery_pyplots_whats_new_99_spines.py
- sphx_glr_gallery_pyplots_compound_path_demo.py
- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_pyplots_whats_new_98_4_fancy.py
- sphx_glr_gallery_pyplots_text_layout.py
- sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py
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- sphx_glr_gallery_subplots_axes_and_figures_align_labels_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py
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- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py
- sphx_glr_gallery_images_contours_and_fields_figimage_demo.py
- sphx_glr_gallery_images_contours_and_fields_barcode_demo.py

- sphx_glr_gallery_images_contours_and_fields_layer_images.py
- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py
- sphx_glr_gallery_text_labels_and_annotations_dfrac_demo.py
- sphx_glr_gallery_text_labels_and_annotations_autowrap.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_fancyarrow_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_rotation_mode.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_font_table_ttf_sgskip.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_baseline_test.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_legend.py
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- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_showcase_mandelbrot.py
- sphx_glr_gallery_showcase_anatomy.py
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- sphx_glr_gallery_axes_grid1_demo_fixed_size_axes.py
- sphx_glr_gallery_axes_grid1_make_room_for_ylabel_using_axesgrid.py
- sphx_glr_gallery_axes_grid1_demo_axes_rgb.py
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- sphx_glr_gallery_axisartist_simple_axis_direction01.py
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- sphx_glr_gallery_axisartist_simple_axisartist1.py
- sphx_glr_gallery_axisartist_simple_axis_direction03.py
- sphx_glr_gallery_axisartist_simple_axisline2.py
- sphx_glr_gallery_axisartist_demo_axisline_style.py
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- sphx_glr_gallery_axisartist_demo_ticklabel_alignment.py
- sphx_glr_gallery_axisartist_axis_direction_demo_step02.py
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- sphx_glr_gallery_axisartist_axis_direction_demo_step03.py
- sphx_glr_gallery_axisartist_demo_parasite_axes.py
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- sphx_glr_gallery_axisartist_demo_curvelinear_grid2.py
- sphx_glr_gallery_axisartist_demo_floating_axis.py
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- sphx_glr_gallery_axisartist_simple_axis_pad.py
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- sphx_glr_gallery_axisartist_demo_floating_axes.py
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- sphx_glr_gallery_misc_svg_filter_line.py
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- sphx_glr_gallery_misc_demo_agg_filter.py
- sphx_glr_gallery_mplot3d_contourf3d.py
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- sphx_glr_gallery_mplot3d_contour3d_2.py
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- sphx_glr_gallery_mplot3d_surface3d_3.py
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- sphx_glr_gallery_mplot3d_bars3d.py
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- sphx_glr_gallery_mplot3d_2dcollections3d.py
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- sphx_glr_gallery_mplot3d_polys3d.py
- sphx_glr_gallery_mplot3d_trisurf3d_2.py
- sphx_glr_gallery_mplot3d_pathpatch3d.py
- sphx_glr_gallery_recipes_create_subplots.py
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- sphx_glr_gallery_user_interfaces_toolmanager_sgskip.py
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- sphx_glr_gallery_userdemo_demo_gridspec05.py
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- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- sphx_glr_gallery_userdemo_demo_gridspec03.py
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75.1.44 matplotlib.pyplot.fill

matplotlib.pyplot.**fill**(**args*, ***kwargs*)

Plot filled polygons.

Parameters

args [sequence of x, y, [color]] Each polygon is defined by the lists of *x* and *y* positions of its nodes, optionally followed by by a *color* specifier. See *matplotlib.colors* for supported color specifiers. The standard color cycle is used for polygons without a color specifier.

You can plot multiple polygons by providing multiple *x*, *y*, *[color]* groups.

For example, each of the following is legal:

```
ax.fill(x, y)                    # a polygon with default color
ax.fill(x, y, "b")               # a blue polygon
ax.fill(x, y, x2, y2)            # two polygons
ax.fill(x, y, "b", x2, y2, "r")  # a blue and a red polygon
```

Returns

a list of :class:‘~matplotlib.patches.Polygon‘

Other Parameters

****kwargs** [*Polygon* properties]

Notes

Use *fill_between()* if you would like to fill the region between two curves.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Examples using `matplotlib.pyplot.fill`

- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_fill_spiral.py

75.1.45 matplotlib.pyplot.fill_between

`matplotlib.pyplot.`**`fill_between`**(*x*, *y1*, *y2=0*, *where=None*, *interpolate=False*, *step=None*, *hold=None*, *data=None*, ***kwargs*)

Fill the area between two horizontal curves.

The curves are defined by the points (*x*, *y1*) and (*x*, *y2*). This creates one or multiple polygons describing the filled area.

You may exclude some horizontal sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *x*.

Parameters

x [array (length N)] The x coordinates of the nodes defining the curves.

y1 [array (length N) or scalar] The y coordinates of the nodes defining the first curve.

y2 [array (length N) or scalar, optional, default: 0] The y coordinates of the nodes defining the second curve.

where [array of bool (length N), optional, default: None] Define *where* to exclude some horizontal regions from being filled. The filled regions are defined by the coordinates `x[where]`. More precisely, fill between `x[i]` and `x[i+1]` if `where[i] and where[i+1]`. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

interpolate [bool, optional] This option is only relvant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for *y1* > *y2* or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *x* array. Such a polygon cannot describe the above semantics close to the intersection. The x-sections containing the intersecion are simply clipped.

Setting *interpolate* to *True* will calculate the actual interscection point and extend the filled region up to this point.

step [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between *x*. The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

'.PolyCollection' A *PolyCollection* containing the plotted polygons.

Other Parameters

****kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points

Table 11 – continued from previous page

Property	Description
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

fill_betweenx Fill between two sets of x-values.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x', 'y1', 'y2'.

Examples using `matplotlib.pyplot.fill_between`

- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py

75.1.46 matplotlib.pyplot.fill_betweenx

`matplotlib.pyplot.`**`fill_betweenx`**(*y*, *x1*, *x2=0*, *where=None*, *step=None*, *interpolate=False*, *hold=None*, *data=None*, ***kwargs*)

Fill the area between two vertical curves.

The curves are defined by the points (*x1*, *y*) and (*x2*, *y*). This creates one or multiple polygons describing the filled area.

You may exclude some vertical sections from filling using *where*.

By default, the edges connect the given points directly. Use *step* if the filling should be a step function, i.e. constant in between *y*.

Parameters

y [array (length N)] The y coordinates of the nodes defining the curves.

x1 [array (length N) or scalar] The x coordinates of the nodes defining the first curve.

x2 [array (length N) or scalar, optional, default: 0] The x coordinates of the nodes defining the second curve.

where [array of bool (length N), optional, default: None] Define *where* to exclude some vertical regions from being filled. The filled regions are defined by the coordinates `y[where]`. More precisely, fill between `y[i]` and `y[i+1]` if `where[i] and where[i+1]`. Note that this definition implies that an isolated *True* value between two *False* values in *where* will not result in filling. Both sides of the *True* position remain unfilled due to the adjacent *False* values.

interpolate [bool, optional] This option is only relvant if *where* is used and the two curves are crossing each other.

Semantically, *where* is often used for *x1 > x2* or similar. By default, the nodes of the polygon defining the filled region will only be placed at the positions in the *y* array. Such a polygon cannot describe the above semantics close to the intersection. The y-sections containing the intersecion are simply clipped.

Setting *interpolate* to *True* will calculate the actual interscection point and extend the filled region up to this point.

step [{'pre', 'post', 'mid'}, optional] Define *step* if the filling should be a step function, i.e. constant in between *y*. The value determines where the step will occur:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

'.PolyCollection' A *PolyCollection* containing the plotted polygons.

Other Parameters

****kwargs** All other keyword arguments are passed on to *PolyCollection*. They control the *Polygon* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]

Table 12 – continued from previous page

Property	Description
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

fill_between Fill between two sets of y-values.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'where', 'x1', 'x2', 'y'.

75.1.47 matplotlib.pyplot.findobj

matplotlib.pyplot.**findobj**(*o=None*, *match=None*, *include_self=True*)

Find artist objects.

Recursively find all *Artist* instances contained in self.

match can be

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

If *include_self* is True (default), include self in the list to be checked for a match.

75.1.48 matplotlib.pyplot.flag

matplotlib.pyplot.**flag**()
Set the colormap to "flag".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.49 matplotlib.pyplot.gca

matplotlib.pyplot.**gca**(***kwargs*)
Get the current *Axes* instance on the current figure matching the given keyword args, or create one.

See also:

matplotlib.figure.Figure.gca The figure's gca method.

Examples

To get the current polar axes on the current figure:

```
plt.gca(projection='polar')
```

If the current axes doesn't exist, or isn't a polar one, the appropriate axes will be created and then returned.

Examples using `matplotlib.pyplot.gca`

- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py
- sphx_glr_gallery_text_labels_and_annotations_rainbow_text.py

- sphx_glr_gallery_text_labels_and_annotations_text_alignment.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_axes_grid1_simple_anchored_artists.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_set_and_get.py
- sphx_glr_gallery_misc_contour_manual.py
- sphx_glr_gallery_misc_anchored_artists.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- sphx_glr_gallery_specialty_plots_hinton_demo.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- *Pyplot tutorial*
- *Legend guide*
- *Tight Layout guide*

75.1.50 matplotlib.pyplot.gcf

matplotlib.pyplot.**gcf**()
Get a reference to the current figure.

Examples using `matplotlib.pyplot.gcf`

- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py
- *Tight Layout guide*

75.1.51 matplotlib.pyplot.gci

matplotlib.pyplot.**gci**()
Get the current colorable artist. Specifically, returns 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.

75.1.52 matplotlib.pyplot.get_current_fig_manager

matplotlib.pyplot.**get_current_fig_manager**()

Examples using matplotlib.pyplot.get_current_fig_manager

- sphx_glr_gallery_misc_agg_buffer.py
- sphx_glr_gallery_user_interfaces_pylab_with_gtk_sgskip.py

75.1.53 matplotlib.pyplot.get_figlabels

matplotlib.pyplot.**get_figlabels**()
Return a list of existing figure labels.

75.1.54 matplotlib.pyplot.get_fignums

matplotlib.pyplot.**get_fignums**()
Return a list of existing figure numbers.

75.1.55 matplotlib.pyplot.get_plot_commands

matplotlib.pyplot.**get_plot_commands**()
Get a sorted list of all of the plotting commands.

75.1.56 matplotlib.pyplot.ginput

matplotlib.pyplot.**ginput**(**args*, ***kwargs*)
Blocking call to interact with a figure.

Wait until the user clicks *n* times on the figure, and return the coordinates of each click in a list.

The buttons used for the various actions (adding points, removing points, terminating the inputs) can be overridden via the arguments *mouse_add*, *mouse_pop* and *mouse_stop*, that give the associated mouse button: 1 for left, 2 for middle, 3 for right.

Parameters

n [int, optional, default: 1] Number of mouse clicks to accumulate. If negative, accumulate clicks until the input is terminated manually.

timeout [scalar, optional, default: 30] Number of seconds to wait before timing out. If zero or negative will never timeout.

show_clicks [bool, optional, default: False] If True, show a red cross at the location of each click.

mouse_add [int, one of (1, 2, 3), optional, default: 1 (left click)] Mouse button used to add points.

mouse_pop [int, one of (1, 2, 3), optional, default: 3 (right click)] Mouse button used to remove the most recently added point.

mouse_stop [int, one of (1, 2, 3), optional, default: 2 (middle click)] Mouse button used to stop input.

Returns

points [list of tuples] A list of the clicked (x, y) coordinates.

Notes

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.

Examples using `matplotlib.pyplot.ginput`

- sphx_glr_gallery_event_handling_ginput_demo_sgskip.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py

75.1.57 matplotlib.pyplot.gray

`matplotlib.pyplot.`**`gray`**`()`

Set the colormap to "gray".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.58 matplotlib.pyplot.grid

`matplotlib.pyplot.`**`grid`**`(`*b=None*, *which='major'*, *axis='both'*, ***kwargs*`)`

Turn the axes grids on or off.

Set the axes grids on or off; *b* is a boolean.

If *b* is *None* and `len(kwargs)==0`, toggle the grid state. If *kwargs* are supplied, it is assumed that you want a grid and *b* is thus set to *True*.

which can be 'major' (default), 'minor', or 'both' to control whether major tick grids, minor tick grids, or both are affected.

axis can be 'both' (default), 'x', or 'y' to control which set of gridlines are drawn.

kwargs are used to set the grid line properties, e.g.,:

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

Valid *Line2D* kwargs are

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

Examples using `matplotlib.pyplot.grid`

- sphx_glr_gallery_api_skewt.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py
- sphx_glr_gallery_misc_customize_rc.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_custom_projection.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- *Pyplot tutorial*

75.1.59 matplotlib.pyplot.hexbin

matplotlib.pyplot.**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='face'*, *reduce_C_function=<function mean>*, *mincnt=None*, *marginals=False*, *hold=None*, *data=None*, ***kwargs*)

Make a hexagonal binning plot.

Make a hexagonal binning plot of *x* versus *y*, where *x*, *y* are 1-D sequences of the same length, *N*. If *C* is *None* (the default), this is a histogram of the number of occurrences of the observations at (x[i],y[i]).

If *C* is specified, it specifies values at the coordinate (x[i],y[i]). These values are accumulated for each hexagonal bin and then reduced according to *reduce_C_function*, which defaults to numpy's mean function (np.mean). (If *C* is specified, it must also be a 1-D sequence of the same length as *x* and *y*.)

Parameters

x, y [array or masked array]

C [array or masked array, optional, default is *None*]

gridsize [int or (int, int), optional, default is 100] 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 [{'log'} or int or sequence, optional, default is *None*] 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'}, optional, default is 'linear'] Use a linear or log10 scale on the horizontal axis.

yscale [{'linear', 'log'}, optional, default is 'linear'] Use a linear or log10 scale on the vertical axis.

mincnt [int > 0, optional, default is *None*] If not *None*, only display cells with more than *mincnt* number of points in the cell

marginals [bool, optional, default is *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 [scalar, optional, default is *None*] The limits of the bins. The default assigns the limits based on *gridsize*, *x*, *y*, *xscale* and *yscale*.

If *xscale* or *yscale* is set to 'log', the limits are expected to be the exponent for a power of 10. E.g. for x-limits of 1 and 50 in 'linear' scale and y-limits of 10 and 1000 in 'log' scale, enter (1, 50, 1, 3).

Order of scalars is (left, right, bottom, top).

Returns

object 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*.

Other Parameters

cmap [object, optional, default is *None*] a *matplotlib.colors.Colormap* instance. If *None*, defaults to rc `image.cmap`.

norm [object, optional, default is *None*] *matplotlib.colors.Normalize* instance is used to scale luminance data to 0,1.

vmin, vmax [scalar, optional, default is *None*] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If *None*, the min and max of the

color array *C* are used. Note if you pass a norm instance your settings for *vmin* and *vmax* will be ignored.

alpha [scalar between 0 and 1, optional, default is *None*] the alpha value for the patches

linewidths [scalar, optional, default is *None*] If *None*, defaults to 1.0.

edgecolors [{'face', 'none', *None*} or color, optional] If 'face' (the default), draws the edges in the same color as the fill color.

If 'none', no edge is drawn; this can sometimes lead to unsightly unpainted pixels between the hexagons.

If *None*, draws outlines in the default color.

If a matplotlib color arg, draws outlines in the specified color.

Notes

The standard descriptions of all the *Collection* parameters:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats

Table 14 – continued from previous page

Property	Description
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

75.1.60 matplotlib.pyplot.hist

matplotlib.pyplot.**hist**(*x*, *bins=None*, *range=None*, *density=None*, *weights=None*, *cumulative=False*, *bottom=None*, *histtype='bar'*, *align='mid'*, *orientation='vertical'*, *rwidth=None*, *log=False*, *color=None*, *label=None*, *stacked=False*, *normed=None*, *hold=None*, *data=None*, ***kwargs*)

Plot a histogram.

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.

Parameters

x [(n,) array or sequence of (n,) arrays] Input values, this takes either a single array or a sequence of arrays which are not required to be of the same length

bins [integer or sequence or 'auto', optional] If an integer is given, `bins + 1` bin edges are calculated and returned, consistent with `numpy.histogram()`.

If `bins` is a sequence, gives bin edges, including left edge of first bin and right edge of last bin. In this case, `bins` is returned unmodified.

All but the last (righthand-most) bin is half-open. In other words, if `bins` is:

```
[1, 2, 3, 4]
```

then the first bin is `[1, 2)` (including 1, but excluding 2) and the second `[2, 3)`. The last bin, however, is `[3, 4]`, which *includes* 4.

Unequally spaced bins are supported if *bins* is a sequence.

If Numpy 1.11 is installed, may also be `'auto'`.

Default is taken from the rcParam `hist.bins`.

range [tuple or None, optional] 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.

Default is `None`

density [boolean, optional] If `True`, the first element of the return tuple will be the counts normalized to form a probability density, i.e., the area (or integral) under the histogram will sum to 1. This is achieved by dividing the count by the number of observations times the bin width and not dividing by the total number of observations. If *stacked* is also `True`, the sum of the histograms is normalized to 1.

Default is `None` for both *normed* and *density*. If either is set, then that value will be used. If neither are set, then the args will be treated as `False`.

If both *density* and *normed* are set an error is raised.

weights [(n,) array_like or None, optional] 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* or *density* is `True`, the weights are normalized, so that the integral of the density over the range remains 1.

Default is `None`

cumulative [boolean, optional] 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* or *density* 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* and/or *density* is also `True`, then the histogram is normalized such that the first bin equals 1.

Default is `False`

bottom [array_like, scalar, or None] Location of the bottom baseline of each bin. If a scalar, the base line for each bin is shifted by the same amount. If an array, each bin is shifted independently and the length of bottom must match the number of bins. If None, defaults to 0.

Default is `None`

histtype [{'bar', 'barstacked', 'step', 'stepfilled'}, optional] The type of histogram to draw.

- 'bar' is a traditional bar-type histogram. If multiple data are given the bars are arranged side by side.
- 'barstacked' is a bar-type histogram where multiple data are stacked on top of each other.
- 'step' generates a lineplot that is by default unfilled.
- 'stepfilled' generates a lineplot that is by default filled.

Default is 'bar'

align [{'left', 'mid', 'right'}, optional] 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.

Default is 'mid'

orientation [{'horizontal', 'vertical'}, optional] If 'horizontal', *barh* will be used for bar-type histograms and the *bottom* kwarg will be the left edges.

rwidth [scalar or None, optional] The relative width of the bars as a fraction of the bin width. If `None`, automatically compute the width.

Ignored if *histtype* is 'step' or 'stepfilled'.

Default is `None`

log [boolean, optional] 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.

Default is `False`

color [color or array_like of colors or None, optional] Color spec or sequence of color specs, one per dataset. Default (`None`) uses the standard line color sequence.

Default is `None`

label [string or None, optional] 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.

default is `None`

stacked [boolean, optional] If `True`, multiple data are stacked on top of each other If `False` multiple data are arranged side by side if histtype is 'bar' or on top of each other if histtype is 'step'

Default is `False`

normed [bool, optional] Deprecated; use the density keyword argument instead.

Returns

n [array or list of arrays] The values of the histogram bins. See *normed* or *density* and *weights* for a description of the possible semantics. If input *x* is an array, then this is an array of length *nbins*. If input is a sequence arrays `[data1, data2,. .]`, then this is a list of arrays with the values of the histograms for each of the arrays in the same order.

bins [array] The edges of the bins. Length nbins + 1 (nbins left edges and right edge of last bin). Always a single array even when multiple data sets are passed in.

patches [list or list of lists] Silent list of individual patches used to create the histogram or list of such list if multiple input datasets.

Other Parameters

****kwargs** [*Patch* properties]

See also:

hist2d 2D histograms

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x'.

Examples using `matplotlib.pyplot.hist`

- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py
- *Image tutorial*
- *Pyplot tutorial*

75.1.61 matplotlib.pyplot.hist2d

`matplotlib.pyplot.`**`hist2d`**(*x*, *y*, *bins=10*, *range=None*, *normed=False*, *weights=None*, *cmin=None*, *cmax=None*, *hold=None*, *data=None*, ***kwargs*)

Make a 2D histogram plot.

Parameters

x, y: array_like, shape (n,) Input values

bins: [None | int | [int, int] | array_like | [array, array]] The bin specification:

- If int, the number of bins for the two dimensions (nx=ny=bins).
- If `[int, int]`, the number of bins in each dimension (nx, ny = bins).
- If array_like, the bin edges for the two dimensions (x_edges=y_edges=bins).
- If `[array, array]`, the bin edges in each dimension (x_edges, y_edges = bins).

The default value is 10.

range [array_like shape(2, 2), optional, default: None] The leftmost and rightmost edges of the bins along each dimension (if not specified explicitly in the bins parameters): `[[xmin, xmax], [ymin, ymax]]`. All values outside of this range will be considered outliers and not tallied in the histogram.

normed [boolean, optional, default: False] Normalize histogram.

weights [array_like, shape (n,), optional, default: None] An array of values w_i weighing each sample (x_i, y_i).

cmin [scalar, optional, default: None] All bins that has count less than cmin will not be displayed and these count values in the return value count histogram will also be set to nan upon return

cmax [scalar, optional, default: None] All bins that has count more than cmax will not be displayed (set to none before passing to imshow) and these count values in the return value count histogram will also be set to nan upon return

Returns

h [2D array] The bi-dimensional histogram of samples x and y. Values in x are histogrammed along the first dimension and values in y are histogrammed along the second dimension.

xedges [1D array] The bin edges along the x axis.

yedges [1D array] The bin edges along the y axis.

image [AxesImage]

Other Parameters

cmap [Colormap or str, optional] A *colors.Colormap* instance. If not set, use rc settings.

norm [Normalize, optional] A *colors.Normalize* instance is used to scale luminance data to `[0, 1]`. If not set, defaults to *colors.Normalize()*.

vmin/vmax [None or scalar, optional] Arguments passed to the *Normalize* instance.

alpha [`0 <= scalar <= 1` or `None`, optional] The alpha blending value.

See also:

hist 1D histogram plotting

Notes

- Currently `hist2d` calculates it's own axis limits, and any limits previously set are ignored.
- Rendering the histogram with a logarithmic color scale is accomplished by passing a *colors.LogNorm* instance to the *norm* keyword argument. Likewise, power-law normalization (similar in effect to gamma correction) can be accomplished with *colors.PowerNorm*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'weights', 'x', 'y'.

75.1.62 matplotlib.pyplot.hlines

matplotlib.pyplot.**hlines**(*y*, *xmin*, *xmax*, *colors='k'*, *linestyles='solid'*, *label=''*, *hold=None*, *data=None*, ***kwargs*)

Plot horizontal lines at each *y* from *xmin* to *xmax*.

Parameters

y [scalar or sequence of scalar] y-indexes where to plot the lines.

xmin, xmax [scalar or 1D array_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

colors [array_like of colors, optional, default: 'k']

linestyles [['solid' | 'dashed' | 'dashdot' | 'dotted'], optional]

label [string, optional, default: '']

Returns

lines [*LineCollection*]

Other Parameters

****kwargs** [*LineCollection* properties.]

See also:

vlines vertical lines

axhline horizontal line across the axes

In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**: * All arguments with the following names: 'colors', 'xmax', 'xmin', 'y'.

75.1.63 matplotlib.pyplot.hold

matplotlib.pyplot.**hold**(*b=None*)

Deprecated since version 2.0: pyplot.hold is deprecated. Future behavior will be consistent with the long-time default: plot commands add elements without first clearing the Axes and/or Figure.

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 add elements to the current axes. When *hold* is *False*, the current axes and figure will be cleared on the next plot command.

75.1.64 matplotlib.pyplot.hot

matplotlib.pyplot.**hot**()

Set the colormap to "hot".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.65 matplotlib.pyplot.hsv

matplotlib.pyplot.**hsv**()

Set the colormap to "hsv".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.66 matplotlib.pyplot.imread

matplotlib.pyplot.**imread**(**args*, ***kwargs*)

Read an image from a file into an array.

fname may be a string path, a valid URL, or a Python file-like object. If using a file object, it must be opened in binary mode.

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()*. Note, URL strings may not be compatible with PIL. Check the PIL documentation for more information.

Examples using `matplotlib.pyplot.imread`

- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_annotation_box.py

75.1.67 matplotlib.pyplot.imsave

matplotlib.pyplot.**imsave**(**args*, ***kwargs*)

Save an array as in image file.

The output formats available depend on the backend being used.

Parameters

fname [str or file-like] Path string 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 [array-like] An MxN (luminance), MxNx3 (RGB) or MxNx4 (RGBA) array.

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 [matplotlib.colors.Colormap, optional] For example, `cm.viridis`. If `None`, defaults to the `image.cmap` rcParam.

format [str] One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

origin [['upper' | 'lower']] Indicates whether the `(0, 0)` index of the array is in the upper left or lower left corner of the axes. Defaults to the `image.origin` rcParam.

dpi [int] The DPI to store in the metadata of the file. This does not affect the resolution of the output image.

75.1.68 matplotlib.pyplot.imshow

matplotlib.pyplot.**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*, *data=None*, ***kwargs*)

Display an image on the axes.

Parameters

X [array_like, shape (n, m) or (n, m, 3) or (n, m, 4)] Display the image in `X` to current axes. `X` may be an array or a PIL image. If `X` is an array, it can have the following shapes and types:

- MxN – values to be mapped (float or int)
- MxNx3 – RGB (float or uint8)
- MxNx4 – RGBA (float or uint8)

MxN arrays are mapped to colors based on the `norm` (mapping scalar to scalar) and the `cmap` (mapping the normed scalar to a color).

Elements of RGB and RGBA arrays represent pixels of an MxN image. All values should be in the range [0 .. 1] for floats or [0 .. 255] for integers. Out-of-range values will be clipped to these bounds.

cmap [*Colormap*, optional, default: None] If None, default to rc `image.cmap` value. `cmap` is ignored if `X` is 3-D, directly specifying RGB(A) values.

aspect [['auto' | 'equal' | scalar], optional, default: None] 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 [string, optional, default: None] 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. If `interpolation` is 'none', then no interpolation is performed on the Agg, ps and pdf backends. Other backends will fall back to 'nearest'.

norm [*Normalize*, optional, default: None] A *Normalize* instance is used to scale a 2-D float `X` input to the (0, 1) range for input to the `cmap`. If `norm` is None, use the default func:`normalize`. If `norm` is an instance of *NoNorm*, `X` must be an array of integers that index directly into the lookup table of the `cmap`.

vmin, vmax [scalar, optional, default: None] `vmin` and `vmax` are used in conjunction with norm to normalize luminance data. Note if you pass a `norm` instance, your settings for `vmin` and `vmax` will be ignored.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque). The `alpha` argument is ignored for RGBA input data.

origin [['upper' | 'lower'], optional, default: None] 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 [scalars (left, right, bottom, top), optional, default: None] The location, in data-coordinates, of the lower-left and upper-right corners. If None, the image is positioned such that the pixel centers fall on zero-based (row, column) indices.

shape [scalars (columns, rows), optional, default: None] For raw buffer images

filternorm [scalar, optional, default: 1] 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 [scalar, optional, default: 4.0] The filter radius for filters that have a radius parameter, i.e. when interpolation is one of: 'sinc', 'lanczos' or 'blackman'

Returns

image [*AxesImage*]

Other Parameters

****kwargs** [*Artist* properties.]

See also:

matshow Plot a matrix or an array as an image.

Notes

Unless *extent* is used, pixel centers will be located at integer coordinates. In other words: the origin will coincide with the center of pixel (0, 0).

Two typical representations are used for RGB images with an alpha channel:

- Straight (unassociated) alpha: R, G, and B channels represent the color of the pixel, disregarding its opacity.
- Premultiplied (associated) alpha: R, G, and B channels represent the color of the pixel, adjusted for its opacity by multiplication.

imshow expects RGB images adopting the straight (unassociated) alpha representation.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.pyplot.imshow`

- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_color_colorbar_basics.py
- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_images_contours_and_fields_barcode_demo.py

- sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py
- sphx_glr_gallery_images_contours_and_fields_layer_images.py
- sphx_glr_gallery_images_contours_and_fields_affine_image.py
- sphx_glr_gallery_images_contours_and_fields_shading_example.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py
- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py
- sphx_glr_gallery_showcase_mandelbrot.py
- *Animated image using a precomputed list of images*
- sphx_glr_gallery_misc_hyperlinks_sgskip.py
- *Image tutorial*
- *Tight Layout guide*

75.1.69 matplotlib.pyplot.inferno

matplotlib.pyplot.**inferno**()
Set the colormap to "inferno".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.70 matplotlib.pyplot.install_repl_displayhook

matplotlib.pyplot.**install_repl_displayhook**()
Install a repl display hook so that any stale figure are automatically redrawn when control is returned to the repl.

This works with IPython terminals and kernels, as well as vanilla python shells.

75.1.71 matplotlib.pyplot.ioff

matplotlib.pyplot.**ioff**()
Turn interactive mode off.

Examples using matplotlib.pyplot.ioff

- *Usage Guide*

75.1.72 matplotlib.pyplot.ion

matplotlib.pyplot.**ion**()
Turn interactive mode on.

75.1.73 matplotlib.pyplot.ishold

matplotlib.pyplot.**ishold**()
Deprecated since version 2.0: pyplot.hold is deprecated. Future behavior will be consistent with the long-time default: plot commands add elements without first clearing the Axes and/or Figure.

Return the hold status of the current axes.

75.1.74 matplotlib.pyplot.isinteractive

matplotlib.pyplot.**isinteractive**()
Return status of interactive mode.

75.1.75 matplotlib.pyplot.jet

matplotlib.pyplot.**jet**()
Set the colormap to "jet".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.76 matplotlib.pyplot.legend

matplotlib.pyplot.**legend**(**args*, ***kwargs*)
Places a legend on the axes.

Call signatures:

```
legend()
legend(labels)
legend(handles, labels)
```

The call signatures correspond to three different ways how to use this method.

1. Automatic detection of elements to be shown in the legend

The elements to be added to the legend are automatically determined, when you do not pass in any extra arguments.

In this case, the labels are taken from the artist. You can specify them either at artist creation or by calling the *set_label()* method on the artist:

```
line, = ax.plot([1, 2, 3], label='Inline label')
ax.legend()
```

or:

```
line.set_label('Label via method')
line, = ax.plot([1, 2, 3])
ax.legend()
```

Specific lines can be excluded from the automatic legend element selection by defining a label starting with an underscore. This is default for all artists, so calling `Axes.legend` without any arguments and without setting the labels manually will result in no legend being drawn.

2. Labeling existing plot elements

To make a legend for lines which already exist on the axes (via plot for instance), simply call this function with an iterable of strings, one for each legend item. For example:

```
ax.plot([1, 2, 3])
ax.legend(['A simple line'])
```

Note: This way of using is discouraged, because the relation between plot elements and labels is only implicit by their order and can easily be mixed up.

3. Explicitly defining the elements in the legend

For full control of which artists have a legend entry, it is possible to pass an iterable of legend artists followed by an iterable of legend labels respectively:

```
legend((line1, line2, line3), ('label1', 'label2', 'label3'))
```

Parameters

handles [sequence of *Artist*, optional] A list of Artists (lines, patches) to be added to the legend. Use this together with *labels*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

The length of handles and labels should be the same in this case. If they are not, they are truncated to the smaller length.

labels [sequence of strings, optional] A list of labels to show next to the artists. Use this together with *handles*, if you need full control on what is shown in the legend and the automatic mechanism described above is not sufficient.

Returns

:class:‘matplotlib.legend.Legend‘ instance

Other Parameters

loc [int or string or pair of floats, default: ’upper right’] The location of the legend. Possible 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

Alternatively can be a 2-tuple giving `x, y` of the lower-left corner of the legend in axes coordinates (in which case `bbox_to_anchor` will be ignored).

bbox_to_anchor [*BboxBase* or pair of floats] Specify any arbitrary location for the legend in `bbox_transform` coordinates (default Axes coordinates).

For example, to put the legend’s upper right hand corner in the center of the axes the following keywords can be used:

```
loc='upper right', bbox_to_anchor=(0.5, 0.5)
```

ncol [integer] The number of columns that the legend has. Default is 1.

prop [None or *matplotlib.font_manager.FontProperties* or dict] The font properties of the legend. If None (default), the current *matplotlib.rcParams* will be used.

fontsize [int or float or {’xx-small’, ’x-small’, ’small’, ’medium’, ’large’, ’x-large’, ’xx-large’}] Controls the font size of the legend. If the value is numeric the size will be the absolute font size in points. String values are relative to the current default font size. This argument is only used if `prop` is not specified.

numpoints [None or int] The number of marker points in the legend when creating a legend entry for a *Line2D* (line). Default is `None`, which will take the value from `rcParams["legend.numpoints"]`.

scatterpoints [None or int] The number of marker points in the legend when creating a legend entry for a *PathCollection* (scatter plot). Default is `None`, which will take the value from `rcParams["legend.scatterpoints"]`.

scatteryoffsets [iterable of floats] The vertical offset (relative to the font size) for the markers created for a scatter plot legend entry. 0.0 is at the base the legend text, and 1.0 is at the top. To draw all markers at the same height, set to `[0.5]`. Default is `[0.375, 0.5, 0.3125]`.

markerscale [None or int or float] The relative size of legend markers compared with the originally drawn ones. Default is `None`, which will take the value from `rcParams["legend.markerscale"]`.

markerfirst [bool] If *True*, legend marker is placed to the left of the legend label. If *False*, legend marker is placed to the right of the legend label. Default is *True*.

frameon [None or bool] Control whether the legend should be drawn on a patch (frame). Default is `None`, which will take the value from `rcParams["legend.frameon"]`.

fancybox [None or bool] Control whether round edges should be enabled around the *FancyBboxPatch* which makes up the legend's background. Default is `None`, which will take the value from `rcParams["legend.fancybox"]`.

shadow [None or bool] Control whether to draw a shadow behind the legend. Default is `None`, which will take the value from `rcParams["legend.shadow"]`.

framealpha [None or float] Control the alpha transparency of the legend's background. Default is `None`, which will take the value from `rcParams["legend.framealpha"]`. If shadow is activated and *framealpha* is `None`, the default value is ignored.

facecolor [None or "inherit" or a color spec] Control the legend's background color. Default is `None`, which will take the value from `rcParams["legend.facecolor"]`. If `"inherit"`, it will take `rcParams["axes.facecolor"]`.

edgecolor [None or "inherit" or a color spec] Control the legend's background patch edge color. Default is `None`, which will take the value from `rcParams["legend.edgecolor"]` If `"inherit"`, it will take `rcParams["axes.edgecolor"]`.

mode [{"expand", None}] If `mode` is set to `"expand"` the legend will be horizontally expanded to fill the axes area (or `bbox_to_anchor` if defines the legend's size).

bbox_transform [None or *matplotlib.transforms.Transform*] The transform for the bounding box (`bbox_to_anchor`). For a value of `None` (default) the Axes' `transAxes` transform will be used.

title [str or None] The legend's title. Default is no title (`None`).

borderpad [float or None] The fractional whitespace inside the legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderpad"]`.

labelspacing [float or None] The vertical space between the legend entries. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.labelspacing"]`.

handlelength [float or None] The length of the legend handles. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handlelength"]`.

handletextpad [float or None] The pad between the legend handle and text. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.handletextpad"]`.

borderaxespad [float or None] The pad between the axes and legend border. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.borderaxespad"]`.

columnspacing [float or None] The spacing between columns. Measured in font-size units. Default is `None`, which will take the value from `rcParams["legend.columnspacing"]`.

handler_map [dict or None] The custom dictionary mapping instances or types to a legend handler. This `handler_map` updates the default handler map found at *matplotlib.legend.Legend.get_legend_handler_map()*.

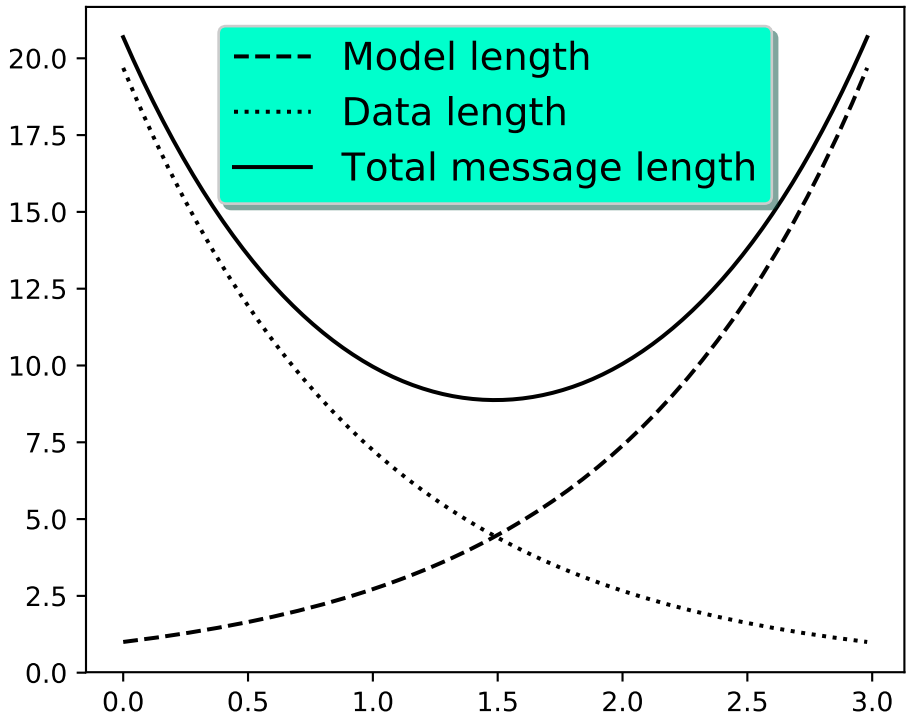
Notes

Not all kinds of artist are supported by the legend command. See *Legend guide* for details.

Examples

Examples using `matplotlib.pyplot.legend`

- sphx_glr_gallery_api_sankey_basics.py
- sphx_glr_gallery_pyplots_whats_new_98_4_legend.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_step_demo.py
- sphx_glr_gallery_lines_bars_and_markers_masked_demo.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py
- sphx_glr_gallery_axes_grid1_parasite_simple.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_zorder_demo.py



- sphx_glr_gallery_user_interfaces_pylab_with_gtk_sgskip.py
- sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py
- sphx_glr_gallery_userdemo_simple_legend01.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py
- *Usage Guide*
- *Legend guide*

75.1.77 matplotlib.pyplot.locator_params

`matplotlib.pyplot.`**`locator_params`**(*axis='both'*, *tight=None*, ***kwargs*)

Control behavior of tick locators.

Parameters

axis [['both' | 'x' | 'y'], optional] The axis on which to operate.

tight [bool or None, optional] Parameter passed to `autoscale_view()`. Default is None, for no change.

Other Parameters

****kw :** 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,

:meth:'autoscale_view' is called automatically after

the parameters are changed.

This presently works only for the

:class:'~matplotlib.ticker.MaxNLocator' used

by default on linear axes, but it may be generalized.

75.1.78 matplotlib.pyplot.loglog

matplotlib.pyplot.**loglog**(**args*, ***kwargs*)

Make a plot with log scaling on both the x and y axis.

Call signatures:

```
loglog([x], y, [fmt], data=None, **kwargs)
loglog([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes both the x-axis and the y-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basex/y*, *subsx/y* and *nonposx/y* control the x/y-axis properties. They are just forwarded to *Axes.set_xscale* and *Axes.set_yscale*.

Parameters

basex, basey [scalar, optional, default 10] Base of the x/y logarithm.

subsx, subsy [sequence, optional] The location of the minor x/y ticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_xscale* / *Axes.set_yscale* for details.

nonposx, nonposy [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in x or y can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by *plot*.

75.1.79 matplotlib.pyplot.magma

matplotlib.pyplot.**magma**()

Set the colormap to "magma".

This changes the default colormap as well as the colormap of the current image if there is one. See help(colormaps) for more information.

75.1.80 matplotlib.pyplot.magnitude_spectrum

matplotlib.pyplot.**magnitude_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, *scale=None*, *hold=None*, *data=None*, ***kwargs*)

Plot the magnitude spectrum.

Call signature:

```
magnitude_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
                   pad_to=None, sides='default', **kwargs)
```

Compute the magnitude spectrum of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

scale [['default' | 'linear' | 'dB']] The scaling of the values in the *spec*. 'linear' is no scaling. 'dB' returns the values in dB scale, i.e., the dB amplitude (20 * log10). 'default' is 'linear'.

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

spectrum [1-D array] The values for the magnitude spectrum before scaling (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | '-' | '--' | '-.' | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None

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Property	Description
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

psd() *psd()* plots the power spectral density.'.

angle_spectrum() *angle_spectrum()* plots the angles of the corresponding frequencies.

phase_spectrum() *phase_spectrum()* plots the phase (unwrapped angle) of the corresponding frequencies.

specgram() *specgram()* can plot the magnitude spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

75.1.81 matplotlib.pyplot.margins

matplotlib.pyplot.**margins**(**args*, ***kw*)

Set or retrieve autoscaling margins.

signatures:

```
margins()
```

returns xmargin, ymargin

```
margins(margin)

margins(xmargin, ymargin)
```

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```
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 padding added to the end of each interval is *margin* times the data interval. The *margin* must be a float in the range [0, 1].

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.

Examples using `matplotlib.pyplot.margins`

- sphx_glr_gallery_ticks_and_spines_ticklabels_rotation.py

75.1.82 matplotlib.pyplot.matshow

matplotlib.pyplot.**matshow**(*A*, *fignum=None*, ***kwargs*)

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.

Parameters

A [array-like(M, N)] The matrix to be displayed.

fignum [None or int or False] If *None*, create a new figure window with automatic numbering.

If *fignum* is an integer, draw into the figure with the given number (create it if it does not exist).

If 0 or *False*, use the current axes if it exists instead of creating a new figure.

Note: Because of how *Axes.matshow* tries to set the figure aspect ratio to be the one of the array, strange things may happen if you reuse an existing figure.

Returns

image [*AxesImage*]

Other Parameters

****kwargs** [*imshow* arguments]

Examples using `matplotlib.pyplot.matshow`

- sphx_glr_gallery_images_contours_and_fields_matshow.py

75.1.83 matplotlib.pyplot.minorticks_off

`matplotlib.pyplot.`**`minorticks_off`**`()`
Remove minor ticks from the current plot.

75.1.84 matplotlib.pyplot.minorticks_on

`matplotlib.pyplot.`**`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.

75.1.85 matplotlib.pyplot.nipy_spectral

`matplotlib.pyplot.`**`nipy_spectral`**`()`
Set the colormap to "nipy_spectral".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.86 matplotlib.pyplot.over

`matplotlib.pyplot.`**`over`**`(`*func*, **args*, ***kwargs*`)`
Deprecated since version 2.0: pyplot.hold is deprecated. Future behavior will be consistent with the long-time default: plot commands add elements without first clearing the Axes and/or Figure.

Call a function with hold(True).

Calls:

```
func(*args, **kwargs)
```

with `hold(True)` and then restores the hold state.

75.1.87 matplotlib.pyplot.pause

matplotlib.pyplot.**pause**(*interval*)

Pause for *interval* seconds.

If there is an active figure, it will be updated and displayed before the pause, and the GUI event loop (if any) will run during the pause.

This can be used for crude animation. For more complex animation, see *matplotlib.animation*.

Notes

This function is experimental; its behavior may be changed or extended in a future release.

Examples using matplotlib.pyplot.pause

- sphx_glr_gallery_animation_animation_demo.py
- sphx_glr_gallery_mplot3d_rotate_axes3d.py
- sphx_glr_gallery_mplot3d_wire3d_animation.py

75.1.88 matplotlib.pyplot.pcolor

matplotlib.pyplot.**pcolor**(**args*, ***kwargs*)

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

X and *Y* can be used to specify the corners of the quadrilaterals.

Hint: `pcolor()` can be very slow for large arrays. In most cases you should use the the similar but much faster *pcolormesh* instead. See there for a discussion of the differences.

Parameters

C [array_like] A scalar 2-D array. The values will be color-mapped.

X, Y [array_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i,j]` has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
                      +---------+
                      | C[i,j] |
                      +---------+
   (X[i, j], Y[i, j])          (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of *X* and *Y* should be one greater than those of *C*. Alternatively, *X*, *Y* and *C* may have equal dimensions, in which case the last row and column of *C* will be ignored.

If *X* and/or *Y* are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

cmap [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

norm [*Normalize*, optional] The Normalize instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

vmin, vmax [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

edgecolors [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or '': No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

alpha [scalar, optional, default: None] The alpha blending value of the face color, between 0 (transparent) and 1 (opaque). Note: The edgecolor is currently not affected by this.

snap [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

Returns

collection [*matplotlib.collections.Collection*]

Other Parameters

antialiaseds [bool, optional, default: False] The default *antialiaseds* is False if the default *edgecolors*="none" is used. This eliminates artificial lines at patch boundaries, and works regardless of the value of alpha. If *edgecolors* is not "none", then the default *antialiaseds* is taken from `rcParams["patch.antialiased"]`, which defaults to True. Stroking the edges may be preferred if *alpha* is 1, but will cause artifacts otherwise.

****kwargs :** Additionally, the following arguments are allowed. They are passed along to the *PolyCollection* constructor:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vma`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool
zorder	float

See also:

pcolormesh for an explanation of the differences between pcolor and pcolormesh.

imshow If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

Notes

Masked arrays

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.

Grid orientation

The grid orientation follows the standard matrix convention: An array *C* with shape (nrows, ncolumns) is plotted with the column number as *X* and the row number as *Y*.

Handling of pcolor() end-cases

`pcolor()` displays all columns of *C* if *X* and *Y* are not specified, or if *X* and *Y* have one more column than *C*. If *X* and *Y* have the same number of columns as *C* then the last column of *C* is dropped. Similarly for the rows.

Note: This behavior is different from MATLAB's `pcolor()`, which always discards the last row and column of *C*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.pyplot.pcolor`

- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py

75.1.89 matplotlib.pyplot.pcolormesh

`matplotlib.pyplot.`**pcolormesh**(**args*, ***kwargs*)

Create a pseudocolor plot with a non-regular rectangular grid.

Call signature:

```
pcolor([X, Y,] C, **kwargs)
```

X and *Y* can be used to specify the corners of the quadrilaterals.

Note: `pcolormesh()` is similar to `pcolor()`. It's much faster and preferred in most cases. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

Parameters

C [array_like] A scalar 2-D array. The values will be color-mapped.

X, Y [array_like, optional] The coordinates of the quadrilateral corners. The quadrilateral for `C[i,j]` has corners at:

```
(X[i+1, j], Y[i+1, j])          (X[i+1, j+1], Y[i+1, j+1])
                      +--------+
                      | C[i,j] |
                      +--------+
   (X[i, j], Y[i, j])          (X[i, j+1], Y[i, j+1]),
```

Note that the column index corresponds to the x-coordinate, and the row index corresponds to y. For details, see the *Notes* section below.

The dimensions of *X* and *Y* should be one greater than those of *C*. Alternatively, *X*, *Y* and *C* may have equal dimensions, in which case the last row and column of *C* will be ignored.

If *X* and/or *Y* are 1-D arrays or column vectors they will be expanded as needed into the appropriate 2-D arrays, making a rectangular grid.

cmap [str or *Colormap*, optional] A Colormap instance or registered colormap name. The colormap maps the *C* values to colors. Defaults to `rcParams["image.cmap"]`.

norm [*Normalize*, optional] The Normalize instance scales the data values to the canonical colormap range [0, 1] for mapping to colors. By default, the data range is mapped to the colorbar range using linear scaling.

vmin, vmax [scalar, optional, default: None] The colorbar range. If *None*, suitable min/max values are automatically chosen by the *Normalize* instance (defaults to the respective min/max values of *C* in case of the default linear scaling).

edgecolors [{'none', None, 'face', color, color sequence}, optional] The color of the edges. Defaults to 'none'. Possible values:

- 'none' or '': No edge.
- *None*: `rcParams["patch.edgecolor"]` will be used. Note that currently `rcParams["patch.force_edgecolor"]` has to be True for this to work.
- 'face': Use the adjacent face color.
- An mpl color or sequence of colors will set the edge color.

The singular form *edgecolor* works as an alias.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

shading [{'flat', 'gouraud'}, optional] The fill style, Possible values:

- 'flat': A solid color is used for each quad. The color of the quad (i, j), (i+1, j), (i, j+1), (i+1, j+1) is given by `C[i,j]`.
- 'gouraud': Each quad will be Gouraud shaded: The color of the corners (i', j') are given by `C[i',j']`. The color values of the area in between is interpolated from the corner values. When Gouraud shading is used, *edgecolors* is ignored.

snap [bool, optional, default: False] Whether to snap the mesh to pixel boundaries.

Returns

mesh [*matplotlib.collections.QuadMesh*]

Other Parameters

****kwargs** Additionally, the following arguments are allowed. They are passed along to the *QuadMesh* constructor:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vma`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string
urls	List[str] or None
visible	bool

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Property	Description
zorder	float

See also:

pcolor An alternative implementation with slightly different features. For a detailed discussion on the differences see *Differences between pcolor() and pcolormesh()*.

imshow If *X* and *Y* are each equidistant, *imshow* can be a faster alternative.

Notes

Masked arrays

C may be a masked array. If `C[i, j]` is masked, the corresponding quadrilateral will be transparent. Masking of *X* and *Y* is not supported. Use *pcolor* if you need this functionality.

Grid orientation

The grid orientation follows the standard matrix convention: An array *C* with shape (nrows, ncolumns) is plotted with the column number as *X* and the row number as *Y*.

Differences between pcolor() and pcolormesh()

Both methods are used to create a pseudocolor plot of a 2-D array using quadrilaterals.

The main difference lies in the created object and internal data handling: While *pcolor* returns a *PolyCollection*, *pcolormesh* returns a *QuadMesh*. The latter is more specialized for the given purpose and thus is faster. It should almost always be preferred.

There is also a slight difference in the handling of masked arrays. Both *pcolor* and *pcolormesh* support masked arrays for *C*. However, only *pcolor* supports masked arrays for *X* and *Y*. The reason lies in the internal handling of the masked values. *pcolor* leaves out the respective polygons from the PolyCollection. *pcolormesh* sets the facecolor of the masked elements to transparent. You can see the difference when using edgecolors. While all edges are drawn irrespective of masking in a QuadMesh, the edge between two adjacent masked quadrilaterals in *pcolor* is not drawn as the corresponding polygons do not exist in the PolyCollection.

Another difference is the support of Gouraud shading in *pcolormesh*, which is not available with *pcolor*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using matplotlib.pyplot.pcolormesh

- sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py

75.1.90 matplotlib.pyplot.phase_spectrum

matplotlib.pyplot.**phase_spectrum**(*x*, *Fs=None*, *Fc=None*, *window=None*, *pad_to=None*, *sides=None*, *hold=None*, *data=None*, ***kwargs*)

Plot the phase spectrum.

Call signature:

```
phase_spectrum(x, Fs=2, Fc=0,  window=mlab.window_hanning,
               pad_to=None, sides='default', **kwargs)
```

Compute the phase spectrum (unwrapped angle spectrum) of *x*. Data is padded to a length of *pad_to* and the windowing function *window* is applied to the signal.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

pad_to [integer] The number of points to which the data segment is padded when performing the FFT. While not increasing the actual resolution of the spectrum (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 the length of the input signal (i.e. no padding).

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

spectrum [1-D array] The values for the phase spectrum in radians (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *spectrum*

line [a *Line2D* instance] The line created by this function

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string

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Table 18 – continued from previous page

Property	Description
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

magnitude_spectrum() *magnitude_spectrum()* plots the magnitudes of the corresponding frequencies.

angle_spectrum() *angle_spectrum()* plots the wrapped version of this function.

specgram() *specgram()* can plot the phase spectrum of segments within the signal in a colormap.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

75.1.91 matplotlib.pyplot.pie

`matplotlib.pyplot.`**`pie`**(*x*, *explode=None*, *labels=None*, *colors=None*, *autopct=None*, *pctdistance=0.6*, *shadow=False*, *labeldistance=1.1*, *startangle=None*, *radius=None*, *counterclock=True*, *wedgeprops=None*, *textprops=None*, *center=(0, 0)*, *frame=False*, *rotatelabels=False*, *hold=None*, *data=None*)

Plot a pie chart.

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. The resulting pie will have an empty wedge of size `1 - sum(x)`.

The wedges are plotted counterclockwise, by default starting from the x-axis.

Parameters

x [array-like] The wedge sizes.

explode [array-like, optional, default: None] If not *None*, is a `len(x)` array which specifies the fraction of the radius with which to offset each wedge.

labels [list, optional, default: None] A sequence of strings providing the labels for each wedge

colors [array-like, optional, default: None] A sequence of matplotlib color args through which the pie chart will cycle. If *None*, will use the colors in the currently active cycle.

autopct [None (default), string, or function, optional] 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 [float, optional, default: 0.6] The ratio between the center of each pie slice and the start of the text generated by *autopct*. Ignored if *autopct* is *None*.

shadow [bool, optional, default: False] Draw a shadow beneath the pie.

labeldistance [float, optional, default: 1.1] The radial distance at which the pie labels are drawn

startangle [float, optional, default: None] If not *None*, rotates the start of the pie chart by *angle* degrees counterclockwise from the x-axis.

radius [float, optional, default: None] The radius of the pie, if *radius* is *None* it will be set to 1.

counterclock [bool, optional, default: True] Specify fractions direction, clockwise or counterclockwise.

wedgeprops [dict, optional, default: None] Dict of arguments passed to the wedge objects making the pie. For example, you can pass in `wedgeprops = {'linewidth': 3}` to set the width of the wedge border lines equal to 3. For more details, look at the doc/arguments of the wedge object. By default `clip_on=False`.

textprops [dict, optional, default: None] Dict of arguments to pass to the text objects.

center [list of float, optional, default: (0, 0)] Center position of the chart. Takes value (0, 0) or is a sequence of 2 scalars.

frame [bool, optional, default: False] Plot axes frame with the chart if true.

rotatelabels [bool, optional, default: False] Rotate each label to the angle of the corresponding slice if true.

Returns

patches [list] A sequence of *matplotlib.patches.Wedge* instances

texts [list] A list of the label *matplotlib.text.Text* instances.

autotexts [list] A list of *Text* instances for the numeric labels. This will only be returned if the parameter *autopct* is not *None*.

Notes

The pie chart will probably look best if the figure and axes are square, or the Axes aspect is equal.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'colors', 'explode', 'labels', 'x'.

Examples using `matplotlib.pyplot.pie`

- sphx_glr_gallery_pie_and_polar_charts_pie_features.py
- sphx_glr_gallery_pie_and_polar_charts_pie_demo2.py
- sphx_glr_gallery_pie_and_polar_charts_nested_pie.py
- sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py

75.1.92 matplotlib.pyplot.pink

matplotlib.pyplot.**pink**()
Set the colormap to "pink".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.93 matplotlib.pyplot.plasma

matplotlib.pyplot.**plasma**()
Set the colormap to "plasma".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.94 matplotlib.pyplot.plot

matplotlib.pyplot.**plot**(**args*, ***kwargs*)
Plot y versus x as lines and/or markers.

Call signatures:

```
plot([x], y, [fmt], data=None, **kwargs)
plot([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

The coordinates of the points or line nodes are given by *x*, *y*.

The optional parameter *fmt* is a convenient way for defining basic formatting like color, marker and linestyle. It's a shortcut string notation described in the *Notes* section below.

```
>>> 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
```

You can use *Line2D* properties as keyword arguments for more control on the appearance. Line properties and *fmt* can be mixed. The following two calls yield identical results:

```
>>> plot(x, y, 'go--', linewidth=2, markersize=12)
>>> plot(x, y, color='green', marker='o', linestyle='dashed',
        linewidth=2, markersize=12)
```

When conflicting with *fmt*, keyword arguments take precedence.

Plotting labelled data

There's a convenient way for plotting objects with labelled data (i.e. data that can be accessed by index `obj['y']`). Instead of giving the data in *x* and *y*, you can provide the object in the *data* parameter and just give the labels for *x* and *y*:

```
>>> plot('xlabel', 'ylabel', data=obj)
```

All indexable objects are supported. This could e.g. be a `dict`, a `pandas.DataFame` or a structured numpy array.

Plotting multiple sets of data

There are various ways to plot multiple sets of data.

- The most straight forward way is just to call *plot* multiple times. Example:

  ```
  >>> plot(x1, y1, 'bo')
  >>> plot(x2, y2, 'go')
  ```

- Alternatively, if your data is already a 2d array, you can pass it directly to *x*, *y*. A separate data set will be drawn for every column.

  Example: an array `a` where the first column represents the *x* values and the other columns are the *y* columns:

  ```
  >>> plot(a[0], a[1:])
  ```

- The third way is to specify multiple sets of *[x]*, *y*, *[fmt]* groups:

  ```
  >>> plot(x1, y1, 'g^', x2, y2, 'g-')
  ```

  In this case, any additional keyword argument applies to all datasets. Also this syntax cannot be combined with the *data* parameter.

By default, each line is assigned a different style specified by a 'style cycle'. The *fmt* and line property parameters are only necessary if you want explicit deviations from these defaults. Alternatively, you can also change the style cycle using the 'axes.prop_cycle' rcParam.

Parameters

x, y [array-like or scalar] The horizontal / vertical coordinates of the data points. *x* values are optional. If not given, they default to `[0, ..., N-1]`.

Commonly, these parameters are arrays of length N. However, scalars are supported as well (equivalent to an array with constant value).

The parameters can also be 2-dimensional. Then, the columns represent separate data sets.

fmt [str, optional] A format string, e.g. 'ro' for red circles. See the *Notes* section for a full description of the format strings.

Format strings are just an abbreviation for quickly setting basic line properties. All of these and more can also be controlled by keyword arguments.

data [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

Note: Technically there's a slight ambiguity in calls where the second label is a valid *fmt*. `plot('n', 'o', data=obj)` could be `plt(x, y)` or `plt(y, fmt)`. In such cases, the former interpretation is chosen, but a warning is issued. You may suppress the warning by adding an empty format string `plot('n', 'o', '', data=obj)`.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

scalex, scaley [bool, optional, default: True] These parameters determined if the view limits are adapted to the data limits. The values are passed on to `autoscale_view`.

****kwargs** [*Line2D* properties, optional] *kwargs* are used to specify properties like a line label (for auto legends), linewidth, antialiasing, marker face color. 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')
```

If you make multiple lines with one plot command, the kwargs apply to all those lines.

Here is a list of available *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance

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Table 19 – continued from previous page

Property	Description
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

scatter XY scatter plot with markers of variing size and/or color (sometimes also called bubble chart).

Notes

Format Strings

A format string consists of a part for color, marker and line:

```
fmt = '[color][marker][line]'
```

Each of them is optional. If not provided, the value from the style cycle is used. Exception: If `line` is given, but no `marker`, the data will be a line without markers.

Colors

The following color abbreviations are supported:

character	color
`'b'`	blue
`'g'`	green
`'r'`	red
`'c'`	cyan
`'m'`	magenta
`'y'`	yellow
`'k'`	black
`'w'`	white

If the color is the only part of the format string, you can additionally use any *matplotlib.colors* spec, e.g. full names (`'green'`) or hex strings (`'#008000'`).

Markers

character	description
'.'	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

Line Styles

character	description
'-'	solid line style
'--'	dashed line style
'-.'	dash-dot line style
':'	dotted line style

Example format strings:

```
'b'    # blue markers with default shape
'ro'   # red circles
'g-'   # green solid line
'--'   # dashed line with default color
'k^:'  # black triangle_up markers connected by a dotted line
```

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Examples using `matplotlib.pyplot.plot`

- sphx_glr_gallery_pyplots_pyplot_simple.py
- sphx_glr_gallery_pyplots_pyplot_formatstr.py
- sphx_glr_gallery_pyplots_pyplot_three.py
- sphx_glr_gallery_pyplots_whats_new_98_4_legend.py
- sphx_glr_gallery_pyplots_pyplot_two_subplots.py
- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_color_color_by_yvalue.py
- sphx_glr_gallery_lines_bars_and_markers_arctest.py
- sphx_glr_gallery_lines_bars_and_markers_simple_plot.py
- sphx_glr_gallery_lines_bars_and_markers_masked_demo.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_masked.py
- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_shapes_and_collections_marker_path.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py
- sphx_glr_gallery_text_labels_and_annotations_titles_demo.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py

- sphx_glr_gallery_style_sheets_plot_solarizedlight2.py
- sphx_glr_gallery_showcase_integral.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py
- *Frame grabbing*
- sphx_glr_gallery_event_handling_ginput_demo_sgskip.py
- sphx_glr_gallery_misc_print_stdout_sgskip.py
- sphx_glr_gallery_misc_coords_report.py
- sphx_glr_gallery_misc_customize_rc.py
- sphx_glr_gallery_misc_set_and_get.py
- sphx_glr_gallery_misc_agg_buffer.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_zorder_demo.py
- sphx_glr_gallery_misc_transoffset.py
- sphx_glr_gallery_misc_multipage_pdf.py
- sphx_glr_gallery_misc_custom_projection.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- sphx_glr_gallery_ticks_and_spines_ticklabels_rotation.py
- sphx_glr_gallery_user_interfaces_pylab_with_gtk_sgskip.py
- sphx_glr_gallery_user_interfaces_toolmanager_sgskip.py
- sphx_glr_gallery_userdemo_simple_legend01.py
- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py
- sphx_glr_gallery_widgets_textbox.py
- sphx_glr_gallery_widgets_buttons.py
- sphx_glr_gallery_widgets_slider_demo.py
- sphx_glr_gallery_widgets_rectangle_selector.py
- *Customizing Matplotlib with style sheets and rcParams*
- *Usage Guide*

- *Pyplot tutorial*
- *Legend guide*
- *Path effects guide*

75.1.95 matplotlib.pyplot.plot_date

matplotlib.pyplot.**plot_date**(*x*, *y*, *fmt='o'*, *tz=None*, *xdate=True*, *ydate=False*, *hold=None*, *data=None*, ***kwargs*)

Plot data that contains dates.

Similar to `plot`, this plots *y* vs. *x* as lines or markers. However, the axis labels are formatted as dates depending on *xdate* and *ydate*.

Parameters

x, y [array-like] The coordinates of the data points. If *xdate* or *ydate* is *True*, the respective values *x* or *y* are interpreted as *Matplotlib dates*.

fmt [str, optional] The plot format string. For details, see the corresponding parameter in `plot`.

tz [[*None* | timezone string | `tzinfo` instance]] The time zone to use in labeling dates. If *None*, defaults to rcParam `timezone`.

xdate [bool, optional, default: True] If *True*, the *x*-axis will be interpreted as Matplotlib dates.

ydate [bool, optional, default: False] If *True*, the *y*-axis will be interpreted as Matplotlib dates.

Returns

lines A list of `Line2D` objects representing the plotted data.

Other Parameters

****kwargs** Keyword arguments control the `Line2D` properties:

Property	Description
`agg_filter`	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
`alpha`	float (0.0 transparent through 1.0 opaque)
`animated`	bool
`antialiased` or aa	bool
`clip_box`	a `Bbox` instance
`clip_on`	bool
`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']

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Table 20 – continued from previous page

Property	Description
dashes	sequence of on/off ink in points
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | `'`
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

matplotlib.dates Helper functions on dates.

matplotlib.dates.date2num Convert dates to num.

matplotlib.dates.num2date Convert num to dates.

matplotlib.dates.drange Create an equally spaced sequence of dates.

Notes

If you are using custom date tickers and formatters, it may be necessary to set the formatters/locators after the call to *plot_date*. *plot_date* will set the default tick locator to *AutoDateLocator*

(if the tick locator is not already set to a *DateLocator* instance) and the default tick formatter to *AutoDateFormatter* (if the tick formatter is not already set to a *DateFormatter* instance).

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Examples using `matplotlib.pyplot.plot_date`

- sphx_glr_gallery_ticks_and_spines_date_demo_rrule.py

75.1.96 matplotlib.pyplot.plotfile

`matplotlib.pyplot.`**`plotfile`**(*fname*, *cols=(0,)*, *plotfuncs=None*, *comments='#'*, *skiprows=0*, *checkrows=5*, *delimiter=', '*, *names=None*, *subplots=True*, *newfig=True*, ***kwargs*)

Plot the data in a file.

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, e.g., 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))
```

(continues on next page)

(continued from previous page)

```
# 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.

Examples using `matplotlib.pyplot.plotfile`

- sphx_glr_gallery_misc_plotfile_demo.py

75.1.97 matplotlib.pyplot.polar

matplotlib.pyplot.**polar**(**args*, ***kwargs*)

Make a polar plot.

call signature:

```
polar(theta, r, **kwargs)
```

Multiple *theta*, *r* arguments are supported, with format strings, as in *plot()*.

Examples using `matplotlib.pyplot.polar`

- sphx_glr_gallery_misc_transoffset.py

75.1.98 matplotlib.pyplot.prism

matplotlib.pyplot.**prism**()

Set the colormap to "prism".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.99 matplotlib.pyplot.psd

matplotlib.pyplot.**psd**(*x*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *return_line=None*, *hold=None*, *data=None*, ***kwargs*)

Plot the power spectral density.

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, return_line=None, **kwargs)
```

The power spectral density P_{xx} 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 P_{xx}, with a scaling to correct for power loss due to windowing.

If len(x) < *NFFT*, it will be zero padded to *NFFT*.

Parameters

x [1-D array or sequence] Array or sequence containing the data

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

noverlap [integer] The number of points of overlap between segments. The default value is 0 (no overlap).

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.

return_line [bool] Whether to include the line object plotted in the returned values. Default is False.

Returns

Pxx [1-D array] The values for the power spectrum `P_{xx}` before scaling (real valued)

freqs [1-D array] The frequencies corresponding to the elements in *Pxx*

line [a *Line2D* instance] The line created by this function. Only returned if *return_line* is True.

Other Parameters

****kwargs :** Keyword arguments control the *Line2D* properties:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
antialiased or aa	bool
clip_box	a *Bbox* instance
clip_on	bool
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
drawstyle	['default' | 'steps' | 'steps-pre' | 'steps-mid' | 'steps-post']
figure	a *Figure* instance
fillstyle	['full' | 'left' | 'right' | 'bottom' | 'top' | 'none']
gid	an id string
label	object
linestyle or ls	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` | '
linewidth or lw	float value in points
marker	*A valid marker style*
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 | int | length-2 tuple of int | slice | list/array of int | float | length-2 tuple of float]
path_effects	*AbstractPathEffect*

Co

Table 21 – continued from previous page

Property	Description
picker	float distance in points or callable pick function `fn(artist, event)`
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
solid_capstyle	['butt' | 'round' | 'projecting']
solid_joinstyle	['miter' | 'round' | 'bevel']
transform	a *matplotlib.transforms.Transform* instance
url	a url string
visible	bool
xdata	1D array
ydata	1D array
zorder	float

See also:

specgram() *specgram()* differs in the default overlap; in not returning the mean of the segment periodograms; in returning the times of the segments; and in plotting a colormap instead of a line.

magnitude_spectrum() *magnitude_spectrum()* plots the magnitude spectrum.

csd() *csd()* plots the spectral density between two signals.

Notes

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)

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Examples using `matplotlib.pyplot.psd`

- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py

75.1.100 matplotlib.pyplot.quiver

matplotlib.pyplot.**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)
```

U and *V* are the arrow data, *X* and *Y* set the location of the arrows, and *C* sets the color of the arrows. These 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 and *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()`.

The default settings auto-scales the length of the arrows to a reasonable size. To change this behavior see the *scale* and *scale_units* kwargs.

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.

Parameters

X [1D or 2D array, sequence, optional] The x coordinates of the arrow locations

Y [1D or 2D array, sequence, optional] The y coordinates of the arrow locations

U [1D or 2D array or masked array, sequence] The x components of the arrow vectors

V [1D or 2D array or masked array, sequence] The y components of the arrow vectors

C [1D or 2D array, sequence, optional] The arrow colors

units [['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy']] The arrow dimensions (except for *length*) are measured in multiples of this unit.

'width' or 'height': the width or height of the axis

'dots' or 'inches': pixels or inches, based on the figure dpi

'x', 'y', or 'xy': respectively *X*, *Y*, or $\sqrt{X^2 + Y^2}$ in data units

The arrows scale differently depending on the units. For 'x' or 'y', the arrows get larger as one zooms in; for other units, the arrow size is independent of the zoom state. For 'width or 'height', the arrow size increases with the width and height of the axes, respectively, when the window is resized; for 'dots' or 'inches', resizing does not change the arrows.

angles [['uv' | 'xy'], array, optional] Method for determining the angle of the arrows. Default is 'uv'.

'uv': the arrow axis aspect ratio is 1 so that if *U*==*V* the orientation of the arrow on the plot is 45 degrees counter-clockwise from the horizontal axis (positive to the right).

'xy': arrows point from (x,y) to (x+u, y+v). Use this for plotting a gradient field, for example.

Alternatively, arbitrary angles may be specified as an array of values in degrees, counter-clockwise from the horizontal axis.

Note: inverting a data axis will correspondingly invert the arrows only with `angles='xy'`.

scale [None, float, optional] Number of data units per arrow length unit, e.g., m/s per plot width; a smaller scale parameter makes the arrow longer. Default is *None*.

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 [['width' | 'height' | 'dots' | 'inches' | 'x' | 'y' | 'xy'], None, optional] If the *scale* kwarg is *None*, the arrow length unit. Default is *None*.

e.g. *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'/'height', then the vector will be half the width/height 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 [scalar, optional] 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, optional] Head width as multiple of shaft width, default is 3

headlength [scalar, optional] Head length as multiple of shaft width, default is 5

headaxislength [scalar, optional] Head length at shaft intersection, default is 4.5

minshaft [scalar, optional] 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, optional] 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' | 'mid' | 'middle' | 'tip'], optional] 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], optional] This is a synonym for the *PolyCollection* facecolor kwarg. If *C* has been set, *color* has no effect.

See also:

quiverkey Add a key to a quiver plot

Notes

Additional *PolyCollection* keyword arguments:

Property	Description
agg_filter	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m,
alpha	float or None
animated	bool
antialiased or antialiaseds	Boolean or sequence of booleans
array	ndarray
capstyle	unknown
clim	a length 2 sequence of floats; may be overridden in methods that have `vmin` and `vmax`
clip_box	a *Bbox* instance
clip_on	bool
clip_path	[(*Path*, *Transform*) | *Patch* | None]
cmap	a colormap or registered colormap name
color	matplotlib color arg or sequence of rgba tuples
contains	a callable function
edgecolor or edgecolors	matplotlib color spec or sequence of specs
facecolor or facecolors	matplotlib color spec or sequence of specs
figure	a *Figure* instance
gid	an id string
hatch	['/' | '\' | '|' | '-' | '+' | 'x' | 'o' | 'O' | '.' | '*']
joinstyle	unknown
label	object
linestyle or dashes or linestyles	['solid' | 'dashed', 'dashdot', 'dotted' | (offset, on-off-dash-seq) | `'-'` | `'--'` | `'-.'` |
linewidth or linewidths or lw	float or sequence of floats
norm	*Normalize*
offset_position	['screen' | 'data']
offsets	float or sequence of floats
path_effects	*AbstractPathEffect*
picker	[None | bool | float | callable]
pickradius	float distance in points
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	*Transform*
url	a url string

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Property	Description
urls	List[str] or None
visible	bool
zorder	float

Examples using `matplotlib.pyplot.quiver`

- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py
- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py

75.1.101 matplotlib.pyplot.quiverkey

matplotlib.pyplot.**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:

***angle* = 0** The angle of the key arrow. Measured in degrees anti-clockwise from the x-axis.

***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.

Examples using `matplotlib.pyplot.quiverkey`

- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py

75.1.102 matplotlib.pyplot.rc

`matplotlib.pyplot.`**`rc`**`(*args, **kwargs)`

Set the current rc params. Group is the grouping for the rc, e.g., 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, e.g., (*xtick*, *ytick*). *kwargs* is a dictionary attribute name/value pairs, e.g.,:

```
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. e.g., 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 `matplotlib.style.use('default')` or *rcdefaults()* to restore the default rc params after changes.

Examples using `matplotlib.pyplot.rc`

- sphx_glr_gallery_color_color_cycler.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_legend.py
- sphx_glr_gallery_misc_customize_rc.py
- sphx_glr_gallery_misc_multipage_pdf.py
- *Styling with cycler*

75.1.103 matplotlib.pyplot.rc_context

`matplotlib.pyplot.`**`rc_context`**(*rc=None*, *fname=None*)

Return a context manager for managing rc settings.

This allows one to do:

```
with mpl.rc_context(fname='screen.rc'):
    plt.plot(x, a)
    with mpl.rc_context(fname='print.rc'):
        plt.plot(x, b)
    plt.plot(x, c)
```

The 'a' vs 'x' and 'c' vs 'x' plots would have settings from 'screen.rc', while the 'b' vs 'x' plot would have settings from 'print.rc'.

A dictionary can also be passed to the context manager:

```
with mpl.rc_context(rc={'text.usetex': True}, fname='screen.rc'):
    plt.plot(x, a)
```

The 'rc' dictionary takes precedence over the settings loaded from 'fname'. Passing a dictionary only is also valid. For example a common usage is:

```
with mpl.rc_context(rc={'interactive': False}):
    fig, ax = plt.subplots()
    ax.plot(range(3), range(3))
    fig.savefig('A.png', format='png')
    plt.close(fig)
```

Examples using `matplotlib.pyplot.rc_context`

- sphx_glr_gallery_ticks_and_spines_auto_ticks.py

75.1.104 matplotlib.pyplot.rcdefaults

matplotlib.pyplot.**rcdefaults**()

Restore the rc params from Matplotlib's internal defaults.

See also:

rc_file_defaults Restore the rc params from the rc file originally loaded by Matplotlib.

matplotlib.style.use Use a specific style file. Call `style.use('default')` to restore the default style.

Examples using `matplotlib.pyplot.rcdefaults`

- sphx_glr_gallery_lines_bars_and_markers_barh.py
- sphx_glr_gallery_misc_customize_rc.py

75.1.105 matplotlib.pyplot.rgrids

matplotlib.pyplot.**rgrids**(**args*, ***kwargs*)

Get or set the radial gridlines 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' )
```

75.1.106 matplotlib.pyplot.savefig

matplotlib.pyplot.**savefig**(**args*, ***kwargs*)

Save the current figure.

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,
        frameon=None)
```

The output formats available depend on the backend being used.

Parameters

fname [str or file-like object] 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.format` is used.

If *fname* is not a string, remember to specify *format* to ensure that the correct backend is used.

Other Parameters

dpi [[*None* | scalar > 0 | 'figure']] The resolution in dots per inch. If *None* it will default to the value `savefig.dpi` in the matplotlibrc file. If 'figure' it will set the dpi to be the value of the figure.

facecolor [color spec or None, optional] the facecolor of the figure; if None, defaults to savefig.facecolor

edgecolor [color spec or None, optional] the edgecolor of the figure; if None, defaults to savefig.edgecolor

orientation [{'landscape', 'portrait'}] not supported on all backends; currently only on postscript output

papertype [str] One of 'letter', 'legal', 'executive', 'ledger', 'a0' through 'a10', 'b0' through 'b10'. Only supported for postscript output.

format [str] One of the file extensions supported by the active backend. Most backends support png, pdf, ps, eps and svg.

transparent [bool] 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.

frameon [bool] If *True*, the figure patch will be colored, if *False*, the figure background will be transparent. If not provided, the rcParam 'savefig.frameon' will be

used.

bbox_inches [str or *Bbox*, optional] Bbox in inches. Only the given portion of the figure is saved. If 'tight', try to figure out the tight bbox of the figure. If None, use savefig.bbox

pad_inches [scalar, optional] Amount of padding around the figure when bbox_inches is 'tight'. If None, use savefig.pad_inches

bbox_extra_artists [list of *Artist*, optional] A list of extra artists that will be considered when the tight bbox is calculated.

Examples using `matplotlib.pyplot.savefig`

- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_misc_print_stdout_sgskip.py
- sphx_glr_gallery_misc_tight_bbox_test.py
- sphx_glr_gallery_misc_rasterization_demo.py
- sphx_glr_gallery_misc_svg_filter_line.py
- sphx_glr_gallery_misc_svg_filter_pie.py
- sphx_glr_gallery_user_interfaces_svg_tooltip_sgskip.py
- sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py
- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py

75.1.107 matplotlib.pyplot.sca

matplotlib.pyplot.**sca**(*ax*)

Set the current Axes instance to *ax*.

The current Figure is updated to the parent of *ax*.

75.1.108 matplotlib.pyplot.scatter

matplotlib.pyplot.**scatter**(*x*, *y*, *s=None*, *c=None*, *marker=None*, *cmap=None*, *norm=None*, *vmin=None*, *vmax=None*, *alpha=None*, *linewidths=None*, *verts=None*, *edgecolors=None*, *hold=None*, *data=None*, ***kwargs*)

A scatter plot of *y* vs *x* with varying marker size and/or color.

Parameters

x, y [array_like, shape (n,)] The data positions.

s [scalar or array_like, shape (n,), optional] The marker size in points**2. Default is `rcParams['lines.markersize'] ** 2`.

c [color, sequence, or sequence of color, optional, default: 'b'] The marker color. Possible values:

- A single color format string.
- A sequence of color specifications of length n.
- A sequence of n numbers to be mapped to colors using *cmap* and *norm*.
- A 2-D array in which the rows are RGB or RGBA.

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. If you want to specify the same RGB or RGBA value for all points, use a 2-D array with a single row.

marker [*MarkerStyle*, optional, default: 'o'] The marker style. *marker* can be either an instance of the class or the text shorthand for a particular marker. See *markers* for more information marker styles.

cmap [*Colormap*, optional, default: None] A *Colormap* instance or registered colormap name. *cmap* is only used if *c* is an array of floats. If `None`, defaults to rc `image.cmap`.

norm [*Normalize*, optional, default: None] A *Normalize* instance is used to scale luminance data to 0, 1. *norm* is only used if *c* is an array of floats. If *None*, use the default *colors.Normalize*.

vmin, vmax [scalar, optional, default: None] *vmin* and *vmax* are used in conjunction with *norm* to normalize luminance data. If None, the respective min and max of the color array is used. *vmin* and *vmax* are ignored if you pass a *norm* instance.

alpha [scalar, optional, default: None] The alpha blending value, between 0 (transparent) and 1 (opaque).

linewidths [scalar or array_like, optional, default: None] The linewidth of the marker edges. Note: The default *edgecolors* is 'face'. You may want to change this as well. If *None*, defaults to rcParams `lines.linewidth`.

verts [sequence of (x, y), optional] If *marker* is *None*, these vertices will be used to construct the marker. The center of the marker is located at (0, 0) in normalized units. The overall marker is rescaled by *s*.

edgecolors [color or sequence of color, optional, default: 'face'] The edge color of the marker. Possible values:

- 'face': The edge color will always be the same as the face color.
- 'none': No patch boundary will be drawn.
- A matplotib color.

For non-filled markers, the *edgecolors* kwarg is ignored and forced to 'face' internally.

Returns

paths [*PathCollection*]

Other Parameters

****kwargs** [*Collection* properties]

See also:

plot To plot scatter plots when markers are identical in size and color.

Notes

- The *plot* function will be faster for scatterplots where markers don't vary in size or color.
- 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.
- Fundamentally, scatter works with 1-D arrays; *x*, *y*, *s*, and *c* may be input as 2-D arrays, but within scatter they will be flattened. The exception is *c*, which will be flattened only if its size matches the size of *x* and *y*.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'c', 'color', 'edgecolors', 'facecolor', 'facecolors', 'linewidths', 's', 'x', 'y'.

Examples using `matplotlib.pyplot.scatter`

- sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_masked.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_star_poly.py
- sphx_glr_gallery_shapes_and_collections_scatter.py
- sphx_glr_gallery_pie_and_polar_charts_polar_scatter.py
- sphx_glr_gallery_misc_hyperlinks_sgskip.py
- sphx_glr_gallery_misc_zorder_demo.py
- *Pyplot tutorial*

75.1.109 matplotlib.pyplot.sci

matplotlib.pyplot.**sci**(*im*)

Set the current image. This image will be the target of colormap commands like *jet()*, *hot()* or *clim()*). The current image is an attribute of the current axes.

Examples using matplotlib.pyplot.sci

- sphx_glr_gallery_shapes_and_collections_line_collection.py

75.1.110 matplotlib.pyplot.semilogx

matplotlib.pyplot.**semilogx**(**args*, ***kwargs*)

Make a plot with log scaling on the x axis.

Call signatures:

```
semilogx([x], y, [fmt], data=None, **kwargs)
semilogx([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the x-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basex*, *subsx* and *nonposx* control the x-axis properties. They are just forwarded to *Axes.set_xscale*.

Parameters

basex [scalar, optional, default 10] Base of the x logarithm.

subsx [array_like, optional] The location of the minor xticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_xscale* for details.

nonposx [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in x can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by *plot*.

75.1.111 matplotlib.pyplot.semilogy

matplotlib.pyplot.**semilogy**(**args*, ***kwargs*)

Make a plot with log scaling on the y axis.

Call signatures:

```
semilogy([x], y, [fmt], data=None, **kwargs)
semilogy([x], y, [fmt], [x2], y2, [fmt2], ..., **kwargs)
```

This is just a thin wrapper around *plot* which additionally changes the y-axis to log scaling. All of the concepts and parameters of plot can be used here as well.

The additional parameters *basey*, *subsy* and *nonposy* control the y-axis properties. They are just forwarded to *Axes.set_yscale*.

Parameters

basey [scalar, optional, default 10] Base of the y logarithm.

subsy [array_like, optional] The location of the minor yticks. If *None*, reasonable locations are automatically chosen depending on the number of decades in the plot. See *Axes.set_yscale* for details.

nonposy [{'mask', 'clip'}, optional, default 'mask'] Non-positive values in y can be masked as invalid, or clipped to a very small positive number.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** All parameters supported by *plot*.

75.1.112 matplotlib.pyplot.set_cmap

matplotlib.pyplot.**set_cmap**(*cmap*)

Set the default colormap. Applies to the current image if any. See help(colormaps) for more information.

cmap must be a *Colormap* instance, or the name of a registered colormap.

See *matplotlib.cm.register_cmap()* and *matplotlib.cm.get_cmap()*.

75.1.113 matplotlib.pyplot.setp

matplotlib.pyplot.**setp**(**args*, ***kwargs*)

Set a property on an artist object.

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
```

You may specify another output file to *setp* if `sys.stdout` is not acceptable for some reason using the `file` keyword-only argument:

```
>>> with fopen('output.log') as f:
>>>     setp(line, file=f)
```

setp() operates on a single instance or a iterable 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
```

Examples using `matplotlib.pyplot.setp`

- sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py
- sphx_glr_gallery_statistics_boxplot_vs_violin.py
- sphx_glr_gallery_statistics_boxplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_arctest.py
- sphx_glr_gallery_lines_bars_and_markers_stem_plot.py
- sphx_glr_gallery_lines_bars_and_markers_masked_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_pie_and_polar_charts_pie_and_donut_labels.py

- sphx_glr_gallery_axes_grid1_inset_locator_demo2.py
- sphx_glr_gallery_axes_grid1_demo_axes_divider.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_set_and_get.py
- sphx_glr_gallery_misc_patheffect_demo.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- sphx_glr_gallery_specialty_plots_topographic_hillshading.py
- sphx_glr_gallery_units_evans_test.py
- *The Lifecycle of a Plot*

75.1.114 matplotlib.pyplot.show

matplotlib.pyplot.**show**(**args*, ***kw*)

Display a figure. When running in ipython with its pylab mode, display all figures and return to the ipython prompt.

In non-interactive mode, display all figures and block until the figures have been closed; in interactive mode it has no effect unless figures were created prior to a change from non-interactive to interactive mode (not recommended). In that case it displays the figures but does not block.

A single experimental keyword argument, *block*, may be set to True or False to override the blocking behavior described above.

Examples using `matplotlib.pyplot.show`

- sphx_glr_gallery_api_font_family_rc_sgskip.py
- sphx_glr_gallery_api_unicode_minus.py
- sphx_glr_gallery_api_font_file.py
- sphx_glr_gallery_api_watermark_text.py
- sphx_glr_gallery_api_quad_bezier.py
- sphx_glr_gallery_api_legend.py
- sphx_glr_gallery_api_watermark_image.py
- sphx_glr_gallery_api_image_zcoord.py
- sphx_glr_gallery_api_mathtext_asarray.py
- sphx_glr_gallery_api_span_regions.py
- sphx_glr_gallery_api_two_scales.py
- sphx_glr_gallery_api_power_norm.py

- sphx_glr_gallery_api_joinstyle.py
- sphx_glr_gallery_api_histogram_path.py
- sphx_glr_gallery_api_scatter_piecharts.py
- sphx_glr_gallery_api_patch_collection.py
- sphx_glr_gallery_api_sankey_links.py
- sphx_glr_gallery_api_line_with_text.py
- sphx_glr_gallery_api_sankey_basics.py
- sphx_glr_gallery_api_logos2.py
- sphx_glr_gallery_api_sankey_rankine.py
- sphx_glr_gallery_api_filled_step.py
- sphx_glr_gallery_api_radar_chart.py
- sphx_glr_gallery_api_skewt.py
- sphx_glr_gallery_pyplots_pyplot_simple.py
- sphx_glr_gallery_pyplots_pyplot_formatstr.py
- sphx_glr_gallery_pyplots_pyplot_three.py
- sphx_glr_gallery_pyplots_fig_x.py
- sphx_glr_gallery_pyplots_whats_new_98_4_legend.py
- sphx_glr_gallery_pyplots_pyplot_two_subplots.py
- sphx_glr_gallery_pyplots_annotation_basic.py
- sphx_glr_gallery_pyplots_whats_new_99_mplot3d.py
- sphx_glr_gallery_pyplots_whats_new_98_4_fill_between.py
- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_dollar_ticks.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_pyplots_fig_axes_labels_simple.py
- sphx_glr_gallery_pyplots_fig_axes_customize_simple.py
- sphx_glr_gallery_pyplots_annotation_polar.py
- sphx_glr_gallery_pyplots_align_ylabels.py
- sphx_glr_gallery_pyplots_whats_new_99_axes_grid.py
- sphx_glr_gallery_pyplots_text_commands.py
- sphx_glr_gallery_pyplots_whats_new_1_subplot3d.py
- sphx_glr_gallery_pyplots_auto_subplots_adjust.py

- sphx_glr_gallery_pyplots_annotate_transform.py
- sphx_glr_gallery_pyplots_whats_new_99_spines.py
- sphx_glr_gallery_pyplots_compound_path_demo.py
- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_pyplots_boxplot_demo_pyplot.py
- sphx_glr_gallery_pyplots_whats_new_98_4_fancy.py
- sphx_glr_gallery_pyplots_text_layout.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_props.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot_toolbar.py
- sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_custom_figure_class.py
- sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_margins.py
- sphx_glr_gallery_subplots_axes_and_figures_ganged_plots.py
- sphx_glr_gallery_subplots_axes_and_figures_align_labels_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_axhspan_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_fahrenheit_celsius_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_axis_equal_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplots_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_broken_axis.py
- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py
- sphx_glr_gallery_color_color_by_yvalue.py
- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_color_colorbar_basics.py

- sphx_glr_gallery_color_color_cycle_default.py
- sphx_glr_gallery_color_color_cycler.py
- sphx_glr_gallery_color_named_colors.py
- sphx_glr_gallery_color_colormap_reference.py
- sphx_glr_gallery_statistics_errorbar.py
- sphx_glr_gallery_statistics_histogram_histtypes.py
- sphx_glr_gallery_statistics_errorbar_features.py
- sphx_glr_gallery_statistics_hexbin_demo.py
- sphx_glr_gallery_statistics_histogram_multihist.py
- sphx_glr_gallery_statistics_histogram_features.py
- sphx_glr_gallery_statistics_boxplot_vs_violin.py
- sphx_glr_gallery_statistics_histogram_cumulative.py
- sphx_glr_gallery_statistics_boxplot_color.py
- sphx_glr_gallery_statistics_multiple_histograms_side_by_side.py
- sphx_glr_gallery_statistics_errorbars_and_boxes.py
- sphx_glr_gallery_statistics_errorbar_limits.py
- sphx_glr_gallery_statistics_violinplot.py
- sphx_glr_gallery_statistics_hist.py
- sphx_glr_gallery_statistics_customized_violin.py
- sphx_glr_gallery_statistics_bxp.py
- sphx_glr_gallery_statistics_boxplot.py
- sphx_glr_gallery_statistics_barchart_demo.py
- sphx_glr_gallery_statistics_boxplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_interp_demo.py
- sphx_glr_gallery_lines_bars_and_markers_arctest.py
- sphx_glr_gallery_lines_bars_and_markers_stem_plot.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_with_legend.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_custom_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_step_demo.py
- sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py
- sphx_glr_gallery_lines_bars_and_markers_simple_plot.py

- sphx_glr_gallery_lines_bars_and_markers_line_demo_dash_control.py
- sphx_glr_gallery_lines_bars_and_markers_masked_demo.py
- sphx_glr_gallery_lines_bars_and_markers_fill.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_errorbar_subsample.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_masked.py
- sphx_glr_gallery_lines_bars_and_markers_barh.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_lines_bars_and_markers_broken_barh.py
- sphx_glr_gallery_lines_bars_and_markers_categorical_variables.py
- sphx_glr_gallery_lines_bars_and_markers_cohere.py
- sphx_glr_gallery_lines_bars_and_markers_vline_hline_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_star_poly.py
- sphx_glr_gallery_lines_bars_and_markers_line_styles_reference.py
- sphx_glr_gallery_lines_bars_and_markers_gradient_bar.py
- sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py
- sphx_glr_gallery_lines_bars_and_markers_marker_fillstyle_reference.py
- sphx_glr_gallery_lines_bars_and_markers_csd_demo.py
- sphx_glr_gallery_lines_bars_and_markers_stackplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_demo2.py
- sphx_glr_gallery_lines_bars_and_markers_spectrum_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_hist.py
- sphx_glr_gallery_lines_bars_and_markers_eventcollection_demo.py
- sphx_glr_gallery_lines_bars_and_markers_multicolored_line.py
- sphx_glr_gallery_lines_bars_and_markers_fill_betweenx_demo.py
- sphx_glr_gallery_lines_bars_and_markers_barchart.py
- sphx_glr_gallery_lines_bars_and_markers_fill_between_demo.py
- sphx_glr_gallery_lines_bars_and_markers_linestyles.py
- sphx_glr_gallery_lines_bars_and_markers_eventplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_marker_reference.py
- sphx_glr_gallery_lines_bars_and_markers_markevery_demo.py
- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py

- sphx_glr_gallery_images_contours_and_fields_matshow.py
- sphx_glr_gallery_images_contours_and_fields_spy_demos.py
- sphx_glr_gallery_images_contours_and_fields_figimage_demo.py
- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_images_contours_and_fields_barcode_demo.py
- sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py
- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_specgram_demo.py
- sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py
- sphx_glr_gallery_images_contours_and_fields_layer_images.py
- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py
- sphx_glr_gallery_images_contours_and_fields_affine_image.py
- sphx_glr_gallery_images_contours_and_fields_image_nonuniform.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_images_contours_and_fields_shading_example.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_barb_demo.py
- sphx_glr_gallery_images_contours_and_fields_demo_bboximage.py
- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py
- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
- sphx_glr_gallery_images_contours_and_fields_contour_image.py

- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
- sphx_glr_gallery_images_contours_and_fields_contourf_demo.py
- sphx_glr_gallery_images_contours_and_fields_triplot_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_demo.py
- sphx_glr_gallery_images_contours_and_fields_tripcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_shapes_and_collections_scatter.py
- sphx_glr_gallery_shapes_and_collections_marker_path.py
- sphx_glr_gallery_shapes_and_collections_ellipse_collection.py
- sphx_glr_gallery_shapes_and_collections_compound_path.py
- sphx_glr_gallery_shapes_and_collections_path_patch.py
- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py
- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
- sphx_glr_gallery_shapes_and_collections_donut.py
- sphx_glr_gallery_shapes_and_collections_line_collection.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_shapes_and_collections_collections.py
- sphx_glr_gallery_shapes_and_collections_dolphin.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_simple_demo.py
- sphx_glr_gallery_text_labels_and_annotations_titles_demo.py
- sphx_glr_gallery_text_labels_and_annotations_dfrac_demo.py
- sphx_glr_gallery_text_labels_and_annotations_figlegend_demo.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_demo.py
- sphx_glr_gallery_text_labels_and_annotations_fancytextbox_demo.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_tex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_autowrap.py
- sphx_glr_gallery_text_labels_and_annotations_accented_text.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py

- sphx_glr_gallery_text_labels_and_annotations_dashpointlabel.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_date.py
- sphx_glr_gallery_text_labels_and_annotations_engineering_formatter.py
- sphx_glr_gallery_text_labels_and_annotations_custom_legends.py
- sphx_glr_gallery_text_labels_and_annotations_custom_date_formatter.py
- sphx_glr_gallery_text_labels_and_annotations_fancyarrow_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_rotation_mode.py
- sphx_glr_gallery_text_labels_and_annotations_rainbow_text.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_font_table_ttf_sgskip.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_baseline_test.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo_kw.py
- sphx_glr_gallery_text_labels_and_annotations_text_alignment.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_annotation_box.py
- sphx_glr_gallery_text_labels_and_annotations_mathtext_examples.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_text_labels_and_annotations_legend_demo.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_text_labels_and_annotations_annotation_demo.py
- sphx_glr_gallery_pie_and_polar_charts_pie_features.py
- sphx_glr_gallery_pie_and_polar_charts_polar_bar.py
- sphx_glr_gallery_pie_and_polar_charts_polar_demo.py
- sphx_glr_gallery_pie_and_polar_charts_polar_legend.py
- sphx_glr_gallery_pie_and_polar_charts_polar_scatter.py
- sphx_glr_gallery_pie_and_polar_charts_pie_demo2.py
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75.1.115 matplotlib.pyplot.specgram

matplotlib.pyplot.**specgram**(*x*, *NFFT=None*, *Fs=None*, *Fc=None*, *detrend=None*, *window=None*, *noverlap=None*, *cmap=None*, *xextent=None*, *pad_to=None*, *sides=None*, *scale_by_freq=None*, *mode=None*, *scale=None*, *vmin=None*, *vmax=None*, *hold=None*, *data=None*, ***kwargs*)

Plot a spectrogram.

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, mode='default', scale='default',
         **kwargs)
```

Compute and plot a spectrogram of data in *x*. Data are split into *NFFT* length segments and the spectrum 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*. The spectrogram is plotted as a colormap (using imshow).

Parameters

x [1-D array or sequence] Array or sequence containing the data.

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.

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.

sides [['default' | 'onesided' | 'twosided']] Specifies which sides of the spectrum 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 spectrum, while 'twosided' forces two-sided.

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 spectrum (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*

NFFT [integer] The number of data points used in each block for the FFT. A power 2 is most efficient. The default value is 256. This should *NOT* be used to get zero padding, or the scaling of the result will be incorrect. Use *pad_to* for this instead.

detrend [{'default', 'constant', 'mean', 'linear', 'none'} or 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. You can also use a string to choose one of the functions. 'default', 'constant', and 'mean' call `detrend_mean()`. 'linear' calls `detrend_linear()`. 'none' calls `detrend_none()`.

scale_by_freq [boolean, optional] 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.

mode [['default' | 'psd' | 'magnitude' | 'angle' | 'phase']] What sort of spectrum to use. Default is 'psd', which takes the power spectral density. 'complex' returns the complex-valued frequency spectrum. 'magnitude' returns the magnitude spectrum. 'angle' returns the phase spectrum without unwrapping. 'phase' returns the phase spectrum with unwrapping.

noverlap [integer] The number of points of overlap between blocks. The default value is 128.

scale [['default' | 'linear' | 'dB']] The scaling of the values in the *spec*. 'linear' is no scaling. 'dB' returns the values in dB scale. When *mode* is 'psd', this is dB power (10 * log10). Otherwise this is dB amplitude (20 * log10). 'default' is 'dB' if *mode* is 'psd' or 'magnitude' and 'linear' otherwise. This must be 'linear' if *mode* is 'angle' or 'phase'.

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.

cmap : A *matplotlib.colors.Colormap* instance; if *None*, use default determined by rc

xextent [[None | (xmin, xmax)]] The image extent along the x-axis. The default sets *xmin* to the left border of the first bin (*spectrum* column) and *xmax* to the right border of the last bin. Note that for *noverlap>0* the width of the bins is smaller than those of the segments.

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

Returns

spectrum [2-D array] Columns are the periodograms of successive segments.

freqs [1-D array] The frequencies corresponding to the rows in *spectrum*.

t [1-D array] The times corresponding to midpoints of segments (i.e., the columns in *spectrum*).

im [instance of class *AxesImage*] The image created by imshow containing the spectrogram

See also:

psd() `psd()` differs in the default overlap; in returning the mean of the segment periodograms; in not returning times; and in generating a line plot instead of colormap.

magnitude_spectrum() A single spectrum, similar to having a single segment when *mode* is 'magnitude'. Plots a line instead of a colormap.

angle_spectrum() A single spectrum, similar to having a single segment when *mode* is 'angle'. Plots a line instead of a colormap.

phase_spectrum() A single spectrum, similar to having a single segment when *mode* is 'phase'. Plots a line instead of a colormap.

Notes

The parameters *detrend* and *scale_by_freq* do only apply when *mode* is set to 'psd'.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x'.

Examples using `matplotlib.pyplot.specgram`

- sphx_glr_gallery_images_contours_and_fields_specgram_demo.py

75.1.116 matplotlib.pyplot.spectral

`matplotlib.pyplot.`**`spectral`**`()`

Set the colormap to "spectral".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.117 matplotlib.pyplot.spring

matplotlib.pyplot.**spring**()
Set the colormap to "spring".

This changes the default colormap as well as the colormap of the current image if there is one. See help(colormaps) for more information.

75.1.118 matplotlib.pyplot.spy

matplotlib.pyplot.**spy**(*Z*, *precision=0*, *marker=None*, *markersize=None*, *aspect='equal'*, ***kwargs*)
Plot the sparsity pattern on a 2-D array.

spy(Z) plots the sparsity pattern of the 2-D array *Z*.

Parameters

Z [sparse array (n, m)] The array to be plotted.

precision [float, optional, default: 0] 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.

origin [["upper", "lower"], optional, default: "upper"] Place the [0,0] index of the array in the upper left or lower left corner of the axes.

aspect [['auto' | 'equal' | scalar], optional, default: "equal"] 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 'auto', changes the image aspect ratio to match that of the axes.

If None, default to rc image.aspect value.

Two plotting styles are available: image or marker. Both

are available for full arrays, but only the marker style

works for :class:‘scipy.sparse.spmatrix‘ instances.

If *marker* and *markersize* are *None*, an image will be

returned and any remaining kwargs are passed to

:func:‘~matplotlib.pyplot.imshow‘; else, a

:class:‘~matplotlib.lines.Line2D‘ object will be returned with

the value of marker determining the marker type, and any

remaining kwargs passed to the

:meth:‘~matplotlib.axes.Axes.plot‘ method.

If *marker* and *markersize* are *None*, useful kwargs include:

*** *cmap***

*** *alpha***

See also:

imshow for image options.

plot for plotting options

Examples using `matplotlib.pyplot.spy`

- sphx_glr_gallery_images_contours_and_fields_spy_demos.py

75.1.119 matplotlib.pyplot.stackplot

`matplotlib.pyplot.`**`stackplot`**(*x*, **args*, ***kwargs*)

Draws a stacked area plot.

Parameters

x [1d array of dimension N]

y [2d array (dimension MxN), or sequence of 1d arrays (each dimension 1xN)] The data is assumed to be unstacked. Each of the following calls is legal:

```
stackplot(x, y)               # where y is MxN
stackplot(x, y1, y2, y3, y4)  # where y1, y2, y3, y4, are all 1xNm
```

baseline [['zero' | 'sym' | 'wiggle' | 'weighted_wiggle']] Method used to calculate the baseline:

- `'zero'`: Constant zero baseline, i.e. a simple stacked plot.
- `'sym'`: Symmetric around zero and is sometimes called 'ThemeRiver'.
- `'wiggle'`: Minimizes the sum of the squared slopes.
- `'weighted_wiggle'`: Does the same but weights to account for size of each layer. It is also called 'Streamgraph'-layout. More details can be found at http://leebyron.com/streamgraph/.

labels [Length N sequence of strings] Labels to assign to each data series.

colors [Length N sequence of colors] A list or tuple of colors. These will be cycled through and used to colour the stacked areas.

****kwargs :** All other keyword arguments are passed to `Axes.fill_between()`.

Returns

list [list of *PolyCollection*] A list of *PolyCollection* instances, one for each element in the stacked area plot.

75.1.120 matplotlib.pyplot.stem

matplotlib.pyplot.**stem**(**args*, ***kwargs*)

Create a stem plot.

A stem plot plots vertical lines at each *x* location from the baseline to *y*, and places a marker there.

Call signature:

```
stem([x,] y, linefmt=None, markerfmt=None, basefmt=None)
```

The x-positions are optional. The formats may be provided either as positional or as keyword-arguments.

Parameters

x [array-like, optional] The x-positions of the stems. Default: (0, 1, ..., len(y) - 1).

y [array-like] The y-values of the stem heads.

linefmt [str, optional] A string defining the properties of the vertical lines. Usually, this will be a color or a color and a linestyle:

Character	Line Style
'-'	solid line
'--'	dashed line
'-.'	dash-dot line
':'	dotted line

Default: 'C0-', i.e. solid line with the first color of the color cycle.

Note: While it is technically possible to specify valid formats other than color or color and linestyle (e.g. 'rx' or '-.'), this is beyond the intention of the method and will most likely not result in a reasonable reasonable plot.

markerfmt [str, optional] A string defining the properties of the markers at the stem heads. Default: 'C0o', i.e. filled circles with the first color of the color cycle.

basefmt [str, optional] A format string defining the properties of the baseline.

Default: 'C3-' ('C2-' in classic mode).

bottom [float, optional, default: 0] The y-position of the baseline.

label [str, optional, default: None] The label to use for the stems in legends.

Returns

container [*StemContainer*] The container may be treated like a tuple (*markerline*, *stemlines*, *baseline*)

Other Parameters

****kwargs** No other parameters are supported. They are currently ignored silently for backward compatibility. This behavior is deprecated. Future versions will not accept any other parameters and will raise a TypeError instead.

Notes

See also:

The MATLAB function stem which inspired this method.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All positional and all keyword arguments.

Examples using `matplotlib.pyplot.stem`

- sphx_glr_gallery_lines_bars_and_markers_stem_plot.py

75.1.121 matplotlib.pyplot.step

`matplotlib.pyplot.`**`step`**(*x*, *y*, **args*, ***kwargs*)

Make a step plot.

Call signatures:

```
step(x, y, [fmt], *, data=None, where='pre', **kwargs)
step(x, y, [fmt], x2, y2, [fmt2], ..., *, where='pre', **kwargs)
```

This is just a thin wrapper around *plot* which changes some formatting options. Most of the concepts and parameters of plot can be used here as well.

Parameters

x [array_like] 1-D sequence of x positions. It is assumed, but not checked, that it is uniformly increasing.

y [array_like] 1-D sequence of y levels.

fmt [str, optional] A format string, e.g. 'g' for a green line. See *plot* for a more detailed description.

Note: While full format strings are accepted, it is recommended to only specify the color. Line styles are currently ignored (use the keyword argument *linestyle* instead). Markers are accepted and plotted on the given positions, however, this is a rarely needed feature for step plots.

data [indexable object, optional] An object with labelled data. If given, provide the label names to plot in *x* and *y*.

where [{'pre', 'post', 'mid'}, optional, default 'pre'] Define where the steps should be placed:

- 'pre': The y value is continued constantly to the left from every *x* position, i.e. the interval `(x[i-1], x[i]]` has the value `y[i]`.
- 'post': The y value is continued constantly to the right from every *x* position, i.e. the interval `[x[i], x[i+1])` has the value `y[i]`.
- 'mid': Steps occur half-way between the *x* positions.

Returns

lines A list of *Line2D* objects representing the plotted data.

Other Parameters

****kwargs** Additional parameters are the same as those for *plot*.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

Examples using `matplotlib.pyplot.step`

- sphx_glr_gallery_lines_bars_and_markers_step_demo.py

75.1.122 matplotlib.pyplot.streamplot

`matplotlib.pyplot.`**`streamplot`**(*x*, *y*, *u*, *v*, *density=1*, *linewidth=None*, *color=None*, *cmap=None*, *norm=None*, *arrowsize=1*, *arrowstyle='-|>'*, *minlength=0.1*, *transform=None*, *zorder=None*, *start_points=None*, *maxlength=4.0*, *integration_direction='both'*, *hold=None*, *data=None*)

Draws streamlines of a vector flow.

x*, *y [1d arrays] an *evenly spaced* grid.

u*, *v [2d arrays] x and y-velocities. Number of rows should match length of y, and the number of columns should match x.

density [float or 2-tuple] Controls the closeness of streamlines. When `density = 1`, the domain is divided into a 30x30 grid—*density* linearly scales this grid. Each cell in the grid can have, at most, one traversing streamline. For different densities in each direction, use [density_x, density_y].

linewidth [numeric or 2d array] vary linewidth when given a 2d array with the same shape as velocities.

color [matplotlib color code, or 2d array] Streamline color. When given an array with the same shape as velocities, *color* values are converted to colors using *cmap*.

cmap [*Colormap*] Colormap used to plot streamlines and arrows. Only necessary when using an array input for *color*.

norm [*Normalize*] Normalize object used to scale luminance data to 0, 1. If None, stretch (min, max) to (0, 1). Only necessary when *color* is an array.

arrowsize [float] Factor scale arrow size.

arrowstyle [str] Arrow style specification. See *FancyArrowPatch*.

minlength [float] Minimum length of streamline in axes coordinates.

***start_points*: Nx2 array** Coordinates of starting points for the streamlines. In data coordinates, the same as the `x` and `y` arrays.

zorder [int] any number

maxlength [float] Maximum length of streamline in axes coordinates.

integration_direction [['forward', 'backward', 'both']] Integrate the streamline in forward, backward or both directions.

Returns:

stream_container [StreamplotSet] Container object with attributes

- lines: *matplotlib.collections.LineCollection* of streamlines
- arrows: collection of *matplotlib.patches.FancyArrowPatch* objects representing arrows half-way along stream lines.

This container will probably change in the future to allow changes to the colormap, alpha, etc. for both lines and arrows, but these changes should be backward compatible.

Examples using `matplotlib.pyplot.streamplot`

- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py

75.1.123 matplotlib.pyplot.subplot

`matplotlib.pyplot.`**`subplot`**`(`**args*, ***kwargs*`)`

Return a subplot axes at the given grid position.

Call signature:

```
subplot(nrows, ncols, index, **kwargs)
```

In the current figure, create and return an *Axes*, at position *index* of a (virtual) grid of *nrows* by *ncols* axes. Indexes go from 1 to `nrows * ncols`, incrementing in row-major order.

If *nrows*, *ncols* and *index* are all less than 10, they can also be given as a single, concatenated, three-digit number.

For example, `subplot(2, 3, 3)` and `subplot(233)` both create an *matplotlib.axes.Axes* at the top right corner of the current figure, occupying half of the figure height and a third of the figure width.

Note: Creating a subplot will delete any pre-existing subplot that overlaps with it beyond sharing a boundary:

```
import matplotlib.pyplot as plt
# plot a line, implicitly creating a subplot(111)
plt.plot([1,2,3])
# now create a subplot which represents the top plot of a grid
# with 2 rows and 1 column. Since this subplot will overlap the
# first, the plot (and its axes) previously created, will be removed
plt.subplot(211)
plt.plot(range(12))
plt.subplot(212, facecolor='y') # creates 2nd subplot with yellow background
```

If you do not want this behavior, use the *add_subplot()* method or the *axes()* function instead.

Keyword arguments:

***facecolor*:** 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*.

See also:

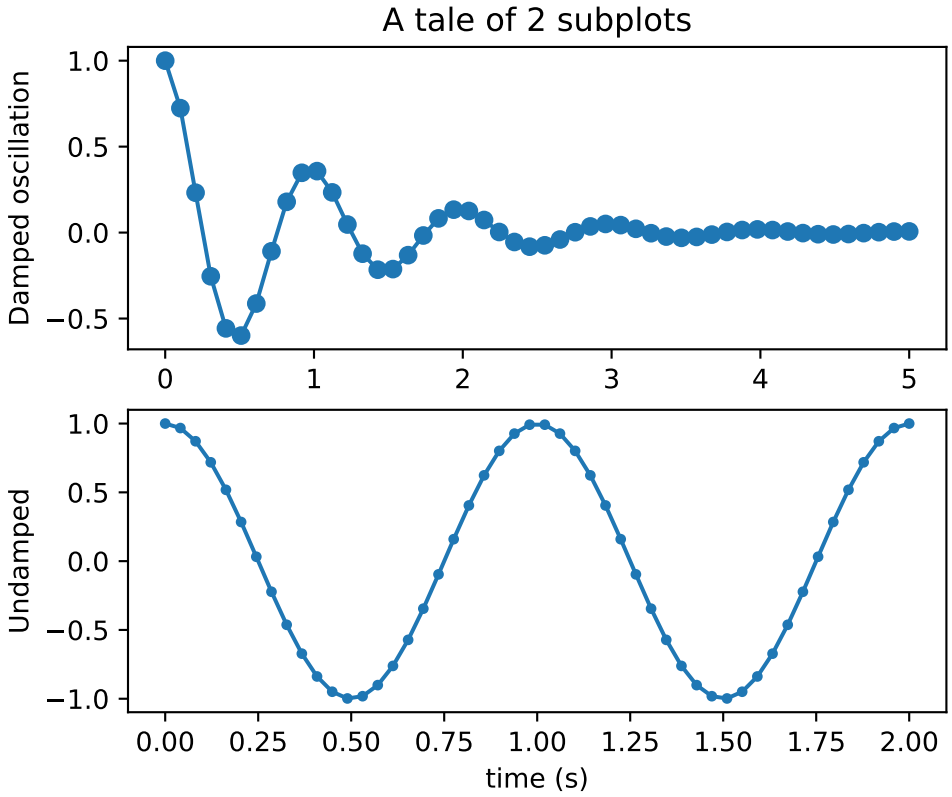
axes() For additional information on *axes()* and *subplot()* keyword arguments.

gallery/pie_and_polar_charts/polar_scatter.py For an example

Example:

Examples using `matplotlib.pyplot.subplot`

- sphx_glr_gallery_pyplots_whats_new_98_4_legend.py
- sphx_glr_gallery_pyplots_pyplot_two_subplots.py
- sphx_glr_gallery_pyplots_pyplot_scales.py



- sphx_glr_gallery_subplots_axes_and_figures_multiple_figs_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_margins.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_zoom_effect.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_star_poly.py
- sphx_glr_gallery_lines_bars_and_markers_linestyles.py
- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py
- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py
- sphx_glr_gallery_shapes_and_collections_fancybox_demo.py

- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo_kw.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_demo_text_path.py
- sphx_glr_gallery_pie_and_polar_charts_polar_bar.py
- sphx_glr_gallery_pie_and_polar_charts_polar_demo.py
- sphx_glr_gallery_pie_and_polar_charts_pie_demo2.py
- *MATPLOTLIB UNCHAINED*
- sphx_glr_gallery_axes_grid1_simple_colorbar.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py
- sphx_glr_gallery_misc_customize_rc.py
- sphx_glr_gallery_misc_zorder_demo.py
- sphx_glr_gallery_misc_transoffset.py
- sphx_glr_gallery_misc_patheffect_demo.py
- sphx_glr_gallery_misc_demo_agg_filter.py
- sphx_glr_gallery_misc_custom_projection.py
- sphx_glr_gallery_recipes_share_axis_lims_views.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- sphx_glr_gallery_ticks_and_spines_tick-locators.py
- sphx_glr_gallery_userdemo_demo_gridspec05.py
- sphx_glr_gallery_userdemo_simple_legend01.py
- sphx_glr_gallery_userdemo_demo_gridspec02.py
- sphx_glr_gallery_userdemo_demo_gridspec03.py
- *Pyplot tutorial*
- *Legend guide*
- *Tight Layout guide*
- *Constrained Layout Guide*

75.1.124 matplotlib.pyplot.subplot2grid

matplotlib.pyplot.**subplot2grid**(*shape*, *loc*, *rowspan=1*, *colspan=1*, *fig=None*, ***kwargs*)

Create an axis at specific location inside a regular grid.

Parameters

shape [sequence of 2 ints] Shape of grid in which to place axis. First entry is number of rows, second entry is number of columns.

loc [sequence of 2 ints] Location to place axis within grid. First entry is row number, second entry is column number.

rowspan [int] Number of rows for the axis to span to the right.

colspan [int] Number of columns for the axis to span downwards.

fig [`Figure`, optional] Figure to place axis in. Defaults to current figure.

****kwargs** Additional keyword arguments are handed to `add_subplot`.

Notes

The following call

```
subplot2grid(shape, loc, rowspan=1, colspan=1)
```

is identical to

```
gridspec=GridSpec(shape[0], shape[1])
subplotspec=gridspec.new_subplotspec(loc, rowspan, colspan)
subplot(subplotspec)
```

Examples using `matplotlib.pyplot.subplot2grid`

- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_userdemo_demo_gridspec01.py
- *Tight Layout guide*
- *Constrained Layout Guide*

75.1.125 matplotlib.pyplot.subplot_tool

matplotlib.pyplot.**subplot_tool**(*targetfig=None*)

Launch a subplot tool window for a figure.

A *matplotlib.widgets.SubplotTool* instance is returned.

Examples using `matplotlib.pyplot.subplot_tool`

- sphx_glr_gallery_subplots_axes_and_figures_subplot_toolbar.py

75.1.126 matplotlib.pyplot.subplots

matplotlib.pyplot.**subplots**(*nrows=1*, *ncols=1*, *sharex=False*, *sharey=False*, *squeeze=True*, *subplot_kw=None*, *gridspec_kw=None*, ***fig_kw*)

Create a figure and a set of subplots

This utility wrapper makes it convenient to create common layouts of subplots, including the enclosing figure object, in a single call.

Parameters

nrows, ncols [int, optional, default: 1] Number of rows/columns of the subplot grid.

sharex, sharey [bool or {'none', 'all', 'row', 'col'}, default: False] Controls sharing of properties among x (`sharex`) or y (`sharey`) axes:

- True or 'all': x- or y-axis will be shared among all subplots.
- False or 'none': each subplot x- or y-axis will be independent.
- 'row': each subplot row will share an x- or y-axis.
- 'col': each subplot column will share an x- or y-axis.

When subplots have a shared x-axis along a column, only the x tick labels of the bottom subplot are created. Similarly, when subplots have a shared y-axis along a row, only the y tick labels of the first column subplot are created. To later turn other subplots' ticklabels on, use *tick_params()*.

squeeze [bool, optional, default: True]

- If True, extra dimensions are squeezed out from the returned array of Axes:
  - if only one subplot is constructed (nrows=ncols=1), the resulting single Axes object is returned as a scalar.
  - for Nx1 or 1xM subplots, the returned object is a 1D numpy object array of Axes objects.
  - 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 Axes object is always a 2D array containing Axes instances, even if it ends up being 1x1.

subplot_kw [dict, optional] Dict with keywords passed to the *add_subplot()* call used to create each subplot.

gridspec_kw [dict, optional] Dict with keywords passed to the *GridSpec* constructor used to create the grid the subplots are placed on.

****fig_kw :** All additional keyword arguments are passed to the *figure()* call.

Returns

fig [*matplotlib.figure.Figure* object]

ax [Axes object or array of Axes objects.] ax can be either a single *matplotlib.axes.Axes* object or an array of Axes objects if more than one subplot was created. The dimensions of the resulting array can be controlled with the squeeze keyword, see above.

See also:

figure, *subplot*

Examples

First create some toy data:

```
>>> x = np.linspace(0, 2*np.pi, 400)
>>> y = np.sin(x**2)
```

Creates just a figure and only one subplot

```
>>> fig, ax = plt.subplots()
>>> ax.plot(x, y)
>>> ax.set_title('Simple plot')
```

Creates two subplots and unpacks 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)
```

Creates four polar axes, and accesses them through the returned array

```
>>> fig, axes = plt.subplots(2, 2, subplot_kw=dict(polar=True))
>>> axes[0, 0].plot(x, y)
>>> axes[1, 1].scatter(x, y)
```

Share a X axis with each column of subplots

```
>>> plt.subplots(2, 2, sharex='col')
```

Share a Y axis with each row of subplots

```
>>> plt.subplots(2, 2, sharey='row')
```

Share both X and Y axes with all subplots

```
>>> plt.subplots(2, 2, sharex='all', sharey='all')
```

Note that this is the same as

```
>>> plt.subplots(2, 2, sharex=True, sharey=True)
```

Examples using `matplotlib.pyplot.subplots`

- sphx_glr_gallery_api_font_family_rc_sgskip.py
- sphx_glr_gallery_api_unicode_minus.py
- sphx_glr_gallery_api_font_file.py
- sphx_glr_gallery_api_watermark_text.py
- sphx_glr_gallery_api_quad_bezier.py
- sphx_glr_gallery_api_legend.py
- sphx_glr_gallery_api_watermark_image.py
- sphx_glr_gallery_api_image_zcoord.py
- sphx_glr_gallery_api_span_regions.py
- sphx_glr_gallery_api_two_scales.py
- sphx_glr_gallery_api_power_norm.py
- sphx_glr_gallery_api_joinstyle.py
- sphx_glr_gallery_api_histogram_path.py
- sphx_glr_gallery_api_scatter_piecharts.py
- sphx_glr_gallery_api_patch_collection.py
- sphx_glr_gallery_api_line_with_text.py
- sphx_glr_gallery_api_filled_step.py
- sphx_glr_gallery_api_radar_chart.py
- sphx_glr_gallery_pyplots_annotation_basic.py
- sphx_glr_gallery_pyplots_whats_new_98_4_fill_between.py
- sphx_glr_gallery_pyplots_dollar_ticks.py
- sphx_glr_gallery_pyplots_align_ylabels.py
- sphx_glr_gallery_pyplots_auto_subplots_adjust.py
- sphx_glr_gallery_pyplots_annotate_transform.py
- sphx_glr_gallery_pyplots_boxplot_demo_pyplot.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_props.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot_toolbar.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_ganged_plots.py
- sphx_glr_gallery_subplots_axes_and_figures_fahrenheit_celsius_scales.py

- sphx_glr_gallery_subplots_axes_and_figures_axis_equal_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_subplots_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_broken_axis.py
- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_color_color_by_yvalue.py
- sphx_glr_gallery_color_color_demo.py
- sphx_glr_gallery_color_colorbar_basics.py
- sphx_glr_gallery_color_color_cycle_default.py
- sphx_glr_gallery_color_color_cycler.py
- sphx_glr_gallery_color_named_colors.py
- sphx_glr_gallery_color_colormap_reference.py
- sphx_glr_gallery_statistics_errorbar.py
- sphx_glr_gallery_statistics_histogram_histtypes.py
- sphx_glr_gallery_statistics_errorbar_features.py
- sphx_glr_gallery_statistics_hexbin_demo.py
- sphx_glr_gallery_statistics_histogram_multihist.py
- sphx_glr_gallery_statistics_histogram_features.py
- sphx_glr_gallery_statistics_boxplot_vs_violin.py
- sphx_glr_gallery_statistics_histogram_cumulative.py
- sphx_glr_gallery_statistics_boxplot_color.py
- sphx_glr_gallery_statistics_multiple_histograms_side_by_side.py
- sphx_glr_gallery_statistics_errorbars_and_boxes.py
- sphx_glr_gallery_statistics_errorbar_limits.py
- sphx_glr_gallery_statistics_violinplot.py
- sphx_glr_gallery_statistics_hist.py
- sphx_glr_gallery_statistics_customized_violin.py
- sphx_glr_gallery_statistics_bxp.py
- sphx_glr_gallery_statistics_boxplot.py
- sphx_glr_gallery_statistics_barchart_demo.py
- sphx_glr_gallery_statistics_boxplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_interp_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_with_legend.py

- sphx_glr_gallery_lines_bars_and_markers_scatter_custom_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_xcorr_acorr_demo.py
- sphx_glr_gallery_lines_bars_and_markers_simple_plot.py
- sphx_glr_gallery_lines_bars_and_markers_line_demo_dash_control.py
- sphx_glr_gallery_lines_bars_and_markers_fill.py
- sphx_glr_gallery_lines_bars_and_markers_errorbar_subsample.py
- sphx_glr_gallery_lines_bars_and_markers_barh.py
- sphx_glr_gallery_lines_bars_and_markers_broken_barh.py
- sphx_glr_gallery_lines_bars_and_markers_categorical_variables.py
- sphx_glr_gallery_lines_bars_and_markers_cohere.py
- sphx_glr_gallery_lines_bars_and_markers_vline_hline_demo.py
- sphx_glr_gallery_lines_bars_and_markers_line_styles_reference.py
- sphx_glr_gallery_lines_bars_and_markers_gradient_bar.py
- sphx_glr_gallery_lines_bars_and_markers_marker_fillstyle_reference.py
- sphx_glr_gallery_lines_bars_and_markers_csd_demo.py
- sphx_glr_gallery_lines_bars_and_markers_stackplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_demo2.py
- sphx_glr_gallery_lines_bars_and_markers_spectrum_demo.py
- sphx_glr_gallery_lines_bars_and_markers_multicolored_line.py
- sphx_glr_gallery_lines_bars_and_markers_fill_betweenx_demo.py
- sphx_glr_gallery_lines_bars_and_markers_barchart.py
- sphx_glr_gallery_lines_bars_and_markers_fill_between_demo.py
- sphx_glr_gallery_lines_bars_and_markers_eventplot_demo.py
- sphx_glr_gallery_lines_bars_and_markers_marker_reference.py
- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py
- sphx_glr_gallery_images_contours_and_fields_spy_demos.py
- sphx_glr_gallery_images_contours_and_fields_quiver_simple_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_clip_path.py
- sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py
- sphx_glr_gallery_images_contours_and_fields_contour_corner_mask.py
- sphx_glr_gallery_images_contours_and_fields_specgram_demo.py
- sphx_glr_gallery_images_contours_and_fields_quadmesh_demo.py

- sphx_glr_gallery_images_contours_and_fields_contourf_hatching.py
- sphx_glr_gallery_images_contours_and_fields_quiver_demo.py
- sphx_glr_gallery_images_contours_and_fields_affine_image.py
- sphx_glr_gallery_images_contours_and_fields_image_nonuniform.py
- sphx_glr_gallery_images_contours_and_fields_contourf_log.py
- sphx_glr_gallery_images_contours_and_fields_shading_example.py
- sphx_glr_gallery_images_contours_and_fields_pcolormesh_levels.py
- sphx_glr_gallery_images_contours_and_fields_multi_image.py
- sphx_glr_gallery_images_contours_and_fields_contour_label_demo.py
- sphx_glr_gallery_images_contours_and_fields_barb_demo.py
- sphx_glr_gallery_images_contours_and_fields_demo_bboximage.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_demo.py
- sphx_glr_gallery_images_contours_and_fields_image_masked.py
- sphx_glr_gallery_images_contours_and_fields_pcolor_demo.py
- sphx_glr_gallery_images_contours_and_fields_contour_demo.py
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- sphx_glr_gallery_images_contours_and_fields_image_transparency_blend.py
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- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
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- sphx_glr_gallery_images_contours_and_fields_custom_cmap.py
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- sphx_glr_gallery_shapes_and_collections_hatch_demo.py
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- sphx_glr_gallery_text_labels_and_annotations_dashpointlabel.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation.py
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- sphx_glr_gallery_style_sheets_dark_background.py
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- sphx_glr_gallery_axes_grid1_demo_axes_rgb.py
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- sphx_glr_gallery_specialty_plots_mri_demo.py
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- sphx_glr_gallery_units_artist_tests.py
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- sphx_glr_gallery_userdemo_anchored_box01.py
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- sphx_glr_gallery_userdemo_annotate_simple_coord03.py
- sphx_glr_gallery_userdemo_colormap_normalizations_power.py
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- sphx_glr_gallery_userdemo_annotate_simple04.py
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- sphx_glr_gallery_userdemo_colormap_normalizations.py
- sphx_glr_gallery_widgets_multicursor.py
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- sphx_glr_gallery_widgets_slider_demo.py
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75.1.127 matplotlib.pyplot.subplots_adjust

matplotlib.pyplot.**subplots_adjust**(**args*, ***kwargs*)

Tune the subplot layout.

call signature:

```
subplots_adjust(left=None, bottom=None, right=None, top=None,
                wspace=None, hspace=None)
```

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 space between subplots,
               # expressed as a fraction of the average axis width
hspace = 0.2   # the amount of height reserved for space between subplots,
               # expressed as a fraction of the average axis height
```

The actual defaults are controlled by the rc file

Examples using `matplotlib.pyplot.subplots_adjust`

- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_subplots_adjust.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_statistics_customized_violin.py
- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py

- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_legend_demo.py
- sphx_glr_gallery_axisartist_demo_parasite_axes2.py
- sphx_glr_gallery_misc_table_demo.py
- sphx_glr_gallery_misc_demo_agg_filter.py
- sphx_glr_gallery_ticks_and_spines_ticklabels_rotation.py
- sphx_glr_gallery_ticks_and_spines_spines.py
- sphx_glr_gallery_ticks_and_spines_tick-locators.py
- sphx_glr_gallery_widgets_textbox.py
- sphx_glr_gallery_widgets_check_buttons.py
- sphx_glr_gallery_widgets_buttons.py
- sphx_glr_gallery_widgets_radio_buttons.py
- sphx_glr_gallery_widgets_slider_demo.py
- *Pyplot tutorial*

75.1.128 matplotlib.pyplot.summer

matplotlib.pyplot.**summer**()
Set the colormap to "summer".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.129 matplotlib.pyplot.suptitle

matplotlib.pyplot.**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 the 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

If the `fontproperties` keyword argument is given then the rcParams defaults for `fontsize` (`figure.titlesize`) and `fontweight` (`figure.titleweight`) will be ignored in favour of the `FontProperties` defaults.

A *matplotlib.text.Text* instance is returned.

Example:

```
fig.suptitle('this is the figure title', fontsize=12)
```

Examples using `matplotlib.pyplot.suptitle`

- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_userdemo_demo_gridspec04.py
- *Pyplot tutorial*

75.1.130 matplotlib.pyplot.switch_backend

`matplotlib.pyplot.`**`switch_backend`**(*newbackend*)

Switch the default backend. This feature is **experimental**, and is only expected to work switching to an image backend. e.g., 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.

75.1.131 matplotlib.pyplot.table

`matplotlib.pyplot.`**`table`**(***kwargs*)

Add a table to the current axes.

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)
```

Returns a *matplotlib.table.Table* instance. Either `cellText` or `cellColours` must be provided. 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	a filter function, which takes a (m, n, 3) float array and a dpi value, and returns a (m, n, 3) array
alpha	float (0.0 transparent through 1.0 opaque)
animated	bool
clip_box	a Bbox instance
clip_on	bool
clip_path	[(Path, Transform) | Patch | None]
contains	a callable function
figure	a Figure instance
fontsize	a float in points
gid	an id string
label	object
path_effects	AbstractPathEffect
picker	[None | bool | float | callable]
rasterized	bool or None
sketch_params	(scale: float, length: float, randomness: float)
snap	bool or None
transform	Transform
url	a url string
visible	bool
zorder	float

Examples using `matplotlib.pyplot.table`

- sphx_glr_gallery_text_labels_and_annotations_font_table_ttf_sgskip.py
- sphx_glr_gallery_misc_table_demo.py

75.1.132 matplotlib.pyplot.text

matplotlib.pyplot.**text**(*x*, *y*, *s*, *fontdict=None*, *withdash=False*, ***kwargs*)

Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.

Parameters

x, y [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.

s [str] The text.

fontdict [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters.

withdash [boolean, optional, default: False] Creates a TextWithDash instance instead of a Text instance.

Returns

text [*Text*] The created *Text* instance.

Other Parameters

****kwargs** [*Text* properties.] Other miscellaneous text parameters.

Examples

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 (e.g., to set a background color) by using the keyword bbox. bbox is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

Examples using `matplotlib.pyplot.text`

- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_text_labels_and_annotations_fancytextbox_demo.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_autowrap.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo_kw.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py

- sphx_glr_gallery_showcase_integral.py
- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py
- sphx_glr_gallery_event_handling_close_event.py
- sphx_glr_gallery_misc_transoffset.py
- sphx_glr_gallery_specialty_plots_anscombe.py
- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- *Pyplot tutorial*
- *Path effects guide*

75.1.133 matplotlib.pyplot.thetagrids

matplotlib.pyplot.**thetagrids**(**args*, ***kwargs*)

Get or set the theta locations of the gridlines in a polar plot.

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). e.g., 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) )
```

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```
# set the locations and labels of the radial gridlines and labels
lines, labels = thetagrids( range(45,360,90), ('NE', 'NW', 'SW','SE') )
```

75.1.134 matplotlib.pyplot.tick_params

matplotlib.pyplot.**tick_params**(*axis='both'*, ***kwargs*)

Change the appearance of ticks, tick labels, and gridlines.

Parameters

axis [{'x', 'y', 'both'}, optional] Which axis to apply the parameters to.

Other Parameters

axis [{'x', 'y', 'both'}] Axis on which to operate; default is 'both'.

reset [bool] 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 *which* ticks.

direction [{'in', 'out', 'inout'}] Puts ticks inside the axes, outside the axes, or both.

length [float] Tick length in points.

width [float] Tick width in points.

color [color] Tick color; accepts any mpl color spec.

pad [float] Distance in points between tick and label.

labelsize [float or str] Tick label font size in points or as a string (e.g., 'large').

labelcolor [color] Tick label color; mpl color spec.

colors [color] Changes the tick color and the label color to the same value: mpl color spec.

zorder [float] Tick and label zorder.

bottom, top, left, right [bool] Whether to draw the respective ticks.

labelbottom, labeltop, labelleft, labelright [bool] Whether to draw the respective tick labels.

labelrotation [float] Tick label rotation

grid_color [color] Changes the gridline color to the given mpl color spec.

grid_alpha [float] Transparency of gridlines: 0 (transparent) to 1 (opaque).

grid_linewidth [float] Width of gridlines in points.

grid_linestyle [string] Any valid *Line2D* line style spec.

Examples

Usage

```
ax.tick_params(direction='out', length=6, width=2, colors='r',
               grid_color='r', grid_alpha=0.5)
```

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. Gridlines will be red and translucent.

Examples using `matplotlib.pyplot.tick_params`

- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py

75.1.135 matplotlib.pyplot.ticklabel_format

matplotlib.pyplot.**ticklabel_format**(***kwargs*)

Change 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	[bool | 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']
useLocale	If True, format the number according to the current locale. This affects things such as the character used for the decimal separator. If False, use C-style (English) formatting. The default setting is controlled by the axes.formatter.use_locale rcparam.
useMathText	If True, render the offset and scientific notation in mathtext

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.

75.1.136 matplotlib.pyplot.tight_layout

matplotlib.pyplot.**tight_layout**(*pad=1.08*, *h_pad=None*, *w_pad=None*, *rect=None*)

Automatically adjust subplot parameters to give specified padding.

Parameters

pad [float] padding between the figure edge and the edges of subplots, as a fraction of the font-size.

h_pad, w_pad [float] padding (height/width) between edges of adjacent subplots. Defaults to `pad_inches`.

rect [if rect is given, it is interpreted as a rectangle] (left, bottom, right, top) in the normalized figure coordinate that the whole subplots area (including labels) will fit into. Default is (0, 0, 1, 1).

Examples using `matplotlib.pyplot.tight_layout`

- sphx_glr_gallery_subplots_axes_and_figures_demo_tight_layout.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_linestyles.py
- sphx_glr_gallery_images_contours_and_fields_interpolation_methods.py
- sphx_glr_gallery_images_contours_and_fields_plot_streamplot.py
- sphx_glr_gallery_images_contours_and_fields_image_annotated_heatmap.py
- sphx_glr_gallery_shapes_and_collections_artist_reference.py
- sphx_glr_gallery_text_labels_and_annotations_figlegend_demo.py
- sphx_glr_gallery_text_labels_and_annotations_engineering_formatter.py
- sphx_glr_gallery_misc_zorder_demo.py
- sphx_glr_gallery_mplot3d_wire3d_zero_stride.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_specialty_plots_mri_with_eeg.py
- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py
- *Tight Layout guide*

75.1.137 matplotlib.pyplot.title

`matplotlib.pyplot.`**`title`**(*s*, **args*, ***kwargs*)

Set a title of the current axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

See also:

See *text()* for adding text to the current axes

Parameters

label [str] Text to use for the title

fontdict [dict] A dictionary controlling the appearance of the title text, the default `fontdict` is:

{'fontsize': rcParams['axes.titlesize'], 'fontweight' : rcParams['axes.titleweight'], 'verticalalignment': 'baseline', 'horizontalalignment': loc}

loc [{'center', 'left', 'right'}, str, optional] Which title to set, defaults to 'center'

Returns

text [*Text*] The matplotlib text instance representing the title

Other Parameters

kwargs [text properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

Examples using `matplotlib.pyplot.title`

- sphx_glr_gallery_api_sankey_basics.py
- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_pyplots_pyplot_scales.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_geo_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_masked_demo.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_lines_bars_and_markers_psd_demo.py
- sphx_glr_gallery_text_labels_and_annotations_titles_demo.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py

- sphx_glr_gallery_text_labels_and_annotations_font_table_ttf_sgskip.py
- sphx_glr_gallery_style_sheets_plot_solarizedlight2.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py
- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py
- sphx_glr_gallery_misc_tight_bbox_test.py
- sphx_glr_gallery_misc_set_and_get.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_zorder_demo.py
- sphx_glr_gallery_misc_contour_manual.py
- sphx_glr_gallery_misc_multipage_pdf.py
- sphx_glr_gallery_misc_table_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- sphx_glr_gallery_user_interfaces_svg_histogram_sgskip.py
- *Usage Guide*
- *Pyplot tutorial*

75.1.138 matplotlib.pyplot.tricontour

matplotlib.pyplot.**tricontour**(**args*, ***kwargs*)

Draw contours on an unstructured triangular grid. *tricontour()* and *tricontourf()* draw contour lines and filled contours, respectively. 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 *matplotlib.tri.Triangulation* object, or

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

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

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to *N+1* automatically chosen contour levels (*N* intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the (len(*V*)-1) regions between the values in *V*, which must be in increasing order.

```
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, in increasing order; e.g., 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: bool enable antialiasing

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 using `matplotlib.pyplot.tricontour`

- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py

- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py

75.1.139 matplotlib.pyplot.tricontourf

matplotlib.pyplot.**tricontourf**(**args*, ***kwargs*)

Draw contours on an unstructured triangular grid. *tricontour()* and *tricontourf()* draw contour lines and filled contours, respectively. 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 *matplotlib.tri.Triangulation* object, or

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

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

The remaining arguments may be:

```
tricontour(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation. The level values are chosen automatically.

```
tricontour(..., Z, N)
```

contour up to *N+1* automatically chosen contour levels (*N* intervals).

```
tricontour(..., Z, V)
```

draw contour lines at the values specified in sequence *V*, which must be in increasing order.

```
tricontourf(..., Z, V)
```

fill the (len(*V*)-1) regions between the values in *V*, which must be in increasing order.

```
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, in increasing order; e.g., 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: bool enable antialiasing

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 using `matplotlib.pyplot.tricontourf`

- sphx_glr_gallery_images_contours_and_fields_irregulardatagrid.py
- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_user.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py

75.1.140 matplotlib.pyplot.tripcolor

matplotlib.pyplot.**tripcolor**(**args*, ***kwargs*)

Create a pseudocolor plot of an unstructured triangular grid.

The triangulation can be specified in one of two ways; either:

```
tripcolor(triangulation, ...)
```

where triangulation is a *matplotlib.tri.Triangulation* object, or

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

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

The next argument must be *C*, the array of color values, either one per point in the triangulation if color values are defined at points, or one per triangle in the triangulation if color values are defined at triangles. If there are the same number of points and triangles in the triangulation it is assumed that color values are defined at points; to force the use of color values at triangles use the kwarg `facecolors=C` instead of just `C`.

shading may be 'flat' (the default) or 'gouraud'. If *shading* is 'flat' and C values are defined at points, the color values used for each triangle are from the mean C of the triangle's three points. If *shading* is 'gouraud' then color values must be defined at points.

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

Examples using `matplotlib.pyplot.tripcolor`

- sphx_glr_gallery_images_contours_and_fields_tripcolor_demo.py

75.1.141 matplotlib.pyplot.triplot

matplotlib.pyplot.**triplot**(**args*, ***kwargs*)

Draw a unstructured triangular grid as lines and/or markers.

The triangulation to plot can be specified in one of two ways; either:

```
triplot(triangulation, ...)
```

where triangulation is a *matplotlib.tri.Triangulation* object, or

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

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

The remaining args and kwargs are the same as for *plot()*.

Return a list of 2 *Line2D* containing respectively:

- the lines plotted for triangles edges
- the markers plotted for triangles nodes

Examples using `matplotlib.pyplot.triplot`

- sphx_glr_gallery_images_contours_and_fields_triinterp_demo.py

- sphx_glr_gallery_images_contours_and_fields_trigradient_demo.py
- sphx_glr_gallery_images_contours_and_fields_triplot_demo.py
- sphx_glr_gallery_images_contours_and_fields_tricontour_smooth_delaunay.py
- sphx_glr_gallery_event_handling_trifinder_event_demo.py

75.1.142 matplotlib.pyplot.twinx

matplotlib.pyplot.**twinx**(*ax=None*)

Make a second axes that shares the *x*-axis. The new axes will overlay *ax* (or the current axes if *ax* is *None*). 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

75.1.143 matplotlib.pyplot.twiny

matplotlib.pyplot.**twiny**(*ax=None*)

Make a second axes that shares the *y*-axis. The new axis will overlay *ax* (or the current axes if *ax* is *None*). The ticks for *ax2* will be placed on the top, and the *ax2* instance is returned.

75.1.144 matplotlib.pyplot.uninstall_repl_displayhook

matplotlib.pyplot.**uninstall_repl_displayhook**()

Uninstalls the matplotlib display hook.

75.1.145 matplotlib.pyplot.violinplot

matplotlib.pyplot.**violinplot**(*dataset*, *positions=None*, *vert=True*, *widths=0.5*, *showmeans=False*, *showextrema=True*, *showmedians=False*, *points=100*, *bw_method=None*, *hold=None*, *data=None*)

Make a violin plot.

Make a violin plot for each column of *dataset* or each vector in sequence *dataset*. Each filled area extends to represent the entire data range, with optional lines at the mean, the median, the minimum, and the maximum.

Parameters

dataset [Array or a sequence of vectors.] The input data.

positions [array-like, default = [1, 2, ..., n]] Sets the positions of the violins. The ticks and limits are automatically set to match the positions.

vert [bool, default = True.] If true, creates a vertical violin plot. Otherwise, creates a horizontal violin plot.

widths [array-like, default = 0.5] Either a scalar or a vector that sets the maximal width of each violin. The default is 0.5, which uses about half of the available horizontal space.

showmeans [bool, default = False] If `True`, will toggle rendering of the means.

showextrema [bool, default = True] If `True`, will toggle rendering of the extrema.

showmedians [bool, default = False] If `True`, will toggle rendering of the medians.

points [scalar, default = 100] Defines the number of points to evaluate each of the gaussian kernel density estimations at.

bw_method [str, scalar or callable, optional] The method used to calculate the estimator bandwidth. This can be 'scott', 'silverman', a scalar constant or a callable. If a scalar, this will be used directly as `kde.factor`. If a callable, it should take a `GaussianKDE` instance as its only parameter and return a scalar. If None (default), 'scott' is used.

Returns

result [dict] A dictionary mapping each component of the violinplot to a list of the corresponding collection instances created. The dictionary has the following keys:

- `bodies`: A list of the *matplotlib.collections.PolyCollection* instances containing the filled area of each violin.
- `cmeans`: A *matplotlib.collections.LineCollection* instance created to identify the mean values of each of the violin's distribution.
- `cmins`: A *matplotlib.collections.LineCollection* instance created to identify the bottom of each violin's distribution.
- `cmaxes`: A *matplotlib.collections.LineCollection* instance created to identify the top of each violin's distribution.
- `cbars`: A *matplotlib.collections.LineCollection* instance created to identify the centers of each violin's distribution.
- `cmedians`: A *matplotlib.collections.LineCollection* instance created to identify the median values of each of the violin's distribution.

Notes

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'dataset'.

75.1.146 matplotlib.pyplot.viridis

matplotlib.pyplot.**viridis**()

Set the colormap to "viridis".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.147 matplotlib.pyplot.vlines

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

Plot vertical lines.

Plot vertical lines at each *x* from *ymin* to *ymax*.

Parameters

x [scalar or 1D array_like] x-indexes where to plot the lines.

ymin, ymax [scalar or 1D array_like] Respective beginning and end of each line. If scalars are provided, all lines will have same length.

colors [array_like of colors, optional, default: 'k']

linestyles [['solid' | 'dashed' | 'dashdot' | 'dotted'], optional]

label [string, optional, default: '']

Returns

lines [*LineCollection*]

Other Parameters

****kwargs** [*LineCollection* properties.]

See also:

hlines horizontal lines

axvline vertical line across the axes

In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**: * All arguments with the following names: 'colors', 'x', 'ymax', 'ymin'.

75.1.148 matplotlib.pyplot.waitforbuttonpress

matplotlib.pyplot.**waitforbuttonpress**(**args*, ***kwargs*)

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.

Examples using `matplotlib.pyplot.waitforbuttonpress`

- sphx_glr_gallery_event_handling_ginput_manual_clabel_sgskip.py

75.1.149 matplotlib.pyplot.winter

`matplotlib.pyplot.`**`winter`**`()`

Set the colormap to "winter".

This changes the default colormap as well as the colormap of the current image if there is one. See `help(colormaps)` for more information.

75.1.150 matplotlib.pyplot.xcorr

`matplotlib.pyplot.`**`xcorr`**`(`*x*, *y*, *normed=True*, *detrend=<function detrend_none>*, *usevlines=True*, *maxlags=10*, *hold=None*, *data=None*, ***kwargs*`)`

Plot the cross correlation between *x* and *y*.

The correlation with lag k is defined as sum_n x[n+k] * conj(y[n]).

Parameters

x [sequence of scalars of length n]

y [sequence of scalars of length n]

hold [bool, optional, *deprecated*, default: True]

detrend [callable, optional, default: `mlab.detrend_none`] *x* is detrended by the *detrend* callable. Default is no normalization.

normed [bool, optional, default: True] If `True`, input vectors are normalised to unit length.

usevlines [bool, optional, default: True] If `True`, `Axes.vlines` is used to plot the vertical lines from the origin to the acorr. Otherwise, `Axes.plot` is used.

maxlags [int, optional] Number of lags to show. If None, will return all `2 * len(x)` - 1 lags. Default is 10.

Returns

lags [array (lenth `2*maxlags+1`)] lag vector.

c [array (length `2*maxlags+1`)] auto correlation vector.

line [*LineCollection* or *Line2D*] *Artist* added to the axes of the correlation

LineCollection if *usevlines* is True *Line2D* if *usevlines* is False

b [*Line2D* or None] Horizontal line at 0 if *usevlines* is True None *usevlines* is False

Other Parameters

linestyle [*Line2D* property, optional] Only used if usevlines is `False`.

marker [string, optional] Default is 'o'.

Notes

The cross correlation is performed with `numpy.correlate()` with `mode = 2`.

Note: In addition to the above described arguments, this function can take a **data** keyword argument. If such a **data** argument is given, the following arguments are replaced by **data[<arg>]**:

- All arguments with the following names: 'x', 'y'.

75.1.151 matplotlib.pyplot.xkcd

`matplotlib.pyplot.`**xkcd**(*scale=1*, *length=100*, *randomness=2*)

Turns on xkcd sketch-style drawing mode. This will only have effect on things drawn after this function is called.

For best results, the "Humor Sans" font should be installed: it is not included with matplotlib.

Parameters

scale [float, optional] The amplitude of the wiggle perpendicular to the source line.

length [float, optional] The length of the wiggle along the line.

randomness [float, optional] The scale factor by which the length is shrunken or expanded.

Notes

This function works by a number of rcParams, so it will probably override others you have set before.

If you want the effects of this function to be temporary, it can be used as a context manager, for example:

```
with plt.xkcd():
    # This figure will be in XKCD-style
    fig1 = plt.figure()
    # ...

# This figure will be in regular style
fig2 = plt.figure()
```

Examples using `matplotlib.pyplot.xkcd`

- sphx_glr_gallery_showcase_xkcd.py

75.1.152 matplotlib.pyplot.xlabel

matplotlib.pyplot.**xlabel**(*s*, **args*, ***kwargs*)

Set the x-axis label of the current axes.

Call signature:

```
xlabel(label, fontdict=None, labelpad=None, **kwargs)
```

This is the pyplot equivalent of calling *set_xlabel* on the current axes. See there for a full parameter description.

Examples using `matplotlib.pyplot.xlabel`

- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_style_sheets_plot_solarizedlight2.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_plotfile_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- sphx_glr_gallery_userdemo_pgf_texsystem_sgskip.py
- sphx_glr_gallery_userdemo_pgf_fonts_sgskip.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py
- *Usage Guide*
- *Pyplot tutorial*

75.1.153 matplotlib.pyplot.xlim

matplotlib.pyplot.**xlim**(**args*, ***kwargs*)

Get or set the x limits of the current axes.

Call signatures:

```
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 *xmin* or *xmax* as kwargs, i.e.:

```
xlim(xmax=3)  # adjust the max leaving min unchanged
xlim(xmin=1)  # adjust the min leaving max unchanged
```

Setting limits turns autoscaling off for the x-axis.

Returns

xmin, xmax A tuple of the new x-axis limits.

Notes

Calling this function with no arguments (e.g. `xlim()`) is the pyplot equivalent of calling *get_xlim* on the current axes. Calling this function with arguments is the pyplot equivalent of calling *set_xlim* on the current axes. All arguments are passed though.

Examples using `matplotlib.pyplot.xlim`

- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_shared_axis_demo.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_step_demo.py
- sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py
- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_text_rotation_relative_to_line.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- *Frame grabbing*

75.1.154 matplotlib.pyplot.xscale

matplotlib.pyplot.**xscale**(**args*, ***kwargs*)

Set the scaling of the x-axis.

Call signature:

```
xscale(scale, **kwargs)
```

Parameters

scale [['linear' | 'log' | 'logit' | 'symlog']] The scaling type.

****kwargs** Additional parameters depend on *scale*. See Notes.

Notes

This is the pyplot equivalent of calling *set_xscale* on the current axes.

Different keywords may be accepted, depending on the scale:

'linear'

'log'

***basex/basey*:** The base of the logarithm

***nonposx/nonposy*: ['mask' | 'clip']** non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

'logit'

***nonpos*: ['mask' | 'clip']** values beyond]0, 1[can be masked as invalid, or clipped to a number very close to 0 or 1

'symlog'

***basex/basey*:** The base of the logarithm

***linthreshx/linthreshy*:** A single float which defines the range (-*x*, *x*), within which the plot is linear. This avoids having the plot go to infinity around zero.

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

***linscalex/linscaley*:** This allows the linear range (*-linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

Examples using `matplotlib.pyplot.xscale`

- sphx_glr_gallery_scales_symlog_demo.py

75.1.155 matplotlib.pyplot.xticks

matplotlib.pyplot.**xticks**(**args*, ***kwargs*)

Get or set the current tick locations and labels of the x-axis.

Call signatures:

```
locs, labels = xticks()            # Get locations and labels

xticks(locs, [labels], **kwargs)  # Set locations and labels
```

Parameters

locs [array_like] A list of positions at which ticks should be placed. You can pass an empty list to disable xticks.

labels [array_like, optional] A list of explicit labels to place at the given *locs*.

****kwargs** *Text* properties can be used to control the appearance of the labels.

Returns

locs An array of label locations.

labels A list of *Text* objects.

Notes

Calling this function with no arguments (e.g. `xticks()`) is the pyplot equivalent of calling *get_xticks* and *get_xticklabels* on the current axes. Calling this function with arguments is the pyplot equivalent of calling *set_xticks* and *set_xticklabels* on the current axes.

Examples

Get the current locations and labels:

```
>>> locs, labels = xticks()
```

Set label locations:

```
>>> xticks(np.arange(0, 1, step=0.2))
```

Set text labels:

```
>>> xticks(np.arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue'))
```

Set text labels and properties:

```
>>> xticks(np.arange(12), calendar.month_name[1:13], rotation=20)
```

Disable xticks:

```
>>> xticks([])
```

Examples using `matplotlib.pyplot.xticks`

- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_lines_bars_and_markers_linestyles.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py
- sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py
- sphx_glr_gallery_misc_table_demo.py
- sphx_glr_gallery_ticks_and_spines_ticklabels_rotation.py
- sphx_glr_gallery_ticks_and_spines_custom_ticker1.py

75.1.156 matplotlib.pyplot.ylabel

matplotlib.pyplot.**ylabel**(*s*, **args*, ***kwargs*)

Set the y-axis label of the current axes.

Call signature:

```
ylabel(label, fontdict=None, labelpad=None, **kwargs)
```

This is the pyplot equivalent of calling *set_ylabel* on the current axes. See there for a full parameter description.

Examples using `matplotlib.pyplot.ylabel`

- sphx_glr_gallery_pyplots_pyplot_simple.py
- sphx_glr_gallery_pyplots_pyplot_mathtext.py
- sphx_glr_gallery_pyplots_pyplot_text.py
- sphx_glr_gallery_subplots_axes_and_figures_invert_axes.py
- sphx_glr_gallery_subplots_axes_and_figures_subplot.py
- sphx_glr_gallery_subplots_axes_and_figures_figure_title.py
- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_scatter_symbol.py
- sphx_glr_gallery_lines_bars_and_markers_nan_test.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_text_labels_and_annotations_text_fontdict.py
- sphx_glr_gallery_text_labels_and_annotations_multiline.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_style_sheets_plot_solarizedlight2.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_misc_tight_bbox_test.py
- sphx_glr_gallery_misc_findobj_demo.py
- sphx_glr_gallery_misc_plotfile_demo.py
- sphx_glr_gallery_misc_table_demo.py
- sphx_glr_gallery_scales_symlog_demo.py
- sphx_glr_gallery_scales_custom_scale.py
- sphx_glr_gallery_userdemo_pgf_preamble_sgskip.py
- *Usage Guide*
- *Pyplot tutorial*

75.1.157 matplotlib.pyplot.ylim

matplotlib.pyplot.**ylim**(**args*, ***kwargs*)

Get or set the y-limits of the current axes.

Call signatures:

```
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 alternatively pass *ymin* or *ymax* as kwargs, i.e.:

```
ylim(ymax=3)  # adjust the max leaving min unchanged
ylim(ymin=1)  # adjust the min leaving max unchanged
```

Setting limits turns autoscaling off for the y-axis.

Returns

ymin, ymax A tuple of the new y-axis limits.

Notes

Calling this function with no arguments (e.g. `ylim()`) is the pyplot equivalent of calling *get_ylim* on the current axes. Calling this function with arguments is the pyplot equivalent of calling *set_ylim* on the current axes. All arguments are passed though.

Examples using `matplotlib.pyplot.ylim`

- sphx_glr_gallery_lines_bars_and_markers_step_demo.py
- sphx_glr_gallery_lines_bars_and_markers_errorbar_limits_simple.py
- sphx_glr_gallery_shapes_and_collections_ellipse_demo.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_fonteffects.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_showcase_integral.py
- *Frame grabbing*
- sphx_glr_gallery_misc_findobj_demo.py
- *Pyplot tutorial*

75.1.158 matplotlib.pyplot.yscale

`matplotlib.pyplot.`**`yscale`**`(`**args*, ***kwargs*`)`

Set the scaling of the y-axis.

Call signature:

```
yscale(scale, **kwargs)
```

Parameters

scale [['linear' | 'log' | 'logit' | 'symlog']] The scaling type.

****kwargs** Additional parameters depend on *scale*. See Notes.

Notes

This is the pyplot equivalent of calling `set_yscale` on the current axes.

Different keywords may be accepted, depending on the scale:

'linear'

'log'

***basex/basey*:** The base of the logarithm

***nonposx/nonposy*: ['mask' | 'clip']** non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

'logit'

***nonpos*: ['mask' | 'clip']** values beyond]0, 1[can be masked as invalid, or clipped to a number very close to 0 or 1

'symlog'

***basex/basey*:** The base of the logarithm

***linthreshx/linthreshy*:** A single float which defines the range (-*x*, *x*), within which the plot is linear. This avoids having the plot go to infinity around zero.

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

***linscalex/linscaley*:** This allows the linear range (-*linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

Examples using `matplotlib.pyplot.yscale`

- sphx_glr_gallery_pyplots_pyplot_scales.py

- sphx_glr_gallery_scales_symlog_demo.py
- *Pyplot tutorial*

75.1.159 matplotlib.pyplot.yticks

matplotlib.pyplot.**yticks**(**args*, ***kwargs*)

Get or set the current tick locations and labels of the y-axis.

Call signatures:

```
locs, labels = yticks()           # Get locations and labels

yticks(locs, [labels], **kwargs)  # Set locations and labels
```

Parameters

locs [array_like] A list of positions at which ticks should be placed. You can pass an empty list to disable yticks.

labels [array_like, optional] A list of explicit labels to place at the given *locs*.

****kwargs** *Text* properties can be used to control the appearance of the labels.

Returns

locs An array of label locations.

labels A list of *Text* objects.

Notes

Calling this function with no arguments (e.g. `yticks()`) is the pyplot equivalent of calling *get_yticks* and *get_yticklabels* on the current axes. Calling this function with arguments is the pyplot equivalent of calling *set_yticks* and *set_yticklabels* on the current axes.

Examples

Get the current locations and labels:

```
>>> locs, labels = yticks()
```

Set label locations:

```
>>> yticks(np.arange(0, 1, step=0.2))
```

Set text labels:

```
>>> yticks(np.arange(5), ('Tom', 'Dick', 'Harry', 'Sally', 'Sue'))
```

Set text labels and properties:

```
>>> yticks(np.arange(12), calendar.month_name[1:13], rotation=45)
```

Disable yticks:

```
>>> yticks([])
```

Examples using `matplotlib.pyplot.yticks`

- sphx_glr_gallery_subplots_axes_and_figures_axes_demo.py
- sphx_glr_gallery_lines_bars_and_markers_bar_stacked.py
- sphx_glr_gallery_lines_bars_and_markers_linestyles.py
- sphx_glr_gallery_text_labels_and_annotations_stix_fonts_demo.py
- sphx_glr_gallery_text_labels_and_annotations_usetex_demo.py
- sphx_glr_gallery_text_labels_and_annotations_arrow_demo.py
- sphx_glr_gallery_showcase_xkcd.py
- sphx_glr_gallery_showcase_bachelors_degrees_by_gender.py
- sphx_glr_gallery_axes_grid1_demo_colorbar_of_inset_axes.py
- sphx_glr_gallery_misc_tight_bbox_test.py
- sphx_glr_gallery_misc_table_demo.py

CHAPTER

SEVENTYSIX

TOOLKITS

76.1 mplot3d API

Contents

- *mplot3d API*
  - *axes3d*
  - *axis3d*
  - *art3d*
  - *Art3D Utility Functions*
  - *proj3d*

76.1.1 axes3d

Note: Significant effort went into bringing axes3d to feature-parity with regular axes objects for version 1.1.0. However, more work remains. Please report any functions that do not behave as expected as a bug. In addition, help and patches would be greatly appreciated!

axes3d.Axes3D(fig[, rect])	3D axes object.

mpl_toolkits.mplot3d.axes3d.Axes3D

class mpl_toolkits.mplot3d.axes3d.**Axes3D**(*fig*, *rect=None*, **args*, ***kwargs*)

3D axes object.

add_collection3d(*col*, *zs=0*, *zdir='z'*)

Add a 3D collection object to the plot.

2D collection types are converted to a 3D version by modifying the object and adding z coordi-

nate information.

Supported are:

- PolyCollection
- LineCollection
- PatchCollection

add_contour_set(*cset*, *extend3d=False*, *stride=5*, *zdir='z'*, *offset=None*)

add_contourf_set(*cset*, *zdir='z'*, *offset=None*)

auto_scale_xyz(*X*, *Y*, *Z=None*, *had_data=None*)

autoscale(*enable=True*, *axis='both'*, *tight=None*)

Convenience method for simple axis view autoscaling. See *matplotlib.axes.Axes.autoscale()* for full explanation. Note that this function behaves the same, but for all three axes. Therefore, 'z' can be passed for *axis*, and 'both' applies to all three axes.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

autoscale_view(*tight=None*, *scalex=True*, *scaley=True*, *scalez=True*)

Autoscale the view limits using the data limits. See *matplotlib.axes.Axes.autoscale_view()* for documentation. Note that this function applies to the 3D axes, and as such adds the *scalez* to the function arguments.

Changed in version 1.1.0: Function signature was changed to better match the 2D version. *tight* is now explicitly a kwarg and placed first.

Changed in version 1.2.1: This is now fully functional.

bar(*left*, *height*, *zs=0*, *zdir='z'*, **args*, ***kwargs*)

Add 2D bar(s).

Argument	Description
left	The x coordinates of the left sides of the bars.
height	The height of the bars.
zs	Z coordinate of bars, if one value is specified they will all be placed at the same z.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.

Keyword arguments are passed onto *bar()*.

Returns a *Patch3DCollection*

bar3d(*x*, *y*, *z*, *dx*, *dy*, *dz*, *color=None*, *zsort='average'*, *shade=True*, **args*, ***kwargs*)

Generate a 3D barplot.

This method creates three dimensional barplot where the width, depth, height, and color of the bars can all be uniquely set.

Parameters

x, y, z [array-like] The coordinates of the anchor point of the bars.

dx, dy, dz [scalar or array-like] The width, depth, and height of the bars, respectively.

color [sequence of valid color specifications, optional] The color of the bars can be specified globally or individually. This parameter can be:

- A single color value, to color all bars the same color.
- An array of colors of length N bars, to color each bar independently.
- An array of colors of length 6, to color the faces of the bars similarly.
- An array of colors of length 6 * N bars, to color each face independently.

When coloring the faces of the boxes specifically, this is the order of the coloring:

1. -Z (bottom of box)
2. +Z (top of box)
3. -Y
4. +Y
5. -X
6. +X

zsort [str, optional] The z-axis sorting scheme passed onto *Poly3DCollection()*

shade [bool, optional (default = True)] When true, this shades the dark sides of the bars (relative to the plot's source of light).

Any additional keyword arguments are passed onto

:func:'~mpl_toolkits.mplot3d.art3d.Poly3DCollection'

Returns

collection [Poly3DCollection] A collection of three dimensional polygons representing the bars.

`can_pan()`
Return *True* if this axes supports the pan/zoom button functionality.

3D axes objects do not use the pan/zoom button.

`can_zoom()`
Return *True* if this axes supports the zoom box button functionality.

3D axes objects do not use the zoom box button.

cla()
Clear axes

clabel(**args*, ***kwargs*)
This function is currently not implemented for 3D axes. Returns *None*.

contour(*X*, *Y*, *Z*, **args*, ***kwargs*)
Create a 3D contour plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
extend3d	Whether to extend contour in 3D (default: False)
stride	Stride (step size) for extending contour
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the contour lines on this position in plane normal to zdir

The positional and other keyword arguments are passed on to *contour()*

Returns a *contour*

contour3D(*X*, *Y*, *Z*, **args*, ***kwargs*)
Create a 3D contour plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
extend3d	Whether to extend contour in 3D (default: False)
stride	Stride (step size) for extending contour
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the contour lines on this position in plane normal to zdir

The positional and other keyword arguments are passed on to *contour()*

Returns a *contour*

contourf(*X*, *Y*, *Z*, **args*, ***kwargs*)
Create a 3D contourf plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the filled contour on this position in plane normal to zdir

The positional and keyword arguments are passed on to *contourf()*

Returns a *contourf*

Changed in version 1.1.0: The *zdir* and *offset* kwargs were added.

contourf3D(*X*, *Y*, *Z*, **args*, ***kwargs*)
Create a 3D contourf plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the filled contour on this position in plane normal to zdir

The positional and keyword arguments are passed on to *contourf()*

Returns a *contourf*

Changed in version 1.1.0: The *zdir* and *offset* kwargs were added.

convert_zunits(*z*)
For artists in an axes, if the zaxis has units support, convert *z* using zaxis unit type

New in version 1.2.1.

disable_mouse_rotation()
Disable mouse button callbacks.

draw(*renderer*)
Draw everything (plot lines, axes, labels)

format_coord(*xd*, *yd*)
Given the 2D view coordinates attempt to guess a 3D coordinate. Looks for the nearest edge to the point and then assumes that the point is at the same z location as the nearest point on the edge.

format_zdata(*z*)
Return *z* string formatted. This function will use the `fmt_zdata` attribute if it is callable, else will fall back on the zaxis major formatter

get_autoscale_on()
Get whether autoscaling is applied for all axes on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

get_autoscalez_on()
Get whether autoscaling for the z-axis is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

get_axis_position()

get_axisbelow()
Get whether axis below is true or not.

For axes3d objects, this will always be *True*

New in version 1.1.0: This function was added for completeness.

get_children()
return a list of child artists

get_frame_on()
Get whether the 3D axes panels are drawn.

New in version 1.1.0.

get_proj()
Create the projection matrix from the current viewing position.

elev stores the elevation angle in the z plane azim stores the azimuth angle in the x,y plane

dist is the distance of the eye viewing point from the object point.

get_w_lims()
Get 3D world limits.

get_xlim()
Get the x-axis range

Returns

xlimits [tuple] Returns the current x-axis limits as the tuple (`left`, `right`).

Notes

The x-axis may be inverted, in which case the `left` value will be greater than the `right` value.

Changed in version 1.1.0: This function now correctly refers to the 3D x-limits

get_xlim3d()
Get the x-axis range

Returns

xlimits [tuple] Returns the current x-axis limits as the tuple (`left`, `right`).

Notes

The x-axis may be inverted, in which case the `left` value will be greater than the `right` value.

Changed in version 1.1.0: This function now correctly refers to the 3D x-limits

get_ylim()
Get the y-axis range

Returns

ylimits [tuple] Returns the current y-axis limits as the tuple (`bottom`, `top`).

Notes

The y-axis may be inverted, in which case the `bottom` value will be greater than the `top` value.

Changed in version 1.1.0: This function now correctly refers to the 3D y-limits.

get_ylim3d()
Get the y-axis range

Returns

ylimits [tuple] Returns the current y-axis limits as the tuple (`bottom`, `top`).

Notes

The y-axis may be inverted, in which case the `bottom` value will be greater than the `top` value.

Changed in version 1.1.0: This function now correctly refers to the 3D y-limits.

get_zbound()
Returns the z-axis numerical bounds where:

```
lowerBound < upperBound
```

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

get_zlabel()
Get the z-label text string.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

get_zlim()
Get 3D z limits.

get_zlim3d()
Get 3D z limits.

get_zmajorticklabels()
Get the ztick labels as a list of Text instances

New in version 1.1.0.

get_zminorticklabels()
Get the ztick labels as a list of Text instances

Note: Minor ticks are not supported. This function was added only for completeness.

New in version 1.1.0.

get_zscale()

get_zticklabels(*minor=False*)
Get ztick labels as a list of Text instances. See *matplotlib.axes.Axes.get_yticklabels()* for more details.

Note: Minor ticks are not supported.

New in version 1.1.0.

get_zticklines()
Get ztick lines as a list of Line2D instances. Note that this function is provided merely for completeness. These lines are re-calculated as the display changes.

New in version 1.1.0.

get_zticks(*minor=False*)
Return the z ticks as a list of locations See *matplotlib.axes.Axes.get_yticks()* for more details.

Note: Minor ticks are not supported.

New in version 1.1.0.

grid(*b=True*, ***kwargs*)
Set / unset 3D grid.

Note: Currently, this function does not behave the same as *matplotlib.axes.Axes.grid()*, but it is intended to eventually support that behavior.

Changed in version 1.1.0: This function was changed, but not tested. Please report any bugs.

have_units()
Return *True* if units are set on the *x*, *y*, or *z* axes

invert_zaxis()
Invert the z-axis.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

locator_params(*axis='both'*, *tight=None*, ***kwargs*)
Convenience method for controlling tick locators.

See *matplotlib.axes.Axes.locator_params()* for full documentation Note that this is for Axes3D objects, therefore, setting *axis* to 'both' will result in the parameters being set for all three axes. Also, *axis* can also take a value of 'z' to apply parameters to the z axis.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

margins(**args*, ***kw*)
Convenience method to set or retrieve autoscaling margins.

signatures:: margins()

returns xmargin, ymargin, zmargin

```
margins(margin)

margins(xmargin, ymargin, zmargin)

margins(x=xmargin, y=ymargin, z=zmargin)

margins(..., tight=False)
```

All forms above set the xmargin, ymargin and zmargin parameters. All keyword parameters are optional. A single argument specifies xmargin, ymargin and zmargin. 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.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

mouse_init(*rotate_btn=1*, *zoom_btn=3*)
Initializes mouse button callbacks to enable 3D rotation of the axes. Also optionally sets the mouse buttons for 3D rotation and zooming.

Argument	Description
rotate_btn	The integer or list of integers specifying which mouse button or buttons to use for 3D rotation of the axes. Default = 1.
zoom_btn	The integer or list of integers specifying which mouse button or buttons to use to zoom the 3D axes. Default = 3.

name = '3d'

plot(*xs*, *ys*, **args*, ***kwargs*)
Plot 2D or 3D data.

Argument	Description
xs, *ys*	x, y coordinates of vertices
zs	z value(s), either one for all points or one for each point.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.

Other arguments are passed on to *plot()*

plot3D(*xs*, *ys*, **args*, ***kwargs*)
Plot 2D or 3D data.

Argument	Description
xs, *ys*	x, y coordinates of vertices
zs	z value(s), either one for all points or one for each point.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.

Other arguments are passed on to *plot()*

plot_surface(*X*, *Y*, *Z*, **args*, ***kwargs*)
Create a surface plot.

By default it will be colored in shades of a solid color, but it also supports color mapping by supplying the *cmap* argument.

Note: The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.

Parameters

X, Y, Z [2d arrays] Data values.

rcount, ccount [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Defaults to 50.

New in version 2.0.

rstride, cstride [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 10.

'classic' mode uses a default of `rstride = cstride = 10` instead of the new default of `rcount = ccount = 50`.

color [color-like] Color of the surface patches.

cmap [Colormap] Colormap of the surface patches.

facecolors [array-like of colors.] Colors of each individual patch.

norm [Normalize] Normalization for the colormap.

vmin, vmax [float] Bounds for the normalization.

shade [bool] Whether to shade the face colors.

****kwargs :** Other arguments are forwarded to *Poly3DCollection*.

plot_trisurf(**args*, ***kwargs*)

Argument	Description
X, *Y*, *Z*	Data values as 1D arrays
color	Color of the surface patches
cmap	A colormap for the surface patches.
norm	An instance of Normalize to map values to colors
vmin	Minimum value to map
vmax	Maximum value to map
shade	Whether to shade the facecolors

The (optional) triangulation can be specified in one of two ways; either:

```
plot_trisurf(triangulation, ...)
```

where triangulation is a *Triangulation* object, or:

```
plot_trisurf(X, Y, ...)
plot_trisurf(X, Y, triangles, ...)
plot_trisurf(X, Y, triangles=triangles, ...)
```

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

The remaining arguments are:

```
plot_trisurf(..., Z)
```

where *Z* is the array of values to contour, one per point in the triangulation.

Other arguments are passed on to *Poly3DCollection*

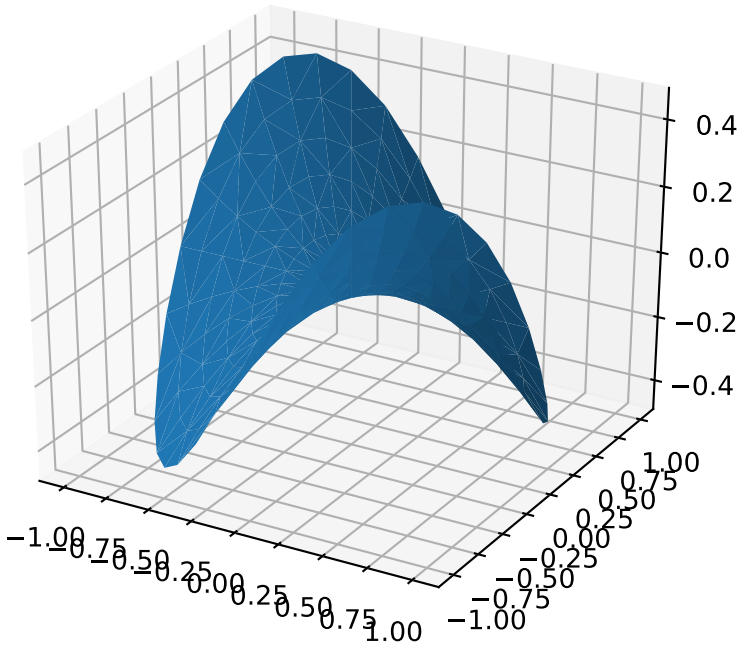
Examples:

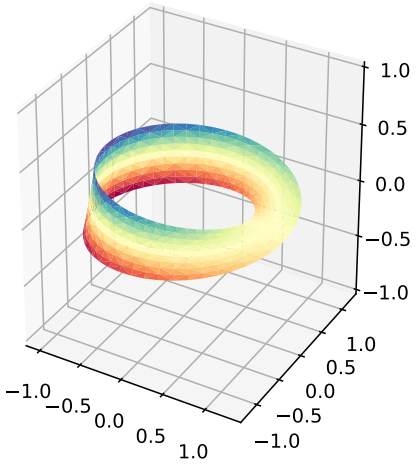
New in version 1.2.0: This plotting function was added for the v1.2.0 release.

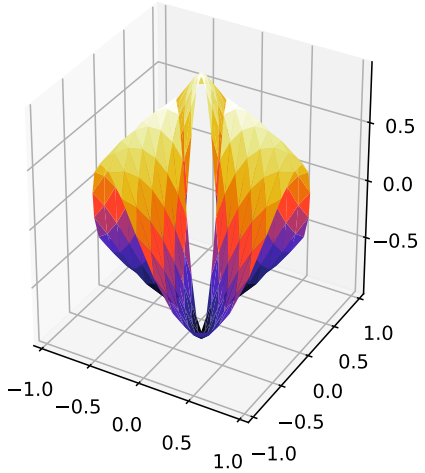
plot_wireframe(*X*, *Y*, *Z*, **args*, ***kwargs*)

Plot a 3D wireframe.

Note: The *rcount* and *ccount* kwargs, which both default to 50, determine the maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points.


0.4
0.2
0.0
−0.2
−0.4
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


1.0
0.5
0.0
−0.5
−1.0
−1.0
−0.5
0.0
0.5
1.0
1.0
0.5
0.0
−0.5
−1.0


0.5
0.0
−0.5
−1.0
−0.5
0.0
0.5
1.0
1.0
0.5
0.0
−0.5
−1.0

Parameters

X, Y, Z [2d arrays] Data values.

rcount, ccount [int] Maximum number of samples used in each direction. If the input data is larger, it will be downsampled (by slicing) to these numbers of points. Setting a count to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot. Defaults to 50.

New in version 2.0.

rstride, cstride [int] Downsampling stride in each direction. These arguments are mutually exclusive with *rcount* and *ccount*. If only one of *rstride* or *cstride* is set, the other defaults to 1. Setting a stride to zero causes the data to be not sampled in the corresponding direction, producing a 3D line plot rather than a wireframe plot.

'classic' mode uses a default of `rstride = cstride = 1` instead of the new default of `rcount = ccount = 50`.

****kwargs :** Other arguments are forwarded to *Line3DCollection*.

`quiver`(**args*, ***kwargs*)

Plot a 3D field of arrows.

call signatures:

```
quiver(X, Y, Z, U, V, W, **kwargs)
```

Arguments:

***X*, *Y*, *Z*:** The x, y and z coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

***U*, *V*, *W*:** The x, y and z components of the arrow vectors

The arguments could be array-like or scalars, so long as they they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

Keyword arguments:

***length*: [1.0 | float]** The length of each quiver, default to 1.0, the unit is the same with the axes

***arrow_length_ratio*: [0.3 | float]** The ratio of the arrow head with respect to the quiver, default to 0.3

***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*. Default is 'tail'

***normalize*: bool** When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

Any additional keyword arguments are delegated to *LineCollection*

quiver3D(**args*, ***kwargs*)
Plot a 3D field of arrows.

call signatures:

```
quiver(X, Y, Z, U, V, W, **kwargs)
```

Arguments:

***X*, *Y*, *Z*:** The x, y and z coordinates of the arrow locations (default is tail of arrow; see *pivot* kwarg)

***U*, *V*, *W*:** The x, y and z components of the arrow vectors

The arguments could be array-like or scalars, so long as they they can be broadcast together. The arguments can also be masked arrays. If an element in any of argument is masked, then that corresponding quiver element will not be plotted.

Keyword arguments:

***length*: [1.0 | float]** The length of each quiver, default to 1.0, the unit is the same with the axes

***arrow_length_ratio*: [0.3 | float]** The ratio of the arrow head with respect to the quiver, default to 0.3

***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*. Default is 'tail'

***normalize*: bool** When True, all of the arrows will be the same length. This defaults to False, where the arrows will be different lengths depending on the values of u,v,w.

Any additional keyword arguments are delegated to *LineCollection*

scatter(*xs*, *ys*, *zs=0*, *zdir='z'*, *s=20*, *c=None*, *depthshade=True*, **args*, ***kwargs*)
Create a scatter plot.

Argument	Description
xs, *ys*	Positions of data points.
zs	Either an array of the same length as *xs* and *ys* or a single value to place all points in the same plane. Default is 0.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.
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, including the case of a single row to specify the same color for all points.
depthshade	Whether or not to shade the scatter markers to give the appearance of depth. Default is *True*.

Keyword arguments are passed on to `scatter()`.

Returns a `Patch3DCollection`

scatter3D(*xs*, *ys*, *zs=0*, *zdir='z'*, *s=20*, *c=None*, *depthshade=True*, **args*, ***kwargs*)
Create a scatter plot.

Argument	Description
xs, *ys*	Positions of data points.
zs	Either an array of the same length as *xs* and *ys* or a single value to place all points in the same plane. Default is 0.
zdir	Which direction to use as z ('x', 'y' or 'z') when plotting a 2D set.
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, including the case of a single row to specify the same color for all points.
depthshade	Whether or not to shade the scatter markers to give the appearance of depth. Default is *True*.

Keyword arguments are passed on to `scatter()`.

Returns a `Patch3DCollection`

set_autoscale_on(*b*)
Set whether autoscaling is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

Parameters

b [bool]

set_autoscalez_on(*b*)
Set whether autoscaling for the z-axis is applied on plot commands

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

Parameters

b [bool]

set_axis_off()
Turn off the axis.

set_axis_on()
Turn on the axis.

set_axisbelow(*b*)
Set whether axis ticks and gridlines are above or below most artists.

For axes3d objects, this will ignore any settings and just use *True*

New in version 1.1.0: This function was added for completeness.

Parameters

b [bool]

set_frame_on(*b*)
Set whether the 3D axes panels are drawn.

New in version 1.1.0.

Parameters

b [bool]

set_proj_type(*proj_type*)
Set the projection type.

Parameters

proj_type [str] Type of projection, accepts 'persp' and 'ortho'.

set_title(*label*, *fontdict=None*, *loc='center'*, ***kwargs*)
Set a title for the axes.

Set one of the three available axes titles. The available titles are positioned above the axes in the center, flush with the left edge, and flush with the right edge.

Parameters

label [str] Text to use for the title

fontdict [dict] A dictionary controlling the appearance of the title text, the default `fontdict` is:

```
{'fontsize': rcParams['axes.titlesize'],
 'fontweight' : rcParams['axes.titleweight'],
 'verticalalignment': 'baseline',
 'horizontalalignment': loc}
```

loc [{'center', 'left', 'right'}, str, optional] Which title to set, defaults to 'center'

pad [float] The offset of the title from the top of the axes, in points. Default is `None` to use rcParams['axes.titlepad'].

Returns

text [*Text*] The matplotlib text instance representing the title

Other Parameters

****kwargs** [*Text* properties] Other keyword arguments are text properties, see *Text* for a list of valid text properties.

set_top_view()

set_xlim(*left=None*, *right=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D x limits.

See *matplotlib.axes.Axes.set_xlim()* for full documentation.

set_xlim3d(*left=None*, *right=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D x limits.

See *matplotlib.axes.Axes.set_xlim()* for full documentation.

set_xscale(*value*, ***kwargs*)
Set the x-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

See also:

matplotlib.scale.LinearScale linear transform

matplotlib.scale.LogTransform log transform

matplotlib.scale.SymmetricalLogTransform symlog transform

matplotlib.scale.LogisticTransform logit transform .. versionadded :: 1.1.0 This function was added, but not tested. Please report any bugs.

Notes

Different kwargs are accepted, depending on the scale. See the *scale* module for more information.

set_ylim(*bottom=None*, *top=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D y limits.

See *matplotlib.axes.Axes.set_ylim()* for full documentation.

set_ylim3d(*bottom=None*, *top=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D y limits.

See *matplotlib.axes.Axes.set_ylim()* for full documentation.

set_yscale(*value*, ***kwargs*)
Set the y-axis scale.

Parameters

value [{"linear", "log", "symlog", "logit"}] scaling strategy to apply

See also:

matplotlib.scale.LinearScale linear transform

matplotlib.scale.LogTransform log transform

matplotlib.scale.SymmetricalLogTransform symlog transform

matplotlib.scale.LogisticTransform logit transform .. versionadded :: 1.1.0 This function was added, but not tested. Please report any bugs.

Notes

Different kwargs are accepted, depending on the scale. See the *scale* module for more information.

set_zbound(*lower=None*, *upper=None*)
Set the lower and upper numerical bounds of the z-axis. This method will honor axes inversion regardless of parameter order. It will not change the `_autoscaleZon` attribute.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

set_zlabel(*zlabel*, *fontdict=None*, *labelpad=None*, ***kwargs*)
Set zlabel. See doc for `set_ylabel()` for description.

set_zlim(*bottom=None*, *top=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D z limits.

See *matplotlib.axes.Axes.set_ylim()* for full documentation

set_zlim3d(*bottom=None*, *top=None*, *emit=True*, *auto=False*, ***kw*)
Set 3D z limits.

See *matplotlib.axes.Axes.set_ylim()* for full documentation

set_zmargin(*m*)
Set padding of Z 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

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

set_zscale(*value*, ***kwargs*)
Set the scaling of the z-axis: 'linear' | 'log' | 'logit' | 'symlog'

ACCEPTS: ['linear' | 'log' | 'logit' | 'symlog']

Different kwargs are accepted, depending on the scale: 'linear'

'log'

***basex/basey*:** The base of the logarithm

***nonposx/nonposy*: ['mask' | 'clip']** non-positive values in *x* or *y* can be masked as invalid, or clipped to a very small positive number

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

'logit'

***nonpos*: ['mask' | 'clip']** values beyond]0, 1[can be masked as invalid, or clipped to a number very close to 0 or 1

'symlog'

***basex/basey*:** The base of the logarithm

***linthreshx/linthreshy*:** A single float which defines the range (-*x*, *x*), within which the plot is linear. This avoids having the plot go to infinity around zero.

***subsx/subsy*:** Where to place the subticks between each major tick. Should be a sequence of integers. For example, in a log10 scale: `[2, 3, 4, 5, 6, 7, 8, 9]`

will place 8 logarithmically spaced minor ticks between each major tick.

***linscalex/linscaley*:** This allows the linear range (*-linthresh* to *linthresh*) to be stretched relative to the logarithmic range. Its value is the number of decades to use for each half of the linear range. For example, when *linscale* == 1.0 (the default), the space used for the positive and negative halves of the linear range will be equal to one decade in the logarithmic range.

Note: Currently, Axes3D objects only supports linear scales. Other scales may or may not work, and support for these is improving with each release.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

set_zticklabels(**args*, ***kwargs*)
Set z-axis tick labels. See *matplotlib.axes.Axes.set_yticklabels()* for more details.

Note: Minor ticks are not supported by Axes3D objects.

New in version 1.1.0.

set_zticks(**args*, ***kwargs*)
Set z-axis tick locations. See *matplotlib.axes.Axes.set_yticks()* for more details.

Note: Minor ticks are not supported.

New in version 1.1.0.

text(*x*, *y*, *z*, *s*, *zdir=None*, ***kwargs*)
Add text to the plot. kwargs will be passed on to Axes.text, except for the `zdir` keyword, which sets the direction to be used as the z direction.

text2D(*x*, *y*, *s*, *fontdict=None*, *withdash=False*, ***kwargs*)
Add text to the axes.

Add the text *s* to the axes at location *x*, *y* in data coordinates.

Parameters

x, y [scalars] The position to place the text. By default, this is in data coordinates. The coordinate system can be changed using the *transform* parameter.

s [str] The text.

fontdict [dictionary, optional, default: None] A dictionary to override the default text properties. If fontdict is None, the defaults are determined by your rc parameters.

withdash [boolean, optional, default: False] Creates a *TextWithDash* instance instead of a *Text* instance.

Returns

text [*Text*] The created *Text* instance.

Other Parameters

****kwargs** [*Text* properties.] Other miscellaneous text parameters.

Examples

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 (e.g., to set a background color) by using the keyword `bbox`. `bbox` is a dictionary of *Rectangle* properties. For example:

```
>>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
```

text3D(*x*, *y*, *z*, *s*, *zdir=None*, ***kwargs*)

Add text to the plot. kwargs will be passed on to Axes.text, except for the `zdir` keyword, which sets the direction to be used as the z direction.

tick_params(*axis='both'*, ***kwargs*)

Convenience method for changing the appearance of ticks and tick labels.

See *matplotlib.axes.Axes.tick_params()* for more complete documentation.

The only difference is that setting *axis* to 'both' will mean that the settings are applied to all three axes. Also, the *axis* parameter also accepts a value of 'z', which would mean to apply to only the z-axis.

Also, because of how Axes3D objects are drawn very differently from regular 2D axes, some of these settings may have ambiguous meaning. For simplicity, the 'z' axis will accept settings as if it was like the 'y' axis.

Note: While this function is currently implemented, the core part of the Axes3D object may ignore some of these settings. Future releases will fix this. Priority will be given to those who file bugs.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

ticklabel_format(***kwargs*)

Convenience method for manipulating the ScalarFormatter used by default for linear axes in Axed3D objects.

See *matplotlib.axes.Axes.ticklabel_format()* for full documentation. Note that this version applies to all three axes of the Axes3D object. Therefore, the *axis* argument will also accept a value of 'z' and the value of 'both' will apply to all three axes.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

tricontour(**args*, ***kwargs*)

Create a 3D contour plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
extend3d	Whether to extend contour in 3D (default: False)
stride	Stride (step size) for extending contour
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the contour lines on this position in plane normal to zdir

Other keyword arguments are passed on to *tricontour()*

Returns a *contour*

Changed in version 1.3.0: Added support for custom triangulations

EXPERIMENTAL: This method currently produces incorrect output due to a longstanding bug in 3D PolyCollection rendering.

tricontourf(**args*, ***kwargs*)

Create a 3D contourf plot.

Argument	Description
X, *Y*,	Data values as numpy.arrays
Z	
zdir	The direction to use: x, y or z (default)
offset	If specified plot a projection of the contour lines on this position in plane normal to zdir

Other keyword arguments are passed on to *tricontour()*

Returns a *contour*

Changed in version 1.3.0: Added support for custom triangulations

EXPERIMENTAL: This method currently produces incorrect output due to a longstanding bug in 3D PolyCollection rendering.

tunit_cube(*vals=None*, *M=None*)

tunit_edges(*vals=None*, *M=None*)

unit_cube(*vals=None*)

update_datalim(*xys*, ***kwargs*)
Update the data lim bbox with seq of xy tups or equiv. 2-D array

view_init(*elev=None*, *azim=None*)
Set the elevation and azimuth of the axes.

This can be used to rotate the axes programmatically.

'elev' stores the elevation angle in the z plane. 'azim' stores the azimuth angle in the x,y plane.

if elev or azim are None (default), then the initial value is used which was specified in the *Axes3D* constructor.

voxels([*x*, *y*, *z*], */*, *filled*, ***kwargs*)
Plot a set of filled voxels

All voxels are plotted as 1x1x1 cubes on the axis, with filled[0,0,0] placed with its lower corner at the origin. Occluded faces are not plotted.

Call signatures:

```
voxels(filled, facecolors=fc, edgecolors=ec, **kwargs)
voxels(x, y, z, filled, facecolors=fc, edgecolors=ec, **kwargs)
```

New in version 2.1.

Parameters

filled [3D np.array of bool] A 3d array of values, with truthy values indicating which voxels to fill

x, y, z [3D np.array, optional] The coordinates of the corners of the voxels. This should broadcast to a shape one larger in every dimension than the shape of `filled`. These can be used to plot non-cubic voxels.

If not specified, defaults to increasing integers along each axis, like those returned by `indices()`. As indicated by the `/` in the function signature, these arguments can only be passed positionally.

facecolors, edgecolors [array_like, optional] The color to draw the faces and edges of the voxels. Can only be passed as keyword arguments. This parameter can be:

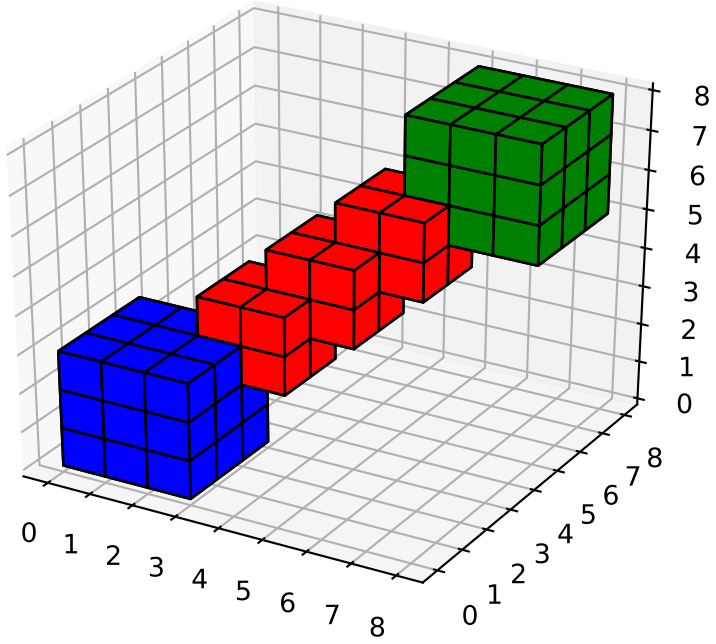
- A single color value, to color all voxels the same color. This can be either a string, or a 1D rgb/rgba array
- `None`, the default, to use a single color for the faces, and the style default for the edges.
- A 3D ndarray of color names, with each item the color for the corresponding voxel. The size must match the voxels.
- A 4D ndarray of rgb/rgba data, with the components along the last axis.

****kwargs** Additional keyword arguments to pass onto *Poly3DCollection()*

Returns

faces [dict] A dictionary indexed by coordinate, where `faces[i,j,k]` is a `Poly3DCollection` of the faces drawn for the voxel `filled[i,j,k]`. If no faces were drawn for a given voxel, either because it was not asked to be drawn, or it is fully occluded, then `(i,j,k) not in faces`.

Examples



zaxis_date(*tz=None*)

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

tz is a timezone string or `tzinfo` instance. Defaults to rc value.

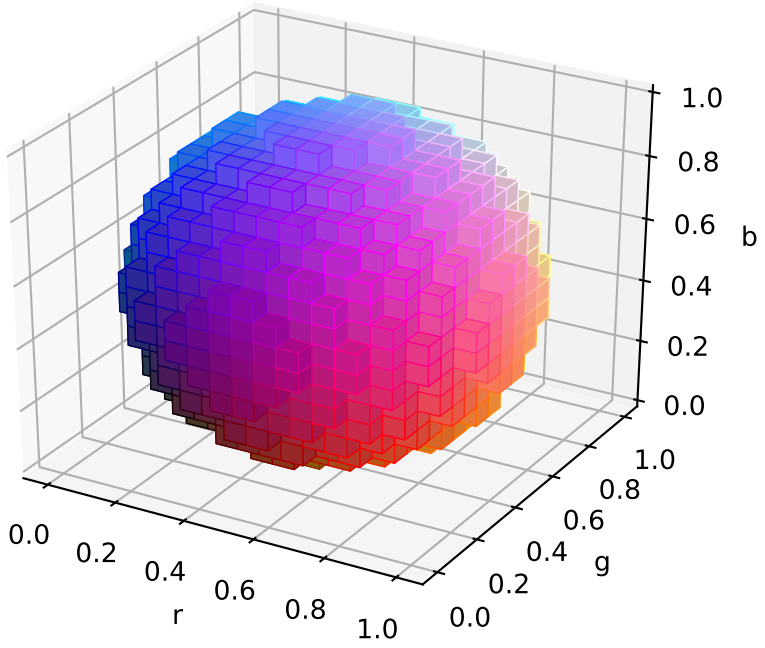
Note: This function is merely provided for completeness. Axes3D objects do not officially support dates for ticks, and so this may or may not work as expected.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.

zaxis_inverted()

Returns True if the z-axis is inverted.

New in version 1.1.0: This function was added, but not tested. Please report any bugs.



76.1.2 axis3d

Note: See `mpl_toolkits.mplot3d.axis3d._axinfo` for a dictionary containing constants that may be modified for controlling the look and feel of mplot3d axes (e.g., label spacing, font colors and panel colors). Historically, axis3d has suffered from having hard-coded constants that precluded user adjustments, and this dictionary was implemented in version 1.1 as a stop-gap measure.

axis3d.Axis(adir, v_intervalx, d_intervalx, ...)	

mpl_toolkits.mplot3d.axis3d.Axis

class mpl_toolkits.mplot3d.axis3d.**Axis**(*adir*, *v_intervalx*, *d_intervalx*, *axes*, **args*, ***kwargs*)

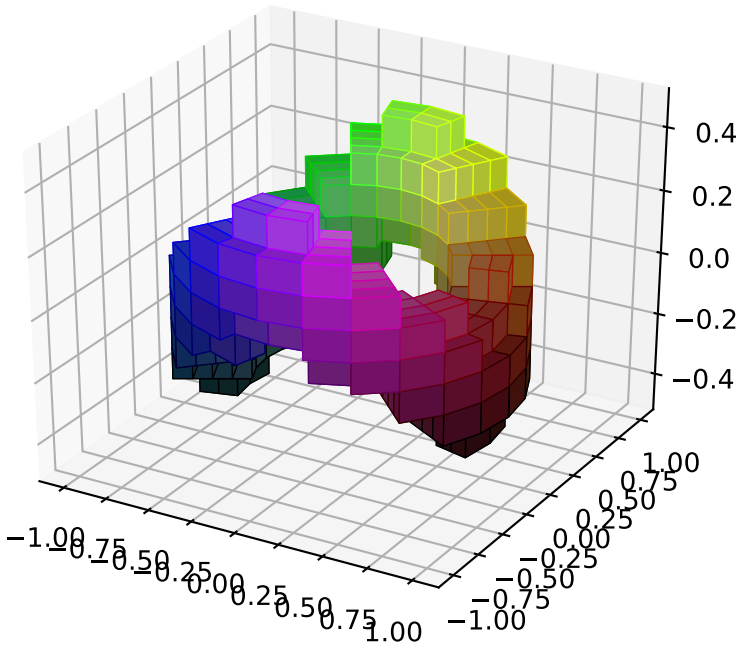
draw(*renderer*)
Draw the axis lines, grid lines, tick lines and labels

draw_pane(*renderer*)

get_major_ticks(*numticks=None*)
get the tick instances; grow as necessary

get_rotate_label(*text*)

get_tick_positions()



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

If *ignore* is *False*, the order of vmin, vmax does not matter; the original axis orientation will be preserved. In addition, the view limits can be expanded, but will not be reduced. This method is for mpl internal use; for normal use, see *set_xlim()*.

76.1.3 art3d

art3d.Line3D(xs, ys, zs, *args, **kwargs)	3D line object.
art3d.Line3DCollection(segments, *args, **kwargs)	A collection of 3D lines.
art3d.Patch3D(*args, **kwargs)	3D patch object.
art3d.Patch3DCollection(*args, **kwargs)	A collection of 3D patches.
art3d.Path3DCollection(*args, **kwargs)	A collection of 3D paths.
art3d.PathPatch3D(path, **kwargs)	3D PathPatch object.
art3d.Poly3DCollection(verts, *args, **kwargs)	A collection of 3D polygons.
art3d.Text3D([x, y, z, text, zdir])	Text object with 3D position and (in the future) direction.

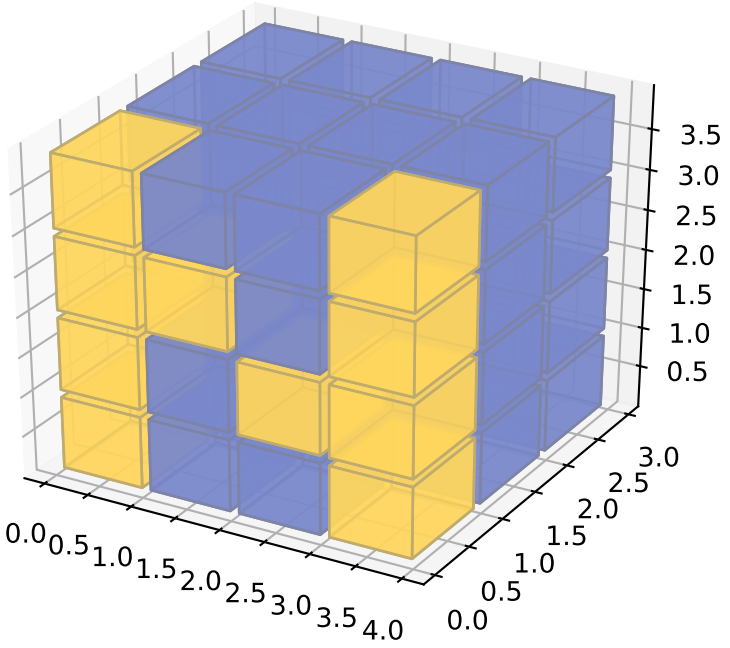
mpl_toolkits.mplot3d.art3d.Line3D

class mpl_toolkits.mplot3d.art3d.**Line3D**(*xs*, *ys*, *zs*, **args*, ***kwargs*)

3D line object.

Keyword arguments are passed onto *Line2D()*.

draw(*renderer*)



set_sort_zpos(*val*)
Set the position to use for z-sorting.

mpl_toolkits.mplot3d.art3d.Patch3D

class mpl_toolkits.mplot3d.art3d.**Patch3D**(**args*, ***kwargs*)
3D patch object.

do_3d_projection(*renderer*)

draw(*renderer*)
Draw the Patch to the given *renderer*.

get_facecolor()
Return the face color of the Patch.

get_path()
Return the path of this patch

set_3d_properties(*verts*, *zs=0*, *zdir='z'*)

mpl_toolkits.mplot3d.art3d.Patch3DCollection

class mpl_toolkits.mplot3d.art3d.**Patch3DCollection**(**args*, ***kwargs*)

A collection of 3D patches.

Create a collection of flat 3D patches with its normal vector pointed in *zdir* direction, and located at *zs* on the *zdir* axis. 'zs' can be a scalar or an array-like of the same length as the number of patches in the collection.

Constructor arguments are the same as for *PatchCollection*. In addition, keywords *zs=0* and *zdir='z'* are available.

Also, the keyword argument "depthshade" is available to indicate whether or not to shade the patches in order to give the appearance of depth (default is *True*). This is typically desired in scatter plots.

do_3d_projection(*renderer*)

set_3d_properties(*zs*, *zdir*)

set_sort_zpos(*val*)

Set the position to use for z-sorting.

mpl_toolkits.mplot3d.art3d.Path3DCollection

class mpl_toolkits.mplot3d.art3d.**Path3DCollection**(**args*, ***kwargs*)

A collection of 3D paths.

Create a collection of flat 3D paths with its normal vector pointed in *zdir* direction, and located at *zs* on the *zdir* axis. 'zs' can be a scalar or an array-like of the same length as the number of paths in the collection.

Constructor arguments are the same as for *PathCollection*. In addition, keywords *zs=0* and *zdir='z'* are available.

Also, the keyword argument "depthshade" is available to indicate whether or not to shade the patches in order to give the appearance of depth (default is *True*). This is typically desired in scatter plots.

do_3d_projection(*renderer*)

set_3d_properties(*zs*, *zdir*)

set_sort_zpos(*val*)

Set the position to use for z-sorting.

mpl_toolkits.mplot3d.art3d.PathPatch3D

class mpl_toolkits.mplot3d.art3d.**PathPatch3D**(*path*, ***kwargs*)

3D PathPatch object.

do_3d_projection(*renderer*)

set_3d_properties(*path*, *zs=0*, *zdir='z'*)

mpl_toolkits.mplot3d.art3d.Poly3DCollection

class mpl_toolkits.mplot3d.art3d.**Poly3DCollection**(*verts*, **args*, ***kwargs*)

A collection of 3D polygons.

Create a Poly3DCollection.

verts should contain 3D coordinates.

Keyword arguments: zsort, see set_zsort for options.

Note that this class does a bit of magic with the _facecolors and _edgecolors properties.

do_3d_projection(*renderer*)

Perform the 3D projection for this object.

draw(*renderer*)

Derived classes drawing method

get_edgecolor()

get_edgecolors()

get_facecolor()

get_facecolors()

get_vector(*segments3d*)

Optimize points for projection

set_3d_properties()

set_alpha(*alpha*)

Set the alpha tranparencies of the collection. *alpha* must be a float or *None*.

ACCEPTS: float or None

set_edgecolor(*colors*)

Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_edgecolors(*colors*)
Set the edgecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolor(*colors*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_facecolors(*colors*)
Set the facecolor(s) of the collection. *c* can be a matplotlib color spec (all patches have same color), or a sequence of specs; 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 spec or sequence of specs

set_sort_zpos(*val*)
Set the position to use for z-sorting.

set_verts(*verts*, *closed=True*)
Set 3D vertices.

set_verts_and_codes(*verts*, *codes*)
Sets 3D vertices with path codes

set_zsort(*zsort*)

Set z-sorting behaviour: boolean: if True use default 'average' string: 'average', 'min' or 'max'

mpl_toolkits.mplot3d.art3d.Text3D

class mpl_toolkits.mplot3d.art3d.**Text3D**(*x=0*, *y=0*, *z=0*, *text=''*, *zdir='z'*, ***kwargs*)
Text object with 3D position and (in the future) direction.

x, *y*, *z* Position of text *text* Text string to display *zdir* Direction of text

Keyword arguments are passed onto *Text()*.

draw(*renderer*)
Draws the Text object to the given *renderer*.

set_3d_properties(*z=0*, *zdir='z'*)

76.1.4 Art3D Utility Functions

art3d.get_colors(c, num)	Stretch the color argument to provide the required number num
art3d.get_dir_vector(zdir)	
art3d.get_patch_verts(patch)	Return a list of vertices for the path of a patch.
art3d.juggle_axes(xs, ys, zs, zdir)	Reorder coordinates so that 2D xs, ys can be plotted in the plane orthogonal to zdir.
art3d.line_2d_to_3d(line[, zs, zdir])	Convert a 2D line to 3D.
art3d.line_collection_2d_to_3d(col[, zs, zdir])	Convert a LineCollection to a Line3DCollection object.
art3d.norm_angle(a)	Return angle between -180 and +180
art3d.norm_text_angle(a)	Return angle between -90 and +90
art3d.patch_2d_to_3d(patch[, z, zdir])	Convert a Patch to a Patch3D object.
art3d.patch_collection_2d_to_3d(col[, zs, ...])	Convert a *PatchCollection* into a Patch3DCollection object (or a *PathCollection* into a Path3DCollection object).
art3d.path_to_3d_segment(path[, zs, zdir])	Convert a path to a 3D segment.
art3d.path_to_3d_segment_with_codes(path[, ...])	Convert a path to a 3D segment with path codes.
art3d.pathpatch_2d_to_3d(pathpatch[, z, zdir])	Convert a PathPatch to a PathPatch3D object.
art3d.paths_to_3d_segments(paths[, zs, zdir])	Convert paths from a collection object to 3D segments.
art3d.paths_to_3d_segments_with_codes(paths[,	Convert paths from a collection object to 3D segments with path codes.
art3d.poly_collection_2d_to_3d(col[, zs, zdir])	Convert a PolyCollection to a Poly3DCollection object.
art3d.rotate_axes(xs, ys, zs, zdir)	Reorder coordinates so that the axes are rotated with zdir along the original z axis.
art3d.text_2d_to_3d(obj[, z, zdir])	Convert a Text to a Text3D object.
art3d.zalpha(colors, zs)	Modify the alphas of the color list according to depth

mpl_toolkits.mplot3d.art3d.get_colors

mpl_toolkits.mplot3d.art3d.**get_colors**(*c*, *num*)

Stretch the color argument to provide the required number num

mpl_toolkits.mplot3d.art3d.get_dir_vector

mpl_toolkits.mplot3d.art3d.**get_dir_vector**(*zdir*)

mpl_toolkits.mplot3d.art3d.get_patch_verts

mpl_toolkits.mplot3d.art3d.**get_patch_verts**(*patch*)
Return a list of vertices for the path of a patch.

mpl_toolkits.mplot3d.art3d.juggle_axes

mpl_toolkits.mplot3d.art3d.**juggle_axes**(*xs*, *ys*, *zs*, *zdir*)
Reorder coordinates so that 2D xs, ys can be plotted in the plane orthogonal to zdir. zdir is normally x, y or z. However, if zdir starts with a '-' it is interpreted as a compensation for rotate_axes.

mpl_toolkits.mplot3d.art3d.line_2d_to_3d

mpl_toolkits.mplot3d.art3d.**line_2d_to_3d**(*line*, *zs=0*, *zdir='z'*)
Convert a 2D line to 3D.

mpl_toolkits.mplot3d.art3d.line_collection_2d_to_3d

mpl_toolkits.mplot3d.art3d.**line_collection_2d_to_3d**(*col*, *zs=0*, *zdir='z'*)
Convert a LineCollection to a Line3DCollection object.

mpl_toolkits.mplot3d.art3d.norm_angle

mpl_toolkits.mplot3d.art3d.**norm_angle**(*a*)
Return angle between -180 and +180

mpl_toolkits.mplot3d.art3d.norm_text_angle

mpl_toolkits.mplot3d.art3d.**norm_text_angle**(*a*)
Return angle between -90 and +90

mpl_toolkits.mplot3d.art3d.patch_2d_to_3d

mpl_toolkits.mplot3d.art3d.**patch_2d_to_3d**(*patch*, *z=0*, *zdir='z'*)
Convert a Patch to a Patch3D object.

mpl_toolkits.mplot3d.art3d.patch_collection_2d_to_3d

mpl_toolkits.mplot3d.art3d.**patch_collection_2d_to_3d**(*col*, *zs=0*, *zdir='z'*, *depthshade=True*)
Convert a *PatchCollection* into a *Patch3DCollection* object (or a *PathCollection* into a *Path3DCollection* object).

Keywords:

za **The location or locations to place the patches in the** collection along the *zdir* axis. Defaults to 0.

zdir The axis in which to place the patches. Default is "z".

depthshade **Whether to shade the patches to give a sense of depth.** Defaults to *True*.

mpl_toolkits.mplot3d.art3d.path_to_3d_segment

mpl_toolkits.mplot3d.art3d.**path_to_3d_segment**(*path*, *zs=0*, *zdir='z'*)
Convert a path to a 3D segment.

mpl_toolkits.mplot3d.art3d.path_to_3d_segment_with_codes

mpl_toolkits.mplot3d.art3d.**path_to_3d_segment_with_codes**(*path*, *zs=0*, *zdir='z'*)
Convert a path to a 3D segment with path codes.

mpl_toolkits.mplot3d.art3d.pathpatch_2d_to_3d

mpl_toolkits.mplot3d.art3d.**pathpatch_2d_to_3d**(*pathpatch*, *z=0*, *zdir='z'*)
Convert a PathPatch to a PathPatch3D object.

Examples using mpl_toolkits.mplot3d.art3d.pathpatch_2d_to_3d

- sphx_glr_gallery_mplot3d_pathpatch3d.py

mpl_toolkits.mplot3d.art3d.paths_to_3d_segments

mpl_toolkits.mplot3d.art3d.**paths_to_3d_segments**(*paths*, *zs=0*, *zdir='z'*)
Convert paths from a collection object to 3D segments.

mpl_toolkits.mplot3d.art3d.paths_to_3d_segments_with_codes

mpl_toolkits.mplot3d.art3d.**paths_to_3d_segments_with_codes**(*paths*, *zs=0*, *zdir='z'*)
Convert paths from a collection object to 3D segments with path codes.

mpl_toolkits.mplot3d.art3d.poly_collection_2d_to_3d

mpl_toolkits.mplot3d.art3d.**poly_collection_2d_to_3d**(*col*, *zs=0*, *zdir='z'*)
Convert a PolyCollection to a Poly3DCollection object.

mpl_toolkits.mplot3d.art3d.rotate_axes

mpl_toolkits.mplot3d.art3d.**rotate_axes**(*xs*, *ys*, *zs*, *zdir*)

Reorder coordinates so that the axes are rotated with zdir along the original z axis. Prepending the axis with a '-' does the inverse transform, so zdir can be x, -x, y, -y, z or -z

mpl_toolkits.mplot3d.art3d.text_2d_to_3d

mpl_toolkits.mplot3d.art3d.**text_2d_to_3d**(*obj*, *z=0*, *zdir='z'*)

Convert a Text to a Text3D object.

mpl_toolkits.mplot3d.art3d.zalpha

mpl_toolkits.mplot3d.art3d.**zalpha**(*colors*, *zs*)

Modify the alphas of the color list according to depth

76.1.5 proj3d

proj3d.inv_transform(xs, ys, zs, M)	
proj3d.line2d(p0, p1)	Return 2D equation of line in the form ax+by+c = 0
proj3d.line2d_dist(l, p)	Distance from line to point line is a tuple of coefficients a,b,c
proj3d.line2d_seg_dist(p1, p2, p0)	distance(s) from line defined by p1 - p2 to point(s) p0
proj3d.mod(v)	3d vector length
proj3d.persp_transformation(zfront, zback)	
proj3d.proj_points(points, M)	
proj3d.proj_trans_clip_points(points, M)	
proj3d.proj_trans_points(points, M)	
proj3d.proj_transform(xs, ys, zs, M)	Transform the points by the projection matrix
proj3d.proj_transform_clip(xs, ys, zs, M)	Transform the points by the projection matrix and return the clipping result returns txs,tys,tzs,tis
proj3d.proj_transform_vec(vec, M)	
proj3d.proj_transform_vec_clip(vec, M)	
proj3d.rot_x(V, alpha)	
proj3d.transform(xs, ys, zs, M)	Transform the points by the projection matrix
proj3d.vec_pad_ones(xs, ys, zs)	
proj3d.view_transformation(E, R, V)	
proj3d.world_transformation(xmin, xmax, ...)	

mpl_toolkits.mplot3d.proj3d.inv_transform

mpl_toolkits.mplot3d.proj3d.**inv_transform**(*xs*, *ys*, *zs*, *M*)

mpl_toolkits.mplot3d.proj3d.line2d

mpl_toolkits.mplot3d.proj3d.**line2d**(*p0*, *p1*)
Return 2D equation of line in the form ax+by+c = 0

mpl_toolkits.mplot3d.proj3d.line2d_dist

mpl_toolkits.mplot3d.proj3d.**line2d_dist**(*l*, *p*)
Distance from line to point line is a tuple of coefficients a,b,c

mpl_toolkits.mplot3d.proj3d.line2d_seg_dist

mpl_toolkits.mplot3d.proj3d.**line2d_seg_dist**(*p1*, *p2*, *p0*)
distance(s) from line defined by p1 - p2 to point(s) p0

p0[0] = x(s) p0[1] = y(s)

intersection point p = p1 + u*(p2-p1) and intersection point lies within segment if u is between 0 and 1

mpl_toolkits.mplot3d.proj3d.mod

mpl_toolkits.mplot3d.proj3d.**mod**(*v*)
3d vector length

mpl_toolkits.mplot3d.proj3d.persp_transformation

mpl_toolkits.mplot3d.proj3d.**persp_transformation**(*zfront*, *zback*)

mpl_toolkits.mplot3d.proj3d.proj_points

mpl_toolkits.mplot3d.proj3d.**proj_points**(*points*, *M*)

mpl_toolkits.mplot3d.proj3d.proj_trans_clip_points

mpl_toolkits.mplot3d.proj3d.**proj_trans_clip_points**(*points*, *M*)

mpl_toolkits.mplot3d.proj3d.proj_trans_points

mpl_toolkits.mplot3d.proj3d.**proj_trans_points**(*points*, *M*)

mpl_toolkits.mplot3d.proj3d.proj_transform

mpl_toolkits.mplot3d.proj3d.**proj_transform**(*xs*, *ys*, *zs*, *M*)
Transform the points by the projection matrix

mpl_toolkits.mplot3d.proj3d.proj_transform_clip

mpl_toolkits.mplot3d.proj3d.**proj_transform_clip**(*xs*, *ys*, *zs*, *M*)
Transform the points by the projection matrix and return the clipping result returns txs,tys,tzs,tis

mpl_toolkits.mplot3d.proj3d.proj_transform_vec

mpl_toolkits.mplot3d.proj3d.**proj_transform_vec**(*vec*, *M*)

mpl_toolkits.mplot3d.proj3d.proj_transform_vec_clip

mpl_toolkits.mplot3d.proj3d.**proj_transform_vec_clip**(*vec*, *M*)

mpl_toolkits.mplot3d.proj3d.rot_x

mpl_toolkits.mplot3d.proj3d.**rot_x**(*V*, *alpha*)

mpl_toolkits.mplot3d.proj3d.transform

mpl_toolkits.mplot3d.proj3d.**transform**(*xs*, *ys*, *zs*, *M*)
Transform the points by the projection matrix

mpl_toolkits.mplot3d.proj3d.vec_pad_ones

mpl_toolkits.mplot3d.proj3d.**vec_pad_ones**(*xs*, *ys*, *zs*)

mpl_toolkits.mplot3d.proj3d.view_transformation

mpl_toolkits.mplot3d.proj3d.**view_transformation**(*E*, *R*, *V*)

mpl_toolkits.mplot3d.proj3d.world_transformation

mpl_toolkits.mplot3d.proj3d.**world_transformation**(*xmin*, *xmax*, *ymin*, *ymax*, *zmin*, *zmax*)

76.2 Matplotlib axes_grid Toolkit

Note: AxesGrid toolkit has been a part of matplotlib since v 0.99. Originally, the toolkit had a single namespace of *axes_grid*. In more recent version, the toolkit has divided into two separate namespace (*axes_grid1* and *axisartist*). While *axes_grid* namespace is maintained for the backward compatibility, use of *axes_grid1* and *axisartist* is recommended. For the documentation on `axes_grid`, see the previous version of the docs.

Part VII

The Matplotlib Developers' Guide

CHAPTER

SEVENTYSEVEN

CONTRIBUTING

This project is a community effort, and everyone is welcome to contribute.

The project is hosted on https://github.com/matplotlib/matplotlib

77.1 Submitting a bug report

If you find a bug in the code or documentation, do not hesitate to submit a ticket to the Bug Tracker. You are also welcome to post feature requests or pull requests.

If you are reporting a bug, please do your best to include the following:

1. A short, top-level summary of the bug. In most cases, this should be 1-2 sentences.
2. A short, self-contained code snippet to reproduce the bug, ideally allowing a simple copy and paste to reproduce. Please do your best to reduce the code snippet to the minimum required.
3. The actual outcome of the code snippet.
4. The expected outcome of the code snippet.
5. The Matplotlib version, Python version and platform that you are using. You can grab the version with the following commands:

```
>>> import matplotlib
>>> matplotlib.__version__
'1.5.3'
>>> import platform
>>> platform.python_version()
'2.7.12'
```

We have preloaded the issue creation page with a Markdown template that you can use to organize this information.

Thank you for your help in keeping bug reports complete, targeted and descriptive.

77.2 Retrieving and installing the latest version of the code

When developing Matplotlib, sources must be downloaded, built, and installed into a local environment on your machine.

Follow the instructions detailed *here* to set up your environment to build Matplotlib from source.

Warning: When working on Matplotlib sources, having multiple versions installed by different methods into the same environment may not always work as expected.

To work on Matplotlib sources, it is strongly recommended to set up an alternative development environment, using the something like virtual environments in python, or a conda environment.

If you choose to use an already existing environment, and not a clean virtual or conda environment, uninstall the current version of Matplotlib in that environment using the same method used to install it.

If working on Matplotlib documentation only, the above steps are *not* absolutely necessary.

We use Git for version control and GitHub for hosting our main repository.

You can check out the latest sources with the command (see *Set up your fork* for more details):

```
git clone https://github.com/matplotlib/matplotlib.git
```

and navigate to the `matplotlib` directory. If you have the proper privileges, you can use `git@` instead of `https://`, which works through the ssh protocol and might be easier to use if you are using 2-factor authentication.

77.2.1 Building Matplotlib for image comparison tests

Matplotlib's test suite makes heavy use of image comparison tests, meaning the result of a plot is compared against a known good result. Unfortunately, different versions of FreeType produce differently formed characters, causing these image comparisons to fail. To make them reproducible, Matplotlib can be built with a special local copy of FreeType. This is recommended for all Matplotlib developers.

Copy `setup.cfg.template` to `setup.cfg` and edit it to contain:

```
[test]
local_freetype = True
tests = True
```

or set the `MPLLOCALFREETYPE` environmental variable to any true value.

77.2.2 Installing Matplotlib in developer mode

To install Matplotlib (and compile the c-extensions) run the following command from the top-level directory

```
python -mpip install -ve .
```

This installs Matplotlib in 'editable/develop mode', i.e., builds everything and places the correct link entries in the install directory so that python will be able to import Matplotlib from the source directory. Thus, any changes to the `*.py` files will be reflected the next time you import the library. If you change the C-extension source (which might happen if you change branches) you will need to run

```
python setup.py build
```

or re-run `python -mpip install -ve .`.

Alternatively, if you do

```
python -mpip install -v .
```

all of the files will be copied to the installation directory however, you will have to rerun this command every time the source is changed. Additionally you will need to copy `setup.cfg.template` to `setup.cfg` and edit it to contain

```
[test]
local_freetype = True
tests = True
```

In either case you can then run the tests to check your work environment is set up properly:

```
python tests.py
```

Note: Additional dependencies for testing: pytest (version 3.1 or later), mock (if Python 2), Ghostscript, Inkscape

---

See also:

- *Developer's tips for testing*

77.3 Contributing code

77.3.1 How to contribute

The preferred way to contribute to Matplotlib is to fork the main repository on GitHub, then submit a "pull request" (PR).

The best practices for using GitHub to make PRs to Matplotlib are documented in the *Development workflow* section.

A brief overview is:

1. Create an account on GitHub if you do not already have one.
2. Fork the project repository: click on the 'Fork' button near the top of the page. This creates a copy of the code under your account on the GitHub server.
3. Clone this copy to your local disk:

```
$ git clone https://github.com/YourLogin/matplotlib.git
```

4. Create a branch to hold your changes:

```
$ git checkout -b my-feature origin/master
```

   and start making changes. Never work in the `master` branch!

5. Work on this copy, on your computer, using Git to do the version control. When you're done editing e.g., `lib/matplotlib/collections.py`, do:

```
$ git add lib/matplotlib/collections.py
$ git commit
```

   to record your changes in Git, then push them to GitHub with:

```
$ git push -u origin my-feature
```

Finally, go to the web page of your fork of the Matplotlib repo, and click 'Pull request' to send your changes to the maintainers for review. You may want to consider sending an email to the mailing list for more visibility.

See also:

- Git documentation
- *Development workflow*.
- *Working with Matplotlib source code*

77.3.2 Contributing pull requests

It is recommended to check that your contribution complies with the following rules before submitting a pull request:

- If your pull request addresses an issue, please use the title to describe the issue and mention the issue number in the pull request description to ensure that a link is created to the original issue.
- All public methods should have informative docstrings with sample usage when appropriate. Use the numpy docstring standard.
- Formatting should follow the recommendations of PEP8. You should consider installing/enabling automatic PEP8 checking in your editor. Part of the test suite is checking PEP8 compliance, things go smoother if the code is mostly PEP8 compliant to begin with.
- Each high-level plotting function should have a simple example in the `Example` section of the docstring. This should be as simple as possible to demonstrate the method. More complex examples should go in the `examples` tree.
- Changes (both new features and bugfixes) should be tested. See *Developer's tips for testing* for more details.
- Import the following modules using the standard scipy conventions:

```
import numpy as np
import numpy.ma as ma
import matplotlib as mpl
import matplotlib.pyplot as plt
import matplotlib.cbook as cbook
import matplotlib.patches as mpatches
```

- If your change is a major new feature, add an entry to the `What's new` section by adding a new file in `doc/users/next_whats_new` (see `doc/users/next_whats_new/README.rst` for more information).
- If you change the API in a backward-incompatible way, please document it in `doc/api/api_changes`, by adding a new file describing your changes (see `doc/api/api_changes/README.rst` for more information)
- See below for additional points about *Keyword argument processing*, if applicable for your pull request.

In addition, you can check for common programming errors with the following tools:

- Code with a good unittest coverage (at least 70%, better 100%), check with:

```
python -mpip install coverage
python tests.py --with-coverage
```

- No pyflakes warnings, check with:

```
python -mpip install pyflakes
pyflakes path/to/module.py
```

Note: The current state of the Matplotlib code base is not compliant with all of those guidelines, but we expect that enforcing those constraints on all new contributions will move the overall code base quality in the right direction.

See also:

- *Coding guidelines*
- *Developer's tips for testing*
- *Writing documentation*

77.3.3 Issues for New Contributors

New contributors should look for the following tags when looking for issues. We strongly recommend that new contributors tackle issues labeled good first issue as they are easy, well documented issues, that do not require an understanding of the different submodules of Matplotlib. This helps the contributor become familiar with the contribution workflow, and for the core devs to become acquainted with the contributor; besides which, we frequently underestimate how easy an issue is to solve!

77.4 Other ways to contribute

Code is not the only way to contribute to Matplotlib. For instance, documentation is also a very important part of the project and often doesn't get as much attention as it deserves. If you find a typo in the documentation, or have made improvements, do not hesitate to send an email to the mailing list or submit a GitHub pull request. Full documentation can be found under the doc/ directory.

It also helps us if you spread the word: reference the project from your blog and articles or link to it from your website!

77.5 Coding guidelines

77.5.1 New modules and files: installation

- If you have added new files or directories, or reorganized existing ones, make sure the new files are included in the match patterns in `MANIFEST.in`, and/or in `package_data` in `setup.py`.

77.5.2 C/C++ extensions

- Extensions may be written in C or C++.
- Code style should conform to PEP7 (understanding that PEP7 doesn't address C++, but most of its admonitions still apply).
- Python/C interface code should be kept separate from the core C/C++ code. The interface code should be named `FOO_wrap.cpp` or `FOO_wrapper.cpp`.
- Header file documentation (aka docstrings) should be in Numpydoc format. We don't plan on using automated tools for these docstrings, and the Numpydoc format is well understood in the scientific Python community.

77.5.3 Keyword argument processing

Matplotlib makes extensive use of `**kwargs` for pass-through customizations from one function to another. A typical example is in *matplotlib.pyplot.text()*. The definition of the pylab text function is a simple pass-through to *matplotlib.axes.Axes.text()*:

```
# in pylab.py
def text(*args, **kwargs):
    ret =  gca().text(*args, **kwargs)
    draw_if_interactive()
    return ret
```

text() in simplified form looks like this, i.e., it just passes all `args` and `kwargs` on to `matplotlib.text.Text.__init__()`:

```
# in axes/_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/_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...
```

77.5.4 Using logging for debug messages

Matplotlib uses the standard python `logging` library to write verbose warnings, information, and debug messages. Please use it! In all those places you write `print()` statements to do your debugging, try using `log.debug()` instead!

To include `logging` in your module, at the top of the module, you need to `import logging`. Then calls in your code like:

```
_log = logging.getLogger(__name__)  # right after the imports

# code
# more code
_log.info('Here is some information')
_log.debug('Here is some more detailed information')
```

will log to a logger named `matplotlib.yourmodulename`.

If an end-user of Matplotlib sets up `logging` to display at levels more verbose than `logger.WARNING` in their code as follows:

```
import logging
fmt = '%(name)s:%(lineno)5d - %(levelname)s - %(message)s'
logging.basicConfig(level=logging.DEBUG, format=fmt)
import matplotlib.pyplot as plt
```

Then they will receive messages like:

```
matplotlib.backends:   89 - INFO - backend MacOSX version unknown
matplotlib.yourmodulename: 347 - INFO - Here is some information
matplotlib.yourmodulename: 348 - DEBUG - Here is some more detailed information
```

Which logging level to use?

There are five levels at which you can emit messages. `logging.critical` and `logging.error` are really only there for errors that will end the use of the library but not kill the interpreter. `logging.warning` overlaps with the `warnings` library. The logging tutorial suggests that the difference between `logging.warning` and `warnings.warn` is that `warnings.warn` be used for things the user must change to stop the warning, whereas `logging.warning` can be more persistent.

By default, `logging` displays all log messages at levels higher than `logging.WARNING` to `sys.stderr`.

Calls to `logging.info` are not displayed by default. They are for information that the user may want to know if the program behaves oddly. For instance, if an object isn't drawn because its position is `NaN`, that can usually be ignored, but a mystified user could set `logging.basicConfig(level=logging.INFO)` and get an error message that says why.

`logging.debug` is the least likely to be displayed, and hence can be the most verbose.

77.5.5 Developing a new backend

If you are working on a custom backend, the *backend* setting in `matplotlibrc` (*Customizing Matplotlib with style sheets and rcParams*) supports an external backend via the `module` directive. If `my_backend.py` is a Matplotlib backend in your *PYTHONPATH*, you can set it on one of several ways

- in `matplotlibrc`:

```
backend : module://my_backend
```

- with the *MPLBACKEND* environment variable:

```
> export MPLBACKEND="module://my_backend"
> python simple_plot.py
```

- with the use directive in your script:

```
import matplotlib
matplotlib.use('module://my_backend')
```

77.5.6 Writing examples

We have hundreds of examples in subdirectories of `matplotlib/examples`, and these are automatically generated when the website is built to show up in the `examples` section of the website.

Any sample data that the example uses should be kept small and distributed with Matplotlib in the `lib/matplotlib/mpl-data/sample_data/` directory. 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')
```

CHAPTER

SEVENTYEIGHT

DEVELOPER'S TIPS FOR TESTING

Matplotlib's testing infrastructure depends on pytest. The tests are in `lib/matplotlib/tests`, and customizations to the pytest testing infrastructure are in `matplotlib.testing`.

78.1 Requirements

Install the latest version of Matplotlib as documented in *Retrieving and installing the latest version of the code* In particular, follow the instructions to use a local FreeType build

The following software is required to run the tests:

- pytest (>=3.1)
- mock, when running Python 2
- Ghostscript (to render PDF files)
- Inkscape (to render SVG files)

Optionally you can install:

- pytest-cov (>=2.3.1) to collect coverage information
- pytest-pep8 to test coding standards
- pytest-timeout to limit runtime in case of stuck tests
- pytest-xdist to run tests in parallel

78.2 Running the tests

Running the tests is simple. Make sure you have pytest installed and run:

```
py.test
```

or:

```
python tests.py
```

in the root directory of the distribution. The script takes a set of commands, such as:

`--pep8`	Perform pep8 checks (requires pytest-pep8)
`-m "not network"`	Disable tests that require network access

Additional arguments are passed on to pytest. See the pytest documentation for supported arguments. Some of the more important ones are given here:

`--verbose`	Be more verbose
`--n NUM`	Run tests in parallel over NUM processes (requires pytest-xdist)
`--timeout=SECONDS`	Set timeout for results from each test process (requires pytest-timeout)
`--capture=no` or `-s`	Do not capture stdout

To run a single test from the command line, you can provide a file path, optionally followed by the function separated by two colons, e.g., (tests do not need to be installed, but Matplotlib should be):

```
py.test lib/matplotlib/tests/test_simplification.py::test_clipping
```

or, if tests are installed, a dot-separated path to the module, optionally followed by the function separated by two colons, such as:

```
py.test --pyargs matplotlib.tests.test_simplification::test_clipping
```

If you want to run the full test suite, but want to save wall time try running the tests in parallel:

```
py.test --verbose -n 5
```

Depending on your version of Python and pytest-xdist, you may need to set `PYTHONHASHSEED` to a fixed value when running in parallel:

```
PYTHONHASHSEED=0 py.test --verbose -n 5
```

An alternative implementation that does not look at command line arguments and works from within Python is to run the tests from the Matplotlib library function `matplotlib.test()`:

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

78.3 Writing a simple test

Many elements of Matplotlib can be tested using standard tests. For example, here is a test from `matplotlib.tests.test_basic`:

```
def test_simple():
    """
    very simple example test
```

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```
    """
    assert 1 + 1 == 2
```

Pytest determines which functions are tests by searching for files whose names begin with `"test_"` and then within those files for functions beginning with `"test"` or classes beginning with `"Test"`.

Some tests have internal side effects that need to be cleaned up after their execution (such as created figures or modified rc params). The pytest fixture `mpl_test_settings()` will automatically clean these up; there is no need to do anything further.

78.4 Random data in tests

Random data can is a very convenient way to generate data for examples, however the randomness is problematic for testing (as the tests must be deterministic!). To work around this set the seed in each test. For numpy use:

```
import numpy as np
np.random.seed(19680801)
```

and Python's random number generator:

```
import random
random.seed(19680801)
```

The seed is John Hunter's birthday.

78.5 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'],
                  extensions=['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)
```

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```
    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')
```

The first time this test is run, there will be no baseline image to compare against, so the test will fail. Copy the output images (in this case `result_images/test_category/spines_axes_positions.png`) to the correct subdirectory of `baseline_images` tree in the source directory (in this case `lib/matplotlib/tests/baseline_images/test_category`). Put this new file under source code revision control (with `git add`). When rerunning the tests, they should now pass.

The `image_comparison()` decorator defaults to generating `png`, `pdf` and `svg` output, but in interest of keeping the size of the library from ballooning we should only include the `svg` or `pdf` outputs if the test is explicitly exercising a feature dependent on that backend.

There are two optional keyword arguments to the `image_comparison` decorator:

- `extensions`: If you only wish to test additional image formats (rather than just `png`), pass any additional file types in the list of the extensions to test. When copying the new baseline files be sure to only copy the output files, not their conversions to `png`. For example only copy the files ending in `pdf`, not in `_pdf.png`.
- `tol`: This is the image matching tolerance, the default `1e-3`. If some variation is expected in the image between runs, this value may be adjusted.

78.6 Known failing tests

If you're writing a test, you may mark it as a known failing test with the `pytest.mark.xfail()` 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:

```
import pytest

@pytest.mark.xfail
def test_simple_fail():
    '''very simple example test that should fail'''
    assert 1 + 1 == 3
```

Note that the first argument to the `xfail()` decorator is a fail condition, which can be a value such as True, False, or may be a dynamically evaluated expression. If a condition is supplied, then a reason must also be supplied with the `reason='message'` keyword argument.

78.7 Creating a new module in matplotlib.tests

We try to keep the tests categorized by the primary module they are testing. For example, the tests related to the `mathtext.py` module are in `test_mathtext.py`.

78.8 Using Travis CI

Travis CI is a hosted CI system "in the cloud".

Travis is configured to receive notifications of new commits to GitHub repos (via GitHub "service hooks") and to run builds or tests when it sees these new commits. It looks for a YAML file called `.travis.yml` in the root of the repository to see how to test the project.

Travis CI is already enabled for the main matplotlib GitHub repository – for example, see its Travis page.

If you want to enable Travis CI for your personal Matplotlib GitHub repo, simply enable the repo to use Travis CI in either the Travis CI UI or the GitHub UI (Admin | Service Hooks). For details, see the Travis CI Getting Started page. This generally isn't necessary, since any pull request submitted against the main Matplotlib repository will be tested.

Once this is configured, you can see the Travis CI results at https://travis-ci.org/your_GitHub_user_name/matplotlib – here's an example.

78.9 Using tox

Tox is a tool for running tests against multiple Python environments, including multiple versions of Python (e.g., 2.7, 3.5, 3.6) and even different Python implementations altogether (e.g., CPython, PyPy, Jython, etc.)

Testing all versions of Python (2.7, 3.6, 3.7, ...) requires having multiple versions of Python installed on your system and on the PATH. Depending on your operating system, you may want to use your package manager (such as apt-get, yum or MacPorts) to do this.

tox makes it easy to determine if your working copy introduced any regressions before submitting a pull request. Here's how to use it:

```
$ pip install tox
$ tox
```

You can also run tox on a subset of environments:

```
$ tox -e py27,py36,py37
```

Tox processes everything serially so it can take a long time to test several environments. To speed it up, you might try using a new, parallelized version of tox called `detox`. Give this a try:

```
$ pip install -U -i http://pypi.testrun.org detox
$ detox
```

Tox is configured using a file called `tox.ini`. You may need to edit this file if you want to add new environments to test (e.g., `py33`) or if you want to tweak the dependencies or the way the tests are run. For more info on the `tox.ini` file, see the Tox Configuration Specification.

CHAPTER

SEVENTYNINE

WRITING DOCUMENTATION

79.1 Getting started

79.1.1 General file structure

All documentation is built from the `doc/` directory. This directory contains both reStructuredText (ReST; `.rst`) files that contain pages in the documentation and configuration files for Sphinx.

The `.rst` 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.

Sphinx also creates `.rst` files that are staged in `doc/api` from the docstrings of the classes in the Matplotlib library. Except for `doc/api/api_changes/`, these `.rst` files are created when the documentation is built.

Similarly, the contents of `docs/gallery` and `docs/tutorials` are generated by the Sphinx Gallery from the sources in `examples` and `tutorials`. These sources consist of python scripts that have ReST documentation built into their comments. Don't directly edit the `.rst` files in `docs/gallery` and `docs/tutorials` as they are regenerated when the documentation are built.

79.1.2 Installing dependencies

The documentation for Matplotlib is generated from reStructuredText (ReST) using the Sphinx documentation generation tool. There are several extra requirements that are needed to build the documentation. They are listed in `doc-requirements.txt` and listed below:

- Sphinx>=1.3, !=1.5.0, !=1.6.4
- colorspacious
- IPython
- mock
- numpydoc>=0.4
- Pillow
- sphinx-gallery>=0.1.12

- graphviz

Note:

- You'll need a minimal working LaTeX distribution for many examples to run.
- Graphviz is not a Python package, and needs to be installed separately.

79.1.3 Building the docs

The documentation sources are found in the `doc/` directory in the trunk. The configuration file for Sphinx is `doc/conf.py`. It controls which directories Sphinx parses, how the docs are built, and how the extensions are used. To build the documentation in html format, cd into `doc/` and run:

```
make html
```

Other useful invocations include

```
# Delete built files.  May help if you get errors about missing paths or
# broken links.
make clean

# Build pdf docs.
make latexpdf
```

The `SPHINXOPTS` variable is set to `-W` by default to turn warnings into errors. To unset it, use

```
make SPHINXOPTS= html
```

You can use the `O` variable to set additional options:

- `make O=-j4 html` runs a parallel build with 4 processes.
- `make O=-Dplot_formats=png:100 html` saves figures in low resolution.
- `make O=-Dplot_gallery=0 html` skips the gallery build.

Multiple options can be combined using e.g. `make O='-j4 -Dplot_gallery=0' html`.

On Windows, options needs to be set as environment variables, e.g. `set O=-W -j4 & make html`.

79.2 Writing ReST pages

Most documentation is either in the docstring of individual classes and methods, in explicit `.rst` files, or in examples and tutorials. All of these use the ReST syntax. Users should look at the ReST documentation for a full description. But some specific hints and conventions Matplotlib uses are useful for creating documentation.

79.2.1 Formatting and style conventions

It is useful to strive for consistency in the Matplotlib documentation. Here are some formatting and style conventions that are used.

Section name formatting

For everything but top-level chapters, use `Upper lower` for section titles, e.g., `Possible hangups` rather than `Possible Hangups`

Function arguments

Function arguments and keywords within docstrings should be referred to using the `*emphasis*` role. This will keep Matplotlib's documentation consistent with Python's documentation:

```
Here is a description of *argument*
```

Do not use the `` `default role` ``:

```
Do not describe `argument` like this.  As per the next section,
this syntax will (unsuccessfully) attempt to resolve the argument as a
link to a class or method in the library.
```

nor the ``` ``literal`` ``` role:

```
Do not describe ``argument`` like this.
```

79.2.2 Referring to other documents and sections

Sphinx allows internal references between documents.

Documents can be linked with the `:doc:` directive:

```
See the :doc:`/faq/installing_faq`

See the tutorial :doc:`/tutorials/introductory/sample_plots`

See the example :doc:`/gallery/lines_bars_and_markers/simple_plot`
```

will render as:

> See the *Installation*
>
> See the tutorial *Sample plots in Matplotlib*
>
> See the example /gallery/lines_bars_and_markers/simple_plot

Sections can also be given reference names. For instance from the *Installation* link:

```
.. _clean-install:

How to completely remove Matplotlib
===================================

Occasionally, problems with Matplotlib can be solved with a clean...
```

and refer to it using the standard reference syntax:

```
See :ref:`clean-install`
```

will give the following link: *How to completely remove Matplotlib*

To maximize internal consistency in section labeling and references, use hyphen separated, descriptive labels for section references. Keep in mind that contents may be reorganized later, so avoid top level names in references like `user` or `devel` or `faq` unless necessary, because for example the FAQ "what is a backend?" could later become part of the users guide, so the label:

```
.. _what-is-a-backend:
```

is better than:

```
.. _faq-backend:
```

In addition, since underscores are widely used by Sphinx itself, use hyphens to separate words.

79.2.3 Referring to other code

To link to other methods, classes, or modules in Matplotlib you can use back ticks, for example:

```
`~matplotlib.collections.LineCollection`
```

returns a link to the documentation of *LineCollection*. For the full path of the class to be shown, omit the tilde:

```
`matplotlib.collections.LineCollection`
```

to get *matplotlib.collections.LineCollection*. It is often not necessary to fully specify the class hierarchy unless there is a namespace collision between two packages:

```
`~.LineCollection`
```

links just as well: *LineCollection*.

Other packages can also be linked via `intersphinx`:

```
`numpy.mean`
```

will return this link: numpy.mean. This works for Python, Numpy, Scipy, and Pandas (full list is in `doc/conf.py`). Sometimes it is tricky to get external Sphinx linking to work; to check that a something exists

to link to the following shell command outputs a list of all objects that can be referenced (in this case for Numpy):

```
python -m sphinx.ext.intersphinx 'https://docs.scipy.org/doc/numpy/objects.inv'
```

79.2.4 Including figures and files

Image files can directly included in pages with the `image::` directive. e.g., `users/navigation_toolbar.rst` displays the toolbar icons with a call to a static image:

```
.. image:: ../_static/toolbar.png
```

as rendered on the page: *Interactive navigation*.

Files can be included verbatim. For instance the `matplotlibrc` file is important for customizing Matplotlib, and is included verbatim in the tutorial in *Customizing Matplotlib with style sheets and rcParams*:

```
.. literalinclude:: ../../_static/matplotlibrc
```

This is rendered at the bottom of *Customizing Matplotlib with style sheets and rcParams*. Note that this is in a tutorial; see *Writing examples and tutorials* below.

The examples directory is also copied to `doc/gallery` by sphinx-gallery, so plots from the examples directory can be included using

```
.. plot:: gallery/pylab_examples/simple_plot.py
```

Note that the python script that generates the plot is referred to, rather than any plot that is created. Sphinx-gallery will provide the correct reference when the documentation is built.

79.3 Writing docstrings

Much of the documentation lives in "docstrings". These are comment blocks in source code that explain how the code works. All new or edited docstrings should conform to the numpydoc guidelines. These split the docstring into a number of sections - see the numpy documentation howto for more details and a guide to how docstrings should be formatted. Much of the ReST syntax discussed above (:ref:writing-rest-pages) can be used for links and references. These docstrings eventually populate the `doc/api` directory and form the reference documentation for the library.

79.3.1 Example docstring

An example docstring looks like:

```
def hlines(self, y, xmin, xmax, colors='k', linestyles='solid',
           label='', **kwargs):
    """
    Plot horizontal lines at each *y* from *xmin* to *xmax*.
```

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```
    Parameters
    ----------
    y : scalar or sequence of scalar
        y-indexes where to plot the lines.

    xmin, xmax : scalar or 1D array_like
        Respective beginning and end of each line. If scalars are
        provided, all lines will have same length.

    colors : array_like of colors, optional, default: 'k'

    linestyles : {'solid', 'dashed', 'dashot', 'dotted'}, optional

    label : string, optional, default: ''

    Returns
    -------
    lines : `~matplotlib.collections.LineCollection`

    Other Parameters
    ----------------
    **kwargs : `~matplotlib.collections.LineCollection` properties.

    See also
    --------
    vlines : vertical lines
    axhline: horizontal line across the axes
    """
```

See the *hlines* documentation for how this renders.

The Sphinx website also contains plenty of documentation concerning ReST markup and working with Sphinx in general.

Note: Some parts of the documentation do not yet conform to the current documentation style. If in doubt, follow the rules given here and not what you may see in the source code. Pull requests updating docstrings to the current style are very welcome.

79.3.2 Formatting conventions

The basic docstring conventions are covered in the numpy documentation howto and the Sphinx documentation. Some Matplotlib-specific formatting conventions to keep in mind:

- Matplotlib does not have a convention whether to use single-quotes or double-quotes. There is a mixture of both in the current code.
- Long parameter lists should be wrapped using a \ for continuation and starting on the new line without any indent:

```
def add_axes(self, *args, **kwargs):
    """
    ...

    Parameters
    ----------
    projection :
        {'aitoff', 'hammer', 'lambert', 'mollweide', 'polar', \
'rectilinear'}, optional
        The projection type of the axes.

    ...
    """
```

Alternatively, you can describe the valid parameter values in a dedicated section of the docstring.

- Generally, do not add markup to types for `Parameters` and `Returns`. This is usually not needed because Sphinx will link them automatically and would unnecessarily clutter the docstring. However, it does seem to fail in some situations. If you encounter such a case, you are allowed to add markup:

```
Returns
-------
lines : `~matplotlib.collections.LineCollection`
```

- rcParams can be referenced with the custom `:rc:` role: `:rc:`foo`` yields `rcParams["foo"]`.

79.3.3 Deprecated formatting conventions

- Formerly, we have used square brackets for explicit parameter lists `['solid' | 'dashed' | 'dotted']`. With numpydoc we have switched to their standard using curly braces `{'solid', 'dashed', 'dotted'}`.

79.3.4 Linking to other code

To link to other methods, classes, or modules in Matplotlib you can encase the name to refer to in back ticks, for example:

```
`~matplotlib.collections.LineCollection`
```

It is also possible to add links to code in Python, Numpy, Scipy, or Pandas. Sometimes it is tricky to get external Sphinx linking to work; to check that a something exists to link to the following shell command outputs a list of all objects that can be referenced (in this case for Numpy):

```
python -m sphinx.ext.intersphinx 'https://docs.scipy.org/doc/numpy/objects.inv'
```

79.3.5 Function arguments

Function arguments and keywords within docstrings should be referred to using the `*emphasis*` role. This will keep Matplotlib's documentation consistent with Python's documentation:

```
Here is a description of *argument*
```

Do not use the `` `default role` ``:

```
Do not describe `argument` like this.
```

nor the ``` ``literal`` ``` role:

```
Do not describe ``argument`` like this.
```

79.3.6 Setters and getters

Artist properties are implemented using setter and getter methods (because Matplotlib predates the introductions of the `property` decorator in Python). By convention, these setters and getters are named `set_PROPERTYNAME` and `get_PROPERTYNAME`; the list of properties thusly defined on an artist and their values can be listed by the *`setp`* and `getp` functions.

Property setter methods should indicate the values they accept using a (legacy) special block in the docstring, starting with `ACCEPTS`, as follows:

```
# in lines.py
def set_linestyle(self, linestyle):
    """
    Set the linestyle of the line

    ACCEPTS: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' | ' ' | '' ]
    """
```

The ACCEPTS block is used to render a table of all properties and their acceptable values in the docs; it can also be displayed using, e.g., `plt.setp(Line2D)` (all properties) or `plt.setp(Line2D, 'linestyle')` (just one property).

There are cases in which the ACCEPTS string is not useful in the generated Sphinx documentation, e.g. if the valid parameters are already defined in the numpydoc parameter list. You can hide the ACCEPTS string from Sphinx by making it a ReST comment (i.e. use `.. ACCEPTS:`):

```
def set_linestyle(self, linestyle):
    """
    An ACCEPTS string invisible to Sphinx.

    .. ACCEPTS: [ '-' | '--' | '-.' | ':' | 'steps' | 'None' | ' ' | '' ]
    """
```

79.3.7 Keyword arguments

Note: The information in this section is being actively discussed by the development team, so use the docstring interpolation only if necessary. This section has been left in place for now because this interpolation is part of the existing documentation.

Since Matplotlib uses a lot of pass-through `kwargs`, e.g., in every function that creates a line (*plot*, *semilogx*, *semilogy*, etc...), it can be difficult for the new user to know which `kwargs` are supported. Matplotlib uses a docstring interpolation scheme to support documentation of every function that takes a `**kwargs`. The requirements are:

1. single point of configuration so changes to the properties don't require multiple docstring edits.
2. as automated as possible so that as properties change, the docs are updated automatically.

The function *matplotlib.artist.kwdoc* and the decorator `matplotlib.docstring.dedent_interpd` facilitate this. They combine Python string interpolation in the docstring with the Matplotlib artist introspection facility that underlies `setp` and `getp`. The `kwdoc` function gives the list of properties as a docstring. In order to use this in another docstring, first update the `matplotlib.docstring.interpd` object, as seen in this example from *matplotlib.lines*:

```
# in lines.py
docstring.interpd.update(Line2D=artist.kwdoc(Line2D))
```

Then in any function accepting *Line2D* pass-through `kwargs`, e.g., *matplotlib.axes.Axes.plot*:

```
# in axes.py
@docstring.dedent_interpd
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
    """
```

Note there is a problem for *Artist* `__init__` methods, e.g., `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 `docstring.interpd.update` calls in *matplotlib.patches*.

79.3.8 Adding figures

As above (see *Including figures and files*), figures in the examples gallery can be referenced with a `:plot:` directive pointing to the python script that created the figure. For instance the *legend* docstring references

the file `examples/api/legend.py`:

```
"""
 ...

Examples
--------

.. plot:: gallery/api/legend.py
"""
```

Note that `examples/api/legend.py` has been mapped to `gallery/api/legend.py`, a redirection that may be fixed in future re-organization of the docs.

Plots can also be directly placed inside docstrings. Details are in *Plot directive documentation*. A short example is:

```
"""
 ...

Examples
--------

.. plot::
   import matplotlib.image as mpimg
   img = mpimg.imread('_static/stinkbug.png')
   imgplot = plt.imshow(img)
"""
```

An advantage of this style over referencing an example script is that the code will also appear in interactive docstrings.

79.4 Writing examples and tutorials

Examples and tutorials are python scripts that are run by Sphinx Gallery to create a gallery of images in the `/doc/gallery` and `/doc/tutorials` directories respectively. To exclude an example from having an plot generated insert "sgskip" somewhere in the filename.

The format of these files is relatively straightforward. Properly formatted comment blocks are treated as ReST text, the code is displayed, and figures are put into the built page.

For instance the example /gallery/lines_bars_and_markers/simple_plot example is generated from `/examples/lines_bars_and_markers/simple_plot.py`, which looks like:

```
"""
============
Simple Plot
============

Create a simple plot.
"""
```

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

# Data for plotting
t = np.arange(0.0, 2.0, 0.01)
s = 1 + np.sin(2 * np.pi * t)

# Note that using plt.subplots below is equivalent to using
# fig = plt.figure and then ax = fig.add_subplot(111)
fig, ax = plt.subplots()
ax.plot(t, s)

ax.set(xlabel='time (s)', ylabel='voltage (mV)',
       title='About as simple as it gets, folks')
ax.grid()
plt.show()
```

The first comment block is treated as ReST text. The other comment blocks render as comments in /gallery/lines_bars_and_markers/simple_plot.

Tutorials are made with the exact same mechanism, except they are longer, and typically have more than one comment block (i.e. *Usage Guide*). The first comment block can be the same as the example above. Subsequent blocks of ReST text are delimited by a line of ### characters:

```
"""
===========
Simple Plot
===========

Create a simple plot.
"""
...
ax.grid()
plt.show()

###############################################################################
# Second plot
# ===========
#
# This is a second plot that is very nice

fig, ax = plt.subplots()
ax.plot(np.sin(range(50)))
```

In this way text, code, and figures are output in a "notebook" style.

79.5 Miscellaneous

79.5.1 Adding animations

There is a Matplotlib Google/Gmail account with username `mplgithub` which was used to setup the github account but can be used for other purposes, like hosting Google docs or Youtube videos. You can embed a Matplotlib animation in the docs by first saving the animation as a movie using *matplotlib.animation.Animation.save()*, and then uploading to matplotlib's Youtube channel and inserting the embedding string youtube provides like:

```
.. raw:: html

   <iframe width="420" height="315"
     src="http://www.youtube.com/embed/32cjc6V0OZY"
     frameborder="0" allowfullscreen>
   </iframe>
```

An example save command to generate a movie looks like this

```
ani = animation.FuncAnimation(fig, animate, np.arange(1, len(y)),
    interval=25, blit=True, init_func=init)

ani.save('double_pendulum.mp4', fps=15)
```

Contact Michael Droettboom for the login password to upload youtube videos of google docs to the mplgithub account.

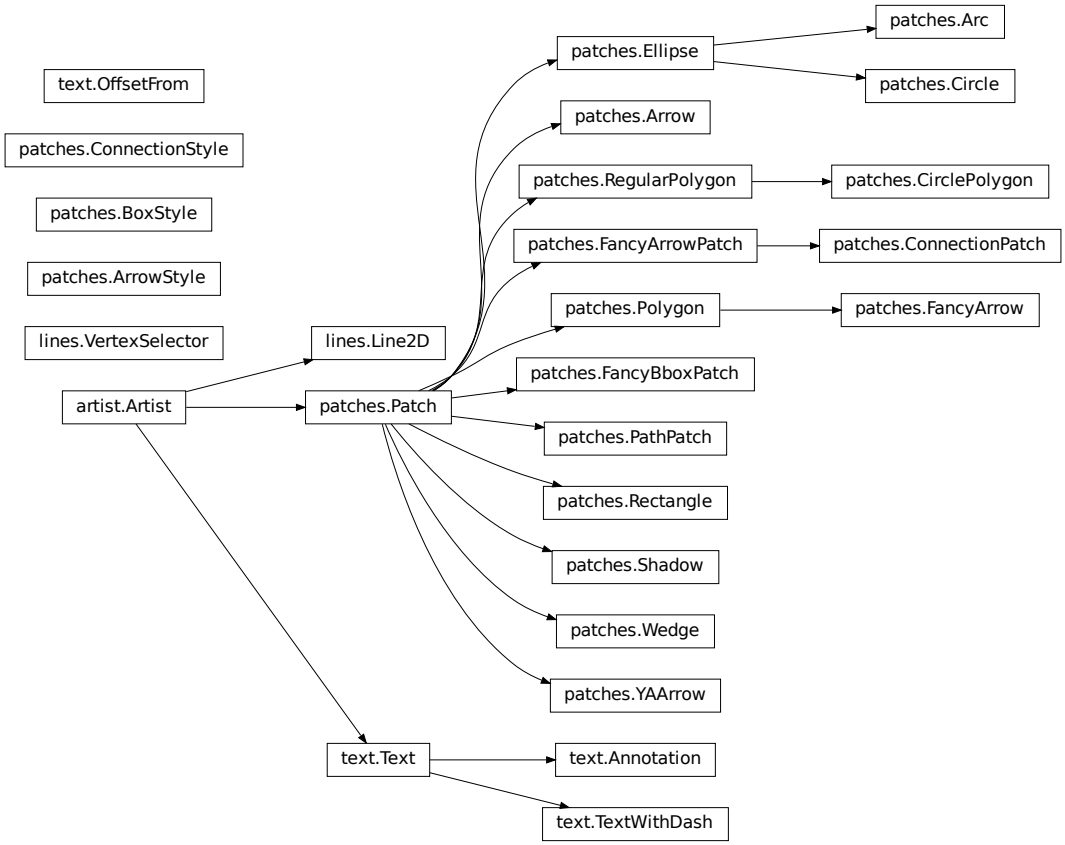
79.5.2 Generating inheritance diagrams

Class inheritance diagrams can be generated with the `inheritance-diagram` directive. To use it, 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
```



79.5.3 Emacs helpers

There is an emacs mode rst.el which automates many important ReST tasks like building and updating table-of-contents, and promoting or demoting section headings. Here is the basic `.emacs` configuration:

```
(require 'rst)
(setq auto-mode-alist
      (append '(("\\.txt$" . rst-mode)
                ("\\.rst$" . rst-mode)
                ("\\.rest$" . rst-mode)) auto-mode-alist))
```

Some helpful functions:

```
C-c TAB - rst-toc-insert

  Insert table of contents at point

C-c C-u - rst-toc-update
```

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```
    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

EIGHTY

PLOT DIRECTIVE DOCUMENTATION

A directive for including a matplotlib plot in a Sphinx document.

By default, in HTML output, `plot` will include a .png file with a link to a high-res .png and .pdf. In LaTeX output, it will include a .pdf.

The source code for the plot may be included in one of three ways:

1. **A path to a source file** as the argument to the directive:

```
.. plot:: path/to/plot.py
```

   When a path to a source file is given, the content of the directive may optionally contain a caption for the plot:

```
.. plot:: path/to/plot.py

   This is the caption for the plot
```

   Additionally, one may specify the name of a function to call (with no arguments) immediately after importing the module:

```
.. plot:: path/to/plot.py plot_function1
```

2. Included as **inline content** to the directive:

```
.. plot::

   import matplotlib.pyplot as plt
   import matplotlib.image as mpimg
   import numpy as np
   img = mpimg.imread('_static/stinkbug.png')
   imgplot = plt.imshow(img)
```

3. Using **doctest** syntax:

```
.. plot::
   A plotting example:
   >>> import matplotlib.pyplot as plt
   >>> plt.plot([1,2,3], [4,5,6])
```

80.1 Options

The `plot` directive supports the following options:

format [{'python', 'doctest'}] Specify the format of the input

include-source [bool] Whether to display the source code. The default can be changed using the `plot_include_source` variable in conf.py

encoding [str] If this source file is in a non-UTF8 or non-ASCII encoding, the encoding must be specified using the `:encoding:` option. The encoding will not be inferred using the `-*- coding -*-` metacomment.

context [bool or str] If provided, the code will be run in the context of all previous plot directives for which the `:context:` option was specified. This only applies to inline code plot directives, not those run from files. If the `:context: reset` option is specified, the context is reset for this and future plots, and previous figures are closed prior to running the code. `:context:close-figs` keeps the context but closes previous figures before running the code.

nofigs [bool] If specified, the code block will be run, but no figures will be inserted. This is usually useful with the `:context:` option.

Additionally, this directive supports all of the options of the `image` directive, except for `target` (since plot will add its own target). These include `alt`, `height`, `width`, `scale`, `align` and `class`.

80.2 Configuration options

The plot directive has the following configuration options:

plot_include_source Default value for the include-source option

plot_html_show_source_link Whether to show a link to the source in HTML.

plot_pre_code Code that should be executed before each plot. If not specified or None it will default to a string containing:

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

plot_basedir Base directory, to which `plot::` file names are relative to. (If None or empty, file names are relative to the directory where the file containing the directive is.)

plot_formats File formats to generate. List of tuples or strings:

```
[(suffix, dpi), suffix, ...]
```

that determine the file format and the DPI. For entries whose DPI was omitted, sensible defaults are chosen. When passing from the command line through sphinx_build the list should be passed as suffix:dpi,suffix:dpi, ...

plot_html_show_formats Whether to show links to the files in HTML.

plot_rcparams A dictionary containing any non-standard rcParams that should be applied before each plot.

plot_apply_rcparams By default, rcParams are applied when `context` option is not used in a plot directive. This configuration option overrides this behavior and applies rcParams before each plot.

plot_working_directory By default, the working directory will be changed to the directory of the example, so the code can get at its data files, if any. Also its path will be added to `sys.path` so it can import any helper modules sitting beside it. This configuration option can be used to specify a central directory (also added to `sys.path`) where data files and helper modules for all code are located.

plot_template Provide a customized template for preparing restructured text.

exception matplotlib.sphinxext.plot_directive.**PlotError**

matplotlib.sphinxext.plot_directive.**mark_plot_labels**(*app*, *document*)
To make plots referenceable, we need to move the reference from the "htmlonly" (or "latexonly") node to the actual figure node itself.

matplotlib.sphinxext.plot_directive.**out_of_date**(*original*, *derived*)
Returns True if derivative is out-of-date wrt original, both of which are full file paths.

matplotlib.sphinxext.plot_directive.**plot_directive**(*name*, *arguments*, *options*, *content*, *lineno*, *content_offset*, *block_text*, *state*, *state_machine*)
Implementation of the `.. plot::` directive.

See the module docstring for details.

matplotlib.sphinxext.plot_directive.**remove_coding**(*text*)
Remove the coding comment, which six.exec_ doesn't like.

matplotlib.sphinxext.plot_directive.**render_figures**(*code*, *code_path*, *output_dir*, *output_base*, *context*, *function_name*, *config*, *context_reset=False*, *close_figs=False*)
Run a pyplot script and save the images in *output_dir*.

Save the images under *output_dir* with file names derived from *output_base*

matplotlib.sphinxext.plot_directive.**run_code**(*code*, *code_path*, *ns=None*, *function_name=None*)
Import a Python module from a path, and run the function given by name, if function_name is not None.

matplotlib.sphinxext.plot_directive.**split_code_at_show**(*text*)
Split code at plt.show()

matplotlib.sphinxext.plot_directive.**unescape_doctest**(*text*)
Extract code from a piece of text, which contains either Python code or doctests.

CHAPTER

EIGHTYONE

DEVELOPER'S GUIDE FOR CREATING SCALES AND TRANSFORMATIONS

Matplotlib supports the addition of custom procedures that transform the data before it is displayed.

There is an important distinction between two kinds of transformations. Separable transformations, working on a single dimension, are called "scales", and non-separable transformations, that handle data in two or more dimensions at a time, are called "projections".

From the user's perspective, the scale of a plot can be set with *set_xscale()* and *set_yscale()*. Projections can be chosen using the `projection` keyword argument to the `plot()` or `subplot()` functions, e.g.:

```
plot(x, y, projection="custom")
```

This document is intended for developers and advanced users who need to create new scales and projections for matplotlib. The necessary code for scales and projections can be included anywhere: directly within a plot script, in third-party code, or in the matplotlib source tree itself.

81.1 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.

81.2 Creating a new projection

Adding a new projection consists of defining a projection axes which subclasses *matplotlib.axes.Axes* and 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 projection axes is defined, it can be used in one of two ways:

- By defining the class attribute `name`, the projection axes can be registered with *matplotlib.projections.register_projection()* and subsequently simply invoked by name:

```
plt.axes(projection='my_proj_name')
```

- For more complex, parameterisable projections, a generic "projection" object may be defined which includes the method `_as_mpl_axes`. `_as_mpl_axes` should take no arguments and return the projection's axes subclass and a dictionary of additional arguments to pass to the subclass' `__init__` method. Subsequently a parameterised projection can be initialised with:

```
plt.axes(projection=MyProjection(param1=param1_value))
```

  where MyProjection is an object which implements a `_as_mpl_axes` method.

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.

81.3 API documentation

- *matplotlib.scale*
- *matplotlib.projections*
- *matplotlib.projections.polar*

CHAPTER

EIGHTYTWO

DEVELOPER'S TIPS FOR WRITING CODE FOR PYTHON 2 AND 3

As of matplotlib 1.4, the six library is used to support Python 2 and 3 from a single code base. The `2to3` tool is no longer used.

This document describes some of the issues with that approach and some recommended solutions. It is not a complete guide to Python 2 and 3 compatibility.

82.1 Welcome to the `__future__`

The top of every `py` file should include the following:

```
from __future__ import (absolute_import, division,
                        print_function, unicode_literals)
import six
```

This will make the Python 2 interpreter behave as close to Python 3 as possible.

All matplotlib files should also import `six`, whether they are using it or not, just to make moving code between modules easier, as `six` gets used *a lot*.

82.2 Finding places to use six

The only way to make sure code works on both Python 2 and 3 is to make sure it is covered by unit tests.

However, the `2to3` commandline tool can also be used to locate places that require special handling with `six`.

(The modernize tool may also be handy, though I've never used it personally).

The six documentation serves as a good reference for the sorts of things that need to be updated.

82.3 The dreaded \u escapes

When `from __future__ import unicode_literals` is used, all string literals (not preceded with a `b`) will become unicode literals.

Normally, one would use "raw" string literals to encode strings that contain a lot of slashes that we don't want Python to interpret as special characters. A common example in matplotlib is when it deals with TeX and has to represent things like `r"\usepackage{foo}"`. Unfortunately, on Python 2there is no way to represent `u` in a raw unicode string literal, since it will always be interpreted as the start of a unicode character escape, such as `u20af`. The only solution is to use a regular (non-raw) string literal and repeat all slashes, e.g. `"\\usepackage{foo}"`.

The following shows the problem on Python 2:

```
>>> ur'\u'
  File "<stdin>", line 1
SyntaxError: (unicode error) 'rawunicodeescape' codec can't decode bytes in
position 0-1: truncated \uXXXX
>>> ur'\\u'
u'\\\\u'
>>> u'\u'
  File "<stdin>", line 1
SyntaxError: (unicode error) 'unicodeescape' codec can't decode bytes in
position 0-1: truncated \uXXXX escape
>>> u'\\u'
u'\\u'
```

This bug has been fixed in Python 3, however, we can't take advantage of that and still support Python 2:

```
>>> r'\u'
'\\u'
>>> r'\\u'
'\\\\u'
>>> '\u'
  File "<stdin>", line 1
SyntaxError: (unicode error) 'unicodeescape' codec can't decode bytes in
position 0-1: truncated \uXXXX escape
>>> '\\u'
'\\u'
```

82.4 Iteration

The behavior of the methods for iterating over the items, values and keys of a dictionary has changed in Python 3. Additionally, other built-in functions such as `zip`, `range` and `map` have changed to return iterators rather than temporary lists.

In many cases, the performance implications of iterating vs. creating a temporary list won't matter, so it's tempting to use the form that is simplest to read. However, that results in code that behaves differently on Python 2 and 3, leading to subtle bugs that may not be detected by the regression tests. Therefore, unless the loop in question is provably simple and doesn't call into other code, the `six` versions that ensure the same behavior on both Python 2 and 3 should be used. The following table shows the mapping of equivalent semantics between Python 2, 3 and six for `dict.items()`:

Python 2	Python 3	six
`d.items()`	`list(d.items())`	`list(six.iteritems(d))`
`d.iteritems()`	`d.items()`	`six.iteritems(d)`

82.5 Numpy-specific things

When specifying dtypes, all strings must be byte strings on Python 2 and unicode strings on Python 3. The best way to handle this is to force cast them using `str()`. The same is true of structure specifiers in the `struct` built-in module.

CHAPTER

EIGHTYTHREE

WORKING WITH *MATPLOTLIB* SOURCE CODE

Contents:

83.1 Introduction

These pages describe a git and github workflow for the Matplotlib project.

There are several different workflows here, for different ways of working with *Matplotlib*.

This is not a comprehensive git reference, it's just a workflow for our own project. It's tailored to the github hosting service. You may well find better or quicker ways of getting stuff done with git, but these should get you started.

For general resources for learning git, see *git resources*.

83.2 Install git

83.2.1 Overview

Debian / Ubuntu	`sudo apt-get install git`
Fedora	`sudo yum install git`
Windows	Download and install msysGit
OS X	Use the git-osx-installer

83.2.2 In detail

See the git page for the most recent information.

Have a look at the github install help pages available from github help

There are good instructions here: https://git-scm.com/book/en/v2/Getting-Started-Installing-Git

83.3 Following the latest source

These are the instructions if you just want to follow the latest *Matplotlib* source, but you don't need to do any development for now.

The steps are:

- *Install git*
- get local copy of the Matplotlib github git repository
- update local copy from time to time

83.3.1 Get the local copy of the code

From the command line:

```
git clone git://github.com/matplotlib/matplotlib.git
```

You now have a copy of the code tree in the new `matplotlib` directory.

83.3.2 Updating the code

From time to time you may want to pull down the latest code. Do this with:

```
cd matplotlib
git pull
```

The tree in `matplotlib` will now have the latest changes from the initial repository.

83.4 Making a patch

You've discovered a bug or something else you want to change in Matplotlib .. — excellent!

You've worked out a way to fix it — even better!

You want to tell us about it — best of all!

The easiest way is to make a *patch* or set of patches. Here we explain how. Making a patch is the simplest and quickest, but if you're going to be doing anything more than simple quick things, please consider following the *Git for development* model instead.

83.4.1 Making patches

Overview

```
# tell git who you are
git config --global user.email you@yourdomain.example.com
git config --global user.name "Your Name Comes Here"
# get the repository if you don't have it
git clone git://github.com/matplotlib/matplotlib.git
# make a branch for your patching
cd matplotlib
git branch the-fix-im-thinking-of
git checkout the-fix-im-thinking-of
# hack, hack, hack
# Tell git about any new files you've made
git add somewhere/tests/test_my_bug.py
# commit work in progress as you go
git commit -am 'BF - added tests for Funny bug'
# hack hack, hack
git commit -am 'BF - added fix for Funny bug'
# make the patch files
git format-patch -M -C master
```

Then, send the generated patch files to the Matplotlib mailing list — where we will thank you warmly.

In detail

1. Tell git who you are so it can label the commits you've made:

   ```
   git config --global user.email you@yourdomain.example.com
   git config --global user.name "Your Name Comes Here"
   ```

2. If you don't already have one, clone a copy of the Matplotlib repository:

   ```
   git clone git://github.com/matplotlib/matplotlib.git
   cd matplotlib
   ```

3. Make a 'feature branch'. This will be where you work on your bug fix. It's nice and safe and leaves you with access to an unmodified copy of the code in the main branch:

   ```
   git branch the-fix-im-thinking-of
   git checkout the-fix-im-thinking-of
   ```

4. Do some edits, and commit them as you go:

   ```
   # hack, hack, hack
   # Tell git about any new files you've made
   git add somewhere/tests/test_my_bug.py
   # commit work in progress as you go
   git commit -am 'BF - added tests for Funny bug'
   # hack hack, hack
   git commit -am 'BF - added fix for Funny bug'
   ```

   Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see why the -a flag?.

5. When you have finished, check you have committed all your changes:

```
git status
```

6. Finally, make your commits into patches. You want all the commits since you branched from the `master` branch:

```
git format-patch -M -C master
```

   You will now have several files named for the commits:

```
0001-BF-added-tests-for-Funny-bug.patch
0002-BF-added-fix-for-Funny-bug.patch
```

   Send these files to the Matplotlib mailing list.

When you are done, to switch back to the main copy of the code, just return to the `master` branch:

```
git checkout master
```

83.4.2 Moving from patching to development

If you find you have done some patches, and you have one or more feature branches, you will probably want to switch to development mode. You can do this with the repository you have.

Fork the Matplotlib repository on github — *Making your own copy (fork) of Matplotlib*. Then:

```
# checkout and refresh master branch from main repo
git checkout master
git pull origin master
# rename pointer to main repository to 'upstream'
git remote rename origin upstream
# point your repo to default read / write to your fork on github
git remote add origin git@github.com:your-user-name/matplotlib.git
# push up any branches you've made and want to keep
git push origin the-fix-im-thinking-of
```

Then you can, if you want, follow the *Development workflow*.

83.5 Git for development

Contents:

83.5.1 Making your own copy (fork) of Matplotlib

You need to do this only once. The instructions here are very similar to the instructions at https://help.github.com/forking/ — please see that page for more detail. We're repeating some of it here just to give the specifics for the Matplotlib project, and to suggest some default names.

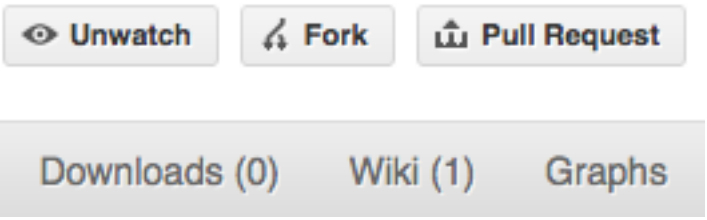
Set up and configure a github account

If you don't have a github account, go to the github page, and make one.

You then need to configure your account to allow write access — see the `Generating SSH keys` help on github help.

Create your own forked copy of Matplotlib

1. Log into your github account.
2. Go to the Matplotlib github home at Matplotlib github.
3. Click on the *fork* button:



Now, after a short pause, you should find yourself at the home page for your own forked copy of Matplotlib.

83.5.2 Set up your fork

First you follow the instructions for *Making your own copy (fork) of Matplotlib*.

Overview

```
git clone https://github.com/your-user-name/matplotlib.git
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

In detail

Clone your fork

1. Clone your fork to the local computer with `git clone https://github.com/your-user-name/matplotlib.git`
2. Investigate. Change directory to your new repo: `cd matplotlib`. Then `git branch -a` to show you all branches. You'll get something like:

```
* master
remotes/origin/master
```

This tells you that you are currently on the `master` branch, and that you also have a `remote` connection to `origin/master`. What remote repository is `remote/origin`? Try `git remote -v` to see the URLs for the remote. They will point to your github fork.

Now you want to connect to the upstream Matplotlib github repository, so you can merge in changes from trunk.

Linking your repository to the upstream repo

```
cd matplotlib
git remote add upstream git://github.com/matplotlib/matplotlib.git
```

`upstream` here is just the arbitrary name we're using to refer to the main Matplotlib repository at Matplotlib github.

Note that we've used `git://` for the URL rather than `https://` or `git@`. The `git://` URL is read only. This means we that we can't accidentally (or deliberately) write to the upstream repo, and we are only going to use it to merge into our own code.

Just for your own satisfaction, show yourself that you now have a new 'remote', with `git remote -v show`, giving you something like:

```
upstream     git://github.com/matplotlib/matplotlib.git (fetch)
upstream     git://github.com/matplotlib/matplotlib.git (push)
origin       https://github.com/your-user-name/matplotlib.git (fetch)
origin       https://github.com/your-user-name/matplotlib.git (push)
```

83.5.3 Configure git

Overview

Your personal git configurations are saved in the `.gitconfig` file in your home directory.

Here is an example `.gitconfig` file:

```
[user]
        name = Your Name
        email = you@yourdomain.example.com

[alias]
        ci = commit -a
        co = checkout
        st = status
        stat = status
        br = branch
        wdiff = diff --color-words

[core]
        editor = vim
```

(continues on next page)

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```
[merge]
        summary = true
```

You can edit this file directly or you can use the `git config --global` command:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
git config --global core.editor vim
git config --global merge.summary true
```

To set up on another computer, you can copy your `~/.gitconfig` file, or run the commands above.

In detail

user.name and user.email

It is good practice to tell git who you are, for labeling any changes you make to the code. The simplest way to do this is from the command line:

```
git config --global user.name "Your Name"
git config --global user.email you@yourdomain.example.com
```

This will write the settings into your git configuration file, which should now contain a user section with your name and email:

```
[user]
      name = Your Name
      email = you@yourdomain.example.com
```

Of course you'll need to replace `Your Name` and `you@yourdomain.example.com` with your actual name and email address.

Aliases

You might well benefit from some aliases to common commands.

For example, you might well want to be able to shorten `git checkout` to `git co`. Or you may want to alias `git diff --color-words` (which gives a nicely formatted output of the diff) to `git wdiff`

The following `git config --global` commands:

```
git config --global alias.ci "commit -a"
git config --global alias.co checkout
git config --global alias.st "status -a"
git config --global alias.stat "status -a"
git config --global alias.br branch
git config --global alias.wdiff "diff --color-words"
```

will create an `alias` section in your `.gitconfig` file with contents like this:

```
[alias]
        ci = commit -a
        co = checkout
        st = status -a
        stat = status -a
        br = branch
        wdiff = diff --color-words
```

Editor

You may also want to make sure that your editor of choice is used

```
git config --global core.editor vim
```

Merging

To enforce summaries when doing merges (`~/.gitconfig` file again):

```
[merge]
   log = true
```

Or from the command line:

```
git config --global merge.log true
```

Fancy log output

This is a very nice alias to get a fancy log output; it should go in the `alias` section of your `.gitconfig` file:

```
lg = log --graph --pretty=format:'%Cred%h%Creset -%C(yellow)%d%Creset %s %Cgreen(%cr)
↪%C(bold blue)[%an]%Creset' --abbrev-commit --date=relative
```

You use the alias with:

```
git lg
```

and it gives graph / text output something like this (but with color!):

```
* 6d8e1ee - (HEAD, origin/my-fancy-feature, my-fancy-feature) NF - a fancy file (45␣
↪minutes ago) [Matthew Brett]
*   d304a73 - (origin/placeholder, placeholder) Merge pull request #48 from hhuuggoo/
↪master (2 weeks ago) [Jonathan Terhorst]
|\
| * 4aff2a8 - fixed bug 35, and added a test in test_bugfixes (2 weeks ago) [Hugo]
|/
* a7ff2e5 - Added notes on discussion/proposal made during Data Array Summit. (2 weeks␣
↪ago) [Corran Webster]
* 68f6752 - Initial implimentation of AxisIndexer - uses 'index_by' which needs to be␣
↪changed to a call on an Axes object - this is all very sketchy right now. (2 weeks␣
↪ago) [Corr
*   376adbd - Merge pull request #46 from terhorst/master (2 weeks ago) [Jonathan␣
↪Terhorst]
|\
| * b605216 - updated joshu example to current api (3 weeks ago) [Jonathan Terhorst]
| * 2e991e8 - add testing for outer ufunc (3 weeks ago) [Jonathan Terhorst]
| * 7beda5a - prevent axis from throwing an exception if testing equality with non-axis␣
↪object (3 weeks ago) [Jonathan Terhorst]
| * 65af65e - convert unit testing code to assertions (3 weeks ago) [Jonathan Terhorst]
| *   956fbab - Merge remote-tracking branch 'upstream/master' (3 weeks ago) [Jonathan␣
↪Terhorst]
| |\
| |/
```

Thanks to Yury V. Zaytsev for posting it.

83.5.4 Development workflow

You already have your own forked copy of the Matplotlib repository, by following *Making your own copy (fork) of Matplotlib*. You have *Set up your fork*. You have configured git by following *Configure git*. Now you are ready for some real work.

Workflow summary

In what follows we'll refer to the upstream Matplotlib `master` branch, as "trunk".

- Don't use your `master` branch for anything. Consider deleting it.
- When you are starting a new set of changes, fetch any changes from trunk, and start a new *feature branch* from that.
- Make a new branch for each separable set of changes — "one task, one branch" (ipython git workflow).
- Name your branch for the purpose of the changes - e.g. `bugfix-for-issue-14` or `refactor-database-code`.
- If you can possibly avoid it, avoid merging trunk or any other branches into your feature branch while you are working.
- If you do find yourself merging from trunk, consider *Rebasing on trunk*

- Ask on the Matplotlib mailing list if you get stuck.
- Ask for code review!

This way of working helps to keep work well organized, with readable history. This in turn makes it easier for project maintainers (that might be you) to see what you've done, and why you did it.

See linux git workflow and ipython git workflow for some explanation.

Consider deleting your master branch

It may sound strange, but deleting your own `master` branch can help reduce confusion about which branch you are on. See deleting master on github for details.

Update the mirror of trunk

First make sure you have done *Linking your repository to the upstream repo*.

From time to time you should fetch the upstream (trunk) changes from github:

```
git fetch upstream
```

This will pull down any commits you don't have, and set the remote branches to point to the right commit. For example, 'trunk' is the branch referred to by (remote/branchname) `upstream/master` - and if there have been commits since you last checked, `upstream/master` will change after you do the fetch.

Make a new feature branch

When you are ready to make some changes to the code, you should start a new branch. Branches that are for a collection of related edits are often called 'feature branches'.

Making an new branch for each set of related changes will make it easier for someone reviewing your branch to see what you are doing.

Choose an informative name for the branch to remind yourself and the rest of us what the changes in the branch are for. For example `add-ability-to-fly`, or `buxfix-for-issue-42`.

```
# Update the mirror of trunk
git fetch upstream
# Make new feature branch starting at current trunk
git branch my-new-feature upstream/master
git checkout my-new-feature
```

Generally, you will want to keep your feature branches on your public github fork of Matplotlib. To do this, you git push this new branch up to your github repo. Generally (if you followed the instructions in these pages, and by default), git will have a link to your github repo, called `origin`. You push up to your own repo on github with:

```
git push origin my-new-feature
```

In git >= 1.7 you can ensure that the link is correctly set by using the `--set-upstream` option:

```
git push --set-upstream origin my-new-feature
```

From now on git will know that `my-new-feature` is related to the `my-new-feature` branch in the github repo.

The editing workflow

Overview

```
# hack hack
git add my_new_file
git commit -am 'NF - some message'
git push
```

In more detail

1. Make some changes
2. See which files have changed with `git status` (see git status). You'll see a listing like this one:

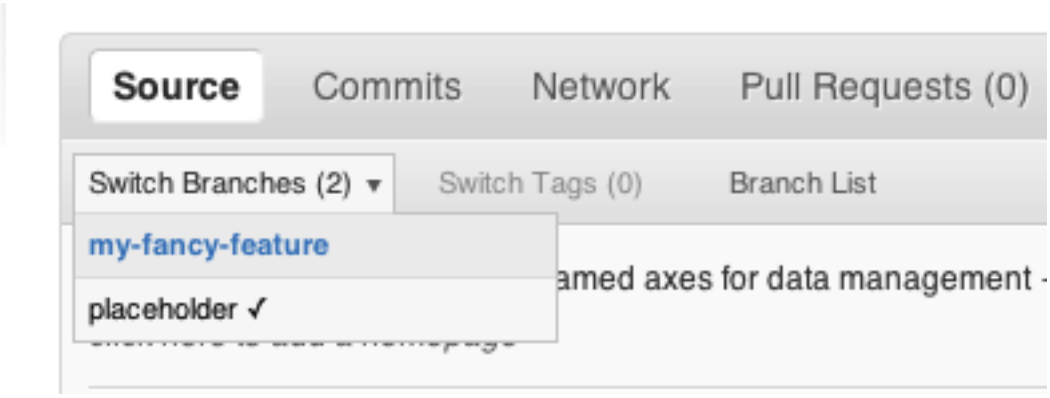
   ```
   # On branch ny-new-feature
   # Changed but not updated:
   #   (use "git add <file>..." to update what will be committed)
   #   (use "git checkout -- <file>..." to discard changes in working directory)
   #
   #  modified:   README
   #
   # Untracked files:
   #   (use "git add <file>..." to include in what will be committed)
   #
   #  INSTALL
   no changes added to commit (use "git add" and/or "git commit -a")
   ```

3. Check what the actual changes are with `git diff` (git diff).
4. Add any new files to version control `git add new_file_name` (see git add).
5. To commit all modified files into the local copy of your repo,, do `git commit -am 'A commit message'`. Note the `-am` options to `commit`. The `m` flag just signals that you're going to type a message on the command line. The `a` flag — you can just take on faith — or see why the -a flag? — and the helpful use-case description in the tangled working copy problem. The git commit manual page might also be useful.
6. To push the changes up to your forked repo on github, do a `git push` (see git push).

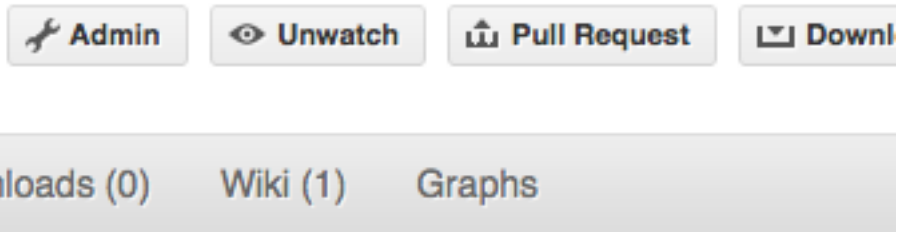
Ask for your changes to be reviewed or merged

When you are ready to ask for someone to review your code and consider a merge:

1. Go to the URL of your forked repo, say `https://github.com/your-user-name/matplotlib`.
2. Use the 'Switch Branches' dropdown menu near the top left of the page to select the branch with your changes:



3. Click on the 'Pull request' button:



   Enter a title for the set of changes, and some explanation of what you've done. Say if there is anything you'd like particular attention for - like a complicated change or some code you are not happy with.

   If you don't think your request is ready to be merged, just say so in your pull request message. This is still a good way of getting some preliminary code review.

Some other things you might want to do

Delete a branch on github

```
git checkout master
# delete branch locally
git branch -D my-unwanted-branch
# delete branch on github
git push origin :my-unwanted-branch
```

Note the colon `:` before `my-unwanted-branch`. See also: https://help.github.com/articles/pushing-to-a-remote/#deleting-a-remote-branch-or-tag

Several people sharing a single repository

If you want to work on some stuff with other people, where you are all committing into the same repository, or even the same branch, then just share it via github.

First fork Matplotlib into your account, as from *Making your own copy (fork) of Matplotlib*.

Then, go to your forked repository github page, say `https://github.com/your-user-name/matplotlib`

Click on the 'Admin' button, and add anyone else to the repo as a collaborator:

Now all those people can do:

```
git clone https://github.com/your-user-name/matplotlib.git
```

Remember that links starting with `https` or `git@` are read-write, and that `git@` uses the ssh protocol; links starting with `git://` are read-only.

Your collaborators can then commit directly into that repo with the usual:

```
git commit -am 'ENH - much better code'
git push origin master # pushes directly into your repo
```

Explore your repository

To see a graphical representation of the repository branches and commits:

```
gitk --all
```

To see a linear list of commits for this branch:

```
git log
```

You can also look at the network graph visualizer for your github repo.

Finally the *Fancy log output* `lg` alias will give you a reasonable text-based graph of the repository.

Rebasing on trunk

Let's say you thought of some work you'd like to do. You *Update the mirror of trunk* and *Make a new feature branch* called `cool-feature`. At this stage trunk is at some commit, let's call it E. Now you make

some new commits on your `cool-feature` branch, let's call them A, B, C. Maybe your changes take a while, or you come back to them after a while. In the meantime, trunk has progressed from commit E to commit (say) G:

```
      A---B---C cool-feature
     /
D---E---F---G trunk
```

At this stage you consider merging trunk into your feature branch, and you remember that this here page sternly advises you not to do that, because the history will get messy. Most of the time you can just ask for a review, and not worry that trunk has got a little ahead. But sometimes, the changes in trunk might affect your changes, and you need to harmonize them. In this situation you may prefer to do a rebase.

rebase takes your changes (A, B, C) and replays them as if they had been made to the current state of `trunk`. In other words, in this case, it takes the changes represented by A, B, C and replays them on top of G. After the rebase, your history will look like this:

```
              A'--B'--C' cool-feature
             /
D---E---F---G trunk
```

See rebase without tears for more detail.

To do a rebase on trunk:

```
# Update the mirror of trunk
git fetch upstream
# go to the feature branch
git checkout cool-feature
# make a backup in case you mess up
git branch tmp cool-feature
# rebase cool-feature onto trunk
git rebase --onto upstream/master upstream/master cool-feature
```

In this situation, where you are already on branch `cool-feature`, the last command can be written more succinctly as:

```
git rebase upstream/master
```

When all looks good you can delete your backup branch:

```
git branch -D tmp
```

If it doesn't look good you may need to have a look at *Recovering from mess-ups*.

If you have made changes to files that have also changed in trunk, this may generate merge conflicts that you need to resolve - see the git rebase man page for some instructions at the end of the "Description" section. There is some related help on merging in the git user manual - see resolving a merge.

Recovering from mess-ups

Sometimes, you mess up merges or rebases. Luckily, in git it is relatively straightforward to recover from such mistakes.

If you mess up during a rebase:

```
git rebase --abort
```

If you notice you messed up after the rebase:

```
# reset branch back to the saved point
git reset --hard tmp
```

If you forgot to make a backup branch:

```
# look at the reflog of the branch
git reflog show cool-feature

8630830 cool-feature@{0}: commit: BUG: io: close file handles immediately
278dd2a cool-feature@{1}: rebase finished: refs/heads/my-feature-branch onto␣
↪11ee694744f2552d
26aa21a cool-feature@{2}: commit: BUG: lib: make seek_gzip_factory not leak gzip obj
...

# reset the branch to where it was before the botched rebase
git reset --hard cool-feature@{2}
```

Rewriting commit history

Note: Do this only for your own feature branches.

There's an embarrassing typo in a commit you made? Or perhaps the you made several false starts you would like the posterity not to see.

This can be done via *interactive rebasing*.

Suppose that the commit history looks like this:

```
git log --oneline
eadc391 Fix some remaining bugs
a815645 Modify it so that it works
2dec1ac Fix a few bugs + disable
13d7934 First implementation
6ad92e5 * masked is now an instance of a new object, MaskedConstant
29001ed Add pre-nep for a copule of structured_array_extensions.
...
```

and `6ad92e5` is the last commit in the `cool-feature` branch. Suppose we want to make the following changes:

- Rewrite the commit message for `13d7934` to something more sensible.
- Combine the commits `2dec1ac`, `a815645`, `eadc391` into a single one.

We do as follows:

```
# make a backup of the current state
git branch tmp HEAD
# interactive rebase
git rebase -i 6ad92e5
```

This will open an editor with the following text in it:

```
pick 13d7934 First implementation
pick 2dec1ac Fix a few bugs + disable
pick a815645 Modify it so that it works
pick eadc391 Fix some remaining bugs

# Rebase 6ad92e5..eadc391 onto 6ad92e5
#
# Commands:
#  p, pick = use commit
#  r, reword = use commit, but edit the commit message
#  e, edit = use commit, but stop for amending
#  s, squash = use commit, but meld into previous commit
#  f, fixup = like "squash", but discard this commit's log message
#
# If you remove a line here THAT COMMIT WILL BE LOST.
# However, if you remove everything, the rebase will be aborted.
#
```

To achieve what we want, we will make the following changes to it:

```
r 13d7934 First implementation
pick 2dec1ac Fix a few bugs + disable
f a815645 Modify it so that it works
f eadc391 Fix some remaining bugs
```

This means that (i) we want to edit the commit message for `13d7934`, and (ii) collapse the last three commits into one. Now we save and quit the editor.

Git will then immediately bring up an editor for editing the commit message. After revising it, we get the output:

```
[detached HEAD 721fc64] FOO: First implementation
 2 files changed, 199 insertions(+), 66 deletions(-)
[detached HEAD 0f22701] Fix a few bugs + disable
 1 files changed, 79 insertions(+), 61 deletions(-)
Successfully rebased and updated refs/heads/my-feature-branch.
```

and the history looks now like this:

```
0f22701 Fix a few bugs + disable
721fc64 ENH: Sophisticated feature
6ad92e5 * masked is now an instance of a new object, MaskedConstant
```

If it went wrong, recovery is again possible as explained *above*.

83.5.5 Maintainer workflow

This page is for maintainers — those of us who merge our own or other peoples' changes into the upstream repository.

Being as how you're a maintainer, you are completely on top of the basic stuff in *Development workflow*.

The instructions in *Linking your repository to the upstream repo* add a remote that has read-only access to the upstream repo. Being a maintainer, you've got read-write access.

It's good to have your upstream remote have a scary name, to remind you that it's a read-write remote:

```
git remote add upstream-rw git@github.com:matplotlib/matplotlib.git
git fetch upstream-rw
```

Integrating changes

Let's say you have some changes that need to go into trunk (`upstream-rw/master`).

The changes are in some branch that you are currently on. For example, you are looking at someone's changes like this:

```
git remote add someone git://github.com/someone/matplotlib.git
git fetch someone
git branch cool-feature --track someone/cool-feature
git checkout cool-feature
```

So now you are on the branch with the changes to be incorporated upstream. The rest of this section assumes you are on this branch.

A few commits

If there are only a few commits, consider rebasing to upstream:

```
# Fetch upstream changes
git fetch upstream-rw
# rebase
git rebase upstream-rw/master
```

Remember that, if you do a rebase, and push that, you'll have to close any github pull requests manually, because github will not be able to detect the changes have already been merged.

A long series of commits

If there are a longer series of related commits, consider a merge instead:

```
git fetch upstream-rw
git merge --no-ff upstream-rw/master
```

The merge will be detected by github, and should close any related pull requests automatically.

Note the `--no-ff` above. This forces git to make a merge commit, rather than doing a fast-forward, so that these set of commits branch off trunk then rejoin the main history with a merge, rather than appearing to have been made directly on top of trunk.

Check the history

Now, in either case, you should check that the history is sensible and you have the right commits:

```
git log --oneline --graph
git log -p upstream-rw/master..
```

The first line above just shows the history in a compact way, with a text representation of the history graph. The second line shows the log of commits excluding those that can be reached from trunk (`upstream-rw/master`), and including those that can be reached from current HEAD (implied with the `..` at the end). So, it shows the commits unique to this branch compared to trunk. The `-p` option shows the diff for these commits in patch form.

Push to trunk

```
git push upstream-rw my-new-feature:master
```

This pushes the `my-new-feature` branch in this repository to the `master` branch in the `upstream-rw` repository.

83.6 git resources

83.6.1 Tutorials and summaries

- github help has an excellent series of how-to guides.
- The pro git book is a good in-depth book on git.
- A git cheat sheet is a page giving summaries of common commands.
- The git user manual
- The git tutorial
- The git community book

- git ready — a nice series of tutorials
- git magic — extended introduction with intermediate detail
- The git parable is an easy read explaining the concepts behind git.
- git foundation expands on the git parable.
- Fernando Perez' git page — Fernando's git page — many links and tips
- A good but technical page on git concepts
- git svn crash course: git for those of us used to subversion

83.6.2 Advanced git workflow

There are many ways of working with git; here are some posts on the rules of thumb that other projects have come up with:

- Linus Torvalds on git management
- Linus Torvalds on linux git workflow . Summary; use the git tools to make the history of your edits as clean as possible; merge from upstream edits as little as possible in branches where you are doing active development.

83.6.3 Manual pages online

You can get these on your own machine with (e.g) `git help push` or (same thing) `git push --help`, but, for convenience, here are the online manual pages for some common commands:

- git add
- git branch
- git checkout
- git clone
- git commit
- git config
- git diff
- git log
- git pull
- git push
- git remote
- git status

83.7 Two and three dots in difference specs

Thanks to Yarik Halchenko for this explanation.

Imagine a series of commits A, B, C, D... Imagine that there are two branches, *topic* and *master*. You branched *topic* off *master* when *master* was at commit 'E'. The graph of the commits looks like this:

```
     A---B---C topic
     /
D---E---F---G master
```

Then:

```
git diff master..topic
```

will output the difference from G to C (i.e. with effects of F and G), while:

```
git diff master...topic
```

would output just differences in the topic branch (i.e. only A, B, and C).

CHAPTER

EIGHTYFOUR

REVIEWERS GUIDELINE

84.1 Pull request checklist

84.1.1 Branch selection

In general target the master branch for all new features and bug-fixes. PRs may target maintenance or doc branches on a case-by-case basis.

84.1.2 Documentation

- Every new feature should be documented. If it's a new module, don't forget to add a new rst file to the API docs.
- Each high-level plotting function should have a small example in the `Example` section of the docstring. This should be as simple as possible to demonstrate the method. More complex examples should go in the `examples` section of the documentation.
- Build the docs and make sure all formatting warnings are addressed.
- See *Writing documentation* for our documentation style guide.
- If your change is a major new feature, add an entry to `doc/users/whats_new.rst`.
- If you change the API in a backward-incompatible way, please document it in `doc/api/api_changes.rst`.

84.2 PR Review guidelines

- Be patient and kind with contributors.
- If you have commit rights, then you are trusted to use them. Please help review and merge PRs!
- Documentation and examples may be merged by the first reviewer. Use the threshold "is this better than it was?" as the review criteria.
- For code changes (anything in `src` or `lib`) at least two developers (those with commit rights) should review all pull requests. If you are the first to review a PR and approve of the changes use the github

'approve review' tool to mark it as such. If you are a subsequent reviewer please approve the review and if you think no more review is needed, merge the PR.

Ensure that all API changes are documented in `doc/api/api_changes` and significant new features have and entry in `doc/user/whats_new`.

- Make sure the Travis, Appvyor, circle, and codecov tests are passing before merging.
  - Whenever a pull request is created or updated, Travis and Appveyor automatically runs the test suite on all versions of Python supported by Matplotlib. The `tox` support in Matplotlib may be useful for testing locally.
- Do not self merge, except for 'small' patches to un-break the CI or when another reviewer explicitly allows it (ex, "Approve modulo CI passing, may self merge when green")
- Squashing is case-by-case. The balance is between burden on the contributor, keeping a relatively clean history, and keeping a history usable for bisecting. The only time we are really strict about it is to eliminate binary files (ex multiple test image re-generations) and to remove upstream merges.
- Do not let perfect be the enemy of the good, particularly for documentation or example PRs. If you find yourself making many small suggestions, either open a PR against the original branch, push changes to the contributor branch, or merge the PR and then open a new PR against upstream.
- If you push to a contributor branch leave a comment explaining what you did, ex "I took the liberty of pushing a small clean-up PR to your branch, thanks for your work.". If you are going to make substantial changes to the code or intent of the PR please check with the contributor first.

84.3 Branches and Backports

The current active branches are

master This will be Matplotlib 3.0. Supports Python 3.5+.

v2.2.x Maintenance branch for Matplotlib 2.2 LTS. Supports Python 2.7, 3.4+

v2.2.N-doc Documentation for the current release. On a patch release, this will be replaced by a properly named branch for the new release.

We always will backport to 2.2.x

- critical bug fixes (segfault, failure to import, things that the user can not work around)
- fixes for regressions against 2.0 or 2.1

Everything else (regressions against 1.x versions, bugs/api inconsistencies the user can work around in their code) are on a case-by-case basis, should be low-risk, and need someone to advocate for and shepherd through the backport.

The only changes to be backported to 2.2.N-doc are changes to `doc`, `examples`, or `tutorials`. Any changes to `lib` or `src` should not be backported to this branch.

84.3.1 Automated backports

We use meeseeksdev bot to automatically backport merges to the correct maintenance branch base on the milestone. To work properly the milestone must be set before merging. If you have commit rights, the bot can also be manually triggered after a merge by leaving a message `@meeseeksdev backport to BRANCH` on the PR. If there are conflicts meeseekdevs will inform you that the backport needs to be done manually.

The target branch is configured by putting `on-merge: backport to TARGETBRANCH` in the milestone description on it's own line.

If the bot is not working as expected, please report issues to Meeseeksdev.

84.3.2 Manual backports

When doing backports please copy the form used by meeseekdev, `Backport PR #XXXX: TITLE OF PR`. If you need to manually resolve conflicts make note of them and how you resolved them in the commit message.

We do a backport from master to v2.2.x assuming:

- `matplotlib` is a read-only remote branch of the matplotlib/matplotlib repo

The `TARGET_SHA` is the hash of the merge commit you would like to backport. This can be read off of the github PR page (in the UI with the merge notification) or through the git CLI tools.

Assuming that you already have a local branch `v2.2.x` (if not, then `git checkout -b v2.2.x`), and that your remote pointing to `https://github.com/matplotlib/matplotlib` is called `upstream`:

```
git fetch upstream
git checkout v2.2.x  # or include -b if you don't already have this.
git reset --hard upstream/v2.2.x
git cherry-pick -m 1 TARGET_SHA
# resolve conflicts and commit if required
```

Files with conflicts can be listed by `git status`, and will have to be fixed by hand (search on >>>>>). Once the conflict is resolved, you will have to re-add the file(s) to the branch and then continue the cherry pick:

```
git add lib/matplotlib/conflicted_file.py
git add lib/matplotlib/conflicted_file2.py
git cherry-pick --continue
```

Use your discretion to push directly to upstream or to open a PR; be sure to push or PR against the `v2.2.x` upstream branch, not `master`!

CHAPTER

EIGHTYFIVE

RELEASE GUIDE

A guide for developers who are doing a matplotlib release.

85.1 All Releases

85.1.1 Testing

We use travis-ci for continuous integration. When preparing for a release, the final tagged commit should be tested locally before it is uploaded:

```
python tests.py --processes=8 --process-timeout=300
```

In addition the following two tests should be run and manually inspected:

```
python unit/memleak_hawaii3.py
pushd examples/tests/
python backend_driver.py
popd
```

85.1.2 GitHub Stats

We automatically extract GitHub issue, PRs, and authors from GitHub via the API:

```
python tools/github_stats.py --since-tag $TAG --project 'matplotlib/matplotlib' --links >
↪ doc/users/github_stats.rst
```

Review and commit changes. Some issue/PR titles may not be valid rst (the most common issue is * which is interpreted as unclosed markup).

85.1.3 Check Docs

Before tagging, update the what's new listing in `doc/users/whats_new.rst` by merging all files in `doc/users/next_whats_new/` coherently. Also, temporarily comment out the include and toctree glob; re-instate these after a release. Finally, make sure that the docs build cleanly

```
make -Cdoc O=-n$(nproc) html latexpdf
```

After the docs are built, check that all of the links, internal and external, are still valid. We use `linkchecker` for this, which has not been ported to python3 yet. You will need to create a python2 environment with `requests==2.9.0` and linkchecker

```
conda create -p /tmp/lnkchk python=2 requests==2.9.0
source activate /tmp/lnkchk
pip install linkchecker
pushd doc/build/html
linkchecker index.html --check-extern
```

Address any issues which may arise. The internal links are checked on travis, this should only flag failed external links.

85.1.4 Create release commit and tag

To create the tag, first create an empty commit with a very terse set of the release notes in the commit message

```
git commit --allow-empty
```

and then create a signed, annotated tag with the same text in the body message

```
git tag -a -s v2.0.0
```

which will prompt you for your gpg key password and an annotation. For pre releases it is important to follow **PEP 440** so that the build artifacts will sort correctly in pypi. Finally, push the tag to GitHub

```
git push -t DANGER v2.0.0
```

Congratulations, the scariest part is done!

To prevent issues with any down-stream builders which download the tarball from GitHub it is important to move all branches away from the commit with the tag[1]:

```
git commit --allow-empty
git push DANGER master
```

If this is a final release, also create a 'doc' branch (this is not done for pre-releases):

[1] The tarball that is provided by GitHub is produced using git archive. We use versioneer which uses a format string in `lib/matplotlib/_version.py` to have `git` insert a list of references to exported commit (see `.gitattributes` for the configuration). This string is then used by `versioneer` to produce the correct version, based on the git tag, when users install from the tarball. However, if there is a branch pointed at the tagged commit, then the branch name will also be included in the tarball. When the branch eventually moves, anyone how checked the hash of the tarball before the branch moved will have an incorrect hash.

To generate the file that GitHub does use

```
git archive v2.0.0 -o matplotlib-2.0.0.tar.gz --prefix=matplotlib-2.0.0/
```

```
git branch v2.0.0-doc
git push DANGER v2.0.0-doc
```

and if this is a major or minor release, also create a bug-fix branch (a micro release will be cut off of this branch):

```
git branch v2.0.x
git push DANGER v2.0.x
```

85.1.5 Release Management / DOI

Via the GitHub UI (chase down link), turn the newly pushed tag into a release. If this is a pre-release remember to mark it as such.

For final releases also get a DOI from zenodo and edit `doc/_templates/citing.html` with DOI link and commit to the VER-doc branch and push to GitHub

```
git checkout v2.0.0-doc
emacs doc/_templates/citing.html
git push DANGER v2.0.0-doc:v2.0.0-doc
```

85.1.6 Building binaries

We distribute mac, windows, and many linux wheels as well as a source tarball via pypi. Before uploading anything, contact the various builders. Mac and manylinux wheels are built on travis . You need to edit the `.travis.yml` file and push to master of the build project.

Update the `master` branch (for pre-releases the `devel` branch) of the conda-forge feedstock via pull request.

If this is a final release the following downstream packagers should be contacted:

- Debian
- Fedora
- Arch
- Gentoo
- Macports
- Homebrew
- Christoph Gohlke
- Continuum
- Enthought

This can be done ahead of collecting all of the binaries and uploading to pypi.

85.1.7 make distribution and upload to pypi / SF

Once you have collected all of the wheels, generate the tarball

```
git checkout v2.0.0
git clean -xfd
python setup.py sdist
```

and copy all of the wheels into `dist` directory. You should use `twine` to upload all of the files to pypi

```
twine upload -s dist/matplotlib*tar.gz
twine upload dist/*whl
```

Congratulations, you have now done the second scariest part!

Additionally, for a final release, upload all of the files to sourceforge.

85.1.8 Build and Deploy Documentation

To build the documentation you must have the tagged version installed, but build the docs from the `ver-doc` branch. An easy way to arrange this is:

```
pip install matplotlib
pip install -r doc-requirements.txt
git checkout v2.0.0-doc
git clean -xfd
cd doc
make O=-n$(nproc) html latexpdf
```

which will build both the html and pdf version of the documentation.

The built documentation exists in the matplotlib.github.com repository. Pushing changes to master automatically updates the website.

The documentation is organized by version. At the root of the tree is always the documentation for the latest stable release. Under that, there are directories containing the documentation for older versions. The documentation for current master are built on travis and push to the devdocs repository. These are available at matplotlib.org/devdocs.

Assuming you have this repository checked out in the same directory as matplotlib

```
cd ../matplotlib.github.com
mkdir 2.0.0
rsync -a ../matplotlib/doc/build/html/* 2.0.0
cp ../matplotlib/doc/build/latex/Matplotlib.pdf 2.0.0
```

which will copy the built docs over. If this is a final release, also replace the top-level docs

```
rsync -a 2.0.0/* ./
```

You will need to manually edit `versions.html` to show the last 3 tagged versions. Now commit and push everything to GitHub

```
git add *
git commit -a -m 'Updating docs for v2.0.0'
git push DANGER master
```

Congratulations you have now done the third scariest part!

It typically takes about 5-10 minutes for GitHub to process the push and update the live web page (remember to clear your browser cache).

85.1.9 Announcing

The final step is to announce the release to the world. A short version of the release notes along with acknowledgments should be sent to

- matplotlib-user@python.org
- matplotlib-devel@python.org
- matplotlib-announce@python.org

For final releases announcements should also be sent to the numpy/scipy/jupyter mailing lists and python-announce.

In addition, announcements should be made on social networks (twitter, g+, FB). For major release, NumFOCUS should be contacted for inclusion in their newsletter and maybe to have something posted on their blog.

CHAPTER

EIGHTYSIX

MINIMUM VERSION OF DEPENDENCIES POLICY

86.1 Python and numpy

- support minor versions of `Python` initially released in the previous 3 years
- support minor versions of `numpy` initially released in the previous 3 years or oldest that supports the minimum python version (which ever is higher)

We will bump the minimum python and numpy versions as we can every minor and major release, but never on a patch release.

86.2 Python Dependencies

For python dependencies we should support at least

with compiled extensions minor versions released in the last 3 years or the oldest that support our minimum python + numpy

without complied extensions minor versions released in the last 2 years or the oldest that supports our minimum python.

We will only bump these dependencies as we need new features or the old versions no longer support our minimum numpy or python.

86.3 System and C-dependencies

For system or c-dependencies (libpng, freetype, GUI frameworks, latex, gs, ffmpeg) support as old as practical. These can be difficult to install for end-users and we want to be usable on as many systems as possible. We will bump these on a case-by-case basis.

CHAPTER

EIGHTYSEVEN

MATPLOTLIB ENHANCEMENT PROPOSALS

Matplotlib Enhancement Proposals (MEP), inspired by cpython's PEP's but less formal, are design documents for large or controversial changes to Matplotilb. These documents should provide a discussion of both why and how the changes should be made.

To create a new MEP open a pull request (PR) adding a file based on *the template* to this the MEP directory. For the initial PR only a rough description is required and it should be merged quickly. Further detailed discussion can happen in follow on PRs.

87.1 MEP Template

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

This MEP template is a guideline of the sections that a MEP should contain. Extra sections may be added if appropriate, and unnecessary sections may be noted as such.

87.1.1 Status

MEPs go through a number of phases in their lifetime:

- **Discussion**: The MEP is being actively discussed on the mailing list and it is being improved by its author. The mailing list discussion of the MEP should include the MEP number (MEPxxx) in the subject line so they can be easily related to the MEP.
- **Progress**: Consensus was reached and implementation work has begun.

- **Completed**: The implementation has been merged into master.
- **Superseded**: This MEP has been abandoned in favor of another approach.
- **Rejected**: There are currently no plans to implement the proposal.

87.1.2 Branches and Pull requests

All development branches containing work on this MEP should be linked to from here.

All pull requests submitted relating to this MEP should be linked to from here. (A MEP does not need to be implemented in a single pull request if it makes sense to implement it in discrete phases).

87.1.3 Abstract

The abstract should be a short description of what the MEP will achieve.

87.1.4 Detailed description

This section describes the need for the MEP. It should describe the existing problem that it is trying to solve and why this MEP makes the situation better. It should include examples of how the new functionality would be used and perhaps some use cases.

87.1.5 Implementation

This section lists the major steps required to implement the MEP. Where possible, it should be noted where one step is dependent on another, and which steps may be optionally omitted. Where it makes sense, each step should include a link related pull requests as the implementation progresses.

87.1.6 Backward compatibility

This section describes the ways in which the MEP breaks backward incompatibility.

87.1.7 Alternatives

If there were any alternative solutions to solving the same problem, they should be discussed here, along with a justification for the chosen approach.

87.2 MEP8: PEP8

- *Status*

- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

87.2.1 Status

Completed

We are currently enforcing a sub-set of pep8 on new code contributions.

87.2.2 Branches and Pull requests

None so far.

87.2.3 Abstract

The matplotlib codebase predates PEP8, and therefore is less than consistent style-wise in some areas. Bringing the codebase into compliance with PEP8 would go a long way to improving its legibility.

87.2.4 Detailed description

Some files use four space indentation, some use three. Some use different levels in the same file.

For the most part, class/function/variable naming follows PEP8, but it wouldn't hurt to fix where necessary.

87.2.5 Implementation

The implementation should be fairly mechanical: running the pep8 tool over the code and fixing where appropriate.

This should be merged in after the 2.0 release, since the changes will likely make merging any pending pull requests more difficult.

Additionally, and optionally, PEP8 compliance could be tracked by an automated build system.

87.2.6 Backward compatibility

Public names of classes and functions that require change (there shouldn't be many of these) should first be deprecated and then removed in the next release cycle.

87.2.7 Alternatives

PEP8 is a popular standard for Python code style, blessed by the Python core developers, making any alternatives less desirable.

87.3 MEP9: Global interaction manager

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Current summary of the mixin*
- *Backward compatibility*
- *Alternatives*

Add a global manager for all user interactivity with artists; make any artist resizeable, moveable, highlightable, and selectable as desired by the user.

87.3.1 Status

Discussion

87.3.2 Branches and Pull requests

https://github.com/dhyams/matplotlib/tree/MEP9

87.3.3 Abstract

The goal is to be able to interact with matplotlib artists in a very similar way as drawing programs do. When appropriate, the user should be able to move, resize, or select an artist that is already on the canvas. Of course, the script writer is ultimately in control of whether an artist is able to be interacted with, or whether it is static.

This code to do this has already been privately implemented and tested, and would need to be migrated from its current "mixin" implementation, to a bona-fide part of matplotlib.

The end result would be to have four new keywords available to matplotlib.artist.Artist: _moveable_, _resizeable_, _selectable_, and _highlightable_. Setting any one of these keywords to True would activate interactivity for that artist.

In effect, this MEP is a logical extension of event handling in matplotlib; matplotlib already supports "low level" interactions like left mouse presses, a key press, or similar. The MEP extends the support to the logical level, where callbacks are performed on the artists when certain interactive gestures from the user are detected.

87.3.4 Detailed description

This new functionality would be used to allow the end-user to better interact with the graph. Many times, a graph is almost what the user wants, but a small repositioning and/or resizing of components is necessary. Rather than force the user to go back to the script to trial-and-error the location, and simple drag and drop would be appropriate.

Also, this would better support applications that use matplotlib; here, the end-user has no reasonable access or desire to edit the underlying source in order to fine-tune a plot. Here, if matplotlib offered the capability, one could move or resize artists on the canvas to suit their needs. Also, the user should be able to highlight (with a mouse over) an artist, and select it with a double-click, if the application supports that sort of thing. In this MEP, we also want to support the highlighting and selection natively; it is up to application to handle what happens when the artist is selected. A typical handling would be to display a dialog to edit the properties of the artist.

In the future, as well (this is not part of this MEP), matplotlib could offer backend-specific property dialogs for each artist, which are raised on artist selection. This MEP would be a necessary stepping stone for that sort of capability.

There are currently a few interactive capabilities in matplotlib (e.g. legend.draggable()), but they tend to be scattered and are not available for all artists. This MEP seeks to unify the interactive interface and make it work for all artists.

The current MEP also includes grab handles for resizing artists, and appropriate boxes drawn when artists are moved or resized.

87.3.5 Implementation

- Add appropriate methods to the "tree" of artists so that the interactivity manager has a consistent interface for the interactivity manager to deal with. The proposed methods to add to the artists, if they are to support interactivity, are:
  - get_pixel_position_ll(self): get the pixel position of the lower left corner of the artist's bounding box
  - get_pixel_size(self): get the size of the artist's bounding box, in pixels
  - set_pixel_position_and_size(self,x,y,dx,dy): set the new size of the artist, such that it fits within the specified bounding box.
- add capability to the backends to 1) provide cursors, since these are needed for visual indication of moving/resizing, and 2) provide a function that gets the current mouse position
- Implement the manager. This has already been done privately (by dhyams) as a mixin, and has been tested quite a bit. The goal would be to move the functionality of the manager into the artists so that it is in matplotlib properly, and not as a "monkey patch" as I currently have it coded.

87.3.6 Current summary of the mixin

(Note that this mixin is for now just private code, but can be added to a branch obviously)

InteractiveArtistMixin:

Mixin class to make any generic object that is drawn on a matplotlib canvas moveable and possibly resizeable. The Powerpoint model is followed as closely as possible; not because I'm enamoured with Powerpoint, but because that's what most people understand. An artist can also be selectable, which means that the artist will receive the on_activated() callback when double clicked. Finally, an artist can be highlightable, which means that a highlight is drawn on the artist whenever the mouse passes over. Typically, highlightable artists will also be selectable, but that is left up to the user. So, basically there are four attributes that can be set by the user on a per-artist basis:

- highlightable
- selectable
- moveable
- resizeable

To be moveable (draggable) or resizeable, the object that is the target of the mixin must support the following protocols:

- get_pixel_position_ll(self)
- get_pixel_size(self)
- set_pixel_position_and_size(self,x,y,sx,sy)

Note that nonresizeable objects are free to ignore the sx and sy parameters. To be highlightable, the object that is the target of the mixin must also support the following protocol:

- get_highlight(self)

Which returns a list of artists that will be used to draw the highlight.

If the object that is the target of the mixin is not an matplotlib artist, the following protocols must also be implemented. Doing so is usually fairly trivial, as there has to be an artist *somewhere* that is being drawn. Typically your object would just route these calls to that artist.

- get_figure(self)
- get_axes(self)
- contains(self,event)
- set_animated(self,flag)
- draw(self,renderer)
- get_visible(self)

The following notifications are called on the artist, and the artist can optionally implement these.

- on_select_begin(self)
- on_select_end(self)

- on_drag_begin(self)
- on_drag_end(self)
- on_activated(self)
- on_highlight(self)
- on_right_click(self,event)
- on_left_click(self,event)
- on_middle_click(self,event)
- on_context_click(self,event)
- on_key_up(self,event)
- on_key_down(self,event)

The following notifications are called on the canvas, if no interactive artist handles the event:

- on_press(self,event)
- on_left_click(self,event)
- on_middle_click(self,event)
- on_right_click(self,event)
- on_context_click(self,event)
- on_key_up(self,event)
- on_key_down(self,event)

The following functions, if present, can be used to modify the behavior of the interactive object:

- press_filter(self,event) # determines if the object wants to have the press event routed to it
- handle_unpicked_cursor() # can be used by the object to set a cursor as the cursor passes over the object when it is unpicked.

Supports multiple canvases, maintaining a drag lock, motion notifier, and a global "enabled" flag per canvas. Supports fixed aspect ratio resizings by holding the shift key during the resize.

Known problems:

- Zorder is not obeyed during the selection/drag operations. Because of the blit technique used, I do not believe this can be fixed. The only way I can think of is to search for all artists that have a zorder greater then me, set them all to animated, and then redraw them all on top during each drag refresh. This might be very slow; need to try.
- the mixin only works for wx backends because of two things: 1) the cursors are hardcoded, and 2) there is a call to wx.GetMousePosition() Both of these shortcomings are reasonably fixed by having each backend supply these things.

87.3.7 Backward compatibility

No problems with backward compatibility, although once this is in place, it would be appropriate to obsolete some of the existing interactive functions (like legend.draggable())

87.3.8 Alternatives

None that I know of.

87.4 MEP10: Docstring consistency

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Numpy docstring format*
  - *Cross references*
  - *Overriding signatures*
  - *Linking rather than duplicating*
  - *autosummary extension*
  - *Examples linking to relevant documentation*
  - *Documentation using help() vs a browser*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

87.4.1 Status

Progress

This is still an on-going effort

87.4.2 Branches and Pull requests

87.4.3 Abstract

matplotlib has a great deal of inconsistency between docstrings. This not only makes the docs harder to read, but it is harder on contributors, because they don't know which specifications to follow. There should be a clear docstring convention that is followed consistently.

The organization of the API documentation is difficult to follow. Some pages, such as pyplot and axes, are enormous and hard to browse. There should instead be short summary tables that link to detailed documentation. In addition, some of the docstrings themselves are quite long and contain redundant information.

Building the documentation takes a long time and uses a `make.py` script rather than a Makefile.

87.4.4 Detailed description

There are number of new tools and conventions available since matplotlib started using Sphinx that make life easier. The following is a list of proposed changes to docstrings, most of which involve these new features.

Numpy docstring format

Numpy docstring format: This format divides the docstring into clear sections, each having different parsing rules that make the docstring easy to read both as raw text and as HTML. We could consider alternatives, or invent our own, but this is a strong choice, as it's well used and understood in the Numpy/Scipy community.

Cross references

Most of the docstrings in matplotlib use explicit "roles" when linking to other items, for example: `:func:`myfunction``. As of Sphinx 0.4, there is a "default_role" that can be set to "obj", which will polymorphically link to a Python object of any type. This allows one to write `` `myfunction` `` instead. This makes docstrings much easier to read and edit as raw text. Additionally, Sphinx allows for setting a current module, so links like `` `~matplotlib.axes.Axes.set_xlim` `` could be written as `` `~axes.Axes.set_xlim` ``.

Overriding signatures

Many methods in matplotlib use the `*args` and `**kwargs` syntax to dynamically handle the keyword arguments that are accepted by the function, or to delegate on to another function. This, however, is often not useful as a signature in the documentation. For this reason, many matplotlib methods include something like:

```
def annotate(self, *args, **kwargs):
    """
    Create an annotation: a piece of text referring to a data
    point.
```

(continues on next page)

(continued from previous page)

```
    Call signature::

      annotate(s, xy, xytext=None, xycoords='data',
               textcoords='data', arrowprops=None, **kwargs)
    """
```

This can't be parsed by Sphinx, and is rather verbose in raw text. As of Sphinx 1.1, if the `autodoc_docstring_signature` config value is set to True, Sphinx will extract a replacement signature from the first line of the docstring, allowing this:

```
def annotate(self, *args, **kwargs):
    """
    annotate(s, xy, xytext=None, xycoords='data',
               textcoords='data', arrowprops=None, **kwargs)

    Create an annotation: a piece of text referring to a data
    point.
    """
```

The explicit signature will replace the actual Python one in the generated documentation.

Linking rather than duplicating

Many of the docstrings include long lists of accepted keywords by interpolating things into the docstring at load time. This makes the docstrings very long. Also, since these tables are the same across many docstrings, it inserts a lot of redundant information in the docs – particularly a problem in the printed version.

These tables should be moved to docstrings on functions whose only purpose is for help. The docstrings that refer to these tables should link to them, rather than including them verbatim.

autosummary extension

The Sphinx autosummary extension should be used to generate summary tables, that link to separate pages of documentation. Some classes that have many methods (e.g. `Axes.axes`) should be documented with one method per page, whereas smaller classes should have all of their methods together.

Examples linking to relevant documentation

The examples, while helpful at illustrating how to use a feature, do not link back to the relevant docstrings. This could be addressed by adding module-level docstrings to the examples, and then including that docstring in the parsed content on the example page. These docstrings could easily include references to any other part of the documentation.

Documentation using help() vs a browser

Using Sphinx markup in the source allows for good-looking docs in your browser, but the markup also makes the raw text returned using help() look terrible. One of the aims of improving the docstrings should be to make both methods of accessing the docs look good.

87.4.5 Implementation

1. The numpydoc extensions should be turned on for matplotlib. There is an important question as to whether these should be included in the matplotlib source tree, or used as a dependency. Installing Numpy is not sufficient to get the numpydoc extensions – it's a separate install procedure. In any case, to the extent that they require customization for our needs, we should endeavor to submit those changes upstream and not fork them.
2. Manually go through all of the docstrings and update them to the new format and conventions. Updating the cross references (from `` `:func:`myfunc` `` to `` `func` ``) may be able to be semi-automated. This is a lot of busy work, and perhaps this labor should be divided on a per-module basis so no single developer is over-burdened by it.
3. Reorganize the API docs using autosummary and `sphinx-autogen`. This should hopefully have minimal impact on the narrative documentation.
4. Modify the example page generator (`gen_rst.py`) so that it extracts the module docstring from the example and includes it in a non-literal part of the example page.
5. Use `sphinx-quickstart` to generate a new-style Sphinx Makefile. The following features in the current `make.py` will have to be addressed in some other way:
   - Copying of some static content
   - Specifying a "small" build (only low-resolution PNG files for examples)

Steps 1, 2, and 3 are interdependent. 4 and 5 may be done independently, though 5 has some dependency on 3.

87.4.6 Backward compatibility

As this mainly involves docstrings, there should be minimal impact on backward compatibility.

87.4.7 Alternatives

None yet discussed.

87.5 MEP11: Third-party dependencies

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Current behavior*
  - *Desired behavior*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

This MEP attempts to improve the way in which third-party dependencies in matplotlib are handled.

87.5.1 Status

Completed – needs to be merged

87.5.2 Branches and Pull requests

#1157: Use automatic dependency resolution

#1290: Debundle pyparsing

#1261: Update six to 1.2

87.5.3 Abstract

One of the goals of matplotlib has been to keep it as easy to install as possible. To that end, some third-party dependencies are included in the source tree and, under certain circumstances, installed alongside matplotlib. This MEP aims to resolve some problems with that approach, bring some consistency, while continuing to make installation convenient.

At the time that was initially done, `setuptools`, `easy_install` and `PyPI` were not mature enough to be relied on. However, at present, we should be able to safely leverage the "modern" versions of those tools, `distribute` and `pip`.

While matplotlib has dependencies on both Python libraries and C/C++ libraries, this MEP addresses only the Python libraries so as to not confuse the issue. C libraries represent a larger and mostly orthogonal set of problems.

87.5.4 Detailed description

matplotlib depends on the following third-party Python libraries:

- Numpy
- dateutil (pure Python)
- pytz (pure Python)
- six – required by dateutil (pure Python)
- pyparsing (pure Python)
- PIL (optional)
- GUI frameworks: pygtk, gobject, tkinter, PySide, PyQt4, wx (all optional, but one is required for an interactive GUI)

Current behavior

When installing from source, a `git` checkout or `pip`:

- `setup.py` attempts to `import numpy`. If this fails, the installation fails.
- For each of `dateutil`, `pytz` and `six`, `setup.py` attempts to import them (from the top-level namespace). If that fails, matplotlib installs its local copy of the library into the top-level namespace.
- `pyparsing` is always installed inside of the matplotlib namespace.

This behavior is most surprising when used with `pip`, because no `pip` dependency resolution is performed, even though it is likely to work for all of these packages.

The fact that `pyparsing` is installed in the matplotlib namespace has reportedly (#1290) confused some users into thinking it is a matplotlib-related module and import it from there rather than the top-level.

When installing using the Windows installer, `dateutil`, `pytz` and `six` are installed at the top-level *always*, potentially overwriting already installed copies of those libraries.

TODO: Describe behavior with the OS-X installer.

When installing using a package manager (Debian, RedHat, MacPorts etc.), this behavior actually does the right thing, and there are no special patches in the matplotlib packages to deal with the fact that we handle `dateutil`, `pytz` and `six` in this way. However, care should be taken that whatever approach we move to continues to work in that context.

Maintaining these packages in the matplotlib tree and making sure they are up-to-date is a maintenance burden. Advanced new features that may require a third-party pure Python library have a higher barrier to inclusion because of this burden.

Desired behavior

Third-party dependencies are downloaded and installed from their canonical locations by leveraging `pip`, `distribute` and `PyPI`.

`dateutil`, `pytz`, and `pyparsing` should be made into optional dependencies – though obviously some features would fail if they aren't installed. This will allow the user to decide whether they want to bother installing a particular feature.

87.5.5 Implementation

For installing from source, and assuming the user has all of the C-level compilers and dependencies, this can be accomplished fairly easily using `distribute` and following the instructions here. The only anticipated change to the matplotlib library code will be to import `pyparsing` from the top-level namespace rather than from within matplotlib. Note that `distribute` will also allow us to remove the direct dependency on `six`, since it is, strictly speaking, only a direct dependency of `dateutil`.

For binary installations, there are a number of alternatives (here ordered from best/hardest to worst/easiest):

1. The distutils wininst installer allows a post-install script to run. It might be possible to get this script to run `pip` to install the other dependencies. (See this thread for someone who has trod that ground before).
2. Continue to ship `dateutil`, `pytz`, `six` and `pyparsing` in our installer, but use the post-install-script to install them *only* if they can not already be found.
3. Move all of these packages inside a (new) `matplotlib.extern` namespace so it is clear for outside users that these are external packages. Add some conditional imports in the core matplotlib codebase so `dateutil` (at the top-level) is tried first, and failing that `matplotlib.extern.dateutil` is used.

2 and 3 are undesirable as they still require maintaining copies of these packages in our tree – and this is exacerbated by the fact that they are used less – only in the binary installers. None of these 3 approaches address Numpy, which will still have to be manually installed using an installer.

TODO: How does this relate to the Mac OS-X installer?

87.5.6 Backward compatibility

At present, matplotlib can be installed from source on a machine without the third party dependencies and without an internet connection. After this change, an internet connection (and a working PyPI) will be required to install matplotlib for the first time. (Subsequent matplotlib updates or development work will run without accessing the network).

87.5.7 Alternatives

Distributing binary `eggs` doesn't feel like a usable solution. That requires getting `easy_install` installed first, and Windows users generally prefer the well known `exe` or `msi` installer that works out of the box.

87.6 MEP12: Improve Gallery and Examples

- *Status*
- *Branches and Pull requests*
- *Abstract*

- *Detailed description*
- *Implementation*
  - *Gallery sections*
  - *Clean up guidelines*
    - *Additional suggestions*
- *Backward compatibility*
- *Alternatives*
  - *Tags*

87.6.1 Status

Progress

Initial changes added in 1.3. Conversion of the gallery is on-going. 29 September 2015 - The last `pylab_examples` where `pylab` is imported has been converted over to use `matplotlib pyplot` and `numpy`.

87.6.2 Branches and Pull requests

#1623, #1924, #2181

PR `#2474 <https://github.com/matplotlib/matplotlib/pull/2474>_` demonstrates a single example being cleaned up and moved to the appropriate section.

87.6.3 Abstract

Reorganizing the matplotlib plot gallery would greatly simplify navigation of the gallery. In addition, examples should be cleaned-up and simplified for clarity.

87.6.4 Detailed description

The matplotlib gallery was recently set up to split examples up into sections. As discussed in that PR[1], the current example sections (`api`, `pylab_examples`) aren't terribly useful to users: New sections in the gallery would help users find relevant examples.

These sections would also guide a cleanup of the examples: Initially, all the current examples would remain and be listed under their current directories. Over time, these examples could be cleaned up and moved into one of the new sections.

This process allows users to easily identify examples that need to be cleaned up; i.e. anything in the `api` and `pylab_examples` directories.

[1] https://github.com/matplotlib/matplotlib/pull/714

87.6.5 Implementation

1. Create new gallery sections. [Done]
2. Clean up examples and move them to the new gallery sections (over the course of many PRs and with the help of many users/developers). [In progress]

Gallery sections

The naming of sections is critical and will guide the clean-up effort. The current sections are:

- Lines, bars, and markers (more-or-less 1D data)
- Shapes and collections
- Statistical plots
- Images, contours, and fields
- Pie and polar charts: Round things
- Color
- Text, labels, and annotations
- Ticks and spines
- Subplots, axes, and figures
- Specialty plots (e.g., sankey, radar, tornado)
- Showcase (plots with tweaks to make them publication-quality)
- separate sections for toolboxes (already exists: 'mplot3d', 'axes_grid', 'units', 'widgets')

These names are certainly up for debate. As these sections grow, we should reevaluate them and split them up as necessary.

Clean up guidelines

The current examples in the `api` and `pylab_examples` sections of the gallery would remain in those directories until they are cleaned up. After clean-up, they would be moved to one of the new gallery sections described above. "Clean-up" should involve:

- sphinx-gallery docstrings: a title and a description of the example formatted as follows, at the top of the example:

```
"""
==============================
Colormaps alter your perception
==============================

Here I plot the function
```

(continues on next page)

(continued from previous page)

```
.. math:: f(x, y) = \sin(x) + \cos(y)

with different colormaps. Look at how colormaps alter your perception!
"""
```

- PEP8 clean-ups (running flake8, or a similar checker, is highly recommended)
- Commented-out code should be removed.
- Replace uses of `pylab` interface with `pyplot` (+ `numpy`, etc.). See c25ef1e
- Remove shebang line, e.g.:

  #!/usr/bin/env python

- Use consistent imports. In particular:

  import numpy as np

  import matplotlib.pyplot as plt

  Avoid importing specific functions from these modules (e.g. `from numpy import sin`)

- Each example should focus on a specific feature (excluding `showcase` examples, which will show more "polished" plots). Tweaking unrelated to that feature should be removed. See f7b2217, e57b5fc, and 1458aa8

Use of `pylab` should be demonstrated/discussed on a dedicated help page instead of the gallery examples.

Note: When moving an existing example, you should search for references to that example. For example, the API documentation for `axes.py` and `pyplot.py` may use these examples to generate plots. Use your favorite search tool (e.g., grep, ack, grin, pss) to search the matplotlib package. See 2dc9a46 and aa6b410

Additional suggestions

- Provide links (both ways) between examples and API docs for the methods/objects used. (issue #2222)
- Use `plt.subplots` (note trailing "s") in preference over `plt.subplot`.
- Rename the example to clarify it's purpose. For example, the most basic demo of `imshow` might be `imshow_demo.py`, and one demonstrating different interpolation settings would be `imshow_demo_interpolation.py` (*not* `imshow_demo2.py`).
- Split up examples that try to do too much. See 5099675 and fc2ab07
- Delete examples that don't show anything new.
- Some examples exercise esoteric features for unit testing. These tweaks should be moved out of the gallery to an example in the `unit` directory located in the root directory of the package.
- Add plot titles to clarify intent of the example. See bd2b13c

87.6.6 Backward compatibility

The website for each Matplotlib version is readily accessible, so users who want to refer to old examples can still do so.

87.6.7 Alternatives

Tags

Tagging examples will also help users search the example gallery. Although tags would be a big win for users with specific goals, the plot gallery will remain the entry point to these examples, and sections could really help users navigate the gallery. Thus, tags are complementary to this reorganization.

87.7 MEP13: Use properties for Artists

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Examples*
  - *axes.Axes.set_axis_off/set_axis_on*
  - *axes.Axes.get_xlim/set_xlim and get_autoscalex_on/set_autoscalex_on*
  - *axes.Axes.get_title/set_title*
  - *axes.Axes.get_xticklabels/set_xticklabels*
- *Alternatives*

87.7.1 Status

- **Discussion**

87.7.2 Branches and Pull requests

None

87.7.3 Abstract

Wrap all of the matplotlib getter and setter methods with python properties, allowing them to be read and written like class attributes.

87.7.4 Detailed description

Currently matplotlib uses getter and setter functions (usually prefixed with get_ and set_, respectively) for reading and writing data related to classes. However, since 2.6 python supports properties, which allow such setter and getter functions to be accessed as though they were attributes. This proposal would implement all existing setter and getter methods as properties.

87.7.5 Implementation

1. All existing getter and setter methods will need to have two aliases, one with the get_ or set_ prefix and one without. Getter methods that currently lack prefixes should be recording in a text file.
2. Classes should be reorganized so setter and getter methods are sequential in the code, with getter methods first.
3. Getter and setter methods the provide additional optional optional arguments should have those arguments accessible in another manner, either as additional getter or setter methods or attributes of other classes. If those classes are not accessible, getters for them should be added.
4. Property decorators will be added to the setter and getter methods without the prefix. Those with the prefix will be marked as deprecated.
5. Docstrings will need to be rewritten so the getter with the prefix has the current docstring and the getter without the prefix has a generic docstring appropriate for an attribute.
6. Automatic alias generation will need to be modified so it will also create aliases for the properties.
7. All instances of getter and setter method calls will need to be changed to attribute access.
8. All setter and getter aliases with prefixes will be removed

The following steps can be done simultaneously: 1, 2, and 3; 4 and 5; 6 and 7.

Only the following steps must be done in the same release: 4, 5, and 6. All other changes can be done in separate releases. 8 should be done several major releases after everything else.

87.7.6 Backward compatibility

All existing getter methods that do not have a prefix (such as get_) will need to be changed from function calls to attribute access. In most cases this will only require removing the parenthesis.

setter and getter methods that have additional optional arguments will need to have those arguments implemented in another way, either as a separate property in the same class or as attributes or properties of another class.

Cases where the setter returns a value will need to be changed to using the setter followed by the getter.

Cases where there are set_ATTR_on() and set_ATTR_off() methods will be changed to ATTR_on properties.

87.7.7 Examples

axes.Axes.set_axis_off/set_axis_on

Current implementation:

```
axes.Axes.set_axis_off()
axes.Axes.set_axis_on()
```

New implementation:

```
True = axes.Axes.axis_on
False = axes.Axes.axis_on
axes.Axes.axis_on = True
axes.Axes.axis_on = False
```

axes.Axes.get_xlim/set_xlim and get_autoscalex_on/set_autoscalex_on

Current implementation:

```
[left, right] = axes.Axes.get_xlim()
auto = axes.Axes.get_autoscalex_on()

[left, right] = axes.Axes.set_xlim(left=left, right=right, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=left, right=None, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=None, right=right, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(left=left, emit=emit, auto=auto)
[left, right] = axes.Axes.set_xlim(right=right, emit=emit, auto=auto)

axes.Axes.set_autoscalex_on(auto)
```

New implementation:

```
[left, right] = axes.Axes.axes_xlim
auto = axes.Axes.autoscalex_on

axes.Axes.axes_xlim = [left, right]
axes.Axes.axes_xlim = [left, None]
axes.Axes.axes_xlim = [None, right]
axes.Axes.axes_xlim[0] = left
axes.Axes.axes_xlim[1] = right

axes.Axes.autoscalex_on = auto

axes.Axes.emit_xlim = emit
```

axes.Axes.get_title/set_title

Current implementation:

```
string = axes.Axes.get_title()
axes.Axes.set_title(string, fontdict=fontdict, **kwargs)
```

New implementation:

```
string = axes.Axes.title
string = axes.Axes.title_text.text

text.Text = axes.Axes.title_text
text.Text.<attribute> = attribute
text.Text.fontdict = fontdict

axes.Axes.title = string
axes.Axes.title = text.Text
axes.Axes.title_text = string
axes.Axes.title_text = text.Text
```

axes.Axes.get_xticklabels/set_xticklabels

Current implementation:

```
[text.Text] = axes.Axes.get_xticklabels()
[text.Text] = axes.Axes.get_xticklabels(minor=False)
[text.Text] = axes.Axes.get_xticklabels(minor=True)
[text.Text] = axes.Axes.([string], fontdict=None, **kwargs)
[text.Text] = axes.Axes.([string], fontdict=None, minor=False, **kwargs)
[text.Text] = axes.Axes.([string], fontdict=None, minor=True, **kwargs)
```

New implementation:

```
[text.Text] = axes.Axes.xticklabels
[text.Text] = axes.Axes.xminorticklabels
axes.Axes.xticklabels = [string]
axes.Axes.xminorticklabels = [string]
axes.Axes.xticklabels = [text.Text]
axes.Axes.xminorticklabels = [text.Text]
```

87.7.8 Alternatives

Instead of using decorators, it is also possible to use the property function. This would change the procedure so that all getter methods that lack a prefix will need to be renamed or removed. This makes handling docstrings more difficult and harder to read.

It is not necessary to deprecate the setter and getter methods, but leaving them in will complicate the code.

This could also serve as an opportunity to rewrite or even remove automatic alias generation.

Another alternate proposal:

Convert `set_xlim`, `set_xlabel`, `set_title`, etc. to `xlim`, `xlabel`, `title`,... to make the transition from `plt` functions to `axes` methods significantly simpler. These would still be methods, not properties, but it's still a great usability enhancement while retaining the interface.

87.8 MEP14: Text handling

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

87.8.1 Status

- **Discussion**

87.8.2 Branches and Pull requests

Issue #253 demonstrates a bug where using the bounding box rather than the advance width of text results in misaligned text. This is a minor point in the grand scheme of things, but it should be addressed as part of this MEP.

87.8.3 Abstract

By reorganizing how text is handled, this MEP aims to:

- improve support for Unicode and non-ltr languages
- improve text layout (especially multi-line text)
- allow support for more fonts, especially non-Apple-format TrueType fonts and OpenType fonts.
- make the font configuration easier and more transparent

87.8.4 Detailed description

Text layout

At present, matplotlib has two different ways to render text: "built-in" (based on FreeType and our own Python code), and "usetex" (based on calling out to a TeX installation). Adjunct to the "built-in" renderer there is also the Python-based "mathtext" system for rendering mathematical equations using a subset of the TeX language without having a TeX installation available. Support for these two engines in strewn about many source files, including every backend, where one finds clauses like

```
if rcParams['text.usetex']: # do one thing else: # do another
```

Adding a third text rendering approach (more on that later) would require editing all of these places as well, and therefore doesn't scale.

Instead, this MEP proposes adding a concept of "text engines", where the user could select one of many different approaches for rendering text. The implementations of each of these would be localized to their own set of modules, and not have little pieces around the whole source tree.

Why add more text rendering engines? The "built-in" text rendering has a number of shortcomings.

- It only handles right-to-left languages, and doesn't handle many special features of Unicode, such as combining diacriticals.
- The multiline support is imperfect and only supports manual line-breaking – it can not break up a paragraph into lines of a certain length.
- It also does not handle inline formatting changes in order to support something like Markdown, re-StructuredText or HTML. (Though rich-text formatting is contemplated in this MEP, since we want to make sure this design allows it, the specifics of a rich-text formatting implementation is outside of the scope of this MEP.)

Supporting these things is difficult, and is the "full-time job" of a number of other projects:

- pango/harfbuzz
- QtTextLayout
- Microsoft DirectWrite
- Apple Core Text

Of the above options, it should be noted that `harfbuzz` is designed from the start as a cross platform option with minimal dependencies, so therefore is a good candidate for a single option to support.

Additionally, for supporting rich text, we could consider using WebKit, and possibly whether than represents a good single cross-platform option. Again, however, rich text formatting is outside of the scope of this project.

Rather than trying to reinvent the wheel and add these features to matplotlib's "built-in" text renderer, we should provide a way to leverage these projects to get more powerful text layout. The "built-in" renderer will still need to exist for reasons of ease of installation, but its feature set will be more limited compared to the others. [TODO: This MEP should clearly decide what those limited features are, and fix any bugs to bring the implementation into a state of working correctly in all cases that we want it to work. I know @leejjoon has some thoughts on this.]

Font selection

Going from an abstract description of a font to a file on disk is the task of the font selection algorithm – it turns out to be much more complicated than it seems at first.

The "built-in" and "usetex" renderers have very different ways of handling font selection, given their different technologies. TeX requires the installation of TeX-specific font packages, for example, and can not use TrueType fonts directly. Unfortunately, despite the different semantics for font selection, the same set of font properties are used for each. This is true of both the `FontProperties` class and the font-related `rcParams` (which basically share the same code underneath). Instead, we should define a core set of font selection parameters that will work across all text engines, and have engine-specific configuration to allow the user to do engine-specific things when required. For example, it is possible to directly select a font by name in the "built-in" using `font.family`, but the same is not possible with "usetex". It may be possible to make it easier to use TrueType fonts by using XeTeX, but users will still want to use the traditional metafonts through TeX font packages. So the issue still stands that different text engines will need engine-specific configuration, and it should be more obvious to the user which configuration will work across text engines and which are engine-specific.

Note that even excluding "usetex", there are different ways to find fonts. The default is to use the font list cache in `font_manager.py` which matches fonts using our own algorithm based on the CSS font matching algorithm. It doesn't always do the same thing as the native font selection algorithms on Linux (fontconfig), Mac and Windows, and it doesn't always find all of the fonts on the system that the OS would normally pick up. However, it is cross-platform, and always finds the fonts that ship with matplotlib. The Cairo and MacOSX backends (and presumably a future HTML5-based backend) currently bypass this mechanism and use the OS-native ones. The same is true when not embedding fonts in SVG, PS or PDF files and opening them in a third-party viewer. A downside there is that (at least with Cairo, need to confirm with MacOSX) they don't always find the fonts we ship with matplotlib. (It may be possible to add the fonts to their search path, though, or we may need to find a way to install our fonts to a location the OS expects to find them).

There are also special modes in the PS and PDF to only use the core fonts that are always available to those formats. There, the font lookup mechanism must only match against those fonts. It is unclear whether the OS-native font lookup systems can handle this case.

There is also experimental support for using fontconfig for font selection in matplotlib, turned off by default. fontconfig is the native font selection algorithm on Linux, but is also cross platform and works well on the other platforms (though obviously is an additional dependency there).

Many of the text layout libraries proposed above (pango, QtTextLayout, DirectWrite and CoreText etc.) insist on using the font selection library from their own ecosystem.

All of the above seems to suggest that we should move away from our self-written font selection algorithm and use the native APIs where possible. That's what Cairo and MacOSX backends already want to use, and it will be a requirement of any complex text layout library. On Linux, we already have the bones of a `fontconfig` implementation (which could also be accessed through pango). On Windows and Mac we may need to write custom wrappers. The nice thing is that the API for font lookup is relatively small, and essentially consist of "given a dictionary of font properties, give me a matching font file".

Font subsetting

Font subsetting is currently handled using ttconv. ttconv was a standalone commandline utility for converting TrueType fonts to subsetted Type 3 fonts (among other features) written in 1995, which matplotlib (well, I) forked in order to make it work as a library. It only handles Apple-style TrueType fonts, not ones with

the Microsoft (or other vendor) encodings. It doesn't handle OpenType fonts at all. This means that even though the STIX fonts come as .otf files, we have to convert them to .ttf files to ship them with matplotlib. The Linux packagers hate this – they'd rather just depend on the upstream STIX fonts. ttconv has also been shown to have a few bugs that have been difficult to fix over time.

Instead, we should be able to use FreeType to get the font outlines and write our own code (probably in Python) to output subsetted fonts (Type 3 on PS and PDF and SVGFonts or paths on SVG). Freetype, as a popular and well-maintained project, handles a wide variety of fonts in the wild. This would remove a lot of custom C code, and remove some code duplication between backends.

Note that subsetting fonts this way, while the easiest route, does lose the hinting in the font, so we will need to continue, as we do now, provide a way to embed the entire font in the file where possible.

Alternative font subsetting options include using the subsetting built-in to Cairo (not clear if it can be used without the rest of Cairo), or using `fontforge` (which is a heavy and not terribly cross-platform dependency).

Freetype wrappers

Our FreeType wrapper could really use a reworking. It defines its own image buffer class (when a Numpy array would be easier). While FreeType can handle a huge diversity of font files, there are limitations to our wrapper that make it much harder to support non-Apple-vendor TrueType files, and certain features of OpenType files. (See #2088 for a terrible result of this, just to support the fonts that ship with Windows 7 and 8). I think a fresh rewrite of this wrapper would go a long way.

Text anchoring and alignment and rotation

The handling of baselines was changed in 1.3.0 such that the backends are now given the location of the baseline of the text, not the bottom of the text. This is probably the correct behavior, and the MEP refactoring should also follow this convention.

In order to support alignment on multi-line text, it should be the responsibility of the (proposed) text engine to handle text alignment. For a given chunk of text, each engine calculates a bounding box for that text and the offset of the anchor point within that box. Therefore, if the va of a block was "top", the anchor point would be at the top of the box.

Rotating of text should always be around the anchor point. I'm not sure that lines up with current behavior in matplotlib, but it seems like the sanest/least surprising choice. [This could be revisited once we have something working]. Rotation of text should not be handled by the text engine – that should be handled by a layer between the text engine and the rendering backend so it can be handled in a uniform way. [I don't see any advantage to rotation being handled by the text engines individually...]

There are other problems with text alignment and anchoring that should be resolved as part of this work. [TODO: enumerate these].

Other minor problems to fix

The mathtext code has backend-specific code – it should instead provide its output as just another text engine. However, it's still desirable to have mathtext layout inserted as part of a larger layout performed by another text engine, so it should be possible to do this. It's an open question whether embedding the text layout of an arbitrary text engine in another should be possible.

The text mode is currently set by a global rcParam ("text.usetex") so it's either all on or all off. We should continue to have a global rcParam to choose the text engine ("text.layout_engine"), but it should under the

hood be an overridable property on the `Text` object, so the same figure can combine the results of multiple text layout engines if necessary.

87.8.5 Implementation

A concept of a "text engine" will be introduced. Each text engine will implement a number of abstract classes. The `TextFont` interface will represent text for a given set of font properties. It isn't necessarily limited to a single font file – if the layout engine supports rich text, it may handle a number of font files in a family. Given a `TextFont` instance, the user can get a `TextLayout` instance, which represents the layout for a given string of text in a given font. From a `TextLayout`, an iterator over `TextSpans` is returned so the engine can output raw editable text using as few spans as possible. If the engine would rather get individual characters, they can be obtained from the `TextSpan` instance:

```
class TextFont(TextFontBase):
    def __init__(self, font_properties):
        """
        Create a new object for rendering text using the given font properties.
        """
        pass

    def get_layout(self, s, ha, va):
        """
        Get the TextLayout for the given string in the given font and
        the horizontal (left, center, right) and verticalalignment (top,
        center, baseline, bottom)
        """
        pass

class TextLayout(TextLayoutBase):
    def get_metrics(self):
        """
        Return the bounding box of the layout, anchored at (0, 0).
        """
        pass

    def get_spans(self):
        """
        Returns an iterator over the spans of different in the layout.
        This is useful for backends that want to editable raw text as
        individual lines.  For rich text where the font may change,
        each span of different font type will have its own span.
        """
        pass

    def get_image(self):
        """
        Returns a rasterized image of the text.  Useful for raster backends,
        like Agg.

        In all likelihood, this will be overridden in the backend, as it can
        be created from get_layout(), but certain backends may want to
```

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```
        override it if their library provides it (as freetype does).
        """
        pass

    def get_rectangles(self):
        """
        Returns an iterator over the filled black rectangles in the layout.
        Used by TeX and mathtext for drawing, for example, fraction lines.
        """
        pass

    def get_path(self):
        """
        Returns a single Path object of the entire laid out text.

        [Not strictly necessary, but might be useful for textpath
        functionality]
        """
        pass

class TextSpan(TextSpanBase):
    x, y      # Position of the span -- relative to the text layout as a whole
              # where (0, 0) is the anchor.  y is the baseline of the span.
    fontfile  # The font file to use for the span
    text      # The text content of the span

    def get_path(self):
        pass  # See TextLayout.get_path

    def get_chars(self):
        """
        Returns an iterator over the characters in the span.
        """
        pass

class TextChar(TextCharBase):
    x, y      # Position of the character -- relative to the text layout as
              # a whole, where (0, 0) is the anchor.  y is in the baseline
              # of the character.
    codepoint # The unicode code point of the character -- only for informational
              # purposes, since the mapping of codepoint to glyph_id may have been
              # handled in a complex way by the layout engine.  This is an int
              # to avoid problems on narrow Unicode builds.
    glyph_id  # The index of the glyph within the font
    fontfile  # The font file to use for the char

    def get_path(self):
        """
        Get the path for the character.
        """
pass
```

Graphic backends that want to output subset of fonts would likely build up a file-global dictionary of characters where the keys are (fontname, glyph_id) and the values are the paths so that only one copy of the path for each character will be stored in the file.

Special casing: The "usetex" functionality currently is able to get Postscript directly from TeX to insert directly in a Postscript file, but for other backends, parses a DVI file and generates something more abstract. For a case like this, `TextLayout` would implement `get_spans` for most backends, but add `get_ps` for the Postscript backend, which would look for the presence of this method and use it if available, or fall back to `get_spans`. This kind of special casing may also be necessary, for example, when the graphics backend and text engine belong to the same ecosystem, e.g. Cairo and Pango, or MacOSX and CoreText.

There are three main pieces to the implementation:

1. Rewriting the freetype wrapper, and removing ttconv.

1. Once (1) is done, as a proof of concept, we can move to the upstream STIX .otf fonts

2. Add support for web fonts loaded from a remote URL. (Enabled by using freetype for font subsetting).

2. Refactoring the existing "builtin" and "usetex" code into separate text engines and to follow the API outlined above.

3. Implementing support for advanced text layout libraries.

(1) and (2) are fairly independent, though having (1) done first will allow (2) to be simpler. (3) is dependent on (1) and (2), but even if it doesn't get done (or is postponed), completing (1) and (2) will make it easier to move forward with improving the "builtin" text engine.

87.8.6 Backward compatibility

The layout of text with respect to its anchor and rotation will change in hopefully small, but improved, ways. The layout of multiline text will be much better, as it will respect horizontal alignment. The layout of bidirectional text or other advanced Unicode features will now work inherently, which may break some things if users are currently using their own workarounds.

Fonts will be selected differently. Hacks that used to sort of work between the "builtin" and "usetex" text rendering engines may no longer work. Fonts found by the OS that weren't previously found by matplotlib may be selected.

87.8.7 Alternatives

TBD

87.9 MEP15 - Fix axis autoscaling when limits are specified for one axis only

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

87.9.1 Status

Discussion

87.9.2 Branches and Pull requests

None so far.

87.9.3 Abstract

When one axis of a 2-dimensional plot if overridden via `xlim` or `ylim`, automatic scaling of the remaining axis should be based on the data that falls within the specified limits of the first axis.

87.9.4 Detailed description

When axis limits for a 2-D plot are specified for one axis only (via `xlim` or `ylim`), matplotlib currently does not currently rescale the other axis. The result is that the displayed curves or symbols may be compressed into a tiny portion of the available area, so that the final plot conveys much less information than it would with appropriate axis scaling.

The proposed change of behavior would make matplotlib choose the scale for the remaining axis using only the data that falls within the limits for the axis where limits were specified.

87.9.5 Implementation

I don't know enough about the internals of matplotlib to be able to suggest an implementation.

87.9.6 Backward compatibility

From the standpoint of software interfaces, there would be no break in backward compatibility. Some outputs would be different, but if the user truly desires the previous behavior, he/she can achieve this by overriding the axis scaling for both axes.

87.9.7 Alternatives

The only alternative that I can see is to maintain the status quo.

87.10 MEP19: Continuous Integration

87.10.1 Status

Completed

87.10.2 Branches and Pull requests

87.10.3 Abstract

matplotlib could benefit from better and more reliable continuous integration, both for testing and building installers and documentation.

87.10.4 Detailed description

Current state-of-the-art

Testing

matplotlib currently uses Travis-CI for automated tests. While Travis-CI should be praised for how much it does as a free service, it has a number of shortcomings:

- It often fails due to network timeouts when installing dependencies.
- It often fails for inexplicable reasons.
- build or test products can only be saved from build off of branches on the main repo, not pull requests, so it is often difficult to "post mortem" analyse what went wrong. This is particularly frustrating when the failure can not be subsequently reproduced locally.
- It is not extremely fast. matplotlib's cpu and memory requirements for testing are much higher than the average Python project.
- It only tests on Ubuntu Linux, and we have only minimal control over the specifics of the platform. It can be upgraded at any time outside of our control, causing unexpected delays at times that may not be convenient in our release schedule.

On the plus side, Travis-CI's integration with github – automatically testing all pending pull requests – is exceptional.

Builds

There is no centralized effort for automated binary builds for matplotlib. However, the following disparate things are being done [If the authors mentioned here could fill in detail, that would be great!]:

- @sandrotosi: builds Debian packages

- @takluyver: Has automated Ubuntu builds on Launchpad
- @cgohlke: Makes Windows builds (don't know how automated that is)
- @r-owen: Makes OS-X builds (don't know how automated that is)

Documentation

Documentation of master is now built by travis and uploaded to http://matplotlib.org/devdocs/index.html

@NelleV, I believe, generates the docs automatically and posts them on the web to chart MEP10 progress.

Peculiarities of matplotlib

matplotlib has complex requirements that make testing and building more taxing than many other Python projects.

- The CPU time to run the tests is quite high. It puts us beyond the free accounts of many CI services (e.g. ShiningPanda)
- It has a large number of dependencies, and testing the full matrix of all combinations is impractical. We need to be clever about what space we test and guarantee to support.

Requirements

This section outlines the requirements that we would like to have.

1. Testing all pull requests by hooking into the Github API, as Travis-CI does
2. Testing on all major platforms: Linux, Mac OS-X, MS Windows (in that order of priority, based on user survey)
3. Retain the last n days worth of build and test products, to aid in post-mortem debugging.
4. Automated nightly binary builds, so that users can test the bleeding edge without installing a complete compilation environment.
5. Automated benchmarking. It would be nice to have a standard benchmark suite (separate from the tests) whose performance could be tracked over time, in different backends and platforms. While this is separate from building and testing, ideally it would run on the same infrastructure.
6. Automated nightly building and publishing of documentation (or as part of testing, to ensure PRs don't introduce documentation bugs). (This would not replace the static documentation for stable releases as a default).
7. The test systems should be manageable by multiple developers, so that no single person becomes a bottleneck. (Travis-CI's design does this well – storing build configuration in the git repository, rather than elsewhere, is a very good design.)
8. Make it easy to test a large but sparse matrix of different versions of matplotlib's dependencies. The matplotlib user survey provides some good data as to where to focus our efforts: https://docs.google.com/spreadsheet/ccc?key=0AjrPjlTMRTwTdHpQS25pcTZIRWdqX0pNckNSU01sMHc#gid=0

9. Nice to have: A decentralized design so that those with more obscure platforms can publish build results to a central dashboard.

87.10.5 Implementation

This part is yet-to-be-written.

However, ideally, the implementation would be a third-party service, to avoid adding system administration to our already stretched time. As we have some donated funds, this service may be a paid one if it offers significant time-saving advantages over free offerings.

87.10.6 Backward compatibility

Backward compatibility is not a major concern for this MEP. We will replace current tools and procedures with something better and throw out the old.

87.10.7 Alternatives

87.10.8 Hangout Notes

CI Infrastructure

- We like Travis and it will probably remain part of our arsenal in any event. The reliability issues are being looked into.
- Enable Amazon S3 uploads of testing products on Travis. This will help with post-mortem of failures (@mdboom is looking into this now).
- We want Mac coverage. The best bet is probably to push Travis to enable it for our project by paying them for a Pro account (since they don't otherwise allow testing on both Linux and Mac).
- We want Windows coverage. Shining Panda is an option there.
- Investigate finding or building a tool that would collect and synthesize test results from a number of sources and post it to Github using the Github API. This may be of general use to the Scipy community.
- For both Windows and Mac, we should document (or better yet, script) the process of setting up the machine for a build, and how to build binaries and installers. This may require getting information from Russel Owen and Christoph Gohlke. This is a necessary step for doing automated builds, but would also be valuable for a number of other reasons.

The test framework itself

- We should investigate ways to make it take less time
  - Eliminating redundant tests, if possible
  - General performance improvements to matplotlib will help

- We should be covering more things, particularly more backends
- We should have more unit tests, fewer integration tests, if possible

87.11 MEP21: color and cm refactor

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Backward compatibility*
- *Alternatives*

87.11.1 Status

- **Discussion**: This MEP has not commenced yet, but here are some ongoing ideas which may become a part of this MEP:

87.11.2 Branches and Pull requests

87.11.3 Abstract

- color
  - tidy up the namespace
  - Define a "Color" class
  - make it easy to convert from one color type to another `hex -> RGB`, `RGB -> hex`, `HSV -> RGB` etc.
  - improve the construction of a colormap - the dictionary approach is archaic and overly complex (though incredibly powerful)
  - make it possible to interpolate between two or more color types in different modes, especially useful for construction of colormaps in HSV space for instance
- cm
  - rename the module to something more descriptive - mappables?

Overall, there are a lot of improvements that can be made with matplotlib color handling - managing backwards compatibility will be difficult as there are some badly named variables/modules which really shouldn't

exist - but a clear path and message for migration should be available, with a large amount of focus on this in the API changes documentation.

87.11.4 Detailed description

87.11.5 Implementation

87.11.6 Backward compatibility

87.11.7 Alternatives

87.12 MEP22: Toolbar rewrite

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *ToolBase(object)*
  - *ToolToggleBase(ToolBase)*
  - *NavigationBase*
  - *ToolbarBase*
- *Backward compatibility*

87.12.1 Status

Progress

87.12.2 Branches and Pull requests

Previous work

- https://github.com/matplotlib/matplotlib/pull/1849
- https://github.com/matplotlib/matplotlib/pull/2557
- https://github.com/matplotlib/matplotlib/pull/2465

Pull Requests:

- Removing the NavigationToolbar classes https://github.com/matplotlib/matplotlib/pull/2740 **CLOSED**
- Keeping the NavigationToolbar classes https://github.com/matplotlib/matplotlib/pull/2759 **CLOSED**
- Navigation by events: https://github.com/matplotlib/matplotlib/pull/3652

87.12.3 Abstract

The main goal of this MEP is to make it easier to modify (add, change, remove) the way the user interacts with the figures.

The user interaction with the figure is deeply integrated within the Canvas and Toolbar. Making extremely difficult to do any modification.

This MEP proposes the separation of this interaction into Toolbar, Navigation and Tools to provide independent access and reconfiguration.

This approach will make easier to create and share tools among users. In the far future, we can even foresee a kind of Marketplace for `Tools` where the most popular can be added into the main distribution.

87.12.4 Detailed description

The reconfiguration of the Toolbar is complex, most of the time it requires a custom backend.

The creation of custom Tools sometimes interferes with the Toolbar, as example see https://github.com/matplotlib/matplotlib/issues/2694 also the shortcuts are hardcoded and again not easily modifiable https://github.com/matplotlib/matplotlib/issues/2699

The proposed solution is to take the actions out of the `Toolbar` and the shortcuts out of the `Canvas`. This actions and shortcuts will be in the form of `Tools`.

A new class `Navigation` will be the bridge between the events from the `Canvas` and `Toolbar` and redirect them to the appropriate `Tool`.

At the end the user interaction will be divided into three classes:

- NavigationBase: This class is instantiated for each FigureManager and connect the all user interactions with the Tools
- ToolbarBase: This existing class is relegated only as a GUI access to Tools.
- ToolBase: Is the basic definition of Tools.

87.12.5 Implementation

ToolBase(object)

Tools can have a graphical representation as the `SubplotTool` or not even be present in the Toolbar as `Quit`

The `ToolBase` has the following class attributes for configuration at definition time

- keymap = None: Key(s) to be used to trigger the tool
- description = ”: Small description of the tool
- image = None: Image that is used in the toolbar

The following instance attributes are set at instantiation:

- name
- navigation

Methods

- trigger(self, event): This is the main method of the Tool, it is called when the Tool is triggered by: * Toolbar button click * keypress associated with the Tool Keymap * Call to navigation.trigger_tool(name)
- set_figure(self, figure): Set the figure and navigation attributes
- `destroy(self, *args)`: Destroy the `Tool` graphical interface (if exists)

Available Tools

- ToolQuit
- ToolEnableAllNavigation
- ToolEnableNavigation
- ToolToggleGrid
- ToolToggleFullScreen
- ToolToggleYScale
- ToolToggleXScale
- ToolHome
- ToolBack
- ToolForward
- SaveFigureBase
- ConfigureSubplotsBase

ToolToggleBase(ToolBase)

The `ToolToggleBase` has the following class attributes for configuration at definition time

- radio_group = None: Attribute to group ’radio’ like tools (mutually exclusive)
- cursor = None: Cursor to use when the tool is active

The **Toggleable** Tools, can capture keypress, mouse moves, and mouse button press

It defines the following methods

- enable(self, event): Called by `ToolToggleBase.trigger` method
- disable(self, event): Called when the tool is untoggled
- toggled : **Property** True or False

Available Tools

- ToolZoom
- ToolPan

NavigationBase

Defines the following attributes

- canvas:
- **keypresslock: Lock to know if the `canvas` key_press_event' is** available and process it
- messagelock: Lock to know if the message is available to write

Public methods for User use:

- nav_connect(self, s, func): Connect to to navigation for events
- nav_disconnect(self, cid): Disconnect from navigation event
- message_event(self, message, sender=None): Emit a tool_message_event event
- active_toggle(self): **Property** The currently toggled tools or None
- get_tool_keymap(self, name): Return a list of keys that are associated with the tool
- set_tool_keymap(self, name, `*keys`): Set the keys for the given tool
- remove_tool(self, name): Removes tool from the navigation control.
- add_tools(self, tools): Add multiple tools to `Navigation`
- add_tool(self, name, tool, group=None, position=None): Add a tool to the Navigation
- tool_trigger_event(self, name, sender=None, canvasevent=None, data=None): Trigger a tool and fire the event
- tools(self) **Property**: Return a dict with available tools with corresponding keymaps, descriptions and objects
- get_tool(self, name): Return the tool object

ToolbarBase

Methods for Backend implementation

- add_toolitem(self, name, group, position, image, description, toggle): Add a toolitem to the toolbar. This method is a callback from `tool_added_event` (emitted by navigation)
- set_message(self, s): Display a message on toolbar or in status bar

- toggle_toolitem(self, name): Toggle the toolitem without firing event.
- remove_toolitem(self, name): Remove a toolitem from the `Toolbar`

87.12.6 Backward compatibility

For backward compatibility added a 'navigation' key to `rcsetup.validate_toolbar`, that is used for Navigation classes instantiation instead of the NavigationToolbar classes

With this parameter, it makes it transparent to anyone using the existing backends.

[@pelson comment: This also gives us an opportunity to avoid needing to implement all of this in the same PR - some backends can potentially exist without the new functionality for a short while (but it must be done at some point).]

87.13 MEP23: Multiple Figures per GUI window

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *FigureManagerBase*
  - *new_figure_manager*
  - *new_figure_manager_given_figure*
  - *NavigationBase*
- *Backward compatibility*
- *Alternatives*

87.13.1 Status

Discussion

87.13.2 Branches and Pull requests

Previous work - https://github.com/matplotlib/matplotlib/pull/2465 **To-delete**

87.13.3 Abstract

Add the possibility to have multiple figures grouped under the same `FigureManager`

87.13.4 Detailed description

Under the current structure, every canvas has its own window.

This is and may continue to be the desired method of operation for most use cases.

Sometimes when there are too many figures open at the same time, it is desirable to be able to group these under the same window [see](https://github.com/matplotlib/matplotlib/issues/2194).

The proposed solution modifies `FigureManagerBase` to contain and manage more than one `canvas`. The settings parameter `rcParams["backend.multifigure"]` control when the **MultiFigure** behaviour is desired.

Note

It is important to note, that the proposed solution, assumes that the [MEP22](https://github.com/matplotlib/matplotlib/wiki/Mep22) is already in place. This is simply because the actual implementation of the `Toolbar` makes it pretty hard to switch between canvases.

87.13.5 Implementation

The first implementation will be done in `GTK3` using a Notebook as canvas container.

`FigureManagerBase`

will add the following new methods

- `add_canvas`: To add a canvas to an existing `FigureManager` object
- `remove_canvas`: To remove a canvas from a `FigureManager` object, if it is the last one, it will be destroyed
- `move_canvas`: To move a canvas from one `FigureManager` to another.
- `set_canvas_title`: To change the title associated with a specific canvas container
- `get_canvas_title`: To get the title associated with a specific canvas container
- `get_active_canvas`: To get the canvas that is in the foreground and is subject to the gui events. There is no `set_active_canvas` because the active canvas, is defined when `show` is called on a `Canvas` object.

`new_figure_manager`

To control which `FigureManager` will contain the new figures, an extra optional parameter `figuremanager` will be added, this parameter value will be passed to `new_figure_manager_given_figure`

new_figure_manager_given_figure

- If `figuremanager` parameter is give, this `FigureManager` object will be used instead of creating a new one.
- If `rcParams['backend.multifigure'] == True`: The last `FigureManager` object will be used instead of creating a new one.

NavigationBase

Modifies the `NavigationBase` to keep a list of canvases, directing the actions to the active one

87.13.6 Backward compatibility

For the **MultiFigure** properties to be visible, the user has to activate them directly setting `rcParams['backend.multifigure'] = True`

It should be backwards compatible for backends that adhere to the current `FigureManagerBase` structure even if they have not implemented the **MultiFigure** magic yet.

87.13.7 Alternatives

Insted of modifying the `FigureManagerBase` it could be possible to add a parallel class, that handles the cases where `rcParams['backend.multifigure'] = True`. This will warranty that there won't be any problems with custom made backends, but also makes bigger the code, and more things to maintain.

87.14 MEP24: negative radius in polar plots

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Related Issues*
- *Backward compatibility*
- *Alternatives*

87.14.1 Status

Discussion

87.14.2 Branches and Pull requests

None

87.14.3 Abstract

It is clear that polar plots need to be able to gracefully handle negative r values (not by clipping or reflection).

87.14.4 Detailed description

One obvious application that we should support is bB plots (see https://github.com/matplotlib/matplotlib/issues/1730#issuecomment-40815837), but this seems more generally useful (for example growth rate as a function of angle). The assumption in the current code (as I understand it) is that the center of the graph is `r==0`, however it would be good to be able to set the center to be at any `r` (with any value less than the off set clipped).

87.14.5 Implementation

87.14.6 Related Issues

#1730, #1603, #2203, #2133

87.14.7 Backward compatibility

87.14.8 Alternatives

87.15 MEP25: Serialization

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Examples*
- *Implementation*

- *Backward compatibility*
- *Alternatives*

87.15.1 Status

Discussion

87.15.2 Branches and Pull requests

- development branches:
- related pull requests:

87.15.3 Abstract

This MEP aims at adding a serializable `Controller` objects to act as an `Artist` managers. Users would then communicate changes to an `Artist` via a `Controller`. In this way, functionality of the `Controller` objects may be added incrementally since each `Artist` is still responsible for drawing everything. The goal is to create an API that is usable both by graphing libraries requiring high-level descriptions of figures and libraries requiring low-level interpretations.

87.15.4 Detailed description

Matplotlib is a core plotting engine with an API that many users already understand. It's difficult/impossible for other graphing libraries to (1) get a complete figure description, (2) output raw data from the figure object as the user has provided it, (3) understand the semantics of the figure objects without heuristics, and (4) give matplotlib a complete figure description to visualize. In addition, because an `Artist` has no conception of its own semantics within the figure, it's difficult to interact with them in a natural way.

In this sense, matplotlib will adopt a standard Model-View-Controller (MVC) framework. The *Model* will be the user defined data, style, and semantics. The *Views* are the ensemble of each individual `Artist`, which are responsible for producing the final image based on the *model*. The *Controller* will be the `Controller` object managing its set of `Artist` objects.

The `Controller` must be able to export the information that it's carrying about the figure on command, perhaps via a `to_json` method or similar. Because it would be extremely extraneous to duplicate all of the information in the model with the controller, only user-specified information (data + style) are explicitly kept. If a user wants more information (defaults) from the view/model, it should be able to query for it.

- This might be annoying to do, non-specified kwargs are pulled from the rcParams object which is in turn created from reading a user specified file and can be dynamically changed at run time. I suppose we could keep a dict of default defaults and compare against that. Not clear how this will interact with the style sheet [[MEP26]] - @tacaswell

Additional Notes:

- The `raw data` does not necessarily need to be a `list`, `ndarray`, etc. Rather, it can more abstractly just have a method to yield data when needed.
- Because the `Controller` will contain extra information that users may not want to keep around, it should *not* be created by default. You should be able to both (a) instantiate a `Controller` with a figure and (b) build a figure with a `Controller`.

Use Cases:

- Export all necessary informat
- Serializing a matplotlib figure, saving it, and being able to rerun later.
- Any other source sending an appropriately formatted representation to matplotlib to open

87.15.5 Examples

Here are some examples of what the controllers should be able to do.

1. Instantiate a matplotlib figure from a serialized representation (e.g., JSON):

```
import json
from matplotlib.controllers import Controller
with open('my_figure') as f:
    o = json.load(f)
c = Controller(o)
fig = c.figure
```

2. Manage artists from the controller (e.g., Line2D):

```
# not really sure how this should look
c.axes[0].lines[0].color = 'b'
# ?
```

3. Export serializable figure representation:

```
o = c.to_json()
# or... we should be able to throw a figure object in there too
o = Controller.to_json(mpl_fig)
```

87.15.6 Implementation

1. Create base `Controller` objects that are able to manage `Artist` objects (e.g., `Hist`)

   Comments:

   - initialization should happen via unpacking **, so we need a copy of call signature parameter for the `Artist` we're ultimately trying to control. Unfortunate hard-coded repetition...
   - should the additional `**kwargs` accepted by each `Artist` be tracked at the `Controller`

- how does a `Controller` know which artist belongs where? E.g., do we need to pass `axes` references?

Progress:

- A simple NB demonstrating some functionality for `Line2DController` objects: https://nbviewer.jupyter.org/gist/theengineear/f0aa8d79f64325e767c0

2. Write in protocols for the `Controller` to *update* the model.

   Comments:

   - how should containers be dealt with? E.g., what happens to old patches when we re-bin a histogram?
   - in the link from (1), the old line is completely destroyed and redrawn, what if something is referencing it?

3. Create method by which a json object can be assembled from the `Controllers`
4. Deal with serializing the unserializable aspects of a figure (e.g., non-affine transforms?)
5. Be able to instantiate from a serialized representation
6. Reimplement the existing pyplot and Axes method, e.g. `pyplot.hist` and `Axes.hist` in terms of the new controller class.

> @theengineer: in #2 above, what do you mean by *get updates* from each `Artist`?

^ Yup. The `Controller` *shouldn't* need to get updated. This just happens in #3. Delete comments when you see this.

87.15.7 Backward compatibility

- pickling will change
- non-affine transformations will require a defined pickling method

87.15.8 Alternatives

PR #3150 suggested adding semantics by parasitically attaching extra containers to axes objects. This is a more complete solution with what should be a more developed/flexible/powerful framework.

87.16 MEP26: Artist styling

- *Status*
- *Branches and Pull requests*
- *Abstract*

- *Detailed description*
- *Implementation*
  - *BNF Grammar*
  - *Syntax*
    - *Selectors*
    - *GID selector*
    - *Attributes and values*
  - *Parsing*
  - *Visitor pattern for matplotlib figure*
- *Backward compatibility*
- *Alternatives*
- *Appendix*
  - *Matplotlib primitives*

87.16.1 Status

Rejected

87.16.2 Branches and Pull requests

87.16.3 Abstract

This MEP proposes a new stylesheet implementation to allow more comprehensive and dynamic styling of artists.

The current version of matplotlib (1.4.0) allows stylesheets based on the rcParams syntax to be applied before creation of a plot. The methodology below proposes a new syntax, based on CSS, which would allow styling of individual artists and properties, which can be applied dynamically to existing objects.

This is related to (and makes steps toward) the overall goal of moving to a DOM/tree-like architecture.

87.16.4 Detailed description

Currently, the look and appearance of existing artist objects (figure, axes, Line2D etc...) can only be updated via `set_` and `get_` methods on the artist object, which is quite laborious, especially if no reference to the artist(s) has been stored. The new style sheets introduced in 1.4 allow styling before a plot is created, but do not offer any means to dynamically update plots or distinguish between artists of the same type (i.e. to specify the `line color` and `line style` separately for differing `Line2D` objects).

The initial development should concentrate on allowing styling of artist primitives (those `artists` that do not contain other `artists`), and further development could expand the CSS syntax rules and parser to allow more complex styling. See the appendix for a list of primitives.

The new methodology would require development of a number of steps:

- A new stylesheet syntax (likely based on CSS) to allow selection of artists by type, class, id etc...
- A mechanism by which to parse a stylesheet into a tree
- A mechanism by which to translate the parse-tree into something which can be used to update the properties of relevant artists. Ideally this would implement a method by which to traverse the artists in a tree-like structure.
- A mechanism by which to generate a stylesheet from existing artist properties. This would be useful to allow a user to export a stylesheet from an existing figure (where the appearance may have been set using the matplotlib API)...

87.16.5 Implementation

It will be easiest to allow a '3rd party' to modify/set the style of an artist if the 'style' is created as a separate class and store against the artist as a property. The `GraphicsContext` class already provides a the basis of a `Style` class and an artists `draw` method can be refactored to use the `Style` class rather than setting up it's own `GraphicsContext` and transferring it's style-related properties to it. A minimal example of how this could be implemented is shown here: https://github.com/JamesRamm/mpl_experiment

IMO, this will also make the API and code base much neater as individual get/set methods for artist style properties are now redundant... Indirectly related would be a general drive to replace get/set methods with properties. Implementing the style class with properties would be a big stride toward this...

For initial development, I suggest developing a syntax based on a much (much much) simplified version of CSS. I am in favour of dubbing this Artist Style Sheets :+1: :

BNF Grammar

I propose a very simple syntax to implement initially (like a proof of concept), which can be expanded upon in the future. The BNF form of the syntax is given below and then explained

```
RuleSet ::= SelectorSequence "{"Declaration"}"

SelectorSequence :: = Selector {"," Selector}

Declaration ::= propName":" propValue";"

Selector ::= ArtistIdent{"#"Ident}

propName ::= Ident

propValue ::= Ident | Number | Colour | "None"
```

`ArtistIdent`, `Ident`, `Number` and `Colour` are tokens (the basic building blocks of the expression) which are defined by regular expressions.

Syntax

A CSS stylesheet consists of a series of **rule sets** in hierarchical order (rules are applied from top to bottom). Each rule follows the syntax

```
selector {attribute: value;}
```

Each rule can have any number of `attribute`: `value` pairs, and a stylesheet can have any number of rules.

The initial syntax is designed only for `artist` primitives. It does not address the question of how to set properties on `container` types (whose properties may themselves be `artists` with settable properties), however, a future solution to this could simply be nested `RuleSet` s

Selectors

Selectors define the object to which the attribute updates should be applied. As a starting point, I propose just 2 selectors to use in initial development:

Artist Type Selector

Select an `artist` by it's type. E.g `Line2D` or `Text`:

```
Line2D {attribute: value}
```

The regex for matching the artist type selector (`ArtistIdent` in the BNF grammar) would be:

```
ArtistIdent = r'(?P<ArtistIdent>
↪\bLine2D\b|\bText\b|\bAxesImage\b|\bFigureImage\b|\bPatch\b)'
```

GID selector

Select an `artist` by its `gid`:

```
Line2D#myGID {attribute: value}
```

A `gid` can be any string, so the regex could be as follows:

```
Ident = r'(?P<Ident>[a-zA-Z_][a-zA-Z_0-9]*)'
```

The above selectors roughly correspond to their CSS counterparts (http://www.w3.org/TR/CSS21/selector.html)

Attributes and values

- `Attributes` are any valid (settable) property for the `artist` in question.
- `Values` are any valid value for the property (Usually a string, or number).

Parsing

Parsing would consist of breaking the stylesheet into tokens (the python cookbook gives a nice tokenizing recipe on page 66), applying the syntax rules and constructing a `Tree`. This requires defining the grammar of the stylesheet (again, we can borrow from CSS) and writing a parser. Happily, there is a recipe for this in the python cookbook aswell.

Visitor pattern for matplotlib figure

In order to apply the stylesheet rules to the relevant artists, we need to 'visit' each artist in a figure and apply the relevant rule. Here is a visitor class (again, thanks to python cookbook), where each `node` would be an artist in the figure. A `visit_` method would need to be implemented for each mpl artist, to handle the different properties for each

```
class Visitor:
    def visit(self, node):
        name = 'visit_' + type(node).__name__
        meth = getattr(self, name, None)
        if meth is None:
            raise NotImplementedError
        return meth(node)
```

An `evaluator` class would then take the stylesheet rules and implement the visitor on each one of them.

87.16.6 Backward compatibility

Implementing a separate `Style` class would break backward compatibility as many get/set methods on an artist would become redundant. While it would be possible to alter these methods to hook into the `Style` class (stored as a property against the artist), I would be in favor of simply removing them to both neaten/simplify the codebase and to provide a simple, uncluttered API...

87.16.7 Alternatives

No alternatives, but some of the ground covered here overlaps with MEP25, which may assist in this development

87.16.8 Appendix

Matplotlib primitives

This will form the initial selectors which stylesheets can use.

- Line2D
- Text
- AxesImage
- FigureImage
- Patch

87.17 MEP27: decouple pyplot from backends

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
- *Future compatibility*
- *Backward compatibility*
- *Alternatives*
- *Questions*

87.17.1 Status

Progress

87.17.2 Branches and Pull requests

Main PR (including GTK3): + https://github.com/matplotlib/matplotlib/pull/4143

Backend specific branch diffs: + https://github.com/OceanWolf/matplotlib/compare/backend-refactor...OceanWolf:backend-refactor-tkagg + https://github.com/OceanWolf/matplotlib/compare/backend-refactor...OceanWolf:backend-refactor-qt + https://github.com/OceanWolf/matplotlib/compare/backend-refactor...backend-refactor-wx

87.17.3 Abstract

This MEP refactors the backends to give a more structured and consistent API, removing generic code and consolidate existing code. To do this we propose splitting:

1. `FigureManagerBase` and its derived classes into the core functionality class `FigureManager` and a backend specific class `WindowBase` and
2. `ShowBase` and its derived classes into `Gcf.show_all` and `MainLoopBase`.

87.17.4 Detailed description

This MEP aims to consolidate the backends API into one single uniform API, removing generic code out of the backend (which includes `_pylab_helpers` and `Gcf`), and push code to a more appropriate level in matplotlib. With this we automatically remove inconsistencies that appear in the backends, such as `FigureManagerBase.resize(w, h)` which sometimes sets the canvas, and other times set the entire window to the dimensions given, depending on the backend.

Two main places for generic code appear in the classes derived from `FigureManagerBase` and `ShowBase`.

1. `FigureManagerBase` has **three** jobs at the moment:
   (a) The documentation describes it as a *''Helper class for pyplot mode, wraps everything up into a neat bundle"*
   (b) But it doesn't just wrap the canvas and toolbar, it also does all of the windowing tasks itself. The conflation of these two tasks gets seen the best in the following line: `` `python self.set_window_title("Figure %d" % num) ` `` This combines backend specific code `self.set_window_title(title)` with matplotlib generic code `title = "Figure %d" % num`.
   (c) Currently the backend specific subclass of `FigureManager` decides when to end the mainloop. This also seems very wrong as the figure should have no control over the other figures.
2. `ShowBase` has two jobs:
   (a) It has the job of going through all figure managers registered in `_pylab_helpers.Gcf` and telling them to show themselves.
   (b) And secondly it has the job of performing the backend specific `mainloop` to block the main programme and thus keep the figures from dying.

87.17.5 Implementation

The description of this MEP gives us most of the solution:

1. To remove the windowing aspect out of `FigureManagerBase` letting it simply wrap this new class along with the other backend classes. Create a new `WindowBase` class that can handle this functionality, with pass-through methods (:arrow_right:) to `WindowBase`. Classes that subclass `WindowBase` should also subclass the GUI specific window class to ensure backward compatibility (`manager.window == manager.window`).

2. Refactor the mainloop of `ShowBase` into `MainLoopBase`, which encapsulates the end of the loop as well. We give an instance of `MainLoop` to `FigureManager` as a key unlock the exit method (requiring all keys returned before the loop can die). Note this opens the possibility for multiple backends to run concurrently.
3. Now that `FigureManagerBase` has no backend specifics in it, to rename it to `FigureManager`, and move to a new file `backend_managers.py` noting that:
   (a) This allows us to break up the conversion of backends into separate PRs as we can keep the existing `FigureManagerBase` class and its dependencies intact.
   (b) and this also anticipates MEP22 where the new `NavigationBase` has morphed into a backend independent `ToolManager`.

FigureManager-Base(canvas, num)	FigureMan-ager(figure, num)	`WindowBase(title)`	Notes
show		show	
destroy	calls destroy on all components	destroy	
full_screen_toggle	handles logic	set_fullscreen	
resize		resize	
key_press	key_press		
get_window_title		get_window_title	
set_window_title		set_window_title	
	_get_toolbar		A common method to all subclasses of FigureManagerBase
		set_default_size	
		add_element_to_	window

ShowBase	MainLoopBase	Notes
mainloop	begin	
	end	Gets called automagically when no more instances of the subclass exist
__call__		Method moved to Gcf.show_all

87.17.6 Future compatibility

As eluded to above when discussing MEP 22, this refactor makes it easy to add in new generic features. At the moment, MEP 22 has to make ugly hacks to each class extending from `FigureManagerBase`. With this code, this only needs to get made in the single `FigureManager` class. This also makes the later deprecation of `NavigationToolbar2` very straightforward, only needing to touch the single `FigureManager` class

MEP 23 makes for another use case where this refactored code will come in very handy.

87.17.7 Backward compatibility

As we leave all backend code intact, only adding missing methods to existing classes, this should work seamlessly for all use cases. The only difference will lie for backends that used `FigureManager.resize`

to resize the canvas and not the window, due to the standardisation of the API.

I would envision that the classes made obsolete by this refactor get deprecated and removed on the same timetable as `NavigationToolbar2`, also note that the change in call signature to the `FigureCanvasWx` constructor, while backward compatible, I think the old (imho ugly style) signature should get deprecated and removed in the same manner as everything else.

back-end	man-ager.resize(w,h)	Extra
gtk3	window	
Tk	canvas	
Qt	window	
Wx	canvas	FigureManagerWx had `frame` as an alias to window, so this also breaks BC.

87.17.8 Alternatives

If there were any alternative solutions to solving the same problem, they should be discussed here, along with a justification for the chosen approach.

87.17.9 Questions

Mdehoon: Can you elaborate on how to run multiple backends concurrently?

OceanWolf: @mdehoon, as I say, not for this MEP, but I see this MEP opens it up as a future possibility. Basically the `MainLoopBase` class acts a per backend Gcf, in this MEP it tracks the number of figures open per backend, and manages the mainloops for those backends. It closes the backend specific mainloop when it detects that no figures remain open for that backend. Because of this I imagine that with only a small amount of tweaking that we can do full-multi-backend matplotlib. No idea yet why one would want to, but I leave the possibility there in MainLoopBase. With all the backend-code specifics refactored out of `FigureManager` also aids in this, one manager to rule them (the backends) all.

Mdehoon: @OceanWolf, OK, thanks for the explanation. Having a uniform API for the backends is very important for the maintainability of matplotlib. I think this MEP is a step in the right direction.

87.18 MEP28: Remove Complexity from Axes.boxplot

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
  - *Importance*

- *Implementation*
  - *Passing transform functions to* `cbook.boxplots_stats`
  - *Simplifications to the* `Axes.boxplot` *API and other functions*
- *Backward compatibility*
  - *Schedule*
  - *Anticipated Impacts to Users*
  - *Anticipated Impacts to Downstream Libraries*
- *Alternatives*
  - *Variations on the theme*
  - *Doing less*
  - *Doing nothing*

87.18.1 Status

Discussion

87.18.2 Branches and Pull requests

The following lists any open PRs or branches related to this MEP:

1. Deprecate redundant statistical kwargs in `Axes.boxplot`: https://github.com/phobson/matplotlib/tree/MEP28-initial-deprecations
2. Deprecate redundant style options in `Axes.boxplot`: https://github.com/phobson/matplotlib/tree/MEP28-initial-deprecations
3. Deprecate passings 2D numpy arrays as input: None
4. Add pre- & post-processing options to `cbook.boxplot_stats`: https://github.com/phobson/matplotlib/tree/boxplot-stat-transforms
5. Exposing `cbook.boxplot_stats` through `Axes.boxplot` kwargs: None
6. Remove redundant statistical kwargs in `Axes.boxplot`: None
7. Remove redundant style options in `Axes.boxplot`: None
8. Remaining items that arise through discussion: None

87.18.3 Abstract

Over the past few releases, the `Axes.boxplot` method has grown in complexity to support fully customizable artist styling and statistical computation. This lead to `Axes.boxplot` being split off into multiple parts. The statistics needed to draw a boxplot are computed in `cbook.boxplot_stats`, while the actual

artists are drawn by `Axes.bxp`. The original method, `Axes.boxplot` remains as the most public API that handles passing the user-supplied data to `cbook.boxplot_stats`, feeding the results to `Axes.bxp`, and pre-processing style information for each facet of the boxplot plots.

This MEP will outline a path forward to rollback the added complexity and simplify the API while maintaining reasonable backwards compatibility.

87.18.4 Detailed description

Currently, the `Axes.boxplot` method accepts parameters that allow the users to specify medians and confidence intervals for each box that will be drawn in the plot. These were provided so that avdanced users could provide statistics computed in a different fashion that the simple method provided by matplotlib. However, handling this input requires complex logic to make sure that the forms of the data structure match what needs to be drawn. At the moment, that logic contains 9 separate if/else statements nested up to 5 levels deep with a for loop, and may raise up to 2 errors. These parameters were added prior to the creation of the `Axes.bxp` method, which draws boxplots from a list of dictionaries containing the relevant statistics. Matplotlib also provides a function that computes these statistics via `cbook.boxplot_stats`. Note that advanced users can now either a) write their own function to compute the stats required by `Axes.bxp`, or b) modify the output returned by `cbook.boxplots_stats` to fully customize the position of the artists of the plots. With this flexibility, the parameters to manually specify only the medians and their confidences intervals remain for backwards compatibility.

Around the same time that the two roles of `Axes.boxplot` were split into `cbook.boxplot_stats` for computation and `Axes.bxp` for drawing, both `Axes.boxplot` and `Axes.bxp` were written to accept parameters that individually toggle the drawing of all components of the boxplots, and parameters that individually configure the style of those artists. However, to maintain backwards compatibility, the `sym` parameter (previously used to specify the symbol of the fliers) was retained. This parameter itself requires fairly complex logic to reconcile the `sym` parameters with the newer `flierprops` parameter at the default style specified by `matplotlibrc`.

This MEP seeks to dramatically simplify the creation of boxplots for novice and advanced users alike. Importantly, the changes proposed here will also be available to downstream packages like seaborn, as seaborn smartly allows users to pass arbitrary dictionaries of parameters through the seaborn API to the underlying matplotlib functions.

This will be achieved in the following way:

1. `cbook.boxplot_stats` will be modified to allow pre- and post- computation transformation functions to be passed in (e.g., `np.log` and `np.exp` for lognormally distributed data)
2. `Axes.boxplot` will be modified to also accept and naïvely pass them to `cbook.boxplots_stats` (Alt: pass the stat function and a dict of its optional parameters).
3. Outdated parameters from `Axes.boxplot` will be deprecated and later removed.

Importance

Since the limits of the whiskers are computed arithmetically, there is an implicit assumption of normality in box and whisker plots. This primarily affects which data points are classified as outliers.

Allowing transformations to the data and the results used to draw boxplots will allow users to opt-out of that assumption if the data are known to not fit a normal distribution.

Below is an example of how `Axes.boxplot` classifies outliers of lognormal data differently depending one these types of transforms.

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import cbook
np.random.seed(0)

fig, ax = plt.subplots(figsize=(4, 6))
ax.set_yscale('log')
data = np.random.lognormal(-1.75, 2.75, size=37)

stats = cbook.boxplot_stats(data, labels=['arithmetic'])
logstats = cbook.boxplot_stats(np.log(data), labels=['log-transformed'])

for lsdict in logstats:
    for key, value in lsdict.items():
        if key != 'label':
            lsdict[key] = np.exp(value)

stats.extend(logstats)
ax.bxp(stats)
fig.show()
```

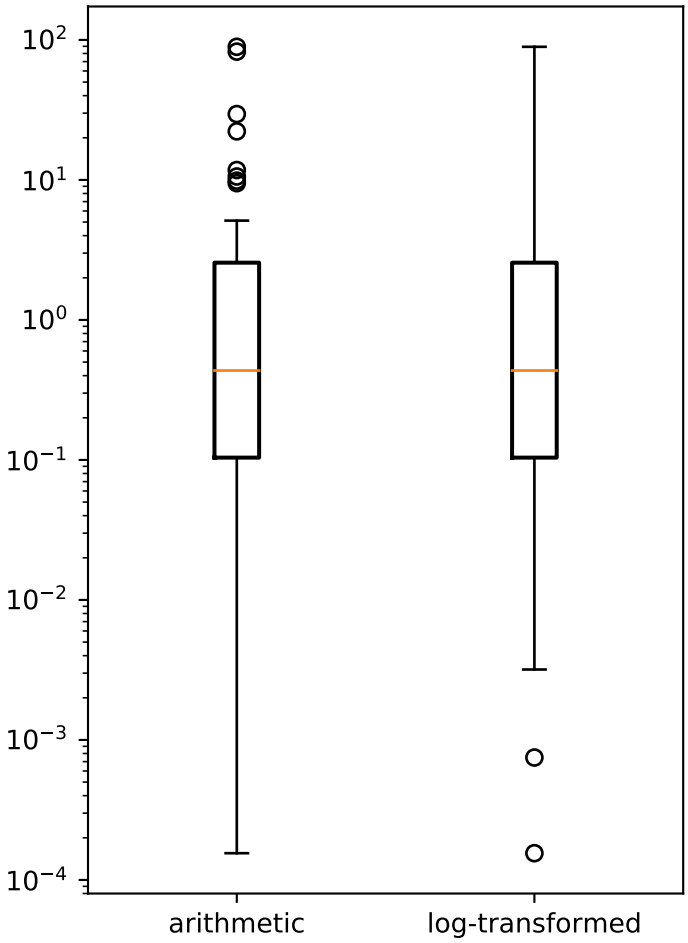
87.18.5 Implementation

Passing transform functions to `cbook.boxplots_stats`

This MEP proposes that two parameters (e.g., `transform_in` and `transform_out` be added to the cookbook function that computes the statistics for the boxplot function. These will be optional keyword-only arguments and can easily be set to `lambda x: x` as a no-op when omitted by the user. The `transform_in` function will be applied to the data as the `boxplot_stats` function loops through each subset of the data passed to it. After the list of statistics dictionaries are computed the `transform_out` function is applied to each value in the dictionaries.

These transformations can then be added to the call signature of `Axes.boxplot` with little impact to that method's complexity. This is because they can be directly passed to `cbook.boxplot_stats`. Alternatively, `Axes.boxplot` could be modified to accept an optional statistical function kwarg and a dictionary of parameters to be direcly passed to it.

At this point in the implementation users and external libraries like seaborn would have complete control via the `Axes.boxplot` method. More importantly, at the very least, seaborn would require no changes to its API to allow users to take advantage of these new options.


10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
arithmetic
log-transformed

Simplifications to the `Axes.boxplot` API and other functions

Simplifying the boxplot method consists primarily of deprecating and then removing the redundant parameters. Optionally, a next step would include rectifying minor terminological inconsistencies between `Axes.boxplot` and `Axes.bxp`.

The parameters to be deprecated and removed include:

1. `usermedians` - processed by 10 SLOC, 3 `if` blocks, a `for` loop
2. `conf_intervals` - handled by 15 SLOC, 6 `if` blocks, a `for` loop
3. `sym` - processed by 12 SLOC, 4 `if` blocks

Removing the `sym` option allows all code in handling the remaining styling parameters to be moved to `Axes.bxp`. This doesn't remove any complexity, but does reinforce the single responsibility principle among `Axes.bxp`, `cbook.boxplot_stats`, and `Axes.boxplot`.

Additionally, the `notch` parameter could be renamed `shownotches` to be consistent with `Axes.bxp`. This kind of cleanup could be taken a step further and the `whis`, `bootstrap`, `autorange` could be rolled into the kwargs passed to the new `statfxn` parameter.

87.18.6 Backward compatibility

Implementation of this MEP would eventually result in the backwards incompatible deprecation and then removal of the keyword parameters `usermedians`, `conf_intervals`, and `sym`. Cursory searches on GitHub indicated that `usermedians`, `conf_intervals` are used by few users, who all seem to have a very strong knowledge of matplotlib. A robust deprecation cycle should provide sufficient time for these users to migrate to a new API.

Deprecation of `sym` however, may have a much broader reach into the matplotlib userbase.

Schedule

An accelerated timeline could look like the following:

1. v2.0.1 add transforms to `cbook.boxplots_stats`, expose in `Axes.boxplot`
2. v2.1.0 Initial Deprecations , and using 2D numpy arrays as input
   (a) Using 2D numpy arrays as input. The semantics around 2D arrays are generally confusing.
   (b) `usermedians`, `conf_intervals`, `sym` parameters
3. v2.2.0
   (a) remove `usermedians`, `conf_intervals`, `sym` parameters
   (b) deprecate `notch` in favor of `shownotches` to be consistent with other parameters and `Axes.bxp`
4. **v2.3.0**
   (a) remove `notch` parameter

(b) move all style and artist toggling logic to `Axes.bxp` such `Axes.boxplot` is little more than a broker between `Axes.bxp` and `cbook.boxplots_stats`

Anticipated Impacts to Users

As described above deprecating `usermedians` and `conf_intervals` will likely impact few users. Those who will be impacted are almost certainly advanced users who will be able to adapt to the change.

Deprecating the `sym` option may import more users and effort should be taken to collect community feedback on this.

Anticipated Impacts to Downstream Libraries

The source code (GitHub master as of 2016-10-17) was inspected for seaborn and python-ggplot to see if these changes would impact their use. None of the parameters nominated for removal in this MEP are used by seaborn. The seaborn APIs that use matplotlib's boxplot function allow user's to pass arbitrary `**kwargs` through to matplotlib's API. Thus seaborn users with modern matplotlib installations will be able to take full advantage of any new features added as a result of this MEP.

Python-ggplot has implemented its own function to draw boxplots. Therefore, no impact can come to it as a result of implementing this MEP.

87.18.7 Alternatives

Variations on the theme

This MEP can be divided into a few loosely coupled components:

1. Allowing pre- and post-computation transformation function in `cbook.boxplot_stats`
2. Exposing that transformation in the `Axes.boxplot` API
3. Removing redundant statistical options in `Axes.boxplot`
4. Shifting all styling parameter processing from `Axes.boxplot` to `Axes.bxp`.

With this approach, #2 depends and #1, and #4 depends on #3.

There are two possible approaches to #2. The first and most direct would be to mirror the new `transform_in` and `tranform_out` parameters of `cbook.boxplot_stats` in `Axes.boxplot` and pass them directly.

The second approach would be to add `statfxn` and `statfxn_args` parameters to `Axes.boxplot`. Under this implementation, the default value of `statfxn` would be `cbook.boxplot_stats`, but users could pass their own function. Then `transform_in` and `tranform_out` would then be passed as elements of the `statfxn_args` parameter.

```
def boxplot_stats(data, ..., transform_in=None, transform_out=None):
    if transform_in is None:
        transform_in = lambda x: x
```

(continues on next page)

(continued from previous page)

```
    if transform_out is None:
        transform_out = lambda x: x

    output = []
    for _d in data:
        d = transform_in(_d)
        stat_dict = do_stats(d)
        for key, value in stat_dict.item():
            if key != 'label':
                stat_dict[key] = transform_out(value)
        output.append(d)
    return output


class Axes(...):
    def boxplot_option1(data, ..., transform_in=None, transform_out=None):
        stats = cbook.boxplot_stats(data, ...,
                                    transform_in=transform_in,
                                    transform_out=transform_out)
        return self.bxp(stats, ...)

    def boxplot_option2(data, ..., statfxn=None, **statopts):
        if statfxn is None:
            statfxn = boxplot_stats
        stats = statfxn(data, **statopts)
        return self.bxp(stats, ...)
```

Both cases would allow users to do the following:

```
fig, ax1 = plt.subplots()
artists1 = ax1.boxplot_optionX(data, transform_in=np.log,
                               transform_out=np.exp)
```

But Option Two lets a user write a completely custom stat function (e.g., `my_box_stats`) with fancy BCA confidence intervals and the whiskers set differently depending on some attribute of the data.

This is available under the current API:

```
fig, ax1 = plt.subplots()
my_stats = my_box_stats(data, bootstrap_method='BCA',
                        whisker_method='dynamic')
ax1.bxp(my_stats)
```

And would be more concise with Option Two

```
fig, ax = plt.subplots()
statopts = dict(transform_in=np.log, transform_out=np.exp)
ax.boxplot(data, ..., **statopts)
```

Users could also pass their own function to compute the stats:

```
fig, ax1 = plt.subplots()
ax1.boxplot(data, statfxn=my_box_stats, bootstrap_method='BCA',
            whisker_method='dynamic')
```

From the examples above, Option Two seems to have only marginal benefit, but in the context of downstream libraries like seaborn, its advantage is more apparent as the following would be possible without any patches to seaborn:

```
import seaborn
tips = seaborn.load_data('tips')
g = seaborn.factorplot(x="day", y="total_bill", hue="sex", data=tips,
                       kind='box', palette="PRGn", shownotches=True,
                       statfxn=my_box_stats, bootstrap_method='BCA',
                       whisker_method='dynamic')
```

This type of flexibility was the intention behind splitting the overall boxplot API in the current three functions. In practice however, downstream libraries like seaborn support versions of matplotlib dating back well before the split. Thus, adding just a bit more flexibility to the `Axes.boxplot` could expose all the functionality to users of the downstream libraries with modern matplotlib installation without intervention from the downstream library maintainers.

Doing less

Another obvious alternative would be to omit the added pre- and post- computation transform functionality in `cbook.boxplot_stats` and `Axes.boxplot`, and simply remove the redundant statistical and style parameters as described above.

Doing nothing

As with many things in life, doing nothing is an option here. This means we simply advocate for users and downstream libraries to take advantage of the split between `cbook.boxplot_stats` and `Axes.bxp` and let them decide how to provide an interface to that.

87.19 MEP29: Text light markup

- *Status*
- *Branches and Pull requests*
- *Abstract*
- *Detailed description*
- *Implementation*
  - *Improvements*

  - *Problems*
- *Backward compatibility*
- *Alternatives*

87.19.1 Status

Discussion

87.19.2 Branches and Pull requests

None at the moment, proof of concept only.

87.19.3 Abstract

This MEP proposes to add lightweight markup to the text artist.

87.19.4 Detailed description

Using different size/color/family in a text annotation is difficult because the `text` method accepts argument for size/color/family/weight/etc. that are used for the whole text. But, if one wants, for example, to have different colors, one has to look at the gallery where one such example is provided: http://matplotlib.org/examples/text_labels_and_annotations/rainbow_text.html

This example takes a list of strings as well as a list of colors which makes it cumbersome to use. An alternative would be to use a restricted set of pango-like markup (see https://developer.gnome.org/pango/stable/PangoMarkupFormat.html) and to interpret this markup.

Some markup examples:

```
Hello <b>world!</b>`
Hello <span color="blue">world!</span>
```

87.19.5 Implementation

A proof of concept is provided in markup_example.py but it currently only handles the horizontal direction.

Improvements

- This proof of concept uses regex to parse the text but it may be better to use the html.parser from the standard library.
- Computation of text fragment positions could benefit from the OffsetFrom class. See for example item 5 in Using Complex Coordinates with Annotations

Problems

- One serious problem is how to deal with text having both latex and html-like tags. For example, consider the following:

```
$<b>Bold$</b>
```

  Recommendation would be to have mutual exclusion.

87.19.6 Backward compatibility

None at the moment since it is only a proof of concept

87.19.7 Alternatives

As proposed by @anntzer, this could be also implemented as improvements to mathtext. For example:

```
r"$\text{Hello \textbf{world}}$"
r"$\text{Hello \textcolor{blue}{world}}$"
r"$\text{Hello \textsf{\small world}}$"
```

CHAPTER

EIGHTYEIGHT

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 (e.g., basemap), but make sure you clearly state the licenses you are using.

88.1 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.

CHAPTER

EIGHTYNINE

DEFAULT COLOR CHANGES

As discussed at length elsewhere [insert links], `jet` is an empirically bad color map and should not be the default color map. Due to the position that changing the appearance of the plot breaks backward compatibility, this change has been put off for far longer than it should have been. In addition to changing the default color map we plan to take the chance to change the default color-cycle on plots and to adopt a different color map for filled plots (`imshow`, `pcolor`, `contourf`, etc) and for scatter like plots.

89.1 Default Heat Map Colormap

The choice of a new color map is fertile ground to bike-shedding ("No, it should be _this_ color") so we have a proposed set criteria (via Nathaniel Smith) to evaluate proposed color maps.

- it should be a sequential colormap, because diverging colormaps are really misleading unless you know where the "center" of the data is, and for a default colormap we generally won't.
- it should be perceptually uniform, i.e., human subjective judgments of how far apart nearby colors are should correspond as linearly as possible to the difference between the numerical values they represent, at least locally.
- it should have a perceptually uniform luminance ramp, i.e. if you convert to greyscale it should still be uniform. This is useful both in practical terms (greyscale printers are still a thing!) and because luminance is a very strong and natural cue to magnitude.
- it should also have some kind of variation in hue, because hue variation is a really helpful additional cue to perception, having two cues is better than one, and there's no reason not to do it.
- the hue variation should be chosen to produce reasonable results even for viewers with the more common types of colorblindness. (Which rules out things like red-to-green.)
- For bonus points, it would be nice to choose a hue ramp that still works if you throw away the luminance variation, because then we could use the version with varying luminance for 2d plots, and the version with just hue variation for 3d plots. (In 3d plots you really want to reserve the luminance channel for lighting/shading, because your brain is *really* good at extracting 3d shape from luminance variation. If the 3d surface itself has massively varying luminance then this screws up the ability to see shape.)
- Not infringe any existing IP

89.1.1 Example script

89.1.2 Proposed Colormaps

89.2 Default Scatter Colormap

For heat-map like applications it can be desirable to cover as much of the luminence scale as possible, however when color mapping markers, having markers too close to white can be a problem. For that reason we propose using a different (but maybe related) color map to the heat map for marker-based. The design parameters are the same as above, only with a more limited luminence variation.

89.2.1 Example script

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

np.random.seed(1234)

fig, (ax1, ax2) = plt.subplots(1, 2)

N = 50
x = np.random.rand(N)
y = np.random.rand(N)
colors = np.random.rand(N)
area = np.pi * (15 * np.random.rand(N))**2  # 0 to 15 point radiuses

ax1.scatter(x, y, s=area, c=colors, alpha=0.5)


X,Y = np.meshgrid(np.arange(0, 2*np.pi, .2),
                  np.arange(0, 2*np.pi, .2))
U = np.cos(X)
V = np.sin(Y)
Q = ax2.quiver(X, Y, U, V, units='width')
qd = np.random.rand(np.prod(X.shape))
Q.set_array(qd)
```

89.2.2 Proposed Colormaps

89.3 Color Cycle / Qualitative color map

When plotting lines it is frequently desirable to plot multiple lines or artists which need to be distinguishable, but there is no inherent ordering.

89.3.1 Example script

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

fig, (ax1, ax2) = plt.subplots(1, 2)

x = np.linspace(0, 1, 10)

for j in range(10):
    ax1.plot(x, x * j)


th = np.linspace(0, 2*np.pi, 1024)
for j in np.linspace(0, np.pi, 10):
    ax2.plot(th, np.sin(th + j))

ax2.set_xlim(0, 2*np.pi)
```

89.3.2 Proposed Color cycle

Part VIII

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)

FreeType FreeType is a font rasterization library used by matplotlib which supports TrueType, Type 1, and OpenType fonts.

GDK The Gimp Drawing Kit for GTK+

GTK The GIMP Toolkit (GTK) graphical user interface library

JPG The Joint Photographic Experts Group (JPEG) compression method and file format for photographic images

numpy numpy is the standard numerical array library for python, the successor to Numeric and numarray. numpy provides fast operations for homogeneous data sets and common mathematical operations like correlations, standard deviation, fourier transforms, and convolutions.

PDF Adobe's Portable Document Format (PDF)

PNG Portable Network Graphics (PNG), a raster graphics format that employs lossless data compression which is more suitable for line art than the lossy jpg format. Unlike the gif format, png is not encumbered by requirements for a patent license.

PS Postscript (PS) is a vector graphics ASCII text language widely used in printers and publishing. Postscript was developed by adobe systems and is starting to show its age: for example is does not have an alpha channel. PDF was designed in part as a next-generation document format to replace postscript

pgi `pgi` exists as a relatively new Python wrapper to GTK3 and acts as a pure python alternative to PyGObject. pgi still exists in its infancy, currently missing many features of PyGObject. However Matplotlib does not use any of these missing features.

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'

PyGObject Like *pygtk*, `PyGObject` provides python wrappers for the *GTK* widgets library; unlike pygtk, PyGObject wraps GTK3 instead of the now obsolete GTK2.

pyqt pyqt provides python wrappers for the *Qt* widgets library and is required by the matplotlib Qt5Agg and Qt4Agg backends. Widely used on linux and windows; many linux distributions package this as 'python-qt5' 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 previous, but most widely used, version of Qt cross-platform application framework for desktop and embedded development.

Qt5 Qt5 is the current 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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