

Python For Data Science

Matplotlib Cheat Sheet

Learn Matplotlib online at www.DataCamp.com

Matplotlib

Matplotlib is a Python 2D plotting library which produces publication-quality figures in a variety of hardcopy formats and interactive environments across platforms.

Prepare The Data

1D Data

```
>>> import numpy as np
>>> x = np.linspace(0, 10, 100)
>>> y = np.cos(x)
>>> z = np.sin(x)
```

2D Data or Images

```
>>> data = 2 * np.random.random((10, 10))
>>> data2 = 3 * np.random.random((10, 10))
>>> Y, X = np.mgrid[-3:3:100j, -3:3:100j]
>>> U = -1 - X**2 + Y
>>> V = 1 + X - Y**2
>>> from matplotlib.cbook import get_sample_data
>>> img = np.load(get_sample_data('axes_grid/bivariate_normal.npy'))
```

Create Plot

```
>>> import matplotlib.pyplot as plt
```

Figure

```
>>> fig = plt.figure()
>>> fig2 = plt.figure(figsize=plt.figaspect(2.0))
```

Axes

All plotting is done with respect to an Axes. In most cases, a subplot will fit your needs. A subplot is an axes on a grid system.

```
>>> fig.add_axes()
>>> ax1 = fig.add_subplot(221) #row-col-num
>>> ax3 = fig.add_subplot(212)
>>> fig3, axes = plt.subplots(nrows=2, ncols=2)
>>> fig4, axes2 = plt.subplots(ncols=3)
```

Save Plot

```
>>> plt.savefig('foo.png') #Save figures
>>> plt.savefig('foo.png', transparent=True) #Save transparent figures
```

Show Plot

```
>>> plt.show()
```

Plotting Routines

1D Data

```
>>> fig, ax = plt.subplots()
>>> lines = ax.plot(x,y) #Draw points with lines or markers connecting them
>>> ax.scatter(x,y) #Draw unconnected points, scaled or colored
>>> axes[0,0].bar([1,2,3],[3,4,5]) #Plot vertical rectangles (constant width)
>>> axes[0,0].barh([0.5,1,2.5],[0,1,2]) #Plot horizontal rectangles (constant height)
>>> axes[1,1].axhline(0.45) #Draw a horizontal line across axes
>>> axes[0,1].axvline(0.65) #Draw a vertical line across axes
>>> ax.fill(x,y,color='blue') #Draw filled polygons
>>> ax.fill_between(x,y,color='yellow') #Fill between y-values and 0
```

2D Data

```
>>> fig, ax = plt.subplots()
>>> im = ax.imshow(img, #Colormapped or RGB arrays
                  cmap='gist_earth',
                  interpolation='nearest',
                  vmin=-2,
                  vmax=2)
>>> axes2[0].pcolor(data2) #Pseudocolor plot of 2D array
>>> axes2[0].pcolormesh(data) #Pseudocolor plot of 2D array
>>> CS = plt.contour(Y,X,U) #Plot contours
>>> axes2[2].contourf(data1) #Plot filled contours
>>> axes2[2]= ax.clabel(CS) #Label a contour plot
```

Vector Fields

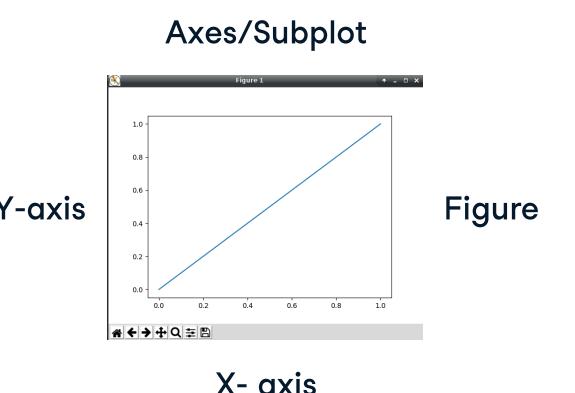
```
>>> axes[0,1].arrow(0,0,0.5,0.5) #Add an arrow to the axes
>>> axes[1,1].quiver(y,z) #Plot a 2D field of arrows
>>> axes[0,1].streamplot(X,Y,U,V) #Plot a 2D field of arrows
```

Data Distributions

```
>>> ax1.hist(y) #Plot a histogram
>>> ax3.boxplot(y) #Make a box and whisker plot
>>> ax3.violinplot(z) #Make a violin plot
```

Plot Anatomy & Workflow

Plot Anatomy



Workflow

The basic steps to creating plots with matplotlib are:

- 1 Prepare Data
 - 2 Create Plot
 - 3 Plot
 - 4 Customized Plot
 - 5 Save Plot
 - 6 Show Plot
- ```
>>> import matplotlib.pyplot as plt
>>> x = [1,2,3,4] #Step 1
>>> y = [10,20,25,30]
>>> fig = plt.figure() #Step 2
>>> ax = fig.add_subplot(111) #Step 3
>>> ax.plot(x, y, color='lightblue', linewidth=3) #Step 3, 4
>>> ax.scatter([2,4,6],
 [5,15,25],
 color='darkgreen',
 marker='^')
>>> ax.set_xlim(1, 6.5)
>>> plt.savefig('foo.png') #Step 5
>>> plt.show() #Step 6
```

## Close and Clear

```
>>> plt.cla() #Clear an axis
>>> plt.clf() #Clear the entire figure
>>> plt.close() #Close a window
```

## Plotting Cutomize Plot

### Colors, Color Bars & Color Maps

```
>>> plt.plot(x, x, x*x2, x, x*x3)
>>> ax.plot(x, y, alpha = 0.4)
>>> ax.plot(x, y, c='k')
>>> fig.colorbar(im, orientation='horizontal')
>>> im = ax.imshow(img,
 cmap='seismic')
```

### Markers

```
>>> fig, ax = plt.subplots()
>>> ax.scatter(x,y,marker=".")
>>> ax.plot(x,y,marker="o")
```

### Linestyles

```
>>> plt.plot(x,y,linewidth=4.0)
>>> plt.plot(x,y,ls='solid')
>>> plt.plot(x,y,ls='--')
>>> plt.plot(x,y,'--',x*x2,y**2,'-.')
>>> plt.setp(lines,color='r',linewidth=4.0)
```

### Text & Annotations

```
>>> ax.text(1,
 -2.1,
 'Example Graph',
 style='italic')
>>> ax.annotate("Sine",
 xy=(8, 0),
 xycoords='data',
 xytext=(10.5, 0),
 textcoords='data',
 arrowprops=dict(arrowstyle="→",
 connectionstyle="arc3"))

```

### MathText

```
>>> plt.title(r'$\sigma_i=15$', fontsize=20)
```

### Limits, Legends and Layouts

#### Limits & Autoscaling

```
>>> ax.margins(x=0.0,y=0.1) #Add padding to a plot
>>> ax.axis('equal') #Set the aspect ratio of the plot to 1
>>> ax.set(xlim=[0,10.5],ylim=[-1.5,1.5]) #Set limits for x-and y-axis
>>> ax.set_xlim(0,10.5) #Set limits for x-axis
```

#### Legends

```
>>> ax.set(title='An Example Axes', #Set a title and x-and y-axis labels
 ylabel='Y-Axis',
 xlabel='X-Axis')
>>> ax.legend(loc='best') #No overlapping plot elements
```

#### Ticks

```
>>> ax.xaxis.set(ticks=range(1,5), #Manually set x-ticks
 ticklabels=[3,100,-12,"foo"])
>>> ax.tick_params(axis='y', #Make y-ticks longer and go in and out
 direction='inout',
 length=10)
```

#### Subplot Spacing

```
>>> fig3.subplots_adjust(wspace=0.5, #Adjust the spacing between subplots
 hspace=0.3,
 left=0.125,
 right=0.9,
 top=0.9,
 bottom=0.1)
>>> fig.tight_layout() #Fit subplot(s) in to the figure area
```

#### Axis Spines

```
>>> ax1.spines['top'].set_visible(False) #Make the top axis line for a plot invisible
>>> ax1.spines['bottom'].set_position(('outward',10)) #Move the bottom axis line outward
```

# matplotlib

Cheat sheet

Version 3.5.0

## Quick start

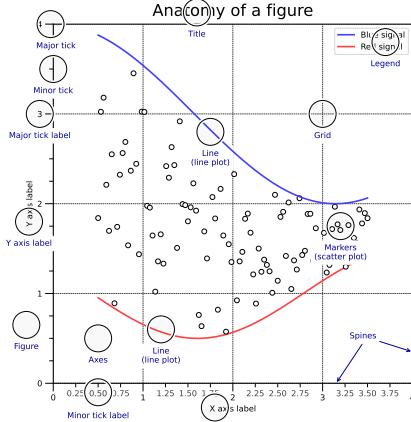
```
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt

X = np.linspace(0, 2*np.pi, 100)
Y = np.cos(X)

fig, ax = plt.subplots()
ax.plot(X, Y, color='green')

fig.savefig("figure.pdf")
fig.show()
```

## Anatomy of a figure



## Subplots layout

```
subplot[s](rows,cols,...) API
fig, axs = plt.subplots(3, 3)

G = gridspec(rows,cols,...) API
ax = G[0,:]

ax.inset_axes(extent) API

d=make_axes_locatable(ax) API
ax = d.new_horizontal('10%')
```

## Getting help

[matplotlib.org](https://matplotlib.org)  
[github.com/matplotlib/matplotlib/issues](https://github.com/matplotlib/matplotlib/issues)  
[discourse.matplotlib.org](https://discourse.matplotlib.org)  
[stack overflow.com/questions/tagged/matplotlib](https://stackoverflow.com/questions/tagged/matplotlib)  
[gitter.im/matplotlib](https://gitter.im/matplotlib)  
[twitter.com/matplotlib](https://twitter.com/matplotlib)  
Matplotlib users mailing list

## Basic plots

```
plot([X],Y,[fmt],...) API
X, Y, fmt, color, marker, linestyle

scatter(X,Y,...) API
X, Y, [sizes, [colors, marker, cmap]

bar[h](x,height,...) API
x, height, width, bottom, align, color

imshow(Z,...) API
Z, cmap, interpolation, extent, origin

contour(f)([X],[Y],Z,...) API
X, Y, Z, levels, colors, extent, origin

pcolormesh([X],[Y],Z,...) API
X, Y, Z, vmin, vmax, cmap
```

```
quiver([X],[Y],U,V,...) API
X, Y, U, V, C, units, angles

pie(X,...) API
Z, explode, labels, colors, radius

text(x,y,text,...) API
x, y, text, va, ha, size, weight, transform

fill_between(x,...) API
X, Y1, Y2, color, where
```

## Advanced plots

```
step(X,Y,[fmt],...) API
X, Y, fmt, color, marker, where

boxplot(X,...) API
X, notch, sym, bootstrap, widths

errorbar(X,Y,xerr,yerr,...) API
X, Y, xerr, yerr, fmt

hist(X, bins, ...) API
X, bins, range, density, weights

violinplot(D,...) API
D, positions, widths, vert

barbs([X],[Y], U, V, ...) API
X, Y, U, V, C, length, pivot, sizes

eventplot(positions,...) API
positions, orientation, lineoffsets

hexbin(X,Y,C,...) API
X, Y, C, gridsize, bins
```

## Scales

```
ax.set_xy scale(scale,...)
linear any values
log values > 0
symlog any values
logit 0 < values < 1
```

## Projections

```
subplot(...,projection=p)
p='polar'
p='3d'
p=Orthographic()
from cartopy.crs import Cartographic
```

## Lines

linestyle or ls  
-----, -., -o-, -.-, -.-o-

capstyle or dash\_capstyle  
"butt", "round", "projecting"

## Markers

Marker codes:  
'.' 'o' 's' 'p' 'x' '\*' 'p' 'D' '<' '>' '^' 'v'  
'1' '2' '3' '4' '+' 'l' '-' '4' '5' '6' '7'  
'\$\heartsuit\$' '\$\clubsuit\$' '\$\spadesuit\$' '\$\diamondsuit\$' '\$\heartsuit\$' '\$\clubsuit\$' '\$\spadesuit\$' '\$\diamondsuit\$'  
markervary  
10  
(0, -1)  
(25, 5)  
(0, 25, -1)

## Colors

|         |              |             |              |        |    |    |    |    |               |
|---------|--------------|-------------|--------------|--------|----|----|----|----|---------------|
| C0      | C1           | C2          | C3           | C4     | C5 | C6 | C7 | C8 | C9            |
| b       | g            | r           | c            | m      | y  | k  | w  | x  | 'Cn'          |
| DarkRed | Firebrick    | Crimson     | IndianRed    | Salmon |    |    |    |    | 'name'        |
| (1,0,0) | (1,0,0,0.75) | (1,0,0,0.5) | (1,0,0,0.25) |        |    |    |    |    | (R,G,B,[A])   |
| #FF0000 | #FF0000BB    | #FF000088   | #FF000044    |        |    |    |    |    | '#RRGGBB[AA]' |

## Colormaps

plt.get\_cmap(name)

Uniform viridis magma plasma

Sequential Greys YlOrBr Wistia

Diverging Spectral coolwarm RdGy

Qualitative tab10 tab20

Cyclic twilight

## Tick locators

```
from matplotlib import ticker
ax.[x|y]axis.set_[minor|major]_locator(locator)

ticker.NullLocator()

ticker.MultipleLocator(0.5)
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

ticker.FixedLocator([0, 1, 5])
0 1 5

ticker.IndexLocator(base=0.5, offset=0.25)
0.25 0.75 1.25 1.75 2.25 2.75 3.25 3.75 4.25 4.75 5.0

ticker.AutoLocator()
0 1 2 3 4 5

ticker.MaxLocator(n=4)
0.0 1.5 3.0 4.5 5.0

ticker.LogLocator(base=10, numticks=15)
101 102 103 104 105 106 107 108 109 1010
```

## Tick formatters

```
from matplotlib import ticker
ax.[x|y]axis.set_[minor|major]_formatter(formatter)

ticker.NullFormatter()

ticker.FixedFormatter(['zero', 'one', 'two', '...', 'five'])
zero one two three four five

ticker.FuncFormatter(lambda x, pos: "%[%.2f]" % x)
[0.00] [1.00] [2.00] [3.00] [4.00] [5.00]

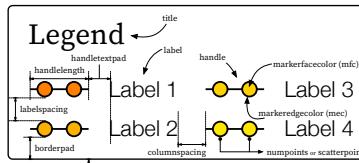
ticker.FormatStrFormatter('>%d<')
>1< >2< >3< >4< >5<

ticker.ScalarFormatter()
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

ticker.PercentFormatter(xmax=5)
0% 20% 40% 60% 80% 100%
```

## Ornaments

ax.legend(...) handles, labels, loc, title, frameon



## Colorbar

mappable, ax, cax, orientation



## Annotate

text, xy, xytext, xycoords, textcoords, arrowprops



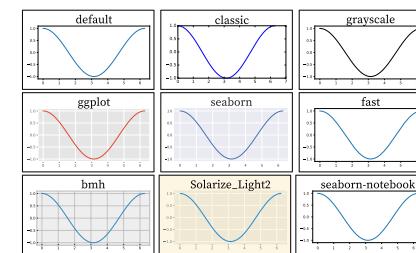
## Animation

```
import matplotlib.animation as mpla

T = np.linspace(0, 2*np.pi, 100)
S = np.sin(T)
line, = plt.plot(T, S)
def animate(i):
 line.set_ydata(np.sin(T+i/50))
anim = mpla.FuncAnimation(
 plt.gcf(), animate, interval=5)
plt.show()
```

## Styles

plt.style.use(style)



## Quick reminder

ax.grid() ax.set\_xy lim(vmin, vmax)  
ax.set\_xy label(label) ax.set\_xy ticks(list)  
ax.set\_xy ticklabels(list) ax.set\_title(title)  
ax.tick\_params(width=10, ...) ax.set\_axis\_on/off()

fig.suptitle(title) fig.tight\_layout()  
plt.gcf(), plt.gca()  
mpl.rc('axes', linewidth=1, ...)  
[fig|ax].patch.set\_alpha(0)  
text=r'\$\frac{e^i}{\pi}\$'

## Keyboard shortcuts

|        |                   |        |                   |
|--------|-------------------|--------|-------------------|
| ctrl+s | Save              | ctrl+w | Close plot        |
| r      | Reset view        | f      | Fullscreen 0/1    |
| f      | View forward      | b      | View back         |
| p      | Pan view          | o      | Zoom to rect      |
| x      | X pan/zoom        | y      | Y pan/zoom        |
| g      | Minor grid 0/1    | G      | Major grid 0/1    |
| l      | X axis log/linear | L      | Y axis log/linear |

## Ten simple rules

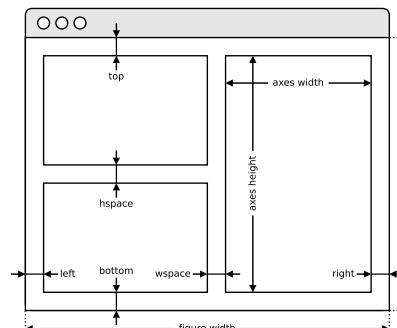
1. Know Your Audience
2. Identify Your Message
3. Adapt the Figure
4. Captions Are Not Optional
5. Do Not Trust the Defaults
6. Use Color Effectively
7. Do Not Mislead the Reader
8. Avoid "Chartjunk"
9. Message Trumps Beauty
10. Get the Right Tool

READ

## Axes adjustments

API

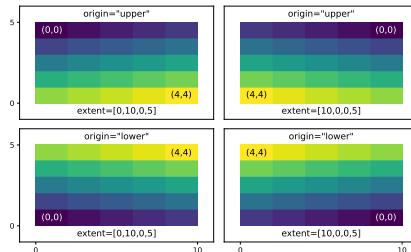
```
plt.subplots_adjust(...)
```



## Extent & origin

API

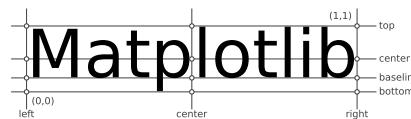
```
ax.imshow(extent=..., origin=...)
```



## Text alignments

API

```
ax.text(..., ha=..., va=..., ...)
```



## Text parameters

API

```
ax.text(..., family=..., size=..., weight=...)
ax.text(..., fontproperties=...)
```

The quick brown fox

xx-large (1.73)

The quick brown fox

x-large (1.44)

The quick brown fox

large (1.20)

The quick brown fox

medium (1.00)

The quick brown fox

small (0.83)

The quick brown fox

x-small (0.69)

The quick brown fox

xx-small (0.58)

The quick brown fox jumps over the lazy dog

black (900)

The quick brown fox jumps over the lazy dog

bold (700)

The quick brown fox jumps over the lazy dog

semibold (600)

The quick brown fox jumps over the lazy dog

normal (400)

The quick brown fox jumps over the lazy dog

ultralight (100)

The quick brown fox jumps over the lazy dog

monospace

The quick brown fox jumps over the lazy dog

serif

The quick brown fox jumps over the lazy dog

sans

The quick brown fox jumps over the lazy dog

cursive

The quick brown fox jumps over the lazy dog

italic

The quick brown fox jumps over the lazy dog

normal

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

small-caps

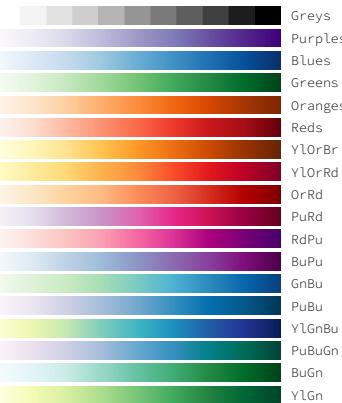
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

normal

## Uniform colormaps



## Sequential colormaps



## Color names

API

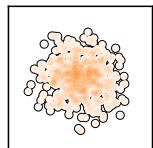
|               |                      |               |                 |   |
|---------------|----------------------|---------------|-----------------|---|
| black         | floralwhite          | darkturquoise | darkblue        | L |
| k             | dodgerblue           | steelblue     | mediumslateblue | K |
| dimgray       | powderblue           | steelblue     | steelblue       | J |
| gray          | lightblue            | steelblue     | steelblue       | I |
| darkgray      | skyblue              | steelblue     | steelblue       |   |
| silver        | lightblue            | steelblue     | steelblue       |   |
| lightgray     | lightblue            | steelblue     | steelblue       |   |
| ivory         | lightyellow          | steelblue     | steelblue       |   |
| bisque        | lightgoldenrodyellow | steelblue     | steelblue       |   |
| gold          | olivedrab            | steelblue     | steelblue       |   |
| lemonchiffon  | yellowgreen          | steelblue     | steelblue       |   |
| khaki         | darkkhaki            | steelblue     | steelblue       |   |
| palegoldenrod | darkkhaki            | steelblue     | steelblue       |   |
| darkgrey      | darkkhaki            | steelblue     | steelblue       |   |
| silver        | darkkhaki            | steelblue     | steelblue       |   |
| lightgrey     | darkkhaki            | steelblue     | steelblue       |   |
| gainsboro     | darkkhaki            | steelblue     | steelblue       |   |
| whitesmoke    | darkkhaki            | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
| gray          | black                | steelblue     | steelblue       |   |
| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black                | steelblue     | steelblue       |   |
| khaki         | black                | steelblue     | steelblue       |   |
| palegoldenrod | black                | steelblue     | steelblue       |   |
| darkgrey      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
| whitesmoke    | black                | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
| gray          | black                | steelblue     | steelblue       |   |
| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black                | steelblue     | steelblue       |   |
| khaki         | black                | steelblue     | steelblue       |   |
| palegoldenrod | black                | steelblue     | steelblue       |   |
| darkgrey      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
| whitesmoke    | black                | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
| gray          | black                | steelblue     | steelblue       |   |
| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black                | steelblue     | steelblue       |   |
| khaki         | black                | steelblue     | steelblue       |   |
| palegoldenrod | black                | steelblue     | steelblue       |   |
| darkgrey      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
| whitesmoke    | black                | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
| gray          | black                | steelblue     | steelblue       |   |
| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black                | steelblue     | steelblue       |   |
| khaki         | black                | steelblue     | steelblue       |   |
| palegoldenrod | black                | steelblue     | steelblue       |   |
| darkgrey      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
| whitesmoke    | black                | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
| gray          | black                | steelblue     | steelblue       |   |
| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black                | steelblue     | steelblue       |   |
| khaki         | black                | steelblue     | steelblue       |   |
| palegoldenrod | black                | steelblue     | steelblue       |   |
| darkgrey      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
| whitesmoke    | black                | steelblue     | steelblue       |   |
| w             | white                | steelblue     | steelblue       |   |
| black         | black                | steelblue     | steelblue       |   |
| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
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| bisque        | black                | steelblue     | steelblue       |   |
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| palegoldenrod | black                | steelblue     | steelblue       |   |
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| lightgrey     | black                | steelblue     | steelblue       |   |
| gainsboro     | black                | steelblue     | steelblue       |   |
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| k             | black                | steelblue     | steelblue       |   |
| dimgray       | black                | steelblue     | steelblue       |   |
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| darkgray      | black                | steelblue     | steelblue       |   |
| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
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| bisque        | black                | steelblue     | steelblue       |   |
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| lightgrey     | black                | steelblue     | steelblue       |   |
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| palegoldenrod | black                | steelblue     | steelblue       |   |
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| k             | black                | steelblue     | steelblue       |   |
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| silver        | black                | steelblue     | steelblue       |   |
| lightgray     | black                | steelblue     | steelblue       |   |
| ivory         | black                | steelblue     | steelblue       |   |
| bisque        | black                | steelblue     | steelblue       |   |
| gold          | black                | steelblue     | steelblue       |   |
| lemonchiffon  | black</td            |               |                 |   |

# Matplotlib tips & tricks

## Transparency

Scatter plots can be enhanced by using transparency (alpha) in order to show area with higher density. Multiple scatter plots can be used to delineate a frontier.

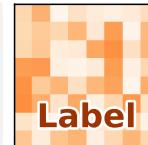
```
X = np.random.normal(-1, 1, 500)
Y = np.random.normal(-1, 1, 500)
ax.scatter(X, Y, 50, "0.0", lw=2) # optional
ax.scatter(X, Y, 50, "1.0", lw=0) # optional
ax.scatter(X, Y, 40, "C1", lw=0, alpha=0.1)
```



## Text outline

Use text outline to make text more visible.

```
import matplotlib.path_effects as fx
text = ax.text(0.5, 0.1, "Label")
text.set_path_effects([
 fx.Stroke(linewidth=3, foreground='1.0'),
 fx.Normal()])
```



## Multiline plot

You can plot several lines at once using None as separator.

```
X,Y = [], []
for x in np.linspace(0, 10*np.pi, 100):
 X.extend([x, x, None]), Y.extend([0, np.sin(x), None])
ax.plot(X, Y, "black")
```



## Dotted lines

To have rounded dotted lines, use a custom linestyle and modify dash\_capstyle.

```
ax.plot([0,1], [0,0], "C1",
 linestyle = (0, (0.01, 1)), dash_capstyle="round")
ax.plot([0,1], [1,1], "C1",
 linestyle = (0, (0.01, 2)), dash_capstyle="round")
```



## Rasterization

If your figure has many graphical elements, such as a huge scatter, you can rasterize them to save memory and keep other elements in vector format.

```
X = np.random.normal(-1, 1, 10_000)
Y = np.random.normal(-1, 1, 10_000)
ax.scatter(X, Y, rasterized=True)
fig.savefig("rasterized-figure.pdf", dpi=600)
```

## Offline rendering

Use the Agg backend to render a figure directly in an array.

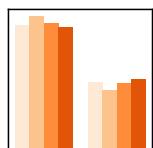
```
from matplotlib.backends.backend_agg import FigureCanvas
canvas = FigureCanvas(Figure())
... # draw some stuff
canvas.draw()
Z = np.array(canvas.renderer.buffer_rgba())
```

## Range of continuous colors

You can use colormap to pick from a range of continuous colors.

```
X = np.random.randn(1000, 4)
cmap = plt.get_cmap("Oranges")
colors = cmap([0.2, 0.4, 0.6, 0.8])

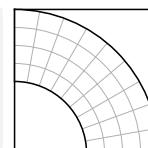
ax.hist(X, 2, histtype='bar', color=colors)
```



## Combining axes

You can use overlaid axes with different projections.

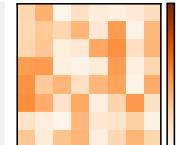
```
ax1 = fig.add_axes([0,0,1,1],
 label="cartesian")
ax2 = fig.add_axes([0,0,1,1],
 label="polar",
 projection="polar")
```



## Colorbar adjustment

You can adjust a colorbar's size when adding it.

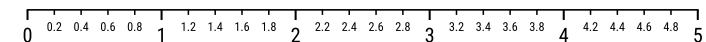
```
im = ax.imshow(Z)
cb = plt.colorbar(im,
 fraction=0.046, pad=0.04)
cb.set_ticks([])
```



## Taking advantage of typography

You can use a condensed font such as Roboto Condensed to save space on tick labels.

```
for tick in ax.get_xmajorticks():
 tick.set_fontname("Roboto Condensed")
```



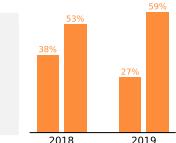
## Getting rid of margins

Once your figure is finished, you can call `tight_layout()` to remove white margins. If there are remaining margins, you can use the `pdfcrop` utility (comes with TeX live).

## Hatching

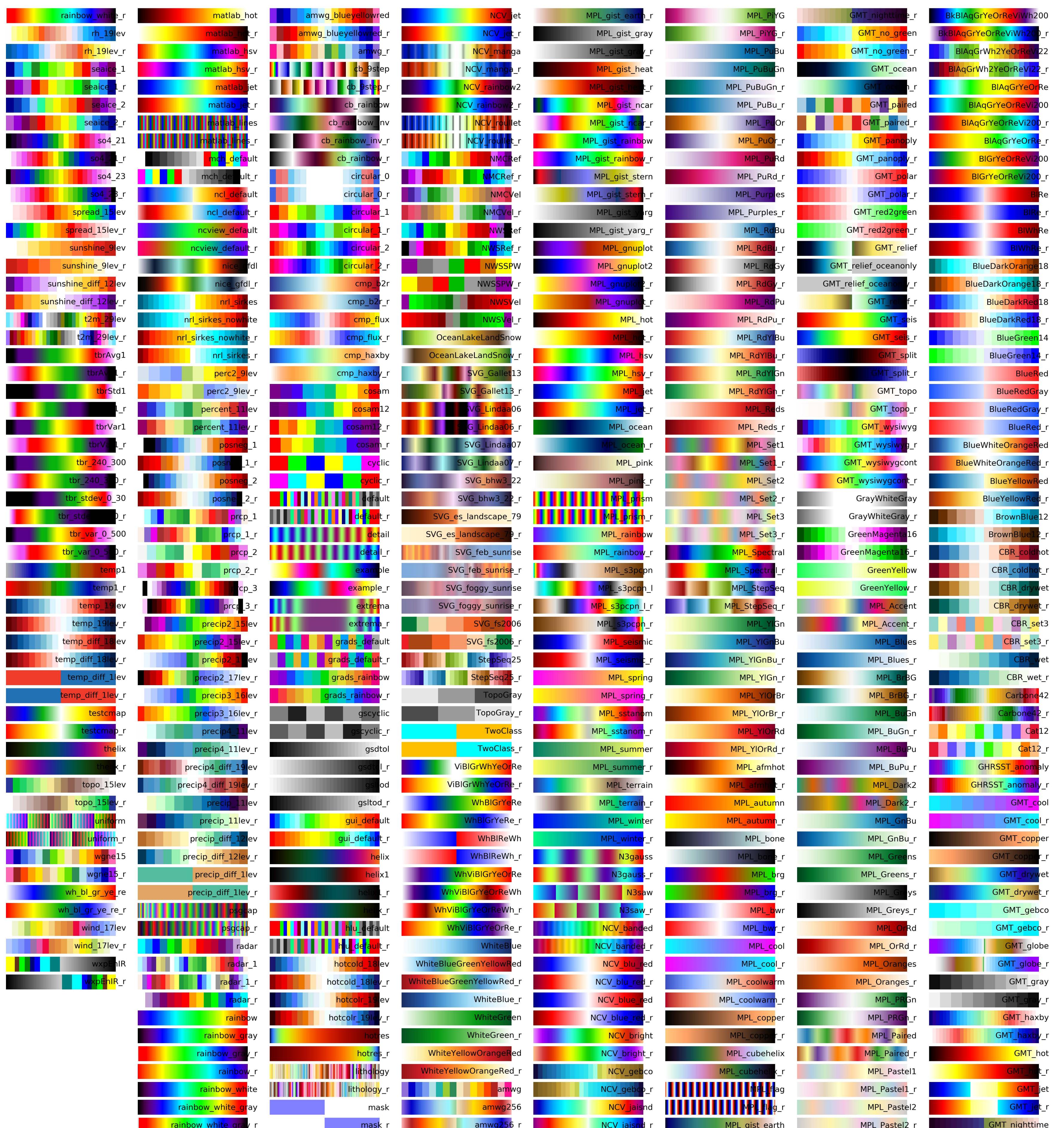
You can achieve a nice visual effect with thick hatch patterns.

```
cmap = plt.get_cmap("Oranges")
plt.rcParams['hatch.color'] = cmap(0.2)
plt.rcParams['hatch.linewidth'] = 8
ax.bar(X, Y, color=cmap(0.6), hatch="/")
```



## Read the documentation

Matplotlib comes with an extensive documentation explaining the details of each command and is generally accompanied by examples. Together with the huge online gallery, this documentation is a gold-mine.



# Python For Data Science Cheat Sheet

## Pandas Basics

Learn Python for Data Science Interactively at [www.DataCamp.com](http://www.DataCamp.com)



### Pandas

The Pandas library is built on NumPy and provides easy-to-use data structures and data analysis tools for the Python programming language.



Use the following import convention:

```
>>> import pandas as pd
```

### Pandas Data Structures

#### Series

A one-dimensional labeled array capable of holding any data type

|   |    |
|---|----|
| a | 3  |
| b | -5 |
| c | 7  |
| d | 4  |

Index

```
>>> s = pd.Series([3, -5, 7, 4], index=['a', 'b', 'c', 'd'])
```

#### DataFrame

| Index | Columns |           |            |
|-------|---------|-----------|------------|
|       | Country | Capital   | Population |
| 0     | Belgium | Brussels  | 11190846   |
| 1     | India   | New Delhi | 1303171035 |
| 2     | Brazil  | Brasilia  | 207847528  |

A two-dimensional labeled data structure with columns of potentially different types

```
>>> data = {'Country': ['Belgium', 'India', 'Brazil'],
 >>> 'Capital': ['Brussels', 'New Delhi', 'Brasilia'],
 >>> 'Population': [11190846, 1303171035, 207847528]}
>>> df = pd.DataFrame(data,
 >>> columns=['Country', 'Capital', 'Population'])
```

### I/O

#### Read and Write to CSV

```
>>> pd.read_csv('file.csv', header=None, nrows=5)
>>> df.to_csv('myDataFrame.csv')
```

#### Read and Write to Excel

```
>>> pd.read_excel('file.xlsx')
>>> df.to_excel('dir/myDataFrame.xlsx', sheet_name='Sheet1')

Read multiple sheets from the same file

>>> xlsx = pd.ExcelFile('file.xlsx')
>>> df = pd.read_excel(xlsx, 'Sheet1')
```

### Asking For Help

```
>>> help(pd.Series.loc)
```

### Selection

#### Getting

|                                                                                                         |                           |
|---------------------------------------------------------------------------------------------------------|---------------------------|
| >>> s['b']<br>-5                                                                                        | Get one element           |
| >>> df[1:]<br>Country Capital Population<br>1 India New Delhi 1303171035<br>2 Brazil Brasilia 207847528 | Get subset of a DataFrame |

### Selecting, Boolean Indexing & Setting

#### By Position

|                                    |                                            |
|------------------------------------|--------------------------------------------|
| >>> df.iloc[[0], [0]]<br>'Belgium' | Select single value by row & column        |
| >>> df.iat[[0], [0]]<br>'Belgium'  | Select single value by row & column labels |

#### By Label

|                                           |                                             |
|-------------------------------------------|---------------------------------------------|
| >>> df.loc[[0], ['Country']]<br>'Belgium' | Select single row of subset of rows         |
| >>> df.at[[0], ['Country']]<br>'Belgium'  | Select a single column of subset of columns |

#### By Label/Position

|                                                                            |                                                                                                |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| >>> df.ix[2]<br>Country Brazil<br>Capital Brasilia<br>Population 207847528 | Select rows and columns                                                                        |
| >>> df.ix[:, 'Capital']<br>0 Brussels<br>1 New Delhi<br>2 Brasilia         | Series s where value is not >1<br>s where value is <-1 or >2<br>Use filter to adjust DataFrame |

#### Boolean Indexing

|                                       |                              |
|---------------------------------------|------------------------------|
| >>> s[~(s > 1)]                       | Setting                      |
| >>> s[(s < -1)   (s > 2)]             | >>> s['a'] = 6               |
| >>> df[df['Population'] > 1200000000] | Set index a of Series s to 6 |

### Read and Write to SQL Query or Database Table

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///memory:')
>>> pd.read_sql("SELECT * FROM my_table;", engine)
>>> pd.read_sql_table('my_table', engine)
>>> pd.read_sql_query("SELECT * FROM my_table;", engine)
read_sql() is a convenience wrapper around read_sql_table() and read_sql_query()
>>> df.to_sql('myDf', engine)
```

### Dropping

```
>>> s.drop(['a', 'c'])
>>> df.drop('Country', axis=1)
```

Drop values from rows (axis=0)  
Drop values from columns (axis=1)

### Sort & Rank

```
>>> df.sort_index()
>>> df.sort_values(by='Country')
>>> df.rank()
```

Sort by labels along an axis  
Sort by the values along an axis  
Assign ranks to entries

### Retrieving Series/DataFrame Information

#### Basic Information

```
>>> df.shape
>>> df.index
>>> df.columns
>>> df.info()
>>> df.count()
```

(rows,columns)  
Describe index  
Describe DataFrame columns  
Info on DataFrame  
Number of non-NA values

#### Summary

```
>>> df.sum()
>>> df.cumsum()
>>> df.min()/df.max()
>>> df.idxmin()/df.idxmax()
>>> df.describe()
>>> df.mean()
>>> df.median()
```

Sum of values  
Cummulative sum of values  
Minimum/maximum values  
Minimum/Maximum index value  
Summary statistics  
Mean of values  
Median of values

### Applying Functions

```
>>> f = lambda x: x*x
>>> df.apply(f)
>>> df.applymap(f)
```

Apply function  
Apply function element-wise

### Data Alignment

#### Internal Data Alignment

NA values are introduced in the indices that don't overlap:

```
>>> s3 = pd.Series([7, -2, 3], index=['a', 'c', 'd'])
>>> s + s3
a 10.0
b NaN
c 5.0
d 7.0
```

### Arithmetic Operations with Fill Methods

You can also do the internal data alignment yourself with the help of the fill methods:

```
>>> s.add(s3, fill_value=0)
a 10.0
b -5.0
c 5.0
d 7.0
>>> s.sub(s3, fill_value=2)
>>> s.div(s3, fill_value=4)
>>> s.mul(s3, fill_value=3)
```

