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Introduction to Python
Data Visualisation

Contents

3 Data Visualisation

- We look at the matplotlib plotting libraries.
- Interactive 2D plotting is available with plotly.

- More information on plotly and some introductory examples can be found in the **Python for Finance** book.
- Likewise, an example for 3D plotting is also found in the book or in online documentation.
- Here, we focus on 2D plotting.

2D Plotting

- Some standard imports and customatisations:

[1]:
```
import matplotlib as mpl
import matplotlib.pyplot as plt  # main plotting subpackage
plt.style.use('seaborn')  # sets the plotting style
mpl.rcParams['font.family'] = 'serif'  # set the font to be serif in all plots
```

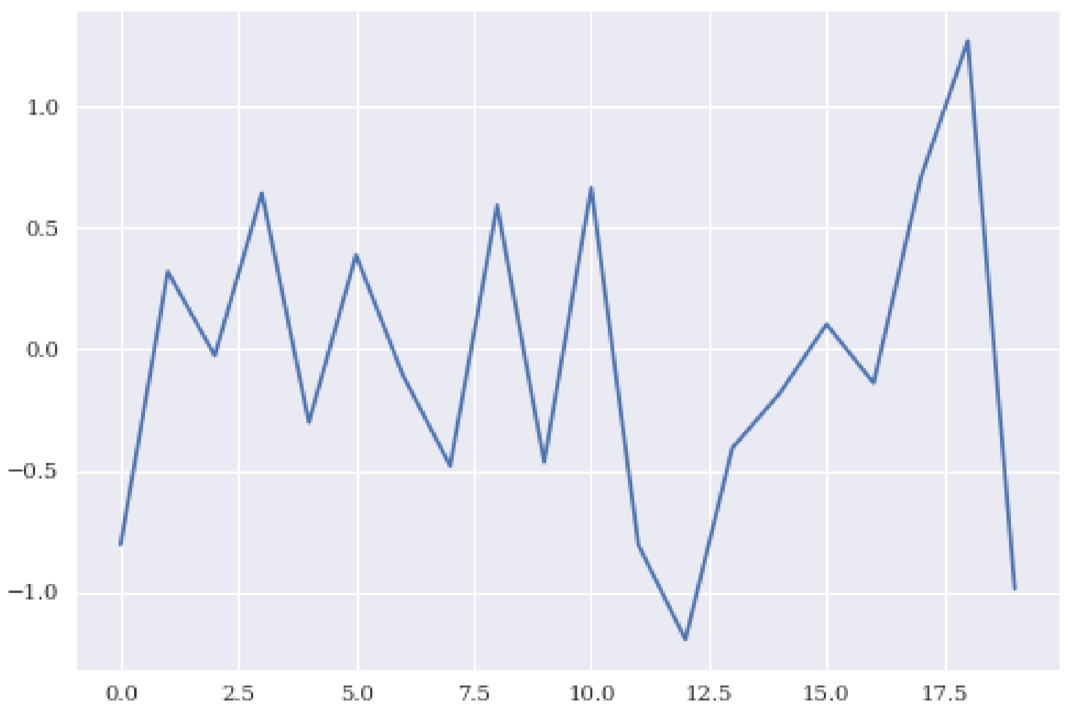
[2]:
```
mpl.__version__  # the version of matplotlib
```

[2]:
```
'3.1.3'
```

Simple plotting

- The standard (and powerful) plotting method is plt.plot().
- It takes as basic argument lists or arrays of x values and y values

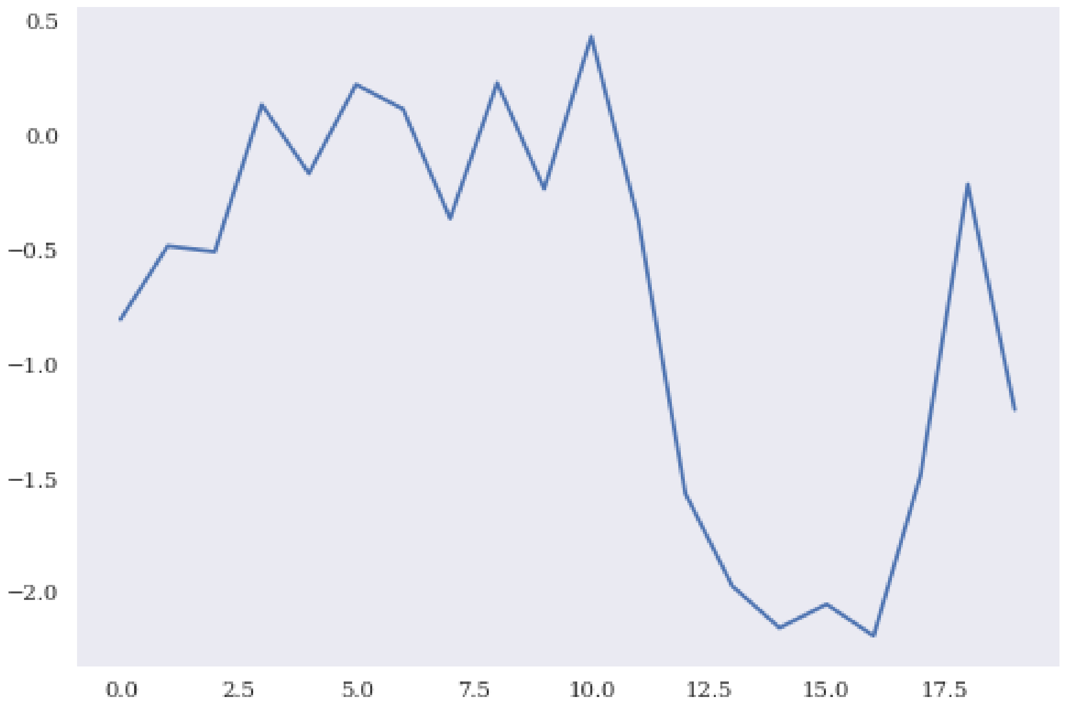
[3]:
```
import numpy as np
np.random.seed(1000)
y=np.random.standard_normal(20) # draw some random numbers
x=np.arange(len(y)) # fix the x axis
plt.plot(x,y); # plot y against x
```



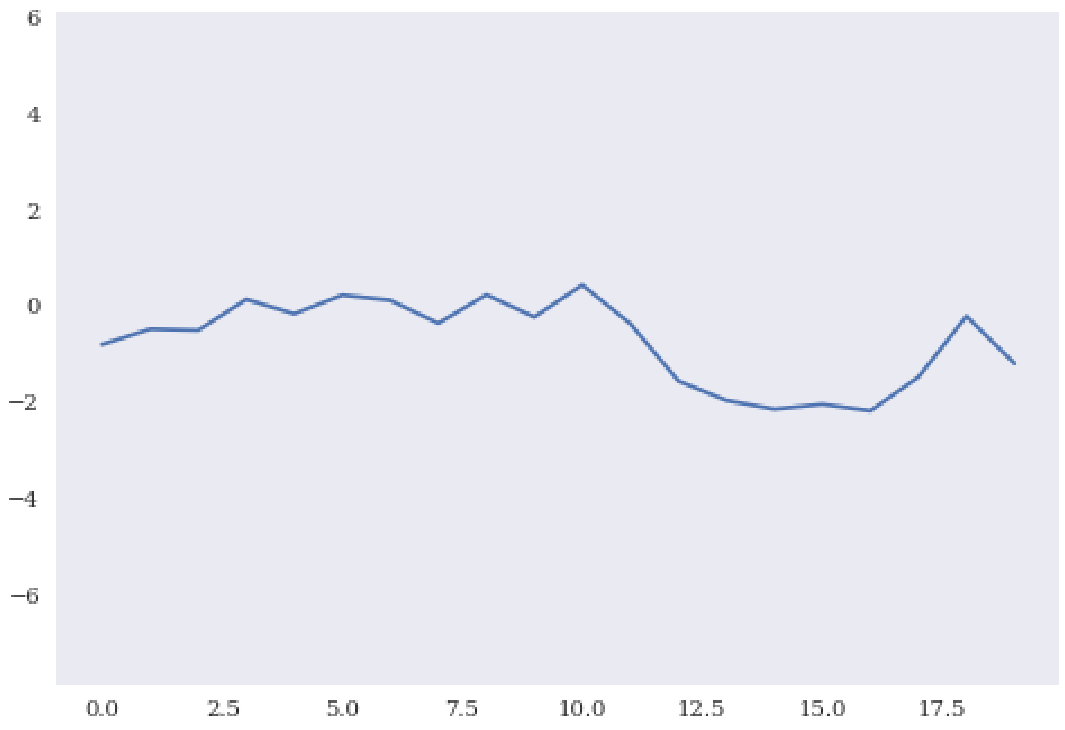
Simple plotting

- A number of functions are available to customise the plot:

[4]:
```
plt.plot(y.cumsum())
plt.grid(False) #
```



[5]:
```
plt.plot(y.cumsum())
plt.grid(False)
plt.axis('equal');
```



Simple plotting

- Options for `plt.axis()`:

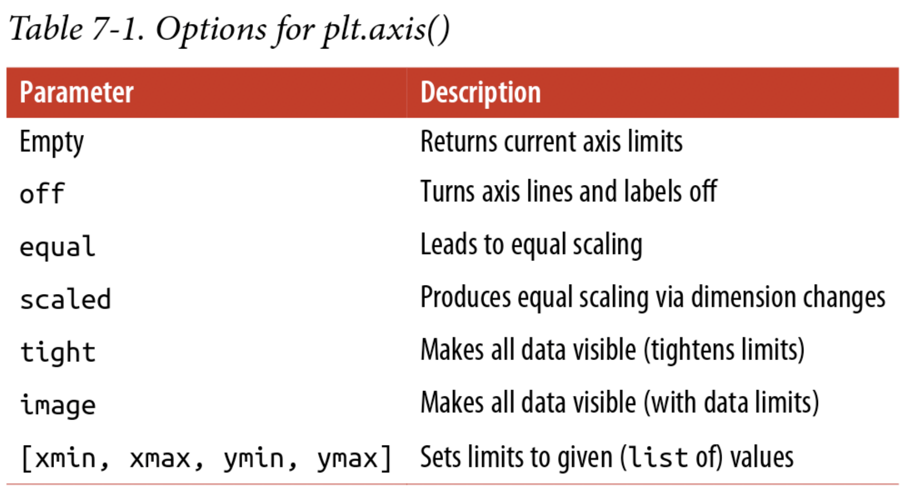


Table 7-1. Options for plt.axis()

Parameter	Description
Empty	Returns current axis limits
`off`	Turns axis lines and labels off
`equal`	Leads to equal scaling
`scaled`	Produces equal scaling via dimension changes
`tight`	Makes all data visible (tightens limits)
`image`	Makes all data visible (with data limits)
`[xmin, xmax, ymin, ymax]`	Sets limits to given (`list` of) values

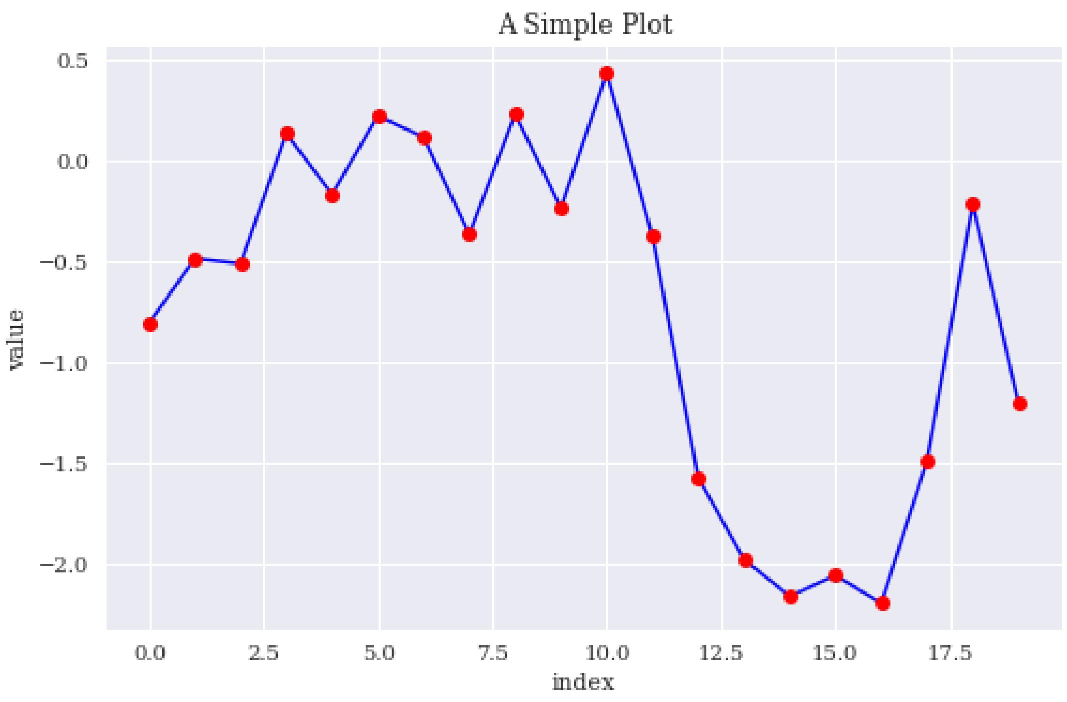
Options for plt.axis

Source: Python for Finance, 2nd ed.

Simple plotting

- Further customisations:

```
[6]: plt.figure(figsize=(8, 5))  # increase size of figure
     plt.plot(y.cumsum(), 'b', lw=1.5)  # plot data in blue with a line width of 1.5
     plt.plot(y.cumsum(), 'ro')  # plot the data points as red dots
     plt.xlabel('index')  # label of x-axis
     plt.ylabel('value')  # label of y-axis
     plt.title('A Simple Plot');  # plot title
```



Simple plotting

- Standard colour abbreviations:

Character	Colour
b	blue
g	green
r	red
c	cyan
m	magenta
y	yellow
k	black
w	white

Simple plotting

- Line styles:

Character	Colour
`'-'`	solid line
`'--'`	dashed line
`'-.`	dash-dot line
`':'`	dotted line

Simple plotting

- Some marker styles:

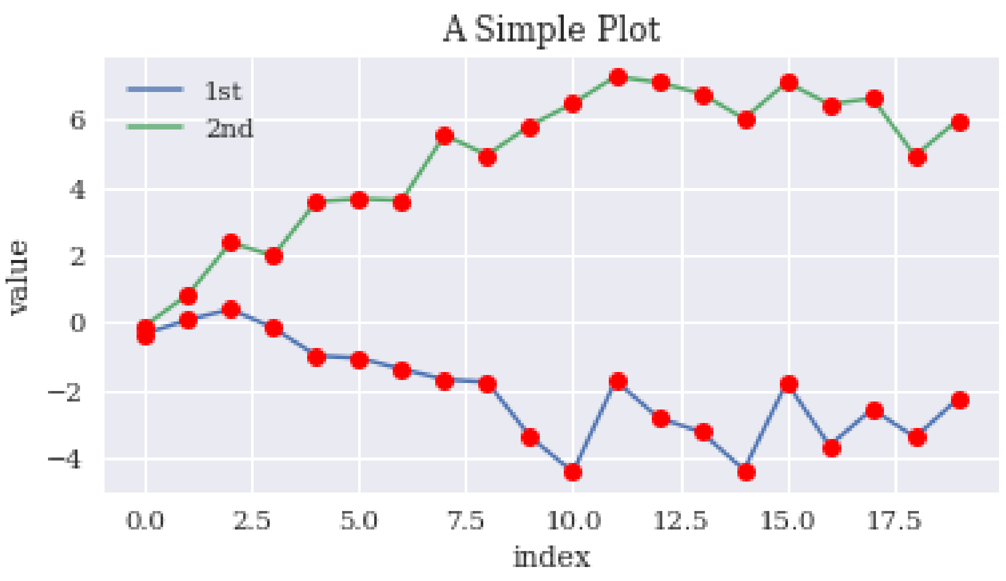
Character	Colour
`'.'`	point
`','`	pixel
`'o'`	circle
`'v'`	triangle down
`'^'`	triangle up
`'<'`	triangle left
`'>'`	triangle right
`'*'`	star
`'h'`	hexagon

- More marker styles are found here and here.

Plotting several data sets

- If the data are arranged in a multi-dimensional array, then `plot()` will automatically plot the columns separately:

[7]:
```python
y = np.random.standard_normal((20, 2)).cumsum(axis=0)
plt.figure(figsize=(6, 3))
plt.plot(y[:, 0], lw=1.5, label='1st')  # define a label to be used in the legend
plt.plot(y[:, 1], lw=1.5, label='2nd')
plt.plot(y, 'ro')
plt.legend(loc=0)  # add a legend, consult the legend help to find out about␣
 ↪locations
plt.xlabel('index')
plt.ylabel('value')
plt.title('A Simple Plot');
```



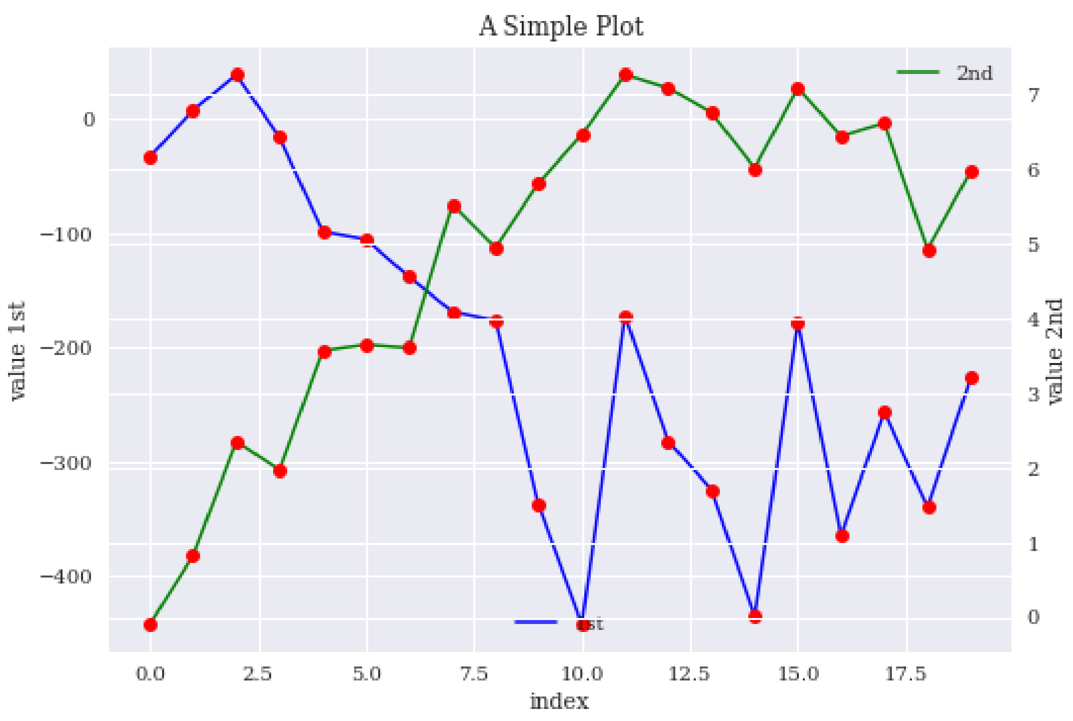
Subplots

- `plt.subplots()` is a powerful method to either combine several plots with separate axes or to produce separate plots.
- In the first example, the plots overlay each other:

Subplots

[8]:
```
y[:,0] = y[:,0] * 100
```

[9]:
```
fig, ax1 = plt.subplots()  # defines  figure and axis objects
plt.plot(y[:, 0], 'b', lw=1.5, label='1st')
plt.plot(y[:, 0], 'ro')
plt.legend(loc=8)
plt.xlabel('index')
plt.ylabel('value 1st')
plt.title('A Simple Plot')
ax2 = ax1.twinx()  # create a second y-axis object
plt.plot(y[:, 1], 'g', lw=1.5, label='2nd')
plt.plot(y[:, 1], 'ro')
plt.legend(loc=0)
plt.ylabel('value 2nd');
```

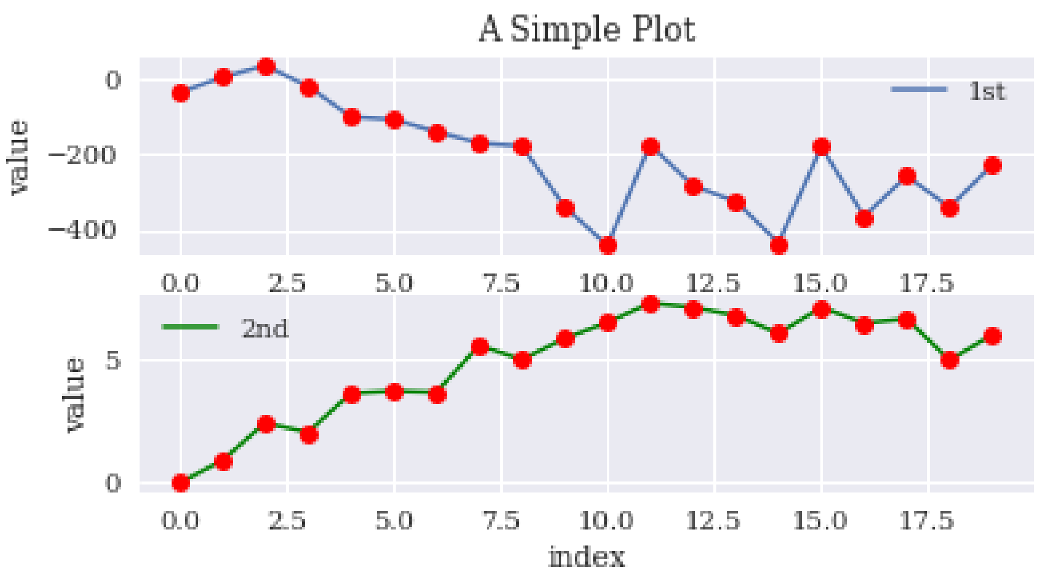


Subplots

- The second example creates two separate plots.
- The main argument to `subplot()` is a 3-digit integer describing the position of the subplot.
- The integers refer to `nrows`, `ncols` and `index`, where `index` starts at 1 in the upper left corner and increases to the right.

Subplots

[10]:
```
plt.figure(figsize=(6, 3))
plt.subplot(211)  # defines the upper plot in a figure with two rows and one column
plt.plot(y[:, 0], lw=1.5, label='1st')
plt.plot(y[:, 0], 'ro')
plt.legend(loc=0)
plt.ylabel('value')
plt.title('A Simple Plot')
plt.subplot(212)  # defines the lower plot
plt.plot(y[:, 1], 'g', lw=1.5, label='2nd')
plt.plot(y[:, 1], 'ro')
plt.legend(loc=0)
plt.xlabel('index')
plt.ylabel('value');
```

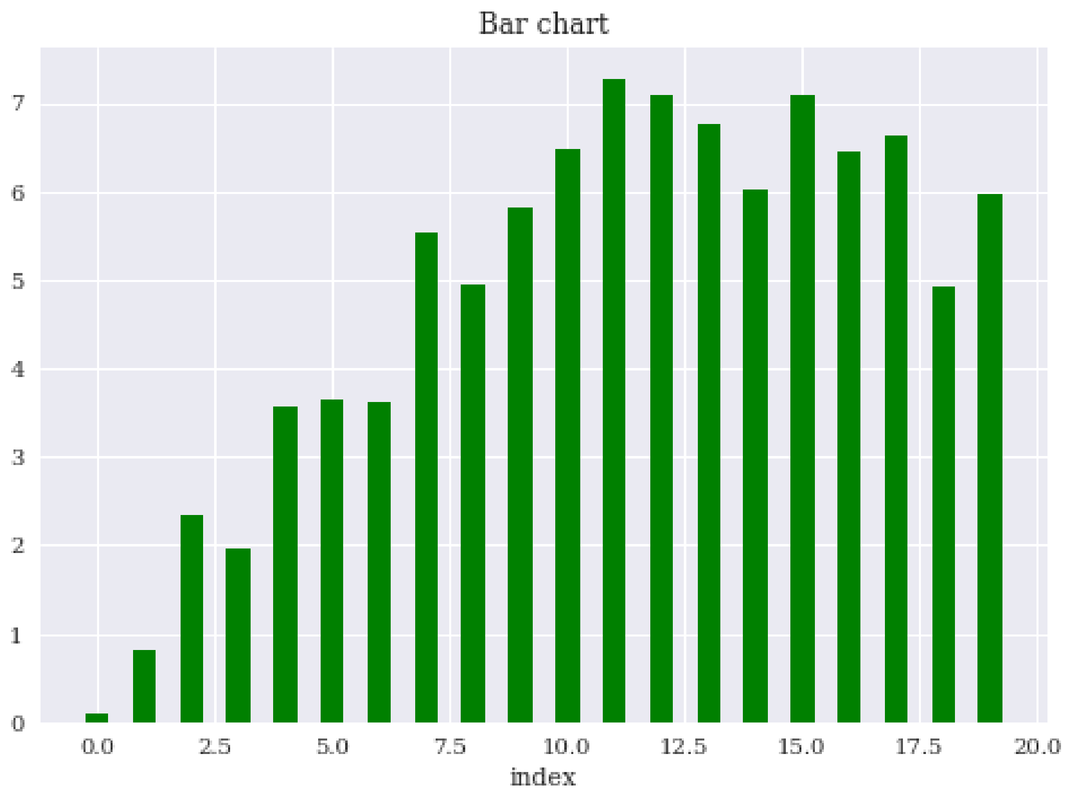


Other plot styles

- The following examples introduce bar charts, scatter plots, histograms and boxplots

Bar chart

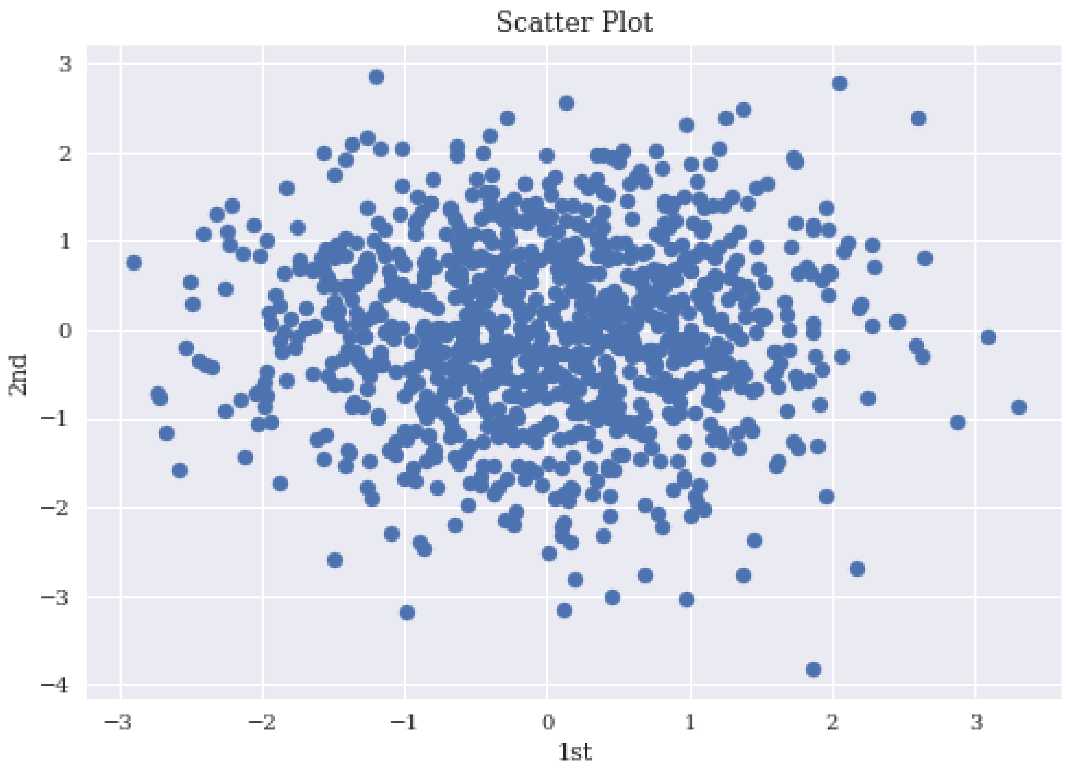
[11]:
```
plt.bar(np.arange(len(y)), abs(y[:, 1]), width=0.5,
        color='g')
plt.xlabel('index')
plt.title('Bar chart');
```



Scatter plot

[12]:
```
y = np.random.standard_normal((1000, 2))
```

[13]:
```
plt.scatter(y[:, 0], y[:, 1], marker='o')
plt.xlabel('1st')
plt.ylabel('2nd')
plt.title('Scatter Plot');
```

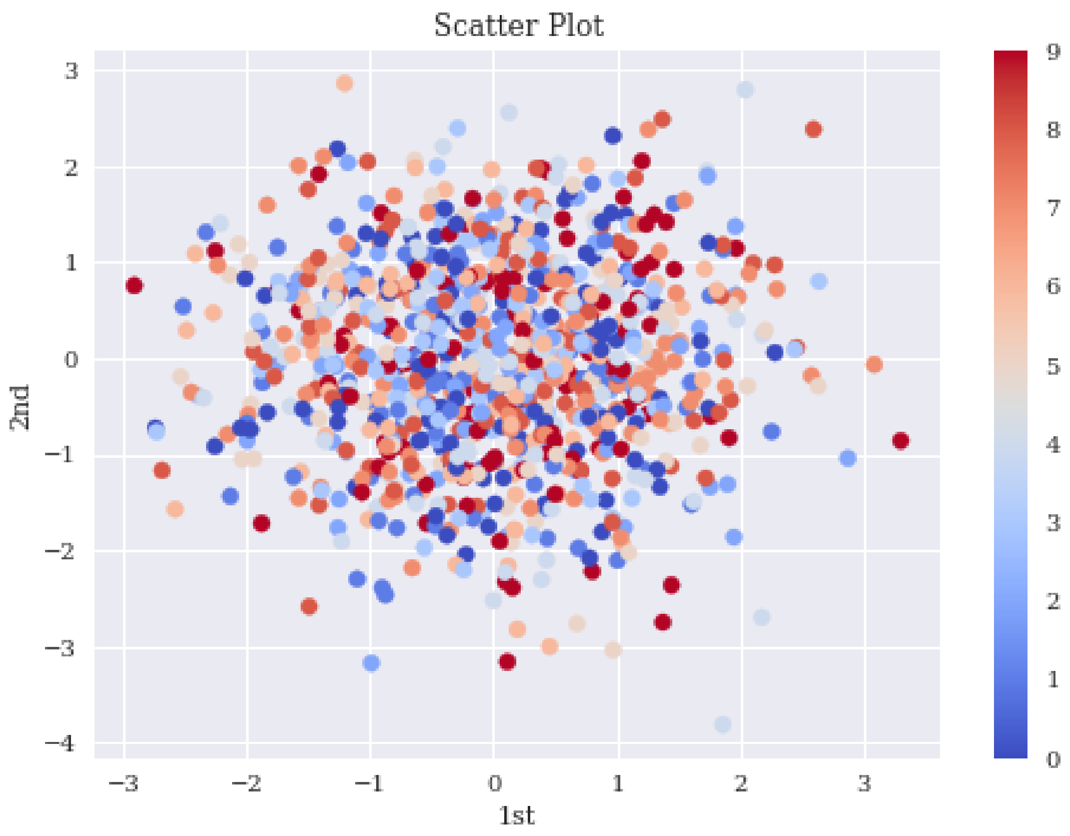


Scatter plot

- Adding a third dimension via a colour map:

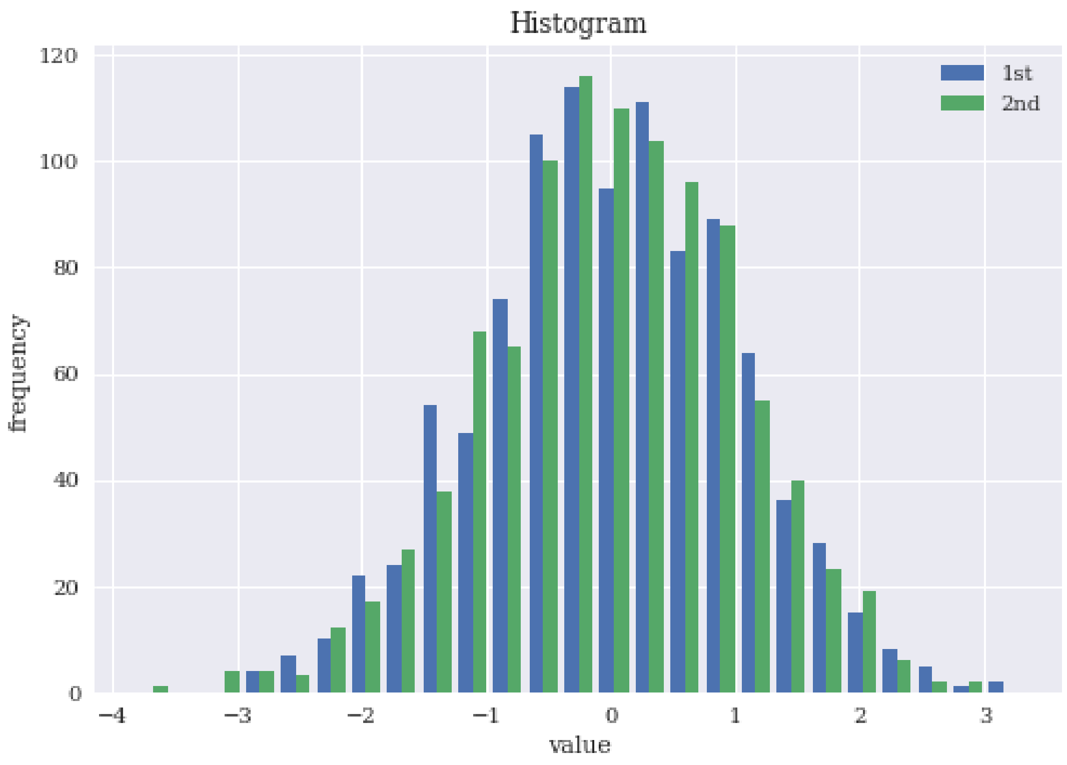
[14]:
```
c = np.random.randint(0, 10, len(y))
```

[15]:
```
plt.scatter(y[:, 0], y[:, 1],
            c=c,
            cmap='coolwarm',
            marker='o')
plt.colorbar()
plt.xlabel('1st')
plt.ylabel('2nd')
plt.title('Scatter Plot');
```



Histogram

```
[16]: plt.hist(y, label=['1st', '2nd'], bins=25)
      plt.legend(loc=0)
      plt.xlabel('value')
      plt.ylabel('frequency')
      plt.title('Histogram');
```



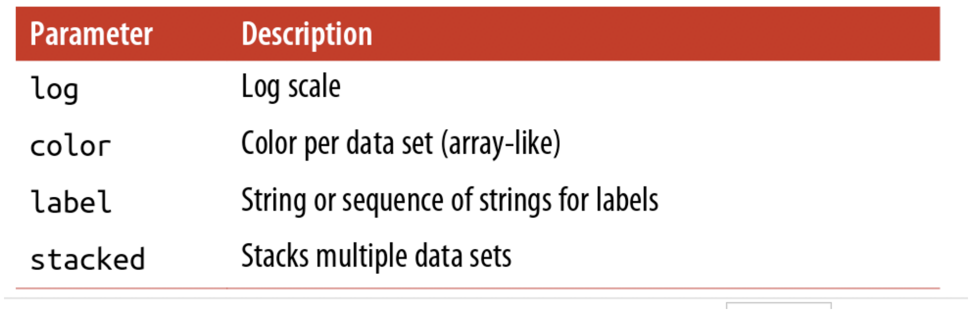
Histogram

- Parameters for `plt.hist()`:

Parameter	Description
`x`	`list` object(s), `ndarray` object
`bins`	Number of bins
`range`	Lower and upper range of bins
`normed`	Norming such that integral value is 1
`weights`	Weights for every value in `x`
`cumulative`	Every bin contains the counts of the lower bins
`histtype`	Options (strings): `bar`, `barstacked`, `step`, `stepfilled`
`align`	Options (strings): `left`, `mid`, `right`
`orientation`	Options (strings): `horizontal`, `vertical`
`rwidth`	Relative width of the bars

Parameters for plt.hist

Source: Python for Finance, 2nd ed.



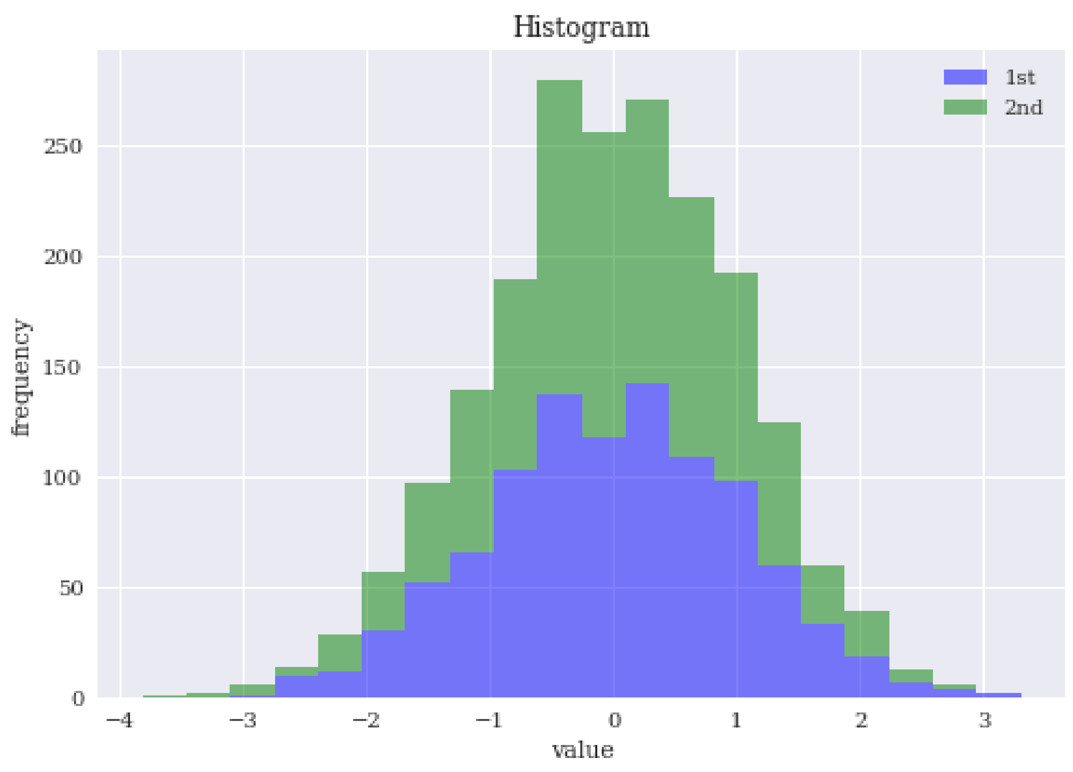
Parameter	Description
`log`	Log scale
`color`	Color per data set (array-like)
`label`	String or sequence of strings for labels
`stacked`	Stacks multiple data sets

Parameters for plt.hist

Histogram

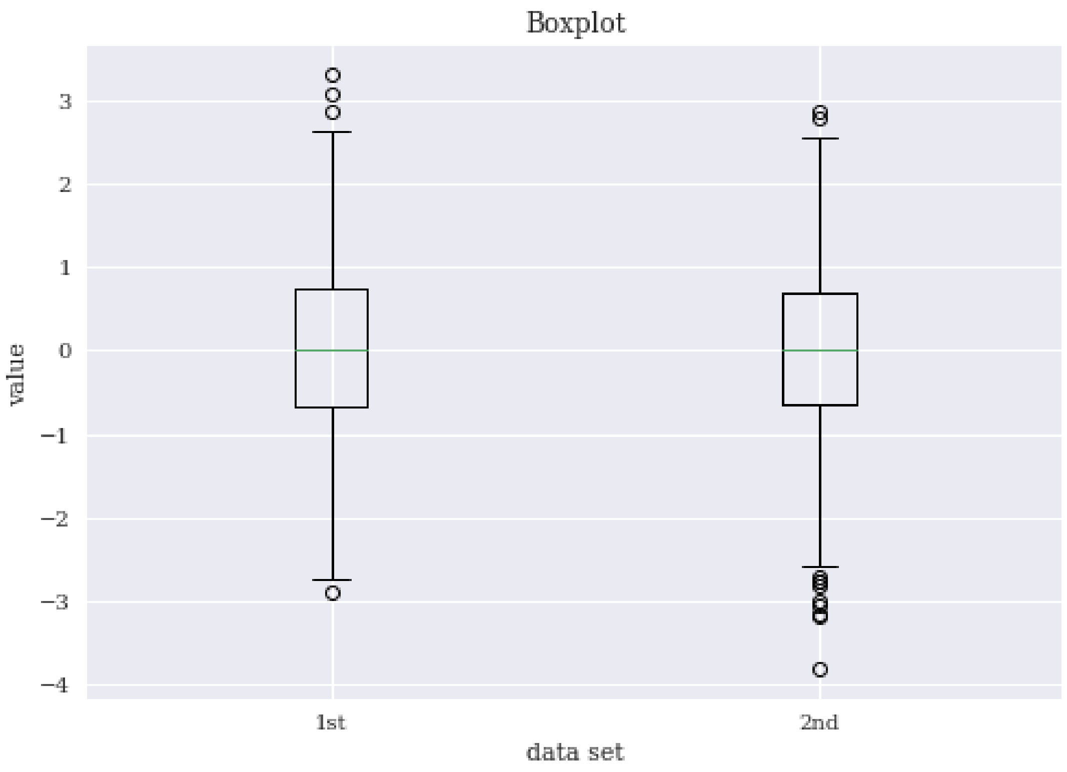
- A stacked histogram:

```
[17]: plt.hist(y, label=['1st', '2nd'], color=['b', 'g'],
                  stacked=True, bins=20, alpha=0.5)
      plt.legend(loc=0)
      plt.xlabel('value')
      plt.ylabel('frequency')
      plt.title('Histogram');
```



Boxplot

```
[18]: fig, ax = plt.subplots()
      plt.boxplot(y)
      plt.setp(ax, xticklabels=['1st', '2nd'])
plt.xlabel('data set')
plt.ylabel('value')
plt.title('Boxplot');
```



Further examples

- Many more examples are found in the `matploblib` gallery.