

# CFDS® – Chartered Financial Data Scientist

## Introduction to Python

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### 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 customisations:

```
In [ ]: import matplotlib.pyplot as plt
import seaborn as sns
sns.set()
```

### 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
-

```
In [ ]: 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:

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

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

## Simple plotting

- Options for `plt.axis()` :

Options for `plt.axis`

Source: Python for Finance, 2nd ed.

## Simple plotting

- Further customisations:

```
In [ ]: plt.figure(figsize=(8, 5)) # increase size of figure
        plt.plot(y.cumsum(), 'b', lw=1.5) # plot data in blue with a line
        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:

```
In [ ]: 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
```

```
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
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

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

```
In [ ]: 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

```
In [ ]: plt.figure(figsize=(6, 3))
plt.subplot(211) # defines the upper plot in a figure with two rows
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

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

### Scatter plot

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

```
In [ ]: 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:

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

```
In [ ]: 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

```
In [ ]: 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()`:

Parameters for `plt.hist`

Parameters for `plt.hist`

Source: Python for Finance, 2nd ed.

## Histogram

- A stacked histogram:

```
In [ ]: 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

```
In [ ]: 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 `matplotlib` [gallery](#).