人工智慧投資分析

AI for Investment Analysis

Python Pandas 量化投資分析

(Quantitative Investing with Pandas in Python)

1082AIIA07

MBA, IMTKU (M2399) (8409) (Spring 2020)

Wed 3, 4 (10:10-12:00) (B206)

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http://mail. tku.edu.tw/myday/

2020-04-22

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2020/03/04	人工智慧投資分析課程介紹 (Course Orientation on AI for Investment Analysis)
2	2020/03/11	AI 金融科技: 金融服務創新應用 (AI in FinTech: Financial Services Innovation and Application)
3	2020/03/18	機器人理財顧問與AI交談機器人 (Robo-Advisors and AI Chatbots)
4	2020/03/25	投資心理學與行為財務學 (Investing Psychology and Behavioral Finance)
5	2020/04/01	財務金融事件研究法 (Event Studies in Finance)
6	2020/04/08	人工智慧投資分析個案研究 I (Case Study on AI for Investment Analysis I)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
7	2020/04/15	Python AI投資分析基礎 (Foundations of AI Investment Analysis in Python)
8	2020/04/22	Python Pandas 量化投資分析 (Quantitative Investing with Pandas in Python)
9	2020/04/29	期中報告 (Midterm Project Report)
10	2020/05/06	Python Scikit-Learn 機器學習投資分析 (Machine Learning for Investment Analysis with Scikit-Learn In Python)
11	2020/05/13	TensorFlow 深度學習投資分析 I (Deep Learning for Investment Analysis with TensorFlow I)
12	2020/05/20	TensorFlow 深度學習投資分析 II (Deep Learning for Investment Analysis with TensorFlow II)

課程大綱 (Syllabus)

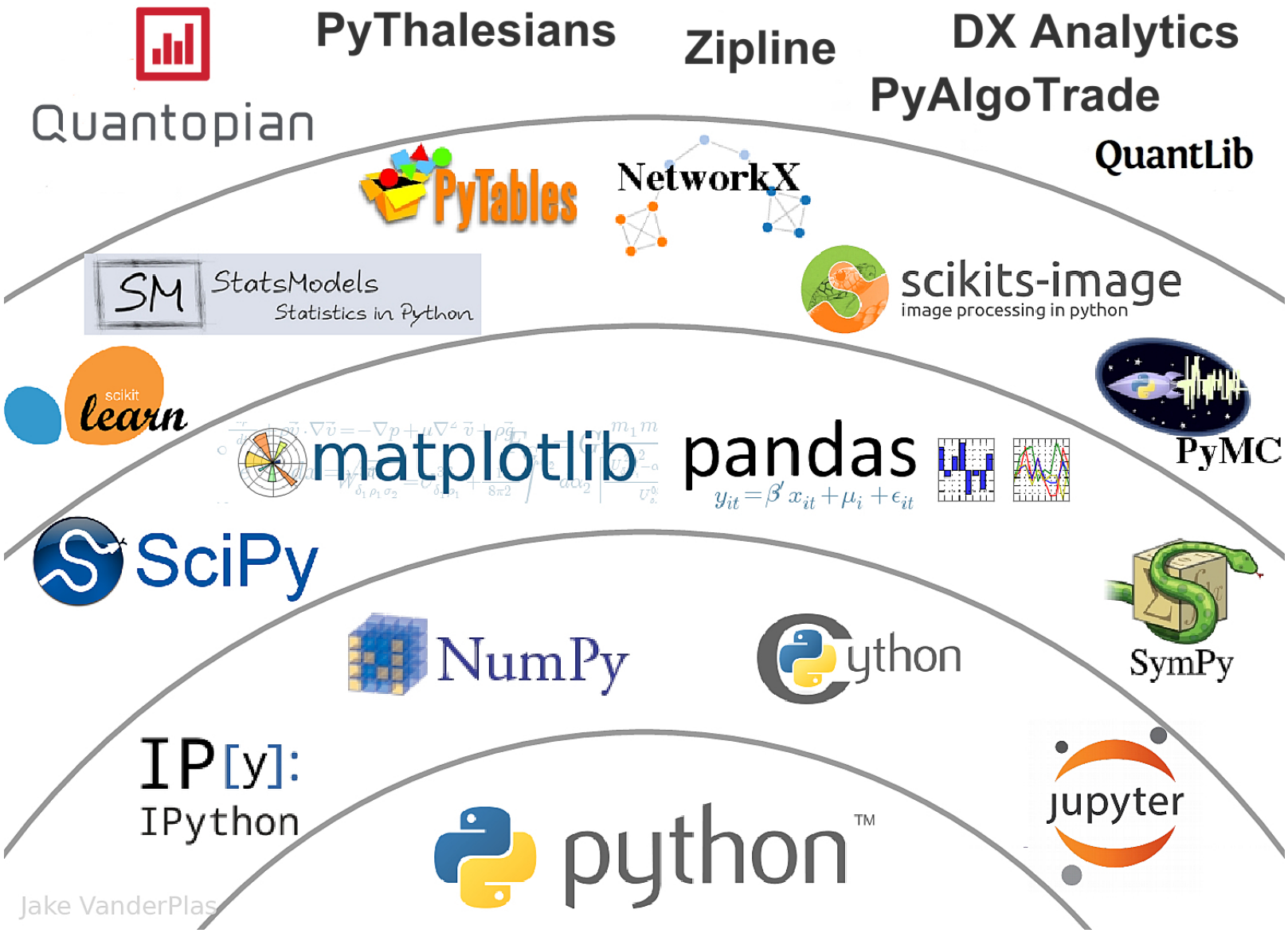
週次 (Week)	日期 (Date)	內容 (Subject/Topics)
13	2020/05/27	人工智慧投資分析個案研究 II (Case Study on Artificial Intelligence for Investment Analysis II)
14	2020/06/03	TensorFlow 深度學習投資分析 III (Deep Learning for Investment Analysis with TensorFlow III)
15	2020/06/10	投資組合最佳化與程式交易 (Portfolio Optimization and Algorithmic Trading)
16	2020/06/17	期末報告 I (Final Project Presentation I)
17	2020/06/24	期末報告 II (Final Project Presentation II)
18	2020/07/01	教師彈性補充教學

Quantitative Investing with Pandas in Python

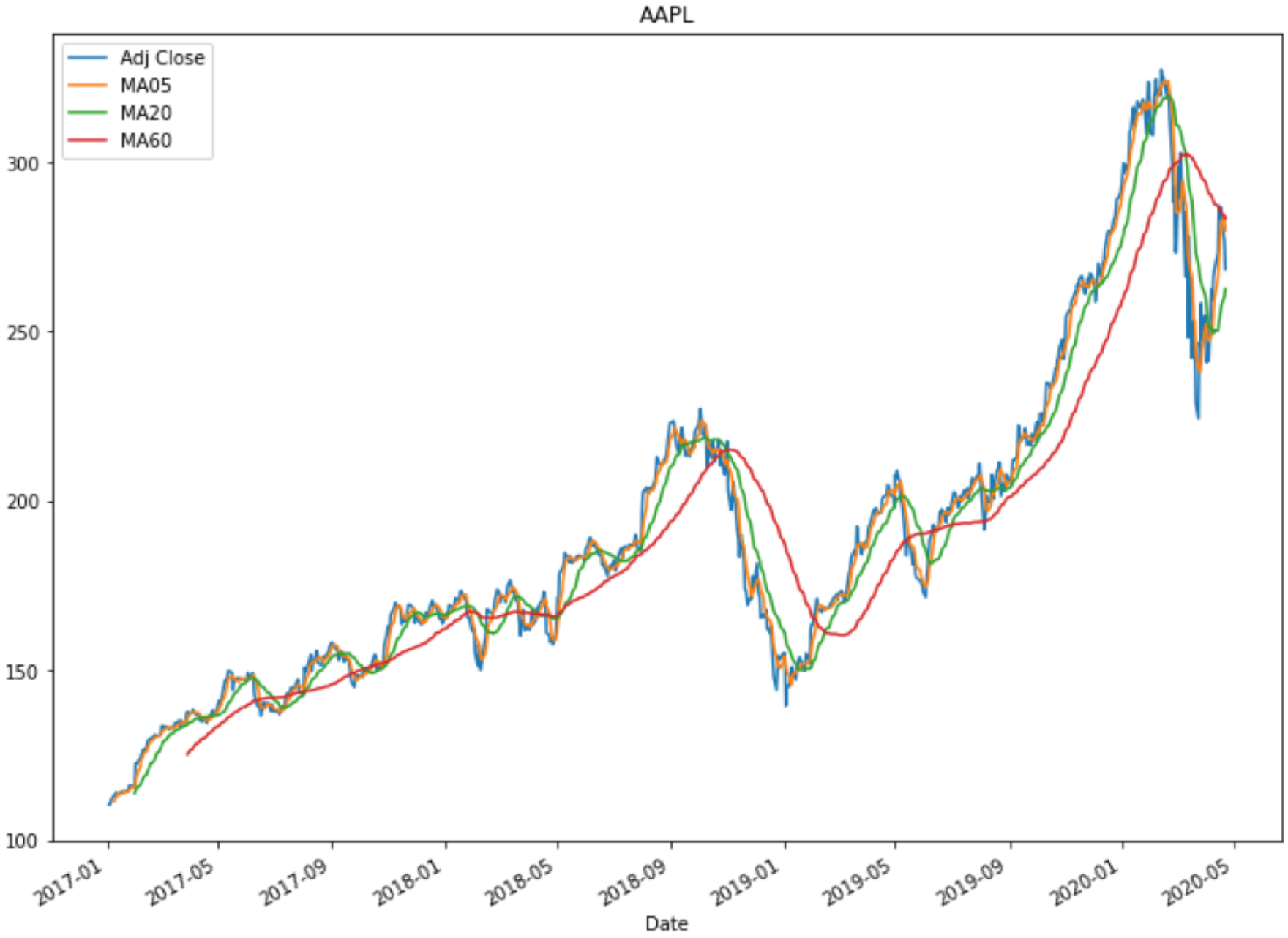
Outline

- **Quantitative Investing with Pandas in Python**
  - **Numpy**
    - Scientific computing
  - **Pandas**
    - Data structures and data analysis tools

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5


AAPL
Adj Close
MA05
MA20
MA60
300
250
200
150
100
2017-01
2017-05
2017-09
2018-01
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
Date

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

python101.ipynb ☆

File Edit View Insert Runtime Tools Help All changes saved

Comment Share A

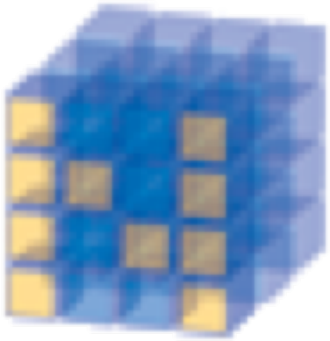
+ Code + Text

RAM Disk Editing

```
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2017, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
print(df.tail())
df2 = pd.read_csv('AAPL.csv') #df.from_csv('AAPL.csv')
print(df2.tail())

df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0), rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0), rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'], color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])

# set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')
plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
```

https://tinyurl.com/imtkupython101

Numpy



NumPy
Base
N-dimensional array
package

NumPy

is the

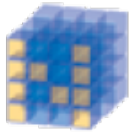
fundamental package

for

scientific computing

with Python.

Source: http://www.numpy.org/

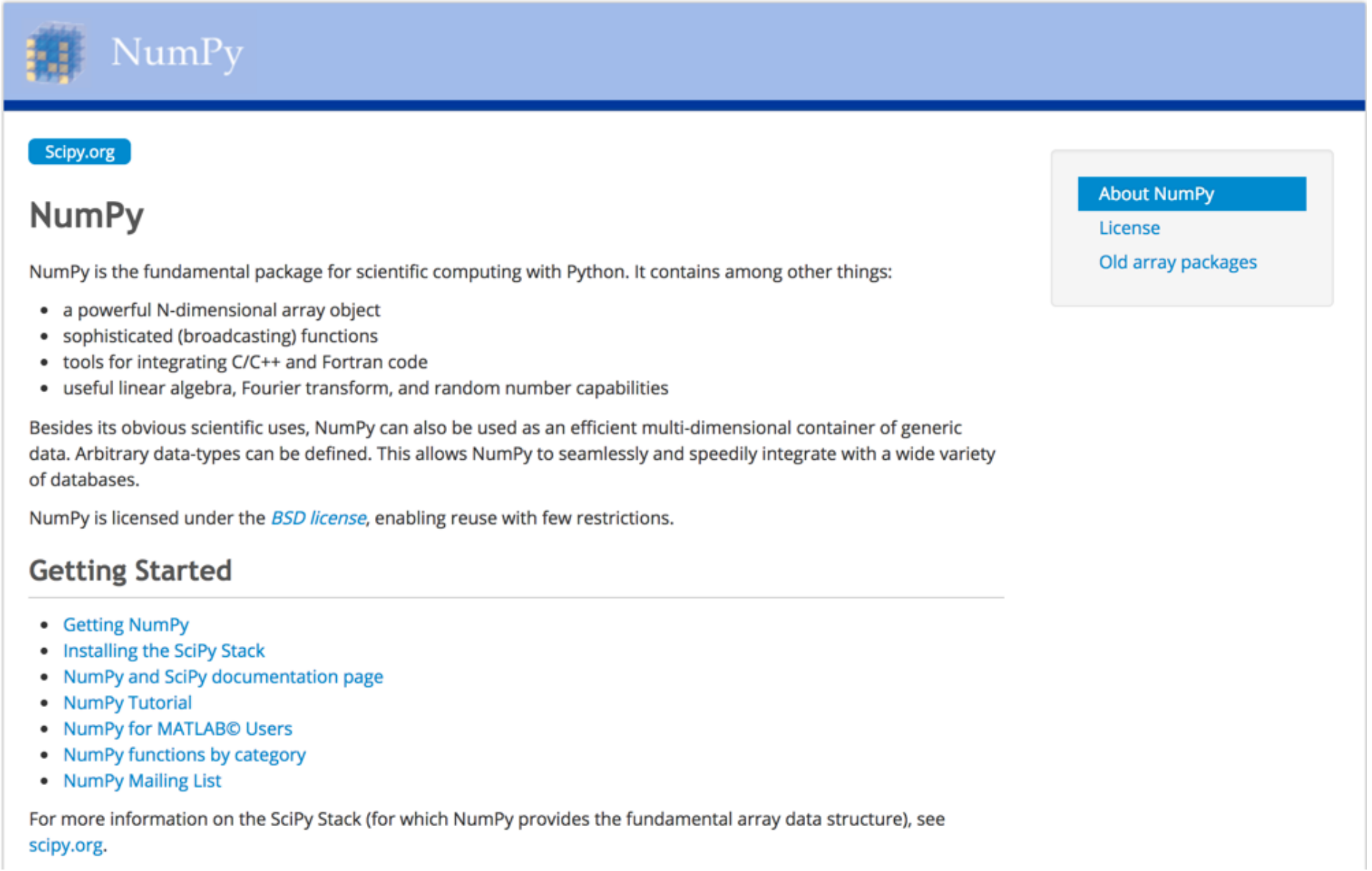


NumPy

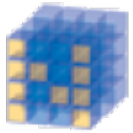
NumPy

- NumPy provides a **multidimensional array** object to store homogenous or heterogeneous data;
  it also provides optimized functions/methods to operate on this array object.

NumPy



http://www.numpy.org/



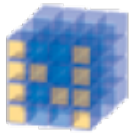
NumPy ndarray

One-dimensional Array (1-D Array)

0	1			n-1
1	**2**	**3**	**4**	**5**

Two-dimensional Array (2-D Array)

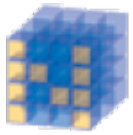
	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**



NumPy

NumPy

```
v = list(range(1, 6))
v
2 * v
import numpy as np
v = np.arange(1, 6)
v
2 * v
```



NumPy

Base
N-dimensional
array package

```
1 v = list(range(1, 6))
2 v
```

```
[1, 2, 3, 4, 5]
```

```
1 2 * v
```

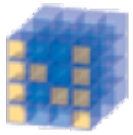
```
[1, 2, 3, 4, 5, 1, 2, 3, 4, 5]
```

```
1 import numpy as np
2 v = np.arange(1, 6)
3 v
```

```
array([1, 2, 3, 4, 5])
```

```
1 2 * v
```

```
array([ 2,  4,  6,  8, 10])
```



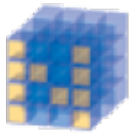
NumPy Create Array

```
import numpy as np
a = np.array([1, 2, 3])
b = np.array([4, 5, 6])
c = a * b
c
```

```
import numpy as np
a = np.array([1, 2, 3])
b = np.array([4, 5, 6])
c = a * b
c
```

```
array([ 4, 10, 18])
```

Source: Yves Hilpisch (2014), Python for Finance: Analyze Big Financial Data, O'Reilly



NumPy

NumPy

```python
import numpy as np

a = np.zeros((2,2))  # Create an array of all zeros
print(a)             # Prints "[[ 0.  0.]
                     #          [ 0.  0.]]"

b = np.ones((1,2))   # Create an array of all ones
print(b)             # Prints "[[ 1.  1.]]"

c = np.full((2,2), 7) # Create a constant array
print(c)               # Prints "[[ 7.  7.]
                       #          [ 7.  7.]]"

d = np.eye(2)        # Create a 2x2 identity matrix
print(d)             # Prints "[[ 1.  0.]
                     #          [ 0.  1.]]"

e = np.random.random((2,2)) # Create an array filled with random values
print(e)                    # Might print "[[ 0.91940167  0.08143941]
                            #               [ 0.68744134  0.87236687]]"
```

```
[[0. 0.]
 [0. 0.]]
[[1. 1.]]
[[7 7]
 [7 7]]
[[1. 0.]
 [0. 1.]]
[[0.66258211 0.65552598]
 [0.00429934 0.21695824]]
```

Source: http://cs231n.github.io/python-numpy-tutorial/

Numpy Quickstart Tutorial

SciPy.org Sponsored By ENTHOUGHT

Scipy.org | Docs | NumPy v1.13.dev0 Manual | NumPy User Guide

index | next | previous

Quickstart tutorial

Prerequisites

Before reading this tutorial you should know a bit of Python. If you would like to refresh your memory, take a look at the Python tutorial.

If you wish to work the examples in this tutorial, you must also have some software installed on your computer. Please see http://scipy.org/install.html for instructions.

The Basics

NumPy's main object is the homogeneous multidimensional array. It is a table of elements (usually numbers), all of the same type, indexed by a tuple of positive integers. In NumPy dimensions are called *axes*. The number of axes is *rank*.

For example, the coordinates of a point in 3D space `[1, 2, 1]` is an array of rank 1, because it has one axis. That axis has a length of 3. In the example pictured below, the array has rank 2 (it is 2-dimensional). The first dimension (axis) has a length of 2, the second dimension has a length of 3.

```
[[ 1., 0., 0.],
 [ 0., 1., 2.]]
```

NumPy's array class is called `ndarray`. It is also known by the alias `array`. Note that `numpy.array` is not the same as the Standard Python Library class `array.array`, which only handles one-dimensional arrays and offers less functionality. The more important attributes of an `ndarray` object are:

ndarray.ndim

the number of axes (dimensions) of the array. In the Python world, the number of dimensions is referred to as *rank*.

ndarray.shape

Table Of Contents

https://docs.scipy.org/doc/numpy-dev/user/quickstart.html

```
import numpy as np
a = np.arange(15).reshape(3, 5)
```

```
a.shape
a.ndim
a.dtype.name
```

```
import numpy as np
a = np.arange(15).reshape(3, 5)
a
```

```
array([[ 0,  1,  2,  3,  4],
       [ 5,  6,  7,  8,  9],
       [10, 11, 12, 13, 14]])
```

```
print(a.shape)
```

```
(3, 5)
```

```
a.ndim
```

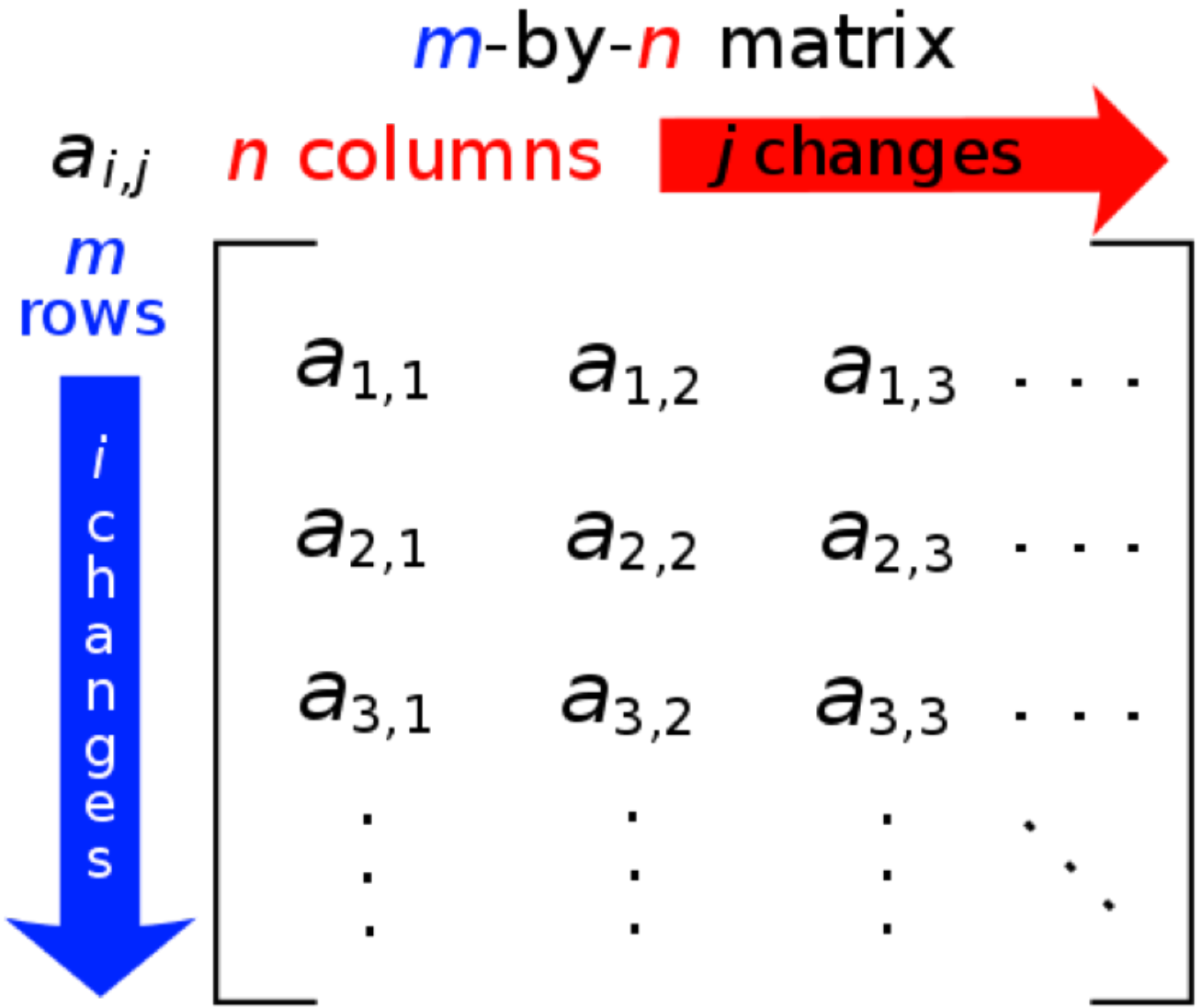
```
2
```

```
a.dtype.name
```

```
'int64'
```

Source: https://docs.scipy.org/doc/numpy-dev/user/quickstart.html

Matrix



Source: https://simple.wikipedia.org/wiki/Matrix_(mathematics)

NumPy ndarray: Multidimensional Array Object

NumPy ndarray

One-dimensional Array (1-D Array)

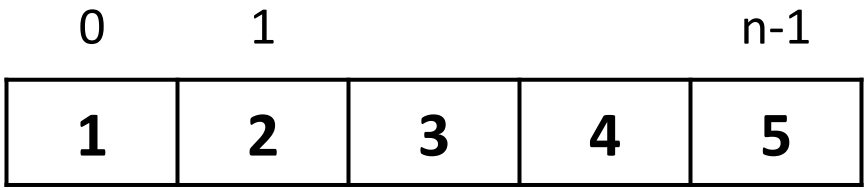
0	1			n-1
1	**2**	**3**	**4**	**5**

Two-dimensional Array (2-D Array)

	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**

```
import numpy as np
a = np.array([1,2,3,4,5])
```

One-dimensional Array (1-D Array)




```
a = np.array([1,2,3,4,5])
a
```

```
array([1, 2, 3, 4, 5])
```

```
a = np.array([[1,2,3,4,5],[6,7,8,9,10],[11,12,13,14,15],[16,17,18,19,20]])
```

Two-dimensional Array (2-D Array)

	0	1			n-1
0	**1**	**2**	**3**	**4**	**5**
1	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**
m-1	**16**	**17**	**18**	**19**	**20**

```
a = np.array([[1,2,3,4,5],[6,7,8,9,10],[11,12,13,14,15],[16,17,18,19,20]])
a
```

```
array([[ 1,  2,  3,  4,  5],
       [ 6,  7,  8,  9, 10],
       [11, 12, 13, 14, 15],
       [16, 17, 18, 19, 20]])
```

```
import numpy as np
a = np.array([[0, 1, 2, 3],
[10, 11, 12, 13],
[20, 21, 22, 23]])
a
```

0	1	2	3
10	11	12	13
20	21	22	23

a = np.array([[0, 1, 2, 3], [10, 11, 12, 13], [20, 21, 22, 23]])

```
a = np.array([[0, 1, 2, 3], [10, 11, 12, 13], [20, 21, 22, 23]])
a
```

```
array([[ 0,  1,  2,  3],
       [10, 11, 12, 13],
       [20, 21, 22, 23]])
```

```
print(a.ndim)
```

```
2
```

```
print(a.shape)
```

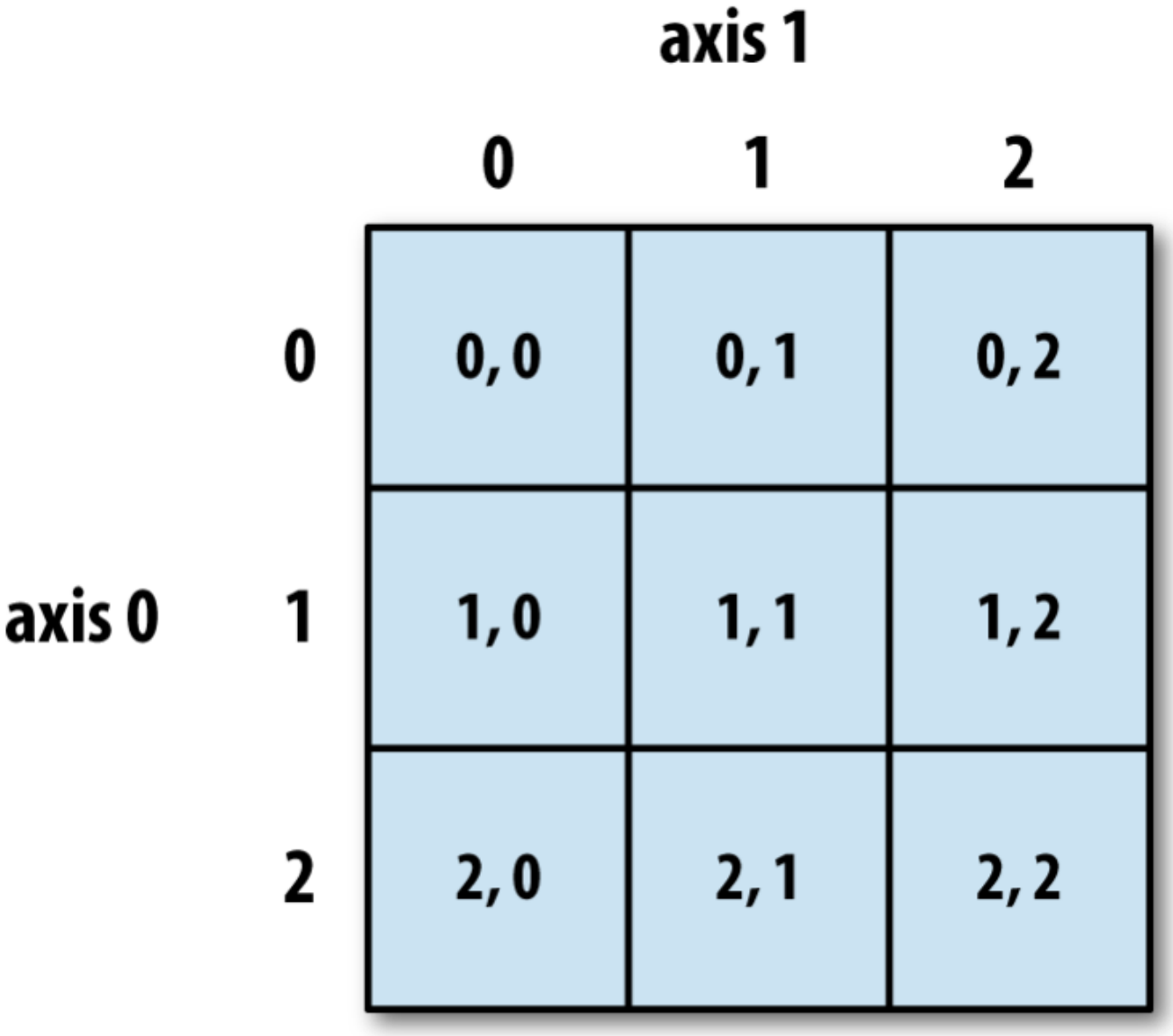
```
(3, 4)
```

0	1	2	3
10	11	12	13
20	21	22	23

NumPy Basics: Arrays and Vectorized Computation

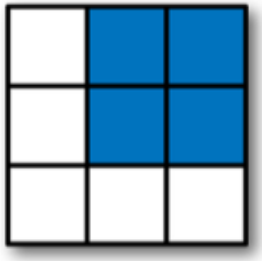
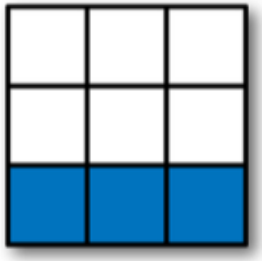
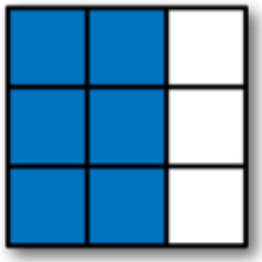
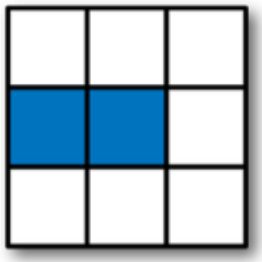
Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

NumPy Array



Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

Numpy Array

	Expression	Shape
	`arr[:2, 1:]`	`(2, 2)`
	`arr[2]`	`(3,)`
	`arr[2, :]`	`(3,)`
	`arr[2:, :]`	`(1, 3)`
	`arr[:, :2]`	`(3, 2)`
	`arr[1, :2]`	`(2,)`
	`arr[1:2, :2]`	`(1, 2)`

Source: https://www.safaribooksonline.com/library/view/python-for-data/9781449323592/ch04.html

Wes McKinney (2017), "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2nd Edition, O'Reilly Media.

Materials and IPython notebooks for "Python for Data Analysis" by Wes McKinney, published by O'Reilly Media

52 commits | **2** branches | **0** releases | **6** contributors

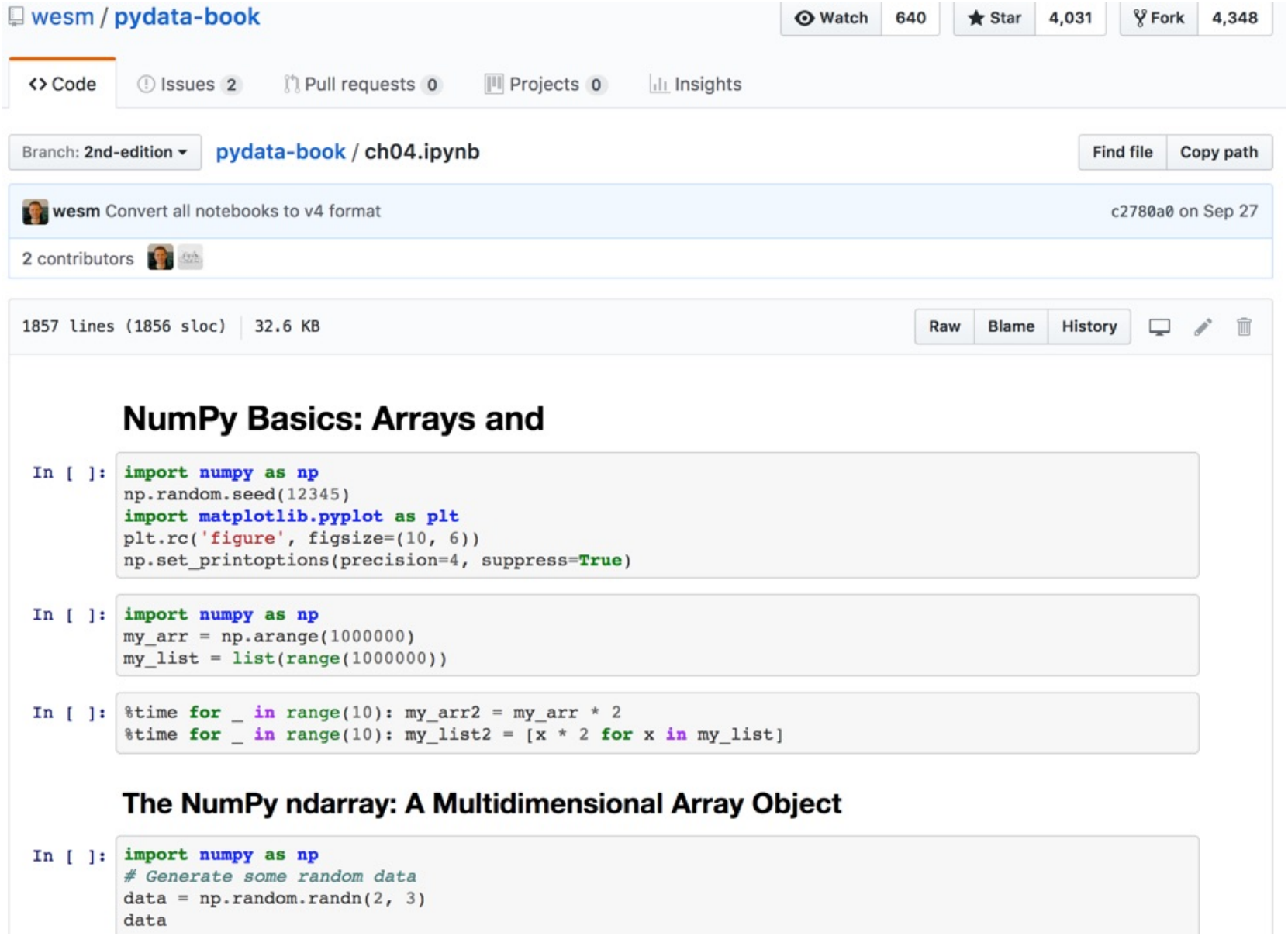
Branch: **2nd-edition** | New pull request | Find file | Clone or download

betatim committed with **wesm** Add requirements (#71) — Latest commit ea47998 5 days ago

datasets	Add Kaggle titanic dataset	5 months ago
examples	Remove sex column from tips dataset	4 months ago
.gitignore	Add gitignore	2 years ago
COPYING	Use MIT license for code examples	a month ago
README.md	Add launch in Azure Notebooks button (#70)	19 days ago
appa.ipynb	Make more cells markdown instead of raw	a month ago
ch02.ipynb	Make more cells markdown instead of raw	a month ago
ch03.ipynb	Make more cells markdown instead of raw	a month ago
ch04.ipynb	Convert all notebooks to v4 format	a month ago
ch05.ipynb	Make more cells markdown instead of raw	a month ago
ch06.ipynb	Make more cells markdown instead of raw	a month ago
ch07.ipynb	Convert all notebooks to v4 format	a month ago
ch08.ipynb	Make more cells markdown instead of raw	a month ago
ch09.ipynb	Make more cells markdown instead of raw	a month ago
ch10.ipynb	Make more cells markdown instead of raw	a month ago

https://github.com/wesm/pydata-book

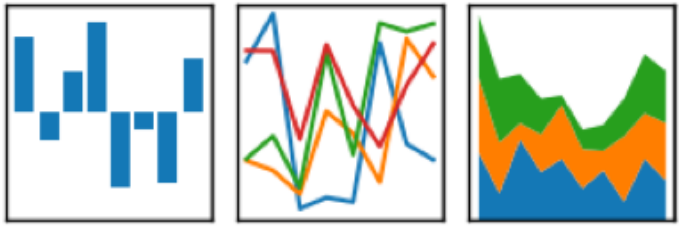
Wes McKinney (2017), "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2nd Edition, O'Reilly Media.



Source: https://github.com/wesm/pydata-book/blob/2nd-edition/ch04.ipynb

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$

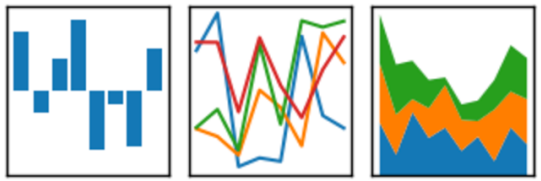


Python Pandas

pandas

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



Python Data Analysis Library

pandas is an open source, BSD-licensed library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language.

pandas is a NUMFocus sponsored project. This will help ensure the success of development of *pandas* as a world-class open-source project.

A Fiscally Sponsored Project of
NUMFOCUS
OPEN CODE = BETTER SCIENCE

0.19.2 Final (December 24, 2016)

This is a minor bug-fix release in the 0.19.x series and includes some small regression fixes, bug fixes and performance improvements.

Highlights include:

- Compatibility with Python 3.6

VERSIONS

Release
0.19.2 - December 2016
download // docs // pdf

Development
0.20.0 - 2017
github // docs

Previous Releases
0.19.1 - download // docs // pdf
0.19.0 - download // docs // pdf
0.18.1 - download // docs // pdf
0.18.0 - download // docs // pdf
0.17.1 - download // docs // pdf
0.17.0 - download // docs // pdf
0.16.2 - download // docs // pdf
0.16.1 - download // docs // pdf
0.16.0 - download // docs // pdf
0.15.2 - download // docs // pdf
0.15.1 - download // docs // pdf
0.15.0 - download // docs // pdf
0.14.1 - download // docs // pdf

http://pandas.pydata.org/

pandas

Python Data Analysis Library

providing high-performance, easy-to-use
data structures and data analysis tools
for the Python programming language.

Source: http://pandas.pydata.org/

pandas Ecosystem

- Statistics and Machine Learning
  - Statsmodels
  - sklearn-pandas
- Visualization
  - Bokeh
  - yhat/ggplot
  - Seaborn
  - Vincent
  - IPython Vega
  - Plotly
  - Pandas-Qt
- IDE
  - IPython
  - quantopian/qgrid
  - Spyder
- API
  - pandas-datareader
  - quandl/Python
  - pydatastream
  - pandaSDMX
  - fredapi
- Domain Specific
  - Geopandas
  - xarray
- Out-of-core
  - Dask
  - Blaze
  - Odo

Source: http://pandas.pydata.org/pandas-docs/stable/index.html

pandas-datareader

pandas-datareader

latest

Search docs

What's New

Remote Data Access

Caching queries

Other Data Sources

Data Readers

Take the Python User's Survey and let us know more about your usage of Python.

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Read the Docs v: latest

pandas-datareader

Up to date remote data access for pandas, works for multiple versions of pandas.

pypi v0.7.0 | build failing | coverage 79% | docs passing | health 95%

Warning

As of v0.6.0 Yahoo!, Google Options, Google Quotes and EDGAR have been immediately deprecated due to large changes in their API and no stable replacement.

Note

As of v0.6.0 Google finance is still functioning for historical price data, although there are frequent reports of failures. Failure is frequently encountered when bulk downloading historical price data.

Usage

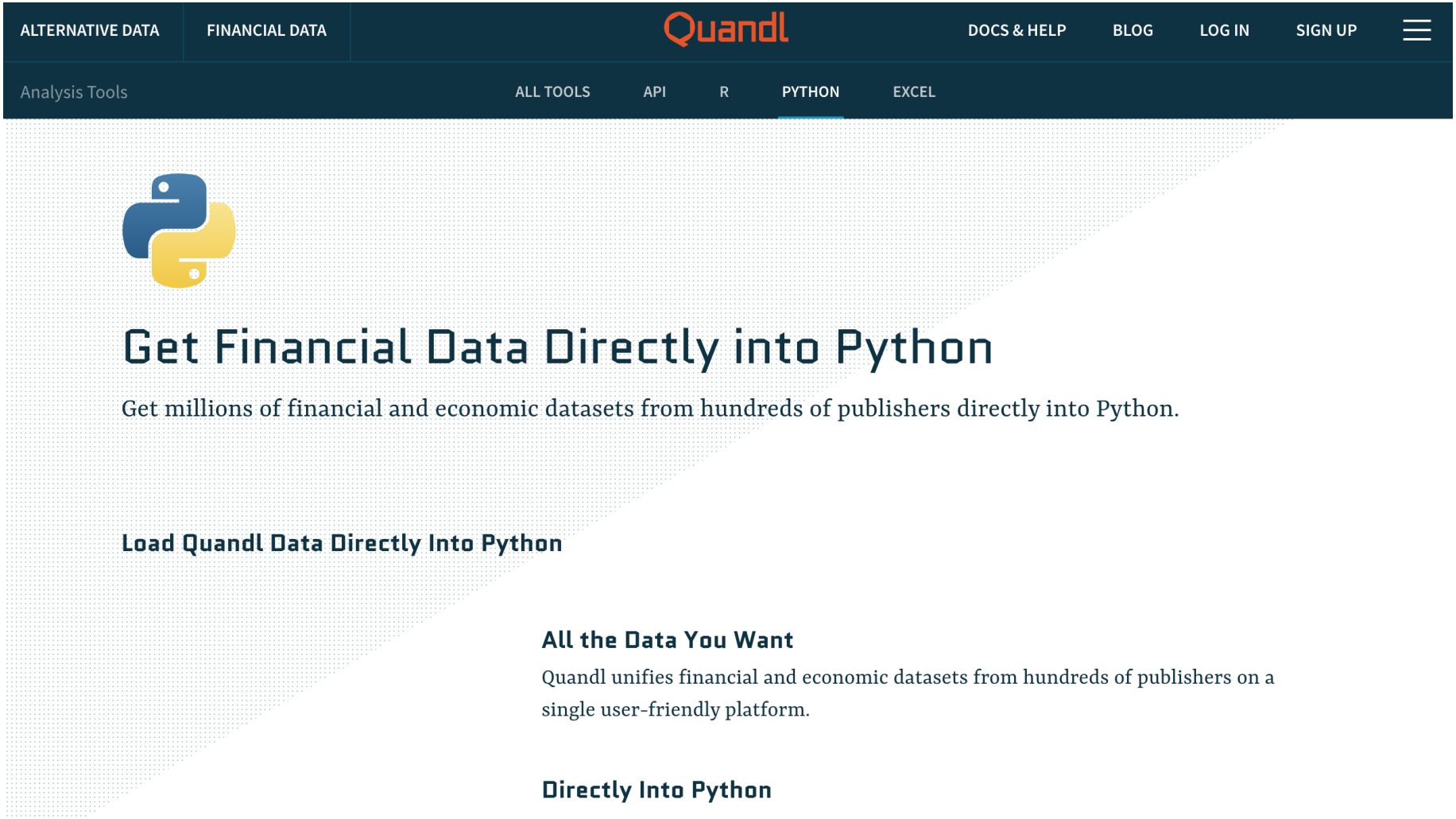
Starting in 0.19.0, pandas no longer supports `pandas.io.data` or `pandas.io.wb`, so you must replace your imports from `pandas.io` with those from `pandas_datareader`:

```
from pandas.io import data, wb # becomes
from pandas_datareader import data, wb
```

Many functions from the data module have been included in the top level API.

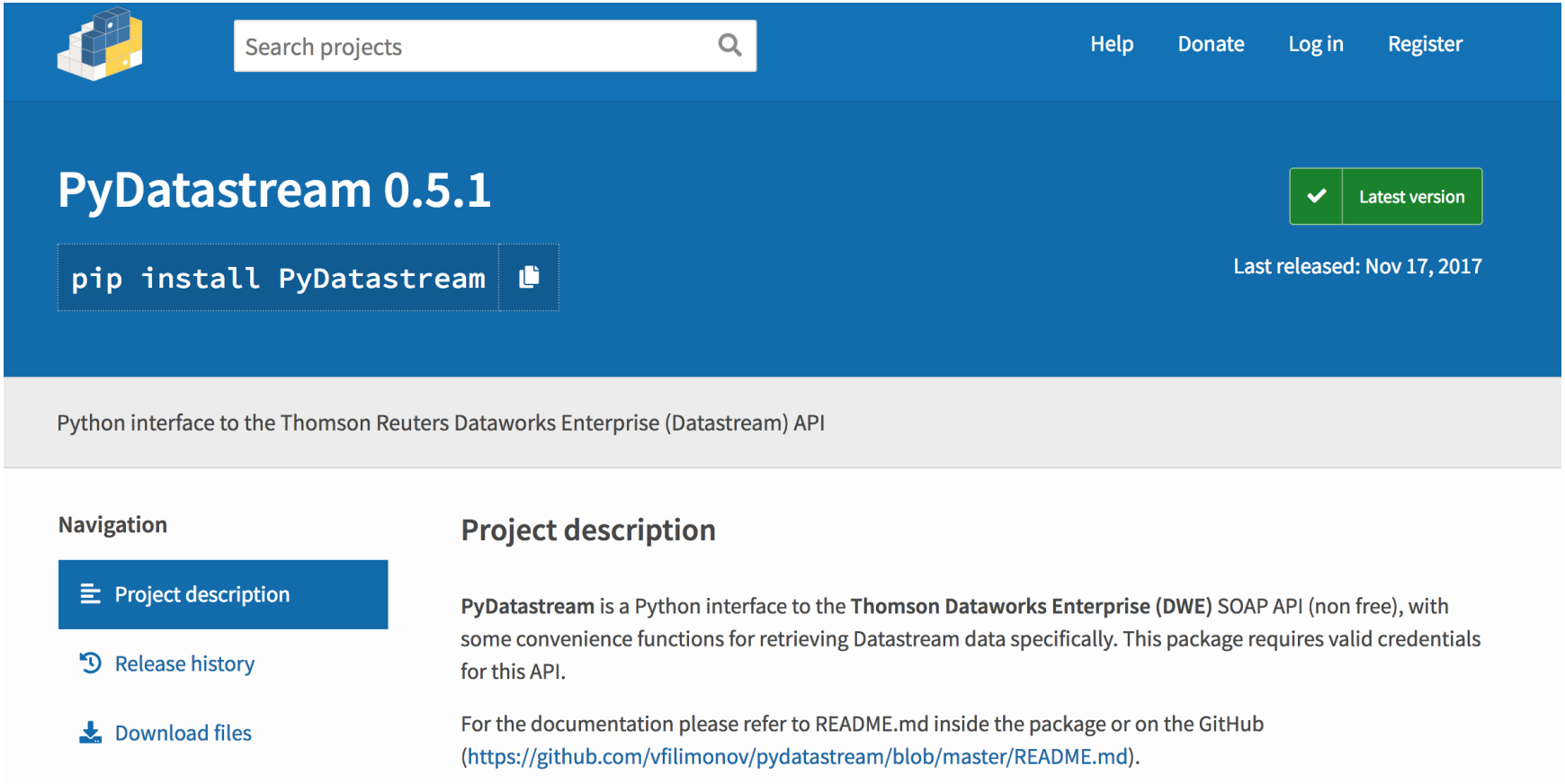
https://pandas-datareader.readthedocs.io/en/latest/

Quandl



https://www.quandl.com/tools/python

PyDatastream



https://pypi.org/project/PyDatastream/

pandasSDMX

This Page

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pandaSDMX: Statistical Data and Metadata eXchange in Python

pandaSDMX is an Apache 2.0-licensed Python client to retrieve and acquire statistical data and metadata disseminated in SDMX 2.1, an ISO-standard widely used by institutions such as statistics offices, central banks, and international organisations. pandaSDMX exposes datasets and related structural metadata including dataflows, codelists, and datastructure definitions as pandas Series or multi-indexed DataFrames. Many other output formats and storage backends are available thanks to Odo.

Supported data providers

pandaSDMX ships with built-in support for the following agencies (others may be configured by the user):

- Australian Bureau of Statistics (ABS)
- European Central Bank (ECB)
- Eurostat
- French National Institute for Statistics (INSEE)
- Instituto Nacional de la Estadìstica y Geografia - INEGI (Mexico)
- International Monetary Fund (IMF) - SDMX Central only
- International Labour Organization (ILO)
- Italian statistics Office (ISTAT)
- Norges Bank (Norway)
- Organisation for Economic Cooperation and Development (OECD)
- United Nations Statistics Division (UNSD)
- UNESCO (free registration required)
- World Bank - World Integrated Trade Solution (WITS)

https://pandasdmx.readthedocs.io/en/latest/

Fred API

Home > Developer API > FRED API

API Keys | Terms of Use

FRED® API

General Documentation | API | Toolkits

The FRED® API is a web service that allows developers to write programs and build applications that retrieve economic data from the FRED® and ALFRED® websites hosted by the Economic Research Division of the Federal Reserve Bank of St. Louis. Requests can be customized according to data source, release, category, series, and other preferences.

General Documentation

- Overview
- What is FRED®?
- What is ALFRED®?
- FRED® versus ALFRED®
- Real-Time Periods
- Errors

API

Categories

- fred/category – Get a category.
- fred/category/children – Get the child categories for a specified parent category.
- fred/category/related – Get the related categories for a category.
- fred/category/series – Get the series in a category.
- fred/category/tags – Get the tags for a category.
- fred/category/related_tags – Get the related tags for a category.

https://research.stlouisfed.org/docs/api/fred/

pandas: powerful Python data analysis toolkit

pandas 0.19.2 documentation »

Table Of Contents

pandas: powerful Python data analysis toolkit

PDF Version

Zipped HTML

Date: Dec 24, 2016 **Version**: 0.19.2

Binary Installers: http://pypi.python.org/pypi/pandas

Source Repository: http://github.com/pydata/pandas

Issues & Ideas: https://github.com/pydata/pandas/issues

Q&A Support: http://stackoverflow.com/questions/tagged/pandas

Developer Mailing List: http://groups.google.com/group/pydata

pandas is a Python package providing fast, flexible, and expressive data structures designed to make working with "relational" or "labeled" data both easy and intuitive. It aims to be the fundamental high-level building block for doing practical, **real world** data analysis in Python. Additionally, it has the broader goal of becoming **the most powerful and flexible open source data analysis / manipulation tool available in any language**. It is already well on its way toward this goal.

pandas is well suited for many different kinds of data:

- Tabular data with heterogeneously-typed columns, as in an SQL table or Excel spreadsheet
- Ordered and unordered (not necessarily fixed-frequency) time series data.
- Arbitrary matrix data (homogeneously typed or heterogeneous) with row and column labels
- Any other form of observational / statistical data sets. The data actually need not be labeled at all to be placed into a pandas data structure

The two primary data structures of pandas, `Series` (1-dimensional) and `DataFrame` (2-dimensional), handle the vast majority of typical use cases in finance, statistics, social science, and many areas of engineering. For R users, `DataFrame` provides everything that R's `data.frame` provides and much more. pandas is built on top of NumPy and is

http://pandas.pydata.org/pandas-docs/stable/

pandas:
powerful Python data analysis toolkit

- Tabular data with heterogeneously-typed columns, as in an SQL table or Excel spreadsheet
- Ordered and unordered (not necessarily fixed-frequency) time series data.
- Arbitrary matrix data (homogeneously typed or heterogeneous) with row and column labels
- Any other form of observational / statistical data sets. The data actually need not be labeled at all to be placed into a pandas data structure

Source: http://pandas.pydata.org/pandas-docs/stable/

Series
DataFrame

- Primary data structures of pandas
  - Series (1-dimensional)
  - DataFrame (2-dimensional)
- Handle the vast majority of typical use cases in finance, statistics, social science, and many areas of engineering.

Source: http://pandas.pydata.org/pandas-docs/stable/

pandas DataFrame

- DataFrame provides everything that R's data.frame provides and much more.
- pandas is built on top of NumPy and is intended to integrate well within a scientific computing environment with many other 3rd party libraries.

pandas
Comparison with SAS

pandas	SAS
DataFrame	data set
column	variable
row	observation
groupby	BY-group
NaN	.

Source: http://pandas.pydata.org/pandas-docs/stable/comparison_with_sas.html

Python Pandas Cheat Sheet

Data Wrangling with pandas Cheat Sheet

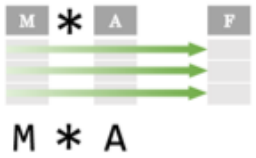
http://pandas.pydata.org

Tidy Data – A foundation for wrangling in pandas

Each **variable** is saved in its own **column**

Each **observation** is saved in its own **row**

Tidy data complements pandas's vectorized operations. pandas will automatically preserve observations as you manipulate variables. No other format works as intuitively with pandas.



Syntax – Creating DataFrames

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

```
df = pd.DataFrame(
        {"a" : [4 ,5, 6],
         "b" : [7, 8, 9],
         "c" : [10, 11, 12]},
       index = [1, 2, 3])
```

Specify values for each column.

```
df = pd.DataFrame(
    [[4, 7, 10],
     [5, 8, 11],
     [6, 9, 12]],
    index=[1, 2, 3],
    columns=['a', 'b', 'c'])
```

Specify values for each row.

		a	b	c
n	v			
d	1	4	7	10
	2	5	8	11
e	2	6	9	12

```
df = pd.DataFrame(
        {"a" : [4 ,5, 6],
         "b" : [7, 8, 9],
         "c" : [10, 11, 12]},
index = pd.MultiIndex.from_tuples(
        [('d',1),('d',2),('e',2)],
          names=['n','v']))
```

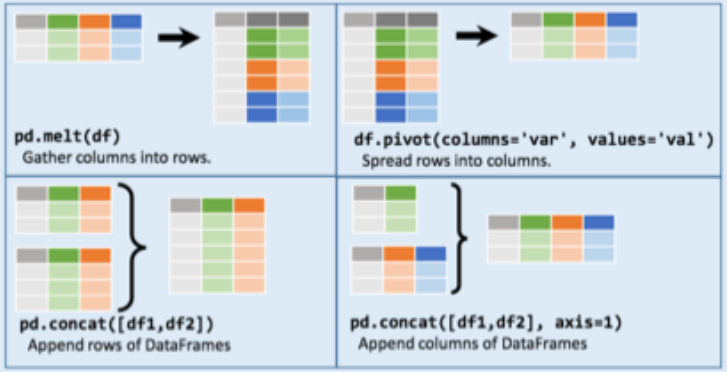
Create DataFrame with a MultiIndex

Method Chaining

Most pandas methods return a DataFrame so that another pandas method can be applied to the result. This improves readability of code.

```
df = (pd.melt(df)
        .rename(columns={
                'variable' : 'var',
                'value' : 'val'})
        .query('val >= 200')
    )
```

Reshaping Data – Change the layout of a data set



pd.melt(df)
Gather columns into rows.

df.pivot(columns='var', values='val')
Spread rows into columns.

pd.concat([df1,df2])
Append rows of DataFrames

pd.concat([df1,df2], axis=1)
Append columns of DataFrames

df=df.sort_values('mpg')
Order rows by values of a column (low to high).

df=df.sort_values('mpg',ascending=False)
Order rows by values of a column (high to low).

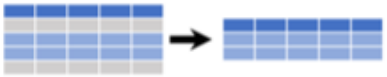
df=df.rename(columns = {'y':'year'})
Rename the columns of a DataFrame

df=df.sort_index()
Sort the index of a DataFrame

df=df.reset_index()
Reset index of DataFrame to row numbers, moving index to columns.

df=df.drop(['Length','Height'], axis=1)
Drop columns from DataFrame

Subset Observations (Rows)



df[df.Length > 7]
Extract rows that meet logical criteria.

df.drop_duplicates()
Remove duplicate rows (only considers columns).

df.head(n)
Select first n rows.

df.tail(n)
Select last n rows.

df.sample(frac=0.5)
Randomly select fraction of rows.

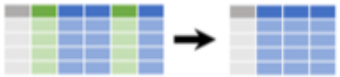
df.sample(n=10)
Randomly select n rows.

df.iloc[10:20]
Select rows by position.

df.nlargest(n, 'value')
Select and order top n entries.

df.nsmallest(n, 'value')
Select and order bottom n entries.

Subset Variables (Columns)



df[['width','length','species']]
Select multiple columns with specific names.

df['width'] *or* **df.width**
Select single column with specific name.

df.filter(regex='*regex*')
Select columns whose name matches regular expression *regex*.

regex (Regular Expressions) Examples	
'\.'	Matches strings containing a period '.'
'Length$'	Matches strings ending with word 'Length'
'^Sepal'	Matches strings beginning with the word 'Sepal'
'^x[1-5]$'	Matches strings beginning with 'x' and ending with 1,2,3,4,5
''^(?!Species$).*'	Matches strings except the string 'Species'

df.loc[:,'x2':'x4']
Select all columns between x2 and x4 (inclusive).

df.iloc[:,[1,2,5]]
Select columns in positions 1, 2 and 5 (first column is 0).

df.loc[df['a'] > 10, ['a','c']]
Select rows meeting logical condition, and only the specific columns .

Logic in Python (and pandas)			
<	Less than	!=	Not equal to
>	Greater than	df.column.isin(*values*)	Group membership
==	Equals	pd.isnull(*obj*)	Is NaN
<=	Less than or equals	pd.notnull(*obj*)	Is not NaN
>=	Greater than or equals	&,|,~,^,df.any(),df.all()	Logical and, or, not, xor, any, all

http://pandas.pydata.org/ This cheat sheet inspired by Rstudio Data Wrangling Cheatsheet (https://www.rstudio.com/wp-content/uploads/2015/02/data-wrangling-cheatsheet.pdf) Written by Irv Lustig, Princeton Consultants

Source: https://github.com/pandas-dev/pandas/blob/master/doc/cheatsheet/Pandas_Cheat_Sheet.pdf

Creating pd.DataFrame

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

In [1]:
```
import numpy as np
import pandas as pd
df = pd.DataFrame({"a": [4, 5, 6],
                   "b": [7, 8, 9],
                   "c": [10, 11, 12]},
                  index = [1, 2, 3])
df
```

Out[1]:

	a	b	c
1	4	7	10
2	5	8	11
3	6	9	12

```
import pandas as pd
df = pd.DataFrame({"a": [4, 5, 6],
                   "b": [7, 8, 9],
                   "c": [10, 11, 12]},
                  index = [1, 2, 3])
```

Source: https://github.com/pandas-dev/pandas/blob/master/doc/cheatsheet/Pandas_Cheat_Sheet.pdf

Pandas DataFrame

```
type(df)
```

```
type(df)
```

```
pandas.core.frame.DataFrame
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
print('pandas imported')
```

```
s = pd.Series([1,3,5,np.nan,6,8])
s
```

```
dates = pd.date_range('20181001',
periods=6)
dates
```

Source: http://pandas.pydata.org/pandas-docs/stable/10min.html

```
1 import numpy as np
2 import pandas as pd
3 import matplotlib.pyplot as plt
4 print('pandas imported')
```

```
pandas imported
```

```
1 s = pd.Series([1,3,5,np.nan,6,8])
2 s
```

```
0    1.0
1    3.0
2    5.0
3    NaN
4    6.0
5    8.0
dtype: float64
```

```
1 dates = pd.date_range('20181001', periods=6)
2 dates
```

```
DatetimeIndex(['2018-10-01', '2018-10-02', '2018-10-03', '2018-10-04',
               '2018-10-05', '2018-10-06'],
              dtype='datetime64[ns]', freq='D')
```

```
df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))
df
```

```
1 df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))
2 df
```

	A	B	C	D
2018-10-01	-0.336188	0.584621	-1.061433	-0.036278
2018-10-02	0.903683	-0.839723	-0.270219	-1.099606
2018-10-03	0.920208	-0.240353	-0.818598	-1.105489
2018-10-04	0.221045	-0.314589	0.042071	-1.447280
2018-10-05	0.946862	-1.570305	-1.009180	-0.375659
2018-10-06	-0.225148	0.510691	2.002372	-0.335005

```
df = pd.DataFrame(np.random.randn(3,5), index=['student1','student2','student3'], columns=list('ABCDE'))
df
```

```
1 df = pd.DataFrame(np.random.randn(3,5), index=['student1','student2','student3'], columns=list('ABCDE'))
2 df
```

	A	B	C	D	E
student1	-0.346884	-1.232934	-0.302072	-1.345084	-0.723880
student2	1.090955	-0.010483	1.280072	-0.253958	-0.030604
student3	0.325660	0.808956	-0.395820	-1.498926	1.603471

```
df2 = pd.DataFrame({ 'A' : 1.,
'B' : pd.Timestamp('20181001'),
'C' : pd.Series(2.5,index=list(range(4)),dtype='float32'),
'D' : np.array([3] * 4,dtype='int32'),
'E' : pd.Categorical(["test","train","test","train"]),
'F' : 'foo' })
df2
```

```
1 df2 = pd.DataFrame({ 'A' : 1.,
2 'B' : pd.Timestamp('20181001'),
3 'C' : pd.Series(2.5,index=list(range(4)),dtype='float32'),
4 'D' : np.array([3] * 4,dtype='int32'),
5 'E' : pd.Categorical(["test","train","test","train"]),
6 'F' : 'foo' })
7 df2
```

	A	B	C	D	E	F
0	1.0	2018-10-01	2.5	3	test	foo
1	1.0	2018-10-01	2.5	3	train	foo
2	1.0	2018-10-01	2.5	3	test	foo
3	1.0	2018-10-01	2.5	3	train	foo

df2.dtypes

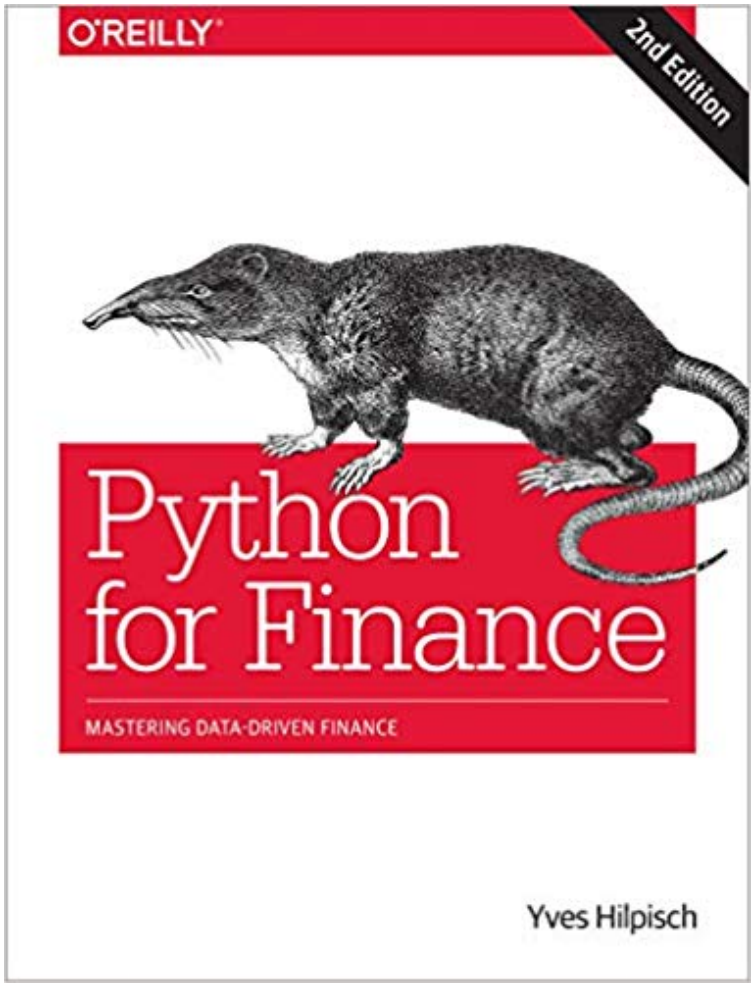
```
df2.dtypes
```

```
A              float64
B    datetime64[ns]
C              float32
D                int32
E             category
F               object
dtype: object
```

Python Pandas for Finance

Source: https://mapattack.wordpress.com/2017/02/12/using-python-for-stocks-1/

Yves Hilpisch (2018),
Python for Finance: Mastering Data-Driven Finance,
O'Reilly



https://github.com/yhilpisch/py4fi2nd

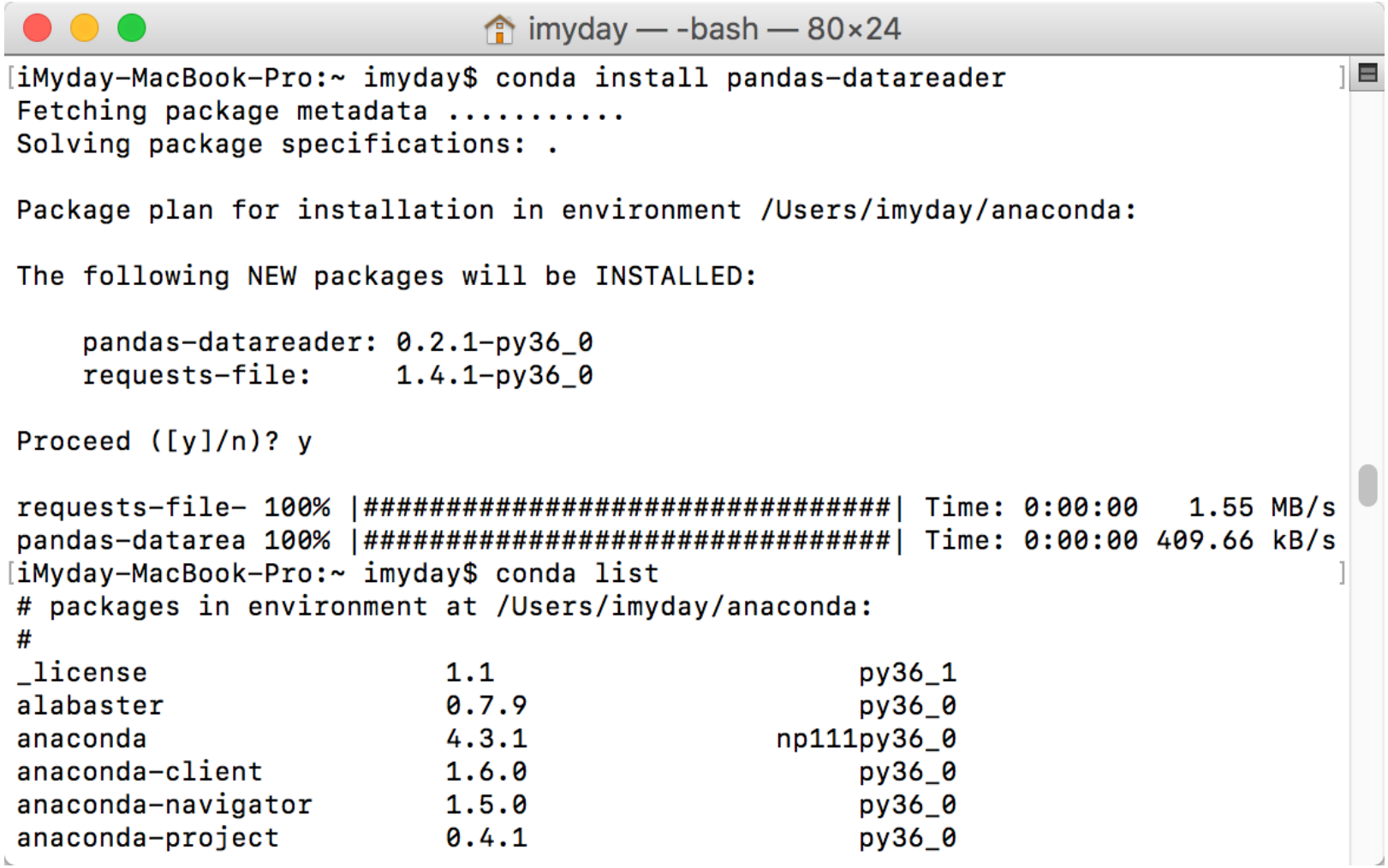
Source: https://www.amazon.com/Python-Finance-Mastering-Data-Driven/dp/1492024333

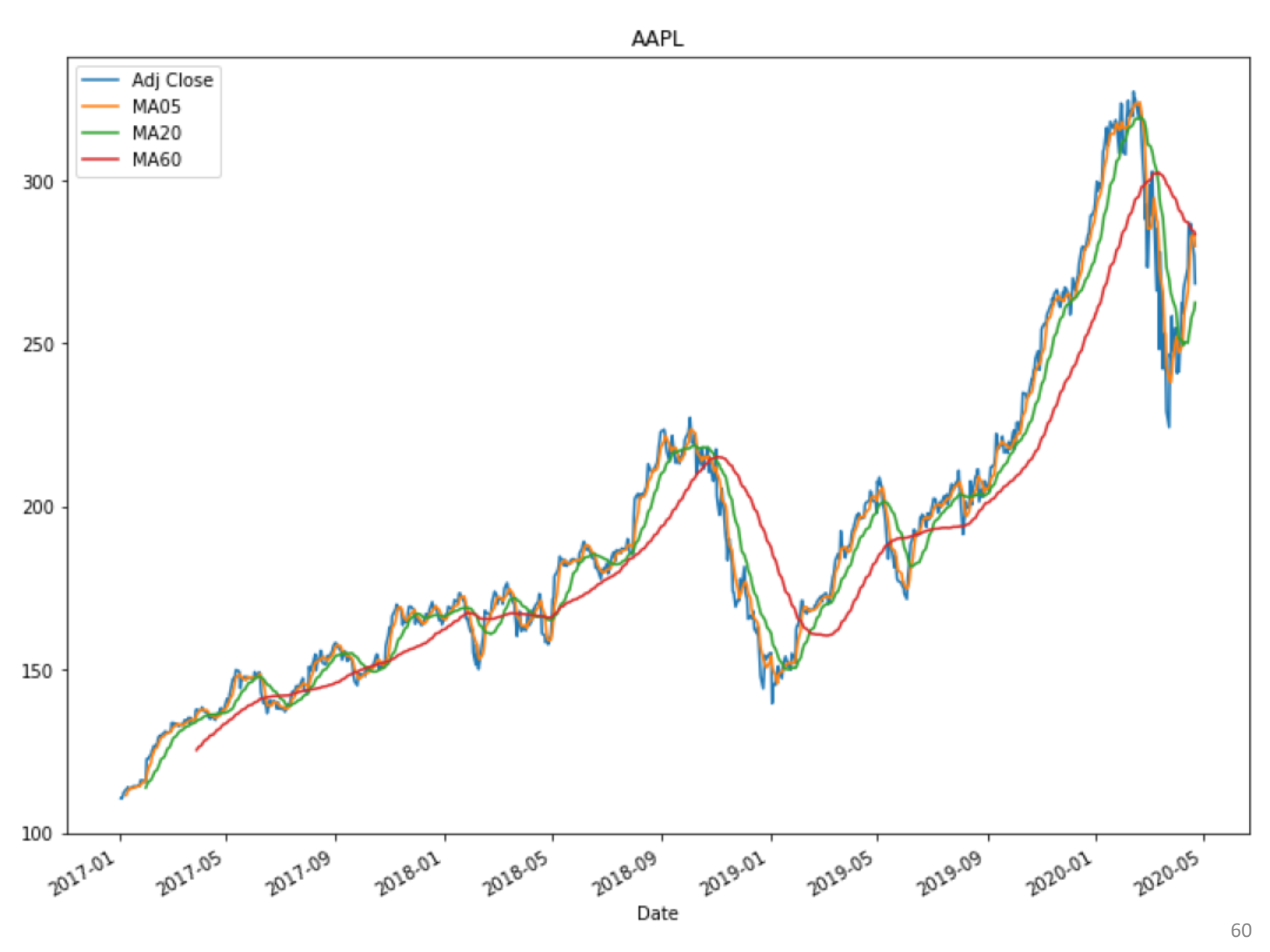
! pip install pandas_datareader

```
1 ! pip install pandas_datareader
```

```
Collecting pandas_datareader
  Downloading https://files.pythonhosted.org/packages/cc/5c/ea5b6dcfd0f55c5fb1e37fb45335ec01cceca199b8a79339137f5ed269e0/pandas_datarea
    100% |████████████████████████████████| 112kB 2.7MB/s
Collecting lxml (from pandas_datareader)
  Downloading https://files.pythonhosted.org/packages/03/a4/9eea8035fc7c7670e5eab97f34ff2ef0ddd78a491bf96df5accedb0e63f5/lxml-4.2.5-cp3
    100% |████████████████████████████████| 5.8MB 7.5MB/s
Requirement already satisfied: pandas>=0.19.2 in /usr/local/lib/python3.6/dist-packages (from pandas_datareader) (0.22.0)
Requirement already satisfied: requests>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from pandas_datareader) (2.18.4)
Requirement already satisfied: wrapt in /usr/local/lib/python3.6/dist-packages (from pandas_datareader) (1.10.11)
Requirement already satisfied: python-dateutil>=2 in /usr/local/lib/python3.6/dist-packages (from pandas>=0.19.2->pandas_datareader) (2
Requirement already satisfied: numpy>=1.9.0 in /usr/local/lib/python3.6/dist-packages (from pandas>=0.19.2->pandas_datareader) (1.14.6)
Requirement already satisfied: pytz>=2011k in /usr/local/lib/python3.6/dist-packages (from pandas>=0.19.2->pandas_datareader) (2018.5)
Requirement already satisfied: idna<2.7,>=2.5 in /usr/local/lib/python3.6/dist-packages (from requests>=2.3.0->pandas_datareader) (2.6)
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /usr/local/lib/python3.6/dist-packages (from requests>=2.3.0->pandas_datareader
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.6/dist-packages (from requests>=2.3.0->pandas_datareader) (
Requirement already satisfied: urllib3<1.23,>=1.21.1 in /usr/local/lib/python3.6/dist-packages (from requests>=2.3.0->pandas_datareader
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2->pandas>=0.19.2->pandas_data
Installing collected packages: lxml, pandas-datareader
Successfully installed lxml-4.2.5 pandas-datareader-0.7.0
```

conda install pandas-datareader




AAPL
Adj Close
MA05
MA20
MA60
300
250
200
150
100
2017-01
2017-05
2017-09
2018-01
2018-05
2018-09
2019-01
2019-05
2019-09
2020-01
2020-05
Date

Finance Data from Yahoo Finance

```
# !pip install pandas_datareader
import pandas_datareader.data as web
import datetime as dt
#Read Stock Data from Yahoo Finance
end = dt.datetime(2017, 12, 31)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()
```

```
# !pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month,
end.day)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()
```

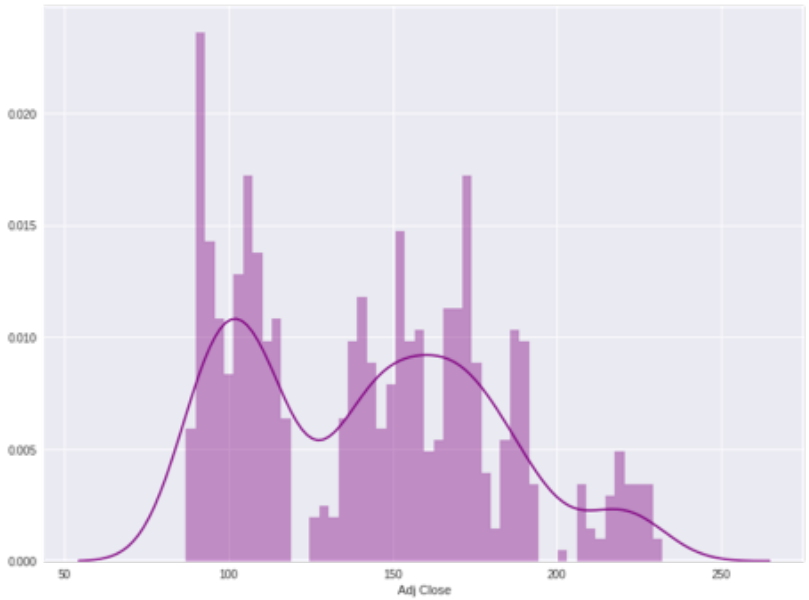
```
df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
```

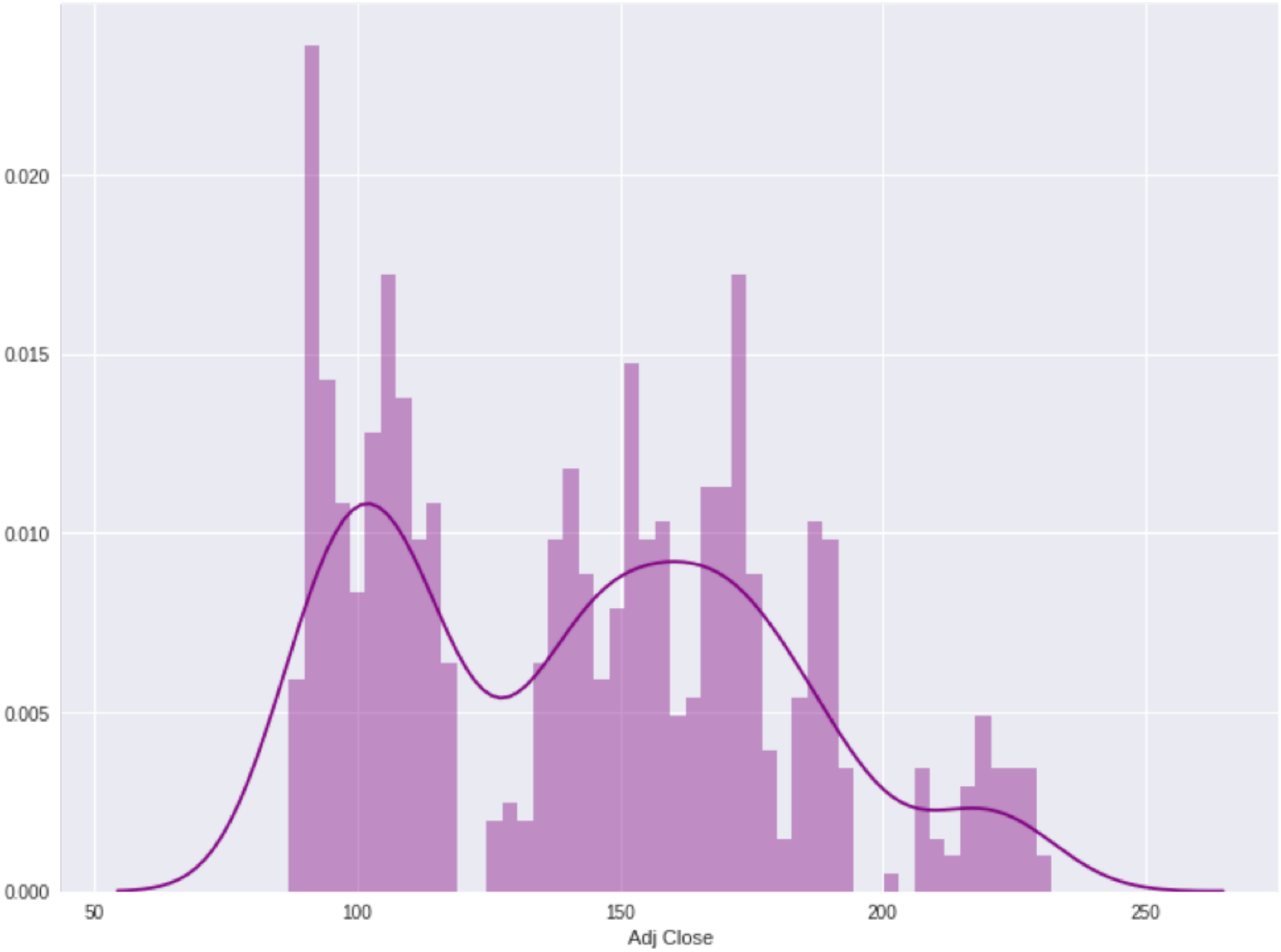
```
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0),
rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0),
rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'],
color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])
```


AAPL
Adj Close
220
200
180
160
140
120
100
80
1e8
Volume
1.0
0.5
0.0
2016-02
2016-06
2016-10
2017-02
2017-06
2017-10
2018-02
2018-06
2018-10

```
 # set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(),
bins=50, color='purple')
```




0.020
0.015
0.010
0.005
0.000
50
100
150
200
250
Adj Close

```
# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean()
#5 days
df['MA20'] = df['Adj
Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj
Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj
Close'],'MA05': df['MA05'],'MA20': df['MA20'],
'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True,
title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
plt.show()
```


AAPL
Adj Close
MA05
MA20
MA60
220
200
180
160
140
120
100
80
2016-02
2016-06
2016-10
2017-02
2017-06
2017-10
2018-02
2018-06
2018-10
Date

```
# !pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()

df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0), rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0), rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'], color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])

# set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
plt.show()
```

```
# !pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()

df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0), rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0), rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'], color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])

# set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
plt.show()
```

Finance Data from Quandl

```
# ! pip install quandl
import quandl
# quandl.ApiConfig.api_key = "YOURAPIKEY"
df = quandl.get("WIKI/AAPL", start_date="2016-01-01", end_date="2017-12-31")
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()
```

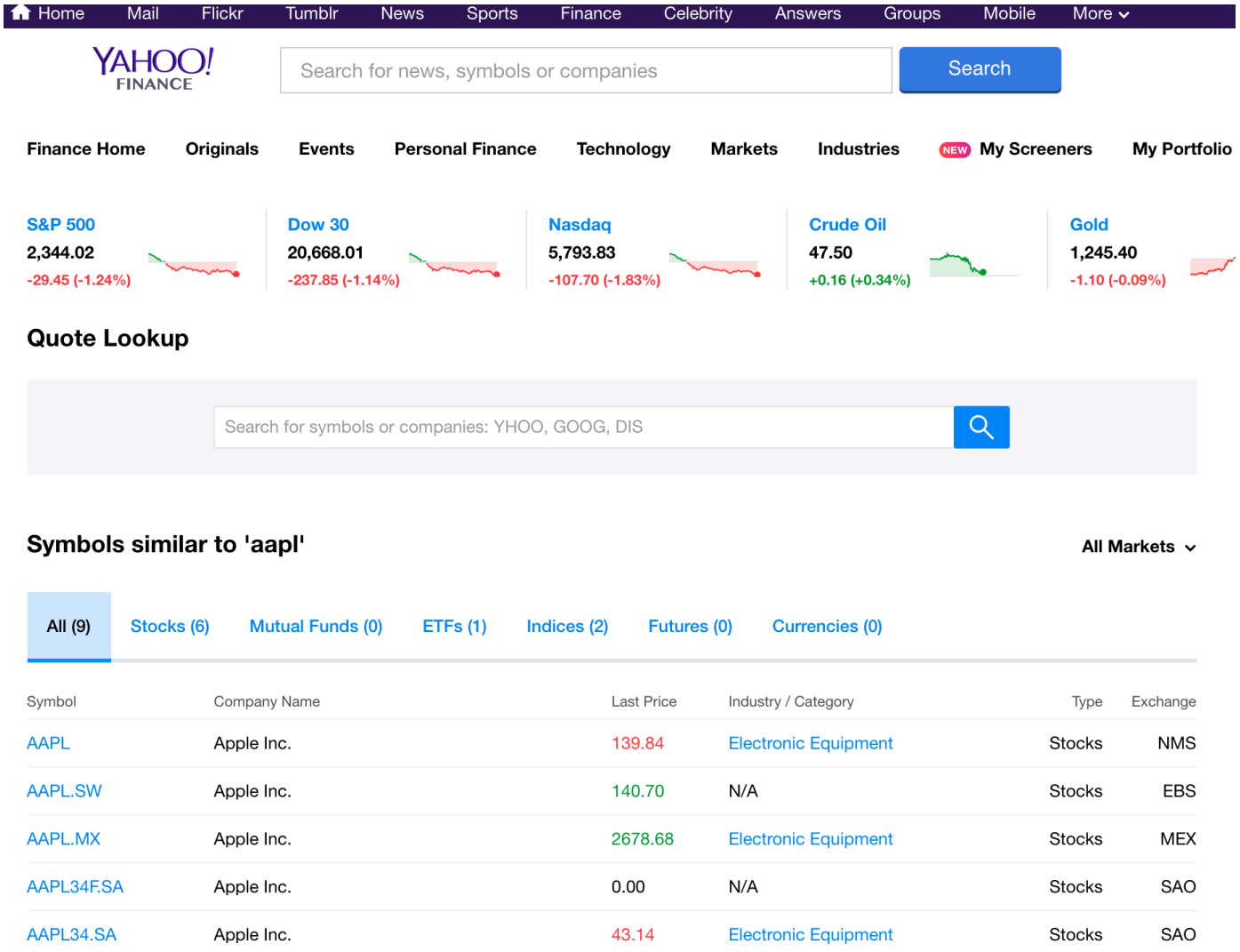
```
1 # ! pip install quandl
2 import quandl
3 # quandl.ApiConfig.api_key = "YOURAPIKEY"
4 df = quandl.get("WIKI/AAPL", start_date="2016-01-01", end_date="2017-12-31")
5 df.to_csv('AAPL.csv')
6 df.from_csv('AAPL.csv')
7 df.tail()
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:5: FutureWarning: from_csv is deprecated. Please use read_csv(...) instead
  """
```

Date	Open	High	Low	Close	Volume	Ex-Dividend	Split Ratio	Adj. Open	Adj. High	Adj. Low	Adj. Close	Adj. Volume
2017-12-22	174.68	175.424	174.500	175.01	16052615.0	0.0	1.0	174.68	175.424	174.500	175.01	16052615.0
2017-12-26	170.80	171.470	169.679	170.57	32968167.0	0.0	1.0	170.80	171.470	169.679	170.57	32968167.0
2017-12-27	170.10	170.780	169.710	170.60	21672062.0	0.0	1.0	170.10	170.780	169.710	170.60	21672062.0
2017-12-28	171.00	171.850	170.480	171.08	15997739.0	0.0	1.0	171.00	171.850	170.480	171.08	15997739.0
2017-12-29	170.52	170.590	169.220	169.23	25643711.0	0.0	1.0	170.52	170.590	169.220	169.23	25643711.0

Source: https://www.quandl.com/tools/python

Yahoo Finance Symbols: AAPL Apple Inc. (AAPL)



http://finance.yahoo.com/q?s=AAPL

Apple Inc. (AAPL) -NasdaqGS

YAHOO! FINANCE

Search for news, symbols or companies | Search

Apple Inc. (AAPL)

NasdaqGS - NasdaqGS Delayed Price. Currency in USD

Add to watchlist

139.84 -1.62 (-1.15%)
At close: 4:00PM EDT

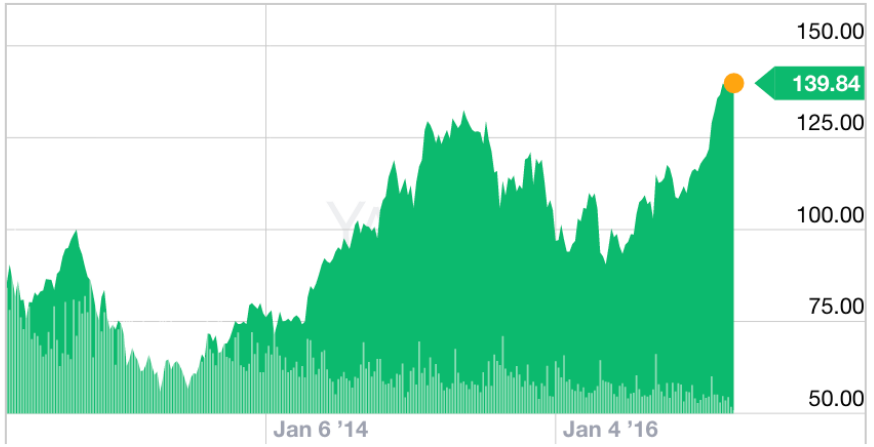
139.35 -0.49 (-0.35%)
After hours: 7:59PM EDT

Summary | Conversations | Statistics | Profile | Financials | Options | Holders | Historical Data | Analysts

Previous Close	141.46	Market Cap	733.68B
Open	142.11	Beta	1.45
Bid	139.31 x 100	PE Ratio (TTM)	16.79
Ask	139.40 x 1300	EPS (TTM)	8.33
Day's Range	139.73 - 142.80	Earnings Date	Apr 24, 2017 - Apr 28, 2017
52 Week Range	89.47 - 142.80	Dividend & Yield	2.28 (1.63%)
Volume	39,529,912	Ex-Dividend Date	N/A
Avg. Volume	26,889,183	1y Target Est	143.29

Trade prices are not sourced from all markets

1D 5D 1M 6M YTD 1Y 2Y **5Y** 10Y MAX | Interactive chart

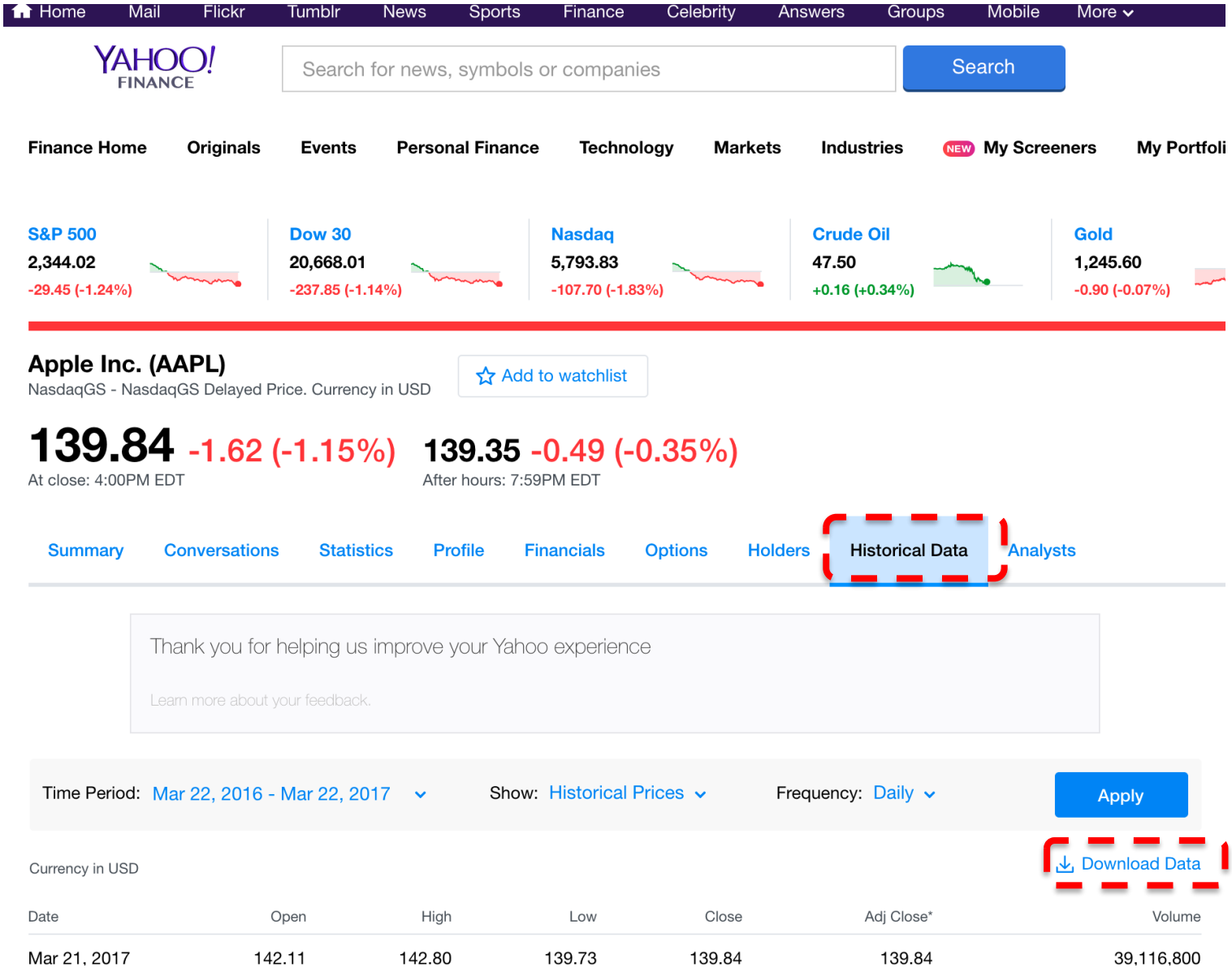


http://finance.yahoo.com/quote/AAPL?p=AAPL

Yahoo Finance Charts: Apple Inc. (AAPL)

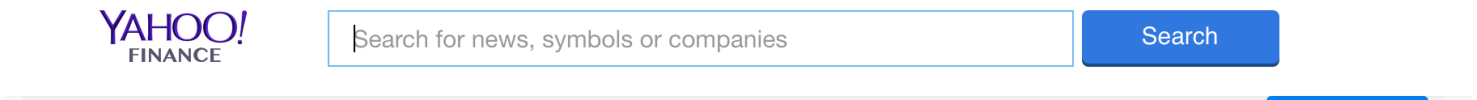
http://finance.yahoo.com/chart/AAPL

Apple Inc. (AAPL) Historical Data



http://finance.yahoo.com/q/hp?s=AAPL+Historical+Prices

Yahoo Finance Historical Prices
Apple Inc. (AAPL)



Time Period: Mar 22, 2016 - Mar 22, 2017 Show: Historical Prices Frequency: Daily Apply

Currency in USD

Download Data

Date	Open	High	Low	Close	Adj Close*	Volume
Mar 21, 2017	142.11	142.80	139.73	139.84	139.84	39,116,800
Mar 20, 2017	140.40	141.50	140.23	141.46	141.46	21,542,000
Mar 17, 2017	141.00	141.00	139.89	139.99	139.99	43,885,000
Mar 16, 2017	140.72	141.02	140.26	140.69	140.69	19,232,000
Mar 15, 2017	139.41	140.75	139.03	140.46	140.46	25,691,800
Mar 14, 2017	139.30	139.65	138.84	138.99	138.99	15,309,100
Mar 13, 2017	138.85	139.43	138.82	139.20	139.20	17,421,700
Mar 10, 2017	139.25	139.36	138.64	139.14	139.14	19,612,800
Mar 09, 2017	138.74	138.79	137.05	138.68	138.68	22,155,900
Mar 08, 2017	138.95	139.80	138.82	139.00	139.00	18,707,200
Mar 07, 2017	139.06	139.98	138.79	139.52	139.52	17,446,300
Mar 06, 2017	139.37	139.77	138.60	139.34	139.34	21,750,000
Mar 03, 2017	138.78	139.83	138.59	139.78	139.78	21,108,100

http://finance.yahoo.com/quote/AAPL/history

Yahoo Finance Historical Prices
Apple Inc. (AAPL)

Search for news, symbols or companies | Search

Time Period: Dec 12, 1980 - Mar 22, 2017 | Show: Historical Prices | Frequency: Daily | Apply

1D 5D 3M 6M
YTD 1Y 5Y MAX

Start Date: 12/12/1980
End Date: 3/22/2017

Done | Cancel

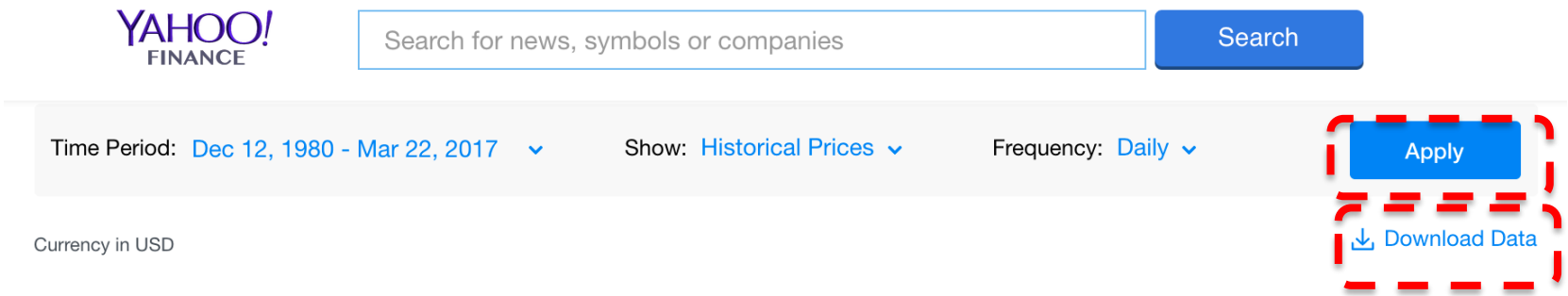
Currency i

Download Data

Date	Open	High	Low	Close	Adj Close*	Volume
Mar 21, 2		42.80	139.73	139.84	139.84	39,116,800
Mar 20, 2		41.50	140.23	141.46	141.46	21,542,000
Mar 17, 2		41.00	139.89	139.99	139.99	43,885,000
Mar 16, 2017	140.72	141.02	140.26	140.69	140.69	19,232,000
Mar 15, 2017	139.41	140.75	139.03	140.46	140.46	25,691,800
Mar 14, 2017	139.30	139.65	138.84	138.99	138.99	15,309,100
Mar 13, 2017	138.85	139.43	138.82	139.20	139.20	17,421,700
Mar 10, 2017	139.25	139.36	138.64	139.14	139.14	19,612,800
Mar 09, 2017	138.74	138.79	137.05	138.68	138.68	22,155,900
Mar 08, 2017	138.95	139.80	138.82	139.00	139.00	18,707,200

http://finance.yahoo.com/quote/AAPL/history?period1=345398400&period2=1490112000&interval=1d&filter=history&frequency=1d

Yahoo Finance Historical Prices
Apple Inc. (AAPL)



Currency in USD

Date	Open	High	Low	Close	Adj Close*	Volume
Mar 21, 2017	142.11	142.80	139.73	139.84	139.84	39,116,800
Mar 20, 2017	140.40	141.50	140.23	141.46	141.46	21,542,000
Mar 17, 2017	141.00	141.00	139.89	139.99	139.99	43,885,000
Mar 16, 2017	140.72	141.02	140.26	140.69	140.69	19,232,000
Mar 15, 2017	139.41	140.75	139.03	140.46	140.46	25,691,800
Mar 14, 2017	139.30	139.65	138.84	138.99	138.99	15,309,100
Mar 13, 2017	138.85	139.43	138.82	139.20	139.20	17,421,700
Mar 10, 2017	139.25	139.36	138.64	139.14	139.14	19,612,800
Mar 09, 2017	138.74	138.79	137.05	138.68	138.68	22,155,900
Mar 08, 2017	138.95	139.80	138.82	139.00	139.00	18,707,200

http://finance.yahoo.com/quote/AAPL/history?period1=345398400&period2=1490112000&interval=1d&filter=history&frequency=1d

Yahoo Finance Historical Prices

http://ichart.finance.yahoo.com/table.csv?s=AAPL

table.csv

```
Date,Open,High,Low,Close,Volume,Adj Close
2017-03-21,142.110001,142.800003,139.729996,139.839996,39116800,139.839996
2017-03-20,140.399994,141.50,140.229996,141.460007,20213100,141.460007
2017-03-17,141.00,141.00,139.889999,139.990005,43597400,139.990005
2017-03-16,140.720001,141.020004,140.259995,140.690002,19132500,140.690002
2017-03-15,139.410004,140.75,139.029999,140.460007,25566800,140.460007
2017-03-14,139.300003,139.649994,138.839996,138.990005,15189700,138.990005
2017-03-13,138.850006,139.429993,138.820007,139.199997,17042400,139.199997
2017-03-10,139.25,139.360001,138.639999,139.139999,19488000,139.139999
2017-03-09,138.740005,138.789993,137.050003,138.679993,22065200,138.679993
2017-03-08,138.949997,139.800003,138.820007,139.00,18681800,139.00
2017-03-07,139.059998,139.979996,138.789993,139.520004,17267500,139.520004
2017-03-06,139.369995,139.770004,138.600006,139.339996,21155300,139.339996
2017-03-03,138.779999,139.830002,138.589996,139.779999,21108100,139.779999
2017-03-02,140.00,140.279999,138.759995,138.960007,26153300,138.960007
2017-03-01,137.889999,140.149994,137.600006,139.789993,36272400,139.789993
2017-02-28,137.080002,137.440002,136.699997,136.990005,23403500,136.990005
2017-02-27,137.139999,137.440002,136.279999,136.929993,20196400,136.929993
2017-02-24,135.910004,136.660004,135.279999,136.660004,21690900,136.660004
2017-02-23,137.380005,137.479996,136.300003,136.529999,20704100,136.529999
2017-02-22,136.429993,137.119995,136.110001,137.110001,20745300,137.110001
```

Yahoo Finance Charts
Alphabet Inc. (GOOG)

http://finance.yahoo.com/echarts?s=GOOG+Interactive#{"showArea":false,"showLine":false,"showCandle":true,"lineType":"candle","range":"5y","allowChartStacking":true}

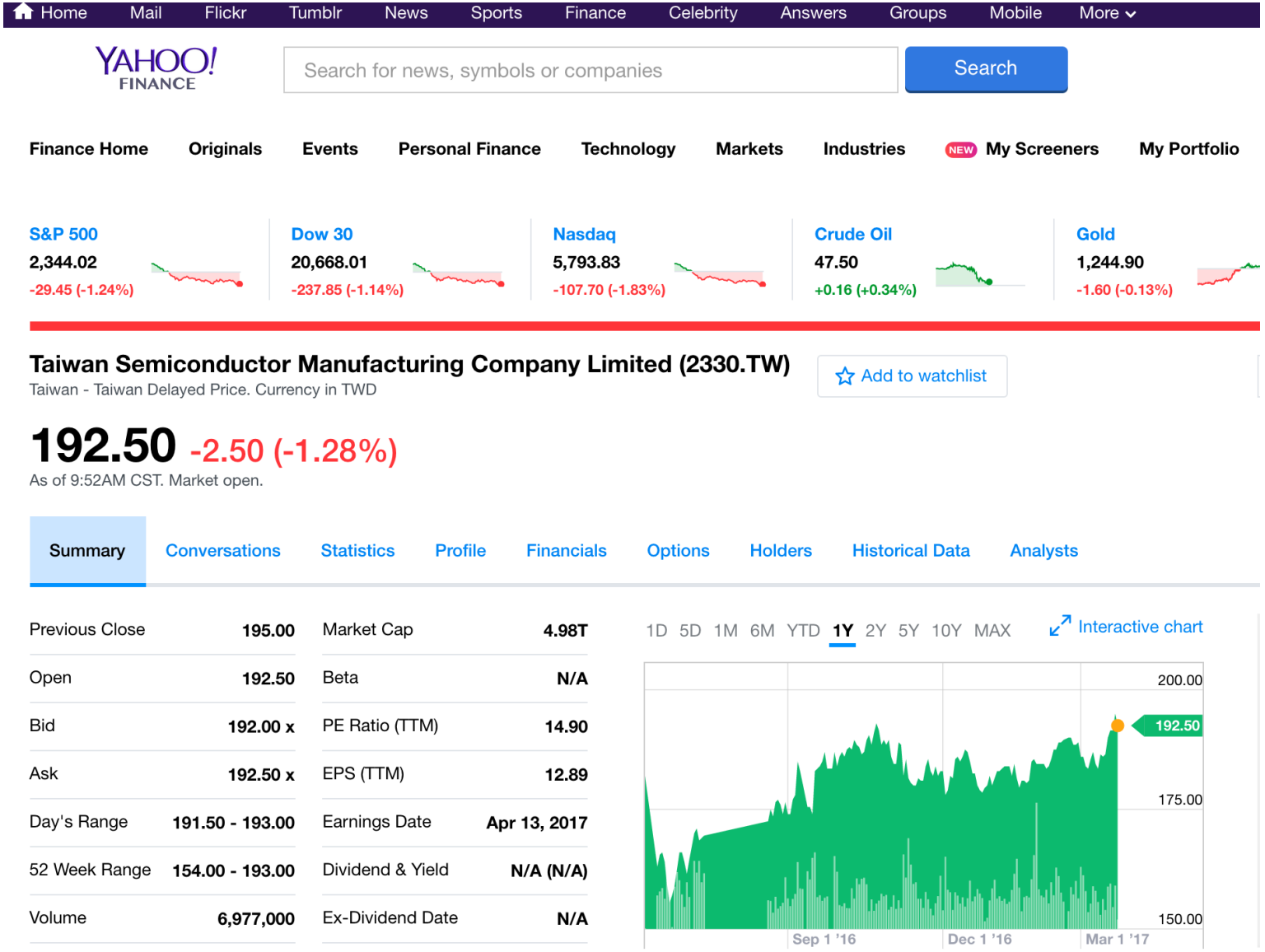
Dow Jones Industrial Average (^DJI)

http://finance.yahoo.com/chart/^DJI

TSEC weighted index (^TWII) - Taiwan

http://finance.yahoo.com/chart/^TWII

Taiwan Semiconductor Manufacturing Company Limited (2330.TW)



http://finance.yahoo.com/q?s=2330.TW

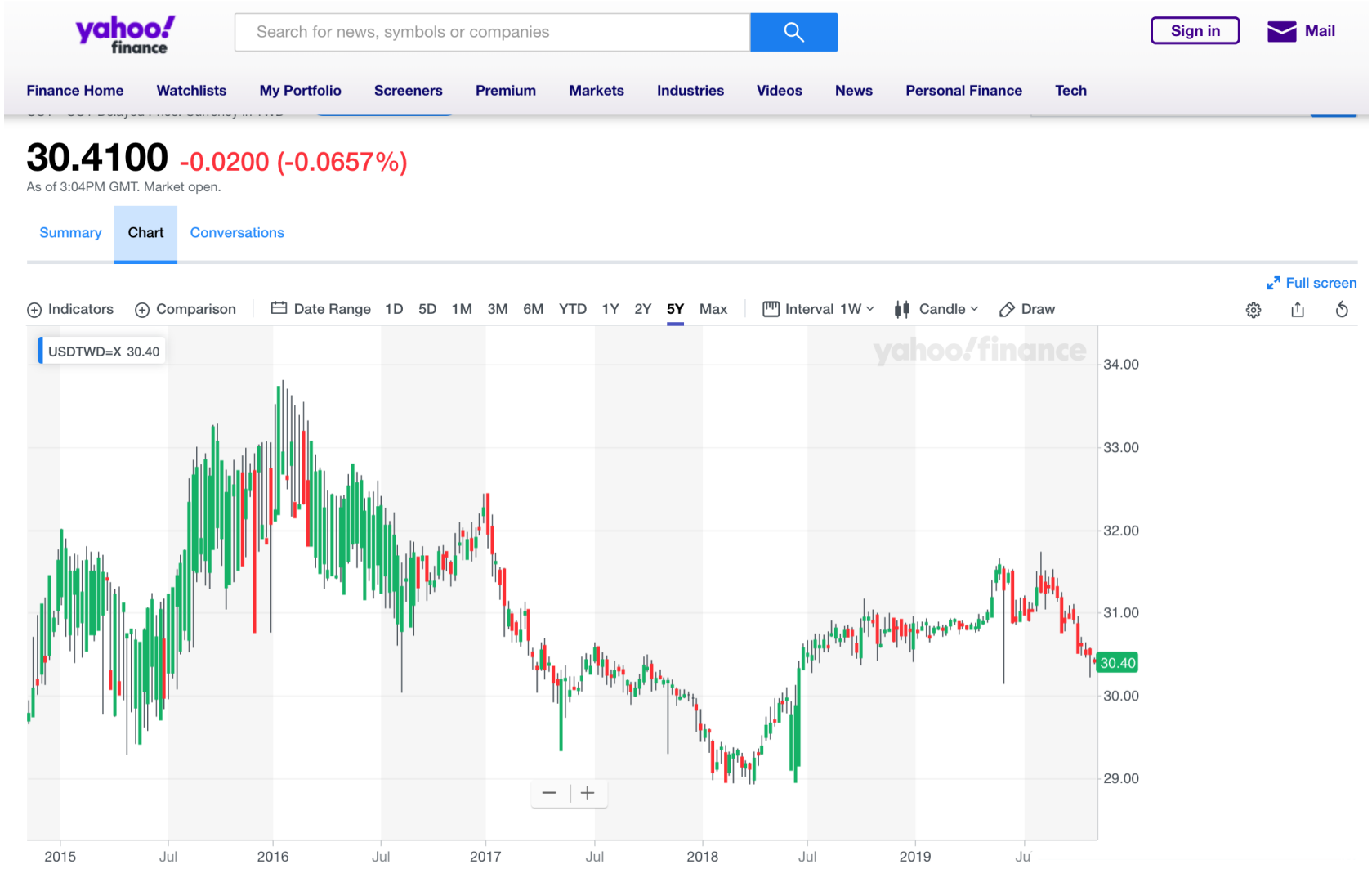
Yahoo Finance Charts
TSMC (2330.TW)

http://finance.yahoo.com/chart/2330.TW

Yahoo Finance Charts
US Dollar/USDX - Index - Cash (DX-Y.NYB)

https://finance.yahoo.com/quote/DX-Y.NYB/chart?p=DX-Y.NYB

Yahoo Finance Charts
USD/TWD (USDTWD=X)

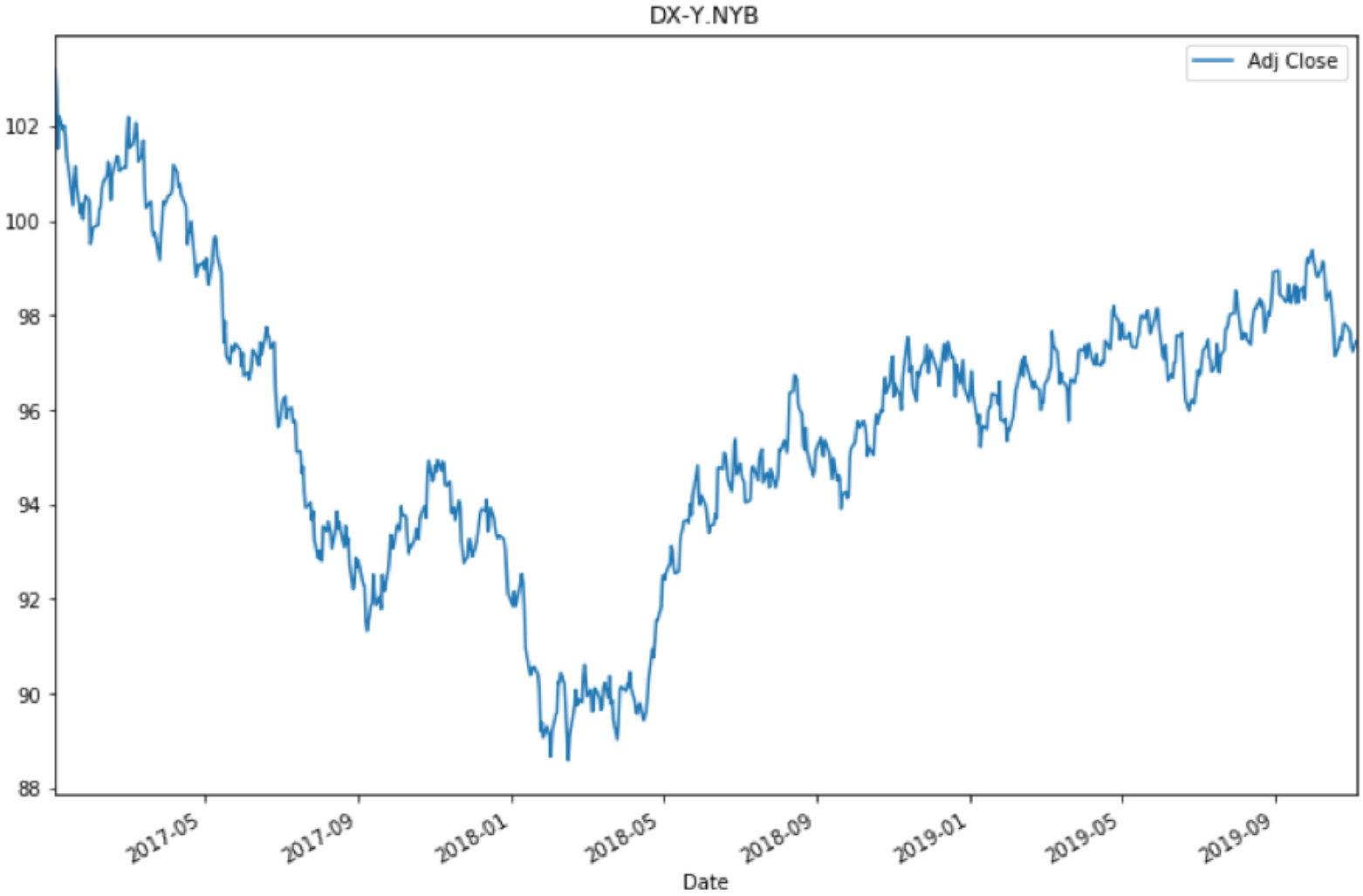


https://finance.yahoo.com/quote/USDTWD%3DX/chart?p=USDTWD%3

US Dollar/USDX - Index - Cash (DX-Y.NYB)

```
#!pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline
#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2017, 1, 1)
df = web.DataReader("DX-Y.NYB", 'yahoo', start, end)
df.to_csv('DX-Y.NYB.csv')
print(df.tail())
df2 = pd.read_csv('DX-Y.NYB.csv')
```

US Dollar/USDX - Index - Cash (DX-Y.NYB)



```
import pandas as pd
import pandas_datareader.data as web
df = web.DataReader('AAPL', data_source='yahoo',
start='1/1/2010', end='3/21/2017')
df.to_csv('AAPL.csv')
df.tail()
```

```
import pandas as pd
import pandas_datareader.data as web
#df = web.DataReader('AAPL', 'yahoo')
df = web.DataReader('AAPL', data_source='yahoo', start='1/1/2010', end='3/21/2017')
#df = web.DataReader('AAPL', data_source='google', start='1/1/2010', end='3/21/2017')
df.to_csv('AAPL.csv')
df.tail()
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2017-03-15	139.410004	140.750000	139.029999	140.460007	25566800	140.460007
2017-03-16	140.720001	141.020004	140.259995	140.690002	19132500	140.690002
2017-03-17	141.000000	141.000000	139.889999	139.990005	43597400	139.990005
2017-03-20	140.399994	141.500000	140.229996	141.460007	20213100	141.460007
2017-03-21	142.110001	142.800003	139.729996	139.839996	39116800	139.839996

```
df = web.DataReader('GOOG',
data_source='yahoo', start='1/1/1980',
end='3/21/2017')
df.head(10)
```

```
df = web.DataReader('GOOG', data_source='yahoo', start='1/1/1980', end='3/21/2017')
df.head(10)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2004-08-19	100.000168	104.060182	95.960165	100.340176	44871300	50.119968
2004-08-20	101.010175	109.080187	100.500174	108.310183	22942800	54.100990
2004-08-23	110.750191	113.480193	109.050183	109.400185	18342800	54.645447
2004-08-24	111.240189	111.600192	103.570177	104.870176	15319700	52.382705
2004-08-25	104.960181	108.000187	103.880180	106.000184	9232100	52.947145
2004-08-26	104.950180	107.950188	104.660179	107.910182	7128600	53.901190
2004-08-27	108.100185	108.620186	105.690180	106.150181	6241200	53.022069
2004-08-30	105.280178	105.490184	102.010172	102.010172	5221400	50.954132
2004-08-31	102.300173	103.710180	102.160177	102.370175	4941200	51.133953
2004-09-01	102.700174	102.970180	99.670169	100.250171	9181600	50.075011

df.tail(10)

```
df.tail(10)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2017-03-08	833.510010	838.150024	831.789978	835.369995	988700	835.369995
2017-03-09	836.000000	842.000000	834.210022	838.679993	1259900	838.679993
2017-03-10	843.280029	844.909973	839.500000	843.250000	1701100	843.250000
2017-03-13	844.000000	848.684998	843.250000	845.539978	1149500	845.539978
2017-03-14	843.640015	847.239990	840.799988	845.619995	779900	845.619995
2017-03-15	847.590027	848.630005	840.770020	847.200012	1379600	847.200012
2017-03-16	849.030029	850.849976	846.130005	848.780029	970400	848.780029
2017-03-17	851.609985	853.400024	847.109985	852.119995	1712300	852.119995
2017-03-20	850.010010	850.219971	845.150024	848.400024	1190300	848.400024
2017-03-21	851.400024	853.500000	829.020020	830.460022	2442900	830.460022

df.count()

```
df.count()
```

```
Open          3169
High          3169
Low           3169
Close         3169
Volume        3169
Adj Close     3169
dtype: int64
```

df.ix['2015-12-31']

```
df.ix['2015-12-31']
```

```
Open          7.695000e+02
High          7.695000e+02
Low           7.583400e+02
Close         7.588800e+02
Volume        1.489600e+06
Adj Close     7.588800e+02
Name: 2015-12-31 00:00:00, dtype: float64
```

```
df.to_csv('2330.TW.Yahoo.Finance.Data.csv')
```

2330.TW.Yahoo.Finance.Data.csv

```
Date,Open,High,Low,Close,Volume,Adj Close
2010-01-01,64.5,64.5,64.5,64.5,0,52.8308
2010-01-04,65.0,65.0,64.0,64.9,39407000,53.1584
2010-01-05,65.0,65.1,63.9,64.5,37138000,52.8308
2010-01-06,64.5,64.9,63.7,64.9,49261000,53.1584
2010-01-07,64.9,65.0,64.2,64.2,42134000,52.5851
2010-01-08,63.5,64.3,63.5,64.0,46076000,52.4213
2010-01-11,64.0,64.9,63.5,64.5,36799000,52.8308
2010-01-12,64.4,64.4,63.3,63.6,49853000,52.0936
2010-01-13,63.0,63.1,62.6,62.8,47976000,51.4384
2010-01-14,63.6,63.6,63.0,63.2,36149000,51.766
2010-01-15,62.9,63.5,62.8,63.5,47852000,52.0117
2010-01-18,62.8,63.1,62.8,62.9,30136000,51.5203
2010-01-19,63.0,63.2,62.0,62.5,47202000,51.1926
2010-01-20,62.9,63.2,62.2,63.0,52281000,51.6022
```

```
import fix_yahoo_finance as yf
data = yf.download("^TWII", start="2017-07-01", end="2017-11-15")
data.to_csv('TWII_201707_201711.csv')
data.tail()
```

```
import fix_yahoo_finance as yf
data = yf.download("^TWII", start="2017-07-01", end="2017-11-15")
data.to_csv('TWII_201707_201711.csv')
data.tail()
```

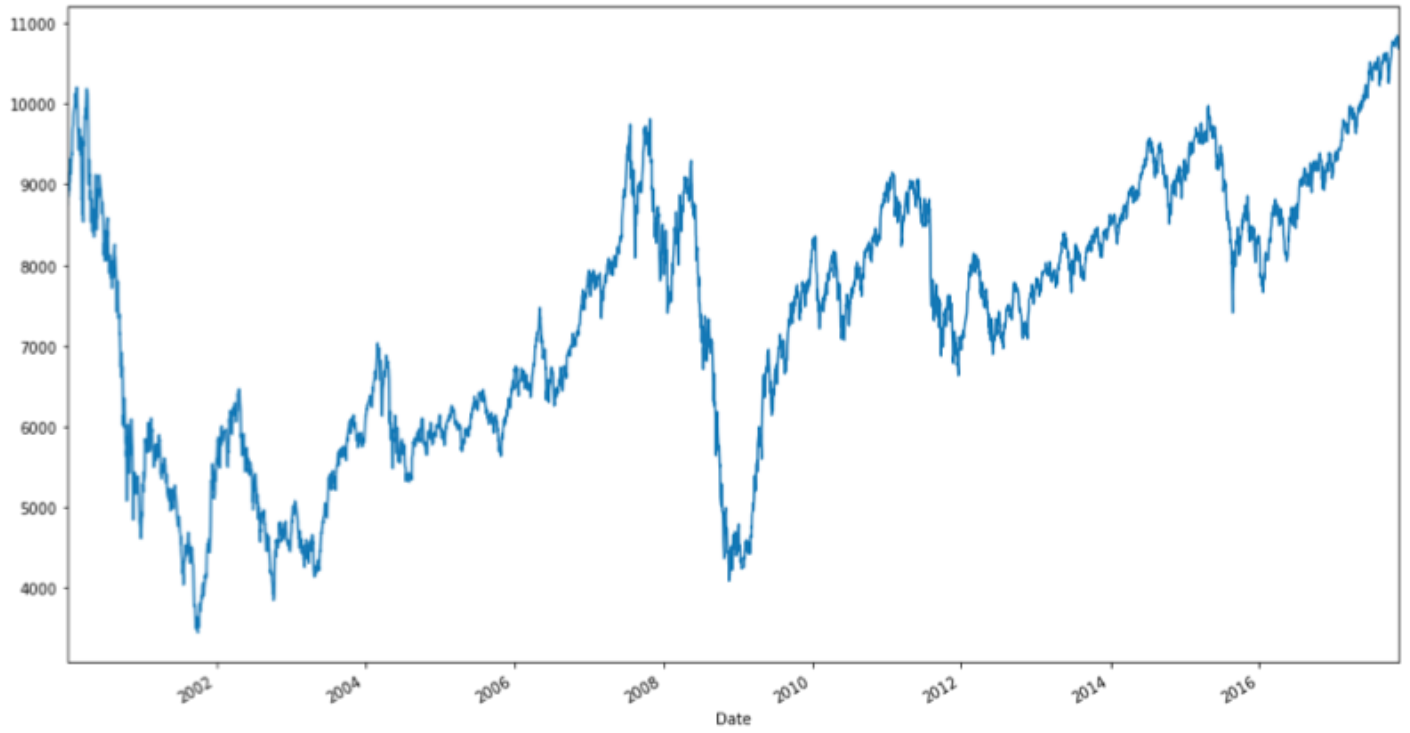
```
[**********************100%**********************]  1 of 1 downloaded
```

	Open	High	Low	Close	Adj Close	Volume
Date						
2017-11-08	10839.440430	10844.740234	10806.009766	10818.990234	10818.990234	2438000
2017-11-09	10802.950195	10831.379883	10721.870117	10743.269531	10743.269531	2917800
2017-11-10	10713.669922	10742.610352	10659.290039	10732.669922	10732.669922	2277000
2017-11-13	10728.219727	10749.389648	10683.919922	10683.919922	10683.919922	2765100
2017-11-14	10716.589844	10735.080078	10654.580078	10687.179688	10687.179688	2596600

df.loc[start:end]

```
df = df.loc['2017-10-01':'2017-11-15']
```

```
import matplotlib.pyplot as plt
%matplotlib inline
import fix_yahoo_finance as yf
df = yf.download("^TWII", start="2000-01-01", end="2017-11-15")
df.to_csv('YF_TWII_2000_2017.csv')
print(df.head())
fig = plt.figure(figsize=(16,9))
df["Adj Close"].plot()
fig.show()
```



candlestick_ohlc

```
import matplotlib.pyplot as plt

from matplotlib.finance
import candlestick_ohlc
```

Source: https://matplotlib.org/examples/pylab_examples/finance_demo.html

```
import matplotlib.pyplot as plt
from matplotlib.finance import candlestick_ohlc
```

Source: https://ntguardian.wordpress.com/2016/09/19/introduction-stock-market-data-python-1/

daily_to_weekly

```
#Convert Daily Data to Weekly Data
def daily_to_weekly(df):
     #dfWeekly = daily_to_weekly(df)
    #df.sort_index(axis=0, level=None, ascending=True, inplace=True)
     Open = df.Open.resample('W-Fri').first() #W #W-MON #W-Fri
     High = df.High.resample('W-Fri').max()
     Low = df.Low.resample('W-Fri').min()
     Close = df.Close.resample('W-Fri').last()
     Volume = df.Volume.resample('W-Fri').sum()
     Adj_Close = df["Adj Close"].resample('W-Fri').last()
    dfWeekly = pd.concat([Open, High, Low, Close, Volume, Adj_Close], axis=1)
    dfWeekly = dfWeekly[pd.notnull(dfWeekly['Adj Close'])]
    return dfWeekly
```

daily_to_monthly

```
#Convert Daily Data to Monthly Data
def daily_to_monthly(df):
    #dfMonthly = daily_to_monthly(df)
    Open = df.Open.resample('M').first()
    High = df.High.resample('M').max()
    Low = df.Low.resample('M').min()
    Close = df.Close.resample('M').last()
    Volume = df.Volume.resample('M').sum()
    Adj_Close = df["Adj Close"].resample('M').last()
   dfMonthly = pd.concat([Open, High, Low, Close, Volume, Adj_Close], axis=1)
    dfMonthly = dfMonthly[pd.notnull(dfMonthly['Adj Close'])]
    return dfMonthly
```

TA-Lib:
Technical Analysis Library

TA-Lib : Technical Analysis Library

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Multi-Platform Tools for Market Analysis ...

TA-Lib is widely used by trading software developers requiring to perform technical analysis of financial market data.

- Includes 200 indicators such as ADX, MACD, RSI, Stochastic, Bollinger Bands etc... (more info)
- Candlestick pattern recognition
- Open-source API for C/C++, Java, Perl, Python and 100% Managed .NET

Free Open-Source Library

TA-Lib is available under a BSD License allowing it to be integrated in your own open-source or commercial application. (more info)

Commercial Application

TA-Lib is also available as an easy to install Excel Add-Ins. Try it for free!

http://ta-lib.org/

Stochastic Oscillator (KD)

```
#Stochastic oscillator %D
def KDJ(df, n, m1, m2):
    #KDJ(df, 9, 3, 3)
    KDJ_n = n
    KDJ_m1 = m1
    KDJ_m2 = m2

    df['Low_n'] = pd.rolling_min(df['Low'], KDJ_n)
    df['Low_n'].fillna(value=pd.expanding_min(df['Low']), inplace=True)
    df['High_n'] = pd.rolling_max(df['High'], KDJ_n)
    df['High_n'].fillna(value=pd.expanding_max(df['High']), inplace=True)

    df['RSV'] = (df['Close'] - df['Low_n']) / (df['High_n'] - df['Low_n']) * 100

    df['KDJ_K'] = pd.ewma(df['RSV'], KDJ_m1)
    df['KDJ_D'] = pd.ewma(df['KDJ_K'], KDJ_m2)
    df['KDJ_J'] = 3 * df['KDJ_K'] - 2 * df['KDJ_D']
    return df
```

Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

Bollinger Bands

```
#Bollinger Bands
def BBANDS20(df, n):
    MA = pd.Series(pd.rolling_mean(df['Close'], n))
    MSD = pd.Series(pd.rolling_std(df['Close'], n))
    b1 = 4 * MSD / MA
    B1 = pd.Series(b1, name = 'BollingerB_' + str(n))
    df = df.join(B1)
    b2 = (df['Close'] - MA + 2 * MSD) / (4 * MSD)
    B2 = pd.Series(b2, name = 'Bollinger%b_' + str(n))
    df = df.join(B2)
    return df
```

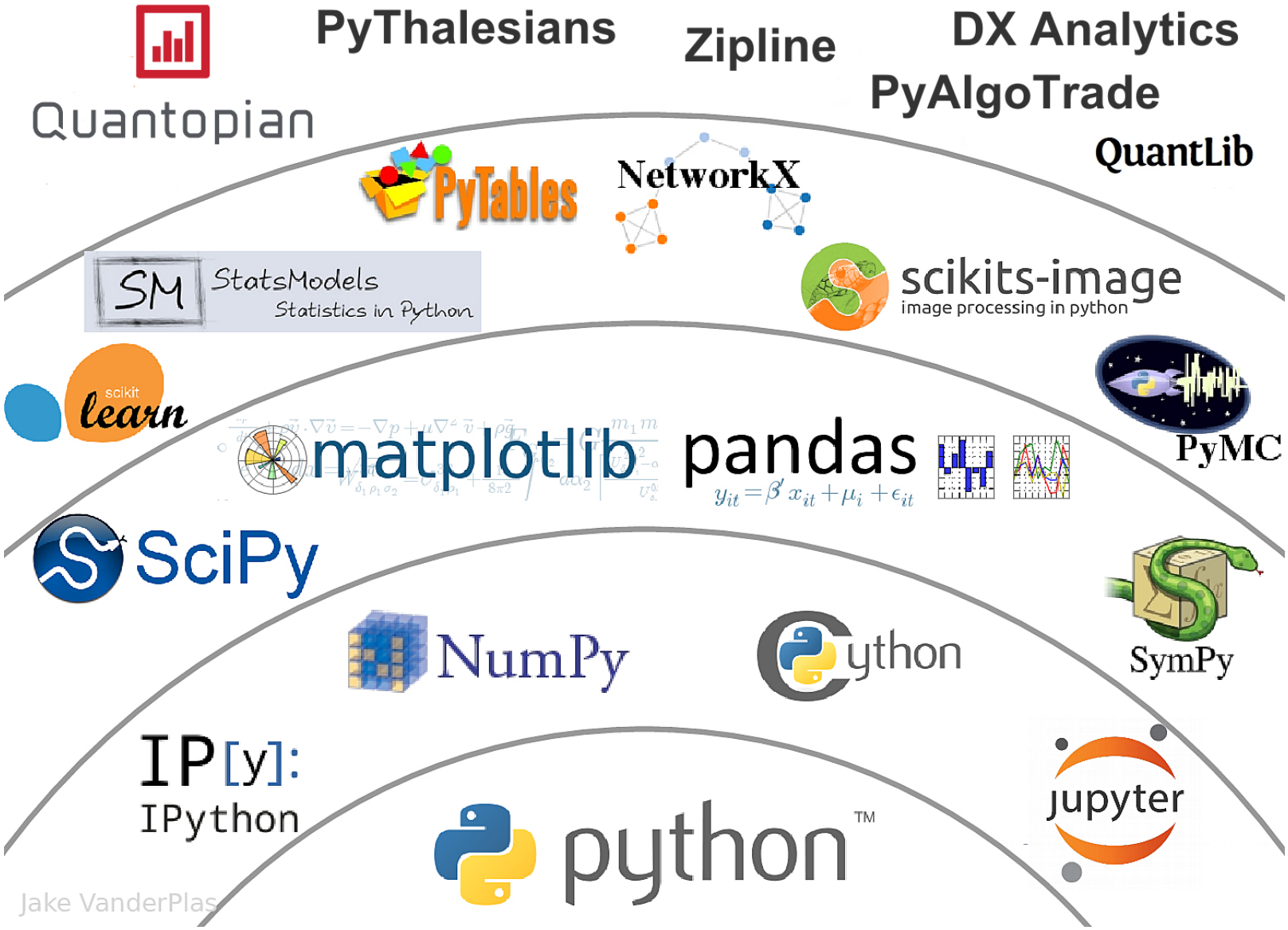
Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

Bollinger Bands

```
#BB Bollinger Bands BB_20
def BB_20(df):
    df['BB_MA20'] = pd.stats.moments.rolling_mean(df["Adj Close"], 20)
    df['BB_SD20'] = pd.stats.moments.rolling_std(df['Adj Close'],20)
    df['BB_UpperBand'] = df['BB_MA20'] + (df['BB_SD20']*2) # Default 2*SD
    df['BB_LowerBand'] = df['BB_MA20'] - (df['BB_SD20']*2)
    df['BB_PB'] = (df['Adj Close'] - df['BB_LowerBand']) / (df['BB_UpperBand'] -
df['BB_LowerBand'])
    df['BB_BW'] = (df['BB_UpperBand'] - df['BB_LowerBand']) / df['BB_MA20']
    df['BB_UpperBand_1SD'] = df['BB_MA20'] + (df['BB_SD20'])
    df['BB_LowerBand_1SD'] = df['BB_MA20'] - (df['BB_SD20'])
    #BB_PB: Bollinger Band Percent b (PB)
    #BB_BW: Bollinger Band Band Width (BW)
    return df
```

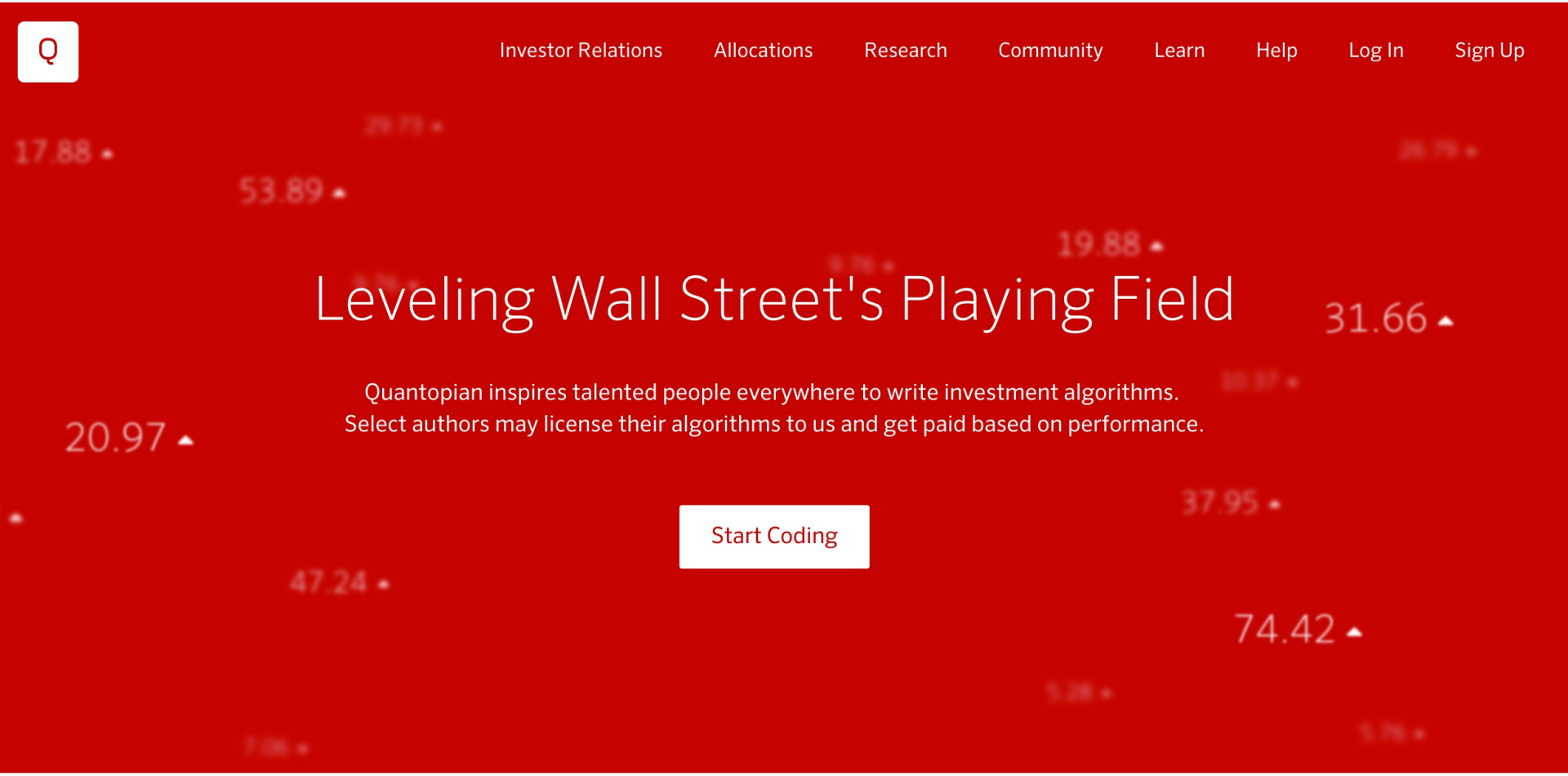
Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5

Quantopian



https://www.quantopian.com/

Summary

- **Quantitative Investing with Pandas in Python**
  - **Numpy**
    - Scientific computing
  - **Pandas**
    - Data structures and data analysis tools

References

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