Python Quick Start Guide

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Python/Environment Setup

Note: this tutorial is for individual users working with Python on their own computers. For mass Python deployment, please contact your local IT administration. Python is installed on all the Finance Lab workstations.

Text Editor

A text editor like Notepad, Notepad++, Notepad2, Atom, etc. is required to write and save the Python code presented in the tutorial into .py files. Notepad is already available on all versions of Windows. The recommended Anaconda/Miniconda installers (next section) include the option to install VSCode, another text editor from Microsoft.

Python Distribution

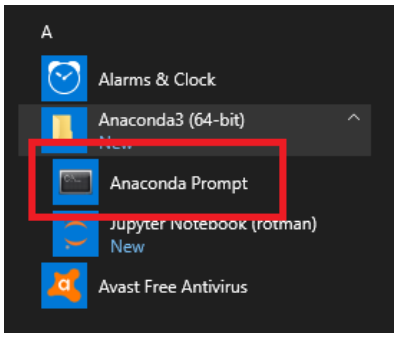
The recommended way to set up your Python environment/workspace is to use either the Anaconda distribution or the Miniconda distribution of Python 3.6+

Anaconda already includes many of the most commonly used data science packages (essentially additional tools) like NumPy (support for multidimensional arrays) and Pandas (easy to use data structures and tools for data analysis), as well as a package and virtual environment manager. Miniconda only contains the package and virtual environment manager, and users can manually decide on which packages to download and install for use.

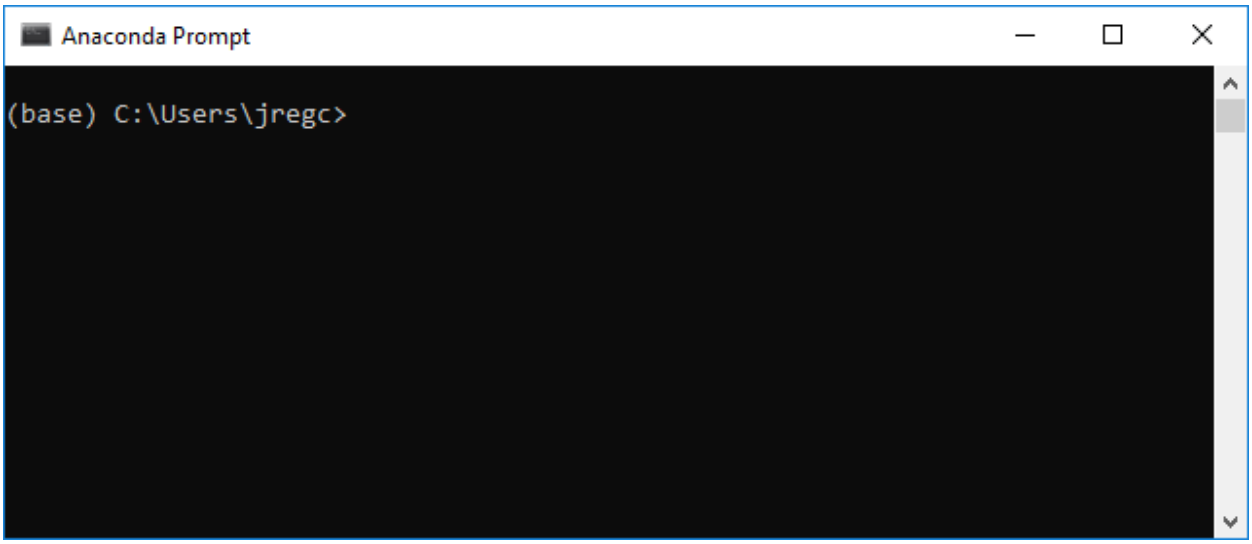
*Note: when installing Anaconda or Miniconda, choose to leave the option 'Add Anaconda to my PATH variable' **unchecked**, and the option 'Register Anaconda as my default Python 3.x' **checked***

Verifying Your Installation

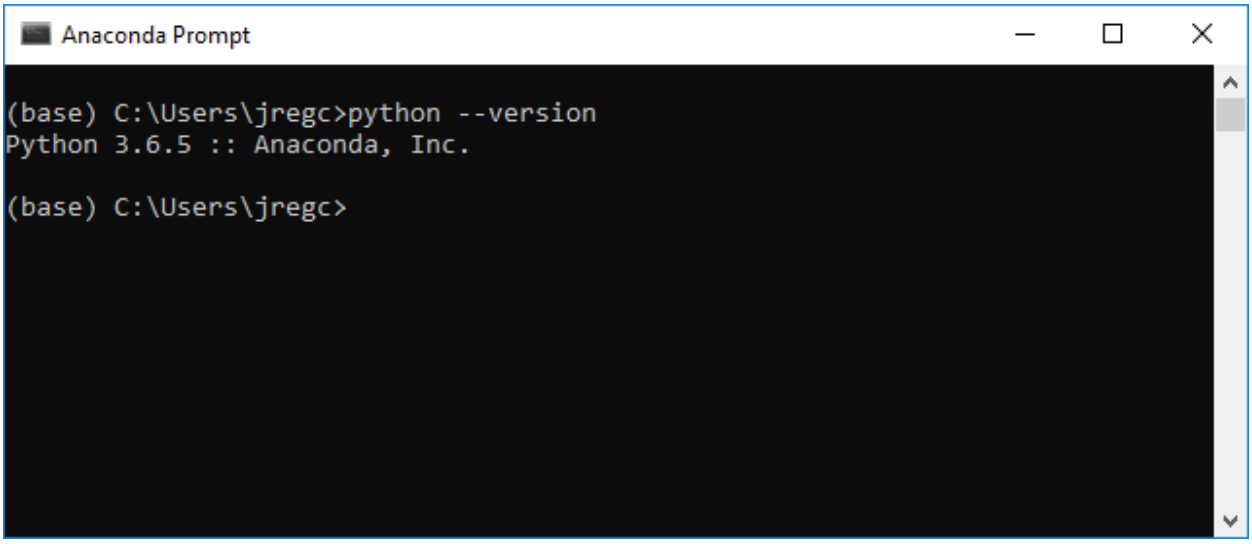
After installing Anaconda or Miniconda, please open the 'Anaconda Prompt' from the Start Menu, or the Command Prompt/PowerShell if you are using a different Python distribution.



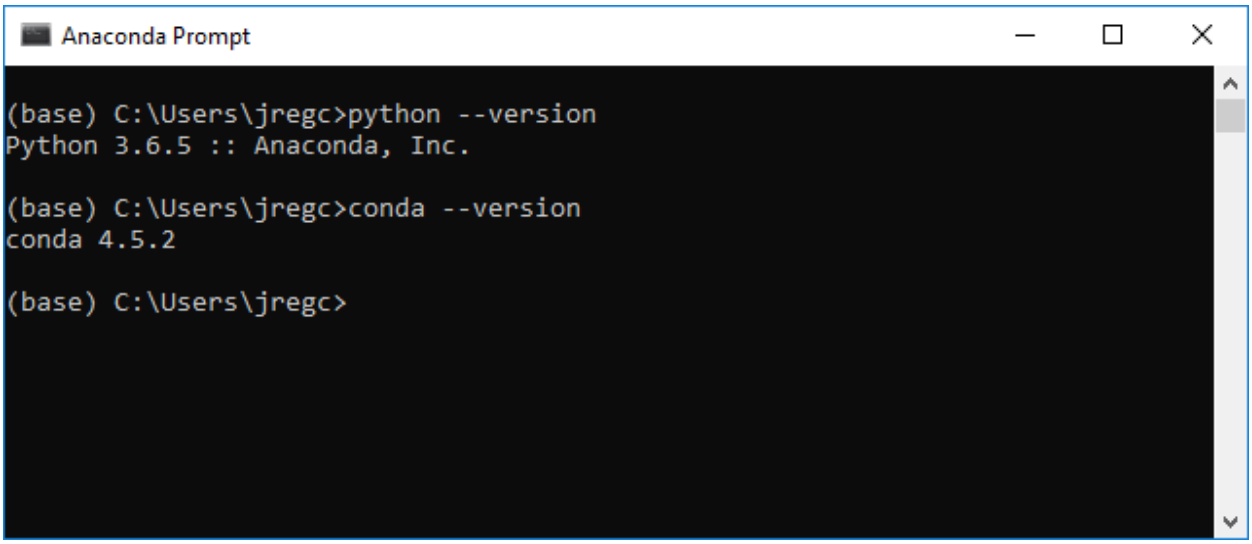
This should open a window looking similar to the following, with 'jregc' being replaced by your user ID. This tutorial will refer to this window as 'the prompt' from here onwards.



Type `python --version` into the prompt and press `enter`. This command asks Python for its current version number. The output should look similar to the following if everything has been installed correctly, where the version number is 3.6 or greater.



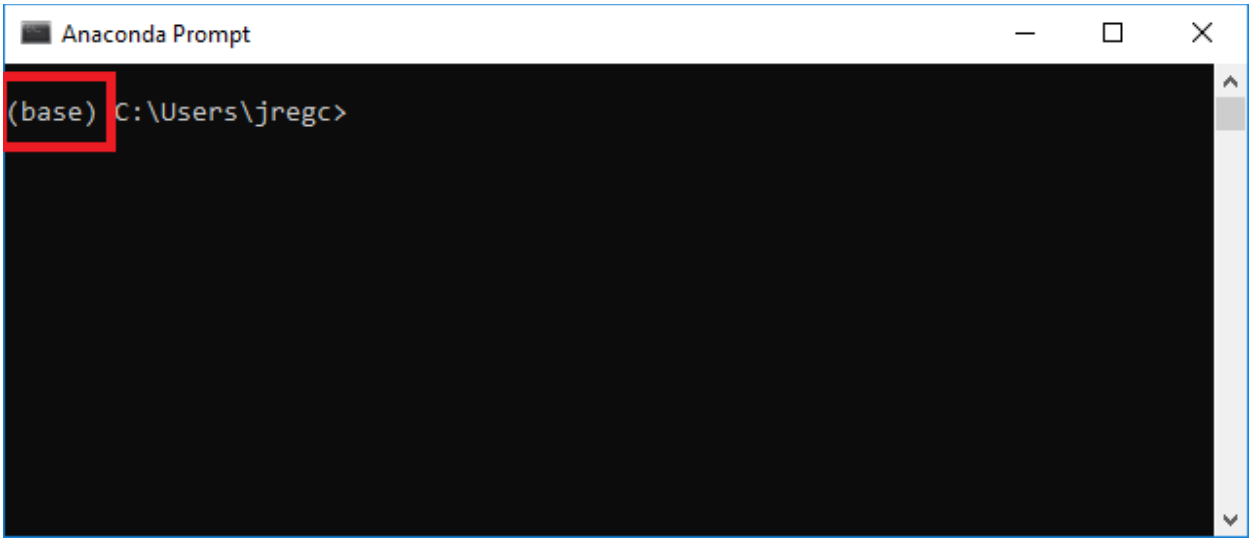
Then type `conda --version` into the prompt and press `enter`. This command asks Anaconda/Miniconda for its current version number. The output should look similar to the following if everything has been installed correctly, where the version number is 4.5 or greater. In the case where the version number is lower than 4.5, type `conda update -n base conda` to get the latest version.



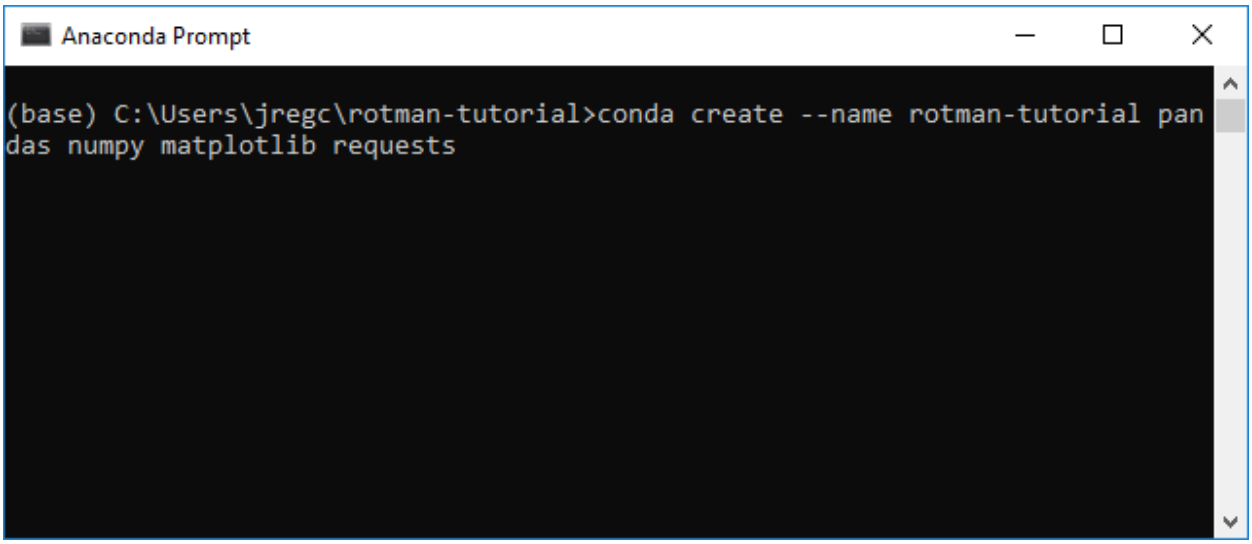
Python Virtual Environments

Anaconda and Miniconda come with the conda package and virtual environment manager. Different Python applications that users write may require different files and packages, and virtual environments help solve this problem. A virtual environment is a self-contained environment/directory that contains its own files, installed packages, and their dependencies that will not interact with other environments' files, packages, and dependencies.

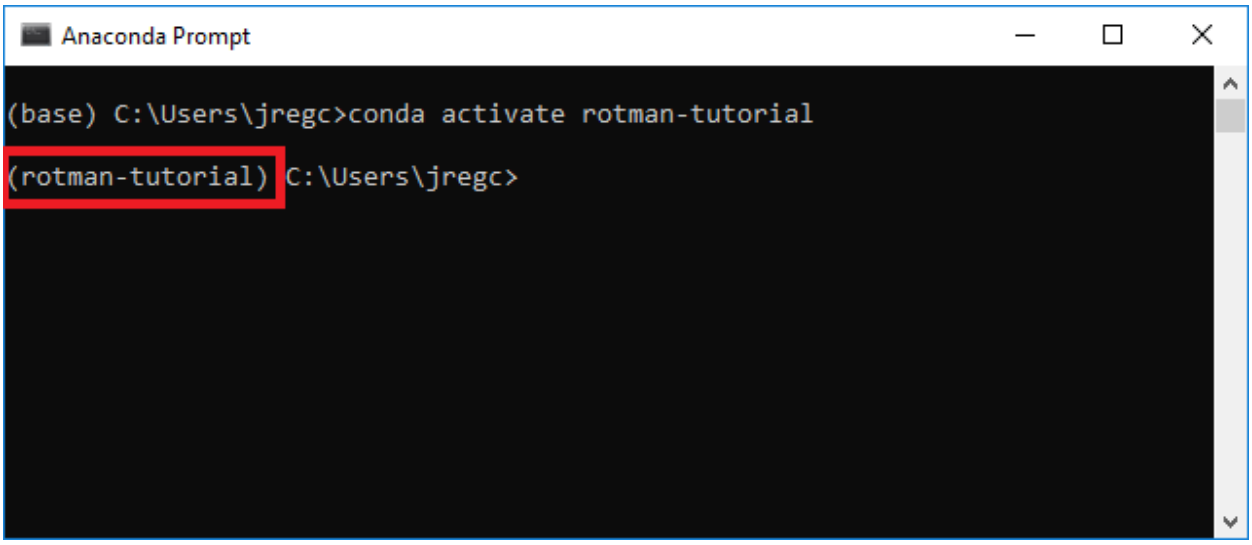
When a user initially starts the prompt, it starts in the 'base' environment, as indicated on the left side of the prompt.



However, it is not recommended to install additional packages in the 'base' environment. To create a new environment, enter `conda create --name <ENV NAME> pandas numpy matplotlib requests`. This will create a new virtual environment, with the name supplied in `<ENV NAME>`, and with the 'pandas', 'numpy', 'matplotlib', and 'requests' packages needed in this tutorial, plus any dependencies for those packages.



In this case, the virtual environment is named 'rotman-tutorial'. Enter `y` into the prompt after `conda` lists the packages that must be downloaded and installed to proceed and create the environment. After the environment is created, enter `conda activate <ENV NAME>` or simply `activate <ENV NAME>` into the prompt to switch the context of the prompt to that environment.

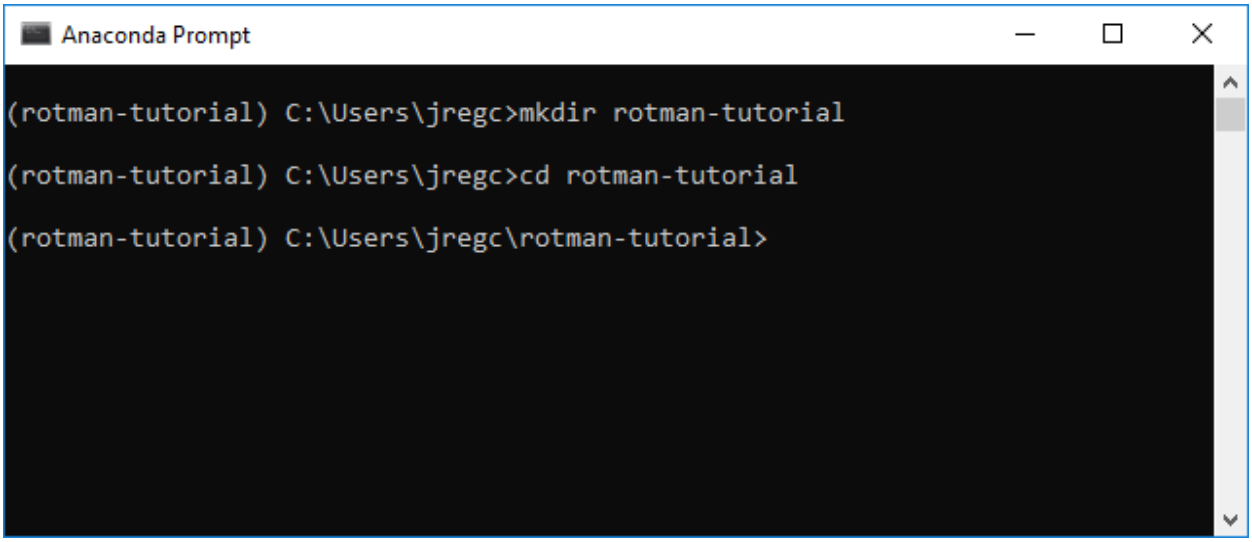


As shown in the above screenshot, after entering `conda activate rotman-tutorial` into the prompt, the prompt indicates that the current environment is 'rotman-tutorial'. If a user wants to deactivate the current environment and go back to the 'base' environment, enter `conda deactivate`.

Introduction to Python

Create a Work Directory

In the local user directory, create a work directory to store the tutorial files. Users can do this from the prompt by entering `mkdir <WORK DIR NAME>` to create a directory in the current location. Then, enter `cd <PATH TO WORK DIR>` to change locations to that directory.



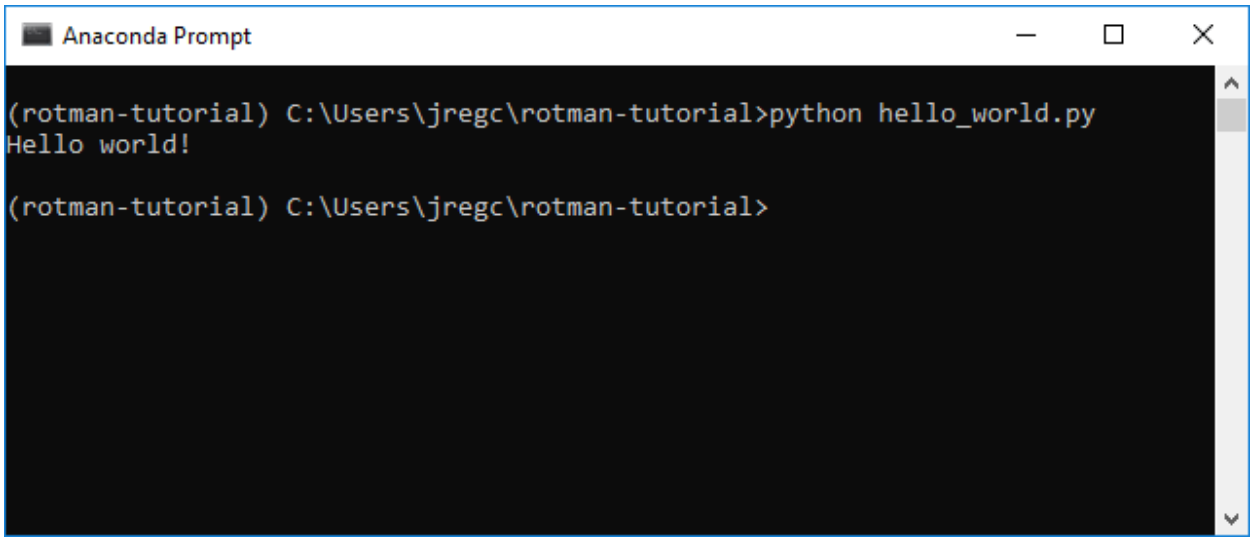
In the above screenshot, a directory called 'rotman-tutorial' was created in the directory `C:\Users\jregc`

Hello World

Open your preferred text editor, type the following into a new file, and save the file in the work directory as `hello_world.py`.

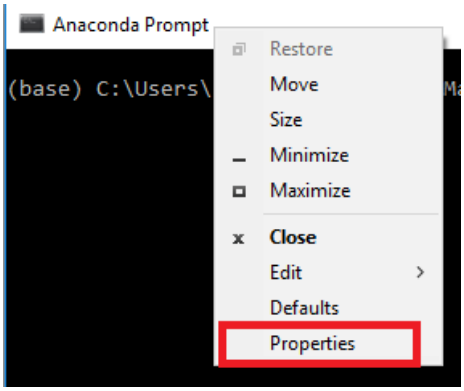
```
def main():
    print('Hello world!')

# this if-block tells Python to call the main() method when it runs the file
from the prompt
if __name__ == '__main__':
    main()
```

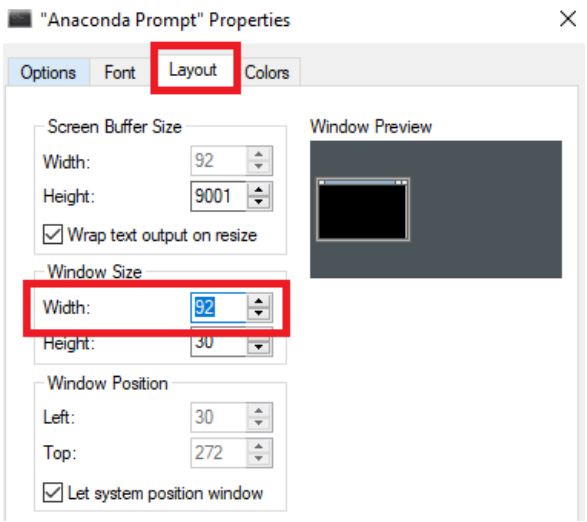
Then in the prompt, enter `python hello_world.py`.



This command tells Python to run the file in the local directory called `hello_world.py`. Inside that file, there is a method called **main** that calls the **print** method. The **print** method takes in the text 'Hello world' as a parameter and prints it out to the prompt as `Hello world!`.

In case the prompt window size needs to be changed, right-click on the top module bar from the prompt window, choose “Properties”, click on “Layout”, and change “Width” under “Window Size” to display any contents properly.



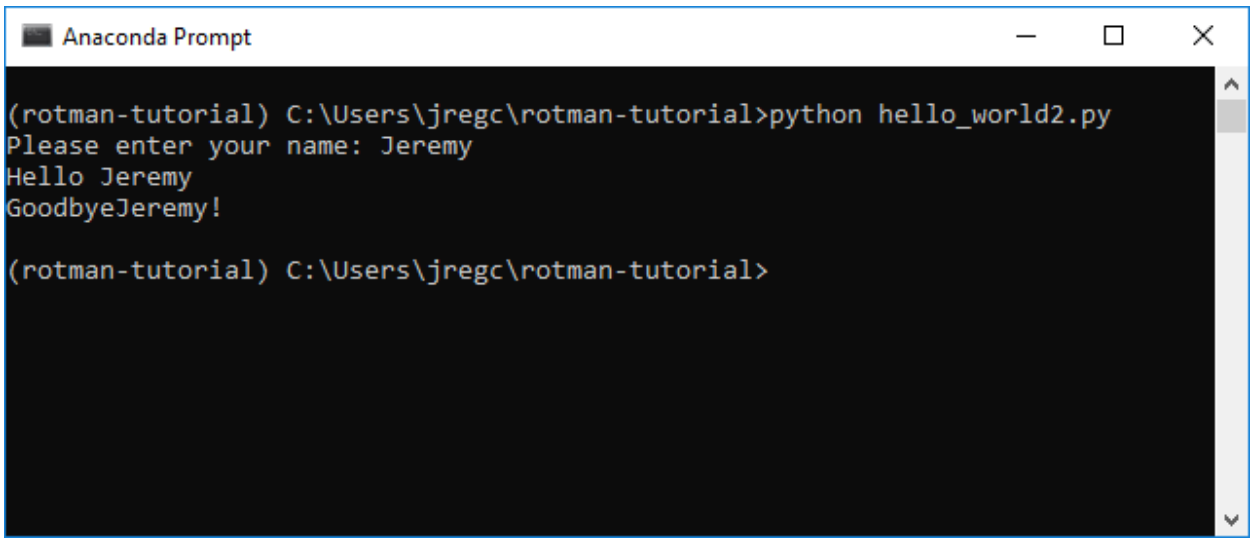


Hello Input

Python can also take in user input. For example, try saving the following into a file called `hello_world2.py` and running it:

```
def main():
    name = input('Please enter your name: ')
    print('Hello', name)
    print('Goodbye' + name + '!')

if __name__ == '__main__':
    main()
```

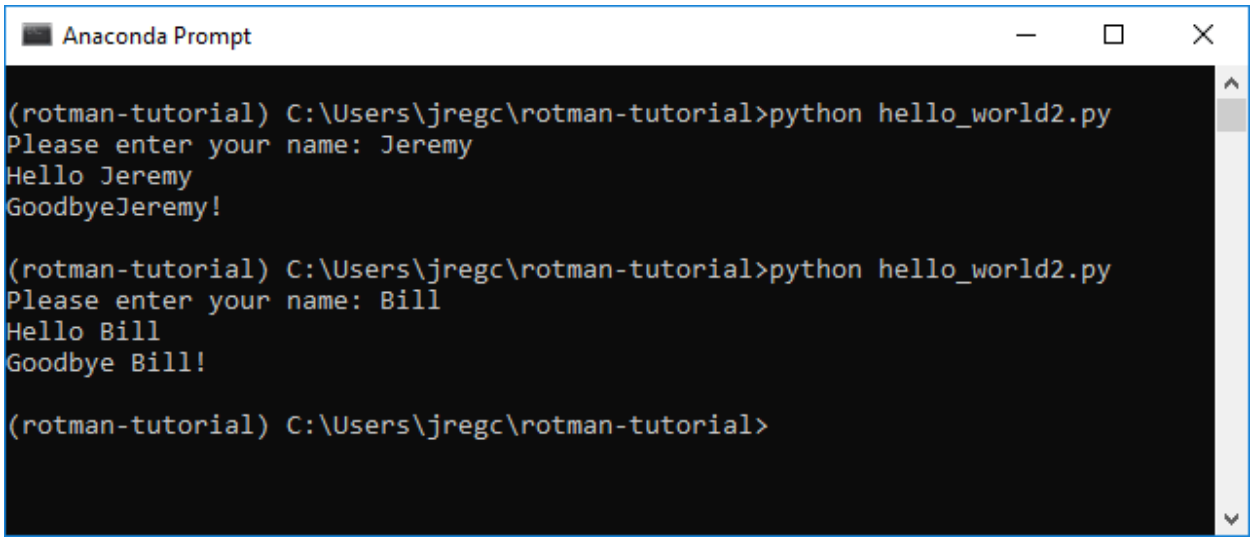

This time, a prompt should be displayed, asking for your name. In effect, the first line of code tells Python to print to the prompt the text `Please enter your name:`, wait for an input to be typed in, and then save that input into the variable called **name**. The second line then tells Python to print `Hello` and the value saved in the variable **name**. The third line shows another way of combining text together to be printed out.



But if you look at what's displayed on the third line of the output, it looks a little messy. Let's fix that:

```
def main():
    name = input('Please enter your name: ')
    print('Hello', name)
    print('Goodbye ' + name + '!')

if __name__ == '__main__':
    main()
```

Note the space in the quoted text 'Goodbye '.

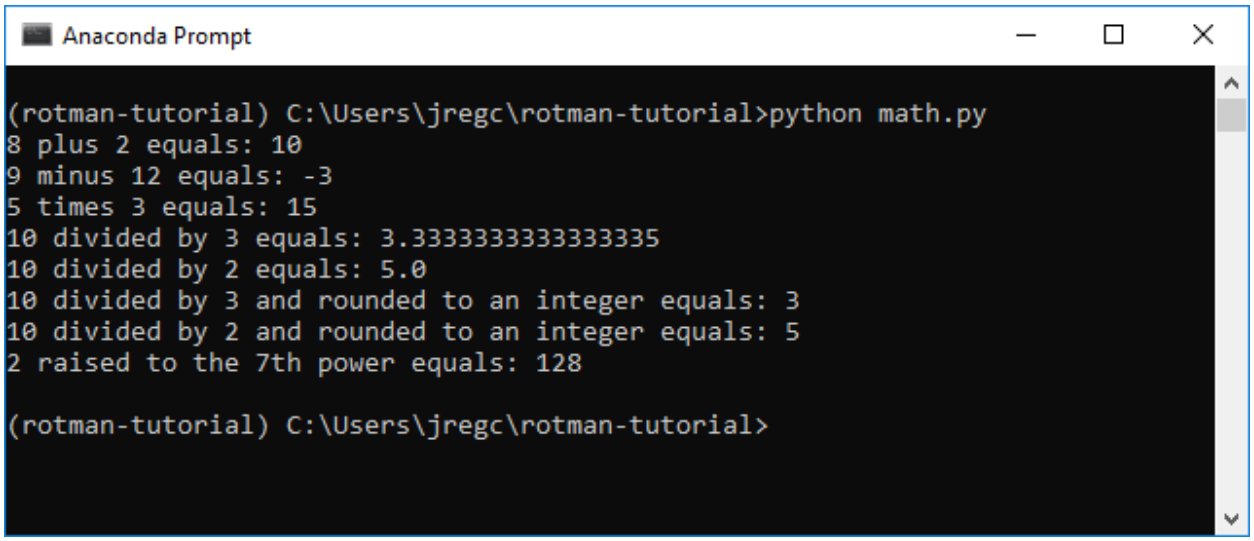


There, that's better!

Mathematical Expressions

Like many programming languages, Python can also perform mathematical calculations. Try saving and running the following as `math.py`:

```
def main():
    print('8 plus 2 equals:', 8 + 2)
    print('9 minus 12 equals:', 9 - 12)
    print('5 times 3 equals:', 5 * 3)
    print('10 divided by 3 equals:', 10 / 3)
    print('10 divided by 2 equals:', 10 / 2)
    print('10 divided by 3 and rounded to an integer equals:', 10 // 3)
    print('10 divided by 2 and rounded to an integer equals:', 10 // 2)
    print('2 raised to the 7th power equals:', 2 ** 7)

if __name__ == '__main__':
    main()
```

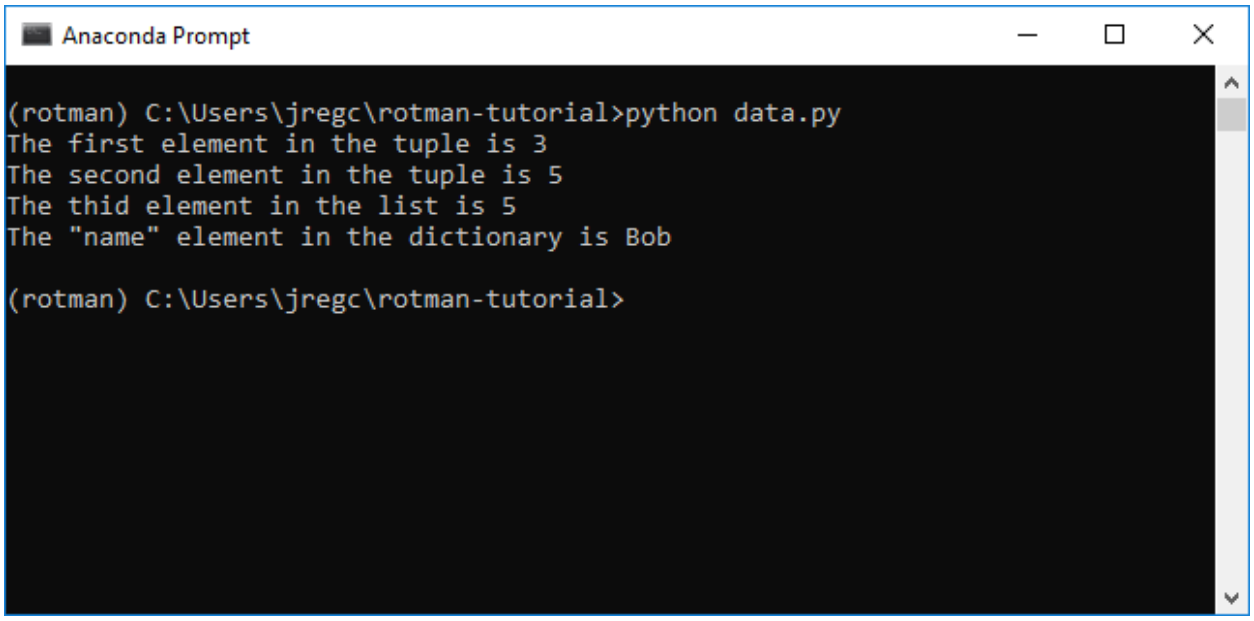


Note that there is a difference between integer and floating-point math, where floating-point numbers are representations of real numbers including decimals.

Tuples, Lists, and Dictionaries

There are also three common data structures that are used in Python: tuples, lists, and dictionaries. Tuples are comma-separated lists of values that cannot be changed once created, while lists are comma-separated lists of values that can be changed. Dictionaries are lists of key/value pairs that are associated with one another. In effect, the major difference is how to access values in the different data structures: usually one will index by number to access values in tuples and lists, while one will index by key to access a value in a dictionary. The following example illustrates how this works.

```
def main():
    t = (3, 5, 10, 9)
    l = [8, 9, 5]
    d = {'key': 'value', 'name': 'Bob'}

    print('The first element in the tuple is', t[0])
    print('The second element in the tuple is', t[1])
    print('The third element in the list is', l[2])
    print('The "name" element in the dictionary is', d['name'])

if __name__ == '__main__':
    main()
```



Note that python uses 0-based indexing, such that the first element is at position 0, the second is at position 1, etc.

Summary

This concludes a basic introduction to Python, necessary for the following sections on using Pandas/NumPy for simple stock return calculations. You should now be able to write a simple set of instructions (a method) in Python, using a pre-defined method (print) and execute it from the prompt.

For a more detailed introduction to Python, please see The Python Tutorial.

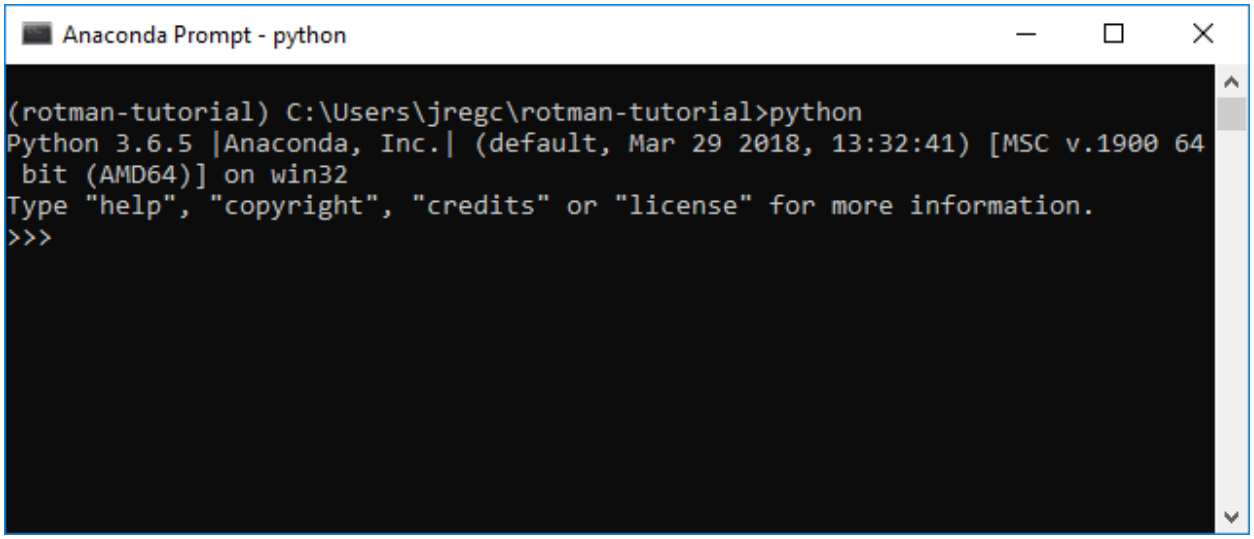
Using Pandas/NumPy Package – Stock Returns Example

Pandas is a commonly used open-source data analysis package for Python. It provides a comprehensive set of easy-to-use data structures and analysis tools. We'll take a quick look at how to use Pandas to read in CSV data from Yahoo Finance and perform some common calculations like returns and summary statistics.

Instead of writing the code into a file and then running it via `python <FILE NAME>.py`, we'll use the interactive Python interpreter available via the prompt. Note however that the code can also be saved into a `.py` file and run, as demonstrated in the Introduction to Python section.

Running the Python Interpreter

To run the Python interpreter, simply enter `python` into the prompt, first ensuring that the 'rotman-tutorial' (or other) virtual environment is active and the prompt is in your working directory.



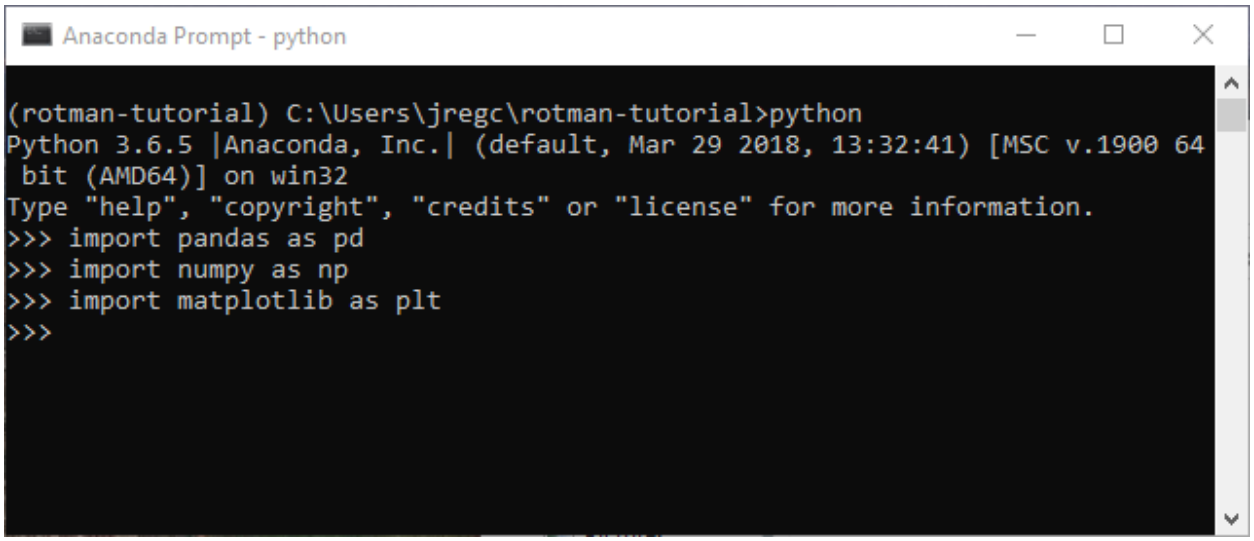
As the screenshot shows, the Python interpreter is active, running Python version 3.6.5. The `>>>` shows that we are in interactive mode, and can enter commands to be interpreted by Python.

To exit the Python interpreter, enter the command `exit()`.

Importing Packages

To import packages, either into a Python file or into the interpreter, type the following lines:

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



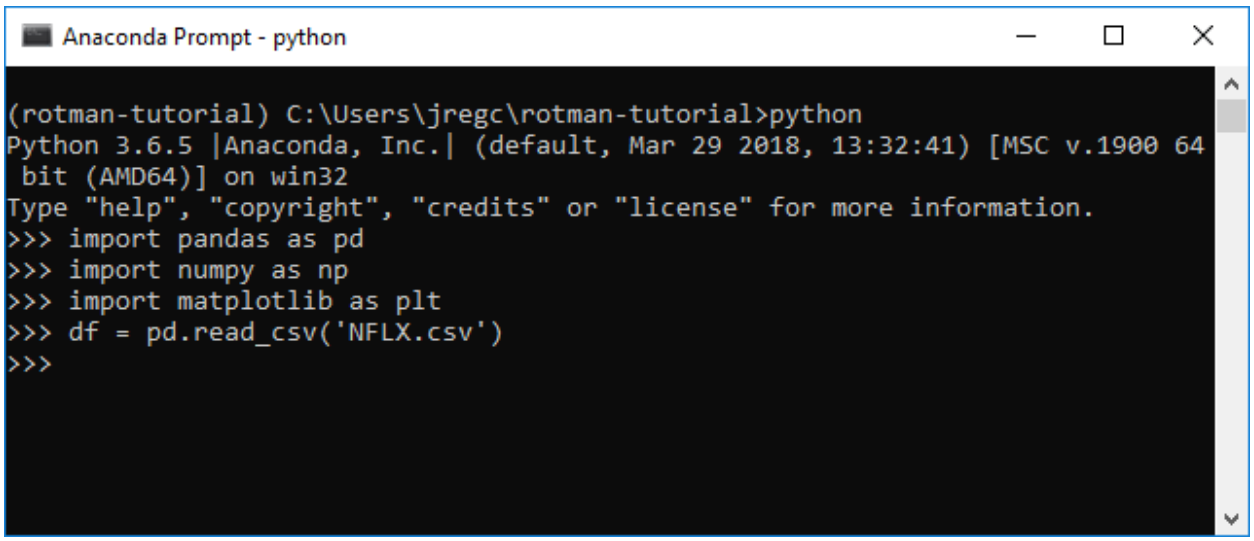
These three lines import the 'pandas', 'numpy', and 'matplotlib.pyplot' packages that we installed in the 'rotman-tutorial' virtual environment which was set up in the Python Virtual Environments section of the tutorial. Additionally, we create nicknames to reference them by ('pd', 'np', and 'plt' respectively). The next section will show how to call methods from these packages.

Reading In Data From CSV

Let's get some data in the form of a CSV file to read. Go to Yahoo Finance, query an equity ticker, and download a 1Y span of historical daily data. Save this CSV in your work directory, as set up in the Create A Work Directory section.

In this tutorial, we're using Netflix (NFLX) historical data.

```
df = pd.read_csv('NFLX.csv')
```



This command calls the read_csv() method available in the 'pandas' package, passing in the filename 'NFLX.csv' as the parameter specifying the file to open and read in the same directory. Relative paths

are also possible, for example `pd.read_csv('data/NFLX.csv')` would read a 'NFLX.csv' file located in a subdirectory named 'data'.

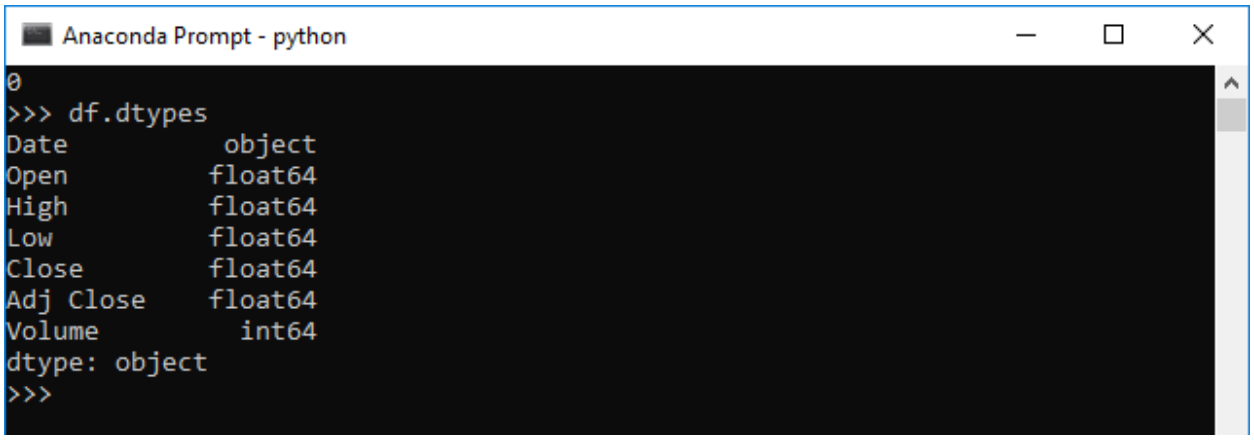
After reading the data in from the CSV file, the read_csv() method returns it as a DataFrame object, and the variable named **df** (for DataFrame) refers to that DataFrame object.

DataFrames

DataFrames are the primary data structure in Pandas, and can be thought of as two dimensional tables with labeled axes, similar to how data is laid out in a `.csv` or `.xls/.xslx` file in rows and columns.

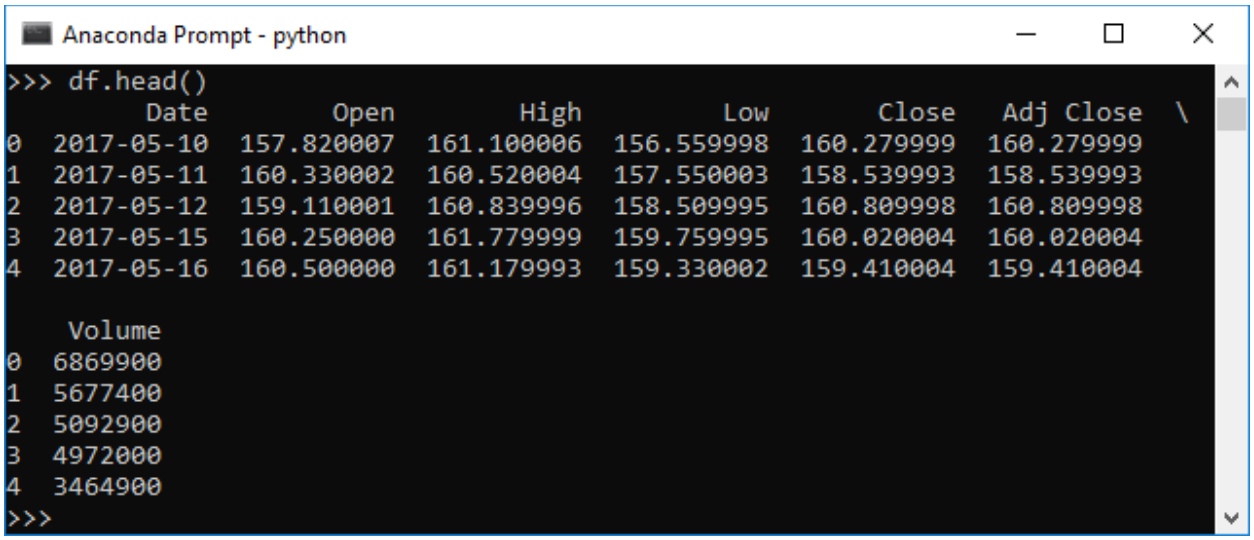
Viewing Data From DataFrames

```
df.dtypes
```



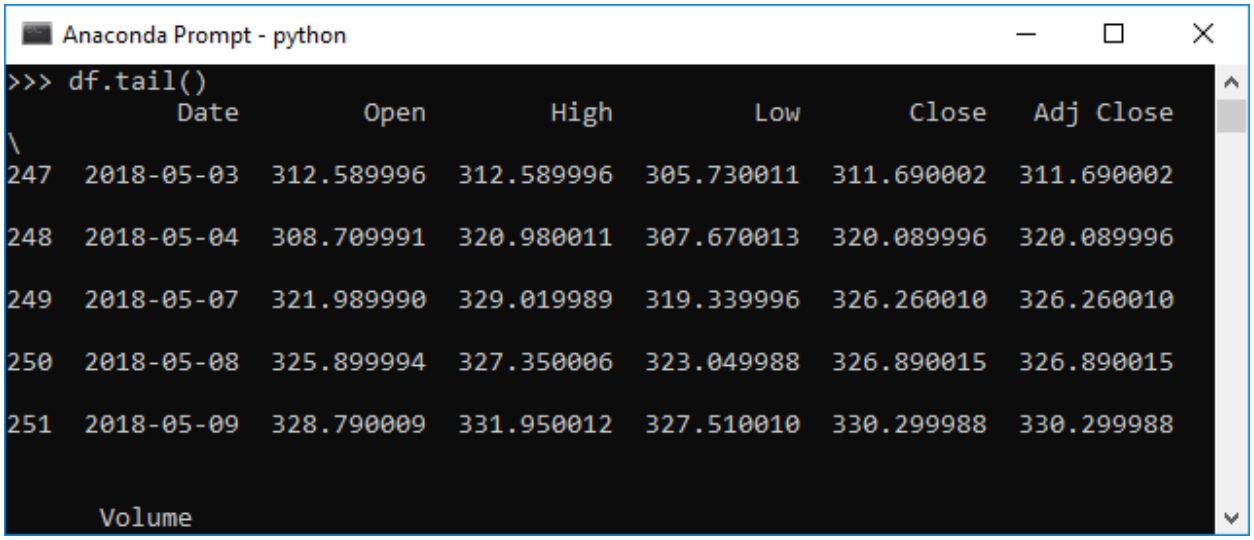
The dtypes attribute provides a list of the data types of each column.

```
df.head()
```



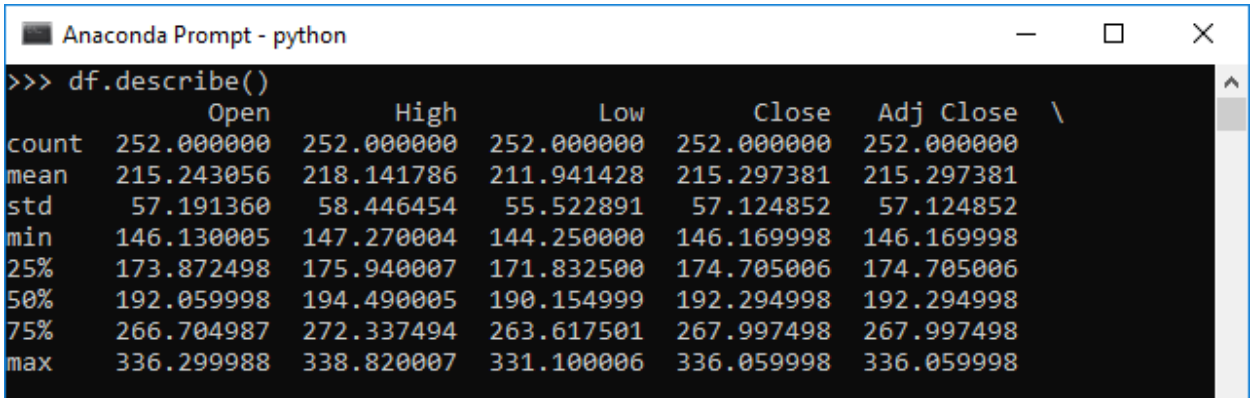
The head() method display the first 5 rows in the DataFrame. A different number of rows to display can be passed in as a parameter (for example `df.head(10)` would display the first 10 rows).

```
df.tail()
```



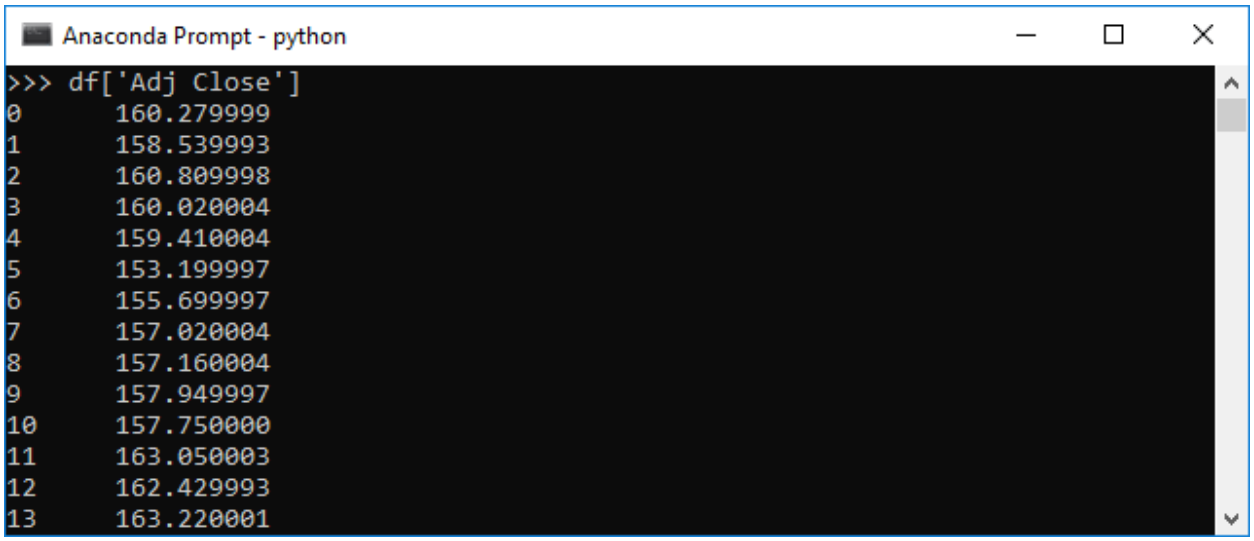
The tail() method displays the last 5 rows in the DataFrame. A different number of rows to display can be passed in as a parameter (for example `df.tail(20)` would display the last 20 rows).

```
df.describe()
```



The describe() method calculates and displays some common sample statistics for the DataFrame's columns, including the count, mean, standard deviation, min/max values, and quartiles. It skips NA values.

```
df['Adj Close']
```

Display a column from the DataFrame, selected by label.

Manipulating Data In DataFrames

It's also possible to add new columns to a DataFrame and perform other calculations:

```
df['Daily Return'] = df['Adj Close'].pct_change()
df['10DMA'] = df['Adj Close'].rolling(window=10, center=False).mean()
df['30DMA'] = df['Adj Close'].rolling(window=30, center=False).mean()
summary = df.describe()
```

From the commands above, three additional columns ('Daily Return', '10DMA', and '30DMA') are added to the DataFrame. The 'Daily Return' column is calculated by calling the pct_change() method, which calculates the percentage change between each row in the 'Adj Close' column. The '10DMA' and '30DMA' columns are calculated by creating rolling 10-day or 30-day windows on the rows in the 'Adj Close' column, and then calculating the mean on those windows.

Then the 'summary' variable is defined as 'df.describe()'. As demonstrated in the previous section, this method will display some common sample statistics whenever a user types 'summary' and hits enter in the prompt.

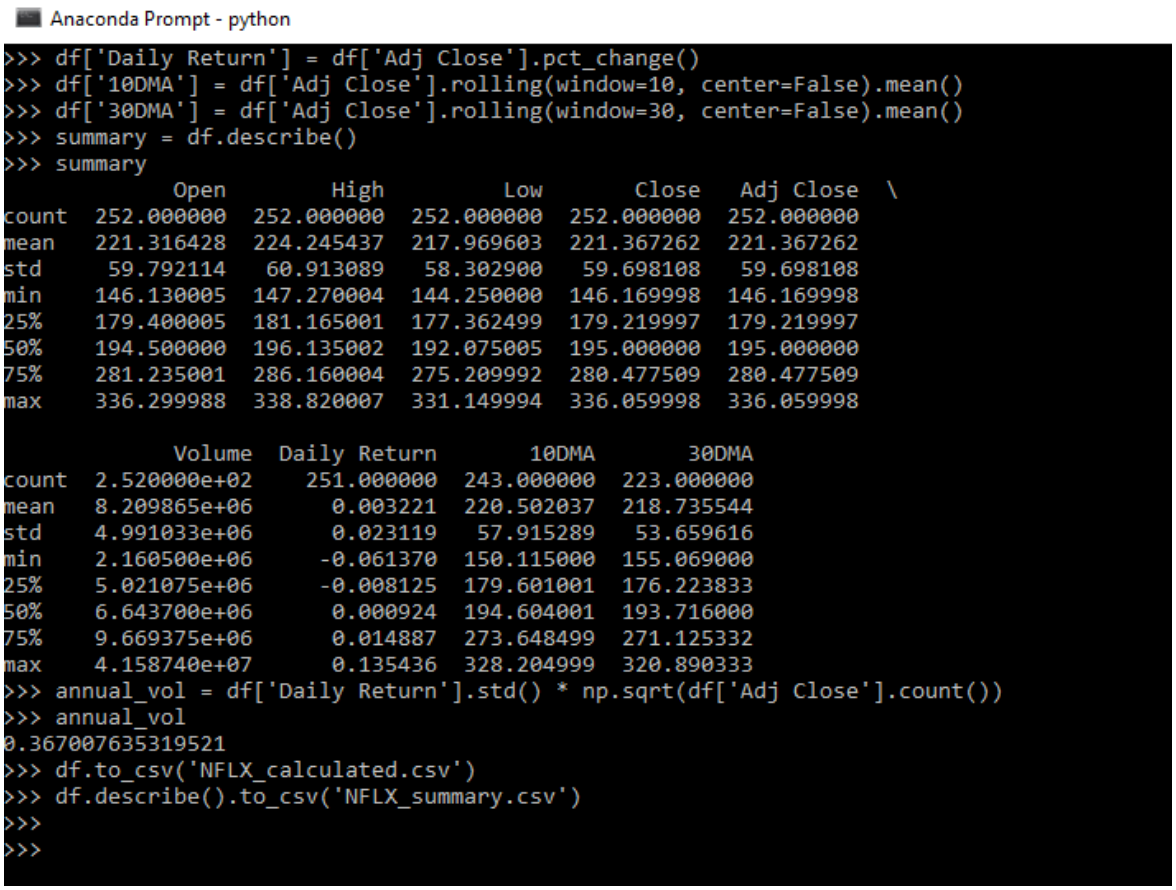
Using the daily return values, a user can also calculate an annualized volatility. From the command below, a standard deviation of the daily returns is first calculated and multiplied by the square root of the number of trading days in a year.

```
annual_vol = df['Daily Return'].std() * np.sqrt(df['Adj Close'].count())
```

A user can simply type in 'annual_vol' and hit enter in the prompt to query the calculated annualized volatility.

The to_csv() method allows a user to export the DataFrame to a csv file. Using the following sample commands, a user can export the entire DataFrame as a csv file with a file name 'NFLX_calculated.csv' or just the summary part with a file name 'NFLX_summary.csv'. The exported files will be made available in the same directory.

```
df.to_csv('NFLX_calculated.csv')
df.describe().to_csv('NFLX_summary.csv')
```



NFLX_calculated.csv

	A	B	C	D	E	F	G	H	I	J	K
1		Date	Open	High	Low	Close	Adj Close	Volume	Daily Retu	10DMA	30DMA
2	0	5/23/2017	157.75	158.31	156.8	157.95	157.95	3370900			
3	1	5/24/2017	158.35	158.48	157.17	157.75	157.75	2970800	-0.00127		
4	2	5/25/2017	161	164.1	160.55	163.05	163.05	8561000	0.033597		
5	3	5/26/2017	162.84	163.05	161.12	162.43	162.43	4834300	-0.0038		
6	4	5/30/2017	163.6	164.75	162.71	163.22	163.22	4828600	0.004864		
7	5	5/31/2017	163.61	164	160.74	163.07	163.07	5328900	-0.00092		
8	6	6/1/2017	163.52	163.93	161.7	162.99	162.99	3896300	-0.00049		
9	7	6/2/2017	163.42	165.36	162.8	165.18	165.18	4259100	0.013436		
10	8	6/5/2017	165.49	165.5	163.43	165.06	165.06	3875200	-0.00073		
11	9	6/6/2017	164.95	166.82	164.51	165.17	165.17	4382100	0.000666	162.587	
12	10	6/7/2017	165.6	166.4	164.41	165.61	165.61	3353100	0.002664	163.353	
13	11	6/8/2017	166.12	166.87	164.84	165.88	165.88	3695200	0.00163	164.166	
14	12	6/9/2017	166.27	166.27	154.5	158.03	158.03	10292000	-0.04732	163.664	
15	13	6/12/2017	155.3	155.53	148.31	151.44	151.44	14114500	-0.0417	162.565	
16	14	6/13/2017	154.38	155.68	150.13	152.72	152.72	8484700	0.008452	161.515	
17	15	6/14/2017	154.34	155.62	150.28	152.2	152.2	6461800	-0.0034	160.428	
18	16	6/15/2017	149.44	152.56	147.3	151.76	151.76	7319700	-0.00289	159.305	
19	17	6/16/2017	151.45	153.53	150.39	152.38	152.38	6909700	0.004085	158.025	
20	18	6/19/2017	154.29	155.58	152.41	153.4	153.4	6544300	0.006694	156.859	
21	19	6/20/2017	153.68	154.5	151.4	152.05	152.05	4878700	-0.0088	155.547	
22	20	6/21/2017	152.5	155.38	152.26	155.03	155.03	5803400	0.019599	154.489	
23	21	6/22/2017	155.13	155.2	153.7	154.89	154.89	3769200	-0.0009	153.39	
24	22	6/23/2017	155.01	158.19	153.76	158.02	158.02	6250800	0.020208	153.389	
25	23	6/26/2017	158.78	159.97	156.56	157.5	157.5	6016000	-0.00329	153.995	
26	24	6/27/2017	156.62	156.98	150.72	151.03	151.03	7424300	-0.04108	153.826	
27	25	6/28/2017	151.64	154.2	150.12	153.41	153.41	5589900	0.015758	153.947	
28	26	6/29/2017	152.82	152.82	148	150.09	150.09	7142500	-0.02164	153.78	
29	27	6/30/2017	149.76	150.71	148.42	149.41	149.41	5213300	-0.00453	153.483	
30	28	7/3/2017	149.8	150.45	145.8	146.17	146.17	3908200	-0.02169	152.76	
31	29	7/5/2017	146.58	148.26	145.58	147.61	147.61	4627800	0.009852	152.316	156.8167
32	30	7/6/2017	146.13	147.27	144.25	146.25	146.25	5486500	-0.00921	151.438	156.4267
33	31	7/7/2017	146.65	150.75	146.65	150.18	150.18	5561300	0.026872	150.967	156.1743

NFLX_summary.csv

	A	B	C	D	E	F	G	H	I	J
1		Open	High	Low	Close	Adj Close	Volume	Daily Retu	10DMA	30DMA
2	count	252	252	252	252	252	252	251	243	223
3	mean	221.3164	224.2454	217.9696	221.3673	221.3673	8209865	0.003221	220.502	218.7355
4	std	59.79211	60.91309	58.3029	59.69811	59.69811	4991033	0.023119	57.91529	53.65962
5	min	146.13	147.27	144.25	146.17	146.17	2160500	-0.06137	150.115	155.069
6	25%	179.4	181.165	177.3625	179.22	179.22	5021075	-0.00813	179.601	176.2238
7	50%	194.5	196.135	192.075	195	195	6643700	0.000924	194.604	193.716
8	75%	281.235	286.16	275.21	280.4775	280.4775	9669375	0.014887	273.6485	271.1253
9	max	336.3	338.82	331.15	336.06	336.06	41587400	0.135436	328.205	320.8903
10										

Summary

This concludes a basic introduction to the use of the Pandas package for data analysis, similar to the basic data analysis and manipulations one would perform in Microsoft Office Excel. For more information about other methods to view and manipulate data in Pandas, please refer to the current documentation.

