

# Introduction to Data Science

## <sup>very</sup> A <sup>^</sup>brief Introduction to Python for Data Science

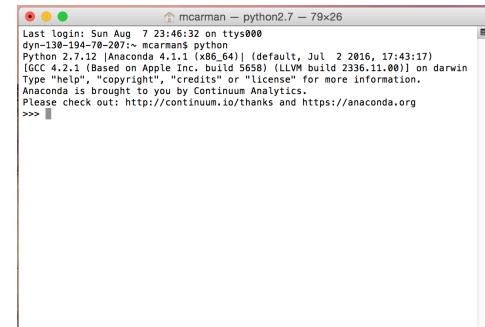
Updated 16/8/2016

# What is Python?

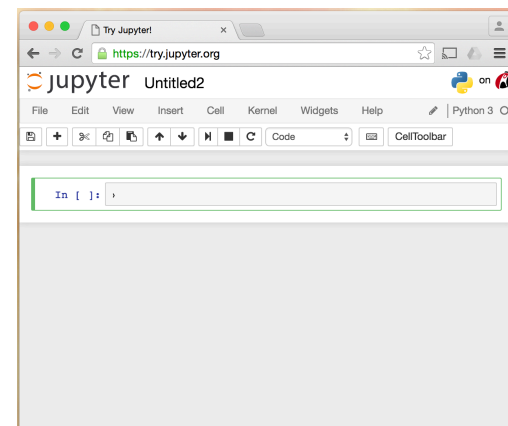
- Python is a general purpose programming language
  - interpreted (aka scripting) language -- like Javascript & R
  - designed by computer scientists (not statisticians)
  - open-source
  - very popular
- Alternatives:
  - R, Matlab, SAS, ...

# Getting started

- **Anaconda** extends Python with various packages useful for Data Science
- Install Python+Anaconda from:
  - <https://www.continuum.io/downloads>
- Or use Python online:
  - by opening a new iPython notebook on Jupyter
  - <https://try.jupyter.org/>



```
mcarman — python2.7 — 79x26
Last login: Sun Aug 7 23:46:32 on ttys000
dyn-130-194-70-207:~ mcarman$ python
Python 2.7.12 [Anaconda 4.1.1 (x86_64)] (default, Jul 2 2016, 17:43:17)
[GCC 4.2.1 (Based on Apple Inc. build 5658) (LLVM build 2336.11.00)] on darwin
Type "help", "copyright", "credits" or "license()" for more information.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://anaconda.org
>>>
```



# Basic Python syntax

- Compute mathematical expressions:

```
> 3+2  
5
```

Here `>` denotes the command prompt

- Define variables and assign values:

```
> A = 10  
> 5*A + 6  
56
```

Formula syntax comes from C, so some expressions are interpreted differently from R:

- e.g. to compute 2 cubed type `2**3` not `2^3`

- Define a list:

```
> B = [5,5,3,0]  
> B  
5 5 3 0
```

Can use square or round brackets:

```
> B = (5,5,3,0)
```

- Access part of list:

```
> B[0]  
5  
> B[1:3]  
[5,3]
```

**BEWARE:** First index of array is 0 not 1!

# Loading libraries

- Load a library with “from ... import ... as ...” keywords

```
> from matplotlib import pyplot as plt  
> plt.boxplot(...)
```

`plt` is the name we are giving to the imported library. We use it whenever we want to call a function provided by the library

Can also use shorter “.” notation rather than “from” to load library:

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

# Data Tables in Python

- The pandas library provides a table structure called DataFrame

```
> import pandas as pd
> df = pd.DataFrame({
    'StudentID' : [264422, 264423, 264444, 259432],
    'Name'      : ['Steven', 'Alex', 'Bill', 'Steven'],
    'Mark'      : [93.5, 61.2, 78.5, 81.1]
})
```

Creates a table with 3 columns:

- **StudentID**, **Name** and **Mark**

- Print out the table table:

```
> print(df)
```

	Mark	Name	StudentID
0	93.5	Steven	264422
1	61.2	Alex	264423
2	78.5	Bill	264444
3	81.1	Steven	259432

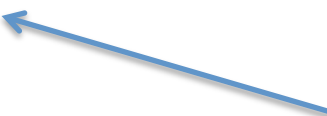
# Selecting Columns and Values

- Select a column by using its column name:

```
> df['Name']  
0    Steven  
1     Alex  
2     Bill  
3    Steven  
Name: Name, dtype: object
```

- Select **multiple columns** using an **list** of column names:

```
> df[['Name', 'Mark']]  
   Name  Mark  
0  Steven  93.5  
1   Alex  61.2  
2   Bill  78.5  
3  Steven  81.1
```



Note the need for the double bracket, since the argument is now an array

- Select a value using the column name and row index:

```
> df['Name'][1]  
'Alex'
```

# Selecting Rows

- Select a particular row from the table:

```
> df.loc[2]
Mark      78.5
Name      Bill
StudentID 264444
Name: 2, dtype: object
```

To select multiple rows, replace the single index by an array:

```
> df.loc[[0,2]]
      Mark  Name  StudentID
0  93.5  Steven   264422
2  78.5   Bill   264444
```

- Select **all** rows with a particular value in one of the columns:

```
> df.loc[df['Name'] == 'Steven']
      Mark  Name  StudentID
0  93.5  Steven   264422
3  81.1  Steven   259432
```



# Loading & Saving Data

- We can loading data in from a CSV file

```
> import pandas as pd  
> df = pd.read_csv('input.csv', sep=',')
```

- And save a resulting data frame to a CSV file

```
> df2 = df.loc[df['Name'] == 'Steven']  
> df2.save_csv('output.csv')
```

# Aggregation and Groupby

- Sometimes we need compute aggregate values (like totals or averages) for a particular column:

```
> df['Mark'].sum()  
314.29999999999995  
> df['Mark'].mean()  
78.57499999999999
```

- And often we'd like to know these aggregate values for certain values of another column, in which case we use the *groupby* function:

```
> df.groupby('Name')['Mark'].mean()  
Name  
Alex      61.2  
Bill      78.5  
Steven    87.3  
Name: Mark, dtype: float64
```

Average value for two students named Steven from original table:

	Mark	Name	StudentID
0	93.5	Steven	264422
1	61.2	Alex	264423
2	78.5	Bill	264444
3	81.1	Steven	259432


# Aggregation and Groupby (cont.)

- In order to “flatten” the results of the *groupby* function back into a table use the *reset\_index* method:

```
> df1 = df.groupby('Name')['Mark'].mean()  
> df1 = df1.reset_index()  
  
   Name  Mark  
0  Alex  61.2  
1  Bill  78.5  
2 Steven 87.3
```

- We can aggregate with respect to **multiple attributes at once** by inserting an array of column names into the *groupby* call:

```
> df.groupby(['Name', 'StudentID'])['Mark'].mean()  
  
Name      StudentID      Mark  
Alex      264423      61.2  
Bill      264444      78.5  
Steven    259432      81.1  
          264422      93.5  
Name: Mark, dtype: float64
```



Mean values for particular combinations of **Name** and **StudentID**

- Finally, we can return the aggregated values (mean or sum) for multiple columns at once by listing the columns explicitly or not at all:

```
> df.groupby(['Name'])['Mark', 'StudentID'].mean()  
> df.groupby(['Name']).mean()
```

# Plotting data

- We can use the matplotlib library to plot data in Python

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

- Define a table with the data to plot:

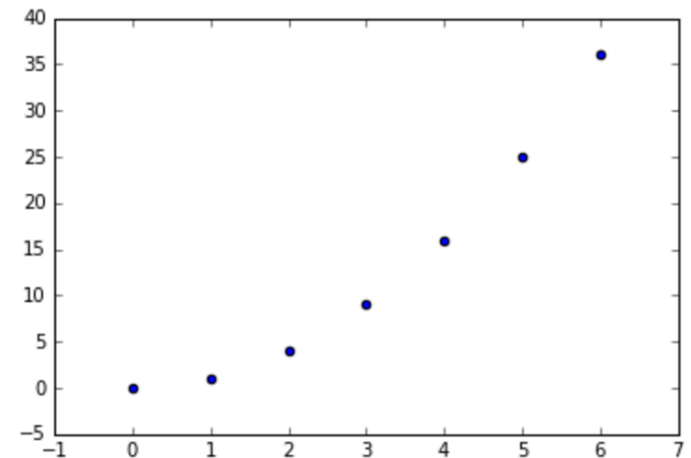
```
> df = pd.DataFrame({  
    'X' : [0,1,2,3,4,5,6],  
    'Y' : [0,1,4,9,16,25,36]})
```

- Create scatter plot

```
> plt.scatter(df['X'], df['Y'])
```

- And show it:

```
plt.show()
```



# End of Introduction

- We'll be playing around with Python in this week's Tutorial
- There are MANY excellent Python resources online if you'd like to learn more
  - for example: [lynda.com](https://www.lynda.com)