# Intermediate Python

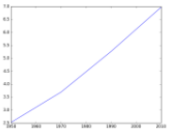
Cheatsheet & Final Project

## Matplotlib

- mother of all visualization packages in Python

**Matplotlib**

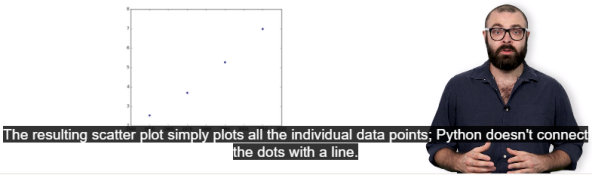
```
import matplotlib.pyplot as plt
year = [1950, 1970, 1990, 2010]
pop = [2.519, 3.692, 5.263, 6.972]
plt.plot(year, pop)
plt.show()
```



- plt.plot(x,y) creates a line graph ^^

**Scatter plot**

```
import matplotlib.pyplot as plt
year = [1950, 1970, 1990, 2010]
pop = [2.519, 3.692, 5.263, 6.972]
plt.scatter(year, pop)
plt.show()
```




- Scatter plot is better because it only shows points.

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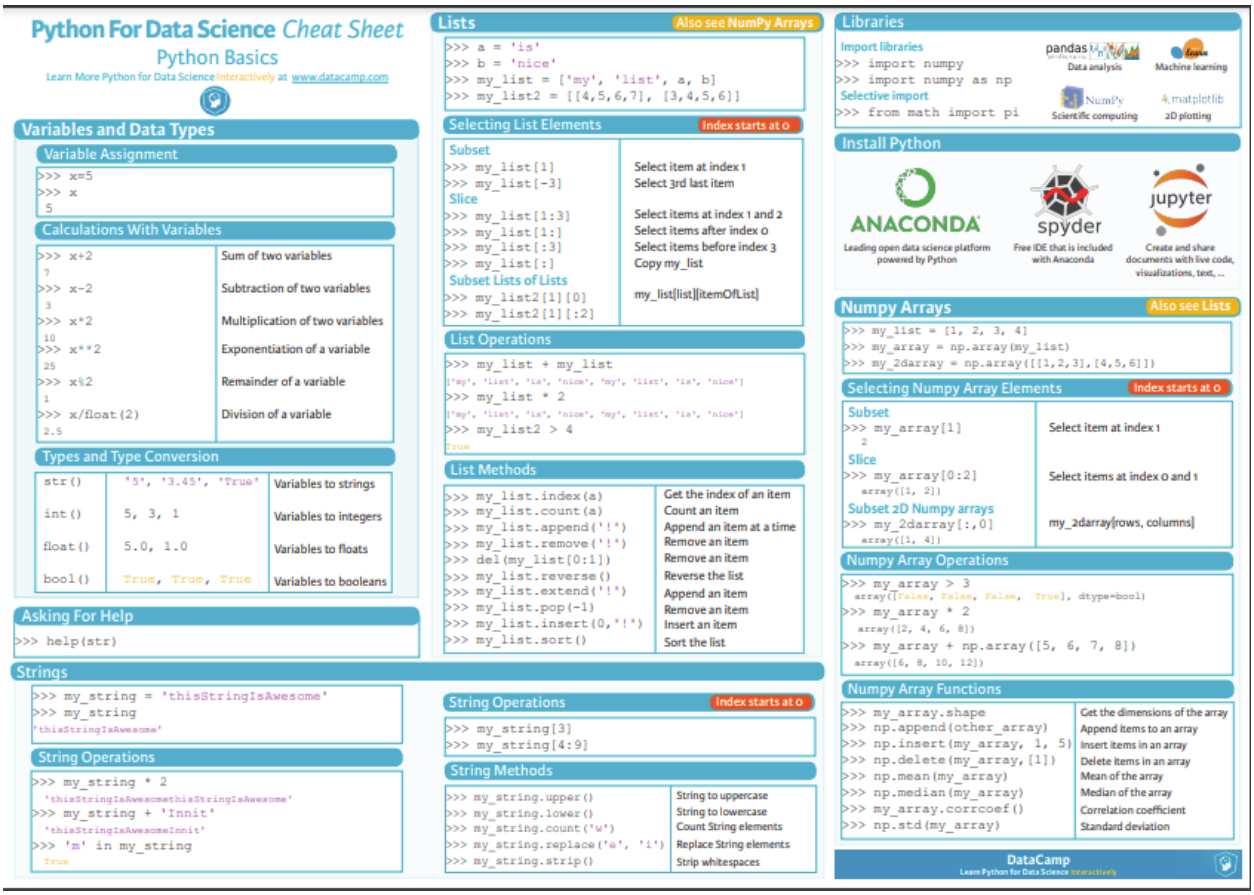
## Python for Data Science Cheatsheet



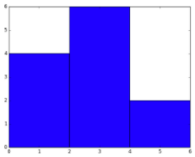

https://s3-us-west-2.amazonaws.com/secure.notion-static.com/f70dceca-c7ce-482a-85f8-8f6b0363aaba/e30fbcd9-f595-4a9f-803d-05ca5bf84612.pdf

# Histograms

- If there is no bin specified, the 10 bins will be the default.

### Matplotlib example

```
values = [0,0.6,1.4,1.6,2.2,2.5,2.6,3.2,3.5,3.9,4.2,6]
plt.hist(values, bins=3)
plt.show()
```




# Customization

## Add historical data

`population.py`

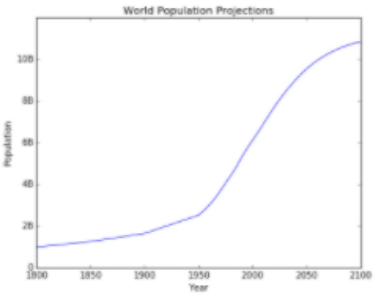
```
import matplotlib.pyplot as plt
year = [1950, 1951, 1952, ..., 2100]
pop = [2.538, 2.57, 2.62, ..., 10.85]

# Add more data
year = [1800, 1850, 1900] + year
pop = [1.0, 1.262, 1.650] + pop

plt.plot(year, pop)

plt.xlabel('Year')
plt.ylabel('Population')
plt.title('World Population Projections')
plt.yticks([0, 2, 4, 6, 8, 10],
           ['0', '2B', '4B', '6B', '8B', '10B'])

plt.show()
```





# Dictionaries

## Dictionary Manipulation (1)

If you know how to access a dictionary, you can also assign a new value to it. To add a new key-value pair to `europe` you can use something like this:

```
europe['iceland'] = 'reykjavik'
```

**Instructions** 100 XP

- Add the key `'italy'` with the value `'rome'` to `europe`.
- To assert that `'italy'` is now a key in `europe`, print out `'italy' in europe`.
- Add another key:value pair to `europe`: `'poland'` is the key, `'warsaw'` is the corresponding value.
- Print out `europe`.

Take Hint (-30 XP)

Incorrect Submission

```
# Definition of dictionary
europe = {'spain':'madrid', 'france':'paris', 'germany':'berlin', 'norway':'oslo' }

# Add italy to europe
europe["italy"] = "rome"
print("italy" in europe)

europe["poland"] = "warsaw"
print(europe)

# Print out italy in europe


# Add poland to europe
```

Run Code | Submit Answer

IPython Shell | Slides

```
True
{'spain': 'madrid', 'norway': 'oslo', 'france': 'paris', 'italy': 'rome', 'poland': 'warsa

<script.py> output:
    True
    {'spain': 'madrid', 'norway': 'oslo', 'france': 'paris', 'italy': 'rome', 'poland': 'w
```

## Dictionary Manipulation (2)

Somebody thought it would be funny to mess with your accurately generated dictionary. An adapted version of the `europe` dictionary is available in the script.

Can you clean up? Do not do this by adapting the definition of `europe`, but by adding Python commands to the script to update and remove key:value pairs.

**Instructions** 100 XP

- The capital of Germany is not `'bonn'`; it's `'berlin'`. Update its value.
- Australia is not in Europe, Austria is! Remove the key `'australia'` from `europe`.
- Print out `europe` to see if your cleaning work paid off.

Take Hint (-30 XP)

```
# Definition of dictionary
europe = {'spain':'madrid', 'france':'paris', 'germany':'bonn',
          'norway':'oslo', 'italy':'rome', 'poland':'warsaw',
          'australia':'vienna' }

# Update capital of germany

europe["germany"] = "berlin"

del(europe["australia"])
print(europe)

# Remove australia

# Print europe
```

Run Code | Submit Answer

IPython Shell | Slides

```
# Print europe

{'spain': 'madrid', 'norway': 'oslo', 'france': 'paris', 'italy': 'rome', 'poland': 'warsa

<script.py> output:
    {'spain': 'madrid', 'norway': 'oslo', 'france': 'paris', 'italy': 'rome', 'poland': 'w
```

## Dictionariception

Remember lists? They could contain anything, even other lists. Well, for dictionaries the same holds. Dictionaries can contain key:value pairs where the values are again dictionaries.

As an example, have a look at the script where another version of `europe` - the dictionary you've been working with all along - is coded. The keys are still the country names, but the values are dictionaries that contain more information than just the capital.

It's perfectly possible to chain square brackets to select elements. To fetch the population for Spain from `europe`, for example, you need:

```
europe['spain']['population']
```

**Instructions** 100 XP

- Use chained square brackets to select and print out the capital of France.
- Create a dictionary, named `data`, with the keys `'capital'` and `'population'`. Set them to `'rome'` and `59.83`, respectively.
- Add a new key-value pair to `europe`; the key is `'italy'` and the value is `data`, the dictionary you just built.

Take Hint (-30 XP)

```
# Dictionary of dictionaries
europe = { 'spain': { 'capital':'madrid', 'population':46.77 },
           'france': { 'capital':'paris', 'population':66.03 },
           'germany': { 'capital':'berlin', 'population':80.62 },
           'norway': { 'capital':'oslo', 'population':5.084 } }

# Print out the capital of France
print(europe["france"]["capital"])

data = {'capital': 'rome', 'population': 59.83}

europe['italy'] = data
print(europe)
# Create sub-dictionary data
# Add data to europe under key 'italy'
# Print europe
```

Run Code | Submit Answer

IPython Shell | Slides

```
# Add data to europe under key 'italy'


# Print europe

paris
{'spain': {'population': 46.77, 'capital': 'madrid'}, 'norway': {'population': 5.084, 'capital': 'oslo
```

# Pandas

- part of the numpy package

## Creating your own dataframe from Dictionary

### DataFrame from Dictionary

```
dict = {
    "country":["Brazil", "Russia", "India", "China", "South Africa"],
    "capital":["Brasilia", "Moscow", "New Delhi", "Beijing", "Pretoria"],
       "area":[8.516, 17.10, 3.286, 9.597, 1.221]
 "population":[200.4, 143.5, 1252, 1357, 52.98] }
```

- keys (column labels)
- values (data, column by column)

```
import pandas as pd
brics = pd.DataFrame(dict)
```

### DataFrame from Dictionary (2)

```
brics
```

| | area | capital | country | population |
|---|---|---|---|---|
| 0 | 8.516 | Brasilia | Brazil | 200.40 |
| 1 | 17.100 | Moscow | Russia | 143.50 |
| 2 | 3.286 | New Delhi | India | 1252.00 |
| 3 | 9.597 | Beijing | China | 1357.00 |
| 4 | 1.221 | Pretoria | South Africa | 52.98 |

```
brics.index = ["BR", "RU", "IN", "CH", "SA"]
brics
```

| | area | capital | country | population |
|---|---|---|---|---|
| BR | 8.516 | Brasilia | Brazil | 200.40 |
| RU | 17.100 | Moscow | Russia | 143.50 |
| IN | 3.286 | New Delhi | India | 1252.00 |
| CH | 9.597 | Beijing | China | 1357.00 |
| SA | 1.221 | Pretoria | South Africa | 52.98 |

## Creating DataFrame from CSV file

### DataFrame from CSV file

- `brics.csv`

```
,country,capital,area,population
BR,Brazil,Brasilia,8.516,200.4
RU,Russia,Moscow,17.10,143.5
IN,India,New Delhi,3.286,1252
CH,China,Beijing,9.597,1357
SA,South Africa,Pretoria,1.221,52.98
```

```
brics = pd.read_csv("path/to/brics.csv")
brics
```

| | Unnamed: 0 | country | capital | area | population |
|---|---|---|---|---|---|
| 0 | BR | Brazil | Brasilia | 8.516 | 200.40 |
| 1 | RU | Russia | Moscow | 17.100 | 143.50 |
| 2 | IN | India | New Delhi | 3.286 | 1252.00 |
| 3 | CH | China | Beijing | 9.597 | 1357.00 |
| 4 | SA | South Africa | Pretoria | 1.221 | 52.98 |

### DataFrame from CSV file

```
brics = pd.read_csv("path/to/brics.csv", index_col = 0)
brics
```

| | country | population | area | capital |
|---|---|---|---|---|
| BR | Brazil | 200 | 8515767 | Brasilia |
| RU | Russia | 144 | 17098242 | Moscow |
| IN | India | 1252 | 3287590 | New Delhi |
| CH | China | 1357 | 9596961 | Beijing |
| SA | South Africa | 55 | 1221037 | Pretoria |

# loc() vs iloc()

- loc is for words, iloc is for integers

- Square brackets
  - Column access `brics[["country", "capital"]]`
  - Row access: only through slicing `brics[1:4]`
- loc (label-based)
  - Row access `brics.loc[["RU", "IN", "CH"]]`
  - Column access `brics.loc[:, ["country", "capital"]]`
  - Row & Column access

```
brics.loc[
["RU", "IN", "CH"],
["country", "capital"]
]
```

**Row & Column loc**

```
        country    capital    area  population
BR       Brazil   Brasilia   8.516      200.40
RU       Russia     Moscow  17.100      143.50
IN        India  New Delhi   3.286     1252.00
CH        China    Beijing   9.597     1357.00
SA  South Africa   Pretoria   1.221       52.98
```

```
brics.loc[["RU", "IN", "CH"], ["country", "capital"]]
```

```
   country    capital
RU  Russia     Moscow
IN   India  New Delhi
CH   China    Beijing
```

**Row Access iloc**

```
        country    capital    area  population
BR       Brazil   Brasilia   8.516      200.40
RU       Russia     Moscow  17.100      143.50
IN        India  New Delhi   3.286     1252.00
CH        China    Beijing   9.597     1357.00
SA  South Africa   Pretoria   1.221       52.98
```

```
brics.iloc[[1,2,3]]
```

```
   country    capital    area  population
RU  Russia     Moscow  17.100       143.5
IN   India  New Delhi   3.286      1252.0
CH   China    Beijing   9.597      1357.0
```

# Array Equivalents of and, or, not

**NumPy**

- `logical_and()`
- `logical_or()`
- `logical_not()`

```
np.logical_and(bmi > 21, bmi < 22)
```

```
array([True, False, True, False, True], dtype=bool)
```

```
bmi[np.logical_and(bmi > 21, bmi < 22)]
```

```
array([21.852, 21.75, 21.441])
```

Also, AND, OR and NOT operators are spelled out on Python

# if, elif, else

```
if condition :
    expression
elif condition :
    expression
else :
    expression
```

control.py

```
z = 6
if z % 2 == 0 :
    print("z is divisible by 2")    # True
elif z % 3 == 0 :
    print("z is divisible by 3")    # Never reached
else :
    print("z is neither divisible by 2 nor by 3")
```

# Filtering Pandas from DataFrames

```
        country    capital    area  population
BR       Brazil   Brasilia   8.516      200.40
RU       Russia     Moscow  17.100      143.50
IN        India  New Delhi   3.286     1252.00
CH        China    Beijing   9.597     1357.00
SA  South Africa   Pretoria   1.221       52.988
```

```
is_huge = brics["area"] > 8
brics[is_huge]
```

```
   country   capital    area  population
BR  Brazil  Brasilia   8.516       200.4
RU  Russia    Moscow  17.100       143.5
CH   China   Beijing   9.597      1357.0
```

```
brics[brics["area"] > 8]
```

```
   country   capital    area  population
BR  Brazil  Brasilia   8.516       200.4
RU  Russia    Moscow  17.100       143.5
CH   China   Beijing   9.597      1357.0
```

## Boolean operators

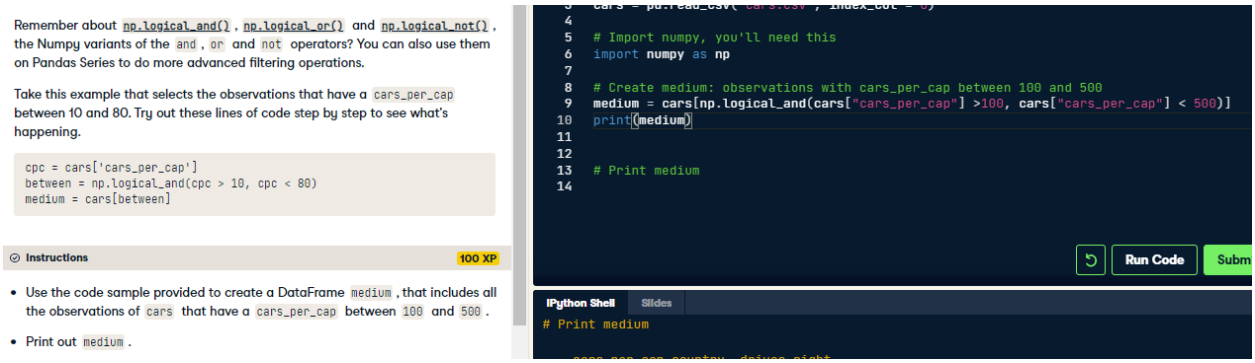
```
country    capital    area  population
BR        Brazil   Brasilia   8.516      200.40
RU        Russia     Moscow  17.100      143.50
IN         India  New Delhi   3.286     1252.00
CH         China    Beijing   9.597     1357.00
SA  South Africa   Pretoria   1.221       52.98
```

```
import numpy as np
np.logical_and(brics["area"] > 8, brics["area"] < 10)
```

```
BR     True
RU    False
IN    False
CH     True
SA    False
Name: area, dtype: bool
```

```
brics[np.logical_and(brics["area"] > 8, brics["area"] < 10)]
```

```
   country   capital   area  population
BR  Brazil  Brasilia  8.516       200.4
CH   China   Beijing  9.597      1357.0
```




# While loop

- repeating action until condition is met

## While

```
while condition :
    expression
```

while_loop.py

```
error = 50.0
#     0.78125
while error > 1:    # False
    error = error / 4
    print(error)
```

```
12.5
3.125
0.78125
```

# For loops

```
for var in seq :
    expression
```

family.py

```
fam = [1.73, 1.68, 1.71, 1.89]
for index, height in enumerate(fam) :
    print("index " + str(index) + ": " + str(height))
```

```
index 0: 1.73
index 1: 1.68
index 2: 1.71
index 3: 1.89
```

```
for c in "family" :
    print(c.capitalize())
```

```
F
A
M
I
L
Y
```

### Loop over list of lists

Remember the `house` variable from the Intro to Python course? Have a look at its definition in the script. It's basically a list of lists, where each sublist contains the name and area of a room in your house.

It's up to you to build a `for` loop from scratch this time!

**Instructions** 100 XP

Write a `for` loop that goes through each sublist of `house` and prints out `the x is y sqm`, where x is the name of the room and y is the area of the room.

```
# house list of lists
house = [["hallway", 11.25],
         ["kitchen", 18.0],
         ["living room", 20.0],
         ["bedroom", 10.75],
         ["bathroom", 9.50]]

# Build a for loop from scratch

for key, value in house:
    print("the " + str(key) + " is " + str(value) + " sqm")
```

# Loop Data Structures

- Dictionary
  - for `key, val in my_dict.items() :`
- Numpy array
  - `for val in np.nditer(my_array) :`

A 2D array is built up of multiple 1D arrays. To explicitly iterate over all separate elements of a multi-dimensional array, you'll need this syntax:

```
for x in np.ndite
r(my_array) :
```

### Dictionary

```
for var in seq :
    expression
```

dictloop.py

```
world = { "afghanistan":30.55,
          "albania":2.77,
          "algeria":39.21 }
for k, v in world.items() :
    print(k + " -- " + str(v))
```

```
algeria -- 39.21
afghanistan -- 30.55
albania -- 2.77
```

### 2D Numpy Arrays

nploop.py

```
import numpy as np
np_height = np.array([1.73, 1.68, 1.71, 1.89, 1.79])
np_weight = np.array([65.4, 59.2, 63.6, 88.4, 68.7])
meas = np.array([np_height, np_weight])
for val in np.nditer(meas) :
    print(val)
```

```
1.73
1.68
1.71
1.89
1.79
65.4
...
```

```
...
```

### iterrows

dfloop.py

```
import pandas as pd
brics = pd.read_csv("brics.csv", index_col = 0)
for lab, row in brics.iterrows():
    print(lab)
    print(row)
```

```
BR
country        Brazil
capital      Brasilia
area            8.516
population      200.4
Name: BR, dtype: object
...
RU
country       Russia
capital       Moscow
area            17.1
population     143.5
Name: RU, dtype: object
IN ...
```

### Selective print

dfloop.py

```
import pandas as pd
brics = pd.read_csv("brics.csv", index_col = 0)
for lab, row in brics.iterrows():
    print(lab + ": " + row["capital"])
```

```
BR: Brasilia
RU: Moscow
IN: New Delhi
CH: Beijing
SA: Pretoria
```

# Adding columns

### Add column

dfloop.py

```
import pandas as pd
brics = pd.read_csv("brics.csv", index_col = 0)
for lab, row in brics.iterrows() :
    # - Creating Series on every iteration
    brics.loc[lab, "name_length"] = len(row["country"])
print(brics)
```

```
        country    capital    area  population  name_length
BR       Brazil   Brasilia   8.516      200.40            6
RU       Russia     Moscow  17.100      143.50            6
IN        India  New Delhi   3.286     1252.00            5
CH        China    Beijing   9.597     1357.00            5
SA  South Africa   Pretoria   1.221       52.98           12
```

### apply

dfloop.py

```
import pandas as pd
brics = pd.read_csv("brics.csv", index_col = 0)
brics["name_length"] = brics["country"].apply(len)
print(brics)
```

```
        country    capital    area  population
BR       Brazil   Brasilia   8.516      200.40
RU       Russia     Moscow  17.100      143.50
IN        India  New Delhi   3.286     1252.00
CH        China    Beijing   9.597     1357.00
SA  South Africa   Pretoria   1.221       52.98
```

- this is better compared the one on the left

Another example using .apply(len)

Compare the `iterrows()` version with the `apply()` version to get the same result in the `brics` DataFrame:

```
for lab, row in brics.iterrows() :
    brics.loc[lab, "name_length"] = len(row["country"])

brics["name_length"] = brics["country"].apply(len)
```

We can do a similar thing to call the `upper()` method on every name in the `country` column. However, `upper()` is a **method**, so we'll need a slightly different approach:

Instructions 100 XP

- Replace the `for` loop with a one-liner that uses `.apply(str.upper)`. The call should give the same result: a column `COUNTRY` should be added to `cars`, containing an uppercase version of the country names.
- As usual, print out `cars` to see the fruits of your hard labor

```
# Import cars data
import pandas as pd
cars = pd.read_csv('cars.csv', index_col = 0)

# Use .apply(str.upper)
for lab, row in cars.iterrows() :
    cars["COUNTRY"] = cars["country"].apply(str.upper)
```

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# Etc:

A typical way to solve problems like this is by using `max()`. If you pass `max()` two arguments, the biggest one gets returned. For example, to make sure that a variable `x` never goes below `10` when you decrease it, you can use:

```
x = max(10, x - 1)
```