# Applied Data Science with Python for Beginners

Lecture 2 - 09 December 2021

# What you learn today...

… how to use Python libraries

… work with data in a DataFrame

… filter, merge and group your data

… visualize data with simple plots

# Libraries

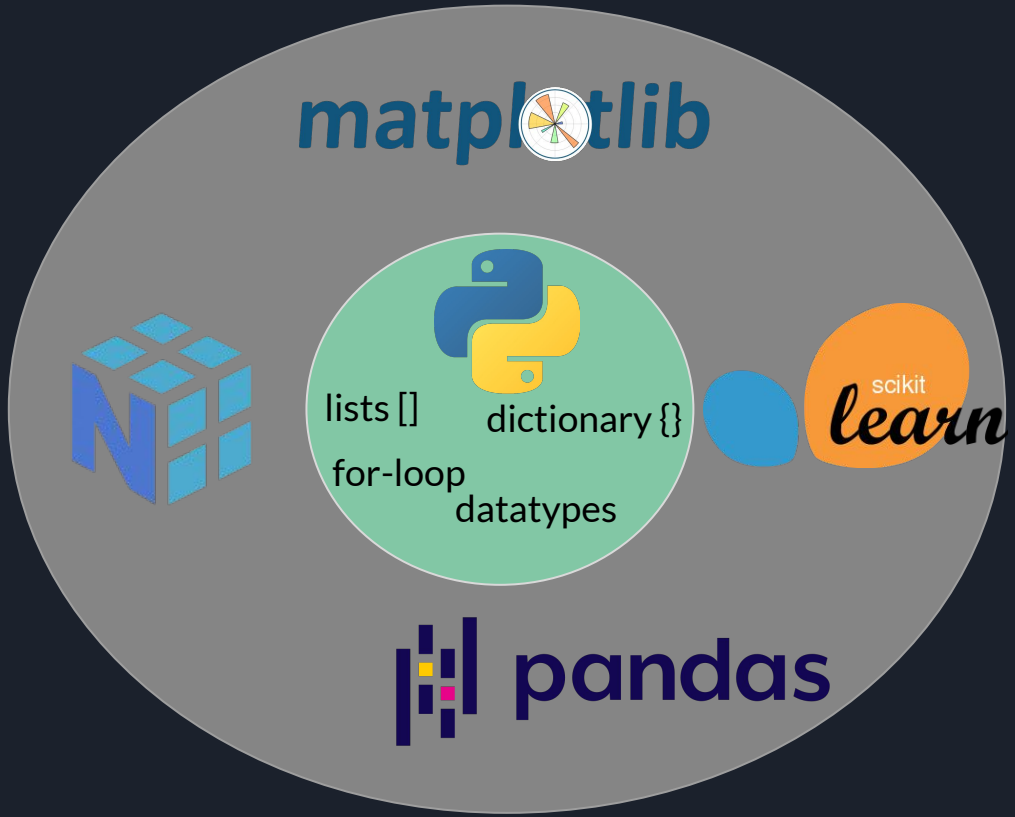
- A collection of functions is bundled in a **library**
- we import these libraries and can use the defined functions
- Some libraries come with a Python installation, some need to be installed


... for plotting and visualization


... for working with tabular data  (Excel-files, csv-files,...)


... creating machine learning models

# Libraries


matplotlib
lists []
dictionary {}
for-loop
datatypes
scikit
learn
pandas

# Function & Methods

## Functions

```
a = function_name(parameter)
```

## Methods

```
a = "a string"
a = a.upper() # ‘A STRING’
```

# Import Libraries

```
import library

a = library.function_name()
```

# Import Libraries

```
import library as l

a = l.function_name()
```

# NumPy - library

- Library for scientific computing
- Work with lists, matrices or higher dimensional structures
- NumPy lists have much more functionality than usual lists

```
import numpy as np

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

# NumPy - library

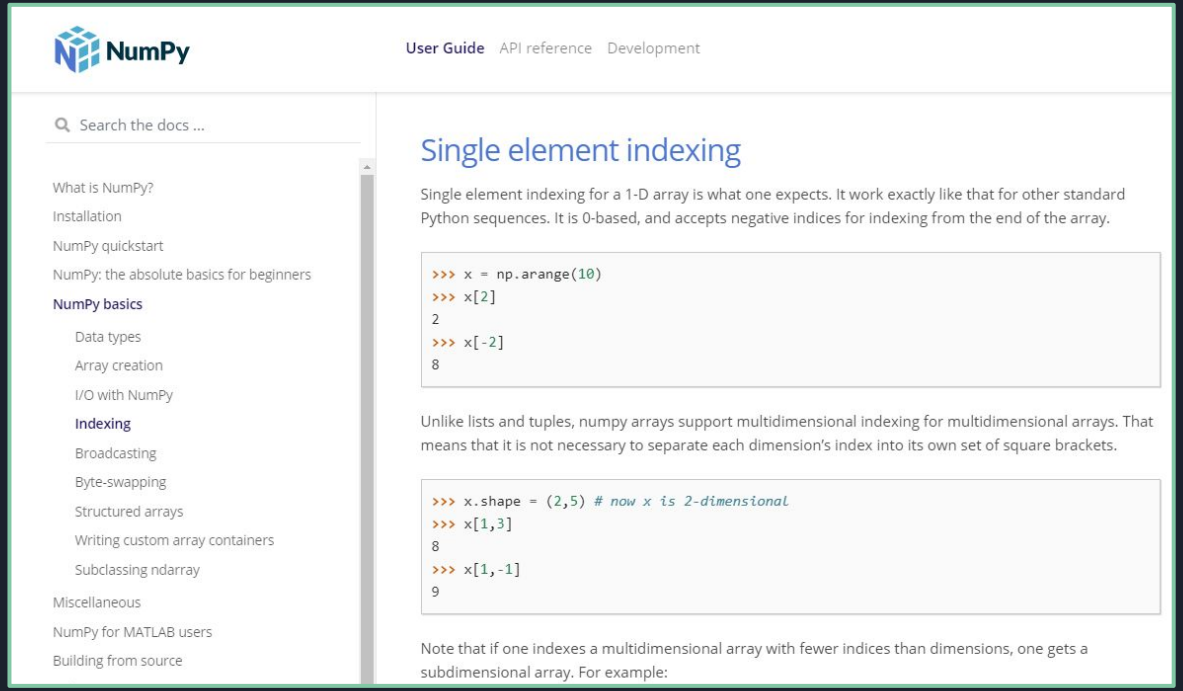
- Library for scientific computing
- Work with lists, matrices or higher dimensional structures
- NumPy lists have much more functionality than usual lists

```
import numpy as np

a = np.array([1,2,3,4])
a.sum() # 10
a.mean() # 2.5
a.std() # 1.118...
```

# Documentation

- Explanations to the methods and functions
- Often include examples and tutorials
- https://numpy.org/doc/



# NumPy - Append

```
import numpy as np

a = np.array([1,2,3,4])
np.append(a, [5,6,7]) # array([1, 2, 3, 4, 5, 6, 7])
```

# NumPy - Append

```
import numpy as np

a = np.array([1,2,3,4])
np.append(a, [5,6,7]) # array([1, 2, 3, 4, 5, 6, 7])
a = np.append(a, [5,6,7])
```

# Compute with arrays - Broadcasting

```
import numpy as np
a = np.array([1,2,3])
a * 2 # array([2, 4, 6])
a ** 2 # array([1, 4, 9])
a - 1 # array([0, 1, 2])
```

# Compute with arrays

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

# Indexing

```
import numpy as np

a = np.array([1,2,3,4])
a[0:2] # array([1,2])
```

# Boolean Indexing

```
import numpy as np

a = np.array([1,2,3,4])
a[[True,True,False,False]] # array([1,2])
```

# Boolean Indexing

```
import numpy as np

a = np.array([1,2,3,4])
a <= 2 # [True, True, False, False]
```

# Boolean Indexing

```
import numpy as np

a = np.array([1,2,3,4])
a <= 2 # [True, True, False, False]
a[a<=2] # array([1,2])
```

# Exercise 1

```
import numpy as np

a = np.array([1,2,3,4])
a = np.append(a, [5,6,7])# [1,2,3,4,5,6,7]
a[a<=2] # [1,2] (boolean indexing)
a.sum() # 28
```

# pandas DataFrame

# pandas - library

```
import pandas as pd

data = {
"Name":["Clara","Tom","Sarah","John"],
"Age" :[20,24,19,21]}

df = pd.DataFrame(data)
```

| | Name | Age |
|---|---|---|
| 0 | Clara | 20 |
| 1 | Tom | 24 |
| 2 | Sarah | 19 |
| 3 | John | 21 |

# DataFrame - data structure

# Read data

- Pandas can read data from files
- Various data formats possible

```
df = pd.read_csv('path_to_file')
df = pd.read_excel('path_to_file')
df = pd.read_sql_table('postgres://db')
```

# First look at the data

```
df.head()
```

| | id | price | neighbourhood_group_cleansed | latitude |
|---|---|---|---|---|
| 0 | 28684898 | $50.00 | Neukölln | 52.473978 |
| 1 | 22607348 | $10.00 | Treptow - Köpenick | 52.468095 |
| 2 | 21019199 | $35.00 | Neukölln | 52.481810 |
| 3 | 21919556 | $99.00 | Pankow | 52.537269 |
| 4 | 4820648 | $39.00 | Friedrichshain-Kreuzberg | 52.491483 |

```
df.describe()
```

| | id | price | latitude | longitude | bathrooms |
|---|---|---|---|---|---|
| count | 1.353100e+04 | 13531.000000 | 13531.000000 | 13531.000000 | 13508.000000 |
| mean | 1.573089e+07 | 70.082625 | 52.509956 | 13.405871 | 1.095203 |
| std | 8.580394e+06 | 255.451132 | 0.030773 | 0.058517 | 0.335469 |
| min | 2.695000e+03 | 0.000000 | 52.346203 | 13.103557 | 0.000000 |
| 25% | 8.041528e+06 | 30.000000 | 52.489082 | 13.374950 | 1.000000 |
| 50% | 1.697254e+07 | 45.000000 | 52.509229 | 13.416764 | 1.000000 |
| 75% | 2.264464e+07 | 70.000000 | 52.532808 | 13.439258 | 1.000000 |
| max | 2.986735e+07 | 9000.000000 | 52.651670 | 13.721671 | 8.500000 |

# Access data

# Access data in a DataFrame

| idx | Name | Age |
|---|---|---|
| 0 | Clara | 20 |
| 1 | Tom | 24 |
| 2 | Sarah | 19 |
| 3 | John | 21 |

```
df = pd.DataFrame(data)
```

# Access data in a DataFrame

| idx | Name | Age |
|---|---|---|
| 0 | Clara | 20 |
| 1 | Tom | 24 |
| 2 | Sarah | 19 |
| 3 | John | 21 |

```
df = pd.DataFrame(data)
df["Name"]
```

# Access data in a DataFrame

| idx | Name | Age |
|---|---|---|
| 0 | Clara | 20 |
| 1 | Tom | 24 |
| 2 | Sarah | 19 |
| 3 | John | 21 |

```
df = pd.DataFrame(data)
df.iLoc[0:3]
```

# Add data to a DataFrame

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 1 |
| 1 | Tom | 24 | 2 |
| 2 | Sarah | 19 | 3 |
| 3 | John | 21 | 4 |

```
df["Grade"] = [1,2,3,4]
```

# Compute with data in a DataFrame

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 1 | Tom | 24 | 3 |
| 2 | Sarah | 19 | 4 |
| 3 | John | 21 | 5 |

```
df["Grade"] = df["Grade"] + 1
```

# Drop data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 1 |
| 1 | Tom | 24 | 2 |
| 2 | Sarah | 19 | 3 |
| 3 | John | 21 | 4 |

```
# Drop column
df = df.drop(column="Grade")
```

# Drop data

| idx | Name | Age | Grade |
|---|---|---|---|
| 2 | Sarah | 19 | 3 |
| 3 | John | 21 | 4 |

```
# Drop column
df = df.drop(column="Grade")
# Drop row
df.drop([0,1], inplace=True)
```

# Filter data

# Filter data - select a subset of the data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 2 | John | 21 | 5 |

```
keep_rows = [True, False,
                 True,False]

df[keep_rows]
```

# Filter data - select a subset of the data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 1 | Tom | 24 | 3 |
| 2 | Sarah | 19 | 4 |
| 3 | John | 21 | 5 |

```
df["Age"] <= 20
→ [True, False, True, False]
```

# Filter data - select a subset of the data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 2 | John | 21 | 5 |

```
df[ df["Age"] <= 20 ]
```

```
[True, False, True, False]
```

# Filter data - select a subset of the data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |

```
df[
    (df["Age"] <= 20) &
    (df["Grade"] < 3)
  ]
```

# Filter data - select a subset of the data

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 2 | Sarah | 19 | 4 |

```
df[
    (df["Age"] == 20) |
    (df["Grade"] == 4 )
  ]
```

# Combine filtering with other methods

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 2 | John | 21 | 5 |

```
df[df["Age"] <= 20]
```

This is again a DataFrame

# Combine filtering with other methods

| idx | Name | Age | Grade |
|---|---|---|---|
| 0 | Clara | 20 | 2 |
| 2 | John | 21 | 5 |

```
df[df["Age"]<=20]["Age"].mean()
```

# Exercise 2

```
import pandas as pd

df = pd.DataFrame(data) # create dataframe
df['new_column'] = [1,2,3]
df.sort_values(by='column_name') # sort
df[df['age']<=20] # filter data
```

# Pandas methods

# Apply pandas methods

- Pandas has large amount of commonly used methods
- Can be applied to single column or whole data frame

```
df["Grade"].mean()
df["Grade"].std()
df["Grade"].sum()
```

# Often used methods

```
df["Grade"].mean()

df["Grade"].sum()

df["Grade"].value_counts()

df.sort_values(by="Grade")

df.groupby(by="Grade").sum()

df1.merge(df2)

df.drop(colums=["Grade"])

df["Grade"].replace(5,"Failed")
```

# Group-By

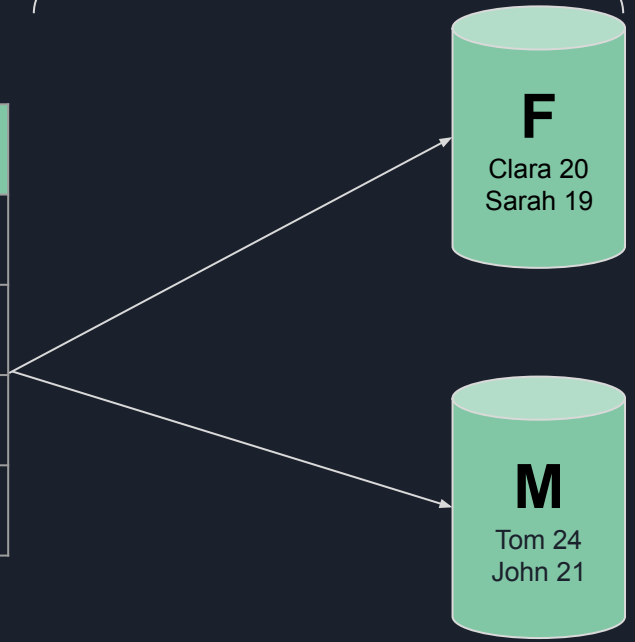
| idx | Name | Age | Gender |
|---|---|---|---|
| 0 | Clara | 20 | F |
| 1 | Tom | 24 | M |
| 2 | Sarah | 19 | F |
| 3 | John | 21 | M |

**What is the average age per gender?**

# Group-By

```
df.groupby(by='Gender').mean()
```

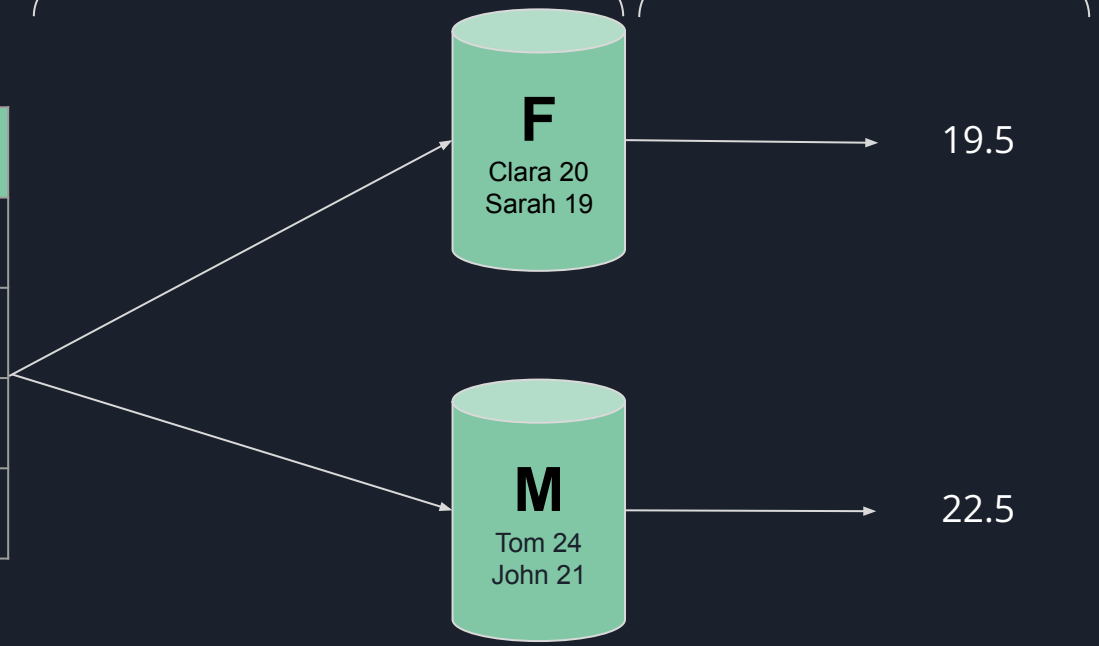
| idx | Name | Age | Gender |
|---|---|---|---|
| 0 | Clara | 20 | F |
| 1 | Tom | 24 | M |
| 2 | Sarah | 19 | F |
| 3 | John | 21 | M |



# Group-By

```
df.groupby(by='Gender').mean()
```

| idx | Name | Age | Gender |
|---|---|---|---|
| 0 | Clara | 20 | F |
| 1 | Tom | 24 | M |
| 2 | Sarah | 19 | F |
| 3 | John | 21 | M |



# Merge DataFrame's

| Name | Age | Grade |
|---|---|---|
| Clara | 20 | 2 |
| Tom | 24 | 3 |
| Sarah | 19 | 4 |

| Name | Subject |
|---|---|
| Sarah | Physics |
| Tom | Politics |
| John | English |

# Merge DataFrame's

| Name | Age | Grade |
|---|---|---|
| Clara | 20 | 2 |
| Tom | 24 | 3 |
| Sarah | 19 | 4 |

| Name | Subject |
|---|---|
| Sarah | Physics |
| Tom | Politics |
| John | English |

| Name | Age | Grade | Subject |
|---|---|---|---|
| Tom | 24 | 3 | Politics |
| Sarah | 19 | 4 | Physics |

# Merge DataFrame's

| Name | Age | Grade |
|---|---|---|
| Clara | 20 | 2 |
| Tom | 24 | 3 |
| Sarah | 19 | 4 |

```
df1.merge(df2, on='Name')
```

| Name | Subject |
|---|---|
| Sarah | Physics |
| Tom | Politics |
| John | English |

| Name | Age | Grade | Subject |
|---|---|---|---|
| Tom | 24 | 3 | Politics |
| Sarah | 19 | 4 | Physics |

# Merge DataFrame's

| Name | Age | Grade |
|---|---|---|
| Clara | 20 | 2 |
| Tom | 24 | 3 |
| Sarah | 19 | 4 |

```
df1.merge(df2,how='left',
on='Name')
```

| Name | Subject |
|---|---|
| Sarah | Physics |
| Tom | Politics |
| John | English |

| Name | Age | Grade | Subject |
|---|---|---|---|
| Tom | 24 | 3 | Politics |
| Sarah | 19 | 4 | Physics |
| Clara | 20 | 2 | - |

# Exercise 3

```
import pandas as pd

df = df.groupby(by='column_name')
df = df.merge(df2,on='column_name',how='left')
```

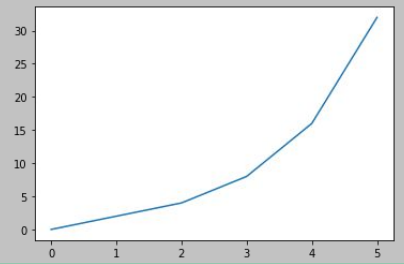
# Visualizations

# matplotlib - library

- data visualization tool
- generate highly customizable plots
- good integrated with pandas

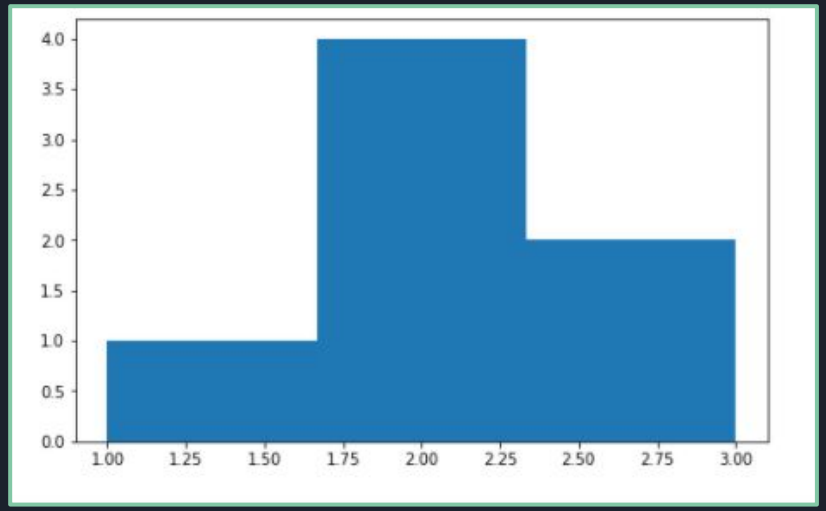
```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]
plt.plot(x,y)
```

Plot:



# Histogram

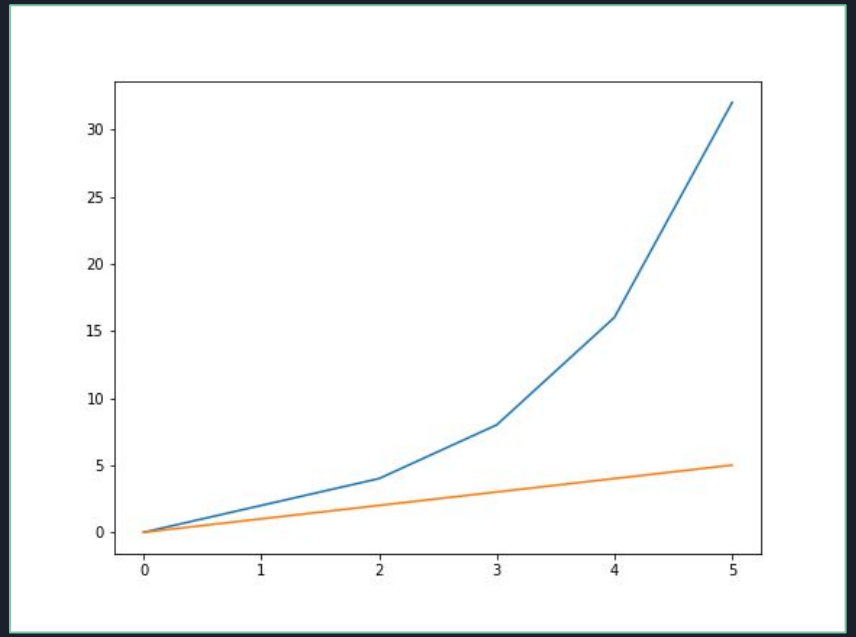
```
import matplotlib.pyplot as plt
x = [1,2,2,2,2,3,3]
plt.hist(x, bins=3)
```



# Customize plots

```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]
y2 = [0,1,2,3,4,5]

plt.plot(x,y)
plt.plot(x,y2)
```

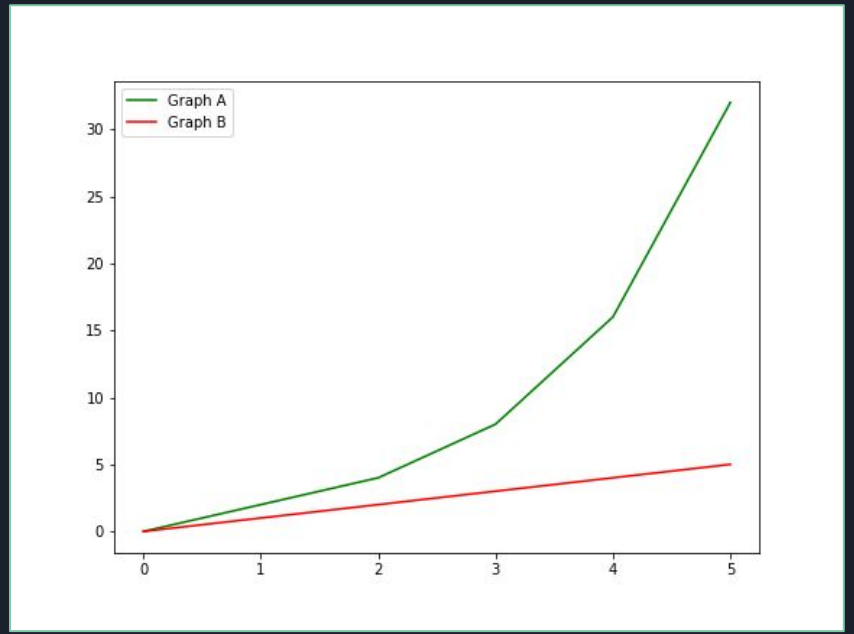


# Customize plots

```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]
y2 = [0,1,2,3,4,5]

plt.plot(x,y, color='green', label='Graph A')
plt.plot(x,y2, color='red', label='Graph B')

plt.legend()
```

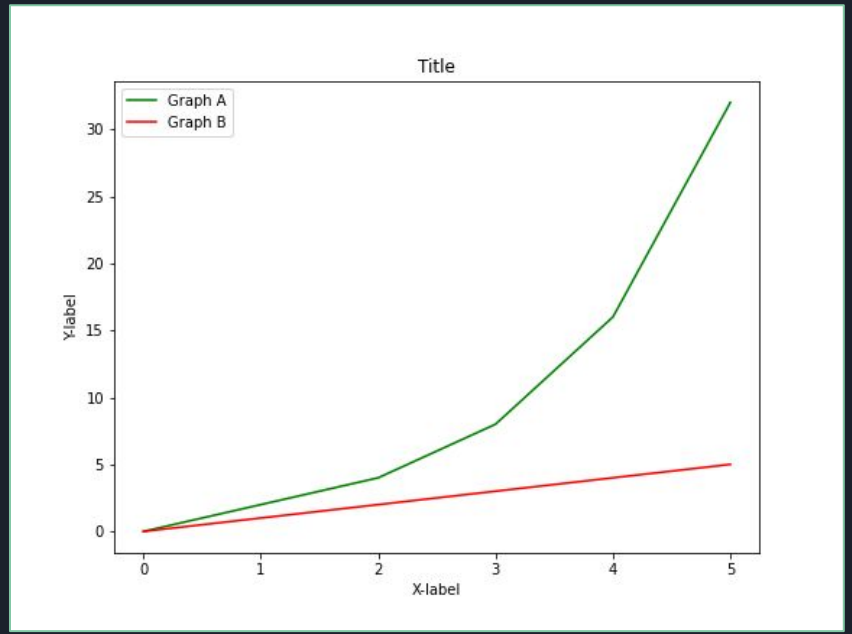


# Customize plots

```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]
y2 = [0,1,2,3,4,5]

plt.plot(x,y, color='green', label='Graph A')
plt.plot(x,y2, color='red', label='Graph B')

plt.legend()
plt.xlabel("X-label")
plt.ylabel("Y-label")
plt.title("Title")
```

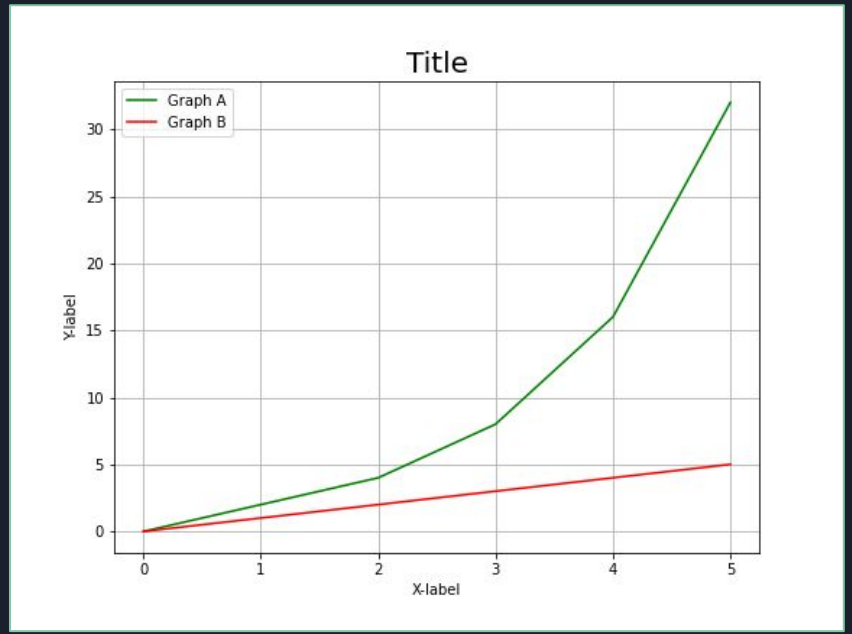


# Customize plots

```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]
y2 = [0,1,2,3,4,5]

plt.plot(x,y, color='green', label='Graph A')
plt.plot(x,y2, color='red', label='Graph B')

plt.legend()
plt.xlabel("X-label")
plt.ylabel("Y-label")
plt.title("Title",
{'fontname':'DejaVu Sans', 'size':'20'})
plt.grid()
```



# pandas & matplotlib

- Pandas and matplotlib work very well together
- We can pass columns of a DataFrame to matplotlib

```
import matplotlib.pyplot as plt
df = pd.DataFrame(data)
plt.hist(df["Age"])
```

# Exercise 4

```
import matplotlib.pyplot as plt
x = [0,1,2,3,4,5]
y = [0,2,4,8,16,32]

plt.plot(x,y, color='green', label='Graph A')

plt.legend()
plt.xlabel("X-label")
plt.ylabel("Y-label")
plt.title("Title")
```