Introduction to Data Science with Python

Chapter 4

Topics of the course

2. Chapter

Python Fundamentals

Basic concepts, Variables, basic data structures, functions

3. Chapter

Data Wrangling & Simple visualizations

How to process data with pandas and visualize it with matplotlib

4. Chapter

Visualizations & Modelling

More plots with matplotlib and seaborn and an introduction to modelling

Advanced Visualisations & Modelling

Clean Data with Pandas

Clean data

Data comes often in an untidy form, therefore some data cleaning is necessary

Name	Town
Clara	Frankfurt a.M.
Sarah	Frankfurt am Main
John	Berlin

```
df1['Town'] = df1['Town'].str.replace(
                         'a.M.','am Main')
```

Clean data

Data comes often in an untidy form, therefore some data cleaning is necessary

Name	Subject
Clara	Physics
Sarah	physics
John	Math

```
df['Subject'] = df['Subject'].str.lower()
```

Fill missing values

Name	Score
Clara	10
Sarah	5
John	NaN

```python
df['Score'] = df['Score'].fillna(0)
```

Fill missing values

Name	Score
Clara	10
Sarah	5
John	NaN → 0

```
df['Score'] = df['Score'].fillna(0)
```

Fill missing values

Name	Score
Clara	10
Sarah	5
John	NaN → 7.5

```
df['Score'] = df['Score'].fillna(df.mean())
```

Drop missing values

Name	Score
Clara	10
Sarah	5
~~John~~	~~NaN~~

```
df = df.dropna()
```

Working with dates

What kind of data type is this : `"27-03-2021"` ?

a) integer b) float [✓ c) string] d) date

Transform string to datetime object

```
df['Birthday'] = pd.to_datetime(df['Birthday'])
```

Name	Birthday
Clara	“10/10/1995”
Sarah	“01/10/1999”
John	“03/05/2001”

Transform string to datetime object

```
df['Birthday'] = pd.to_datetime(df['Birthday'], format="%d/%m/%Y")
```

Name	Birthday
Clara	“10/10/1995”
Sarah	“01/10/1999”
John	“03/05/2001”

Transform string to datetime object

```
df['Birthday'] = pd.to_datetime(df['Birthday'], format="%m-%d-%Y")
```

Name	Birthday
Clara	“10-10-1995”
Sarah	“10-01-1999”
John	“05-03-2001”

Transform string to datetime object

```
df['day'] = df['Birthday'].dt.day
df['weekday'] = df['Birthday'].dt.weekday
df['month'] = df['Birthday'].dt.month
```

Name	Birthday	day	weekday	month
Clara	“10-10-1995”	10	1	10
Sarah	“10-01-1999”	1	4	10
John	“05-03-2001”	3	3	5

Set date as index

date	City	Temperature
“2021-04-20”	‘Frankfurt’	10
“2021-04-21”	‘Frankfurt’	11
“2021-04-22”	‘Frankfurt’	12

```
df = df.set_index(['date'])
```

Select timespans

When the index is in datetime format, you can access the data in the following way:

date	City	Temperature
“2021-04-20”	‘Frankfurt’	10
“2021-04-21”	‘Frankfurt’	11
“2021-04-22”	‘Frankfurt’	12

```python
df['2021'] # all data from 2021
df['2021-04':'2021-05']
df['2021':]
```

Exercise 1

```
df['date'] = pd.to_datetime(df['date'])
df = df.set_index(['date'])
df['2021-04':'2021-05']
df[df[‘col_name’] == ‘some condition’]

plt.plot(df[‘col_name’][‘2000’])
```

pandas has a lot of useful functionality

- The official documentation of pandas has more than 3000 pages
- work with missing values
    - fill with mean value
    - interpolate between values
    - fill with last value
- Read data from various sources
    - Excel, CSV, SQL, Stata, SPSS, SAS, HTML Tables from websites
- Windowing functions
    - Moving average,...

Advanced Visualisations & Modelling

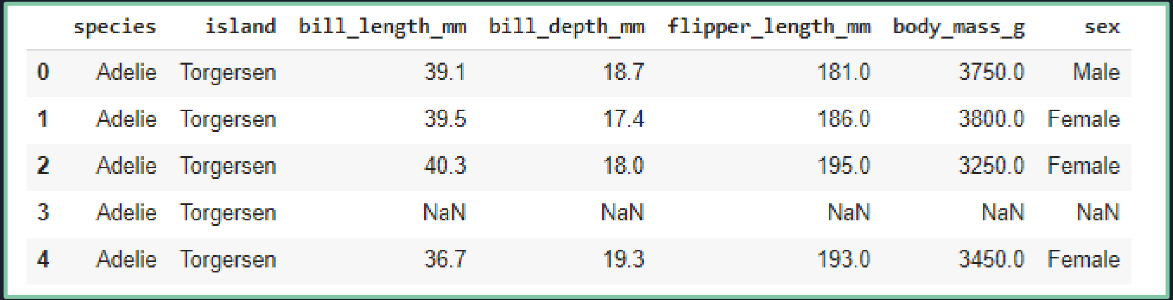
Advanced Visualizations with Seaborn

seaborn - library

- statistical data visualization tools
- based on matplotlib
- makes it easy to create more sophisticated plots
- best to visualize relations between columns of a dataset

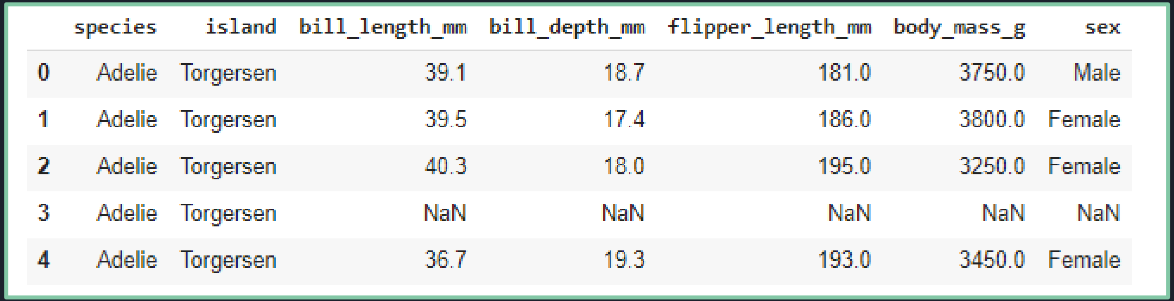
```python
import seaborn as sns
```

Look into a penguins dataset



	species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex
0	Adelie	Torgersen	39.1	18.7	181.0	3750.0	Male
1	Adelie	Torgersen	39.5	17.4	186.0	3800.0	Female
2	Adelie	Torgersen	40.3	18.0	195.0	3250.0	Female
3	Adelie	Torgersen	NaN	NaN	NaN	NaN	NaN
4	Adelie	Torgersen	36.7	19.3	193.0	3450.0	Female

Look into a penguins dataset



	species	island	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g	sex
0	Adelie	Torgersen	39.1	18.7	181.0	3750.0	Male
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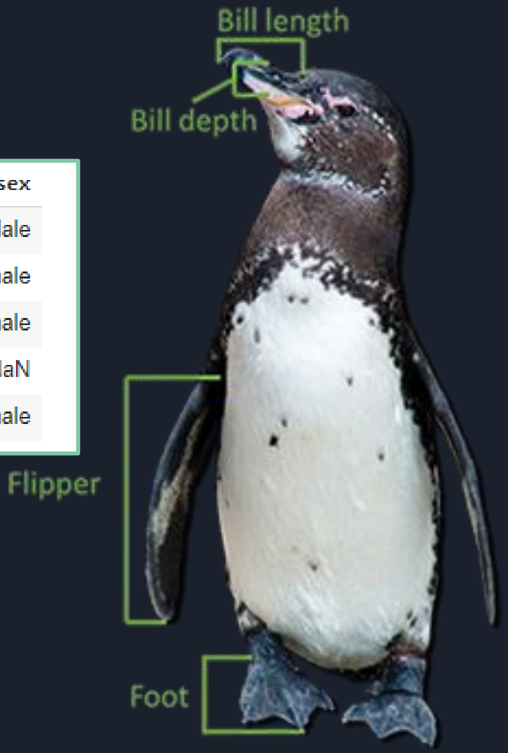
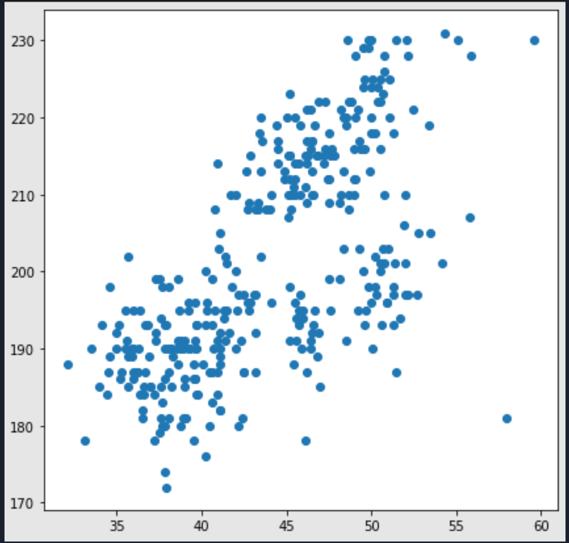


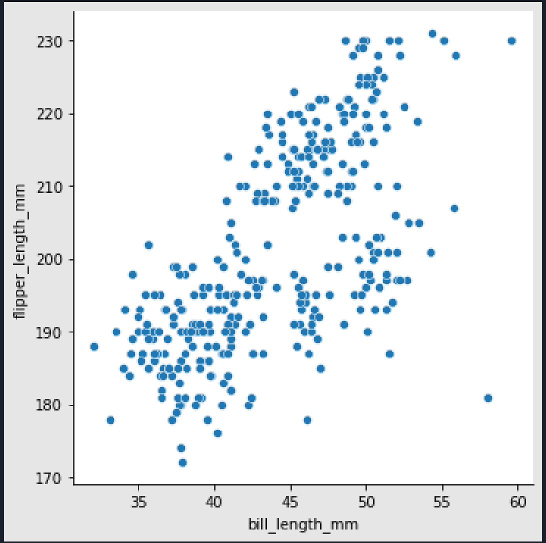
Source: https://www.galapagos.org/blog/the-measure-of-a-penguin/

Matplotlib vs Seaborn

```
plt.scatter(df['bill_length_mm'],df['flipper_length_mm'])
```

```
sns.relplot(df['bill_length_mm'],df['flipper_length_mm'])
```



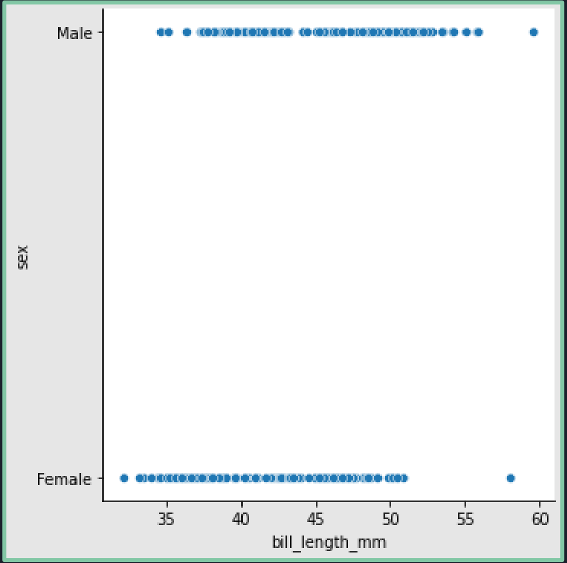


Matplotlib vs Seaborn

```
plt.scatter(df['bill_length_mm'],df[sex])
```

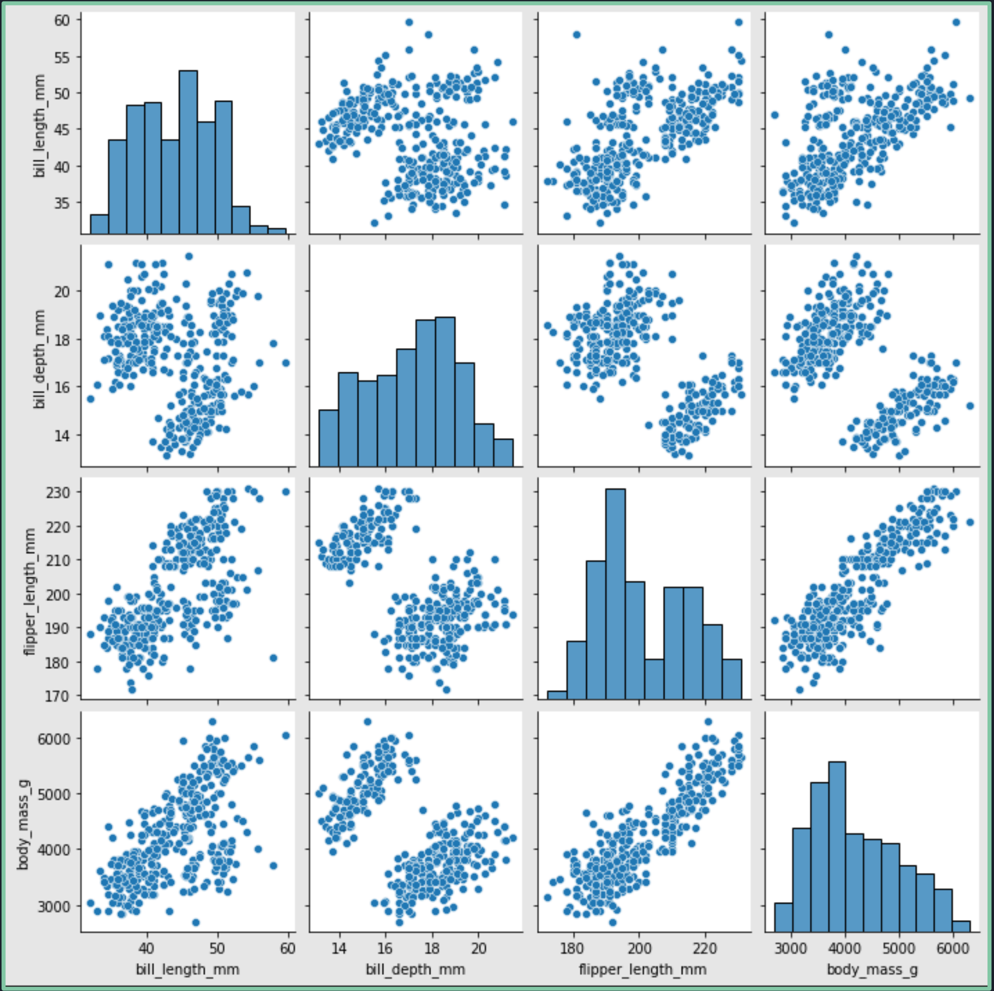
```
sns.relplot(df['bill_length_mm'],df[sex])
```

```
TypeError
```

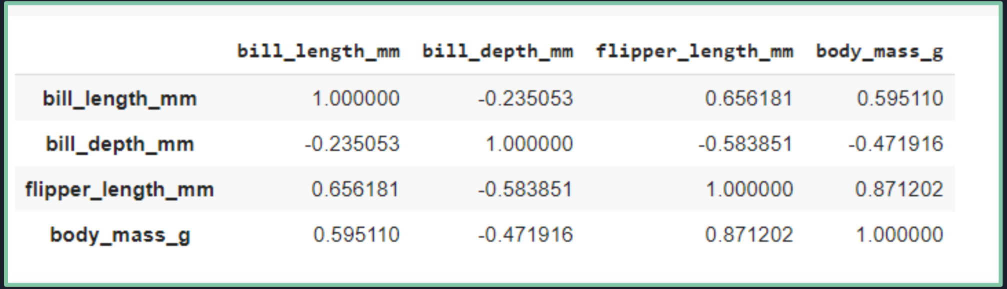


Pairplot

```
sns.pairplot(df)
```



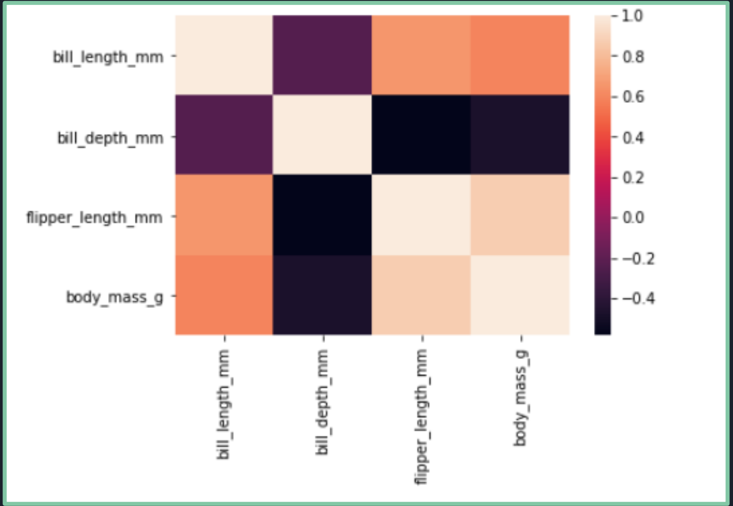
Visualize correlations



	bill_length_mm	bill_depth_mm	flipper_length_mm	body_mass_g
bill_length_mm	1.000000	-0.235053	0.656181	0.595110
bill_depth_mm	-0.235053	1.000000	-0.583851	-0.471916
flipper_length_mm	0.656181	-0.583851	1.000000	0.871202
body_mass_g	0.595110	-0.471916	0.871202	1.000000

```
df.corr()
```

Visualize correlations



```
sns.heatmap(df.corr())
```

Exercise 2

```
sns.pairplot(df)
sns.pairplot(df, hue='col_name')
```

Matplotlib & Seaborn Gallery

- Documentation contains example plots
- Each plot comes with the corresponding code
- https://matplotlib.org/stable/gallery/index.html
- https://seaborn.pydata.org/examples/index.html

Advanced Visualisations & Modelling

Modelling Basics

Linear Regression

Source: https://avantecture.com/p/phoenixsee/

How expensive is this house?

Based on information like:

- amount of rooms
- location
- size

Housing regression

Old collected data

House	Location	Rooms	Price
A	Berlin	6	500k €
B	Frankfurt	8	600k €
C	Berlin	7	300k €

New data

House	Location	Rooms	Price
D	Frankfurt	8	?
E	Frankfurt	5	?
F	Berlin	4	?

Housing regression

Old collected data

House	Location	Rooms	Price
A	Berlin	6	500k €
B	Frankfurt	8	600k €
C	Berlin	7	300k €

Features

New data

House	Location	Rooms	Price
D	Frankfurt	8	?
E	Frankfurt	5	?
F	Berlin	4	?

Housing regression

Old collected data

House	Location	Rooms	Price
A	Berlin	6	500k €
B	Frankfurt	8	600k €
C	Berlin	7	300k €

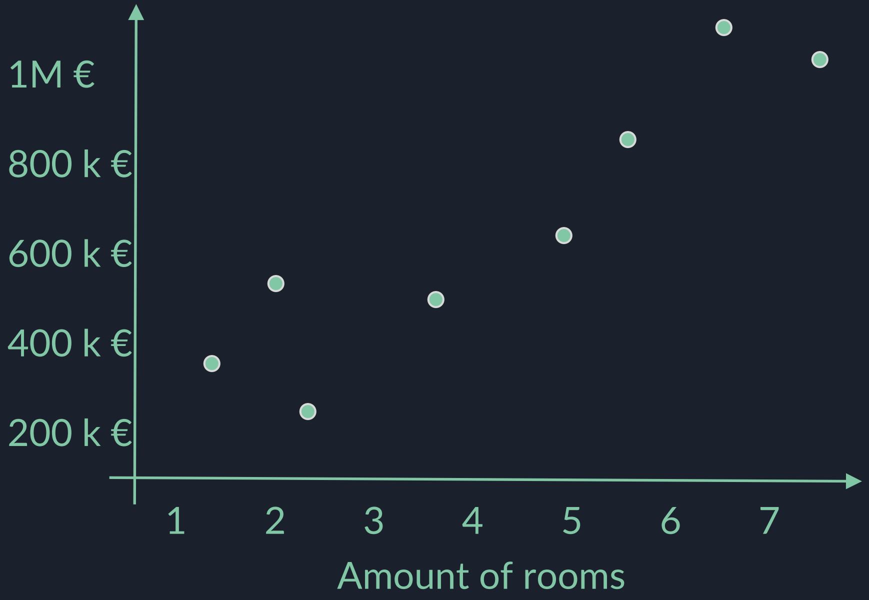
Features

Target column

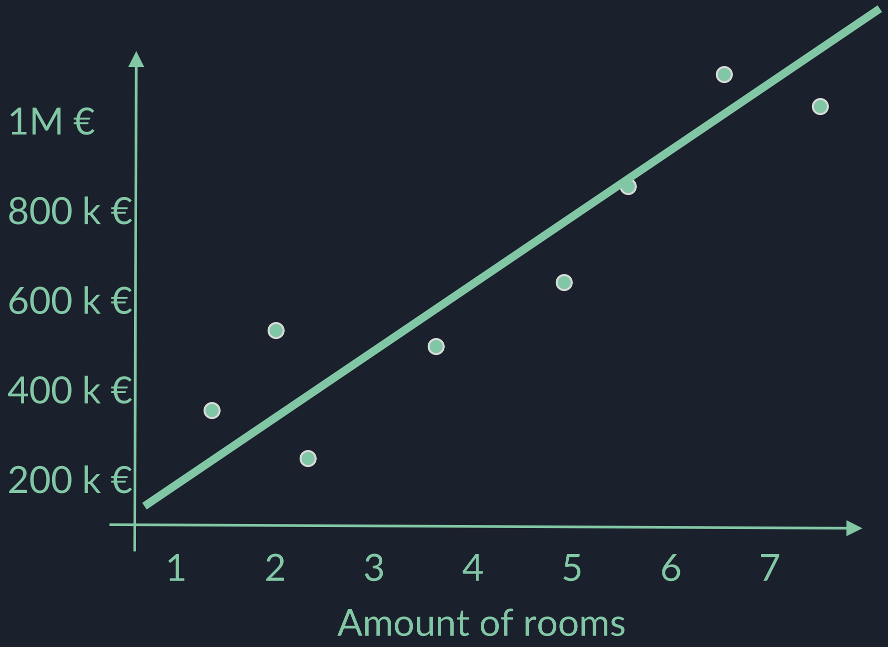
New data

House	Location	Rooms	Price
D	Frankfurt	8	?
E	Frankfurt	5	?
F	Berlin	4	?

Linear Regression

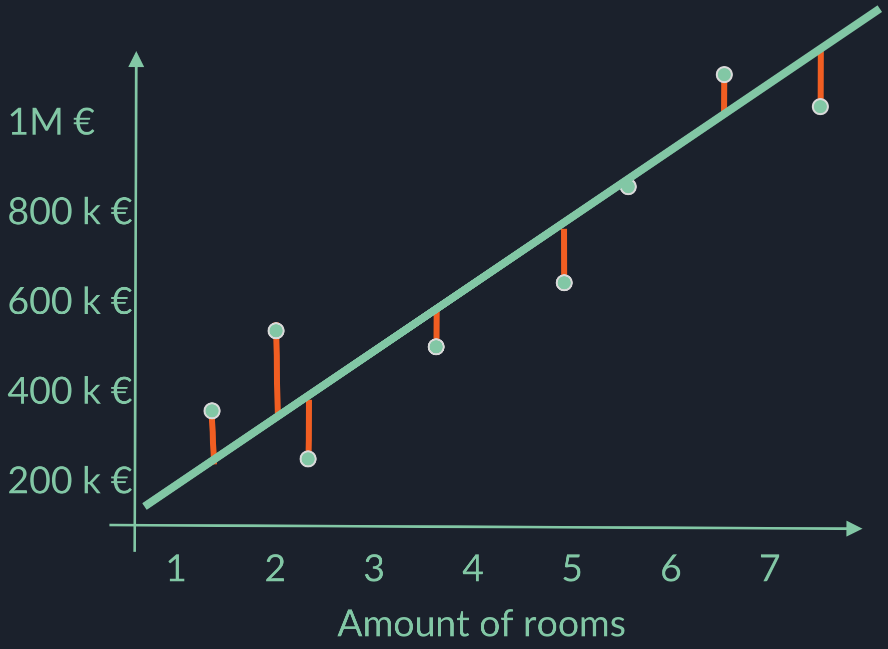


Linear Regression



$$price = a \cdot rooms + b$$

Linear Regression



$$price = a \cdot rooms + b$$

$$\text{RMSE} = \sqrt{\frac{1}{T}\sum_{i=1}^{T}(y_{i,predicted} - y_{i,true})^2)}$$

Linear Regression

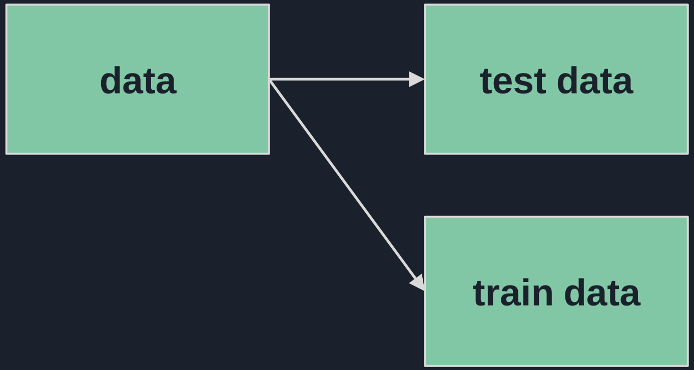
House	Bedrooms	Rooms	Price
A	1	6	500k €
B	3	8	600k €
C	2	7	300k €

$$price = a_1 \cdot rooms + a_2 \cdot size + a_3 \cdot bedrooms + b$$

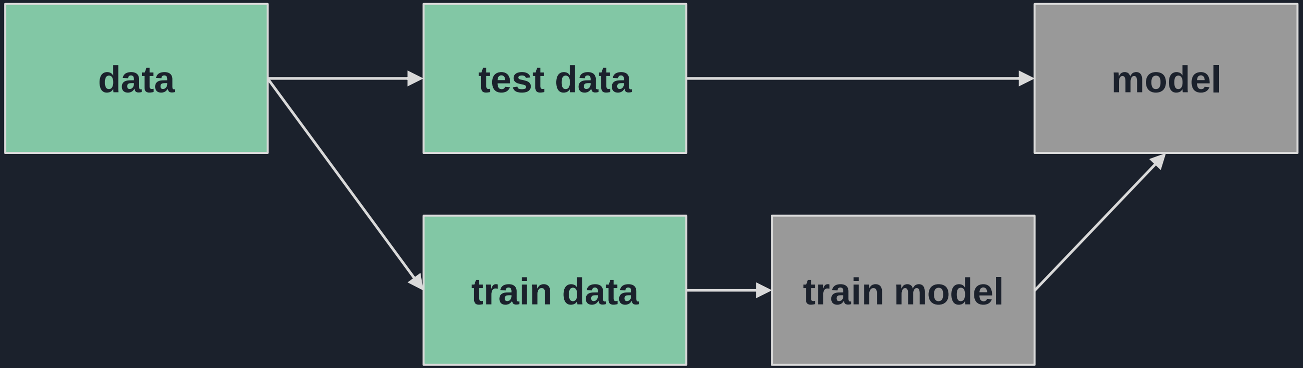
How good is your model?

How does the model perform on unseen data?

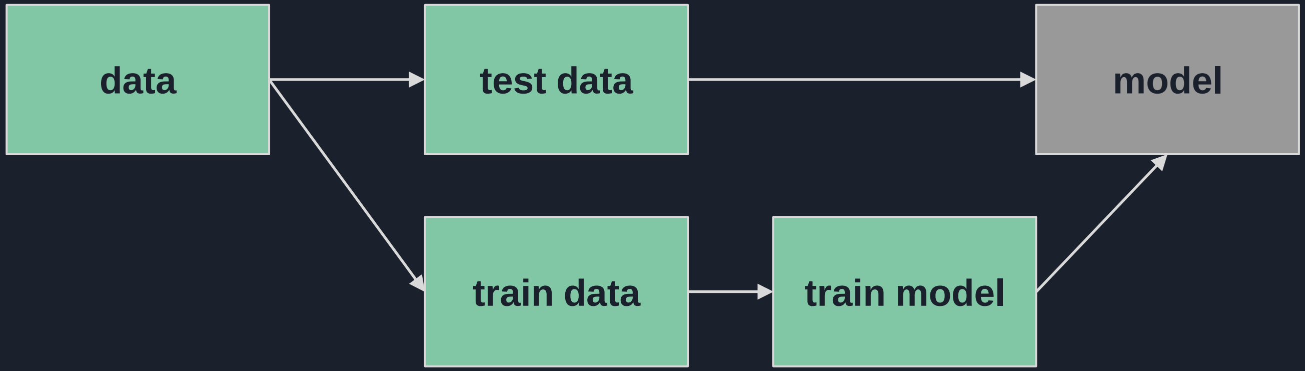
Split data in a train (70%) and test (30%) set to evaluate your model



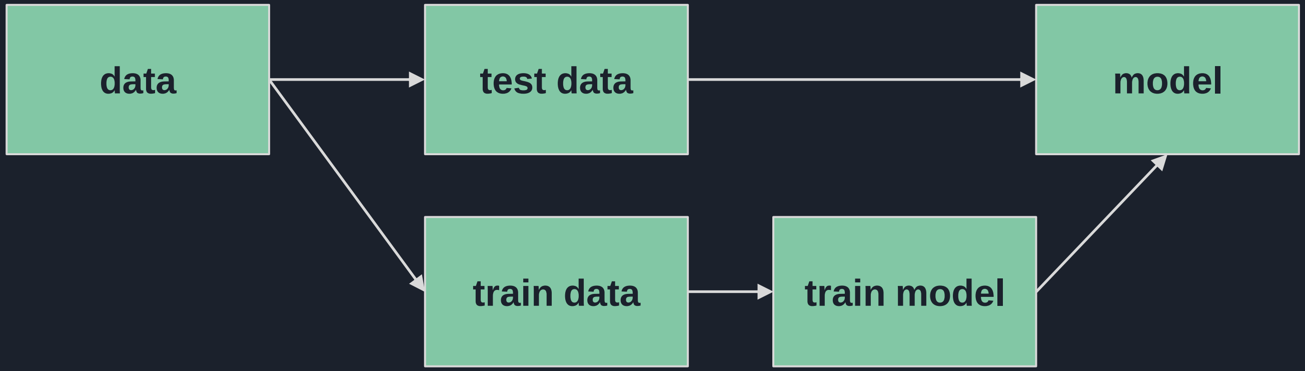
Typical workflow



Typical workflow



Typical workflow



Linear Regression with Python

```
import pandas as pd # data
from sklearn.model_selection import train_test_split # split data
from sklearn.linear_model import LinearRegression # create model
from sklearn.metrics import mean_squared_error # test model
```

Linear Regression with Python

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

df = pd.read_csv('/content/housing.csv')
X = df[['total_rooms','households']]
y_target = df['median_house_value']
```

Linear Regression with Python

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

df = pd.read_csv('/content/housing.csv')
X = df[['total_rooms','households']]
y_target = df['median_house_value']

X_train, X_test, y_train, y_test = train_test_split(X, y_target, test_size=0.3)
model = LinearRegression()
model.fit(X_train, y_train)
```

Linear Regression with Python

```python
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

df = pd.read_csv('/content/housing.csv')
X = df[['total_rooms','households']]
y_target = df['median_house_value']

X_train, X_test, y_train, y_test = train_test_split(X, y_target, test_size=0.3)
model = LinearRegression()
model.fit(X_train, y_train)

y_predict = model.predict(X_test)
rmse = mean_squared_error(y_test, y_predict, squared=False)
```

Exercise 3

Linear Regression with Python

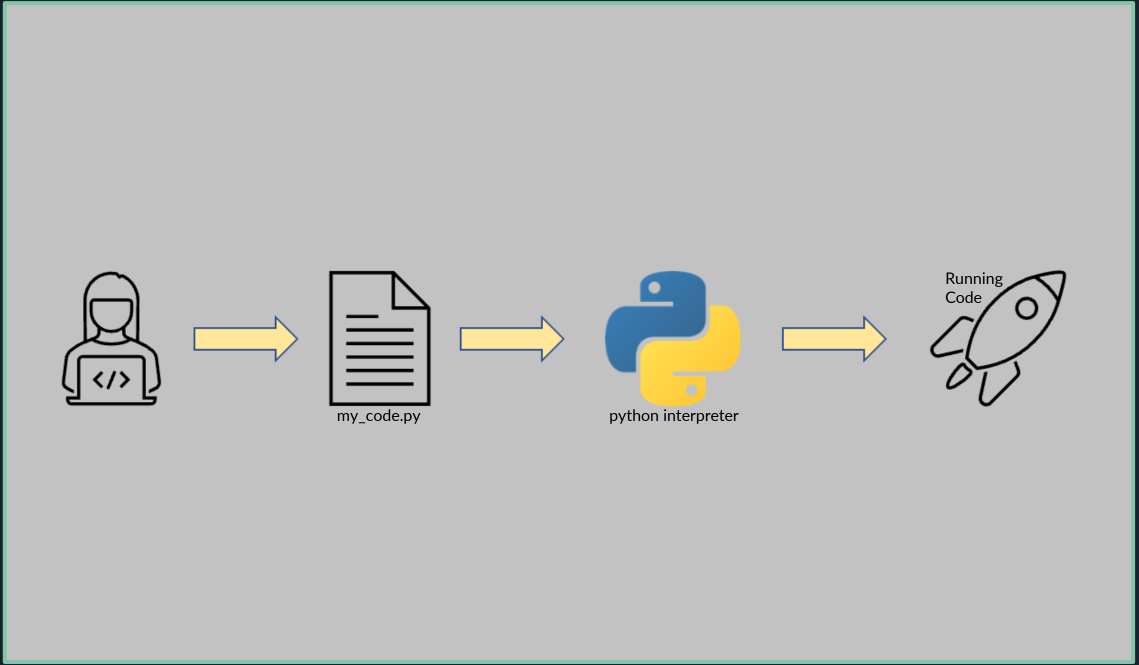
```
from sklearn.metrics import mean_squared_error
from sklearn.metrics import r2_score
from sklearn.metrics import median_absolute_error


rmse = mean_squared_error(y_test, y_predict, squared=False)
r2 = r2_score(y_test, y_predict)
mae = median_absolute_error(y_test, y_predict)
```

Advanced Visualisations & Modelling

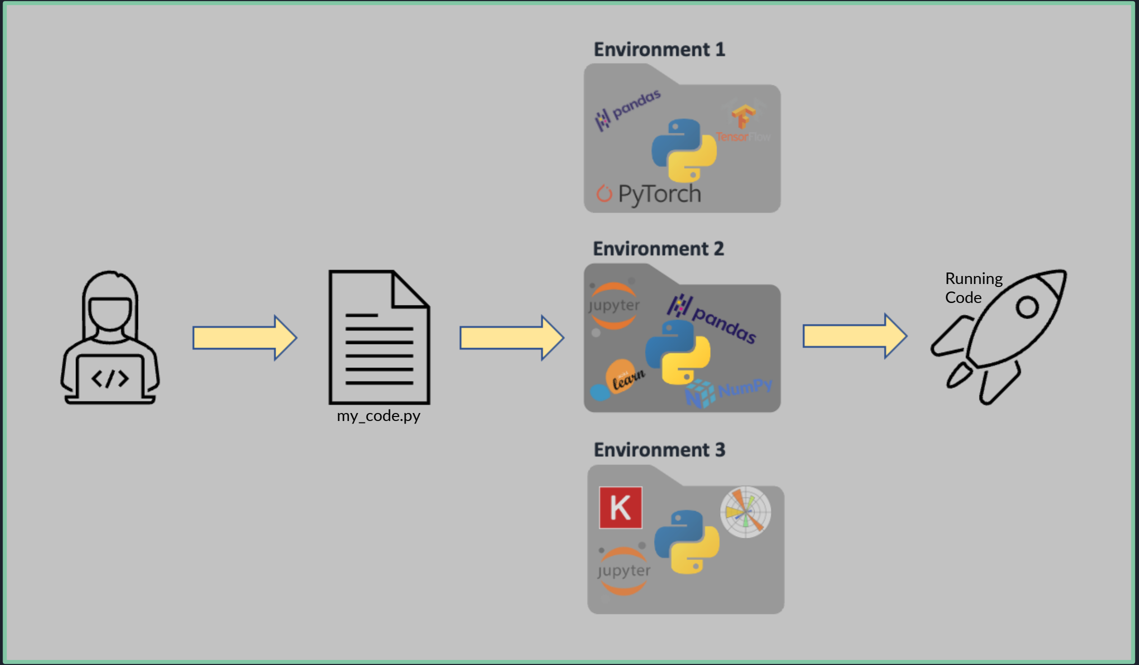
Python Local Installation

Code Execution



- **Download Python:** https://www.python.org/

Environments



- To install packages for a particular project
- Dependencies are installed in different directories

Anaconda distribution

- Python interpreter
- Jupyter Notebooks (similar to Colab, but local)
- Manage environments and packages
- Runs on Windows, Mac and Linux

Installation:
https://docs.anaconda.com/anaconda/install/

Getting started:
https://docs.anaconda.com/anaconda/user-guide/getting-started/

Pycharm

- Python IDE
- Free Educational License for Pro Version
- Many Alternatives: VS Code, Atom, …

Installation:
https://www.jetbrains.com/community/education/#students