Introduction to Data Science

with Python

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May 15, 2022

Presenter

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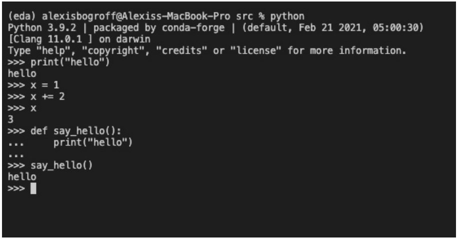
- 4 years Teaching Assistant and lecturer in VBA, Python for finance, SQL, Data Analysis and Data Science
- 9 months Researcher Assistant at Paris 1 Panthéon-Sorbonne within H2020 European Project
- 1 year Data Scientist at Pléiade Asset Management

Why Python?

- Versatile
- Simple
- Open Source
- Most used for Data Science

Programming Environment

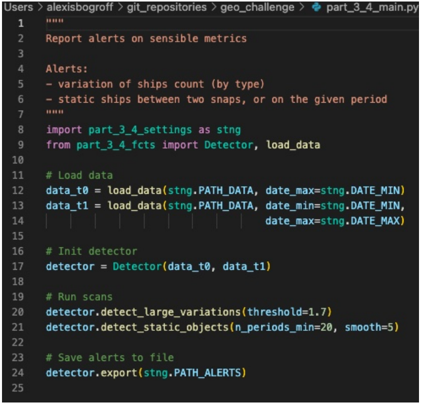
- Interactive console



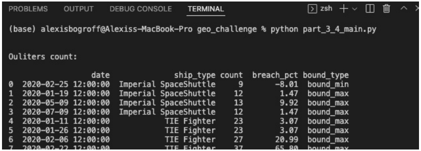
```
(eda) alexisbogroff@Alexiss-MacBook-Pro src % python
Python 3.9.2 | packaged by conda-forge | (default, Feb 21 2021, 05:00:30)
[Clang 11.0.1 ] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("hello")
hello
>>> x = 1
>>> x += 2
>>> x
3
>>> def say_hello():
...     print("hello")
...
>>> say_hello()
hello
>>> 
```

Programming Environment

- Interactive console
- Scripts


Users > alexisbogroff > git_repositories > geo_challenge > part_3_4_main.py

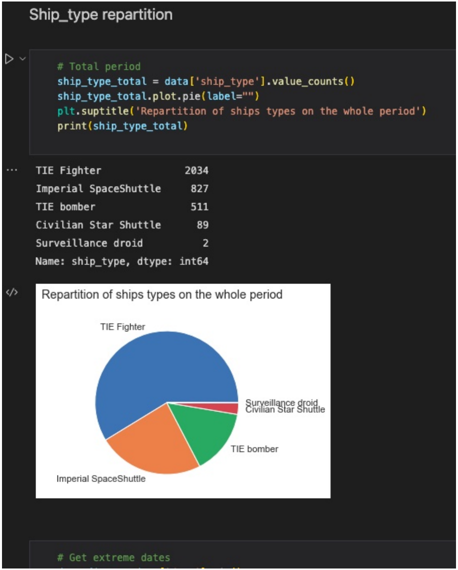
```python
"""
Report alerts on sensible metrics

Alerts:
- variation of ships count (by type)
- static ships between two snaps, or on the given period
"""
import part_3_4_settings as stng
from part_3_4_fcts import Detector, load_data

# Load data
data_t0 = load_data(stng.PATH_DATA, date_max=stng.DATE_MIN)
data_t1 = load_data(stng.PATH_DATA, date_min=stng.DATE_MIN,
                                    date_max=stng.DATE_MAX)

# Init detector
detector = Detector(data_t0, data_t1)

# Run scans
detector.detect_large_variations(threshold=1.7)
detector.detect_static_objects(n_periods_min=20, smooth=5)

# Save alerts to file
detector.export(stng.PATH_ALERTS)

```



```
(base) alexisbogroff@Alexiss-MacBook-Pro geo_challenge % python part_3_4_main.py


Ouliters count:

                  date              ship_type count  breach_pct bound_type
0  2020-02-25 12:00:00  Imperial SpaceShuttle     9       -8.01  bound_min
1  2020-01-19 12:00:00  Imperial SpaceShuttle    12        1.47  bound_max
2  2020-05-09 12:00:00  Imperial SpaceShuttle    13        9.92  bound_max
3  2020-07-09 12:00:00  Imperial SpaceShuttle    12        1.47  bound_max
4  2020-01-11 12:00:00            TIE Fighter    23        3.07  bound_max
5  2020-01-26 12:00:00            TIE Fighter    23        3.07  bound_max
6  2020-02-06 12:00:00            TIE Fighter    27       20.99  bound_max
7  2020-02-22 12:00:00            TIE Fighter    37       65.80  bound_max
```

Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks



Ship_type repartition

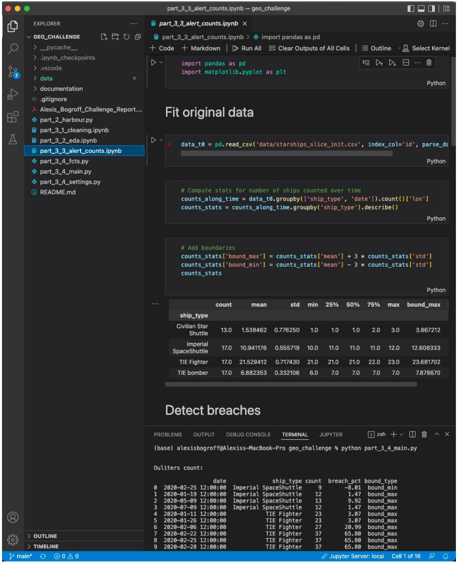
```
# Total period
ship_type_total = data['ship_type'].value_counts()
ship_type_total.plot.pie(label="")
plt.suptitle('Repartition of ships types on the whole period')
print(ship_type_total)
```

```
TIE Fighter              2034
Imperial SpaceShuttle     827
TIE bomber                511
Civilian Star Shuttle      89
Surveillance droid          2
Name: ship_type, dtype: int64
```

```
# Get extreme dates
```

Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks
- Code editors (VS Code)



```python
import pandas as pd
import matplotlib.pyplot as plt
```

Fit original data

```python
data_t0 = pd.read_csv('data/starships_slice_init.csv', index_col='id', parse_da
```

```python
# Compute stats for number of ships counted over time
counts_along_time = data_t0.groupby(['ship_type', 'date']).count()['lon']
counts_stats = counts_along_time.groupby('ship_type').describe()
```

```python
# Add boundaries
counts_stats['bound_max'] = counts_stats['mean'] + 3 * counts_stats['std']
counts_stats['bound_min'] = counts_stats['mean'] - 3 * counts_stats['std']
counts_stats
```

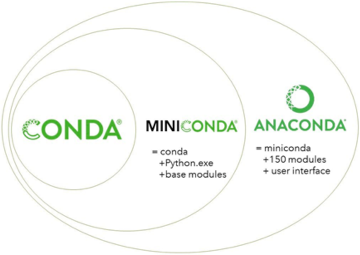
	count	mean	std	min	25%	50%	75%	max	bound_max
ship_type									
Civilian Star Shuttle	13.0	1.538462	0.776250	1.0	1.0	1.0	2.0	3.0	3.867212
Imperial SpaceShuttle	17.0	10.941176	0.555719	10.0	11.0	11.0	11.0	12.0	12.608333
TIE Fighter	17.0	21.529412	0.717430	21.0	21.0	21.0	22.0	23.0	23.681702
TIE bomber	17.0	6.882353	0.332106	6.0	7.0	7.0	7.0	7.0	7.878670

Detect breaches

```
(base) alexisbogroff@Alexiss-MacBook-Pro geo_challenge % python part_3_4_main.py


Ouliters count:

                  date               ship_type count  breach_pct bound_type
0  2020-02-25 12:00:00  Imperial SpaceShuttle     9       -8.01  bound_min
1  2020-01-19 12:00:00  Imperial SpaceShuttle    12        1.47  bound_max
2  2020-05-09 12:00:00  Imperial SpaceShuttle    13        9.92  bound_max
3  2020-07-09 12:00:00  Imperial SpaceShuttle    12        1.47  bound_max
4  2020-01-11 12:00:00             TIE Fighter    23        3.07  bound_max
5  2020-01-26 12:00:00             TIE Fighter    23        3.07  bound_max
6  2020-02-06 12:00:00             TIE Fighter    27       20.99  bound_max
7  2020-02-22 12:00:00             TIE Fighter    37       65.80  bound_max
8  2020-02-25 12:00:00             TIE Fighter    37       65.80  bound_max
9  2020-02-28 12:00:00             TIE Fighter    37       65.80  bound_max
```

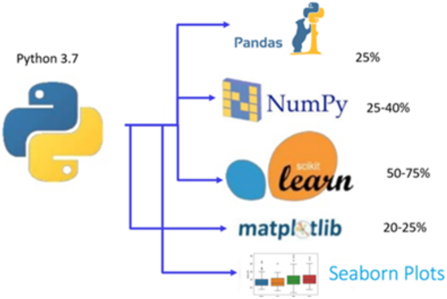
Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks
- Code editors (VS Code)
- Packages managers (Conda, Pip)



Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks
- Code editors (VS Code)
- Packages managers (Conda, Pip)
- Packages / Libraries (Pandas, Matplotlib)



Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks
- Code editors (VS Code)
- Packages managers (Conda, Pip)
- Packages / Libraries (Pandas, Matplotlib)
- Virtual Environments

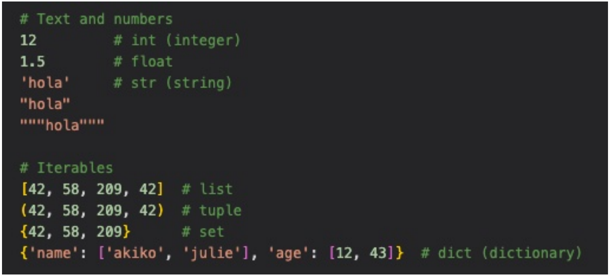
- Virtualenv
- Pipenv
- Venv
- Poetry

Programming Environment

- Interactive console
- Scripts
- Jupyter Notebooks
- Code editors
  (VS Code)
- Packages managers
  (Conda, Pip)
- Packages / Libraries
  (Pandas, Matplotlib)
- Virtual Environments
- Version Control Systems
  (Git, Github, Gitlab)

Essentials in the Python language

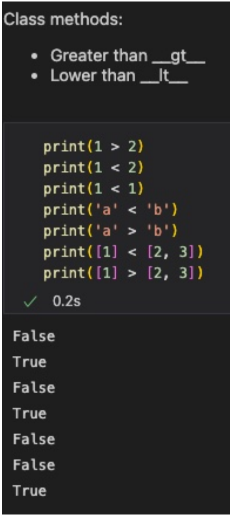
- Data types and structures
  - Numbers
  - Text (strings)
  - Iterables
  - Other



```python
# Text and numbers
12          # int (integer)
1.5         # float
'hola'      # str (string)
"hola"
"""hola"""

# Iterables
[42, 58, 209, 42]  # list
(42, 58, 209, 42)  # tuple
{42, 58, 209}      # set
{'name': ['akiko', 'julie'], 'age': [12, 43]}  # dict (dictionary)
```

Essentials in the Python language

- Operators
  - Greater than, lower than



Class methods:

- Greater than __gt__
- Lower than __lt__

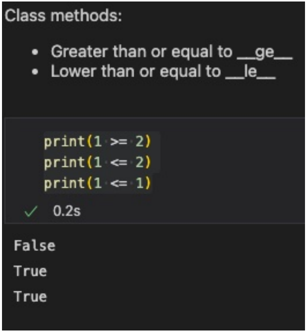
```
print(1 > 2)
print(1 < 2)
print(1 < 1)
print('a' < 'b')
print('a' > 'b')
print([1] < [2, 3])
print([1] > [2, 3])
```

✓ 0.2s

```
False
True
False
True
False
False
True
```

Essentials in the Python language

- Operators
  - Greater than, lower than
  - Greater or equal than, lower or equal than



Class methods:

- Greater than or equal to __ge__
- Lower than or equal to __le__

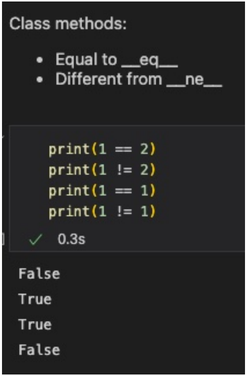
```
print(1 >= 2)
print(1 <= 2)
print(1 <= 1)
```

✓ 0.2s

```
False
True
True
```

Essentials in the Python language

- Operators
  - Greater than, lower than
  - Greater or equal than, lower or equal than
  - Equals to, different from



Class methods:

- Equal to __eq__
- Different from __ne__

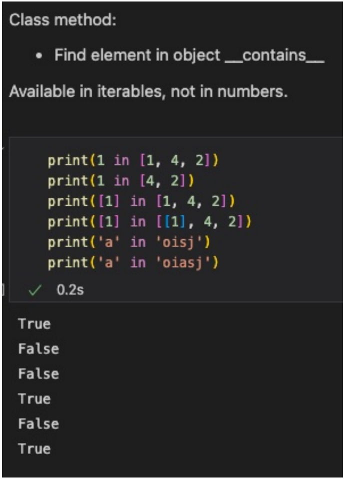
```
print(1 == 2)
print(1 != 2)
print(1 == 1)
print(1 != 1)
```

✓ 0.3s

```
False
True
True
False
```

Essentials in the Python language

- Operators
  - Greater than, lower than
  - Greater or equal than, lower or equal than
  - Equals to, different from
  - in



Class method:

- Find element in object __contains__

Available in iterables, not in numbers.

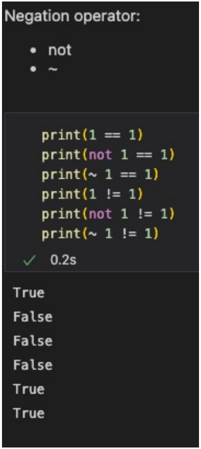
```
print(1 in [1, 4, 2])
print(1 in [4, 2])
print([1] in [1, 4, 2])
print([1] in [[1], 4, 2])
print('a' in 'oisj')
print('a' in 'oiasj')
```

✓ 0.2s

```
True
False
False
True
False
True
```

Essentials in the Python language

- Operators
  - Greater than, lower than
  - Greater or equal than, lower or equal than
  - Equals to, different from
  - in
  - not



Negation operator:

- not
- ~

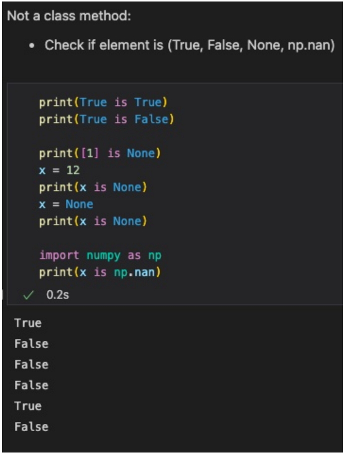
```
print(1 == 1)
print(not 1 == 1)
print(~ 1 == 1)
print(1 != 1)
print(not 1 != 1)
print(~ 1 != 1)
```

✓ 0.2s

```
True
False
False
False
True
True
```

Essentials in the Python language

- Operators
  - Greater than, lower than
  - Greater or equal than, lower or equal than
  - Equals to, different from
  - in
  - not
  - is



Not a class method:

- Check if element is (True, False, None, np.nan)

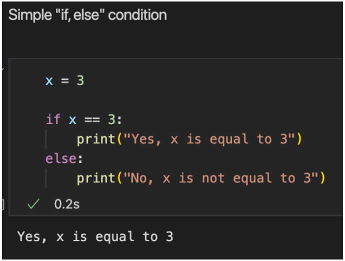
```
print(True is True)
print(True is False)

print([1] is None)
x = 12
print(x is None)
x = None
print(x is None)

import numpy as np
print(x is np.nan)
```

✓ 0.2s

```
True
False
False
False
True
False
```

Essentials in the Python language

- Conditional structures
  - if else statement



Simple "if, else" condition

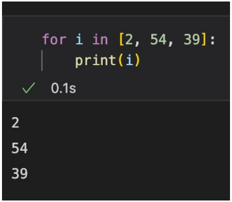
```
x = 3

if x == 3:
    print("Yes, x is equal to 3")
else:
    print("No, x is not equal to 3")
```

✓ 0.2s

```
Yes, x is equal to 3
```

Essentials in the Python language

- Control structures
  - for loop



```
for i in [2, 54, 39]:
    print(i)
```

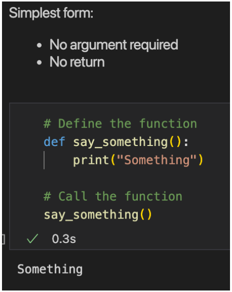
✓ 0.1s

```
2
54
39
```

Essentials in the Python language

- Functions
  - A function can:
    - take no, to many arguments
    - arguments can be "Positional" or "Keyword" arguments
    - return nothing (None) or anything (to many things)
    - synonyms: arguments / parameters / inputs
  - One must:
    - Define the function
    - Call the function

Functions



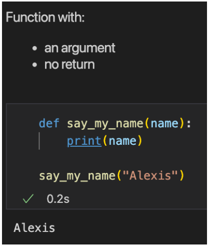
Simplest form:

- No argument required
- No return

```
# Define the function
def say_something():
    print("Something")

# Call the function
say_something()
```

✓ 0.3s

```
Something
```



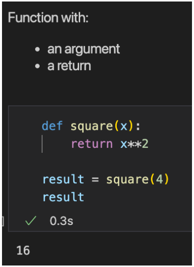
Function with:

- an argument
- no return

```
def say_my_name(name):
    print(name)

say_my_name("Alexis")
```

✓ 0.2s

```
Alexis
```



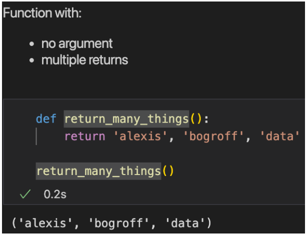
Function with:

- an argument
- a return

```
def square(x):
    return x**2

result = square(4)
result
```

✓ 0.3s

```
16
```



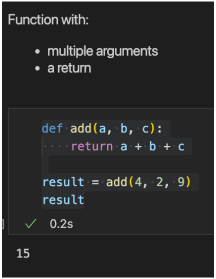
Function with:

- no argument
- multiple returns

```
def return_many_things():
    return 'alexis', 'bogroff', 'data'

return_many_things()
```

✓ 0.2s

```
('alexis', 'bogroff', 'data')
```



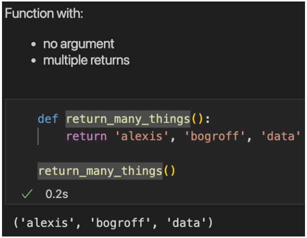
Function with:

- multiple arguments
- a return

```
def add(a, b, c):
    return a + b + c

result = add(4, 2, 9)
result
```

✓ 0.2s

```
15
```



Function with:

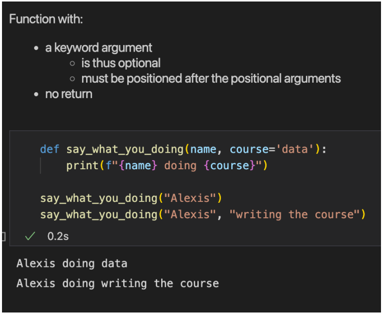
- no argument
- multiple returns

```
def return_many_things():
    return 'alexis', 'bogroff', 'data'

return_many_things()
```

✓ 0.2s

```
('alexis', 'bogroff', 'data')
```

Functions



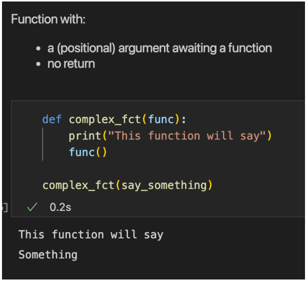
Function with:

- a keyword argument
  - is thus optional
  - must be positioned after the positional arguments
- no return

```
def say_what_you_doing(name, course='data'):
    print(f"{name} doing {course}")

say_what_you_doing("Alexis")
say_what_you_doing("Alexis", "writing the course")
```

✓ 0.2s

```
Alexis doing data
Alexis doing writing the course
```



Function with:

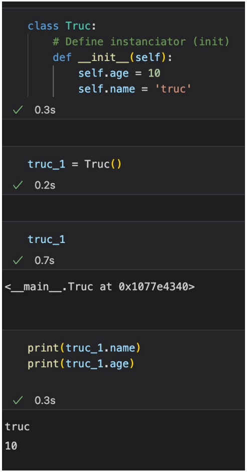
- a (positional) argument awaiting a function
- no return

```
def complex_fct(func):
    print("This function will say")
    func()

complex_fct(say_something)
```

✓ 0.2s

```
This function will say
Something
```

Objects - init



```
class Truc:
    # Define instanciator (init)
    def __init__(self):
        self.age = 10
        self.name = 'truc'
```
✓ 0.3s

```
truc_1 = Truc()
```
✓ 0.2s

```
truc_1
```
✓ 0.7s

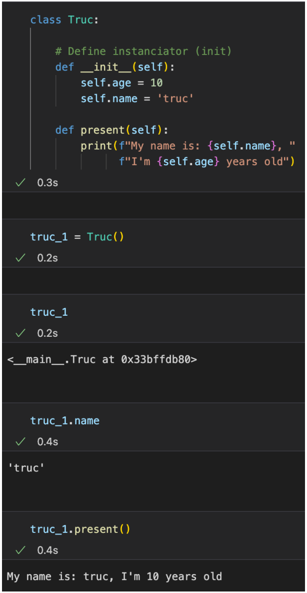
```
<__main__.Truc at 0x1077e4340>
```

```
print(truc_1.name)
print(truc_1.age)
```
✓ 0.3s

```
truc
10
```

- Define init
- Define properties / attributes (internal variables)
- Access through **self**
- Instanciate
- Object reference
- Access properties

Objects - method



```
class Truc:

    # Define instanciator (init)
    def __init__(self):
        self.age = 10
        self.name = 'truc'

    def present(self):
        print(f"My name is: {self.name}, "
              f"I'm {self.age} years old")
```

✓ 0.3s

```
truc_1 = Truc()
```

✓ 0.2s

```
truc_1
```

✓ 0.2s

```
<__main__.Truc at 0x33bffdb80>
```

```
truc_1.name
```

✓ 0.4s

```
'truc'
```

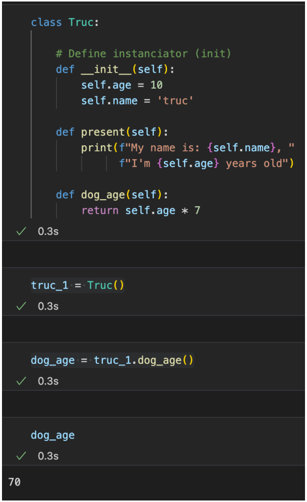
```
truc_1.present()
```

✓ 0.4s

```
My name is: truc, I'm 10 years old
```

- Create method
- Pass **self** argument
- Access attributes via **self.attribute**
- Re-instanciate object ⚠
- New reference
- Access method via **self.method**

Objects - method with return



```
class Truc:

    # Define instanciator (init)
    def __init__(self):
        self.age = 10
        self.name = 'truc'

    def present(self):
        print(f"My name is: {self.name}, "
              f"I'm {self.age} years old")

    def dog_age(self):
        return self.age * 7
```

✓ 0.3s

```
truc_1 = Truc()
```

✓ 0.3s

```
dog_age = truc_1.dog_age()
```

✓ 0.3s

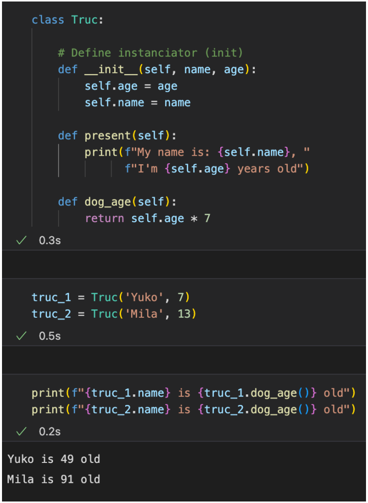
```
dog_age
```

✓ 0.3s

```
70
```

- Create method with return
- Set variable using return value

Objects - init with arguments



```
class Truc:

    # Define instanciator (init)
    def __init__(self, name, age):
        self.age = age
        self.name = name

    def present(self):
        print(f"My name is: {self.name}, "
              f"I'm {self.age} years old")

    def dog_age(self):
        return self.age * 7
```

✓ 0.3s

```
truc_1 = Truc('Yuko', 7)
truc_2 = Truc('Mila', 13)
```

✓ 0.5s

```
print(f"{truc_1.name} is {truc_1.dog_age()} old")
print(f"{truc_2.name} is {truc_2.dog_age()} old")
```

✓ 0.2s

```
Yuko is 49 old
Mila is 91 old
```

- Set specific init values
- Create different objects

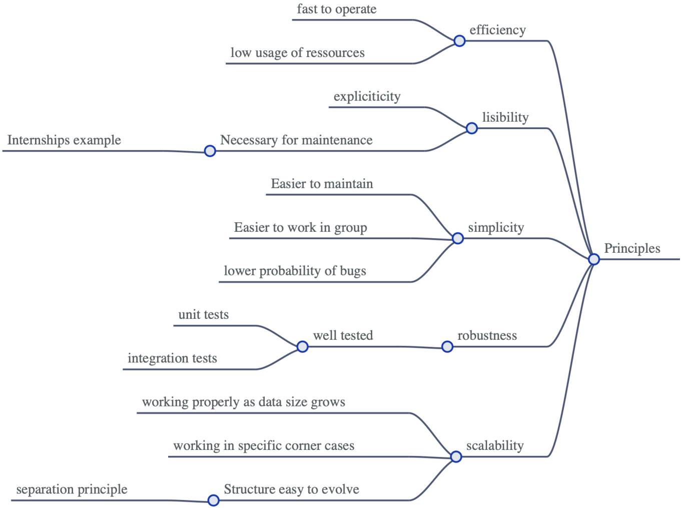
Coding conventions

- Names
  - variables: snake_style
  - constants: CAPITAL_SNAKE_STYLE
  - functions: snake_style
  - classes: First_letter_capital
- Spaces
- Max number characters by row: **79**
- Creation of iterables (lists, dicts)
- Comments
- File, functions, classes description

Coding conventions

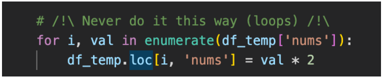
- Code order in a file:
  - Description
  - Imports
  - Constants
  - Functions and Classes alphabetically
  - Body (functions calls, loops, variables)
- Code organisation between files (script):
  - Main file
  - Functions and Classes file
  - Settings file
- Code organisation files (Jupyter Notebook):
  - Load and prepare data file
  - Analysis file
  - Predictions file

Programming in general, good practices

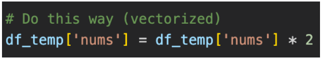


Programming in general, good practices

- Vectorization
- Don’t use loops when its possible to vectorize
- Same in Python, Matlab
- *This code is explained in the next course*



```python
# /!\ Never do it this way (loops) /!\
for i, val in enumerate(df_temp['nums']):
    df_temp.loc[i, 'nums'] = val * 2
```



```python
# Do this way (vectorized)
df_temp['nums'] = df_temp['nums'] * 2
```

Programming in general, other languages

- Difference between programming for:
  - Analysis, statistics
  - Software development
    - Front-end
    - Back-end

How to learn programming

- Trial and error
- Could be enough at first:
  - Python official documentation
  - Exercises Coding game
  - Google, Stackoverflow, Blogs
- Progress:
  - Choose project (company, Kaggle, personal)
  - Peers: open-source project, Data For Good
  - MOOC: advanced course