

Python Advanced Course

Part I

Stefano Alberto Russo

Why should you listen to me?

An hybrid profile: BSc in Computer Science + MSc in Computational Physics

Started at CERN, as research fellow working on data analysis & Big Data

Then, 5 years in startups.

- Core team member of an IoT energy metering and analytics startup,
- Joined Entrepreneur First, Europe's best deep tech startup accelerator

Now back into research:

- INAF and UniTS, working on resource-intensive data analysis
- adjunct prof. of computer science at University of Trieste (Python)
- plus, experienced consultant for a number of private companies

Course structure

4h

1h	Lecture (part I)
1h	Exercise + review
15m	<i>Break</i>
45m	Lecture (part II)
1h	Exercise + review

4h

1h	Lecture (part III)
1h	Exercise + review
15m	<i>Break</i>
45m	Lecture (part IV)
1h	Exercise + review

Outline

- Part I: Object Oriented Programming
 - What is OOP?
 - Logical Example
 - Attributes and methods
 - Why to use objects
 - Defining objects
- Part II: Improving your code
 - Extending objects
 - Lambdas
 - Comprehensions
 - Iterables
 - Properties
- Part III: Exceptions
 - What are exceptions?
 - Handling exceptions
 - Raising exceptions
 - Creating custom exceptions
- Part IV: logging and testing
 - The Python logging module
 - Basics about testing
 - The Python unit-testing module
 - Test-driven development

Object Oriented Programming

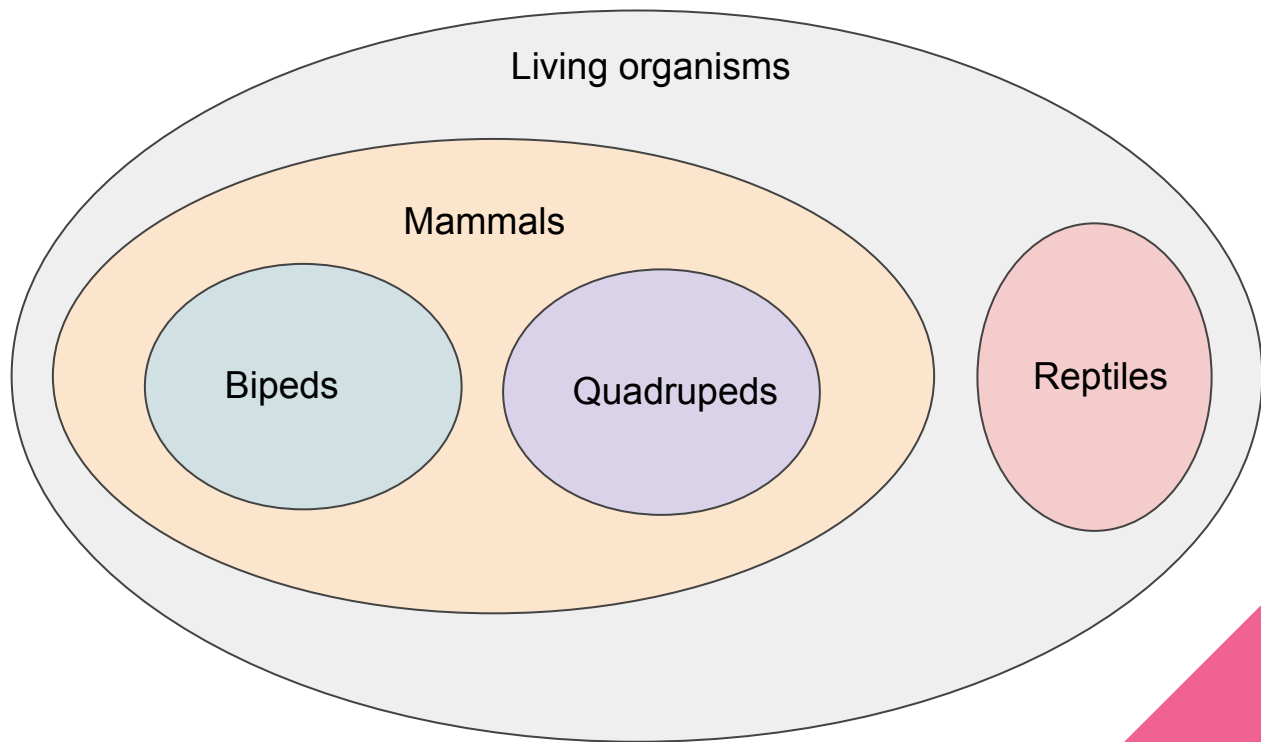
→ *What is it?*

It is a programming paradigm. Things change quite a lot from “classic” programming. Objects are “entities” which model the world around us.

Objects are defined as *classes*

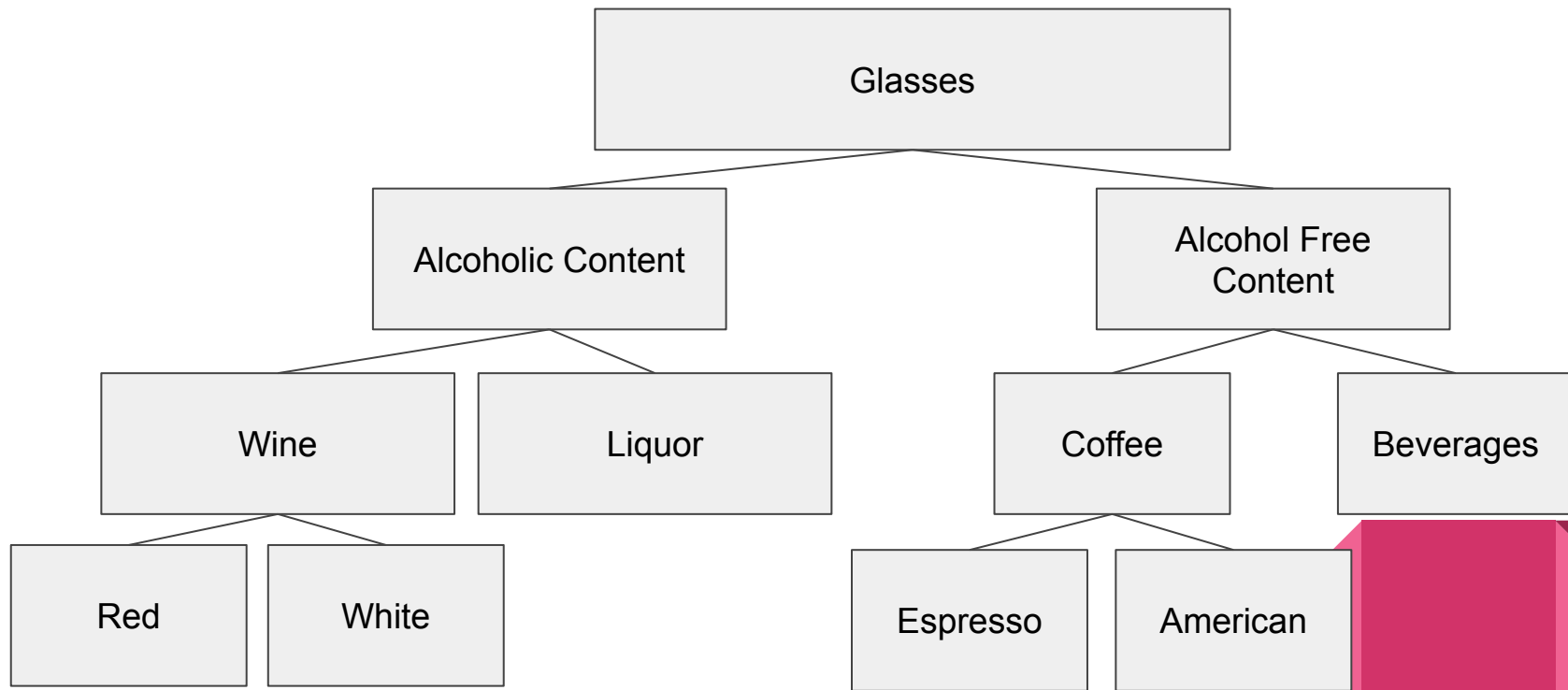
Object Oriented Programming

→ *What is it?*



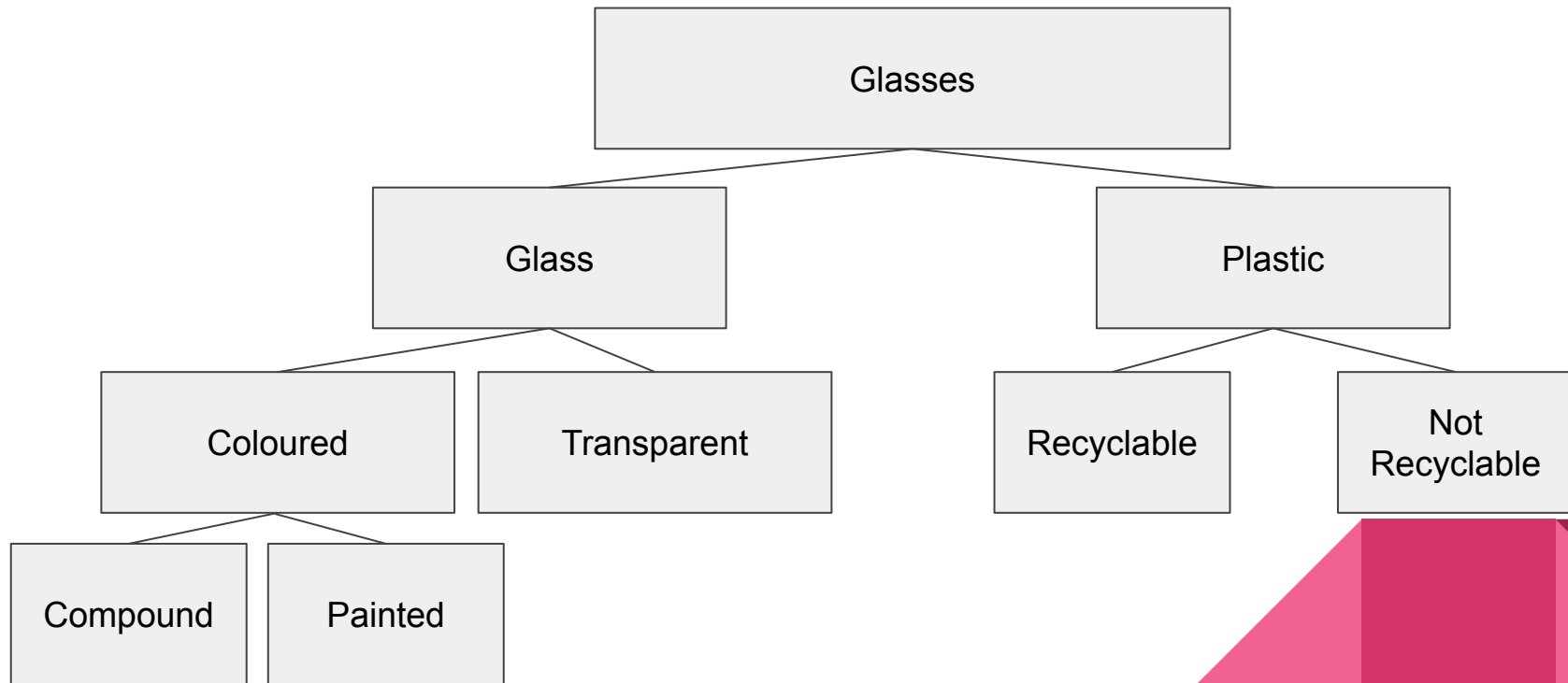
Object Oriented Programming

→ *What is it?*



Object Oriented Programming

→ *What is it?*



Object Oriented Programming

→ *What is it?*

It is a programming paradigm. Things change quite a lot from “classic” programming. Objects are “entities” which model the world around us.

Objects are defined as *classes*.

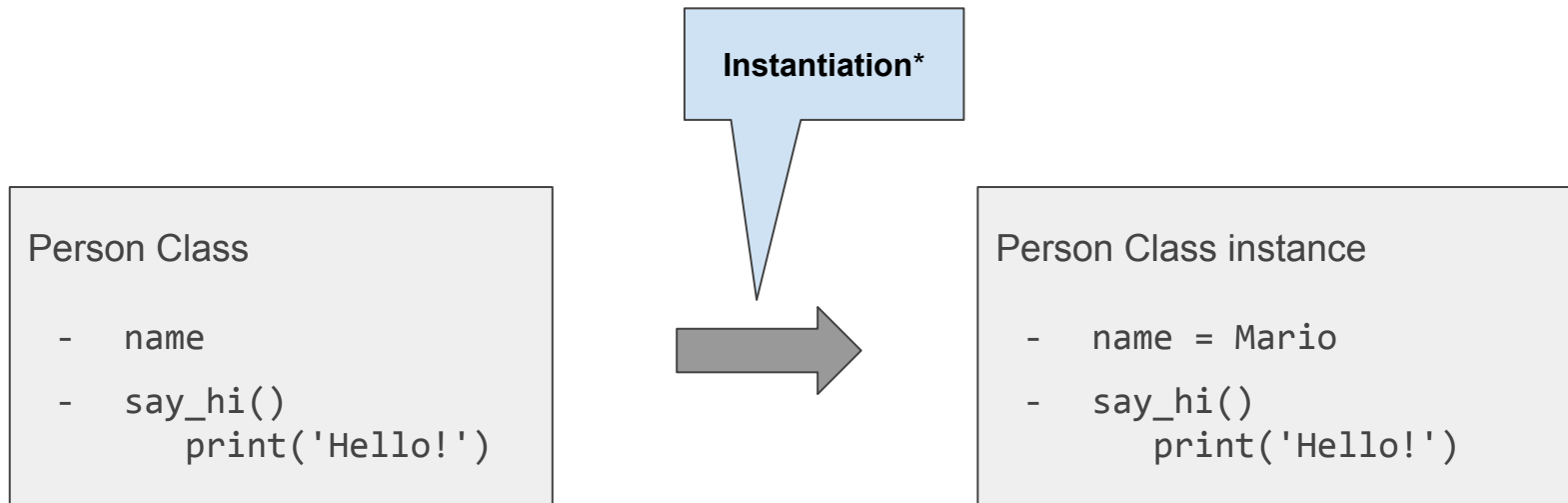
To use objects, we need to create an *instance* of their class.

Objects can have:

- attributes (variables)
- methods (functions)

Object Oriented Programming

→ *Logical Example*



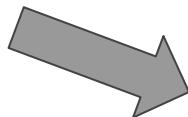
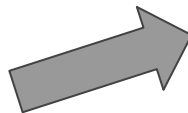
**Also known as construction or initialization*

Object Oriented Programming

→ Logical Example

Person Class

- name
- say_hi()
 print('Hello!')



Person Class instance

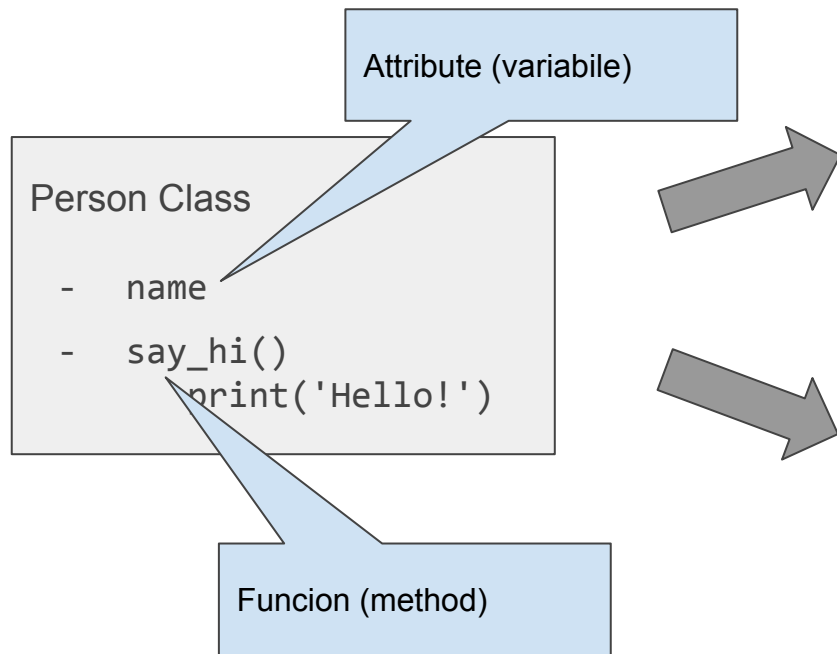
- name = Mario
- say_hi()
 print('Hello!')

Person Class instance

- name = Lucia
- say_hi()
 print('Hello!')

Object Oriented Programming

→ Logical Example



Person Class instance

```
- name = Mario  
- say_hi()  
  print('Hello!')
```

Person Class instance

```
- name = Lucia  
- say_hi()  
  print('Hello!')
```

Object Oriented Programming

→ *Class / instance attributes and methods*

By default, attributes and methods depend on the *instance* of the the class: they behave differently for each instance.

However, if they don't have to, then they can be defined as *class* or *static*.

For example, the `say_hi()` function can be defined as a class method, as it produce the same result regardless of the instance. If instead we wanted to make the `say_hi()` function to include the name of the person, then we couldn't.

Person Class

- name
- say_hi()
 print('Hello!')

Object Oriented Programming

→ *Why to use objects*

We use object for mainly two reasons:

- They allow to represent very well hierarchies (and to exploit common characteristics between them)
- Once instantiated, they allow to easily hold the status (without having to rely on external support data structures)

Object Oriented Programming

→ *Conventions*

In Python there is a well defined styling convention:

- **lowercase** characters and **underscores** for **variables** and the object **instances**
- **CamelCase** for the **class** names

Moreover, double underscores before and after the name of a method mean that that method is exclusively for internal (private) use, as for the string representation (`__str__`) or the initiator of the object (`__init__`).

→ They are commonly called “magic methods”.

Object Oriented Programming

→ *In Python everything is an object*

```
>>> my_string_2 = 'corso di laboratorio di programmazione'
>>> dir(my_string_2)
['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__', '__ge__', '__getattribute__', '__getitem__', '__getnewargs__', '__gt__', '__hash__', '__init__', '__init_subclass__', '__iter__', '__le__', '__len__', '__lt__', '__mod__', '__mul__', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__repr__', '__rmod__', '__rmul__', '__setattr__', '__sizeof__', '__str__', '__subclasshook__', 'capitalize', 'casefold', 'center', 'count', 'encode', 'endswith', 'expandtabs', 'find', 'format', 'format_map', 'index', 'isalnum', 'isalpha', 'isascii', 'isdecimal', 'isdigit', 'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace', 'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip', 'maketrans', 'partition', 'replace', 'rfind', 'rindex', 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split', 'splitlines', 'startswith', 'strip', 'swapcase', 'title', 'translate', 'upper', 'zfill']
>>> my_string_2.title()
'Corso Di Laboratorio Di Programmazione'
```


Object Oriented Programming

→ *In Python everything is an object*

examples.py

```
my_string = 'a,b,c'  
print(my_string)  
print(my_string.split(','))  
print(my_string)
```

```
> python examples.py  
a,b,c  
['a', 'b', 'c']  
a,b,c
```

examples.py

```
my_list = [1,2,3,4]  
print(my_list)  
print(my_list.reverse())  
print(my_list)
```

```
> python examples.py  
[1, 2, 3, 4]  
None  
[4, 3, 2, 1]
```

Object Oriented Programming

→ *Parenthesis: in-place operations*

examples.py

```
my_string = 'a,b,c'  
print(my_string)  
print(my_string.split(','))  
print(my_string)
```

Operation (function, method) which when executed returns a result

```
> python examples.py  
a,b,c  
['a', 'b', 'c']  
a,b,c
```

examples.py

```
my_list = [1,2,3,4]  
print(my_list)  
print(my_list.reverse())  
print(my_list)
```

Operation (function, method) which when executed changes the object, does not return anything!

```
> python examples.py  
[1, 2, 3, 4]  
None  
[4, 3, 2, 1]
```

Object Oriented Programming

→ *Defining objects*

objects.py

```
class Person():  
    pass  
  
person = Person()  
print(person)
```

```
> python objects.py  
<__main__.Person object at 0x7ff378a93fa0>  
> |
```

Object Oriented Programming

→ *Defining objects*

objects.py

```
class Person():  
    pass
```

```
person = Person()  
print(person)
```

instantiation

```
> python objects.py  
<__main__.Person object at 0x7ff378a93fa0>  
> |
```

Object Oriented Programming

→ *Defining objects*

objects.py

```
class Person():  
  
    def __init__(self, name, surname):  
  
        # Set name and surname  
        self.name = name  
        self.surname = surname  
  
person = Person('Mario', 'Rossi')  
print(person)  
print(person.name)  
print(person.surname)
```

```
> python objects.py  
<__main__.Person object at 0x7f8a75ac0fa0>  
Mario  
Rossi  
> |
```

Object Oriented Programming

→ Defining objects

The “init” function is responsible for initializing the object. If it is not defined, the default one is used, which does nothing.

objects.py

```
class Person():  
  
    def __init__(self, name, surname):  
  
        # Set name and surname  
        self.name = name  
        self.surname = surname  
  
person = Person('Mario', 'Rossi')  
print(person)  
print(person.name)  
print(person.surname)
```

```
> python objects.py  
<__main__.Person object at 0x7f8a75ac0fa0>  
Mario  
Rossi  
> 
```

“self” means “myself”, “myself class *instance*”. It is mandatory in every instance method, even if not used.

Object Oriented Programming

→ *Defining objects*

- To define class methods, use the **@classmethod** decorator. They have the “cls” as first argument instead of the “self”
- To define static methods, use the **@staticmethod** decorator. They do not have any special argument (no “self” nor “cls”).
 - A decorator is something placed above a function which “wraps” the function and tells it to behave in a particular way
- To define static/class attributes, define them in the body of the class

Object Oriented Programming

→ *Defining objects*

objects.py

The “init” function is a magic method.

```
class Person():  
    def __init__(self, name, surname):  
        # Set name and surname  
        self.name = name  
        self.surname = surname  
  
person = Person('Mario', 'Rossi')  
print(person)  
print(person.name)  
print(person.surname)
```

```
> python objects.py  
<__main__.Person object at 0x7f8a75ac0fa0>  
Mario  
Rossi  
> |
```


Object Oriented Programming

→ *Magic methods*

objects.py

```
class Person():  
  
    def __init__(self, name, surname):  
  
        # Set name and surname  
        self.name = name  
        self.surname = surname  
  
    def __str__(self):  
        return 'Person "{} {}".format(self.name, self.surname)  
  
person = Person('Mario', 'Rossi')  
print(person)
```

```
> python objects.py  
Person "Mario Rossi"  
> |
```

Object Oriented Programming

→ *Magic methods*

objects.py

```
class Person():  
  
    def __init__(self, name, surname):  
  
        # Set name and surname  
        self.name = name  
        self.surname = surname  
  
    def __str__(self):  
        return 'Person "{} {}".format(self.name, self.surname)  
  
person = Person('Mario', 'Rossi')  
print(person)
```

The `__str__` function is a magic method as well, and it is responsible for the string representation of the object (i.e. when you print it)

```
> python objects.py  
Person "Mario Rossi"  
> |
```

objects.py

```
# Import the random module
import random

class Person():

    def __init__(self, name, surname):

        # Set name and surname
        self.name = name
        self.surname = surname

    def __str__(self):
        return 'Person "{} {}".format(self.name, self.surname)

    def say_hi(self):

        # Generate a random number between 0, 1 and 2.
        random_number = random.randint(0,2)

        # Choose a random greeting
        if random_number == 0:
            print('Hello, I am {} {}'.format(self.name, self.surname))
        elif random_number == 1:
            print('Hi, I am {}'.format(self.name))
        elif random_number == 2:
            print('Yo bro! {} here!'.format(self.name))

person = Person('Mario', 'Rossi')
person.say_hi()
```

```
> python objects.py
Hello, I am Mario Rossi.
```

```
> python objects.py
Hi, I am Mario!
```

```
> python objects.py
Yo bro! Mario here!
```

objects.py

```
# Import the random module
import random

class Person():

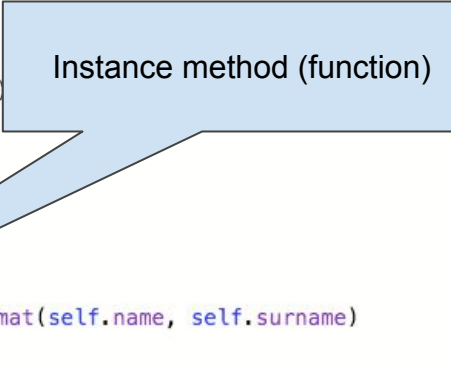
    def __init__(self, name, surname):
        # Set name and surname
        self.name = name
        self.surname = surname

    def __str__(self):
        return 'Person "{} {}"'.format(self.name, self.surname)

    def say_hi(self):
        # Generate a random number between 0, 1 and 2.
        random_number = random.randint(0,2)

        # Choose a random greeting
        if random_number == 0:
            print('Hello, I am {} {}'.format(self.name, self.surname))
        elif random_number == 1:
            print('Hi, I am {}'.format(self.name))
        elif random_number == 2:
            print('Yo bro! {} here!'.format(self.name))

person = Person('Mario', 'Rossi')
person.say_hi()
```



Instance method (function)

```
> python objects.py
Hello, I am Mario Rossi.
```

```
> python objects.py
Hi, I am Mario!
```

```
> python objects.py
Yo bro! Mario here!
```

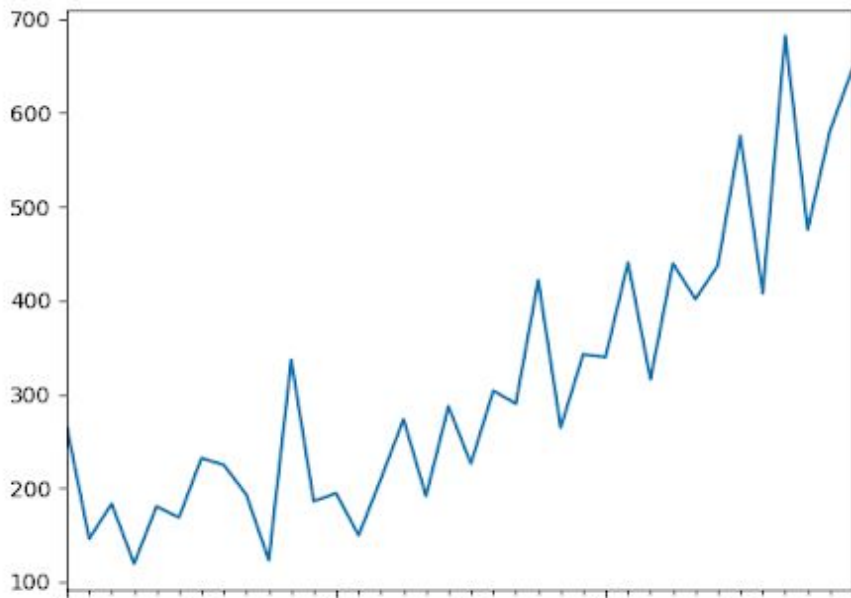
End of part I

→ *Questions?*

Next: exercise 1

Exercise 1

We want to write a predictive model for monthly shampoo sales.



Exercise 1

We want to write a predictive model for monthly shampoo sales.

Our model is extremely simple:

- given a window of n
- the sales at $t+1$ are given by:
 - the average increment computed over the previous n months
 - summed to the last point (t) of the window

Exercise 1

→ Example

Let's choose to use 3 months for the prediction (**n=3**) and say that we want to predict the sales for December (**t+1**).

We know that sales for September (**t-2**), October (**t-1**) and November (**t**) have been, respectively, of 50, e 52 e 60 units.

Month	Step	Sales
September	t-2	50
October	t-1	52
November	t (now)	60
December	t+1	?

Exercise 1

→ Example

Let's choose to use 3 months for the prediction ($n=3$) and say that we want to predict the sales for December ($t+1$).

We know that sales for September ($t-2$), October ($t-1$) and November (t) have been, respectively, of 50, 52 and 60 units.

Month	Step	Sales
September	$t-2$	50
October	$t-1$	52
November	t (now)	60
December	$t+1$	$(50+52)/2 + 60 = 65$

Exercise 1

The `IncrementModel()` class must have a *fit()* method (which does nothing) and a *predict()* method. Both methods must take a “data” argument.

exercice.py

```
class IncrementModel():  
  
    def __init__(self, window)  
        self.window = window  
  
    def fit(self, data):  
        # Not implemented  
        pass  
  
    def predict(self, data):  
        # Compute and return the prediction  
        prediction = ...  
        return prediction
```