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Python 3 Beginner

Chapter **00**

Previously, on Python 3 Beginner…

release 1.0.0

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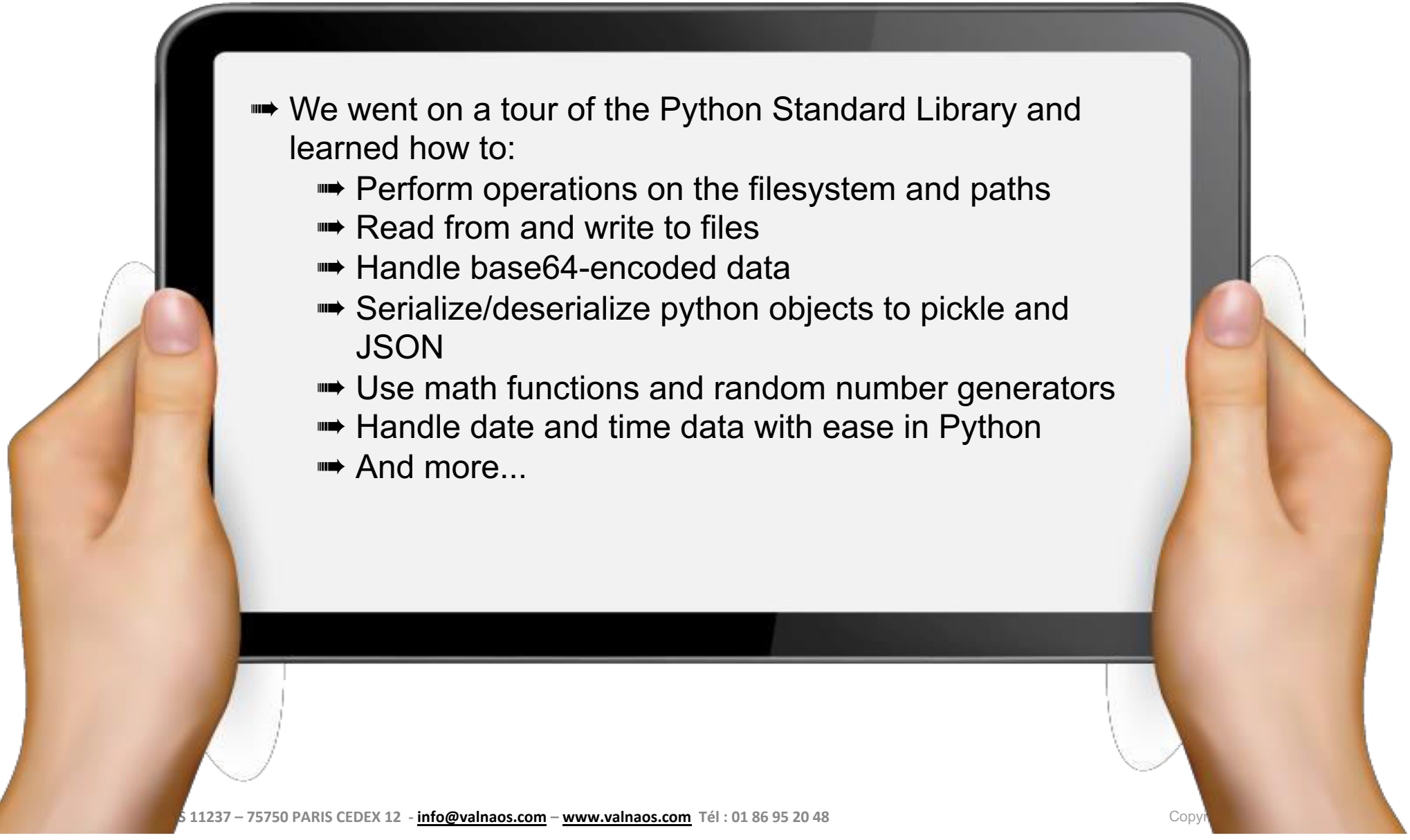
What we saw last time



Q&A

Where? Who?

Class Material

➠ GitHub: https://github.com/cstar-industries/python-3-beginner

Instructor

➠ Charles Francoise <charles@cstar.io>

Session Objectives

At the end of this session, you will be able to:

- Define your own types in Python with a **class**
- Add variables and methods to your custom types
- Create **instances** of your classes
- Use classes as a better replacement to other data types (like `dicts`)
- Understand and make use of **inheritance** to better re-use existing code
- Use **type annotations** and **docstrings** to make your code readable by anyone

Session Syllabus

Chapter	Subject	Start	End	Total Time (in hours)
00	Previously on Python 3 Beginner…	14:00	14:15	00:15
01	Functions: Part I	14:15	15:00	00:45
	Coffee Break	*15:00*	*15:10*	*00:10*
02	Functions: Part II	15:10	15:55	00:45
	Coffee Break	*15:55*	*16:05*	*00:10*
03	Generators and Error Handling	16:05	16:50	00:45
	Coffee Break	*16:50*	*17:00*	*00:10*
	Workshop	17:00	18:00	01:00
	Total			**04:00**

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Python 3 Beginner

Chapter **01**

Classes in Python

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Types are classes

- We've seen a number of types:
  - Some basic: `int`, `float`, `bool`...
  - Some more complex: `list`, `dict`, `datetime`...
- To get the type of an object we use the `type` built-in function

```
type(3)
```

```
int
```

```
print(type(3))
```

```
<class 'int'>
```

- What is this `class` ?

Types are classes

➠ Classes have variables

```
print(datetime.resolution)
```

```
0:00:00.000001
```

➠ Classes have functions

```
print(datetime.now)
```

```
<function datetime.now>
```

```
print(datetime.now())
```

```
2020-04-25 21:55:25.754109
```

Types are classes

➠ The objects' methods are functions from the class

```
d = datetime.now()
print(datetime.timestamp(d))
print(d.timestamp())
```

```
1587893892.289229
1587893892.289229
```

```
s = 'hello'
print(str.upper(s))
print(s.upper())
```

```
HELLO
HELLO
```

Let's write some code!

```
s = 'hello'
print(str.upper(s))
print(s.upper())
```

```
HELLO
HELLO
```

Classes are namespaces

- To create a class, use the `class` keyword
- A class definition block (indented) begins after the colon
- As with functions, symbols defined inside the class are not visible outside the block

```
class A:
    greeting = 'Hello'
    counter = 0

print(A)
print(type(A))
print(A.greeting)
```

```
<class '__main__.A'>
<class 'type'>
Hello
```

Classes are namespaces

➠ Classes "contain" variables

```
print(A.counter)
A.counter += 1
print(A.counter)
```

```
0
1
```

➠ Classes "contain" functions

```
class A:
    def say_hello():
        print("Hello World!")

A.say_hello()
```

```
Hello World!
```

Classes are namespaces

Let's write some code!

```
class A:
    def say_hello():
        print('Hello World!')
```

```
A.say_hello()
```

Classes are types

- You can create an object using your class using a function-like notation

```
a = A()
type(a)
```

```
__main__.A
```

- The class is the object's type

```
type(a) == A
```

```
True
```

- An object of type `A` is also called an *instance* of class `A`.

Classes are types

➠ What happens when we use a function as a method?

```
a.say_hello()
```

```
TypeError: say_hello() takes 0 positional arguments but 1 was given
```

➠ Remember how we used the function from the class

```
s = 'hello'
print(str.upper(s))
print(s.upper())
```

```
HELLO
HELLO
```

Classes are types

- Let's define a new class B with a function taking a single argument: `self`

```
class B:
    def say_hello(self):
        print('Hello World!')

b = B()
b.say_hello()
```

```
Hello World!
```

- The function can still be used from the class

```
B.say_hello(b)
```

```
Hello World!
```

Classes are types

- Using a method with the *instance.methodname* notation is equivalent to passing the instance as first argument to the function
- By convention, this first argument is always named `self`
- Similar to `this` in C++ and Java, but explicitly bound as an argument

Classes are types

➠ Class attributes are available in instances

```
class C:
    greeting = 'Hello!'

print(C.greeting)

c = C()
print(c.greeting)
```

```
Hello!
Hello!
```

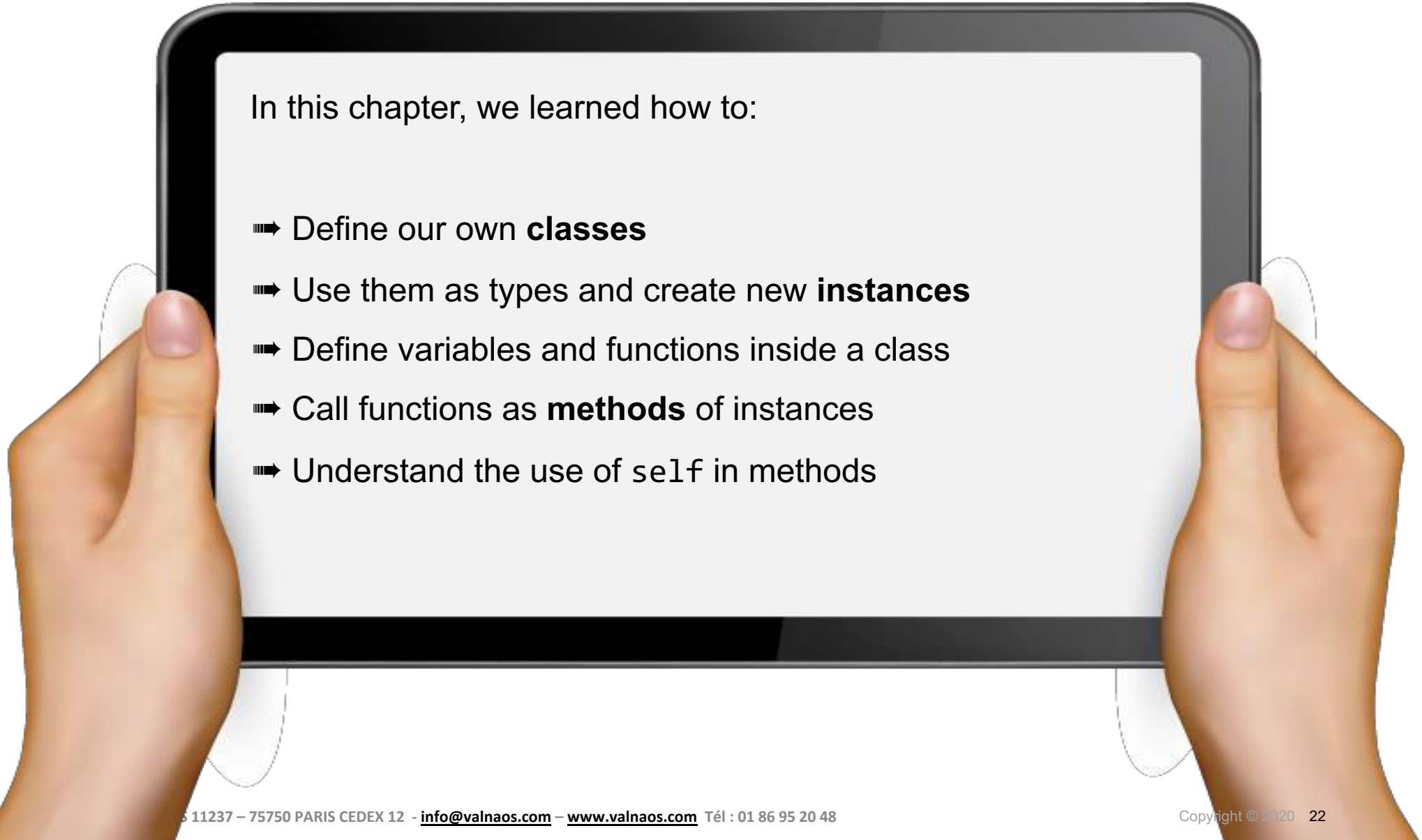
Let's write some code!

```
class B:
    def print_self(obj):
        print(obj)

b = B()
print(b)
b.print_self()
```

```
<__main__.B object at 0x7ff4d0f840f0>
<__main__.B object at 0x7ff4d0f840f0>
```

Chapter Summary



In this chapter, we learned how to:

- Define our own **classes**
- Use them as types and create new **instances**
- Define variables and functions inside a class
- Call functions as **methods** of instances
- Understand the use of `self` in methods

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Chapter **02**

Object-Oriented Programming

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More on methods

➠ Methods can have more than one argument

```
class A:
    def add_two(self, num):
        return num + 2

a = A()
print(a.add_two(8))
```

```
10
```

➠ First argument – `self` – always set to instance

Initializer special function

- The special method `__init__` is called when you create a new instance
- Arguments given to the creation call are passed on to `__init__`
- Use the `__init__` function to create and initialize instance attributes

```
class A:
    def __init__(self, id):
        self.created_at = datetime.now()
        self.id = id

a = A(303)
print(a.created_at)
print(a.id)
```

```
2020-04-26 15:21:01.374870
303
```

Instance variables

➠ Instance variables are unique to each instance

```
a = A(303)

# Time passes...
b = A(123)

print(f'a({a.id}) - {a.created_at}')
print(f'b({b.id}) - {b.created_at}')
```

```
a(303) - 2020-04-26 15:21:01.374870
b(123) - 2020-04-26 16:20:11.459183
```

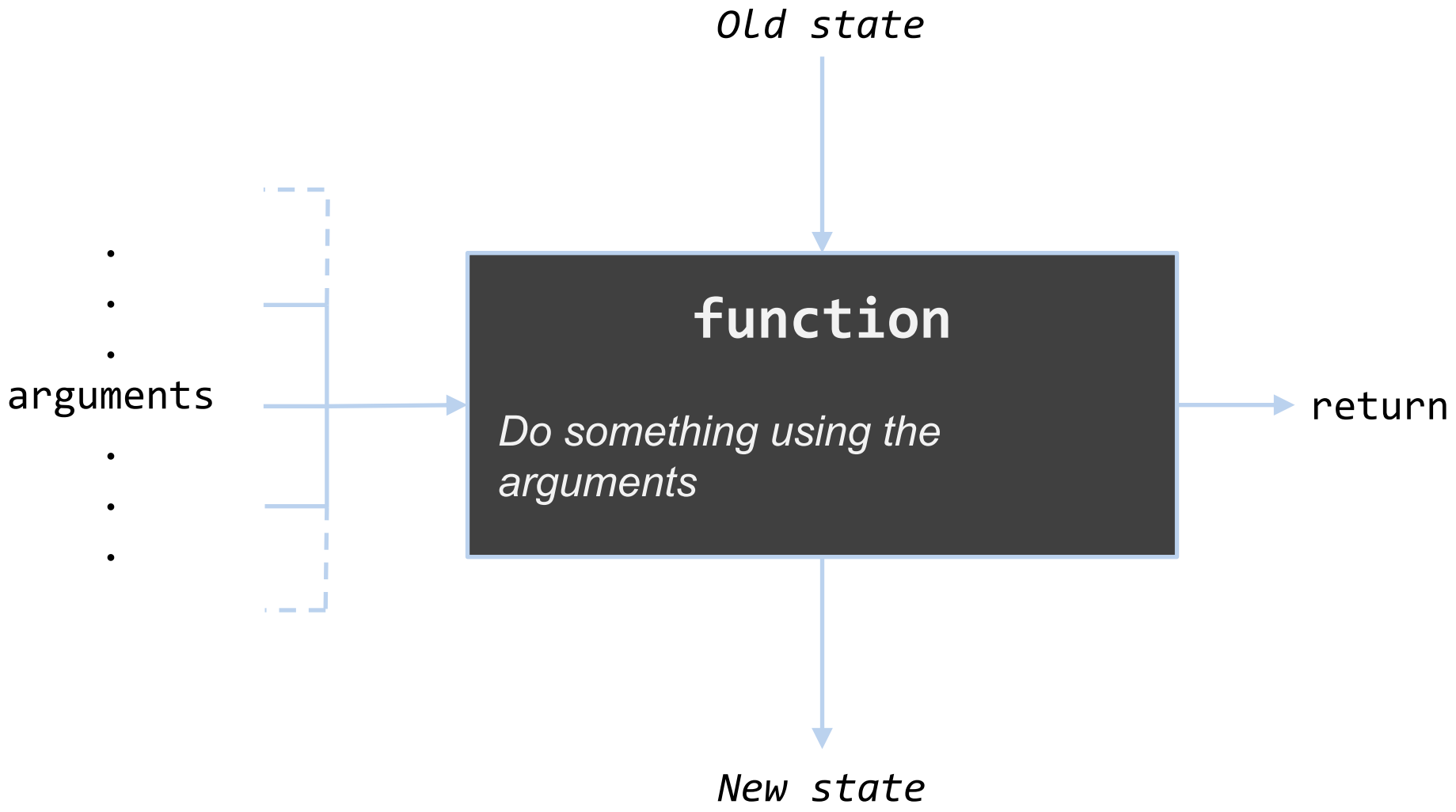
Instance variables

➠ Use methods to change instance attributes

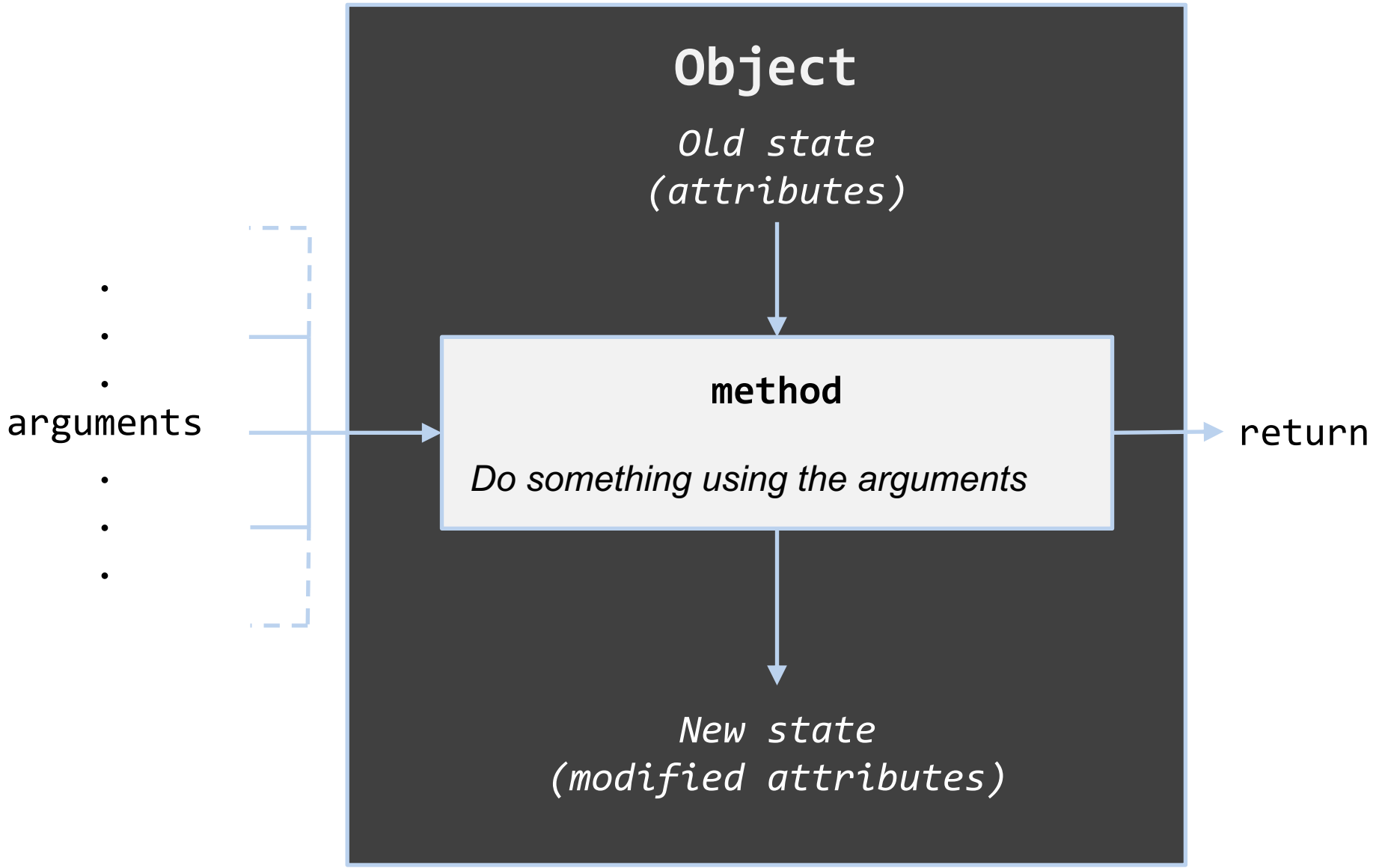
```
class Adder:
    def __init__(self):
        self.add_counter = 0

    def add(self, a, b):
        self.add_counter += 1
        return a + b

a1 = Adder()
a2 = Adder()

print(a1.add(2, 3), a1.add(3, 7))
print(a1.add_counter)
print(a2.add_counter)
```

```
5 10
2
0
```

(Return to) Conceptual view of a function



Conceptual view of an object



Conceptual view of an object

*An object is a mechanism to bundle **state** (attributes) with **behavior** (methods).*

Objects as higher level structured data

➠ Before classes we used `dicts`

```
guido = {'first_name': 'Guido', 'last_name': 'van Rossum', 'email':
'guido@python.org'}

def format_contact(c):
    return f'{c['first_name']} {c['last_name']} <{c['email']}>'

print(format_contact(guido))
```

```
Guido van Rossum <guido@python.org>
```

➠ Let's do this with classes

Objects as higher level structured data

- Write initializer
- Use attributes instead of dict keys
- Write functions as methods

```
class Contact:
    def __init__(self, first_name, last_name, email):
        self.first_name = first_name
        self.last_name = last_name
        self.email = email

    def format(self):
        return f'{self.first_name} {self.last_name} <{self.email}>'

guido = Contact('Guido', 'van Rossum', 'guido@python.org')
print(guido.format())
```

```
Guido van Rossum <guido@python.org>
```

Let's write some code!

```
def f():
    a = []
    print(a)
    a += [0, 1, 2]
    print(a)

f()
print(a)
```

```
[]
[0, 1, 2]

NameError: name 'a' is not defined
```

Class attributes vs. Instance attributes

➠ Class attributes are shared by all instances

```
class A:
    items = []

    def add_item(self, item):
        self.items.append(item)

a = A()
b = A()

a.add_item('hello')
b.add_item('world')
print(a.items)
```

```
['hello', 'world']
```

Class attributes vs. Instance attributes

➠ Instance attributes are unique to each instance

```
class A:
    def __init__(self):
        self.items = []

    def add_item(self, item):
        self.items.append(item)

a = A()
b = A()

a.add_item('hello')
b.add_item('world')

print(a.items)
```

```
['hello']
```

Class attributes vs. Instance attributes

➠ Class methods apply to the class object (not the instance)

```
class A:
    number_of_instances = 0

    def __init__(self):
        self.add_instance()

    @classmethod
    def add_instance(cls):
        cls.number_of_instances += 1

a = A()
b = A()

print(A.number_of_instances)
```

```
2
```

Class attributes vs. Instance attributes

➠ Static methods apply to no object (regular function)

```
class A:
    def __init__(self):
        self.add_instance()

    @staticmethod
    def greet(greetee):
        print(f'Hello {greetee}!')

A.greet('World')
```

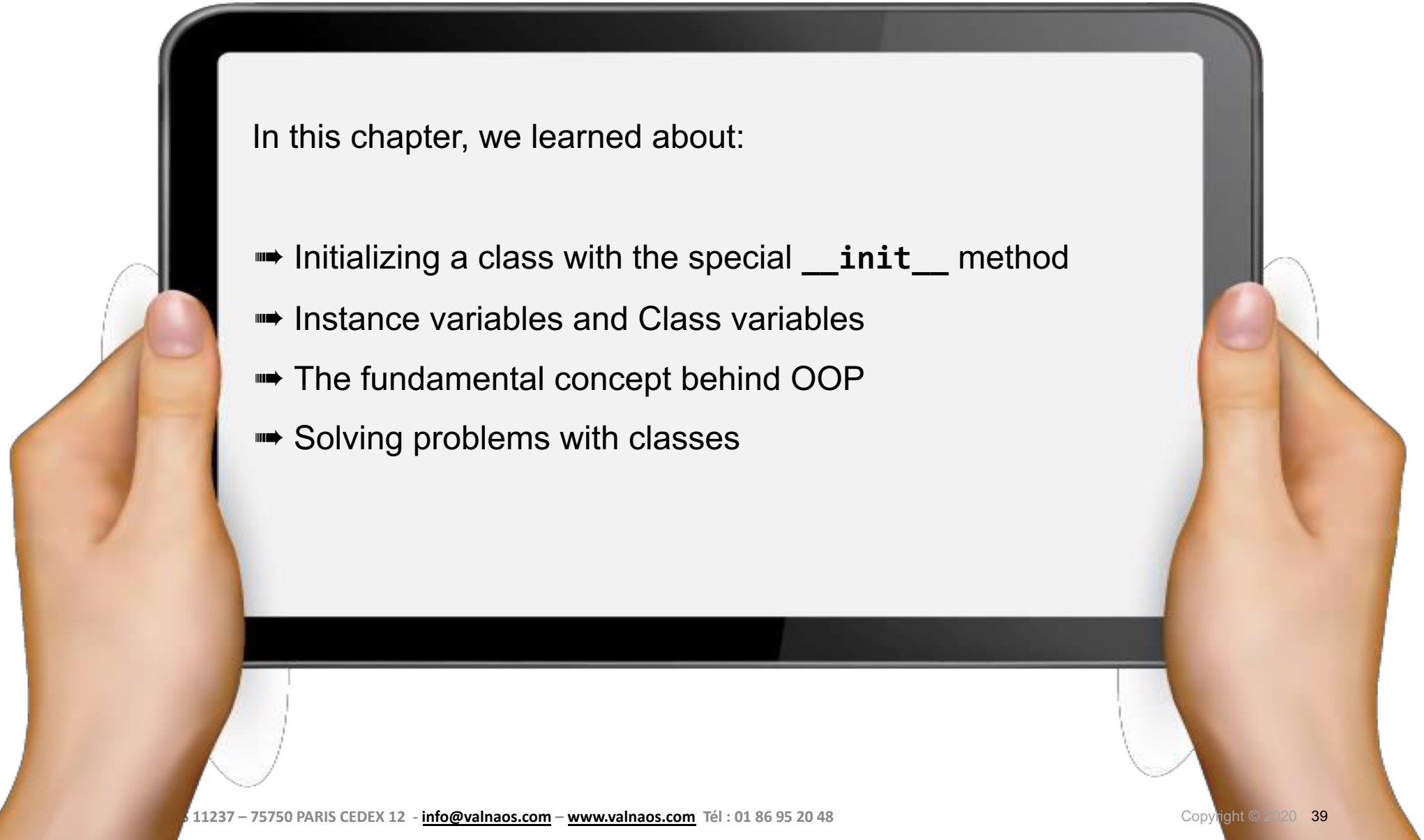
```
Hello World!
```

Let's write some code!

```
red_team = Team('Red Team')

red_team.add_person('Jack')
red_team.add_person('John')
red_team.add_person('Bart')

print(f'{red_team.name}: {red_team.people}')
```

```
Red Team: ['Jack', 'John', 'Bart']
```

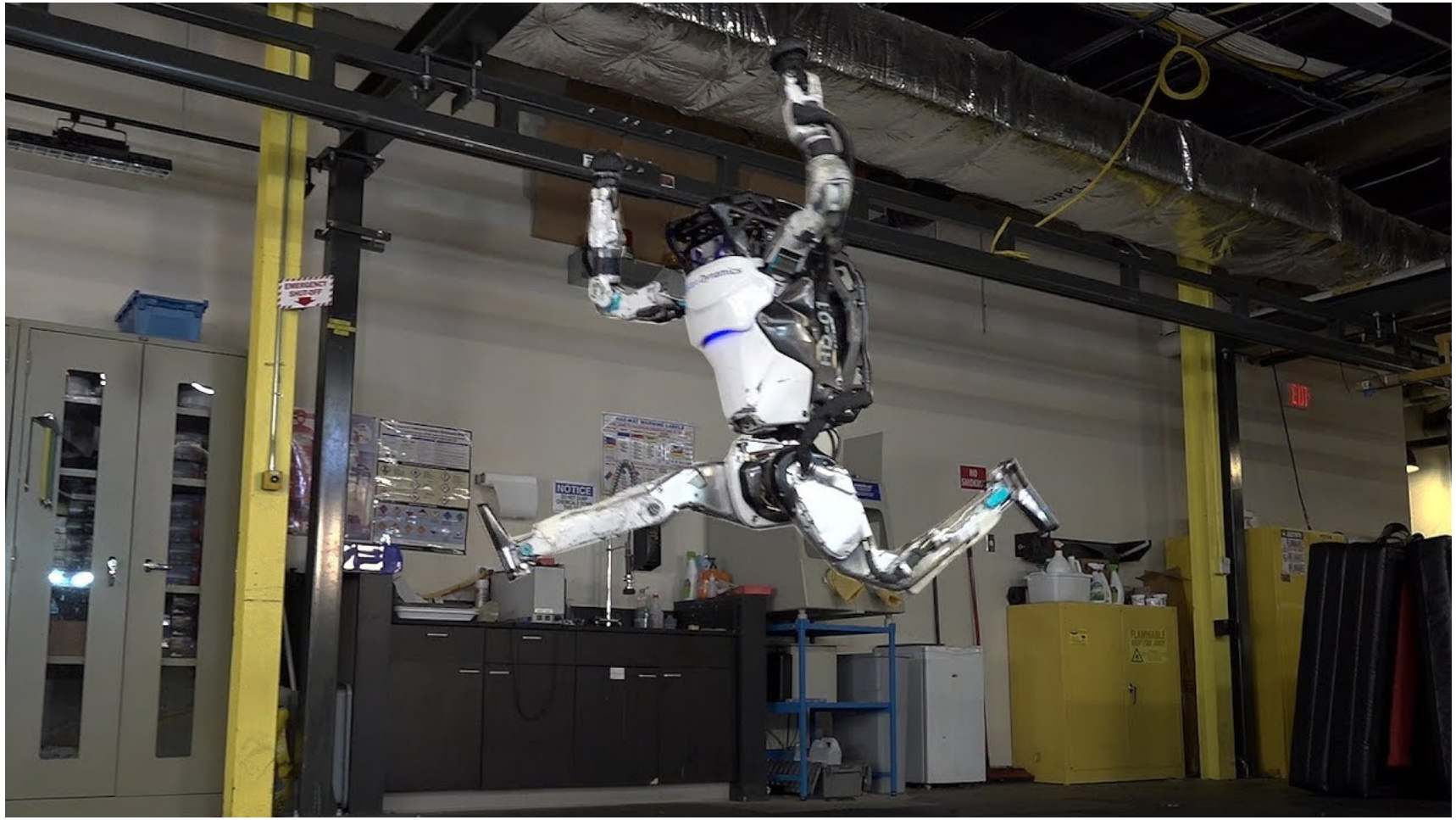
Chapter Summary



In this chapter, we learned about:

- Initializing a class with the special **`__init__`** method
- Instance variables and Class variables
- The fundamental concept behind OOP
- Solving problems with classes

Workout Time!



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Chapter **03**

Inheritance and Python specifics

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Inheritance

➠ Sometimes, classes can share a lot of behavior with others

```
class Album:
    def __init__(self, title, artist, songs):
        self.title = title
        self.artist = artist
        self.songs = songs

    def play(self):
        print(f'Playing "{self.songs[0]}"...')

class Playlist:
    def __init__(self, title):
        self.title = title
        self.songs = []

    def add_song(self, song):
        self.songs.append(song)

    def play(self):
        print(f'Playing "{self.songs[0]}"...')
```

Inheritance

➠ Create a class with all common code: the *superclass*

```
class Collection:
    def __init__(self, title):
        self.title = title
        self.songs = []

    def play(self):
        print(f'Playing "{self.songs[0]}"...')
```

Inheritance

- Create specialized classes *(subclasses)* without repeating code

```
class Album(Collection):
    def __init__(self, title, artist, songs):
        super().__init__(title)
        self.artist = artist
        self.songs = songs
```

```
class Playlist(Collection):
    def add_song(self, song):
        self.songs.append(song)
```

- Call methods from the superclass on the subclass

```
album = Album('2001', 'Dr. Dre', [...])
album.play()
```

```
Playing "Lolo(Intro)"...
```

Let's write some code!

```
c = C('Instance of C', hello='world', count=1)
print(c.data)
```

```
Initializing C: Instance of C
Initializing B: Instance of C
Initializing A: Instance of C
{'hello': 'world', 'count': 1}
```

Annotations

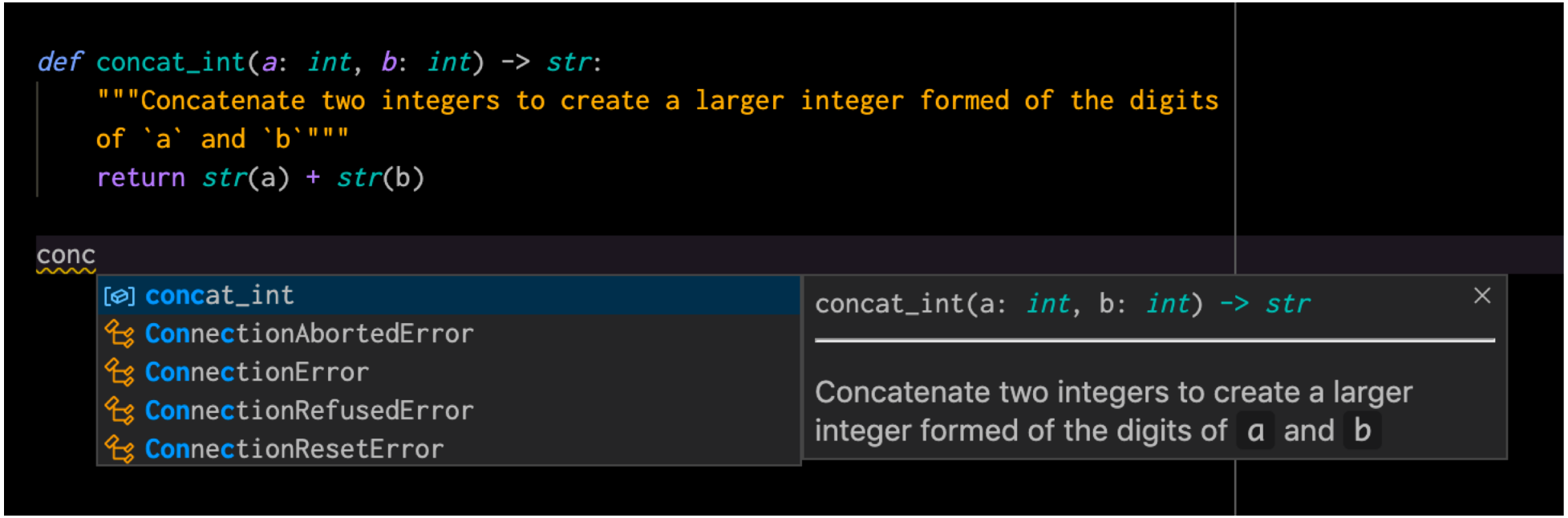
- Use *docstrings* to document your code (classes, attributes and methods)

```
class Accumulator:
    """Accumulates count by adding values. Initialized at 0"""
    def __init__(self):
        self.acc = 0

    def add(self, increment):
        """Increase the count by increment"""
        self.acc += increment

help(Accumulator)
```

```
class Accumulator(builtins.object)
 |  Accumulates count by adding values. Initialized at 0
 |
 |  Methods defined here:
 |
 |  add(self, increment)
 |      Increase the count by increment
```

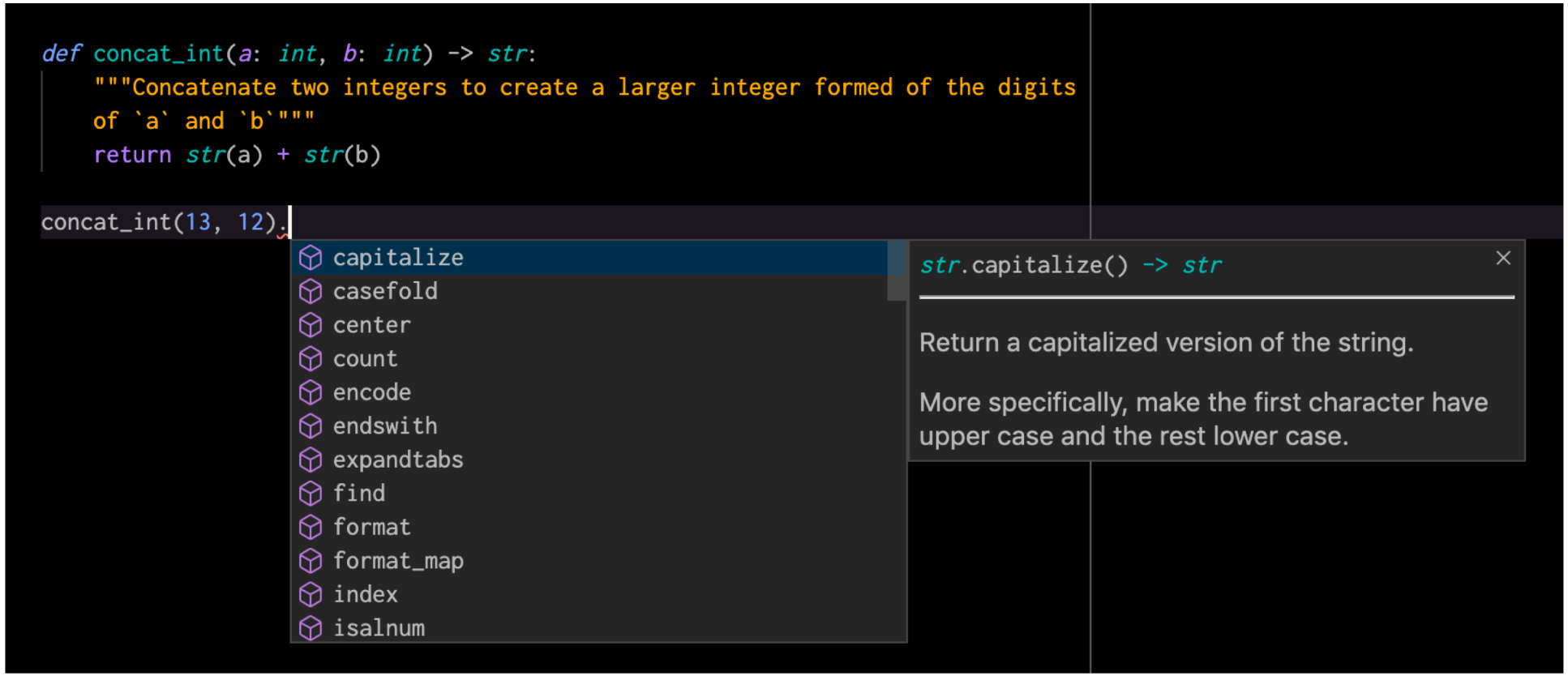
Annotations

- Type annotations will be used by code editors and linters to help avoid bugs in your code



Annotations

- Type annotations will be used by code editors and linters to help avoid bugs in your code



Special methods

- There are other special methods besides `__init__` to interact more idiomatically with the Python language

```
class Accumulator:
    def __init__(self):
        self.acc = 0

    def add(self, increment):
        self.acc += increment

a = Accumulator()
b = Accumulator()
print(a == b)
```

```
False
```

Special methods

➠ Redefine equality with __eq__

```
class Accumulator:
...
    def __eq__(self, other):
        return self.acc == other.acc

a = Accumulator()
b = Accumulator()
print(a == b)

a.increment(1)
print(a == b)
```

```
True
False
```

Special methods

➠ Provide relevant stringification with `__str__` and `__repr__`

```
class Accumulator:
...
    def __repr__(self):
        return f'Accumulator({self.acc})'
    def __str__(self):
        return str(self.acc)

a = Accumulator()
a.add(1138)
print(a)
a
```

```
1138
Accumulator(1138)
```

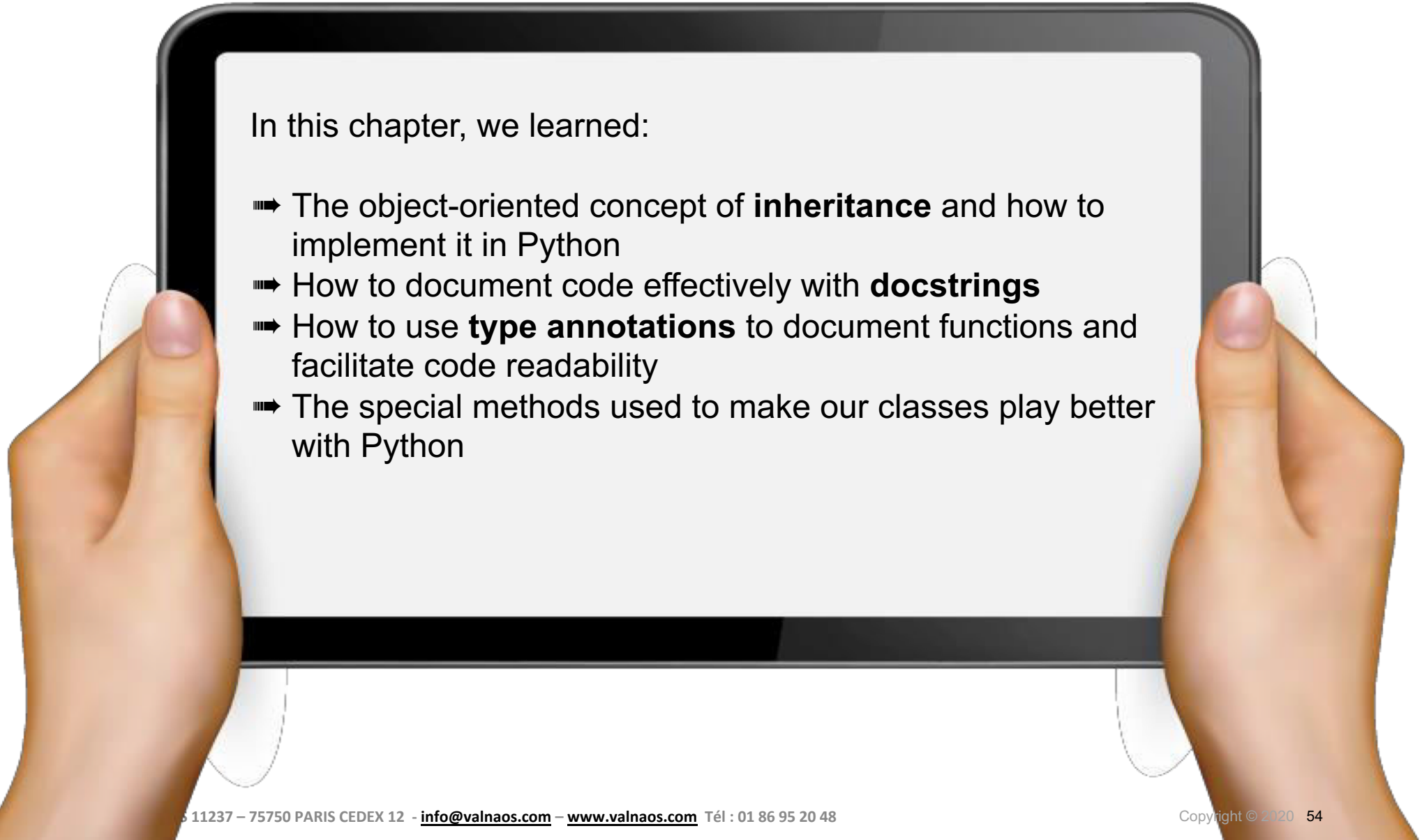
Special methods

- Any other operator can be redefined:
  - `<` : `__lt__`, `>` : `__gt__`, `!=` : `__ne__`...
- Indexing with `[]` can be defined in your classes: `__getitem__`, `__setitem__`...
- Type conversion with: `__str__`, `__int__`, `__bytes__`...
- Even iteration with `for` can work in your classes with: `__iter__` and `__next__`
- ⚠️ This power should not be abused. Only use this when you are sure it is useful, and the usage is unambiguous to anyone else. Remember: *Clear is better than clever.*
- To learn more, read the documentation.

Let's write some code!

```
class Accumulator:
    """Accumulates count by adding values. Initialized at 0"""
    def __init__(self):
        self.acc = 0

    def add(self, increment: int):
        """Increase the count by increment"""
        self.acc += increment

    def __eq__(self, other):
        return self.acc == other.acc
    def __repr__(self):
        return f'Accumulator({self.acc})'
    def __str__(self):
        return str(self.acc)
```

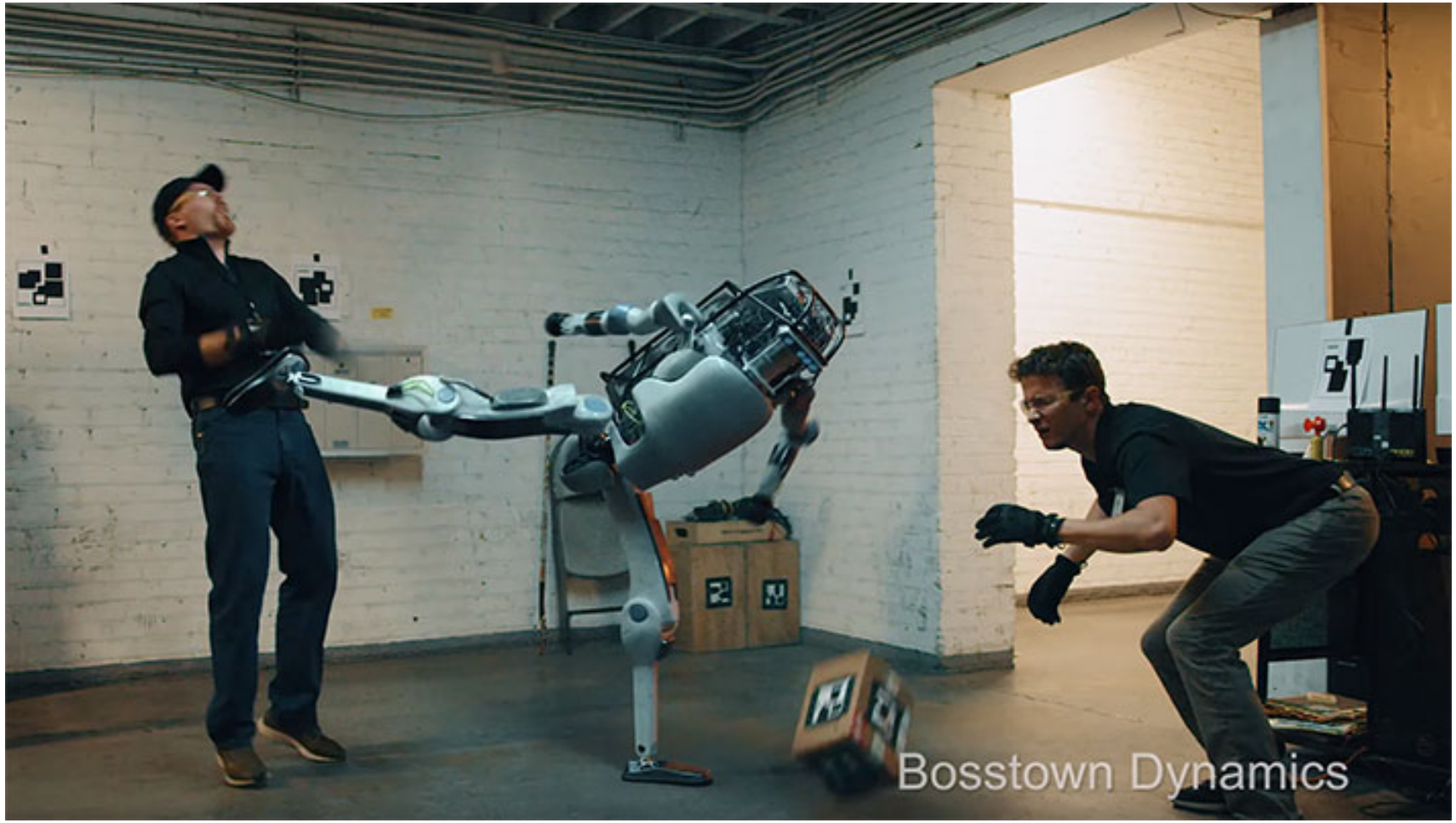
Chapter Summary



In this chapter, we learned:

- The object-oriented concept of **inheritance** and how to implement it in Python
- How to document code effectively with **docstrings**
- How to use **type annotations** to document functions and facilitate code readability
- The special methods used to make our classes play better with Python

Workout Time!



Q&A

Workshop

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Thank you for your attention!

