Object Oriented Programming in Python

Classes and objects

CentraleSupélec

Outline

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Object-oriented programming (OOP)

OOP: a programming paradigm for directly mapping real-life problems into a program

- it is based on the notion of class (a user-defined data type)
- and objects (instances of a given class)

an object is a data structure that contains:

- data: in form of variables called attributes or fields
- behaviour: in form of procedures called methods

Real-world objects

real-world objects share two characteristics: they all have a state and a behaviour

examples of real-world objects

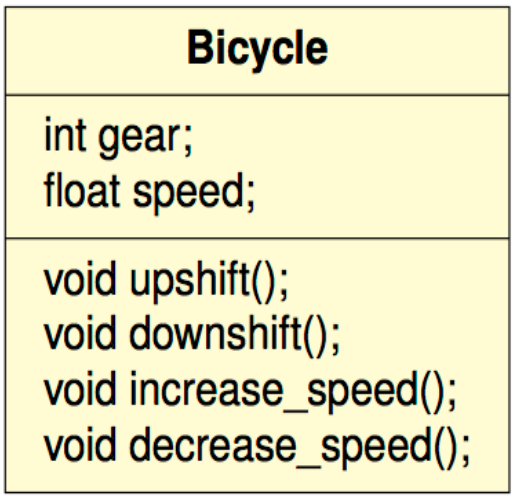
- Dog:
  - state: name, color, breed, hungry, ...
  - behaviour: barking, fetching, wagging tail, eating, ...
- Bicycle:
  - state: current gear, current pedal cadence, current speed, ...
  - behaviour: changing gear, changing pedal cadence, applying brakes, ...

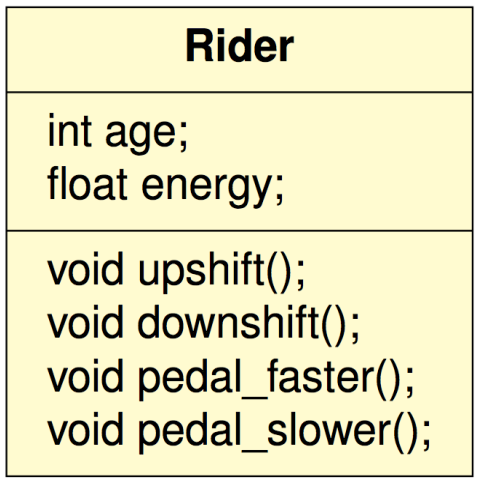
Example: class "Bicycle" and class "Rider"

class name

attributes
(state variables)

methods
(class interface)





class name

attributes
(state variables)

methods
(class interface)

What is a (software) class ?

class: the *blueprint* characterising a category of objects

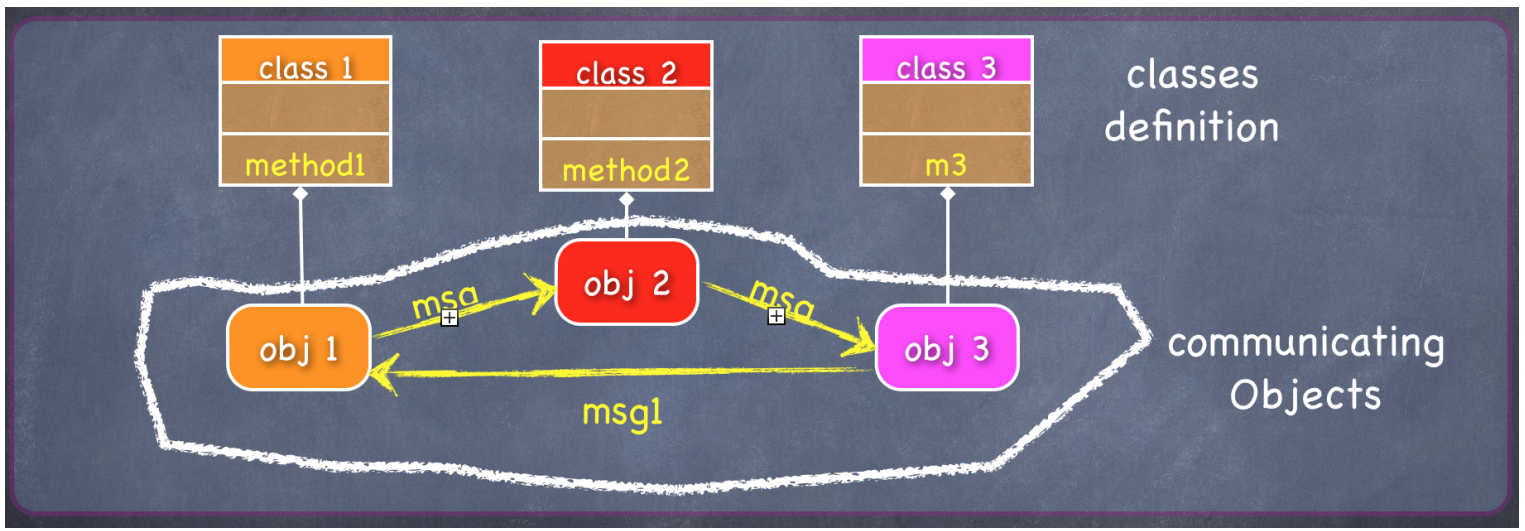
- defines the attributes representing the state of objects
- defines the methods representing the behaviour of objects

several objects can be instantiated from a given class

What an Object-Oriented program looks like?

an Object-Oriented program consists of:

- a collection of classes definitions
- a collection of objects' instances



computation: instantiated objects perform the desired computation by invoking each other methods (i.e. by exchanging messages)

Outline

Classes in Python

- Class: bundle together *data* and *functionalities*
  - defining a Class defines a *new data type* allowing new *instances* (objects) of that data type to be made

- Object: Objects are an encapsulation of variables and functions into a single entity.
  - Objects get their variables and functions from classes.

Class definition syntax

in Python a class definition looks like this:

```
class ClassName:
    <statement-1>
    .
    .
    .
    <statement-N>
```

Example:

```
class MyClass:
    # this is a comment
    """A simple example class"""

    # this is an attribute
    i = 12345

    # this is a method
    def f(self):
        return 'hello world'
```

defines a class called `MyClass` with one attribute named `i` and one function named `f`

Object instantiation

```
class MyClass:
    i = 12345

    def f(self):
        return 'hello world'
```

instantiation of an object of a class: uses *function call notation*

```
myobject = MyClass() #
```

`myobject` is an object of type `MyClass`

Accessing object's variables and functions

To access a variable or a function of an object you use the . operator

```
class MyClass:
    i = 12345

    def f(self):
        print('hello world')

myobject = MyClass()
print(myobject.i) # access the attribute 'i' of 'myobject' prints 12345
myobject.f(); # execute function f() of 'myobject' hence prints "hello world"
```

Instanciating several objects of a class

You can create as many objects as you want of a given class

```
class MyClass:
    i = 12345

    def f(self):
        print('hello world')

myobject1 = MyClass()
myobject2 = MyClass()
myobject2 = 1;
print(myobject1.i) # access the attribute 'i' of 'myobject1' prints 12345
print(myobject2.i) # access the attribute 'i' of 'myobject2' prints 1
```

Object's initialisation: the `__init__()` function

All classes have a function called `__init__()`, which is always executed when the class is being initiated.

`__init__()` function is used to assign values to object'a attributes and perform operations necessary when the object is being created:

```
class Person:
  def __init__(self, name, age):
    self.name = name
    self.age = age

p1 = Person("John", 36) # create a Person object with name "John" and age 36

print(p1.name)
print(p1.age)
```

Remark: the `__init__()` function is automatically called whenever an object is createtd

The `self` parameter (of a class method)

Every method defined in a class must have at least one parameter (which refers to the object of the class)

such parameter is normally denoted `self` and MUST BE the first parameter of a method

```
class Person:
  def __init__(self, name, age): # 'self' is used to refer to the 'name' and 'age' of the object being created
    self.name = name
    self.age = age

  def myfunc(abc): # in this case 'abc' is used in place of 'self'
    print("Hello my name is " + abc.name)

p1 = Person("John", 36) # create a Person object with name "John" and age 36
p1.myfunc()
```

Remark: the `__init__()` function is automatically called whenever an object is createtd

Inheritance: parent-class and child-class

Inheritance allows to define a class as a child-class of a parent-class

- **Parent-class**: the class being inherited from,
- **Child-class**: the class that inherits from another class

To create a class that inherits the functionality from another class, send the parent class as a parameter when creating the child class

```
class Student(Person): # Student is a child-class of Person
  def __init__(self, name, age): # this __init__ overrides the __init__ in Person
    self.name = name
    self.age = age
```

Remark: the `__init__()` in the child-class overrides that in the parent class

when you create a `Student` object the `__init__()` in `Student` is executed not that in `Person`

The super() function (inheriting from parent)

super() allows to accessing inherited methods that have been overridden in a class.

commonly used in child-class __init__() to delegate to the parent-class the initialisation of inherited attributes

```
class Person:
  def __init__(self, fname, lname):
    self.firstname = fname # the first name of a person
    self.lastname = lname # the last name of a person

  def printname(self):
    print(self.firstname, self.lastname) # prints the person's first and last name

class Student(Person):
  def __init__(self, fname, lname, year): #overrides the __init__ of Person
    super().__init__(fname, lname) # call __init__ of Person to initialise first and last name of Student
    self.graduationyear = year # year of graduation

  def welcome(self): # print a welcome message for a Student
    print("Welcome", self.firstname, self.lastname, "to the class of", self.graduationyear)

x = Student("Mike", "Olsen", 2019) # create a Student object
x.welcome() # print welcome message for Student x
```

Class versus instance variables

Instance variables: used for data unique to each instance object

Class variables: used for attributes and methods shared by all instances of the class:

```
class Dog:
    kind = 'canine' # class variable shared by all instances

    def __init__(self, name):
        self.name = name # instance variable unique to each instance

d = Dog('Fido') # create a dog
e = Dog('Buddy') # create a dog
print(d.kind) # prints 'canine' which is shared by all dogs
print(e.kind) # prints 'canine' which is shared by all dogs
print(d.name) # prints 'Fido' which is unique to d
print(e.name) # prints 'Buddy' which is unique to e
```