Introduction to OOP
Objects and classes

Course: Object Oriented Programming (OOP)

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Contents

- Brief history of OOP
- Motivation for OOP
- Objects and classes

What do we already know about OOP?

- Object oriented programming is a programming paradigm
- Objects, attributes and methods are the key elements in object oriented programming.

What we already know about functions?

A function is a set of instructions or procedures to perform a specific task.

Object functions are called methods.

What do we already know about memory management?

Memory management is a form of resource management applied to computer memory.

We recognize:

- Automatic memory management
- Manual memory management

What do we already know about paradigms?

Procedural - states and variables are mainly in global scope

Functional - stateless, immutable variables

Object oriented - many scopes, data are stored in objects

There are many others.

Procedural paradigm example

```
x = 5
x += 1
x *= 2
print(x)
```

Functional paradigm example

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

def add_one(x):
    return x + 1

print(multiply_by_two(add_one(5)))
```

Brief history of OOP

OOP history

- Terminology invoking "objects" and "oriented" in the sense of OOP made its first appearance at MIT in the late 1950s and early 1960s.
- In the 1970s, the first version of the Smalltalk programming language was developed.
- In 1986, the Association for Computing Machinery organised the first Conference on Object-Oriented Programming, Systems, Languages, and Applications (OOPSLA), which was unexpectedly attended by 1,000 people.

OOP history

- In the mid-1980s Objective-C was developed by Brad Cox and Bjarne Stroustrup
- In the early and mid-1990s object-oriented programming developed as the dominant programming paradigm
- Object-oriented features have been added to many previously existing languages, including Ada, BASIC, Fortran, Pascal, and COBOL.

OOP history

- Probably the most commercially important recent object-oriented languages are Java, C#, C++ and Visual Basic.NET (VB.NET).
- A number of languages have emerged that are primarily object-oriented (Python, Ruby, etc.).

Motivation for OOP

OOP motivation

- Save time and code
- Save even more time and code
- Work on abstract level
- Allow to start and test in broad scope and work on details later
- Simplification of massive projects

Basic concepts of OOP

- Encapsulation
- Inheritance
- Polymorphism
- Abstraction

Basic concepts - Encapsulation

- Encapsulation refers to the bundling of data with the methods that operate on that data, or the restricting of direct access to some of an object's components.
- In most of the OOP languages, you can specify **private**, **protected** and **public** properties of an object.

Basic concepts - Inheritance

- Inheritance is concept of creating subclass from parent class in order to re-use some or all features of the parent class.
- It is basically a code sharing among classes.

Basic concepts - Polymorphism

- Polymorphism is the provision of a single interface to entities of different types.
- In other words, similar objects have similar properties. So they can be interchangeable.

Basic concepts - Abstraction

- Abstraction is concept of hiding unnecessary details to allow focus on a greater picture.
- Abstraction is related to generalization (using same/similar concepts to handle different objects etc.)

Objects and classes

Basic building blocks in OOP

- **Classes**
- **Objects** (instances of classes)
- **Methods** (functions, procedures)
- **Attributes** (fields, variables, or properties)

Class vs object vs instance

Class - template (blueprint) for objects

Object / instance - item created according to a class

Programmer writes code for classes, program creates instances and use them.

Object and instance are not totally the same, but in our scope we can interchange them freely.

Example: Class vs object

```
class ExampleClass:
    pass

example_instance1 = ExampleClass()
example_instance2 = ExampleClass()
```

OOP features common with other paradigms

- Variables - also know: parameters, references, attributes, …
- Procedures - functions, methods, …
- Members - name commonly used for class/object variables and/or methods

Access modifiers

- **Public** - Accessible everywhere.
- **Private** - Accessible only within the defining class
- **Protected** - Accessible within the defining class and its derived subclasses.

This terminology is slightly language specific.

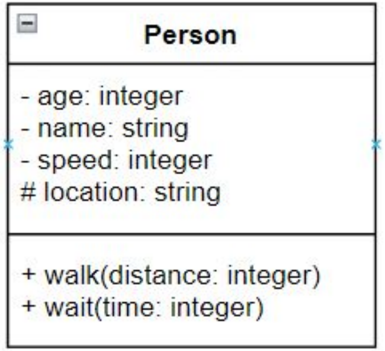
Example of access modifiers

All person related properties and functions are bundled in **Person class**

Private (**-** in UML)

Public (**+** in UML)

Protected (**#** in UML)



Person

- age: integer
- name: string
- speed: integer
location: string

+ walk(distance: integer)
+ wait(time: integer)

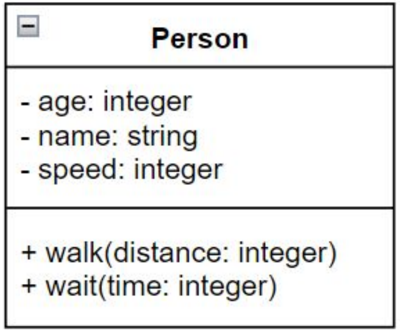
Types of attributes

- **Class attributes (static property)** – belong to the class as a whole; there is only one copy of each one
- **Instance attributes** – data that belongs to individual objects; every object has its own copy of each one

Example of instance properties

Class can have multiple properties - attributes common for all instances. Imagine multiple instances of the Person class:

	age	speed	name
Instance1	56	4.8	Alice
Instance2	28	2.6	Bob



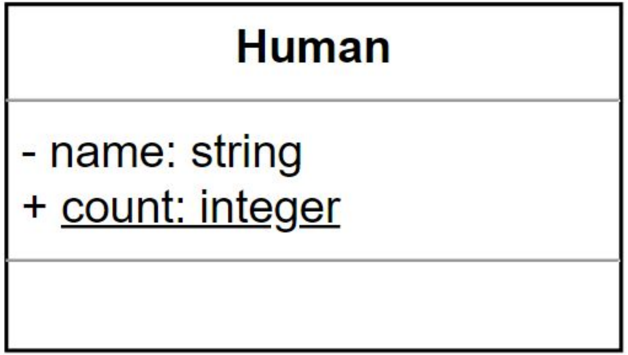
Person

- age: integer
- name: string
- speed: integer

+ walk(distance: integer)
+ wait(time: integer)

Class vs instance properties

- Instance properties are properties with individual values for instances.
- Class properties (**static properties**) are properties with values common for all instances.



Human

- name: string
+ count: integer

Methods

- **Class methods** – belong to the class as a whole and have access to only class variables and inputs
- **Instance methods** – belong to individual objects, and have access to instance variables for the specific object they are called on, inputs, and class variables
- **Static methods** – methods without access to class or instance variables

Note: it is language specific and quite confusing.

Example of methods

```
class Example:
    def method(self, x):
        self.x = x
        Example.x = x

    @classmethod
    def classmethod(cls, x):
        cls.x = x

    @staticmethod
    def staticmethod(x):
        x = x
```

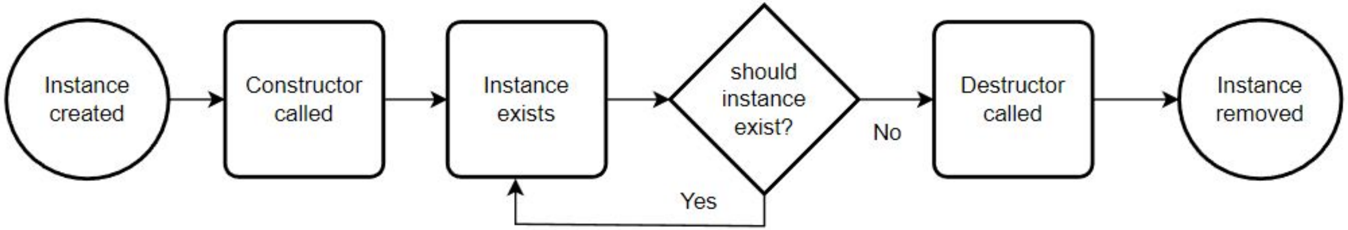
Constructor, destructor

- **Constructor** - this method is called during creation of an instance. Commonly used to prepopulate class attributes with provided inputs.
- **Destructor** - this method is called during destruction of an instance. This method should clean the instance from memory.

Constructor, destructor and garbage collector

The **garbage collector** attempts to reclaim memory which was allocated by the program, but is no longer referenced.

Some languages prefer **manual memory management**.



Constructor and destructor example

```
class Human():

    def __init__(self, name):
        self.name = name
        print(self.name, ": I am alive!")

    def __del__(self):
        print(self.name, ": Now it is over")

a = Human("A")
b = Human("B")
b = False
```

Resulting output:

```
A : I am alive!
B : I am alive!
B : Now it is over
A : Now it is over
```

Example: class property

```
class Human:
    count = 0
    def __init__(self):
        Human.count += 1
    def __del__(self):
        Human.count -= 1

print(Human.count)
humans = [Human() for _ in range(10)]
print(Human.count)
humans = None
print(Human.count)
```

Resulting output:

```
0

10

0
```

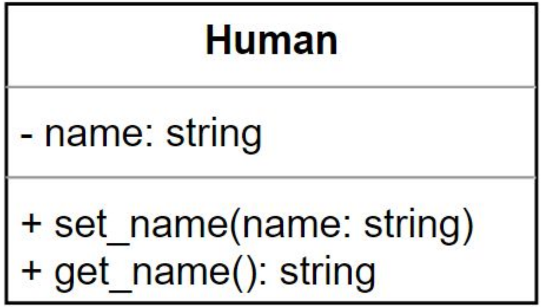
Magic methods

Magic methods are special methods. Implementation vary according to the language. In general:

- They have specific reserved namespace.
- These methods are often called when some conditions are met.
- Prime example is constructor and destructor.

Getter and setter methods

- Methods designed to get and set a property of an object.
- Setter can provide additional validation of the new value.



Human

- name: string

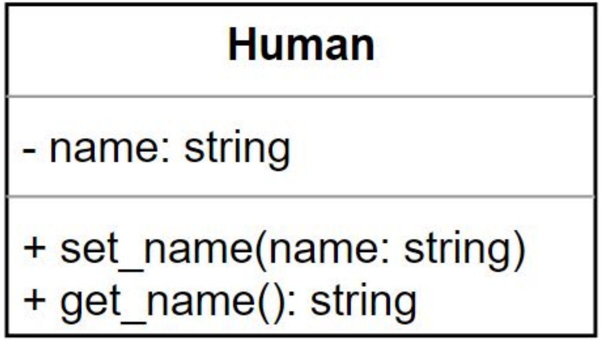
+ set_name(name: string)
+ get_name(): string

Getter and setter: simple example

```
class Human:
    def __init__(self, name):
        self._name = name

    def get_name(self):
        return self._name

    def set_name(self, value):
        self._name = value
```



Human

- name: string

+ set_name(name: string)
+ get_name(): string

Bonus content

Some magic methods in Python

__len__: length (list, string, etc.)

__abs__: absolute values (numbers, etc.)

__add__ : + operator

__str__: string representation of the object

__ge__, __le__: greater than or equal, less than or equal (>=, <=)

Magic Methods in Python

Use dir() function to see members of an object:

```
>> dir(5)
['__abs__', '__add__', '__and__', '__bool__', '__ceil__', '__class__',
'__delattr__', '__dir__', '__divmod__', '__doc__', '__eq__', '__float__',
'__floor__', '__floordiv__', '__format__', '__ge__', '__getattribute__',
'__getnewargs__', '__gt__', '__hash__', '__index__', '__init__',
'__init_subclass__', '__int__', '__invert__', '__le__', '__lshift__', '__lt__',
'__mod__', '__mul__', '__ne__', '__neg__', '__new__', '__or__', '__pos__',
'__pow__', '__radd__', '__rand__', '__rdivmod__', '__reduce__', '__reduce_ex__',
'__repr__', '__rfloordiv__', '__rlshift__', '__rmod__', '__rmul__', '__ror__',
'__round__', '__rpow__', '__rrshift__', '__rshift__', '__rsub__', '__rtruediv__',
'__rxor__', '__setattr__', '__sizeof__', '__str__', '__sub__', '__subclasshook__',
'__truediv__', '__trunc__', '__xor__', 'as_integer_ratio', 'bit_length',
'conjugate', 'denominator', 'from_bytes', 'imag', 'numerator', 'real', 'to_bytes']
```