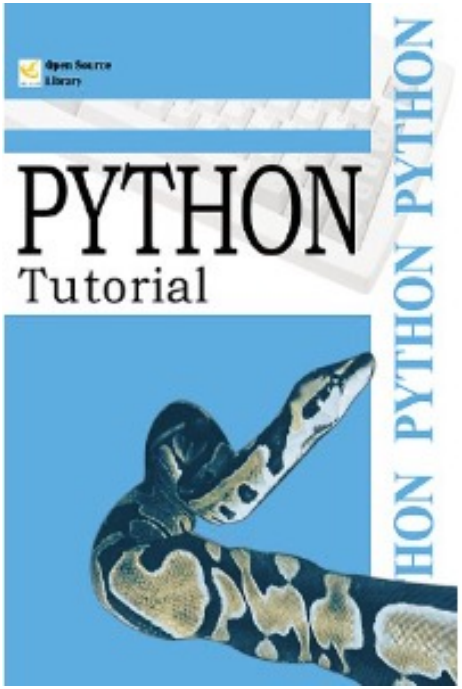
# Object Oriented Programming

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# Objectives

## Specific Objectives

- Overview of main programming paradigms
- Understand the Object Oriented concepts

## Source

- https://docs.python.org/3.10/tutorial/appetite.html
- https://python-textbok.readthedocs.io/en/1.0/index.html
- Python Tutorial - GuidoVan Rossum (2012)

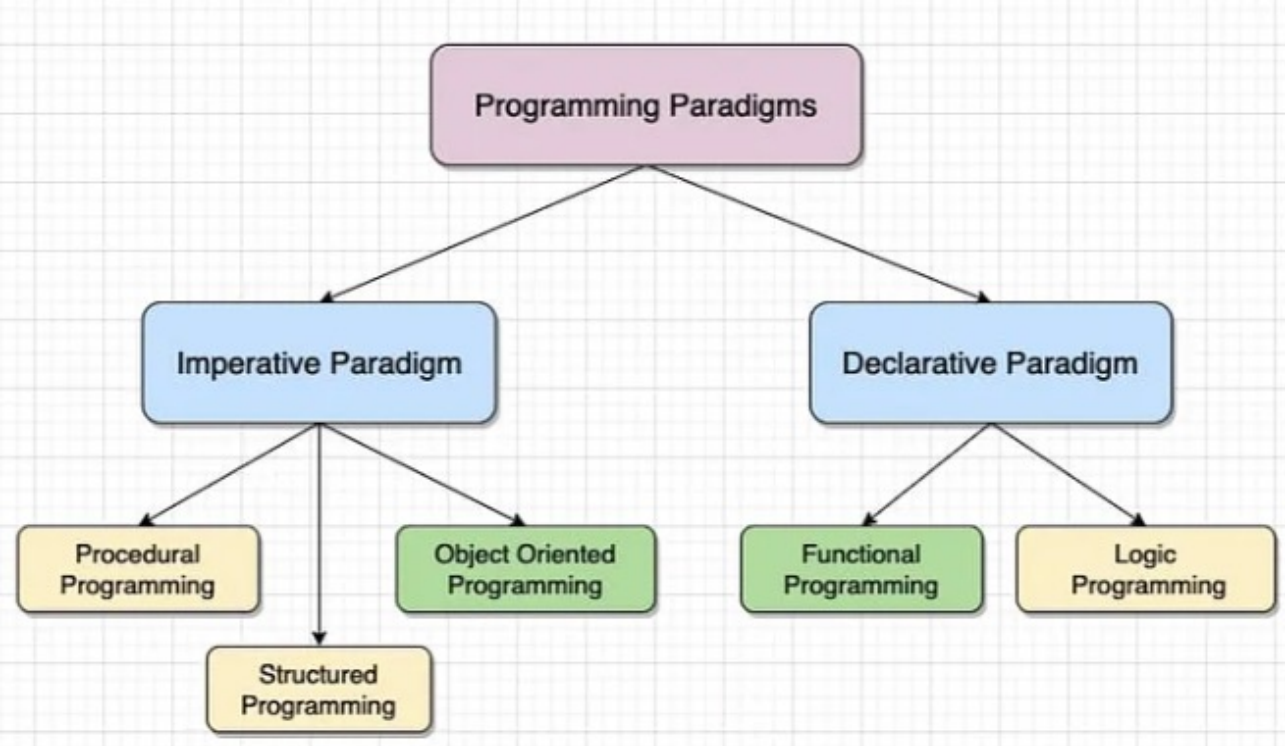
# Outline

- Introduction
- Basic Principles of OOP
- Benefits of OOP

# Introduction

- Programming is the process of creating a set of instructions that tell a computer how to perform a task
  - Purpose: to solve problems or perform specific tasks through automation
  - Components: code, algorithms, data structures, and logic
- A programming language is a formal language comprising a set of instructions that produce various kinds of output
  - Purpose: to communicate instructions to a computer
  - Examples: Python, Java, C++, JavaScript, Ruby
- A paradigm is a style or way of programming
  - Purpose: to provide a methodology for solving problems using programming languages
  - Types: different paradigms offer different ways to structure and organize code

# Programming paradigms



# Programming paradigms

- Imperative : focuses on how to perform tasks
  - Procedural: the program is built from procedures or functions. It uses a modular approach, where the program is divided into small functions e.g. C, Pascal, Python
  - Structural: emphasizes the use of blocks, structured control flow constructs like loops and conditionals e.g. Ada, C
  - Object-Oriented: organizes code around objects and their interactions, e.g. C++, Python
  - Others: Event-Driven, Concurrent, Reactive…
- Declarative: focuses on what the program should accomplish, without explicitly specifying how to achieve the result e.g. SQL, HTML
  - Functional Paradigm: treats computation as the evaluation of functions, e.g. Lisp, Python
  - Logic Paradigm: uses logic statements to express computation, e.g. Prolog

# Advantages (I)

1. **Reusability**: ability to use existing software components in new applications without significant modification
   - Impact: promotes efficient development practices by leveraging pre-existing code, reducing duplication, and ensuring consistency across projects
   - E,g: libraries and frameworks that provide reusable components for common functionalities
2. **Extensibility**: the ease with which a software system can be expanded and enhanced with new capabilities
   - Impact: ensures that the software can evolve over time, accommodating new requirements and technologies without extensive rewrites
   - E.g: plugin architectures and modular design patterns that allow for easy addition of new features

# Advantages (II)

- **Maintainability**: the effort required to identify and fix defects, update functionalities, and improve performance
  - Impact: reduces long-term costs associated with software maintenance by facilitating easier updates and enhancements
  - E.g.: well-documented code and adherence to coding standards that make it easier for new developers to understand and work on the project
- **Usability**: the degree to which Sw can be used by specified consumers to achieve quantified objectives with effectiveness, efficiency, and satisfaction
  - Impact: increases user adoption and satisfaction by providing intuitive and accessible interfaces
  - E.g.: user interface design principles that focus on user-centric design and usability testing

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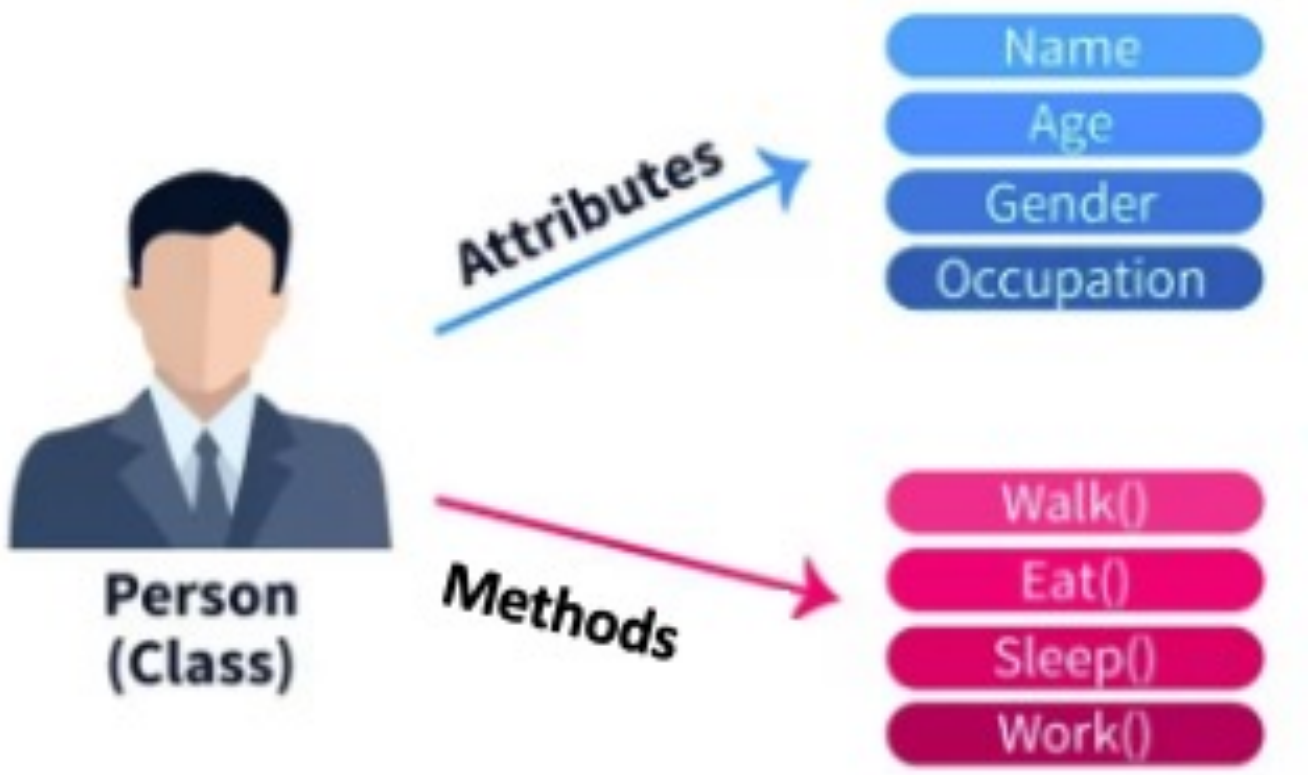
- **Basic Principles of OOP**
  - Classes and Objects
  - Encapsulation
  - Inheritance
  - Polymorphism
  - Abstraction
- Benefits of OOP

# Class

- Is a blueprint or template that defines the structure and behavior (data and methods) that the objects of the class will have
- Is used to describe something in the world, such as occurrences, things, external entities, etc
- Is a collection of objects
- Once a class is declared, the programmer can create any number of objects of that class
- Defines properties and behavior of objects
- A user-defined datatype that behaves the same as the built-in datatypes

# Class

Features that determine the qualities of an object

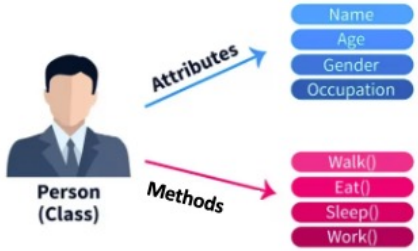


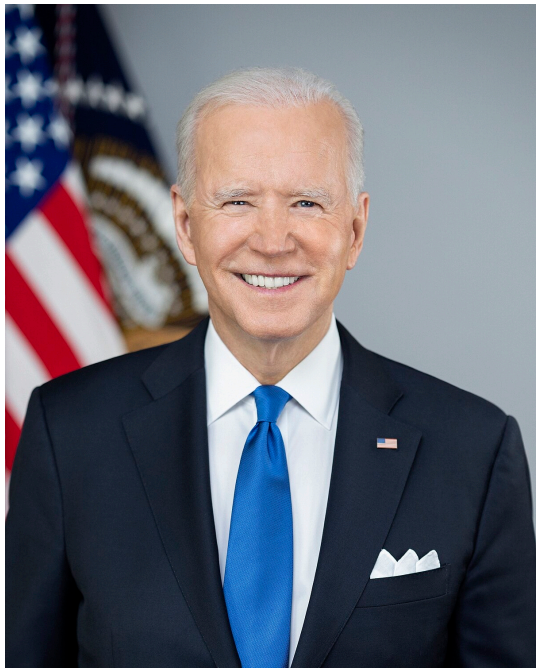

Functions that perform operations

# Object

- Is an instance of a class
- Every object contains some data and function(s) (called methods)
- These methods store data in variables and respond to the messages that they receive from other objects by executing their methods
- While a class is a logical structure, an object is a physical entity
- It is created from a class and can use the class's methods and properties

# Objects


Name
Age
Gender
Occupation
Attributes
Person
(Class)
Methods
Walk()
Eat()
Sleep()
Work()



# Summary

| Class | Object |
| --- | --- |
| A class is a template for declaring and creating objects | An object is a class instance that allows programmers to use variables and methods from inside the class |
| Memory is not allocated to classes. Classes have no physical existence | When objects are created, memory is allocated to them in the heap memory |
| You can declare a class only once | A class can be used to create many objects |
| A class is a logical entity | An object is a physical entity |
| We cannot manipulate a class as it is not available in memory | Objects can be manipulated |
| Classes can have attributes and methods defined | Objects can have specific values assigned to their attributes |

# Example

## Class

```
class Person:
    def __init__(self, name, age, gender, occupation):
        self._name = name
        self._age = age
        self._gender = gender
        self._occupation = occupation

    def get_name(self):
        return self._name

    def walk(self):
        ...

   ...
```

# Access Rules

- Method Execution and Access
  - A method is always executed for an object of its class
  - A method can access (invoke) all other members (attributes and methods) of its class
- Object Invocation
  - An object of a class can only invoke methods of its class
  - It can only respond to the messages for which it has been programmed

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# Encapsulation (I)

- Wrapping data (variables) and code (methods) together as a single unit
- Purpose is to protect the data from unauthorized access and modification

# Encapsulation (II)

- It defines three access levels:
  1. Public: any data or method can be accessed by any method belonging to any class. This is the lowest level of data protection
  2. Protected: any data or method can be accessed only by that class or by any class that is inherited from it
  3. Private: any data or method can be accessed only by that class in which it is declared. This is the highest level of data protection

# Example

## Encapsulation

```
class Person:

   def __init__(self, name):

      self.__name = name # private attribute

   def get_name(self):

      return self.__name # Public method

persona = Person("Luis")

print(persona.get_name()) # Correct

print(persona.__name) # Error: private attribute
```

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# Inheritance

- A mechanism where a new class (*child class*) inherits the properties and behaviors of an existing class (*super class*)
- Purpose is to promote code reuse
- Allows the use and adaptation of the attributes and methods of the parent class to the child class
- Types of inheritance (both supported by Python)
  - Single: if the child class inherits from a single class
  - Multiple:  if the child class inherits from more classes (and others combinations)
- When we need to adapt an inheritanced method →Overriding

# Example

## Inheritance

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

    def speak(self):
        pass

class Dog(Animal):
    def speak(self):
        return 'Woof!'

class Cat(Animal):
    def speak(self):
        return 'Meow!'
...
```

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# Polymorphism

- The ability of different classes to respond to the same method call in different ways
- Purpose is to allow for methods to be used interchangeably among different classes
- Python does not support “method overloading” like other languages
- It does allow overriding methods in derived classes

# Example

## Polymorphism

```
def make_animal_speak(animal):
    print(animal.speak())

dog = Dog('Rex')
cat = Cat('Whiskers')

make_animal_speak(dog)   # Output: Woof!
make_animal_speak(cat)   # Output: Meow!
```

# Example

## Overloading a method: Not in Python

```
class Ejemplo:

    def metodo(self, x):

        return x

    def metodo(self, x, y):  # This method hides previous method

        return x + y

# Second method replaces the first

metodo = Ejemplo().metodo(2,3)

# metodo = Ejemplo().metodo(23) #Error

print(metodo)
```

# Example

## Example: overriding method

```
class Animal:

    def speak(self):

        return "Some generic sound"

class Dog(Animal):

    def speak(self):

        return ”Guau!"



my_dog = Dog()

print(my_dog.speak())  # Output: Guau!
```

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# Abstraction

- The concept of hiding the complex implementation details and showing only the necessary features
- Purpose is to reduce complexity and increase efficiency

# Example

## Abstraction

```
from abc import ABC, abstractmethod

class Shape(ABC):
    @abstractmethod
    def area(self):
        pass

class Rectangle(Shape):
    def __init__(self, width, height):
        self.width = width
        self.height = height

    def area(self):
        return self.width * self.height
```

# Outline

- Introduction
- Basic Principles of OOP
- **Benefits of OOP**

# Benefits of OOP

- Modularity: code is organized into distinct classes
- Reusability: use existing code through inheritance
- Pluggability and Debugging Ease: replaceable components and easier debugging
- Maintainability: easier to manage and update code