

Getting Started with Object-Oriented Programming in Python

Guest Lectures at TTK University of Applied Sciences, Tallinn, Estonia

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Andy Louwyck & Dominique Stove

Vives University of Applied Sciences, Kortrijk, Belgium

Who's Teaching Today?

Andy Louwyck

- Master and Doctor in Science: Geology
- Associate Degree in Programming
- Micro Degree in AI & Data Science
- Lecturer in IT at Vives University of Applied Sciences
- AI Coordinator at Flanders Environment Agency

Dominique Stove

- Master in Applied Economics
- Teaching Master's Degree in Economics, Mathematics, and Physics
- Lecturer in IT at Vives University of Applied Sciences
- IT Consultant in Infrastructure
- Founder and Business Owner of IqPro



Vives Campus in the City of Kortrijk



Informatics Program for Exchange Students



<https://www.vives.be/en/commercial-sciences-business-management-and-informatics/informatics-kortrijk>

The Informatics-programme is a programme consisting of lectures, group work, visits and projects in the field of Business and Informatics. Evaluation follows the rules of the European Credit Transfer System (ECTS). Incoming students can select a programme of up to 30 ECTS credits per semester.

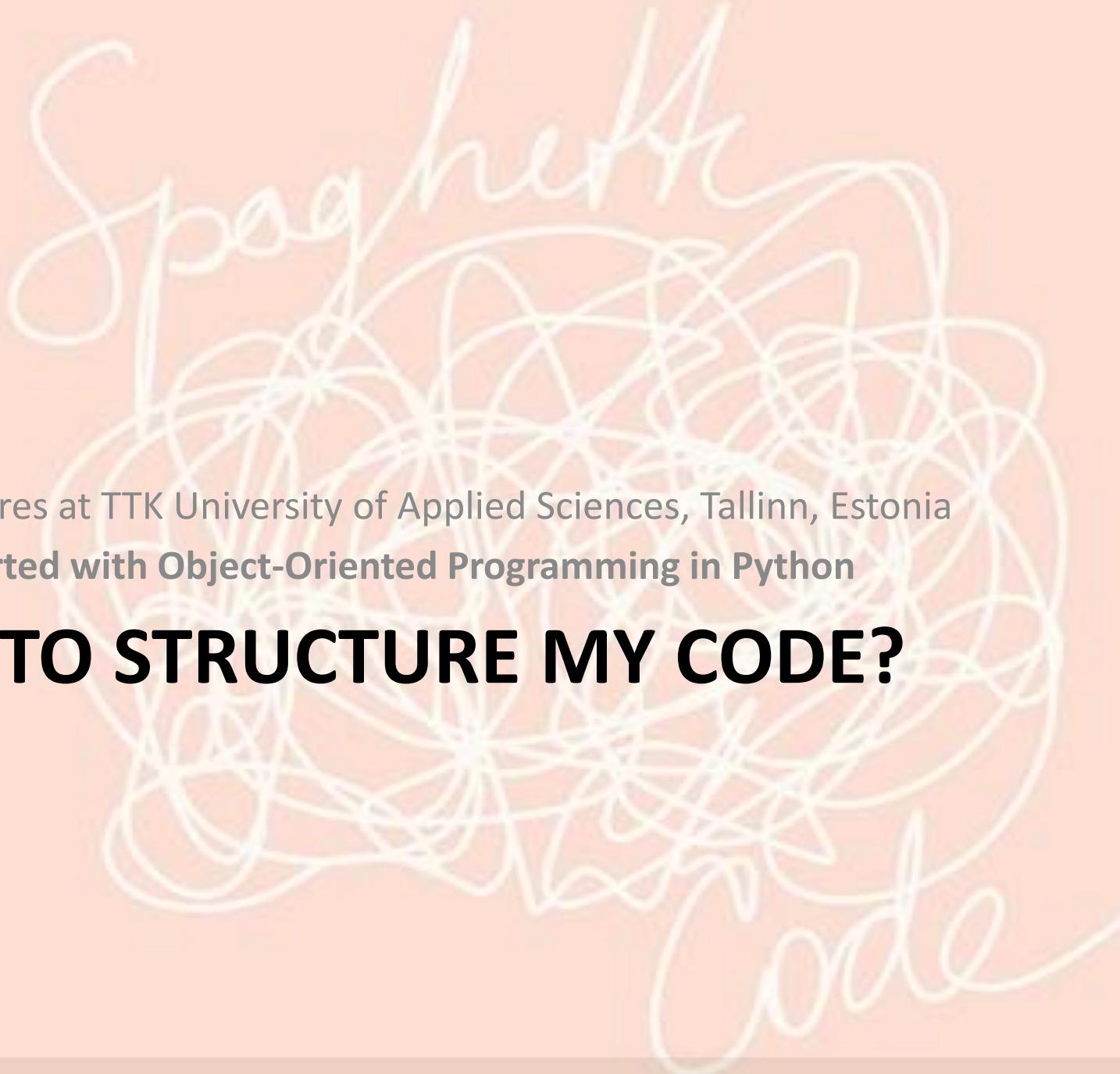
New full-year program!

Title	ECTS	hours/week S1	hours/week S2	Semester
Introduction to Artificial Intelligence	5	3	0	1
Programming in Python	3	2	0	1
Digital Workplace	3	2	0	1
Android App Development	5	3	0	1
E-business en E-marketing	3	2	0	1
Introduction to linux	3	2	0	1
Cybersecurity	5	3	0	1
Professional and International Communication 3 (English)	3	2	0	1
	30	19	0	
Machine Learning - Fundamentals	6	0	4	2
IT-Project	5	0	3	2
Power Tools	3	0	3	2
Full-Stack Development in .NET	6	0	4	2
Mobile App Development iOS	5	0	4	2
Data Engineering	5	0	3	2
Node.js Development	3	0	2	2
	33	0	23	

Let's Dive In!

1. Introduction: how to structure code?
2. What is object-oriented programming (OOP)?
3. From theory to code: OOP in Python
4. Demo + exercises





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Getting Started with Object-Oriented Programming in Python

HOW TO STRUCTURE MY CODE?

Which code would you write?

Approach 1

```
1 print(3.14159 * 5 * 2)  
2
```

Approach 2

```
1 def calculate_area(radius):  
2     pi = 3.14159  
3     area = pi * radius ** 2  
4     return area  
5  
6 print(calculate_area(5))
```

Which code would you write?

Approach 1

Pros:

- Very short and simple
- Quick for one-time use

Cons:

- Hard to reuse
- No clear structure
- Difficult to maintain

Approach 2

Pros:

- Code is reusable
- Better structure
- Easier to maintain and extend
- Hides details by using local variables

Cons:

- Slightly more code
- Requires understanding functions

What do you think of this object-oriented version?

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

What do you think of this object-oriented version?

Pros

- Well structured
- Groups data and behavior in one place
- Keeps related details together
- Easy to reuse for many circles
- Easy to maintain
- Easy to extend (e.g. add perimeter)

Cons

- More code than a simple function
- Adds an extra concept: classes and objects
- Slightly harder for beginners to read
- Overkill for very small scripts

Components in this OO example

class definition

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159
```

constructor

attributes

method

self refers to the created object

```
6     def area(self):  
7         return self.pi * (self.radius ** 2)
```

8

```
9  
10    c = Circle(5)
```

object instantiation

```
11    print(c.area())
```

method call

Class definition — class Circle:

The blueprint that groups related **data** and **behavior**.

class definition

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

Constructor (`__init__`) — `def __init__(self, radius):`

Runs when you create an object; **initializes** the object's state.

```
1 class Circle:  
2     def __init__(self, radius):  
3         self.radius = radius  
4         self.pi = 3.14159  
5  
6     def area(self):  
7         return self.pi * (self.radius ** 2)  
8  
9  
10    c = Circle(5)  
11    print(c.area())
```

constructor

Instantiation — `c = Circle(5)`

Creates a new object (an instance of `Circle`).

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5) ← object instantiation  
11    print(c.area())
```

self (the object itself)

Refers to the current instance; used to access attributes and methods.

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

self refers to the created object

Attributes — `self.radius`, `self.pi`

Data stored inside each object (the object's state).

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

attributes

Method — def area(self):

Behavior that uses the object's data to compute a result.

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     method → def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

Method call (dot notation) — c.area()

Invokes the object's behavior; returns the computed area.

```
1 class Circle:  
2  
3     def __init__(self, radius):  
4         self.radius = radius  
5         self.pi = 3.14159  
6  
7     def area(self):  
8         return self.pi * (self.radius ** 2)  
9  
10    c = Circle(5)  
11    print(c.area())
```

method call

Circles also know their perimeter!

```
1  class Circle:  
2  
3      def __init__(self, radius):  
4          self.radius = radius  
5          self.pi = 3.14159  
6  
7      def area(self):  
8          return self.pi * (self.radius ** 2)  
9  
10     def perimeter(self):  
11         return 2 * self.pi * self.radius  
12  
13 c = Circle(5)  
14 print(c.area())  
15 print(c.perimeter())
```

methods

method calls

```
graph LR; subgraph MethodsBox [methods]; direction TB; M1[def __init__] --> M2[def perimeter]; end; subgraph MethodCallsBox [method calls]; direction TB; C1[print(c.area())] --> C2[print(c.perimeter())]; end;
```

Which code do you prefer?

Procedural programming

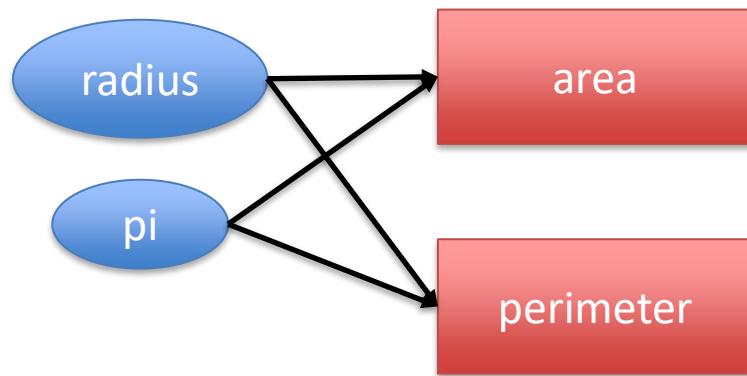
```
1 pi = 3.14159
2
3 def area(radius):
4     return pi * (radius ** 2)
5
6 def perimeter(radius):
7     return 2 * pi * radius
8
9 radius = 5
10 print(area(radius))
11 print(perimeter(radius))
```

Object-oriented programming (OOP)

```
1 class Circle:
2
3     def __init__(self, radius):
4         self.radius = radius
5         self.pi = 3.14159
6
7     def area(self):
8         return self.pi * (self.radius ** 2)
9
10    def perimeter(self):
11        return 2 * self.pi * self.radius
12
13 c = Circle(5)
14 print(c.area())
15 print(c.perimeter())
```

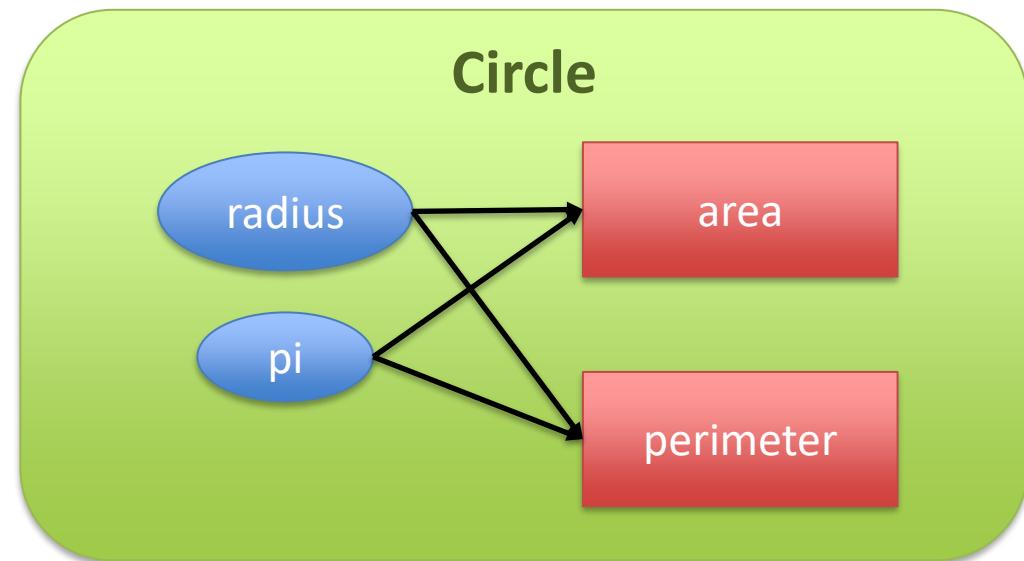
Which code do you prefer?

Procedural programming



Variables (data) and functions (behavior) are separate; they are **not bundled** into a single structure

Object-oriented programming (OOP)



A **class** that **encapsulates** both **variables (data)** and **functions (behavior)** in one single structure

Which code do you prefer?

Procedural programming

Pros:

- Simple for small scripts
- Easy to understand for beginners
- Quick to implement

Cons:

- Data and behavior are separate
- Harder to maintain when many related functions
- No clear structure for scaling

Object-oriented programming (OOP)

Pros:

- Groups data and behavior together
- Easier to reuse and extend
- Better structure for complex systems

Cons:

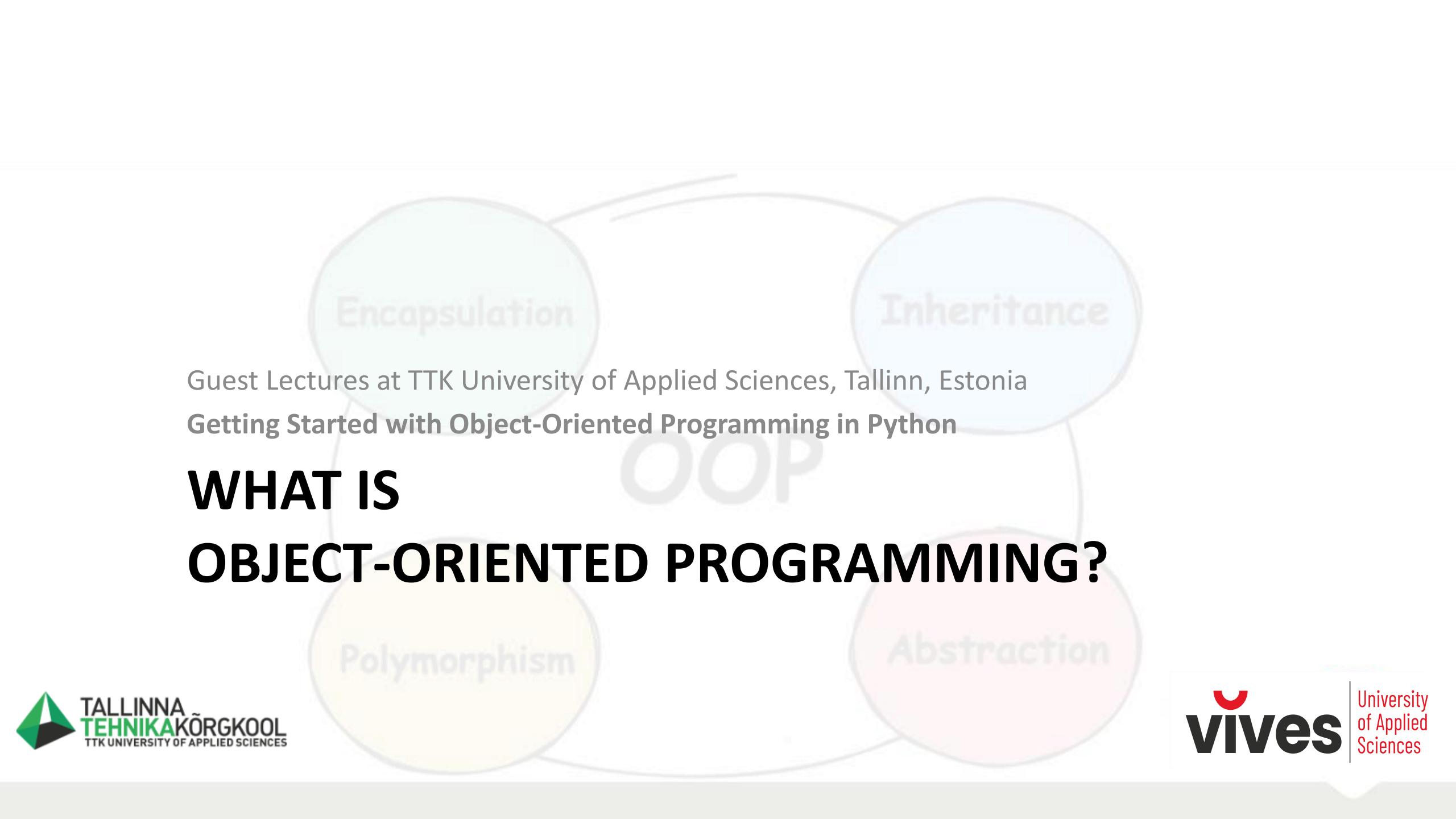
- More code for simple tasks
- Slightly more overhead
- Requires understanding of classes and objects

There is a third approach...

Besides procedural and object-oriented programming, Python also supports **functional programming** (which is beyond the scope of this lecture):

```
1 import math
2
3 radii = [2, 3.5, 5]
4
5 areas = list(map(lambda r: math.pi * (r ** 2), radii))
6 perimeters = list(map(lambda r: 2 * math.pi * r, radii))
7
8 print(areas)
9 print(perimeters)
```

“No state, just transform a list of radii into a list of areas/perimeters”

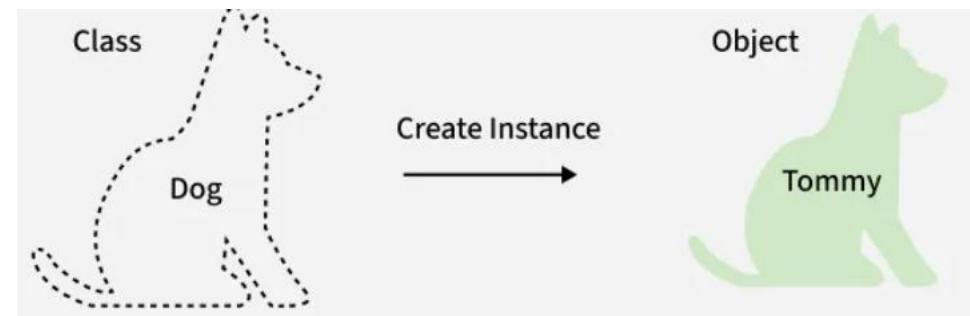


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Getting Started with Object-Oriented Programming in Python

WHAT IS OBJECT-ORIENTED PROGRAMMING?

Classes and Objects



Class

- A **blueprint** for creating objects
- Defines **attributes** and **methods**
- Example:

```
class Circle:  
    def __init__(self, radius):  
        self.radius = radius  
    def area(self):  
        return 3.14159 * (self.radius ** 2)
```

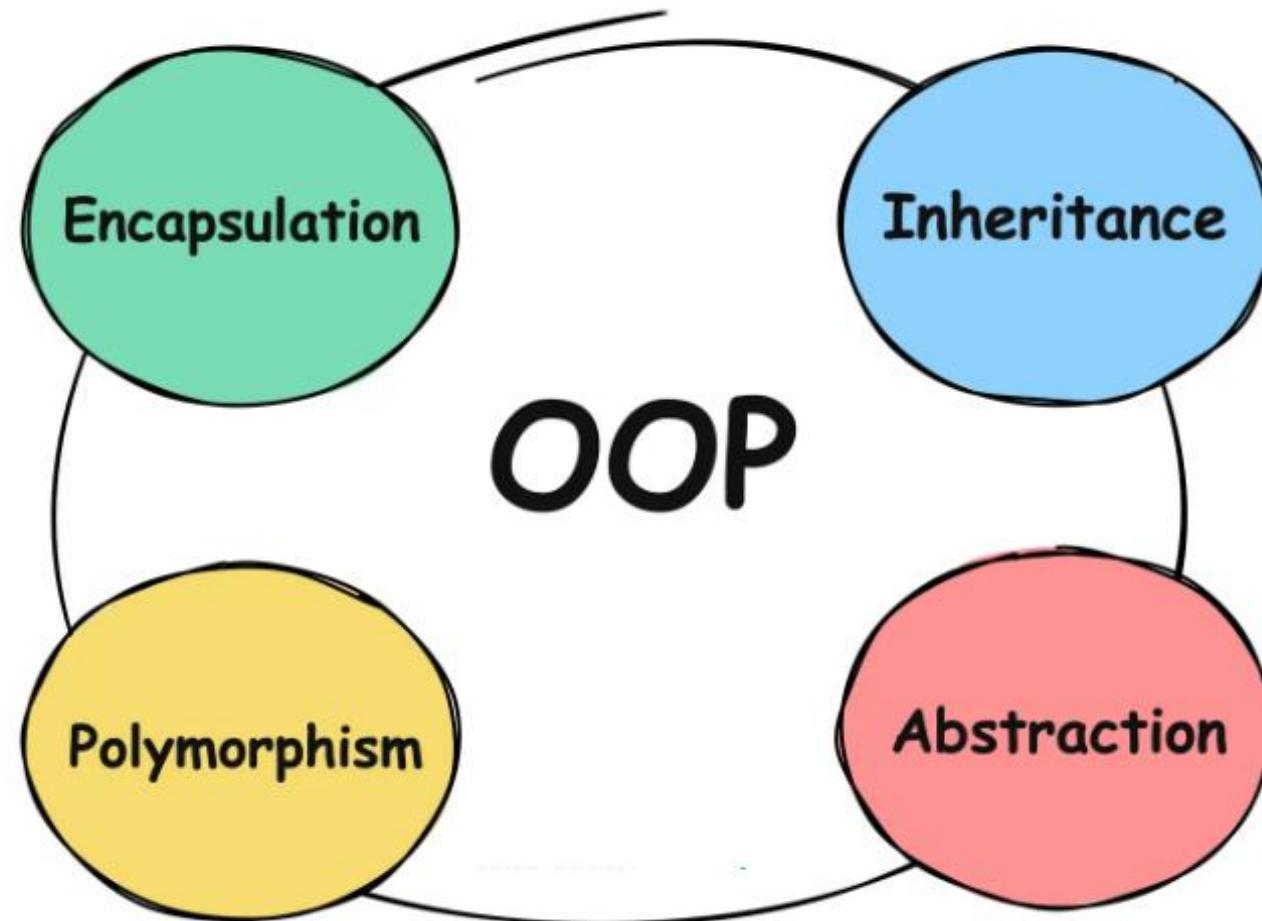
Object

- An **instance** of a class
- Has its own **state** (= attribute values)
- Example:

```
c = Circle(5)  
print(c.area())
```

"c is an object of class Circle and its state is defined by a radius of 5"

The 4 Main Features of Object-Oriented Programming



The 4 Main Features of Object-Oriented Programming

1. Encapsulation

- **Bundling data (attributes) and behavior (methods)** inside a single unit (class).
- Controls access to internal details, exposing only what's necessary.

2. Inheritance

- Creating new classes based on existing ones, **reusing and extending functionality**.
- Example: the circle class could inherit from a cilinder class and adopt the area method

3. Polymorphism

- Same interface, **different implementations**.
- Example: the area method is implemented for circle and cilinder classes each with its own logic.

4. Abstraction

- Hiding implementation details and showing only the **essential interface**.
- Example: you call the area method from a circle object without worrying about the formula

Encapsulation

Definition:

Encapsulation means bundling data and methods inside a class and restricting direct access to some attributes to protect the integrity of the data.

Example:

```
1  class BankAccount:  
2      def __init__(self, balance):  
3          self.__balance = balance # private attribute  
4  
5      def deposit(self, amount):  
6          self.__balance += amount  
7  
8      def get_balance(self):  
9          return self.__balance  
10  
11 account = BankAccount(100)  
12 account.deposit(50)  
13 print(account.get_balance()) # Output: 150
```

Inheritance

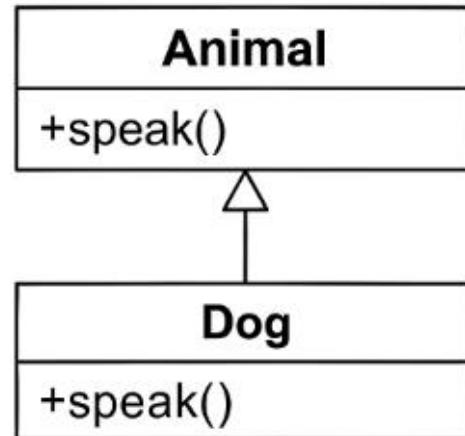
Definition:

Inheritance allows a class to acquire properties and methods from another class, promoting code reuse.

Example:

```
1  class Animal:  
2      def speak(self):  
3          print("I am an animal")  
4  
5  class Dog(Animal):  
6      def speak(self):  
7          print("Woof!")  
8  
9  dog = Dog()  
10 dog.speak() # Output: Woof!
```

UML Class Diagram



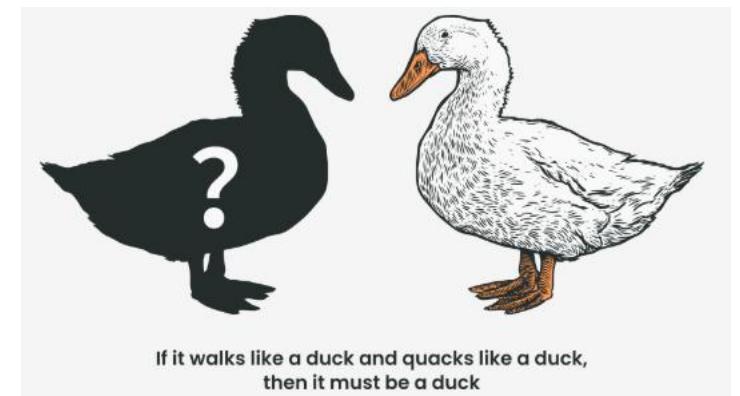
Polymorphism

Definition:

Polymorphism means the same method name can behave differently depending on the object.

Example:

```
1 class Cat:  
2     def speak(self):  
3         return "Meow"  
4  
5 class Dog:  
6     def speak(self):  
7         return "Woof"  
8  
9 def animal_sound(animal):  
10    print(animal.speak())  
11  
12 animal_sound(Cat()) # Output: Meow  
13 animal_sound(Dog()) # Output: Woof
```



Abstraction

Definition:

Abstraction hides complex implementation details and exposes only the essential features. This is often done using **abstract base classes** (which is out of scope).

Example:

```
1  from abc import ABC, abstractmethod
2
3  class Shape(ABC):
4      @abstractmethod
5      def area(self):
6          pass
7
8  class Circle(Shape):
9      def __init__(self, radius):
10         self.radius = radius
11
12     def area(self):
13         return 3.14 * self.radius ** 2
14
15 circle = Circle(5)
16 print(circle.area()) # Output: 78.5
```

Why Use Object-Oriented Programming?

- **Why OOP?**
 - Organizes code into **classes and objects**, making it easier to manage.
 - Models real-world entities, improving **readability and understanding**.
- **Key Benefits:**
 - **Reusability:** Use existing classes through inheritance.
 - **Maintainability:** Easier to update and extend code.
 - **Encapsulation:** Keeps data and behavior together, reducing complexity.
 - **Scalability:** Ideal for large applications with many interacting components.

Inheritance In Python

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FROM THEORY TO CODE: OOP IN PYTHON

Defining Classes and Creating Objects

Explanation:

In Python, classes are created using the `class` keyword.

Objects are instances of classes.

Code example:

```
1 # Define a class
2 class Car:
3     def __init__(self, brand, model):
4         self.brand = brand
5         self.model = model
6
7 # Create an object
8 my_car = Car("Tesla", "Model 3")
9 print(my_car.brand) # Output: Tesla
```

Constructor and Attributes

Explanation:

The `__init__` method acts as a constructor and initializes object attributes when an instance is created.

Code example:

```
1 class Student:  
2     def __init__(self, name, age):  
3         self.name = name  
4         self.age = age  
5  
6 student = Student("Alice", 21)  
7 print(student.name, student.age) # Output: Alice 21
```

Methods in Python Classes

Explanation:

Methods are functions that belong to a class and are defined using the `def` keyword.

- **Instance methods:** Operate on object attributes and require `self`
- **Static methods:** Don't require `self` as they don't need object attributes; use `@staticmethod`

Code example:

```
1  class Person:  
2      def __init__(self, name):  
3          self.name = name  
4  
5      def greet(self): # instance method  
6          return "Hello, my name is " + self.name  
7  
8      @staticmethod  
9      def info(): # static method  
10         return "I am a person."  
11  
12 # Usage  
13 p = Person("Alice")  
14 print(p.greet())      # Output: Hello, my name is Alice  
15 print(Person.info())  # Output: I am a person.
```

Access Modifiers

Explanation:

Python uses naming conventions for access control:

- **Public:** `self.attribute`
- **Private:** `self.__attribute`

Code example:

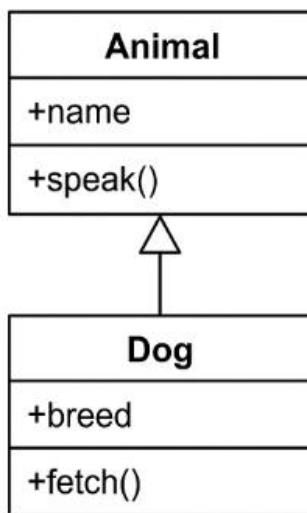
```
1  class BankAccount:  
2      def __init__(self, owner, balance):  
3          self.owner = owner          # public  
4          self.__balance = balance    # private  
5  
6      def deposit(self, amount):  
7          self.__balance += amount  
8  
9      # Usage  
10 account = BankAccount("Alice", 100)  
11 print(account.owner)          # OK  
12 # print(account.__balance)    # Error: Attribute is private  
13 account.deposit(50)
```

Inheritance

Explanation:

Inheritance allows a subclass to reuse attributes and methods from a superclass. The subclass can **add new attributes or methods** beyond what is inherited.

Code example:



```
1 # Parent class
2 class Animal:
3     def __init__(self, name):
4         self.name = name
5
6     def speak(self):
7         print(self.name + " makes a sound.")
8
9 # Child class (inherits from Animal)
10 class Dog(Animal):
11     def __init__(self, name, breed):
12         super().__init__(name) # Call parent constructor
13         self.breed = breed    # New attribute
14
15     def fetch(self):
16         print(self.name + " is fetching the ball!")
17         print("Breed: " + self.breed)
18
19 # Usage
20 dog = Dog("Buddy", "Golden Retriever")
21 dog.speak()   # Inherited method
22 dog.fetch()   # New method
```

- Use `class Child(Parent):` to inherit.
- `super().__init__()` calls the parent constructor.
- Subclass can add **extra attributes and methods**.

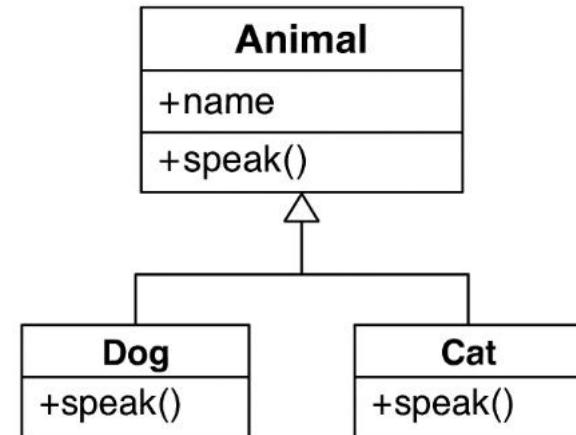
More than one subclass

Explanation:

A superclass can have **multiple subclasses**, each of which can have its own subclasses.

Code example:

```
1 # Parent class
2 class Animal:
3     def __init__(self, name):
4         self.name = name
5
6     def speak(self):
7         print(self.name + " makes a sound.")
8
9 # First child class
10 class Dog(Animal):
11     def speak(self):
12         print(self.name + " barks!")
13
14 # Second child class
15 class Cat(Animal):
16     def speak(self):
17         print(self.name + " meows!")
18
19 # Usage
20 dog = Dog("Buddy"); dog.speak() # Buddy barks!
21 cat = Cat("Whiskers"); cat.speak() # Whiskers meows!
```



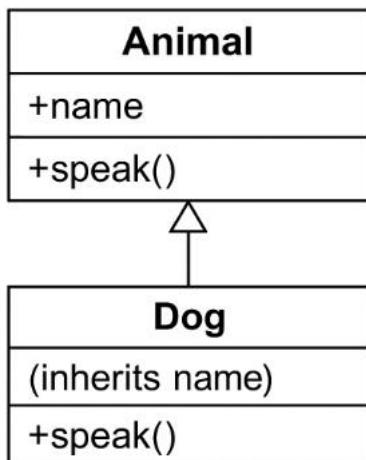
Subclasses override the speak method

Method overriding

Explanation:

A subclass can **redefine a method** from its parent class. The new method replaces the inherited one when called on the child object.

Code example:



```
1 # Parent class
2 class Animal:
3     def __init__(self, name):
4         self.name = name
5
6     def speak(self):
7         print(self.name + " makes a sound.")
8
9 # Child class overrides speak()
10 class Dog(Animal):
11     def speak(self):
12         super().speak() # Call parent method
13         print(self.name + " barks!") # Custom behavior
14
15 # Usage
16 animal = Animal("Generic Animal"); animal.speak() # Generic Animal makes a sound.
17 dog = Dog("Buddy"); dog.speak() # Buddy makes a sound. Buddy barks!
```

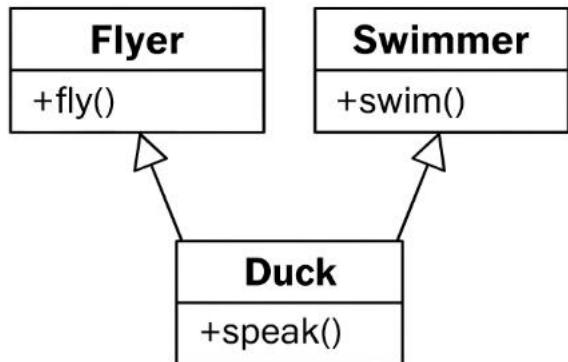
- `self` refers to the current object instance.
- `super().method()` calls the parent's implementation.
- Overriding allows **custom behavior** for subclasses.

Multiple inheritance

Explanation:

A class can inherit from **more than one parent class**. This allows combining functionality from multiple sources. But use with care as it can lead to complexity!

Code example:



```
1 # First parent class
2 class Flyer:
3     def fly(self):
4         print("I can fly!")
5
6 # Second parent class
7 class Swimmer:
8     def swim(self):
9         print("I can swim!")
10
11 # Child class inherits from both
12 class Duck(Flyer, Swimmer):
13     def speak(self):
14         print("Quack!")
15
16 # Usage
17 duck = Duck()
18 duck.fly()    # I can fly!
19 duck.swim()   # I can swim!
20 duck.speak()  # Quack!
```

- Syntax: `class Child(Parent1, Parent2):`
- Methods from both parents are available in the child.



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OOP IN PYTHON: EXERCISES

GitHub Repo

https://github.com/alouwyck/vives_ttk_tallinn

The screenshot shows a GitHub repository page. At the top, it displays the URL https://github.com/alouwyck/vives_ttk_tallinn, the owner's name 'alouwyck', and the repository name 'vives_ttk_tallinn'. Below this is a navigation bar with links for 'Code' (which is underlined), 'Issues', 'Pull requests', and 'Actions'. The main content area shows the repository name 'vives_ttk_tallinn' next to a green circular icon, and a 'Public' badge. It also shows a dropdown menu for the 'main' branch, a count of '1 Branch', and '0 Tags'. A section below lists the creator 'alouwyck' and notes that it was 'Created using Colab'. A folder named 'oop_python' is shown at the bottom, with its box highlighted by a red rectangle.

Sources

- <https://realpython.com/python3-object-oriented-programming/>
- <https://www.geeksforgeeks.org/python/python-oops-concepts/>
- https://www.w3schools.com/python/python_oop.asp
- <https://blog.algomaster.io/p/basic-oop-concepts-explained-with-code>
- <https://www.geeksforgeeks.org/python/python-classes-and-objects>
- <https://www.cspsprotocol.com/python-inheritance-tutorial/>
- Microsoft Copilot using GPT-5 was applied to generate some of the content