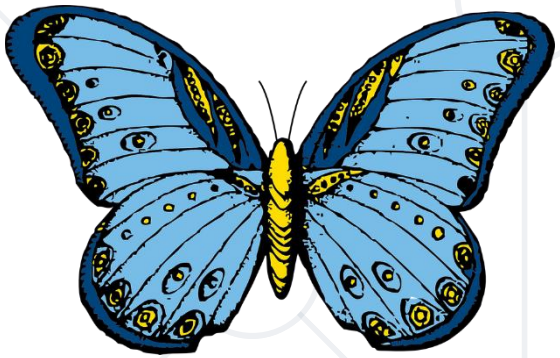
Polymorphism and Abstraction

Having Multiple Forms



SoftUni Team

Technical Trainers

Software University

SoftUni

Software University

https://softuni.bg

Table of Contents

Have a Question?

Software University

sli.do

#python-advanced

What is a Polymorphism

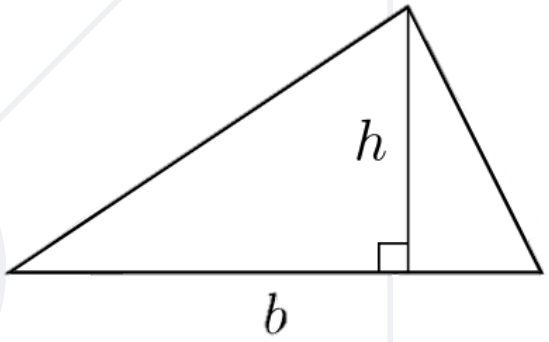
Definition and Examples

Polymorphism Definition

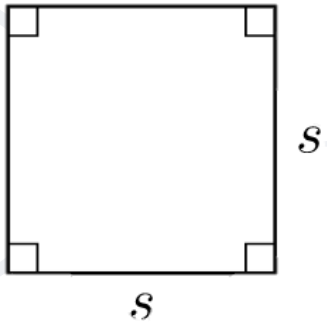
- Polymorphism is based on the Greek words "poly" (**many**) and "morphism" (**forms**)
- It is the ability to present the **same interface** for **differing underlying forms** through the interface of **their base class**
- e. g., **Square**, and **Triangle inherit Shape**, so their instances can be used from an instance of type Shape

Run-Time Polymorphism

- A subclass can **override** a method of its superclass
  - e. g., **both** triangle and square are **shapes** and have **area**



$$A = \frac{b \cdot h}{2}$$



$$A = s^2$$

Example: Run-Time Polymorphism

```
class Shape:
    def calculate_area(self):
        return None

class Square(Shape):
    side_length = 2
    def calculate_area(self):
        return self.side_length * 2

class Triangle(Shape):
    base_length = 4
    height = 3
    def calculate_area(self):
        return 0.5 * self.base_length * self.height
```

Overriding `calculate_area` method

Without Polymorphism

- A **type check** may be required before performing an action on an object to **determine the correct method** to call

```
for obj in Square(), Triangle():
    if isinstance(obj, Square):
        area = obj.calculate_square_area()
    elif isinstance(obj, Triangle):
        area = obj.calculate_triangle_area()
    print(area)
```

If not overriding `calculate_area` method

Compile-Time Polymorphism

- Python **does not** support compile-time polymorphism or **method overloading**
- If a class has multiple methods **with the same name**, the method defined in the **last will override** the earlier one

```
class Person:
    def say_hello():
        return "Hi!"
    def say_hello():
        return "Hello"

print(Person.say_hello()) # Hello
```

Problem: Robots

- **Refactor** the **provided code**, so we do not need to do **any type-checking**. The classes should implement the method, so it returns the number of sensors for **each type** of robot.

Solution: Robots

```
class MedicalRobot(Robot):
    @staticmethod
    def sensors_amount():
        return 6

class ChefRobot(Robot):
    @staticmethod
    def sensors_amount():
        return 4

class WarRobot(Robot):
    @staticmethod
    def sensors_amount():
        return 12
```

```
def number_of_robot_sensors(robot):
    print(robot.sensors_amount())

basic_robot = Robot('Robo')
da_vinci = MedicalRobot('Da Vinci')
moley = ChefRobot('Moley')
griffin = WarRobot('Griffin')

number_of_robot_sensors(basic_robot)
number_of_robot_sensors(da_vinci)
number_of_robot_sensors(moley)
number_of_robot_sensors(griffin)
```

Overloading Built-in Methods

Overloading Built-in Methods

- **Change the behavior** of functions such as len, abs, str, repr, and so on
- To do this, you only need to **define** the corresponding **special method in your class**

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

    def __len__(self):
        return self.size

my_class = MyClass("Class Name", 3)
print(len(my_class)) # 3
```

Operator Overloading

- An operator behaves **differently** based on the **type of the operands**
  - e.g., operator "**+**" is used to add two **integers** as well as join two **strings** and merge two **lists**
  - It is **overloaded** by **int** class, **str** class and **list** class

```
integer = 1 + 1
string = "Hello, " + "SoftUni"
list = ["1", "2"] + ["3", "4"]
```

Operator Magic Methods

Magic Methods	Get Called Using
__add__(self, other)	+
__sub__(self, other)	-
__mul__(self, other)	*
__floordiv__(self, other)	//
__truediv__(self, other)	/
__pow__(self, other[, modulo])	**

Example: Overloading __add__()

- If we have a **class Purchase** and we want to **sum** all expenses using the **+** operator, we can override the **__add__** method

```
class Purchase:
    def __init__(self, product_name, cost):
        self.product_name = product_name
        self.cost = cost

    def __add__(self, other):
        name = f'{self.product_name}, {other.product_name}'
        cost = self.cost + other.cost
        return Purchase(name, cost)

first_purchase = Purchase('sofa', 650)
second_purchase = Purchase('table', 150)
print(first_purchase + second_purchase)  # sofa, table; 800
```

"Rich Comparison" Magic Methods

Magic Methods	Get Called Using
__lt__(self, other)	<
__le__(self, other)	<=
__eq__(self, other)	==
__ne__(self, other)	!=
__gt__(self, other)	>
__ge__(self, other)	>=

Example: Overloading __gt__()

- If we have a **class Person** and we want to **compare** them by their salary using the **>** operator, we can override the **__gt__** method

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

    def __gt__(self, other):
        return self.salary > other.salary

person_one = Person('John', 20)
person_two = Person('Natasha', 36)
print(person_one > person_two)  # False
```

Problem: Image Area

- Create a class called **`ImageArea`**
- It stores the **`width`** and the **`height`** of an image
- Create a method called **`get_area()`** which returns the area of the image
- Implement all the **magic methods** for **comparison** of two image areas (>, >=, <, <=, ==, !=) which will compare their areas

Solution: ImageArea

```
class ImageArea:
    def __init__(self, width, height):
        self.width = width
        self.height = height

    def get_area(self):
        return self.width * self.height

    def __eq__(self, other):
        return self.get_area() == other.get_area()

    # TODO: Implement the other comparison methods
```

Duck Typing

Duck Typing Definition

- Duck Typing is a **type system** used in dynamic languages
- "If it **looks like a duck** and **quacks like a duck**, **it's a duck**"
  - i.e., we don't care about **objects' types**, but whether **they have the methods** we need

Example: Duck Typing

- We **can create a method** that calls the sound method, **no matter** what the object which makes the sound is

```
class Cat:
    def sound(self):
        print("Meow!")

class Train:
    def sound(self):
        print("Sound from wheels slipping!")

for any_type in Cat(), Train():
    any_type.sound()
```

Works for both classes

Problem: Playing

- Create a method called `start_playing` which will receive an instance and will print its `play()` method if it has one

```
# Test Code
class Guitar:
    def play(self):
        return "Playing the guitar"

guitar = Guitar()
start_playing(guitar)
# Playing the guitar
```

```
# Test Code
class Children:
    def play(self):
        return "Children are playing"

piano = Children()
start_playing(piano)
# Children are playing
```

Solution: Playing

```
def start_playing(obj):
    return obj.play()

# Test Code
class Guitar:
    def play(self):
        return "Playing the guitar"

guitar = Guitar()
start_playing(guitar)
```

What is an Abstraction

Definition and Examples

A Word about Abstraction

- In object-oriented programming, abstraction is one of the **four central principles**
- Through abstraction, we hide all but the relevant data about an object to **reduce complexity** and **increase efficiency**
- Abstraction can be achieved by:
  - Functions and methods
  - **Abstract classes**

Abstract Classes

- Abstract classes are classes that contain one or more **abstract methods**
  - An abstract method is a method that is **declared** but contains **no implementation**
- Abstract classes may not be instantiated and require **subclasses** to provide implementations for the abstract methods

Abstract Classes in Python

- It could be achieved using **exceptions**, but it **not a good practice**

```
class Shape:
    def __init__(self):
        if type(self) is Shape:
            raise Exception('This is an abstract class')

    def area(self):
        raise Exception('This is an abstract class')

    def perimeter(self):
        raise Exception('This is an abstract class')
```

Abstract Classes with ABC Module

- Abstract base classes (ABCs) **enforce** derived classes to implement particular methods from the base class
  - We implement it using the **abc** module

```
class Shape:

    def __init__(self):
        if type(self) == Shape:
            raise Exception('…')

    def area(self):
        raise Exception('…')

    def perimeter(self):
        raise Exception('…')
```

```
from abc import ABC, abstractmethod

class Shape(ABC):

    @abstractmethod
    def area(self):
        pass

    @abstractmethod
    def perimeter(self):
        pass
```

Example: Abstract classes (1)

```
from abc import ABC, abstractmethod

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

    @abstractmethod
    def sound(self):
        raise NotImplementedError("Subclass must implement")

# Continues on next slide
```

Defining an Abstract Class

Makes a Method Abstract

Example: Abstract classes (2)

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

    def sound(self):
        print("Bark!")

class Cat(Animal):
    def __init__(self, name):
        super().__init__(name)

    def sound(self):
        print("Meow!")
```

Inherit the Abstract Class

Implement the Abstract method

```
cat = Cat("Willy")
cat.sound()
dog = Dog("Willy")
dog.sound()
animal = Animal("Willy")
animal.sound()
# Meow!
# Bark!
# Error!
```

Problem: Shapes

- Create an abstract class **`Shape`** with abstract methods **`calculate_area`** and **`calculate_perimeter`**
- Create classes that implement the methods:
  - **`Circle`** - receives **radius** upon initialization
  - **`Rectangle`** - receives **height** and **width** upon initialization
  - The **fields** of Circle and Rectangle should be **private**

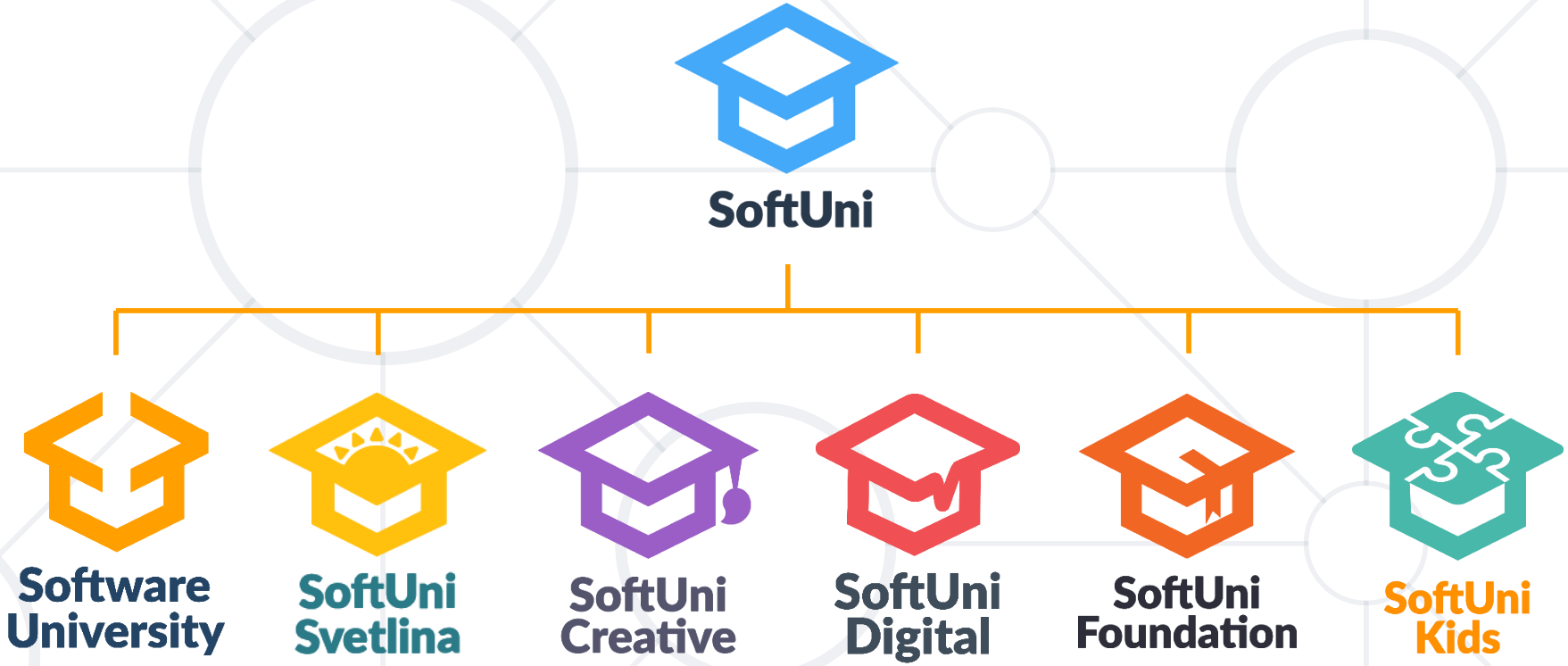
Solution: Shapes

```
from abc import ABC, abstractmethod
from math import pi

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

    @abstractmethod
    def calculate_area(self):
        pass
# TODO: Implement Circle and Rectangle
```

Summary

- **Polymorphism** means same function name being uses for different types
- Through **abstraction**, we hide all but the relevant data about an object
- Abstract classes may **not be instantiated**, and require subclasses

Questions?



SoftUni Diamond Partners

Software University

SCHWARZ

LIDL

Kaufland

SCHWARZ Produktion

prezero

Coca-Cola HBC Bulgaria

POKERSTARS | CAREERS

Postbank

Решения за твоето утре

AMBITIONED

DXC TECHNOLOGY

SOFTWARE GROUP

Bosch.IO

INDEAVR

Serving the high achievers

DRAFT KINGS

PHAR VISION

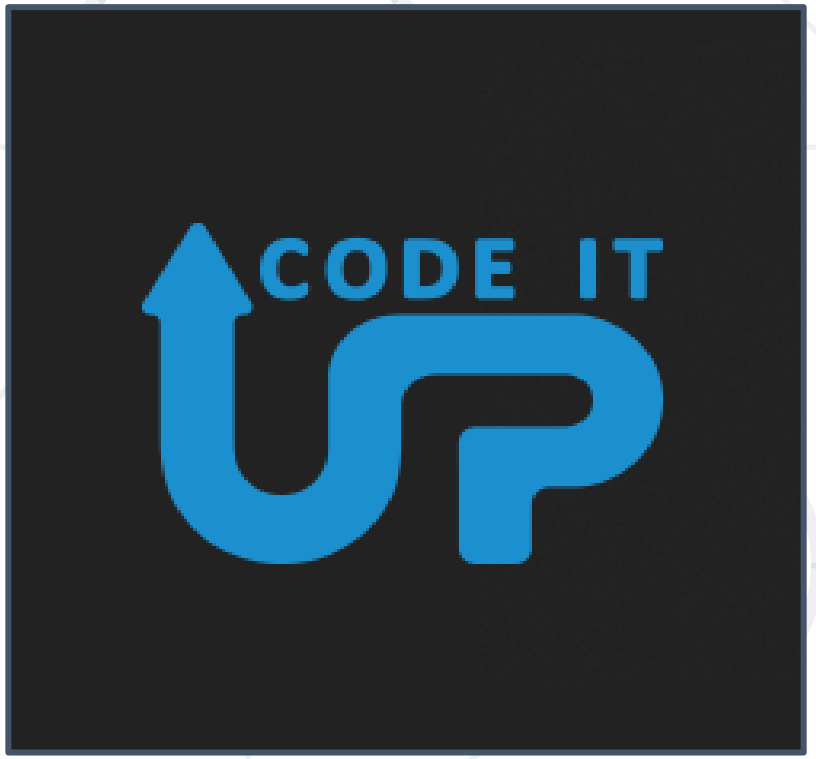
SmartIT

createX

SUPER HOSTING .BG

Educational Partners

Software University



Trainings @ Software University (SoftUni)

- Software University – High-Quality Education, Profession and Job for Software Developers
  - softuni.bg, softuni.org
- Software University Foundation
  - softuni.foundation
- Software University @ Facebook
  - facebook.com/SoftwareUniversity
- Software University Forums
  - forum.softuni.bg

License

- This course (slides, examples, demos, exercises, homework, documents, videos, and other assets) is **copyrighted content**
- Unauthorized copy, reproduction, or use is illegal
- © SoftUni – https://about.softuni.bg
- © Software University – https://softuni.bg