Python OOP

```
Module Code: ELEE1147

Module Name: Programming for Engineers

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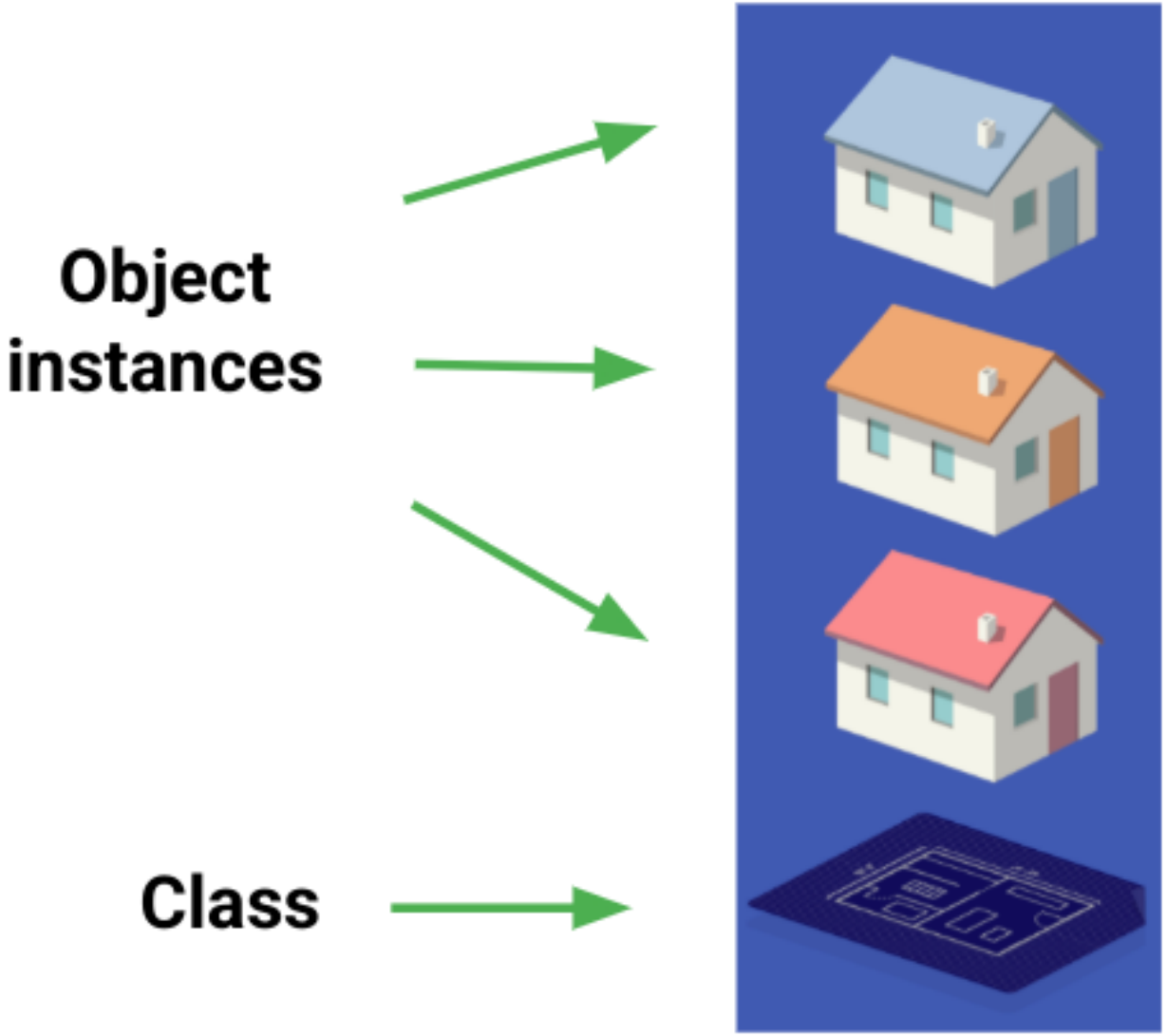
Object-Oriented Programming in Python

- **What is OOP?**
  - A programming paradigm based on "objects"
  - Combines **data** and **methods** into single entities
  - Focuses on **modularity** and **reusability**
- **Key Features:**
  - Encapsulation
  - Inheritance
  - Polymorphism
  - Abstraction

Classes

Classes are software programming models - abstractions of the real world or system entities.

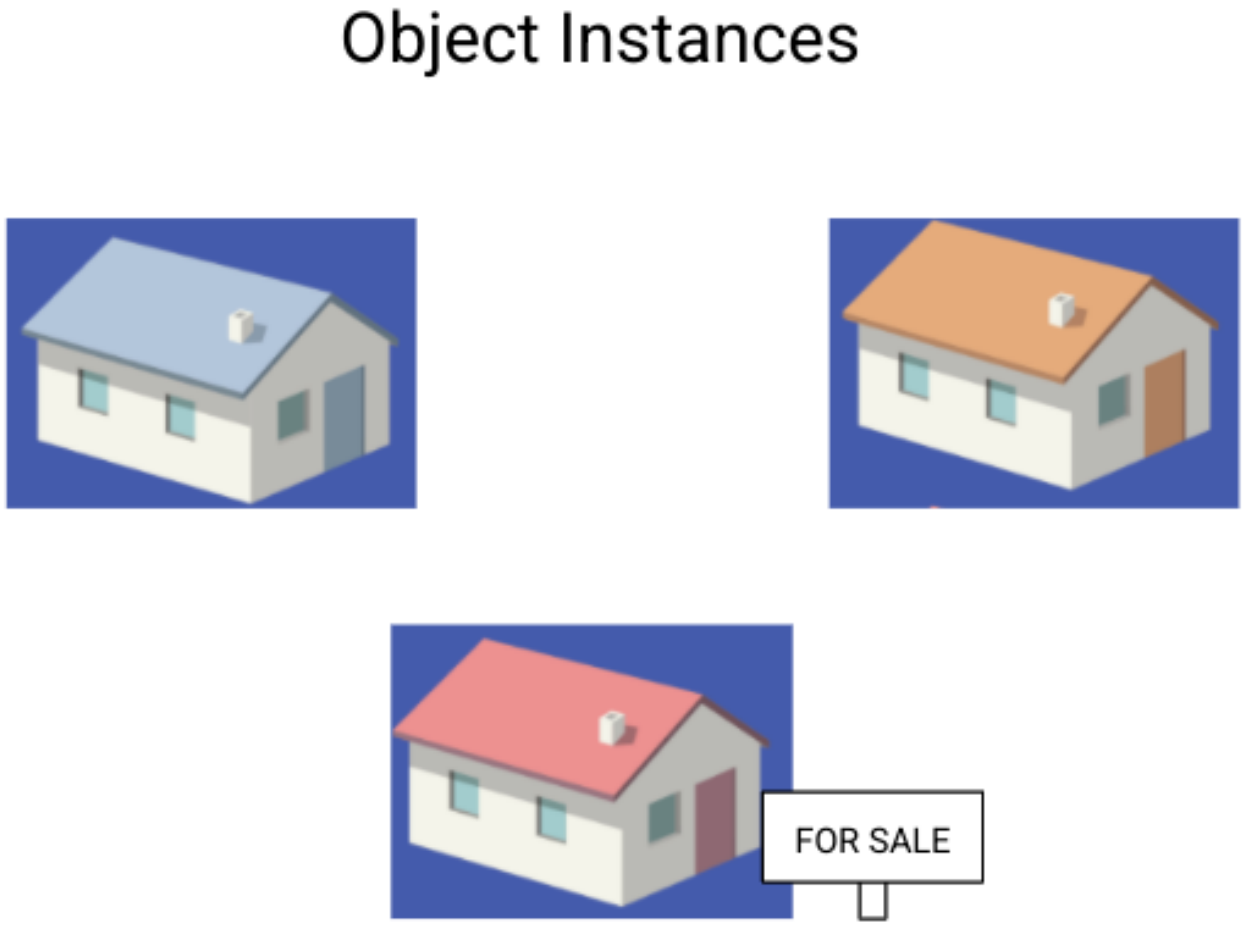
Classes define methods that operate on their object instances



Classes vs Objects (2)

House Class

- Data
  - House color (`String`)
  - Number of windows (`Number`)
  - Is for sale (`Boolean`)
- Behavior
  - `updateColor()`
  - `putOnSale()`



Key Concepts in Python OOP

1. Classes and Objects

- **Class**: A blueprint for creating objects.
- **Object**: An instance of a class.

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

my_dog = Dog("Alfski", "Norwegian Elkhound")  # Object creation
```

- `self`: Refers to the instance of the class.

2. Encapsulation

- **Definition**: Bundling data and methods into a single unit (class) and restricting direct access to some components.
- Example:

```
class BankAccount:
    def __init__(self, balance):
        self.__balance = balance  # Private attribute

    def deposit(self, amount):
        self.__balance += amount

    def get_balance(self):
        return self.__balance
```

- Use **getter and setter methods** to access private attributes.

3. Inheritance

- **Definition**: A mechanism to derive a class from another class.
- Python supports single and multiple inheritance.
- Example:

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

    def eat(self):
        print("I can eat!")

    def sleep(self):
        print("I can sleep")

class Dog(Animal):
    def __init__(self, name, breed):
        # Call the parent class's __init__
        super().__init__(name)
        self.breed = breed

    def bark(self):
        print("Woof!")

dog = Dog("Alfski", "Norwegian Elkhound")
print(dog.name)  # Alfski
print(dog.breed)  # Norwegian Elkhound
```

4. Polymorphism

- **Definition**: The ability of objects to take many forms.
- Example:

```
class Bird:
    def fly(self):
        print("Bird flies")

class Penguin(Bird):
    def fly(self):
        print("Penguins cannot fly")

def test_fly(bird):
    bird.fly()

test_fly(Bird())    # Bird flies
test_fly(Penguin())  # Penguins cannot fly
```

5. Abstraction

- **Definition**: Hiding implementation details while showing essential features.
- Achieved using abstract base classes.

```
from abc import ABC, abstractmethod

class Shape(ABC):
    @abstractmethod
    def area(self):
        pass ## keyword for placeholder

class Circle(Shape):
    def __init__(self, radius):
        self.radius = radius

    def area(self):
        return 3.14 * self.radius ** 2

circle = Circle(5)
print(circle.area())  # 78.5
```

Special Methods in Python

- **Magic/Dunder Methods**: Special methods with double underscores.
- Examples:
  - `__init__`: Initialize an object.
  - `__str__`: String representation of an object.
  - `__add__`: Define addition behavior for objects.

```
class Vector:
    def __init__(self, x, y):
        self.x = x
        self.y = y

    def __add__(self, other):
        return Vector(self.x + other.x, self.y + other.y)

    def __str__(self):
        return f"Vector({self.x}, {self.y})"

v1 = Vector(2, 3)
v2 = Vector(5, 6)
print(v1 + v2)  # Vector(7, 9)
```

Why Use OOP?

- **Benefits:**
  - Code reusability through inheritance.
  - Modularity for easier debugging and maintenance.
  - Encapsulation enhances data security.
  - Polymorphism makes systems more flexible.
- **Real-World Use Cases:**
  - GUI applications
  - Games
  - Web frameworks

Summary

- OOP provides a structured and modular way of programming.
- Key concepts:
  - Classes and Objects
  - Encapsulation
  - Inheritance
  - Polymorphism
  - Abstraction
  - `super()` for parent class method calls
- Use OOP for scalable and maintainable code.