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Lecture: (12)

(Constructor & Destructor)

Subject: Object oriented programming II
Class: Second
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Constructor & Destructor in Python

Constructor & Destructor in Python :

Constructor & Destructor are an important concept of oops in Python .

Constructor: A constructor in Python is a special type of method which is used to initialize the instance members of the class. The task of constructors is to initialize and assign values to the data members of the class when an object of the class is created .

Destructor: Destructor in Python is called when an object gets destroyed. In Python, destructors are not needed, because Python has a garbage collector that handles memory management automatically .

Constructor:

- The __init__ method is similar to **constructors** in c++ and Java.
- Constructors are used to initialize the object's state.
- The task of constructors is to initialize(assign values) to the data members of the class when an object of class is created.

Synatx:

```
class ClassName:
  def __init__( self , variables...):
    ##body
```

Types of Constructor:

- **default constructor:** The default constructor is a simple constructor which doesn't have any argument to pass. Its definition has only one argument which is a reference to the instance being constructed.
- **parameterized constructor:** constructor which has parameters to pass is known as parameterized constructor. The parameterized constructor takes its first argument as a reference to the instance being constructed known as self.

Code #1:

```
#python Program
#Rishikesh
#constructor
#default Constructor
```

```
class A(object):
    def __init__(self):
        self.str1 = “PrepInsta”
        print( self.str1)
        print(‘In constructor’)


ob = A()
```

Output:

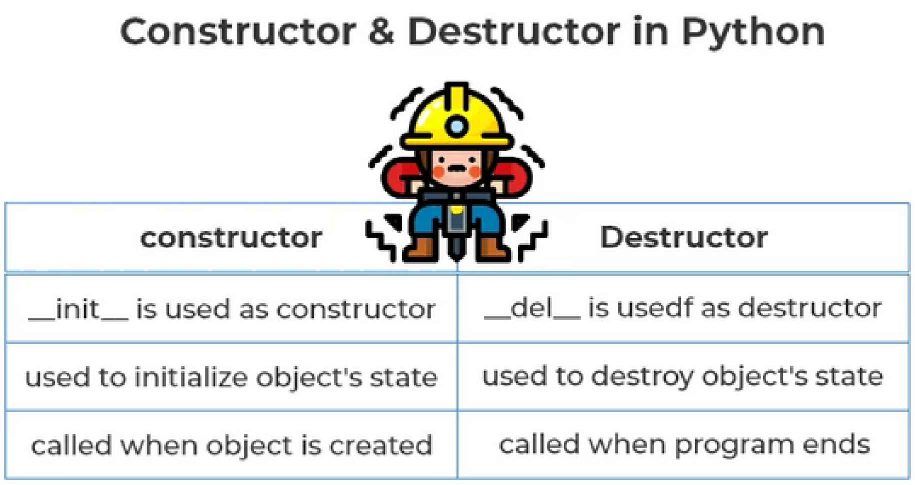
```
PrepInsta
In constructor
```

Destructor:

- The __del__ method is similar to **destructor** in c++ and Java.
- Destructors are used to destroying the object’s state.

Syntax:

```
class ClassName:
  def __del__( self ,):
    ##body
```


Constructor & Destructor in Python

constructor	Destructor
__init__ is used as constructor	__del__ is usedf as destructor
used to initialize object's state	used to destroy object's state
called when object is created	called when program ends

- This program that demonstrates constructors and resource management in Python, inspired by a simple library system:

```
class Book:
    def __init__(self, title, author):
        self.title = title
        self.author = author
        self.checked_out = False

    def check_out(self):
        if not self.checked_out:
            self.checked_out = True
            return True
        else:
            return False

    def check_in(self):
        if self.checked_out:
            self.checked_out = False
            return True
        else:
            return False

    def __str__(self):
        return f"{self.title} by {self.author} - Checked Out: 
{self.checked_out}"

# Create two book instances
book1 = Book("The Great Gatsby", "F. Scott Fitzgerald")
book2 = Book("To Kill a Mockingbird", "Harper Lee")

# Check out and check in books
book1.check_out()
book2.check_out()

# Display book information
print(book1)
print(book2)
```

In this program:

- We have a `Book` class with a constructor that initializes book attributes, including title, author, and whether the book is checked out or not.
- The `check_out` method allows us to check out a book, and the `check_in` method allows us to return it.
- The `__str__` method is used to create a string representation of the book, indicating its title, author, and whether it's checked out.
- We create two book instances, check them out, and then display their information.

This simple program illustrates how you can use constructors and methods to manage book objects in a basic library system.

Constructors in Python

Constructors in Python are used to initialize the attributes of an object with default or given values. They are defined with the `__init__()` method and are automatically called when an object is created.

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

    def greet(self):
        print(f"Hello, my name is {self.name} and I am {self.age} years
old.")

# Create a new Person object
person = Person("Bard", 1)

# Call the greet() method
person.greet()
```

Output:

```
Hello, my name is Bard and I am 1 years old.
```

Destructors in Python

Destructors in Python are used to clean up any resources that an object is using before it is destroyed. They are defined with the `__del__()` method and are automatically called when an object is deleted.

```
class File:
    def __init__(self, filename):
        self.file = open(filename, "w")

    def write(self, data):
        self.file.write(data)

    def close(self):
        self.file.close()

    def __del__(self):
        self.close()
```

```
# Create a new File object
file = File("myfile.txt")

# Write some data to the file
file.write("This is some data to write to the file.")

# Close the file
file.close()

# Delete the file object
del file
```

Even though we explicitly called the `close()` method on the `file` object, the `__del__()` method will still be called when the object is deleted. This ensures that the file is always closed, even if we forget to do it explicitly.

Use cases for constructors and destructors

Constructors and destructors are useful for a variety of tasks, such as:

- **Initializing object attributes:** Constructors can be used to initialize the attributes of an object with default or given values. This ensures that all objects of the class are properly initialized, regardless of how they are created.
- **Cleaning up resources:** Destructors can be used to clean up any resources that an object is using before it is destroyed. This can help to prevent memory leaks and other problems.
- **Enforcing encapsulation:** Constructors and destructors can be used to enforce encapsulation by hiding the internal implementation of a class from its users.

Overall, constructors and destructors are powerful features of Python that can be used to improve the quality and maintainability of your code.

Encapsulation and abstraction are two fundamental principles in object-oriented programming (OOP). They help in organizing and managing code, making it more understandable and maintainable. In Python, like in many other OOP languages, you can apply encapsulation and abstraction as follows:

1. **Encapsulation**:

   Encapsulation is the practice of bundling the data (attributes) and the methods (functions) that operate on the data into a single unit, known as a class. This helps in controlling access to the data and ensures that the data is used and modified in a controlled manner. In Python, encapsulation is implemented by using private and protected members.

   - **Private Members**: In Python, you can mark an attribute or method as private by prefixing it with an underscore (e.g., `_variable` or `_method`). This is a convention and not enforced by the language, but it indicates to other developers that the attribute or method is intended for internal use and should not be accessed directly.

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  ```
  class MyClass:
   def __init__(self):
       self._my_variable = 10

   def _my_method(self):
       return self._my_variable
  ```

- **Protected Members**: Python doesn't have a strict concept of protected members, but you can prefix an attribute or method with a double underscore (e.g., `__variable`). This will name-mangle the member, making it harder (but not impossible) to access from outside the class.

```
 class MyClass:
        def __init__(self):
            self.__my_variable = 10

        def __my_method(self):
         return self.__my_variable
```

- Abstraction:

Abstraction is the process of simplifying complex reality by modeling classes based on the essential attributes and behaviors of an object, while hiding the unnecessary details. In Python, you can achieve abstraction by defining classes with well-defined interfaces, i.e., a set of public methods that describe how the class can be used, while keeping the implementation details hidden.

```
class Shape:
    def area(self):
        pass

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

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

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

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

- In the example above, the `Shape` class defines an interface with an `area` method that every shape subclass must implement. The subclasses `Circle` and `Rectangle` provide their own implementations, but the details of those implementations are hidden from the user of the classes.
- In summary, encapsulation and abstraction in Python are achieved through conventions for controlling access to class members and by defining well-defined interfaces that hide the implementation details. These principles help make your code more maintainable and understandable.

- This example program that demonstrates encapsulation and abstraction in Python, using a simple banking system:

```
class Account:
    def __init__(self, account_number, account_holder, balance=0):
        self._account_number = account_number  # Encapsulated as a protected
attribute
        self._account_holder = account_holder  # Encapsulated as a protected
attribute
        self._balance = balance  # Encapsulated as a protected attribute

    def deposit(self, amount):
        if amount > 0:
            self._balance += amount
            print(f"Deposited ${amount}. New balance: ${self._balance}")
        else:
            print("Invalid deposit amount.")

    def withdraw(self, amount):
        if 0 < amount <= self._balance:
            self._balance -= amount
            print(f"Withdrew ${amount}. New balance: ${self._balance}")
        else:
            print("Invalid withdrawal amount or insufficient funds.")

    def get_balance(self):
        return self._balance  # Encapsulation allows controlled access

    def account_info(self):
        return f"Account: {self._account_number}, Holder:
{self._account_holder}, Balance: ${self._balance}"

class SavingsAccount(Account):
    def __init__(self, account_number, account_holder, balance=0,
interest_rate=0.01):
        super().__init__(account_number, account_holder, balance)
        self._interest_rate = interest_rate

    def apply_interest(self):
        interest = self._balance * self._interest_rate
        self._balance += interest
        print(f"Interest applied: ${interest}. New balance:
${self._balance}")

# Create a savings account
savings_account = SavingsAccount("12345", "John Doe", 1000)

# Perform transactions and display account information
print("Account information:")
print(savings_account.account_info())

savings_account.deposit(500)
savings_account.withdraw(200)
savings_account.apply_interest()

print("Updated account information:")
print(savings_account.account_info())
```

In this program:

- The `Account` class encapsulates account details such as `account_number`, `account_holder`, and `balance`. These attributes are marked as protected. The class provides methods to deposit, withdraw, get the balance, and retrieve account information.
- The `SavingsAccount` class is a subclass of `Account` that adds an `interest_rate` attribute and a method to apply interest. It inherits the encapsulated attributes and behaviors from the base class.
- We create a `SavingsAccount` instance, perform transactions (deposit, withdrawal, and interest application), and display account information.

This example demonstrates how encapsulation is used to protect attributes, and abstraction is achieved by providing an abstracted interface for interacting with the bank accounts. The specific implementation details are hidden from the user of the class, making it easier to use and maintain.

- This example program that demonstrates encapsulation and abstraction in Python, using a simplified employee management system:

```
class Employee:
    def __init__(self, employee_id, name):
        self._employee_id = employee_id  # Encapsulated as a protected
attribute
        self._name = name  # Encapsulated as a protected attribute
        self._salary = 0  # Encapsulated as a protected attribute

    def calculate_salary(self):
        pass  # Abstract method, to be defined in subclasses

    def get_employee_id(self):
        return self._employee_id

    def get_name(self):
        return self._name

    def get_salary(self):
        return self._salary

    def employee_info(self):
        return f"Employee ID: {self._employee_id}, Name: {self._name},
Salary: ${self._salary}"

class Manager(Employee):
    def calculate_salary(self):
        self._salary = 50000

class Developer(Employee):
    def __init__(self, employee_id, name, programming_language):
        super().__init__(employee_id, name)
        self._programming_language = programming_language

    def calculate_salary(self):
        self._salary = 60000

    def get_programming_language(self):
        return self._programming_language

# Create employees and display their information
manager = Manager("1", "Alice")
developer = Developer("2", "Bob", "Python")

print("Employee information:")
print(manager.employee_info())
print(developer.employee_info())
```

```
# Calculate and display salaries
manager.calculate_salary()
developer.calculate_salary()

print("\nUpdated employee information:")
print(manager.employee_info())
print(developer.employee_info())
```

In this program:

- The `Employee` class encapsulates employee details such as `employee_id`, `name`, and `salary`. These attributes are marked as protected. The class provides methods to calculate the salary, get employee information, and retrieve individual attributes.
- The `Manager` and `Developer` classes are subclasses of `Employee` that override the `calculate_salary` method to set the salary based on their roles. The `Developer` class also has an additional attribute, `programming_language`.
- We create instances of `Manager` and `Developer`, display their information, calculate salaries, and display the updated information.

This example illustrates how encapsulation is used to protect attributes, and abstraction is achieved by providing an abstracted interface for interacting with employee objects. The specific implementation details are hidden from the user of the class, making it easier to use and maintain.

- This program that demonstrates encapsulation and abstraction in Python by modeling a school's student and teacher information:

```
class Person:
    def __init__(self, name, age):
        self._name = name  # Encapsulated as a protected attribute
        self._age = age  # Encapsulated as a protected attribute

    def get_name(self):
        return self._name

    def get_age(self):
        return self._age

    def introduce(self):
        pass  # Abstract method, to be defined in subclasses

class Student(Person):
    def __init__(self, name, age, student_id):
        super().__init__(name, age)
        self._student_id = student_id  # Encapsulated as a protected
attribute

    def introduce(self):
        return f"Hi, I'm {self._name}, a student with ID {self._student_id}."

class Teacher(Person):
    def __init__(self, name, age, employee_id):
        super().__init__(name, age)
        self._employee_id = employee_id  # Encapsulated as a protected
attribute

    def introduce(self):
        return f"Hello, I'm {self._name}, a teacher with employee ID
{self._employee_id}."

# Create students and teachers and display their information
student1 = Student("Alice", 18, "S12345")
student2 = Student("Bob", 17, "S67890")
teacher1 = Teacher("Ms. Johnson", 35, "T101")
teacher2 = Teacher("Mr. Smith", 42, "T202")

print("Student and teacher information:")
print(student1.introduce())
print(student2.introduce())
print(teacher1.introduce())
print(teacher2.introduce())
```

In this program:

- The `Person` class encapsulates personal information such as `name` and `age`. These attributes are marked as protected. The class provides methods to get these attributes and an abstract `introduce` method.
- The `Student` and `Teacher` classes are subclasses of `Person` that provide concrete implementations of the `introduce` method and have additional attributes (`student_id` and `employee_id`) specific to their roles.
- We create instances of `Student` and `Teacher`, display their information by calling the `introduce` method, and demonstrate encapsulation by using protected attributes for `name`, `age`, `student_id`, and `employee_id`.

This example showcases encapsulation by protecting attributes and abstraction by providing an abstracted interface for interacting with person objects. It hides implementation details, making it easier to use and maintain.

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- This program that demonstrates encapsulation and abstraction in Python, simulating a simple online shopping system with products and customers:

```
class Product:
    def __init__(self, product_id, name, price):
        self._product_id = product_id  # Encapsulated as a protected 
attribute
        self._name = name  # Encapsulated as a protected attribute
        self._price = price  # Encapsulated as a protected attribute

    def get_product_id(self):
        return self._product_id

    def get_name(self):
        return self._name

    def get_price(self):
        return self._price

    def product_info(self):
        return f"Product: {self._name} (ID: {self._product_id}), Price: 
${self._price}"

class Customer:
    def __init__(self, customer_id, name):
        self._customer_id = customer_id  # Encapsulated as a protected 
attribute
        self._name = name  # Encapsulated as a protected attribute
        self._cart = []  # Encapsulated as a protected attribute

    def add_to_cart(self, product):
        self._cart.append(product)
        return f"{self._name} added {product.get_name()} to the cart."

    def checkout(self):
        total_price = sum(product.get_price() for product in self._cart)
        self._cart = []
        return f"{self._name} checked out. Total price: ${total_price}"

    def customer_info(self):
        return f"Customer: {self._name} (ID: {self._customer_id})"

# Create products and customers
product1 = Product(1, "Laptop", 800)
product2 = Product(2, "Headphones", 50)

customer1 = Customer(101, "Alice")
customer2 = Customer(102, "Bob")

# Interaction
```

```
print("Online Shopping System:")
print(product1.product_info())
print(product2.product_info())
print(customer1.customer_info())
print(customer2.customer_info())

print(customer1.add_to_cart(product1))
print(customer2.add_to_cart(product2))
print(customer1.checkout())
print(customer2.add_to_cart(product1))
print(customer2.checkout())
```

In this program:

- The `Product` class encapsulates information about products, including their `product_id`, `name`, and `price`. The attributes are marked as protected.
- The `Customer` class encapsulates information about customers, including their `customer_id`, `name`, and a shopping cart. The attributes are marked as protected.
- Both classes provide methods for adding products to the cart, checking out, and providing information about the products and customers.
- The program simulates interactions between customers and products, demonstrating encapsulation by protecting attributes and abstraction by providing an abstracted interface for interacting with product and customer objects.

This example models a basic online shopping system using encapsulation and abstraction principles.

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