COS20007: Object Oriented Programming

Pass Task 6.2: Key Object Oriented Concepts

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Object-Oriented Programming: Four Key Principles

Core Principles Explained

1. Encapsulation - Data Protection and Information Hiding

Definition: Encapsulation is the bundling of data (attributes) and methods that operate on that data within a single unit (class), while restricting direct access to internal components through access modifiers.

Example: In a `BankAccount` class, the balance field is marked as private, preventing external code from directly modifying it. Access is controlled through public methods like `deposit()` and `withdraw()` that include validation logic.

Program Relation: When creating shape drawing program, each `Shape` and its inheritance's fields are encapsulated within the classes, accessible only through getter/setter methods that validated grade ranges (0-100).

2. Inheritance - Code Reusability and Hierarchical Relationships

Definition: Inheritance allows a new class (child/derived) to acquire properties and behaviors from an existing class (parent/base), promoting code reuse and establishing "is-a" relationships.

Example: A `Vehicle` base class contains common properties like speed and fuel. `Car` and `Motorcycle` classes inherit from Vehicle, gaining these properties while adding their specific features like `numberOfDoors` for Car.

Program Relation: In a shapes drawing program, a base `Shape` class provided common methods like `Draw()`, while specific shapes like `Circle` and `Rectangle` inherited these behaviors and implemented their own calculation logic.

3. Polymorphism - One Interface, Multiple Forms

Definition: Polymorphism enables objects of different classes to be treated as objects of a common base class, allowing the same interface to represent different underlying data types and behaviors.

Example: Different animal objects (Dog, Cat, Bird) all implement a `makeSound()` method differently, but can be stored in an Animal array and called uniformly, producing species-specific sounds.

Program Relation: In a shape drawing program, different `Shape` types (`Circle`, `Rectangle`, `Line`) all implemented a common `Shape` interface with a `Draw()`, `isAt()` and `DrawOutline()` methods, allowing each `Shape` to make various shapes through the same interface.

4. Abstraction - Hiding Complexity, Showing Essentials

Definition: Abstraction focuses on exposing only essential features of an object while hiding unnecessary implementation details, simplifying interaction with complex systems.

Example: A `Car` class provides simple methods like `Start()`, `Accelerate()`, and `Brake()` without exposing the internal complexities of engine ignition, fuel injection systems, or brake pad mechanics to the driver.

Program Relation: In shape drawing program, user do not need to know how each `Shape` is drawn to screen and how each `Shape` is drawn in a way. The `SplashKit` Library automatically refresh the screen and render our drawings. User only need to use `SplashKit.RefreshScreen()`, and do not need to know how it renders. For each `Shape`‘s `isAt()` method as well, users do not need to know how each `Shape` detects the area of click. So all the implementations are hide and user only need to know what they want to use and what method should they called.

How These Principles Interconnect

These principles work synergistically to create robust, maintainable software:

- **Encapsulation** provides the foundation by creating secure, self-contained units
- **Inheritance** builds upon encapsulation by extending existing secure units
- **Polymorphism** leverages inheritance to create flexible, interchangeable components
- **Abstraction** simplifies the use of all these complex relationships

The beauty of OOP lies in how these principles reinforce each other: inheritance promotes code reuse while maintaining encapsulation, polymorphism enables flexible design while preserving abstraction, and abstraction makes complex inheritance hierarchies manageable.

Exception Handling Examples

1. File Operations

```
try
{
    string content = File.ReadAllText("data.txt");
    // Process file content
}
catch (FileNotFoundException ex)
{
    Console.WriteLine("File not found: " + ex.Message);
}
catch (UnauthorizedAccessException ex)
{
    Console.WriteLine("Access denied: " + ex.Message);
}
```

File operations are inherently risky due to external dependencies (file existence, permissions, disk space).

2. Database Connections

```
try
{
    using (SqlConnection conn = new SqlConnection(connectionString))
    {
        conn.Open();
        // Database operations
    }
}
catch (SqlException ex)
{
    Console.WriteLine("Database connection failed: " + ex.Message);
}
catch (InvalidOperationException ex)
{
    Console.WriteLine("Connection error: " + ex.Message);
}
```

Network issues, server downtime, or authentication failures can occur unpredictably in database operations.

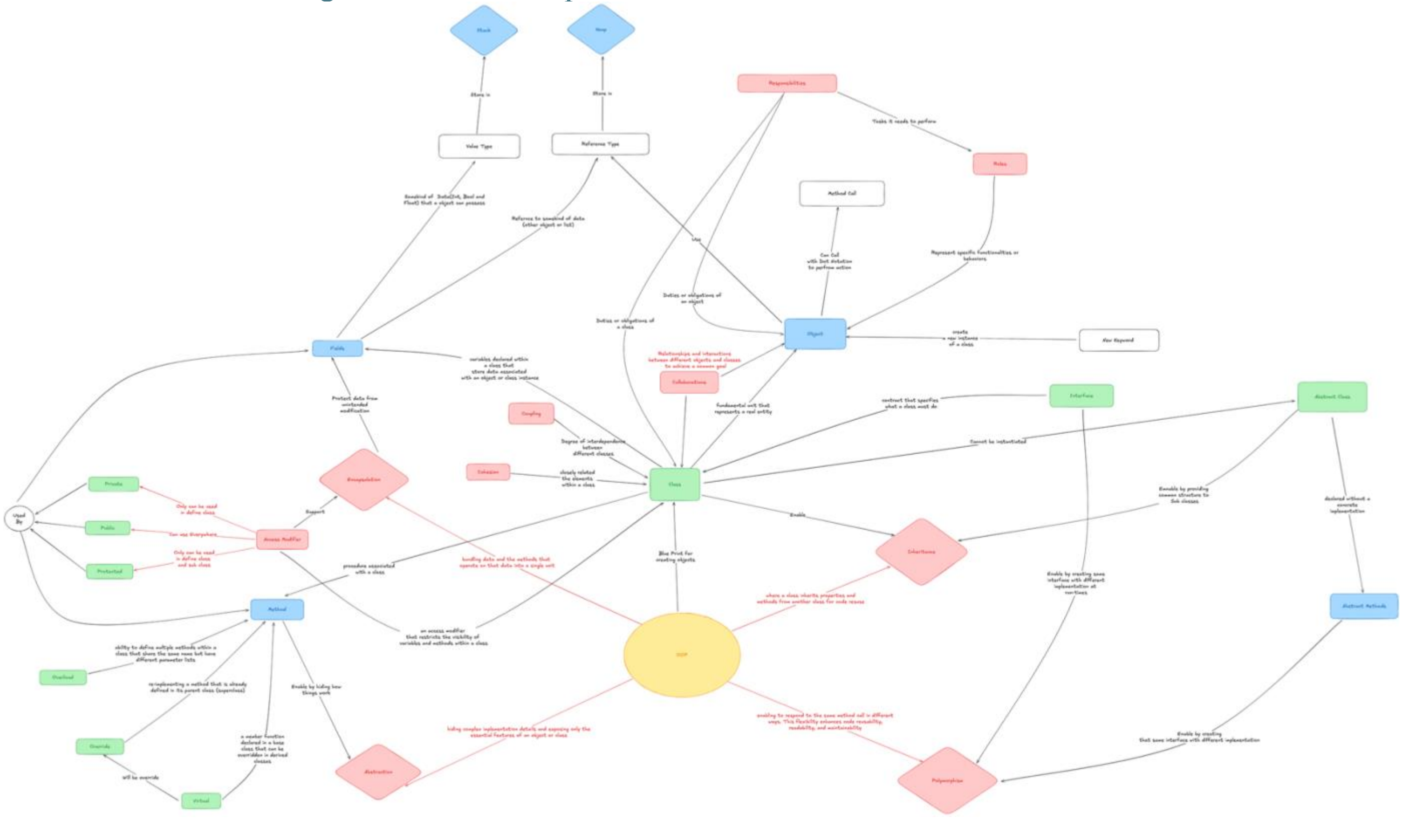
3. User Input Validation

```
try
{
    Console.Write("Enter your age: ");
    string userInput = Console.ReadLine();
    int age = int.Parse(userInput);

    if (age < 0)
        throw new ArgumentException("Age cannot be negative");

    Console.WriteLine($"Your age is: {age}");
}
catch (FormatException ex)
{
    Console.WriteLine("Please enter a valid number");
}
catch (ArgumentException ex)
{
    Console.WriteLine(ex.Message);
}
```

User input is unpredictable and may not match expected formats or constraints, requiring graceful error handling to maintain program stability.

Concept Map

Click Here to see in Google Drive if the Map is Blur on PDF



Stack
Heap
Store in
Store in
Value Type
Reference Type
Somekind of Data(Int, Bool and Float) that a object can possess
Reference to somekind of data (other object or list)
Responsibilities
Tasks it needs to perform
Roles
Method Call
Can Call with Dot Notation to perform action
Represent specific functionalities or behaviors
Use
Duties or obligations of an object
Duties or obligations of a class
Object
create new instance of a class
New Keyword
Fields
variables declared within a class that store data associated with an object or class instance
Relationships and interactions between different objects and classes to achieve a common goal
Collaborations
Protect data from unintended modification
Coupling
Degree of interdependence between different classes
Fundamental unit that represents a real entity
contract that specifies what a class must do
Interface
Abstract Class
Cannot be instantiated
Cohesion
closely related the elements within a class
Class
Encapsulation
Used By
Private
Public
Protected
Only can be used in define class
Can use Everywhere
Only can be used in define class and sub class
Support
Access Modifier
Enable
Enable by providing common structure to Sub classes
declared without a concrete implementation
Inheritance
procedure associated with a class
bundling data and the methods that operate on that data into a single unit
Blue Print for creating objects
Method
an access modifier that restricts the visibility of variables and methods within a class
where a class inherits properties and methods from another class for code reuse
Enable by creating same interface with different implementation at runtimes
Abstract Methods
ability to define multiple methods within a class that share the same name but have different parameter lists
Overload
re-implementing a method that is already defined in its parent class (superclass)
Enable by hiding how things work
OOP
a member function declared in a base class that can be overridden in derived classes
hiding complex implementation details and exposing only the essential features of an object or class
enabling to respond to the same method call in different ways. This flexibility enhances code reusability, readability, and maintainability
Enable by creating that same interface with different implementation
Override
will be override
Virtual
Abstraction
Polymorphism

References

Oracle Corporation. (2024). *The Java tutorials: Object-oriented programming concepts*. Oracle. https://docs.oracle.com/javase/tutorial/java/concepts/