COS20007: Object Oriented Programming

Pass Task 6.2: Key Object Oriented Concepts

Show Wai Yan/105293041

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

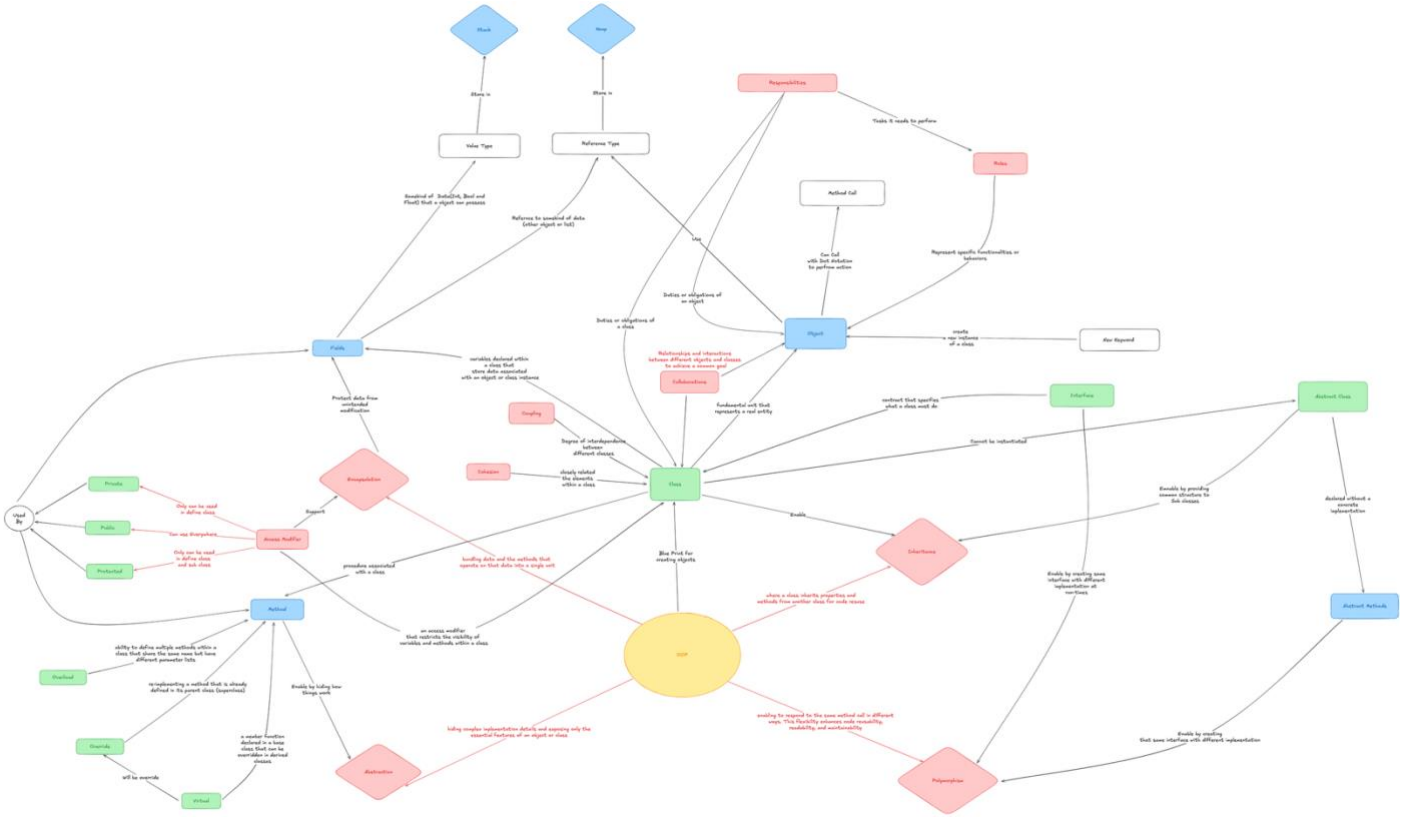
```
try
{
    Console.Write("Enter your age: ");
    string userInput = Console.ReadLine();
    int age = int.Parse(userInput);

    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



References

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