

Object Oriented Programming

Week 04

Abstract Classes, Interfaces and
Exception Handling

Learning Outcomes

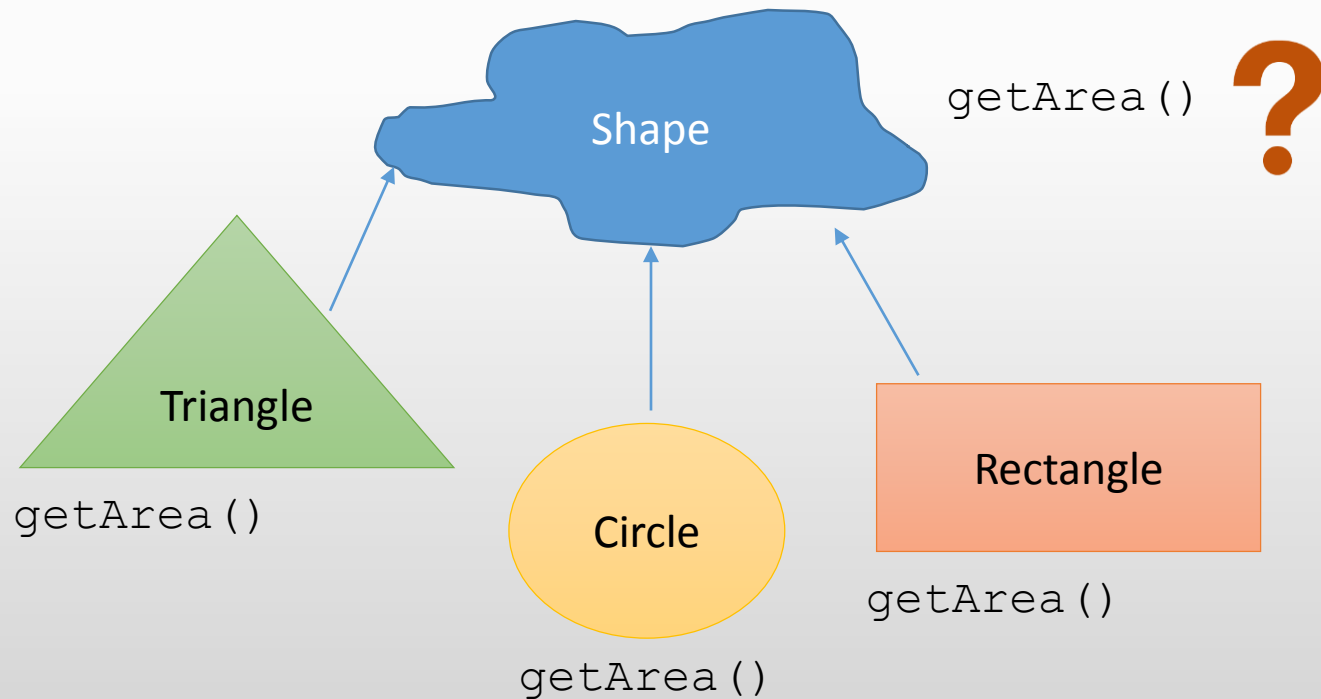
At the end of the Lecture students should be able to apply the following concepts in the programs that you write.

- Abstract Classes
- Interfaces
- Exception Handling – Catching runtime Errors
- Packages
- Access Modifiers default

Abstract Classes

- Used in situations in which you will want to define a superclass where some methods don't have a complete implementation.
- We are expecting the sub classes will implement these abstract methods.
- This situation is applicable when a superclass is unable to create a meaningful implementation for a method. e.g an `getArea()` method of a `Shape` class.

Abstract Class



Abstract Classes

- Refer the following class called Shape.

```
class Shape {  
    public double getArea() {  
        // How to Implement this code  
    }  
}
```

- Any Shape has an area. So that class shape can contain a method called getArea()

But how to calculate the area of a shape?

If we are asked to calculate the area of a circle, then we know how to calculate the area of a circle.

```
class Circle extends Shape {  
    double radius;  
    public double getArea() {  
        return Math.PI * radius * radius;  
    }  
}
```

Abstract Classes

- getArea() method will have different implementations depending on the child class.
- Class Shape behave as a super class.
- Any shape has an area. So that class Shape can contain a method called getArea().
- But implementing getArea() method is possible only when we know the child class.
- The implementation of getArea() method is different from one child class to another.

```
class Rectangle extends Shape {  
    double width, height;  
    public double getArea() {  
        return width * height;  
    }  
}
```

Abstract Class

- The methods which cannot be implemented MUST be defined as abstract.

```
abstract class Shape {  
    abstract public double getArea();  
}
```

- An abstract method does not have a method implementation (**not even { }**).
- We cannot invoke (call) an abstract method.
- The class which contain at least one abstract method MUST be defined abstract

Abstract Class

- Every child class **MUST** override all the abstract methods of the parent class.
- If a child class did not override all the abstract method of the parent, then the child class also become abstract.

Abstract Classes

- Cannot create instances (objects) from an abstract class.
- Abstract Classes force the child class to contain methods defined by the parent class.
- Their purpose is to behave as parent (base) classes.
- Abstract classes are very generic
- Usually a class hierarchy is headed by an abstract class
- Classes from which objects can be instantiated - concrete
- The ability to create abstract methods is powerful – each new class that inherits is forced to override these methods.
ex. Mouse clicks and drags

Abstract Classes

- An abstract class can behave as a data type.

Shape s1; ← Correct

- But cannot create instances (object) from an abstract class.

s1 = new Shape(); ← Wrong

- But super class variables can refer to child class objects.

s1 = new Circle();
Shape s2 = new Rectangle() ← Correct

- Can call the getArea() method belongs to the child.

s1.getArea();
s2.getArea(); ← Correct
But the two method calls will perform two different actions

Coding exercise

- Let's try out the first coding exercise!
- Assume that you need to create a class **Animal** that has a two methods **eat()** and **makeSound()** and the subclasses **Dog** and **Cat**. Implement the three classes and necessary methods using the concept of the abstract classes. The implemented classes should be capable of creating the given program and generating the given output.

Program

```
Animal dog = new Dog();
```

```
dog.eat();
```

```
dog.makeSound();
```

```
Animal cat = new Cat();
```

```
cat.eat();
```

```
cat.makeSound();
```

Output

```
I am eating
```

```
Woof woof
```

```
I am eating
```

```
Meaw meaw
```

Sample answer

```
public abstract class Animal {  
    public void eat() {  
        System.out.println("I am eating");  
    }  
  
    abstract void makeSound();  
}
```

```
public class Dog extends Animal{  
  
    void makeSound() {  
        System.out.println("Woof woof");  
    }  
}
```

```
public class Cat extends Animal{  
  
    void makeSound() {  
        System.out.println("Meow Meow");  
    }  
}
```

Sample Answer

```
public class AnimalMain {  
    public static void main(String[] args) {  
        Animal dog = new Dog();  
        dog.eat();  
        dog.makeSound();  
  
        Animal cat = new Cat();  
        cat.eat();  
        cat.makeSound();  
    }  
}
```

```
I am eating  
Woof woof  
I am eating  
Meow Meow
```

Interfaces

- Is a contract between a class and the outside world.
- When a class implements an interface it promises to provide the behavior in the interface (Implement the methods specified in the interface).
 - Similar to abstract class but all methods are abstract
- **Interfaces can also store constants.** These are essentially public static final variables.

Interfaces

```
interface Callback {  
    void callback(int param);  
}  
  
class Client implements Callback {  
    // Implement Callback's interface  
    public void callback(int p) {  
        System.out.println("callback called with " + p);  
    }  
    void nonIfaceMeth() {  
        System.out.println("Classes that implement interfaces " +  
                           "may also define other members, too.");  
    }  
}
```

Interface.java

Interfaces

- Are fully abstract classes.
- Similar to classes, but
All the methods in an interface are defined with out a body.
- Methods are automatically abstract
- Cannot contain class variables. But can contain constants (final variables)

```
interface Inter1 {  
    int COUNT = 10;  
    void test1();  
    void test2();  
}
```


Interfaces

```
class Test implements Inter1 {  
    public void test1() {  
    }  
    public void test2() {  
    }  
}
```

Must Implement all
methods in
Interface
(otherwise should
be defined as an
abstract class)

Access level must be
public

Coding exercise

- Let's try a coding exercise!
- Create the `Printable` interface. Create two classes `Employee` and `Book` with suitable attributes. Have a constructor to assign attributes.
- Implement the printable interface in the `Employee` and `Book` class.
- Create `MyMain` class with a `main` method and create objects of the `Book` and `Employee` classes.
- Print the details of the book and the employee.

```
interface Printable {  
    void print();  
}
```

Sample answer

```
public interface Printable {  
    void print();  
}
```

```
public class Book implements Printable{  
    private int id;  
    private String name;  
    private String author;  
  
    public Book(int id, String name, String author) {  
        this.id = id;  
        this.name = name;  
        this.author = author;  
    }  
  
    public void print() {  
        System.out.println("Id: "+id);  
        System.out.println("Name: "+name);  
        System.out.println("Author: "+author);  
        System.out.println();  
    }  
}
```

```
public class Employee implements Printable{  
    private int id;  
    private String name;  
    private String address;  
  
    public Employee(int id, String name, String address) {  
        this.id = id;  
        this.name = name;  
        this.address = address;  
    }  
  
    public void print() {  
        System.out.println("Id: "+id);  
        System.out.println("Name: "+name);  
        System.out.println("Address: "+address);  
        System.out.println();  
    }  
}
```

Sample answer

```
public class MyMain {  
  
    public static void main(String[] args) {  
        Printable printable = new Employee(1, "Amal", "Matara");  
        printable.print();  
  
        printable = new Book(1, "Amba Yahaluwo", "T.B. Ilangaratne");  
        printable.print();  
    }  
}
```

```
Id: 1  
Name: Amal  
Address: Matara
```

```
Id: 1  
Name: Amba Yahaluwo  
Author: T.B. Ilangaratne
```

Interfaces

- A Class can implement any number of interfaces.

```
class Test implements Inter1, Inter2, Inter3 {
```

- The class MUST override all the methods mentioned in all the interfaces.
- If the class did not override at least one method of the interfaces then the class become abstract.

Interfaces

- Java do not allow multiple inheritance.



```
class PartTimeStudent extends Employee, Student {  
    -  
}
```

- Classes can extend exactly one class and implement any number of interfaces.



```
class PartTimeStudent implements Employee, Student {  
    -  
}
```

- Using interfaces we can achieve some thing similar to multiple inheritance.
- An interface can extends another interface.

Interfaces

- Interfaces are designed to support dynamic method resolution at run time.
- it is possible for classes that are unrelated in terms of the class hierarchy to implement the same interface. This is where the real power of interfaces is realized.

Abstract classes vs Interfaces

- Use an abstract class if
 - You want to share the code.
 - Expect to have common methods or properties
 - You want to have access modifiers other than public
 - You want to have properties which not static or not final
- Use an interface if
 - You want Unrelated classes to implement the interfaces.
 - Want to take advantages of multiple inheritances

Data access control

- **Member access modifiers** – control access to class members through the keywords **public**, **protected**, **default (friendly, no specifier)** and **private**
- **public** – members declared as public are accessible from anywhere in the program when the object is referenced.
- **protected** – subclasses can access protected method/data from the parent class.
- **Default** – such a class, method, or field can be accessed by a class inside the same package only.
- **private** – members declared as private are accessible *ONLY* to methods of the class in which they are defined. All private data are always accessible through the methods of their own class.
- **USUALLY: data (instance variables)** are declared **private**, **methods** are declared **public**.
- **NOTE:** using **public data** is uncommon and **dangerous** practice

Controlling access – Class member

Same class

Member Restriction	this	Subclass	Package	General
public	✓	✓	✓	✓
protected	✓	✓	✓	—
default	✓	—	✓	—
private	✓	—	—	—

Here a member is either a property or a method.

Java Packages

- *Packages* are containers for classes. They are used to keep the class name space compartmentalized.
- For example, a package allows you to create a class named **List**, which you can store in your own package without concern that it will collide with some other class named **List** stored elsewhere.
- Packages are stored in a hierarchical manner and are explicitly imported into new class definitions.

Java Packages

- The Java Package name consists of words separated by periods. The first part of the name represents the organization which created the package. The remaining words of the Java Package name reflect the contents of the package. The Java Package name also reflects its directory structure.
- Importing a Class from an Existing Java Package Through the import statement.
 - * - all classes
- Example **`import java.io.*;`**
`import java.awt.Font;`
- CANNOT import a package, only a class:
`import java.io;` - wrong!

Default Packages

- If a class is in the same package as the class that uses it, it does not need **import** statement.
- **Default package** - all the complied classes in the current directory. If a package is not specified, the class is placed in the default package.

Java Standard Packages

Package Name	Description java.lang is imported by default
java.lang	Contains language support classes (for e.g classes which defines primitive data types, math operations, etc.) . This package is automatically imported.
java.io	Contains classes for supporting input / output operations.
java.util	Contains utility classes which implement data structures like Linked List, Hash Table, Dictionary, etc and support for Date / Time operations.
java.applet	Contains classes for creating Applets.
java.awt	Contains classes for implementing the components of graphical user interface (like buttons, menus, etc.).
java.net	Contains classes for supporting networking operations.