Object-oriented Programming in Java

Session: 11

Design Patterns

Objectives

- Describe polymorphism
- Describe the procedure to override methods of the Object class
- Explain design patterns
- Describe the Singleton, Data Access Object (DAO), and Factory and Observer design patterns
- Describe delegation
- Explain composition and aggregation

Introduction

- The concept of polymorphism can be applied to Java.
- In Java, a subclass can have its own unique behavior even while sharing certain common functionalities with the parent class.

Implementing Polymorphism [1-4]

- A super class named `Car` has been created having two methods, `accelerate()` and `printDescription()`.
- A sub class named `LuxuryCar` is created based on `Car` and overrides the methods of the `Car` class.

Code Snippet

```
class LuxuryCar extends Car {
 // LuxuryCar defines an additional feature named perks
 public String perks;
 public LuxuryCar(int mileage, String color, String make,
String perks)
 {
 super(mileage, color, make);
 this.perks = perks;
 }
```

Implementing Polymorphism [2-4]

```
public void accelerate() {
 System.out.println("Luxury Car is Accelerating");
 }
 public void printDescription() {
 super.printDescription();
 System.out.println("The " + "Luxury car is a: " +
this.perks +
 ".");
 }
}
```

Implementing Polymorphism [3-4]

Code Snippet 2 creates two instances of type `Car`, instantiates them, and invokes the `accelerate()` and `printDescription()` methods on each instance respectively.

Code Snippet

```
public class PolymorphismTest {
 /**
 * @param args the command line arguments
 */
 public static void main(String[] args) {
 Car objCar, objLuxuryCar;
 objCar = new Car(80, "Red", "BMW");
 objLuxuryCar = new LuxuryCar(120, "Yellow", "Ferrari",
"Sports
 Car");
```

Implementing Polymorphism [4-4]

```
objCar.accelerate();
 objCar.printDescription();
 //System.out.println("Now inside LuxuryCar");
 objLuxuryCar.accelerate();
 objLuxuryCar.printDescription();
 }
}
```

Overriding the Methods of Object Class [1-12]

- `Object` is the root class.
- Its methods can be overridden by any class (unless the methods are marked as final).
- Following are the methods that can be overridden with a different functionality as compared to the root class:
  - `public boolean equals(Object obj)`
  - `public int hashCode()`
  - `public String toString()`
- The `equals()` method compares two objects to determine if they are equal.
- There are two different types of equality. They are:
  - `Reference equality`
  - `Logical equality`
- Reference equality is when the physical memory locations of the two strings are same.
- Logical equality is when data in the objects are the same.

Overriding the Methods of Object Class [2-12]

Code Snippet

```
public class EqualityTest {
 /**
 * @param args the command line arguments
 */
 public static void main(String[] args) {
 String strAObj = new String("JOHN");
 String strBObj = new String("JOHN");
String strCObj = new String("ANNA");
String strEObj = strAObj;
 System.out.println(strAObj == strBObj);
 System.out.println(strAObj == strCObj);
 System.out.println(strAObj == strEObj);
 }
}
```

Overriding the Methods of Object Class [3-12]

- The equality operator (==) compares the memory addresses of the two strings.
- When `strAObj` is compared to `strBObj`, the result is false, although their value is same, which is `JOHN`.
- A comparison between `strAObj` and `strCObj` returns false because the references of the two different String objects are different addresses.
- When strAObj is compared to strEObj, the result is true because they point to the same memory location.
- The Code Snippet displays the following output:

```
run:
false
false
true
BUILD SUCCESSFUL (total time: 0 seconds)
```

Overriding the Methods of Object Class [4-12]

Code Snippet

```
public class LogicalEqualityTest {
 /**
 * @param args the command line arguments
 */
 public static void main(String[] args) {
// TODO code application logic here
String strAObj = new String("JOHN");
String strBObj = new String("JOHN");
String strCObj = new String("ANNA");
 // Create a String reference and assign an existing
 // String's reference
 // to it so that both references point to the same
 // String object in memory.
 String strEObj = strAObj;
```

Overriding the Methods of Object Class [5-12]

```
// Print the results of the equality checks
 System.out.println("============================");
 System.out.println("Logical or Value Equality");
 System.out.println("============================");
 //Tests logical or value equality
 System.out.println(strAObj.equals(strBObj));
 System.out.println(strAObj.equals(strCObj));
 System.out.println(strAObj.equals(strEObj));
 }
}
```

Overriding the Methods of Object Class [6-12]

- The `equals()` method is used to check for logical equality.
- Note that the `equals()` method is implicitly inherited from the `Object` class.
- The `String` class overrides the `equals()` method and compares the two String objects character by character.
- The Code Snippet displays the following output:

```
run:
================================
Reference Equality
================================
false
false
true
================================
Logical Equality
================================
true
false
true
BUILD SUCCESSFUL (total time: 0 seconds)
```

Overriding the Methods of Object Class [7-12]

- The `hashCode()` method of `Object` class returns the object's memory address in hexadecimal format.
- It is used along with the `equals()` method in hash-based collections such as Hashtable.
- If two objects are equal, their hash code should also be equal.

Code Snippet

```
public class Student
{
 private int ID;
 public int getID()
 {
Scanner sc = new Scanner(System.in);
System.out.println("Enter values");
int ID = Integer.parseInt(sc.nextLine());
return ID;
}
```

Overriding the Methods of Object Class [8-12]

```
public boolean equals(Object obj)
{
 if (getID() == ((Student)obj).getID())
 return true;
else
 return false;
}
public int hashCode()
{
 return ID;
}
/**
 * @param args the command line arguments
*/
```

Overriding the Methods of Object Class [9-12]

```
public static void main(String[] args)
{
 Student s1 = new Student();
 Student s2 = new Student();
if (s1.equals(s2))
System.out.println("The two ID values are equal");
else
 System.out.println("The two ID values are not
equal");
}
}
```

Overriding the Methods of Object Class [10-12]

- The `Student` class defines three methods in addition to `main()` method.
- The `getID()` method accepts an ID value from the standard input.
- The overridden `equals()` method accepts a parameter of type `Object`.
- It compares the ID value of this object with the ID value of the current object.
- The overridden `hashCode()` method returns the ID value.
- In the `main()` method, two objects of `Student` class, namely, `s1` and `s2` are created.
- The `equals()` method is invoked on `s1` and the object `s2` is passed as a parameter.
- Depending on the user input, the output will be displayed accordingly.

Overriding the Methods of Object Class [11-12]

- The `toString()` method of `Object` class returns a string representation of the object.
- It is typically used for debugging.

Code Snippet

```
public class Exponent {
 private double num, exp;
 public Exponent(double num, double exp) {
 this.num = num;
 this.exp = exp;
 }
 /* Returns the string representation of this
number.
 The format of string is "Number + e Value" where
Number is the
 number value and e Value is the exponent part.
```

Overriding the Methods of Object Class [12-12]

```
@Override
 public String toString() {
 return String.format(num + "E+" + exp);
 }
/**
 * @param args the command line arguments
*/
public static void main(String[] args) {
Exponent c1 = new Exponent(10, 15);
 System.out.println(c1);
 }
}
```

The instanceof Operator [1-5]

- The `instanceof` operator is used to compare an object to a specified type such as instance of a class and an instance of a subclass.

Code Snippet

```
class Employee {
 int empcode;
 String name;
 String dept;
 int bonus;
}
class Manager extends Employee {
 String name;
 int mgrid;
}
```

The instanceof Operator [2-5]

```
public class Square {
 /**
 * @param args the command line arguments
 */
 public static void main(String[] args) {
Employee emp1 = new Employee();
 Scanner sc = new Scanner(System.in);
 System.out.println("Enter values");
 emp1.name = sc.nextLine();
 Employee m1 = new Manager();
 m1.name = sc.nextLine();
 if (emp1 instanceof Employee) {
 emp1.bonus = 7000;
 System.out.println(emp1.name + " is an employee and
has bonus
 "+emp1.bonus);
```

The instanceof Operator [3-5]

```
 if (emp1 instanceof Manager) {
 emp1.bonus = 12000;
 System.out.println(emp1.name + " is a manager and
has bonus
 "+emp1.bonus);
 }
 if (m1 instanceof Employee) {
 m1.bonus = 7000;
 System.out.println(m1.name + " is an employee and
has bonus "+
 m1.bonus);
 }
```

The instanceof Operator [4-5]

```
if (m1 instanceof Manager) {
 m1.bonus = 12000;
 System.out.println(m1.name + " is a manager and has
bonus "+
 m1.bonus);
  }
  }
}
```

The instanceof Operator [5-5]

- The code defines the following:
  - Parent class, `Employee`
  - Child class, `Manager` that inherits from the parent
- The following displays the output of the code:

```
run:
Enter values
Jake Kreston
Peter Smith
Jake Kreston is an employee and has bonus 7000
Peter Smith is an employee and has bonus 7000
Peter Smith is a manager and has bonus 12000
BUILD SUCCESSFUL (total time: 12 seconds)
```

Design Patterns [1-10]

- A design pattern is a clearly defined solution to problems that occur frequently.
- Design pattern are based on the fundamental principles of object oriented design.
- Following are the different types of design patterns:
  - Creational Patterns
  - Structural Patterns
  - Behavioral Patterns
- Singleton pattern is a type of creational pattern.
- The singleton design pattern provides complete information on such class implementations.

Design Patterns [2-10]

- Consider the following when implementing the singleton design pattern:
  - The reference is finalized so that it does not reference a different instance.
  - The private modifier allows only same class access and restricts attempts to instantiate the singleton class.
  - The factory method provides greater flexibility. It is commonly used in singleton implementations.
  - The singleton class usually includes a private constructor that prevents a constructor to instantiate the singleton class.
  - To avoid using the factory method, a public variable can be used at the time of using a static reference.

Design Patterns [3-10]

Code Snippet

```
class SingletonExample {
 private static SingletonExample singletonExample = null;
 private SingletonExample() {
 }
 public static SingletonExample getInstance() {
 if (singletonExample == null) {
    singletonExample = new SingletonExample();
 }
   return singletonExample;
 }
 public void display() {
   System.out.println("Welcome to Singleton Design
   Pattern");
 }
}
```

Design Patterns [4-10]

- The `SingletonExample` class contains a private static `SingletonExample` field.
- There is a private constructor.
- The public static `getInstance()` method returns the only `SingletonExample` instance.
- There is a public `sayHello()` method that can test the singleton.

Code Snippet

```
public class SingletonTest {
 /**
 * @param args the command line arguments
 */
 public static void main(String[] args) {
 SingletonExample singletonExample =
SingletonExample.getInstance();
 singletonExample.display();
 }
}
```

- The `display`() method is called on the singleton class.
- The output of the program is "`Welcome to Singleton Design Pattern`".

Design Patterns [6-10]

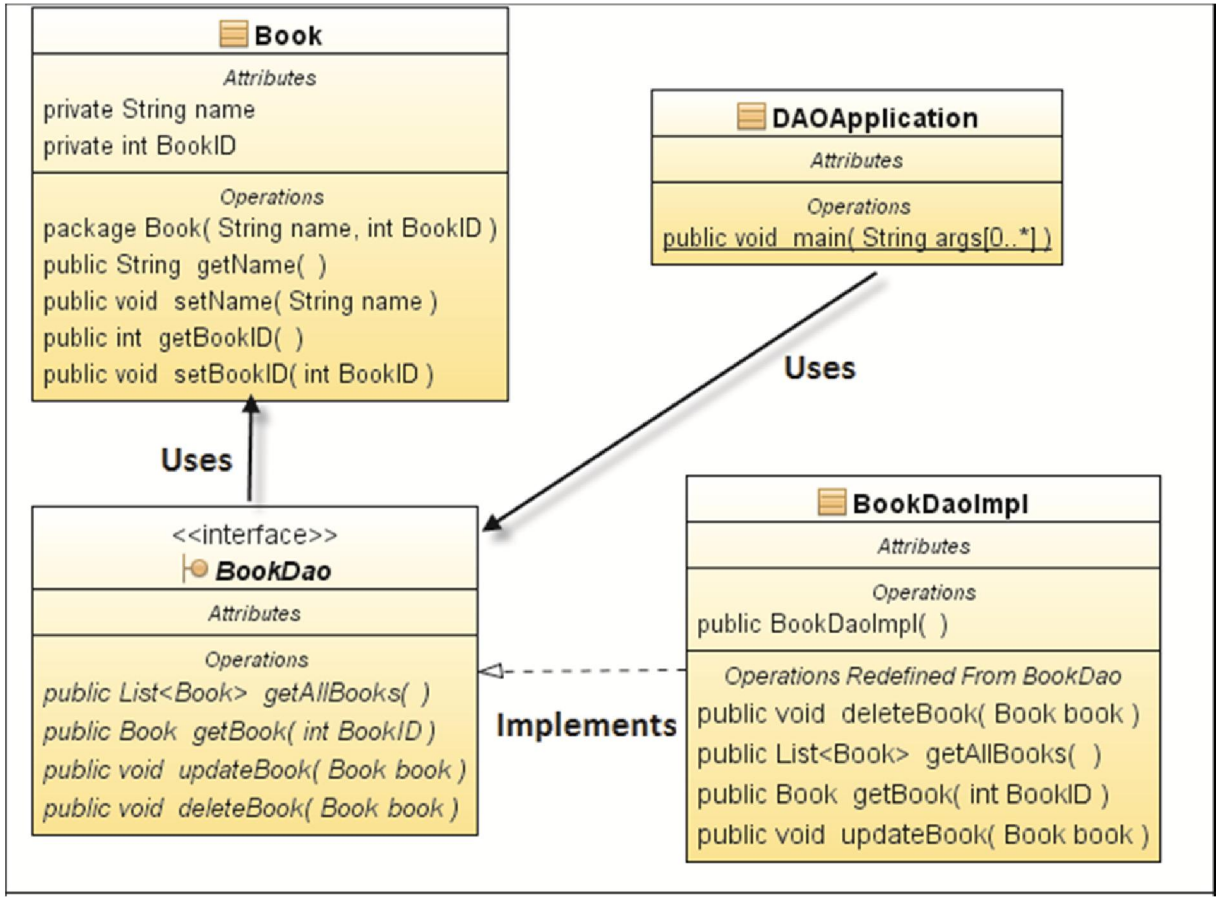
- In Java, interfaces include constant fields.
- They can be used as reference types.
- They are important components of many design patterns.
- An interface declaration includes the following:
  - Modifiers
  - The keyword interface
  - The interface name
  - A comma-separated list of parent interfaces that it can extend
  - The interface body

Design Patterns [7-10]

- The Data Access Object (DAO) pattern is used when an application is created that needs to persist its data.
- The DAO pattern involves a technique for separating the business logic from persistence logic.
- The DAO pattern uses the following:
  - DAO Interface
  - DAO Concrete Class
  - Model Object or Value Object

Design Patterns [8-10]

The following figure shows the structure of a DAO design pattern:



Design Patterns [9-10]

Factory Pattern:

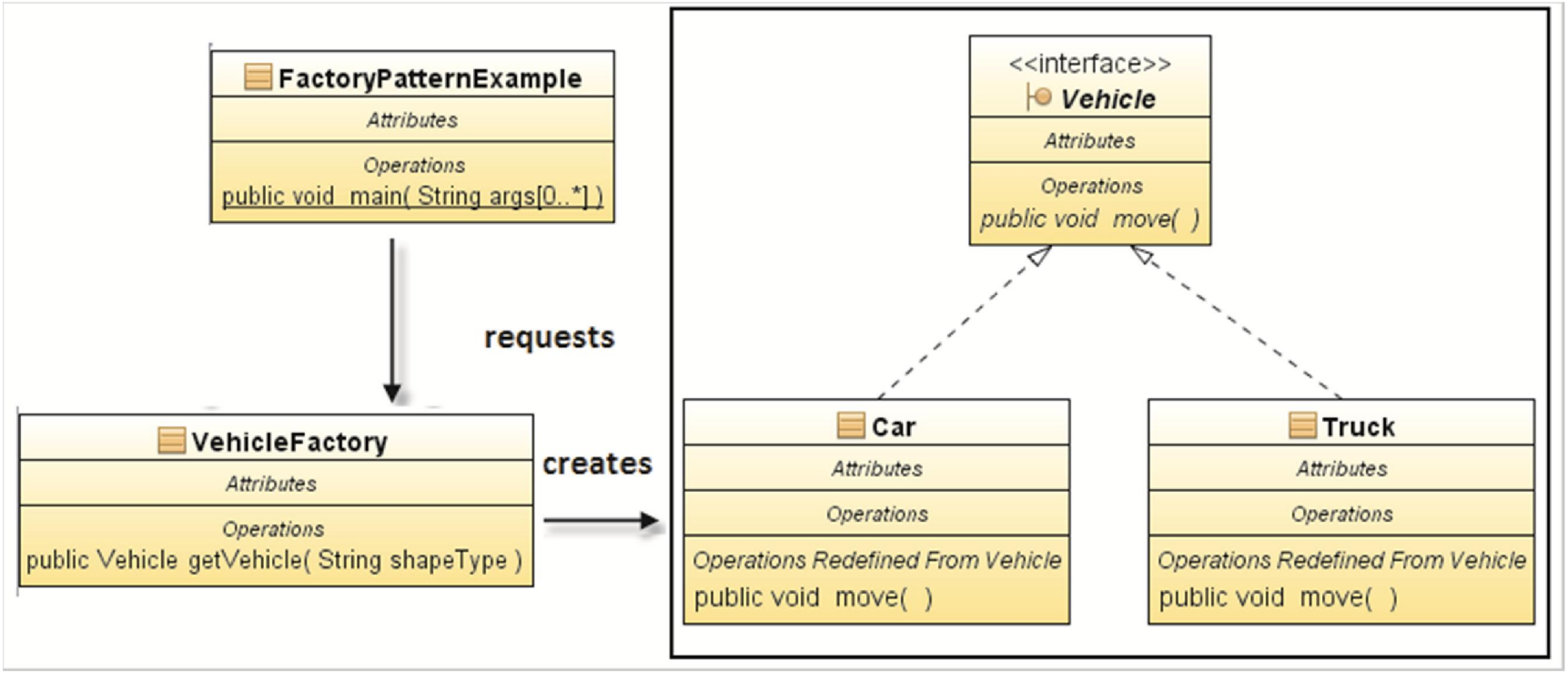
- It is one of the commonly used design patterns in Java.
- It belongs to the creational pattern category.
- This pattern does not perform direct constructor calls when invoking a method.

Observer Pattern:

- This helps to observe the behavior of objects such as change in state or change in property.
- Here, an object called the subject maintains a collection of objects called observers.
- Whenever the subject changes, it notifies the observers.
- Observers can be added or removed from the collection of observers in the subject.

Design Patterns [10-10]

The following figure shows the factory pattern diagram:



Delegation

- Delegation is a relationship between objects.
- Here, one object forwards method calls to another object, which is called its delegate.
- Unlike inheritance, delegation does not create a super class.
- Delegation does not force to accept all the methods of the super class.
- Delegation supports code reusability and provides run-time flexibility.

Composition and Aggregation [1-6]

- Composition refers to the process of composing a class from references to other objects.
- Composition forms the building blocks for data structures.
- Programmers can use object composition to create more complex objects.
- In aggregation, one class owns another class.
- In composition, when the owning object is destroyed, so are the objects within it but in aggregation, this is not true.
- Composition and aggregation are design concepts and not actual patterns.

Composition and Aggregation [2-6]

Code Snippet

```
// Composition
class House
{
   // House has door.
   // Door is built when House is built,
   // it is destroyed when House is destroyed.
   private Door dr;
};
```

To implement object composition, perform the following steps:

- Create a class with reference to other classes.
- Add the same signature methods that forward to the referenced object.

Composition and Aggregation [3-6]

- Consider an example of a student attending a course.
  - The student 'has a' course.
  - The composition for the **`Student`** and **`Course`** classes is depicted in the following Code Snippet:

Code Snippet

```
package composition;
 public class Course {
  private String title;
  private long score;
  private int id;

  public String getTitle() {
     return title;
  }
```

Composition and Aggregation [4-6]

```
  public void setTitle(String title) {
      this.title = title;
  }
  public long getScore() {
      return score;
  }
  public void setScore(long score) {
      this.score = score;
  }
  public int getId() {
      return id;
  }
  public void setId(int id) {
      this.id = id;
  }
}
```

Composition and Aggregation [5-6]

```
package composition;
 public class Student {
    //composition has-a relationship
    private Course course;
    public Student(){
      this.course=new Course();
      course.setScore(1000);
 }
 public long getScore() {
   return course.getScore();
 }
 /**
 * @param args the command line arguments
 */
```

Composition and Aggregation [6-6]

```
public static void main(String[] args)
 {
    Student p = new Student();
    System.out.println(p.getScore());
 }
}
```

Summary

- The development of application software is performed using a programming language that enforces a particular style of programming, also referred to as programming paradigm.
- In structured programming paradigm, the application development is decomposed into a hierarchy of subprograms.
- In object-oriented programming paradigm, applications are designed around data, rather than focusing only on the functionalities.
- The main building blocks of an OOP language are classes and objects. An object represents a real-world entity and a class is a conceptual model.
- Java is an OOP language as well a platform used for developing applications that can be executed on different platforms. Java platform is a software-only platform that runs on top of the other hardware-based platforms.
- The editions of Java platform are Java SE, Java EE, and Java ME.
- The components of Java SE platform are JDK and JRE. JRE provides JVM and Java libraries that are used to run a Java program. JDK includes the necessary development tools, runtime environment, and APIs for creating Java programs.