SmartCliff
CAREER MOBILITY SOLUTIONS

SDE Readiness Training

Empowering Tomorrow's Innovators

Module I

Java Software Development: Effective Problem Solving

SmartCliff
Career Mobility Solutions

Object Oriented Programming (OOP) Concepts

Learning Level : Basics

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Contents

Inheritance

Introduction

- **Inheritance** is one of the important features of Object-Oriented Programming which allows you to create **hierarchical classifications.**
- Inheritance represents the **IS-A relationship** which is also known as a ***parent-child*** relationship.
- Inheritance is the process of **acquiring the properties** from one class (**Parent class**) to other classes (**child classes**).
- With the help of inheritance, we can create a more **general class** (**Parent class**) at the top and it may then be inherited by other more **specific classes** (**Child classes**).
- **Child classes** will have the **properties of parent class** and its **own attributes and behaviors** that are unique to it as well.

Important Terminologies

- **Class:** Class is a **template or blueprint** of the objects. It defines the state (variables) and behaviour (methods) common to all objects of a certain kind.
- **Subclass/Child class:** Subclass is a class which inherits the other class. It is also called a **derived class, extended class, or child class.**
- **Super Class/Parent Class:** Super class is the class from where a subclass inherits the features. It is also called a **base class or a parent class**.

Example #1

Grand Dad

House - owns

Inherited from

Dad

House - derives

Car - owns

Inherited from

Son

House - derives

Car - derives

Bike - owns

Example #2

Parent Class

Super Hero Common characteristics

Speed
Strength
Durability
Agility

Spiderman IS-A Super Hero

Child Classes

•extrasensory and vision powers
•freezing breath

•Genius-level intellect
•detective
•strategist

•ability to cling
•spider-sense
•web-shooters

•Supersonic flight
Energy repulsor
•missile projection
Regenerative life support

Need

- **Reusability:** It is a mechanism which facilitates you to **reuse the fields and methods** of the existing class. As the name implies, the child **inherits characteristics** of the parent.
- There is **less code** duplication.
- **Code modification** can be done once for **all subclasses**.

The syntax of Java Inheritance

Syntax

```
class SubClass-name extends SuperClass-name {

   //methods and fields  of subclass


}
```

- The **extends** keyword denotes that a **subclass is derived from an existing super class**. It indicates that you are extending the functionality of an existing class.

Association Vs Aggregation Vs Composition Relationship

- An **association relationship** between **two or more objects.** It refers to **how objects are related to each other** and how they are **using each other's functionality**.
- Association refers to the relationship between multiple objects.
- Association relationship can be **one-to-one, one-to-many, many-to-one, or many-to-many**.

Example

- 

A and B calls each other (one-to-one)
- 

(one-to-many)
- 

(many-to-one)
- 

(many-to-many)
- **Aggregation** and **Composition** are two types of association.

Association Vs Aggregation Vs Composition Relationship

- **Aggregation** is a **weak association**. An association is said to be aggregation if **both objects can exist independently.**
- It is a **unidirectional association** i.e., a one-way relationship.
- In Aggregation, both the entries can **survive individually** which means **ending one entity will not affect the other entity.**

Example

- 

A has-an instance of B; B can exist without A
- A Team object and a Player object. The team contains multiple players, but a player can exist without a team.

Association Vs Aggregation Vs Composition Relationship

- The **composition** is the **strong type of association**.
- An association is said to composition if an **object owns another object**, and **another object cannot exist without the owner object**.
- In composition, **both the entities are dependent on each other**.

Example

- 

A has-an instance of B; B can not exist without A
- Human object contains the heart and heart cannot exist without Human.

Types of Inheritance

Below are the types of inheritance.

- Single Inheritance
- Multilevel Inheritance
- Multiple Inheritance
- Hierarchical Inheritance
- Hybrid Inheritance

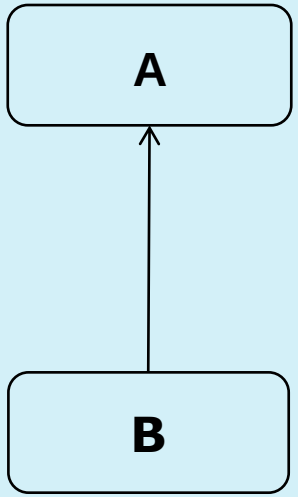
Note:

- Java supports Single, Multilevel and Hierarchical inheritance directly, but Multiple and Hybrid inheritance can be achieved through Interfaces.

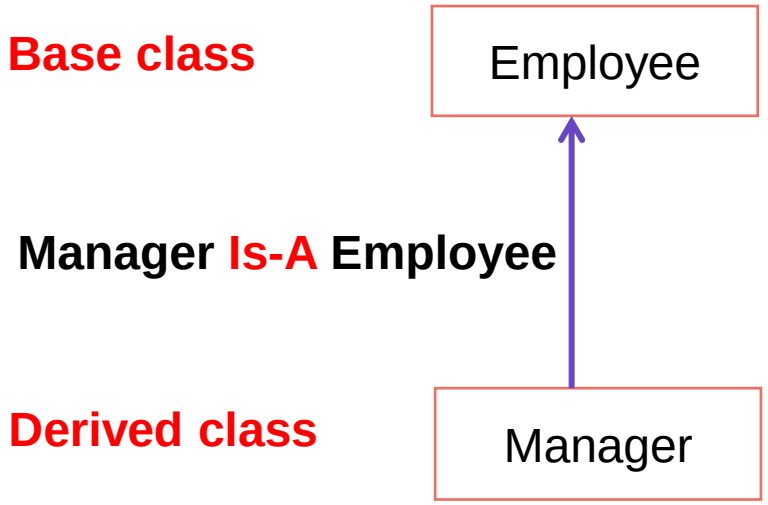
Single Inheritance

- Single inheritance is the concept of deriving the **properties and behaviours** from single base (parent) class
- **Syntax:**

```
class A{
 ....
 ....
}
class  B extends A{
 ....
 ....
}
```



Example:



Single Inheritance – Example

```
/** This example demonstrates single inheritance concept **/

class Employee {                //parent class
        String empName;
        int empId;
        void setData(String name, int id){   // base class method
                empName=name;
                empId=id;
        }
        void displayData(){                   // base class method
                System.out.println("Employee Name:"+empName);
                System.out.println("ID:"+empId);
        }
}
```

Single Inheritance – Example

```
class Manager extends Employee {          //child class
        String empDept;
        void setDept(String dept) {          //sub class method
                empDept = dept;
        }
        void displayDept(){                        //sub class method
                System.out.println("Department:"+dept);
        }
}
```

Single Inheritance – Example

```
public class SingleInheritanceDemo{
        public static void main(String args[]){
                Manager m=new Manager();          //child class object
                m.setData("Arun", 123);  //access base class members
                m.setDept("Marketing");
                m. displayData();  //access base class members
                m. displayDept();
        }
}
```

Output

Employee Name: Arun

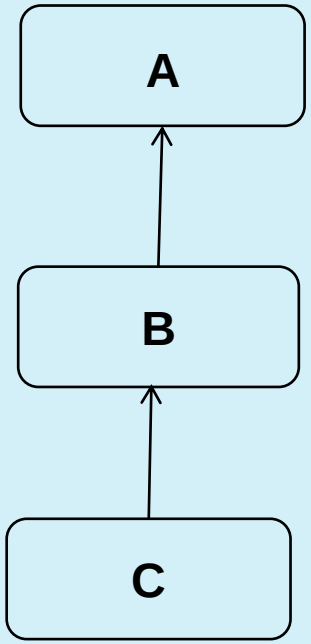
ID:123

Department: Marketing

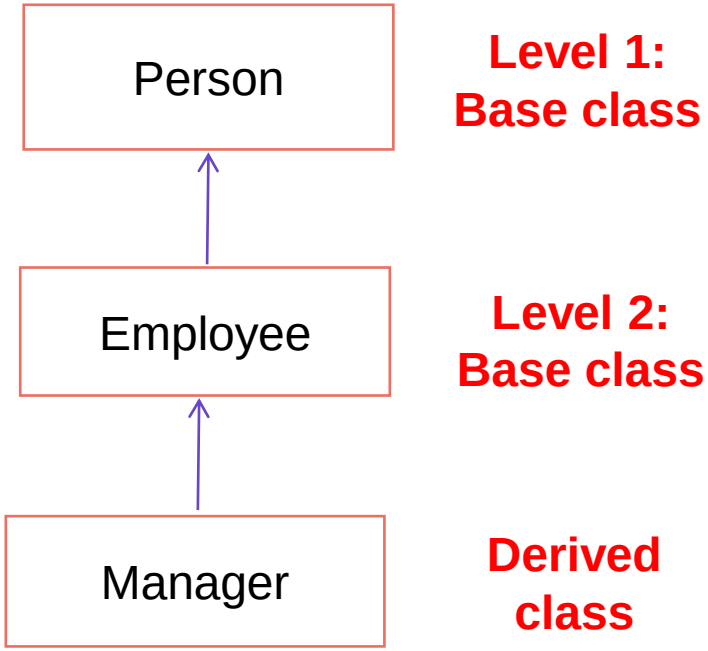
Multilevel Inheritance

- In the case of multi-level inheritance, a subclass that is inheriting one **parent class will also act as the base class** for another class.
- **Syntax:**

```
class A{
  ....
 }
class  B extends A{
  ....
  ....
}
class  C extends B{
  ....
  ....
 }
```



Example:



Multilevel Inheritance- Example

```
/**   * This example demonstrates Multilevel inheritance concept **/

class Person {                    //Level 1:Base class
        String name;
        int age;
        void setPersonData(String name, int age){
                this.name=name;
                this.age=age;
        }
        void displayPersonData() {
                System.out.println("Name:"+name);
                System.out.println("Age:"+age);
        }
}
```

Multilevel Inheritance- Example

```
class Employee  extends Person{        //Level 2:Base class
        int empId;
        void setEmpData(String id){
                empId=id;
        }
        void displayEmpData(){
                System.out.println("ID:"+empID);
        }
}
```

Multilevel Inheritance- Example

```
class Manager extends Employee {          //child class
        String dept;
        float sal;
        void setManagerData(String depart, float salary){
                dept = depart;
                sal=salary;
        }
        void displayManagerData(){
                System.out.println("Department:"+dept);
                System.out.println("Salary :"+ sal);
        }
}
```

Multilevel Inheritance- Example

```
public class MlevelInherDemo{
        public static void main(String args[]) {
                Manager m=new Manager();          //child class object
                m.setPersonData("Arun", 34);
                m.setEmpData("M123");
                m.setManagerData("Marketing",60000);
                m.displayPersonData();
                m.displayEmpData();
                m.displayManagerData();
        }
}
```

Output

Name: Arun

Age:34

ID:M123

Department: Marketing

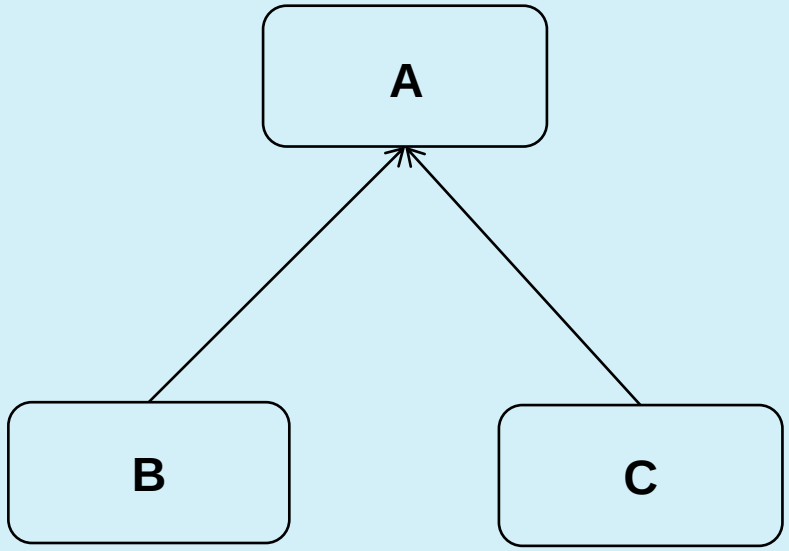
Salary :60000.0

Hierarchical Inheritance

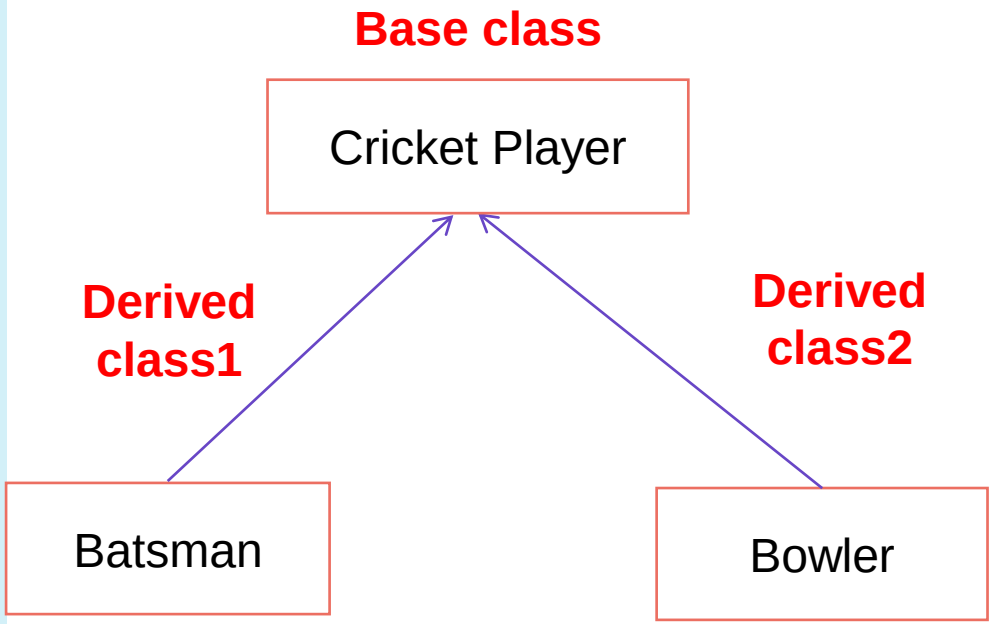
- In Hierarchical Inheritance concept, there is **one base class for multiple subclasses**.

Syntax:

```
class A{
 ....
 ....
  }
class  B extends A{
 ....
 ....
}
class  C extends A{
 ....
 ....
 }
```



Example:



Hierarchical Inheritance – Example

```
/**
 * This example demonstrates Hierarchical inheritance concept **/
class CricketPlayer {                    //Base class
        String playerName;
        String teamName;
        void setPlayerData(String playerName, String teamName){
                this.playerName=playerName;
                this.teamName=teamName;
        }
        void displayPlayerData() {
                System.out.println(" Player Name:"+playerName);
                System.out.println("Team Name:"+teamName);
        }
}
```

Hierarchical Inheritance – Example

```
class Batsman extends CricketPlayer {                    //Derived class 1
        int hScore;
        float batAvg;

        void setBatsmanData(int hScore, float batAvg){
                this.hScore=hScore;
                this.batAvg=batAvg;
        }
        void displayBatsmanData(){
                System.out.println(" Highest Score:"+hScore);
                System.out.println("Batting Average:"+batAvg);
        }
}
```

Hierarchical Inheritance – Example

```
class Bowler extends CricketPlayer {                    //Derived class  2
        int wickets;
        float bowlAvg;
        void setBowlerData(int wickets, float bowlAvg){
                this.wickets=wickets;
                this.bowlAvg=bowlAvg;
        }
        void displayBowlerData() {
                System.out.println(" No. of Wickets:"+wickets);
                System.out.println("Bowling Average:"+bowlAvg);
        }
}
```

Hierarchical Inheritance – Example

```
public class HInherDemo{
        public static void main(String args[]){
                Batsman B1=new Batsman();       //Base Class Object
                Bowler B2=new Bowler();
                B1.setPlayerData("Sachin", "India");
                B1.setBatsmanData(200, 84.5);
                B2.setPlayerData("Bumra", "India");
                B2.setBowlerData(140, 6.75);
                B1.displayPlayerData();
                B1.displayBatsmanData();
                B2.displayPlayerData();
                B2.displayBowlerData();
        }
}
```

Output

Player Name: Sachin

Team Name: India

Highest Score:200

Batting Average:84.5

Player Name: Bumra

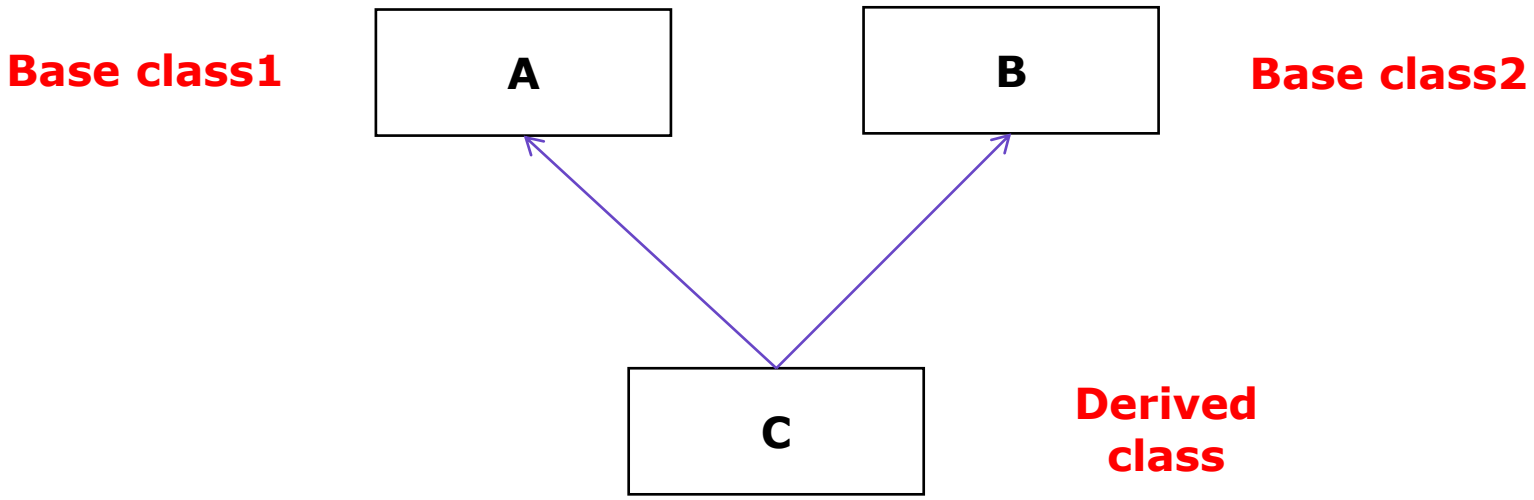
Team Name: India

No. of Wickets:140

Bowling Average:6.75

Multiple Inheritance

- Multiple Inheritance concept, there is **more than one base classes** for a subclass.



Note:

- Due to **ambiguity issue** Java doesn't support multiple inheritance through class.
- Both multiple and hybrid inheritance supported through **interface concept**.

super Keyword

- The **super** keyword in Java is a **reference variable** which is used to refer **immediate parent class object.**
- Whenever you create the instance of subclass, an **instance of parent class** is created **implicitly** which is referred by super reference variable.
- Super keyword can be used at **variable, method and constructor** level.
- The **super** keyword is **similar to 'this'** keyword.
  - **Difference**: super keyword is used to refer the **members of super class.** But 'this' keyword used to refer current **class's instance and static variables**.

super Keyword in Variable Level: Example

```
/**
 * This example demonstrates the usage of super in variable level. **/
class ProjectLeader {                  //parent class
                String proleadName="Ram Kumar";
                int empId = 1000;
}
class Programmer extends ProjectLeader  {          //child class
                String progName;
                int empId;
                void setData(String name, int id){   // derived class method
                                progName=name;
                                empId=id;
                }
```

super Keyword in Variable Level: Example

```
        void displayData(){   // derived class method
                System.out.println(" Programmer Name: "+ progName);
                 System.out.println(" Programmer Id: "+ empId);
                 System.out.println(" Project Leader Name: "+ super.proleadName);
                 System.out.println(" Project Leader Id: "+ super.empId);  // access base class variable using super
    }
}
public class SuperVariableDemo{
        public static void main(String args[]){
                Programmer obj=new Programmer ();          //child class object
                 obj.setData("Arun", 111);
                obj.displayData()
        }
}
```

Output

Programmer Name: Arun

Programmer Id: 111

Project Leader Name: Ram Kumar

Project Leader Id: 1000

super Keyword in Method Level : Example

```
/**
 * This example demonstrates the usage of super in method level. **/
class ProjectLeader {                  //parent class
                String proleadName="Ram Kumar";
                int empId = 1000;
                void displayData(){   // base class method
                                System.out.println("Project Leader Name: "+ proleadName);
                                System.out.println("Project Leader Id: "+ empId);
                }
}
```

super Keyword in Method Level : Example

```
class Programmer extends ProjectLeader  {          //child class
    String progName;
    int empId;
    void setData(String name, int id){   // derived class method
       progName=name;
       empId=id;
    }
            void displayData(){   // derived class method
                        System.out.println("Programmer Name: "+ progName);
                        System.out.println("Programmer Id: "+ empId);
                        super.displayData();  //call base class method using super
    }
}
```

super Keyword in Method Level : Example

```
public class SuperMethodDemo{
   public static void main(String args[]){
                  Programmer obj=new Programmer ();          //child class object
                   obj.setData("Arun", 111);
                    obj.displayData();
    }
}
```

Output

```
Programmer Name: Arun
 Programmer Id: 111
Project Leader Name: Ram Kumar
Project Leader Id: 1000
```

Inheritance and Constructors

- **Can Constructors be inherited?**
  - No
- **Reasons:** Constructors are special and have same name as class name. So, if **constructors** were inherited in child class, then child class would contain a **parent class constructor** which is **against the constraint** that constructor should have **same name as class name**.
- Constructors are invoked in the **order of their derivation i.e., first base class then derived class constructor.**
- Constructor of base class with **no argument** gets **automatically called** in derived class constructor.
- But in case of **parameterized base class constructor** call using **super keyword**. In this case, **Base class constructor** call must be the **first line in** derived class constructor.

Inheritance and Constructors: Example

```
/**
* This example demonstrates order of invocation of constructors **/
class Base {
        Base( ){
                System.out.println(“Inside Base’s Constructor”);
         }
}
class Derived1 extends Base {
        Derived1( ){
                System.out.println(“Inside Derived1’s Constructor”);
        }
}
```

Inheritance and Constructors: Example

```
class Derived2 extends Derived1 {
        Derived2(){
                System.out.println("Inside Derived2's Constructor");
        }
}

class OrderOfConstructorCallDemo{
        public static void main(String args[]) {
                Derived2 obj = new Derived2();
        }
}
```

Output

Inside Base's Constructor

Inside Derived1's Constructor

Inside Derived2's Constructor

Polymorphism

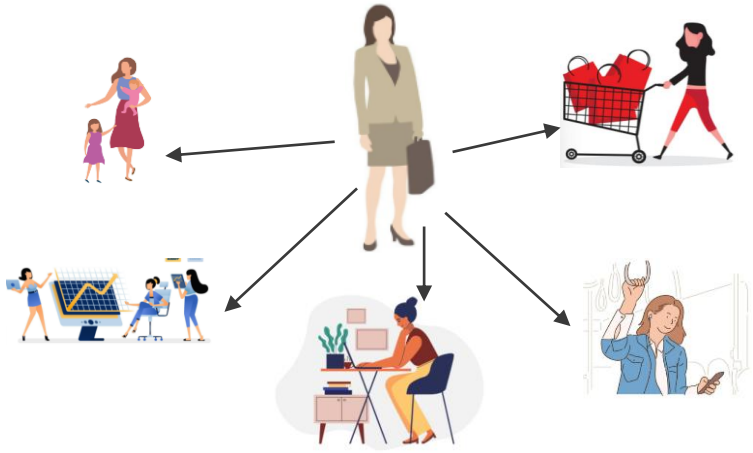
Introduction

- **Polymorphism** is one of the important features of Object-Oriented Programming.
- **Polymorphism** can be defined as the ability of an object to **take many forms**. Simply , polymorphism allows performing the **same action in different ways**.
- **Example:**
- A person at the same time can have **different characteristics**. Like a man at the same time is a **father, a husband, an employee**. So, the same **person posse's different behaviour in different situations.**

Introduction

Example 1: we are turn on the computer by one button at the same time we can turn off the computer by the same button.

Example 2: A person might have a **variety of characteristics**. He is a man, and he can also be a father, a husband, or an employee. As a result, the same person behaves differently in different situations.



Introduction

There are **two types of polymorphism** in java:

1. **Static** Polymorphism also known as **compile time** polymorphism

   Example : Method Overloading

2. **Dynamic** Polymorphism also known as **runtime** polymorphism

   Example: Method Overriding

Compile time polymorphism: Method Overloading

- When a **type of the object** is determined at the **compile time** (by the compiler), it is known as **compile time polymorphism** or ***static binding*** *or* **Early Binding.**
- That means Java would be able to **understand which function to be called**, at the **compile time itself.**
- **Example:** Method Overloading
- **Method overloading** : If the class contains **two or more methods** having the **same name** but **different arguments / signature**, then it is called as ***method overloading*****.**

Compile time polymorphism: Method Overloading

- The compiler will be able to make the call to a **correct method**, depending on the **actual number** of **arguments**, its **data type** and **the sequence they are passed in**.

Example:

```
int add(int, int)
double add(double, double);
float add(float, int, float);
```

Note:

- **Because of ambiguity**, method overloading is not possible by **changing the return type** of method only.
- **For Example**: int add(int,int);
  double add(int,int);

Compile time polymorphism: Method Overloading

- In Java, method overloading mainly used in the **inbuilt classes.**

Method	Use
void println()	Terminates the current line by writing the line separator string
void println(boolean x)	Prints a boolean value and then terminates the line
void println(char x)	Prints a character and then terminates the line
void println(char[] x)	Prints an array of characters and then terminates the line

Method Overloading: Example

```
/**
 * This program demonstrates method overloading*/
public class Adder {
        static int add(int a, int b) {
              return a + b;
        }
        static double add(double a, double b) {
               return a + b;
        }
}
```

Method Overloading: Example

```
class MainClass {
        public static void main(String[] args) {
                System.out.println("Output of Method Add(int,int) - "+Adder.add(5, 6));
                System.out.println("Output of Method Add(double,double) - "+Adder.add(12.8, 9.2));
        }
}
```

Output

```
Output of Method Add(int,int) - 11
Output of Method Add(double,double) - 22.0
```

Runtime polymorphism: Method Overriding

- The process of binding the code associated with the **function call during runtime** rather than compile-time is known as **Runtime Polymorphism** or **Dynamic Binding** or **Late Binding.**
- **Example: Method Overriding**
- **Method Overriding:** If subclass (child class) has **same name**, **same parameters** and **same return type** as a method in **super-class** then the method in the subclass is said to ***override*** the method in the super-class.
- In simple words, the function has **same name and same signature** is known as **method overriding**.
- Overridden method in Java application is called **and executed** at **run time** only. In method overriding the derived class can give its **own specific implementation** to an inherited method.

Runtime polymorphism: Method Overriding

- In this process, the overridden method would be called through the **reference variable of a super class**. The determination of the method, which is to be called, is based on the object, being referred to by the reference variable (**upcasting**). That's why it is also called as **Dynamic Method Dispatch**.
- **Upcasting** means assigning child class reference to parent class reference**.**

Note:

- They must have the same argument list.
- They must have the same return type.
- Constructors cannot be overridden.

Upcasting: Example

```
/*** This abstract code illustrates the upcasting. */

class A {

}


class B extends A {

}


 class Demo {
        public static void main(String[] args) {
              A a = new B();      //upcasting
        }
 }
```

Method Overriding-Example

```
 /**
 * This example demonstrates method overriding
**/
 class Vehicle {
    void run() {
     System.out.println(“Vehicle is running”);
    }
}
class Truck extends Vehicle {
    void run()    {
     System.out.println(“Truck is running”);
    }
}
```

Method Overriding-Example

```
class OverrideDemo{
   public static void main(String args[]) {
      Vehicle obj = new Vehicle();
      obj.run();                    //Vehicle class run () method invoked
      Vehicle obj = new Truck();
      obj.run();                    //Truck class run () method invoked

   }
}
```

final Keyword

- **final keyword** can be used in context of **behavioral restriction** on
  - **Variables**: When a variable is made as final then it behaves as **constant**
  - **Methods**: If a method is set as final then it **cannot be overridden** by the sub classes. It restricts overriding.
  - **Classes**: When a class is set as final then it prevents from being inherited.

final variable: Example

```
/**   * This program demonstrates the use of final variable */
public class Sample  {
    final double pi=3.14159;
    public Sample()   {
        pi = 3.14;
    }
    public static void main(String[] args) {
        Sample obj = new Sample();
        System.out.println(obj.pi);
}
```

Output:

Compile Time Error : cannot assign a value to final variable pi

final Method: Example

```
/**
 * This program demonstrates the use of final method
*/
class Base  {
        public final void display(String s) {  //final method
                System.out.println(s);
        }
}
class Sample extends Base {
        public void display(String s)    {
                System.out.println(s);
        }
```

final Method: Example

```
        public static void main(String args[]) {
                Sample obj = new Sample();
                obj.display("TRY ME");
        }
}
```

Output:

Compile Time Error : Cannot override the final method from Base

final Class: Example

```
/**
 * This program demonstrates the use of final class */
final class Base  {
    public final void display(String s)     {
      System.out.println(s);
    }
}
class Sample extends Base {
  public void display(String s) {
    System.out.println(s);
   }
```

final Class: Example

```
        public static void main(String args[])  {
                Sample obj = new Sample();
                obj.display("TRY ME");
        }
}
```

Output:

Compile Time Error : The type Sample cannot subclass the final class Base

Abstraction

Introduction

- **Abstraction** is the one of the important feature of Object-Oriented Programming.
- It is a process of **hiding the implementation** details and showing only the **functionality** to the user.
  - In other words, it shows only essential things to the user and hides the other internal details.
  - **For Example,** when you **send an email** to someone you just click send and you get the success message.
  - **What happens when you click send?**
  - How is data transmitted over network to the recipient?
  - All these are hidden from you (**because it is irrelevant to you**).

Introduction

ATM user need not to know what is the process behind the screen.

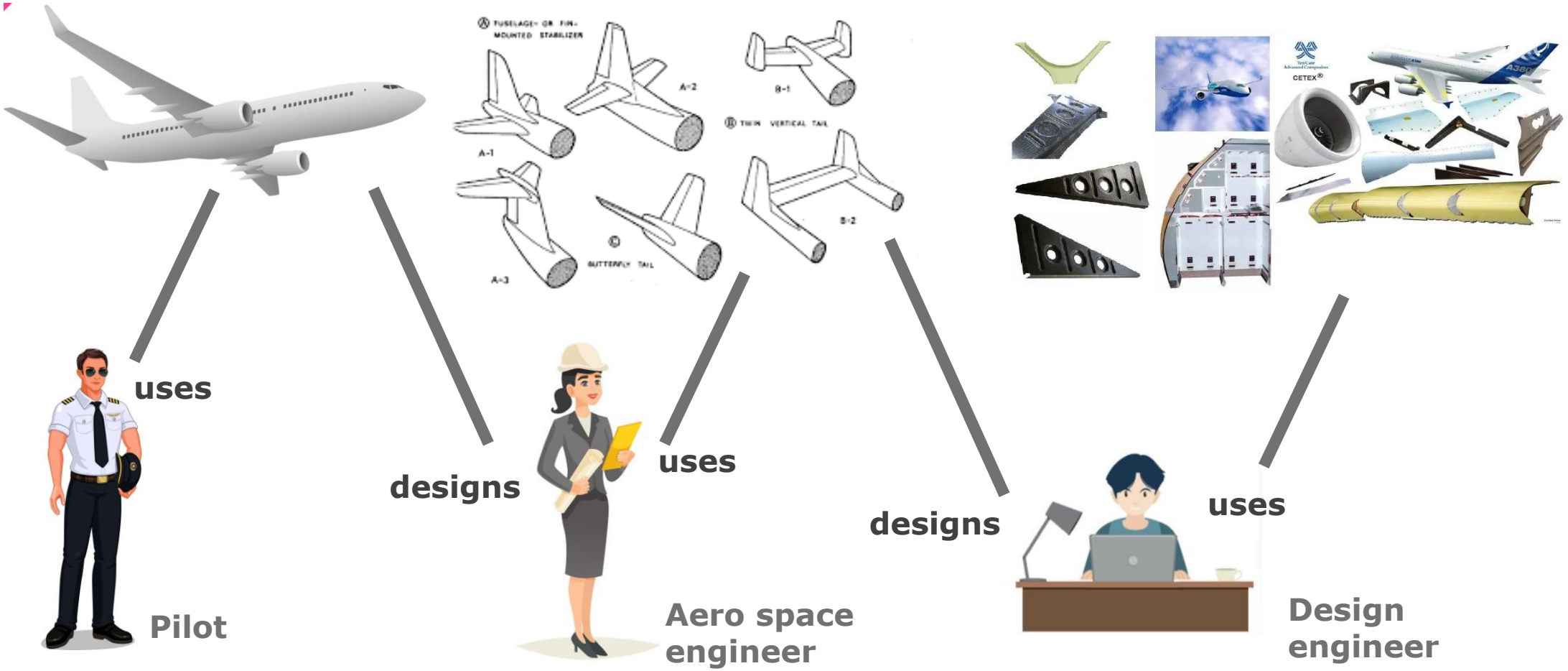
Musician need not to know how the sound is produced. All they need to know is which key to press

Note: An abstraction includes the essential details relative to the perspective of the user.

Introduction

Note: **An abstraction includes the essential details relative to the perspective of the user.**

Introduction



Note: An abstraction includes the essential details relative to the perspective of the user.

Abstract Class

- An **abstract class** is a restricted class, that cannot be used to create objects. That means we are forcing the programmer to inherit the abstract class and use it, but not directly.
- A class which is declared with **abstract keyword**, becomes an **abstract class**. **Abstract class** can have **abstract methods** and as well as **concrete methods**.

```
Public abstract class Shape {
   void draw() {
      System.out.println("drawing...");      //Concrete Method
   }
   public abstract void area();               //Abstract Methods
   public abstract void perimeter();
}
```

Note: **abstract method** is a method which will not have the body, whereas concrete methods must have the body.

Abstract Class: Need

- Abstract classes are used to **define generic types of behaviours** at the top of an object-oriented programming **class hierarchy and** use its subclasses to provide implementation details of the abstract class. This feature helps to bring **complete visualization** of your application.
- The subclasses extend the **same Abstract class** and provide **different implementations** for the abstract methods.

Note:

- Any class that extends an abstract class **must implement all the abstract methods** declared by the super class.

Abstract Class

Points to remember:

- For abstract class we cannot create object. **(Why?)**
- Abstract class can contain both abstract and concrete methods.
- It can have constructors and static methods also.
- It can have final methods, which will force the programmer not to **change the body of the methods** in the subclass.
- It contain abstract methods that **must be implemented** later by any **non abstract subclasses.**

Abstract Class: Example

```
/**
 * This program demonstrates runtime polymorphism using abstract class
*/
abstract class Shape {
    void draw() {  //concrete method
        System.out.println("drawing...");
    }
    abstract void area();  //abstract method
    abstract void perimeter();  // abstract method
}
class Rectangle extends Shape {
    private int length, breadth;
    Rectangle(int length, int breadth){
                this.length = length;
                this.breadth = breadth;
    }
```

Abstract Class: Example

```
@Override
    void area() {
        System.out.println("Area of Rectangle: " + (length * breadth));
    }
  @Override
    void perimeter() {
        System.out.println("Perimeter of Rectangle: " + (2 * (length + breadth)));
    }
}
class Square extends Shape {
    private int side;
    Square(int side){
                this.side = side;
    }
```

Abstract Class: Example

```
@Override
    void area() {
        System.out.println("Area of Square: " + (side * side));
    }
  @Override
    void perimeter() {
        System.out.println("Perimeter of Square: " + (4 * side));
    }
}
class Circle extends Shape {
    private double radius;
    final static double PI = 3.14;
    Circle(double radius){
                this.radius = radius;
    }
```

Abstract Class: Example

```
@Override
    void area() {
        System.out.println("Area of Circle: " + (PI * radius * radius));
    }

    @Override
    void perimeter() {
        System.out.println("Perimeter of Circle: " + (2 * PI * radius));
    }
}
```

Abstract Class: Example

```
class MainTest {
    public static void main(String args[]) {
        Shape s;
        s = new Rectangle(3,5);
        s.area();
        s.perimeter();

        s = new Square(5);
        s.area();
        s.perimeter();

        s = new Circle(4.5);
        s.area();
        s.perimeter();    }
}
```

Output:

Area of Rectangle: 15

Perimeter of Rectangle: 16

Area of Square: 25

Perimeter of Square: 20

Area of Circle: 63.585

Perimeter of Circle: 28.26

Interface

Introduction

- Another way to achieve Abstraction in java is **interface**. Unlike abstract class an **interface** is used for **full abstraction.**
- **Interface** is a reference type in java. It is very similar to class, but it is **not a class**. In interface all the **variables** declared in **final static variables by default** and **methods** are **public abstract by default**.
- From **Java 8 onwards** interface also support **default methods** and **static methods**, which may have implementation details.
- **Default methods** were introduced **to provide backward compatibility for old interfaces** so that they can have **new methods without effecting existing code**.
- **Syntax:**

```
interface interfaceName { ... }
```

Need

- It is used to achieve **full abstraction (100%).**
- **Multiple Inheritance** can be achieved with interfaces, because the **class can implement multiple interfaces.**

Note:

- We cannot create object for interface.
- The class which is implementing the interface, must define all the methods of interface. If it fails to define any method of the interface, the class becomes abstract class. if one of the methods is a default method, it needs not be redefined.

Example #1

```
//The class which is implementing the interface, must define all the methods of interface.  If it fails to define any method of the interface, the class becomes abstract class. if one of the methods is a default method, it needs not be redefined.

// Define the Shape interface with a default method
interface Shape {
        double DEFAULT_VALUE = 1.0; // Public static final constant

        double calculateArea();
        double calculatePerimeter();

        // Default method
       default String getDescription() {
              return "A shape with unspecified dimensions.";
        }
}
```

Example #1

```
// Implement the Shape interface in the Circle class
abstract class Circle implements Shape {
        private double radius;

        public Circle(double radius) {
            this.radius = radius;
        }
        // Constructor that uses the DEFAULT_VALUE
        public Circle() {
            this.radius = DEFAULT_VALUE;
        }
        // calculatePerimeter method is implemented
        @Override
        public double calculatePerimeter() {
            return 2 * Math.PI * radius;
        }
        // getDescription method is implemented
        @Override
        public String getDescription() {
            return "A circle with radius " + radius;
       }
}
```

Example #1

```
// Implement the Shape interface in the Rectangle class
class Rectangle implements Shape {
        private double length;
        private double width;
        public Rectangle(double length, double width) {
              this.length = length;
              this.width = width;
        }
         public Rectangle() {
             this.length = DEFAULT_VALUE;
             this.width = DEFAULT_VALUE;
        }
       @Override
       public double calculateArea() {
           return length * width;
       }
       @Override
       public double calculatePerimeter() {
            return 2 * (length + width);
}
```

Example #1

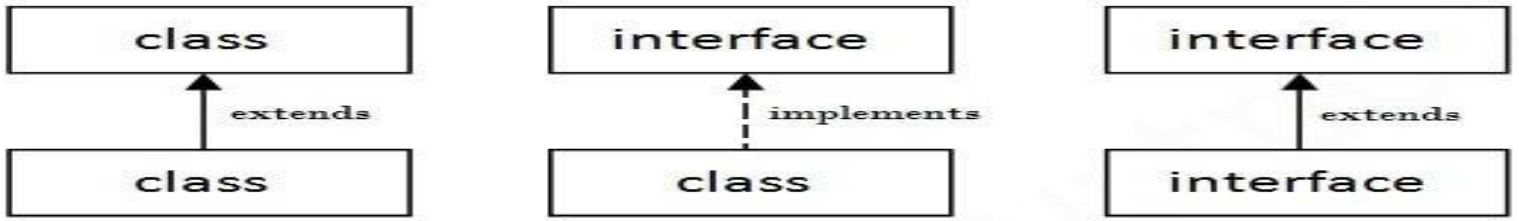
```
    @Override
    public String getDescription() {
        return "A rectangle with length " + length + " and width " + width;
    }
}
public class InWithdefault {
    public static void main(String[] args) {
      // Creating an instance of Circle will result in a compilation error
      Circle circle = new Circle(5);
    }
}
```

Output:

```
Exception in thread "main" java.lang.Error: Unresolved compilation problem:
Cannot instantiate the type Circle
```

Points to Remember

- Interface can extend one or more other interface.
- Interface cannot implement a class.
- Interface can be nested inside another interface.
- An interface cannot contain a constructor. **(Why?)**
- When a class implements an interface, it is like **signing an agreement**. The agreement indicates that the class will **implement the methods defined by the interface**.



Example #2

```
/**
 * This program demonstrates interface concepts
*/
interface Vehicle {
    void changeGear(int);
    void speedUp(int);
    void applyBrakes(int);
}
 class Bicycle implements Vehicle{
    int speed;
    int gear;
    //Abstract Method Implementation
    public void changeGear(int newGear){
        gear = newGear;
    }
```

Example #2

```
//Abstract Method Implementation
    public void speedUp(int increment){
        speed = speed + increment;
    }
 //Abstract Method Implementation
    public void applyBrakes(int decrement){
        speed = speed - decrement;
    }

    public void printStates() {
         System.out.println("Speed: " + speed + " Gear: " + gear);
    }
}
```

Example #2

```
class Bike implements Vehicle {
    int speed;
    int gear;
    //Abstract Method Implementation
    public void changeGear(int newGear){
        gear = newGear;
    }
    //Abstract Method Implementation
    public void speedUp(int increment){
        speed = speed + increment;
    }
     //Abstract Method Implementation
    public void applyBrakes(int decrement){
        speed = speed - decrement;
    }
```

Example #2

```
    public void printStates() {
        System.out.println("Speed: " + speed + " Gear: " + gear);
    }
}
class MainClass {
        public static void main (String[] args) {
            Bicycle bicycle = new Bicycle();  //Bicycle Class Object Creation
            bicycle.changeGear(3);
            bicycle.speedUp(2);
            bicycle.applyBrakes(1);
           System.out.println("Bicycle present state :");
           bicycle.printStates();
```

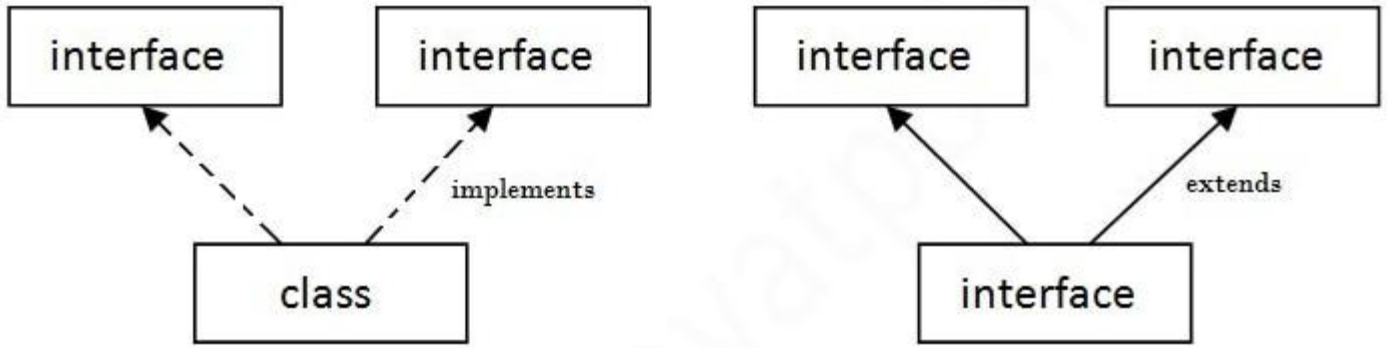
Example #2

```
        Bike bike = new Bike(); //Bike Class Object Creation
         bike.changeGear(2);
         bike.speedUp(3);
         bike.applyBrakes(3);
         System.out.println("Bike present state :");
         bike.printStates();
    }
}
```

Interface

Points to remember:

- Java **does not support multiple inheritance** (a class can only inherit from only one class). But it can be **achieved with interfaces**, because the class **can implement multiple interfaces**.
- Two Possible situation to achieve **multiple inheritance using interface** are as follows:



Multiple Inheritance using interface: Example #1

```
/**
 * This program demonstrates multiple interfaces
*/
interface CollegeData {
    public void collegeDetail();
    public void studentData();
}

interface HostelData {
    public void hostelDetail();
    public void studentRecord();
}
```

Multiple Inheritance using interface: Example #1

```
class StudentRecord implements CollegeData, HostelData {
  @Override
  public void hostelDetail() {
     System.out.println("Hostel Name :B-Block");
     System.out.println("Room No: 202");
  }

  @Override
  public void studentRecord()  {
     System.out.println("Good Behaviour");
     System.out.println("Overall Attendance is Good");
  }
```

Multiple Inheritance using interface: Example #1

```
@Override
    public void collegeDetail() {
        System.out.println("College Name :AAAA");
        System.out.println("College Grade : A");
        System.out.println("University of College :XXXX");
    }

    @Override
    public void studentData() {
        System.out.println("Year of passed out:2021");
        System.out.println("Student Conduct is Good");
    }
}
```

Multiple Inheritance using interface: Example #1

```
class MultipleInheritance{
        public static void main (String[] args)  {
            StudentRecord obj = new StudentRecord();
            obj.collegeDetail();
            obj.studentData();
            obj.hostelDetail();
            obj.studentData();
       }
}
```

Multiple Inheritance using interface: Example#2

```
public interface SearchbyGenre {
        public abstract void searchbyGenre(String genre);
}
public interface SearchbyTitle {
        public abstract void searchbyTitle(String title);
}
public class Catalog implements SearchbyTitle, SearchbyGenre {
        private static Date lastUpdated;
        private static List<Movie> MovieList = new ArrayList<Movie>();
        @Override
        public void searchbyTitle(String title) {
                for (Movie movie:MovieList) {
                        if(movie.getTitle().equals(title)) {
                                movie.getMovieDetail();
                        }
                }
        }
```

Multiple Inheritance using interface: Example#2

```
    @Override
     public void searchbyGenre(String genre) {
            for (Movie movie:MovieList) {
                if(movie.getGenre().equalsIgnoreCase(genre)) {
                            movie.getMovieDetail();
                }
            }
     }
  public static void main(String[] arg) {
      Catalog C = new Catalog();
      Calendar cal = Calendar.getInstance();
      DateFormat dateFormat = new SimpleDateFormat("MM/dd/yyyy");
      Date date = cal.getTime();
      String todaysdate = dateFormat.format(date);
      Movie M1 = new Movie("AAA","Drama",3,"English",date,"France","Action");
      MovieList.add(M1);
```

Multiple Inheritance using interface: Example#2

```
        Movie M2 = new Movie("BBB","Story",3,"English",date,"India","Documentry");
        MovieList.add(M2);
        Movie M3 = new Movie("CCC","Drama",3,"English",date,"Italy","Action");
        MovieList.add(M3);
        System.out.println("----------Searching Movie by Genre----------");
        C.searchbyGenre("Action");
        System.out.println("----------Searching Movie by Title----------");
        C.searchbyTitle("BBB");
    }
}
```

Output

```
----------Searching Movie by Genre----------
| AAA | Drama | 3 | English | 01/04/2022 | France | Action
| CCC | Drama | 3 | English | 01/04/2022 | Italy | Action
----------Searching Movie by Title----------
| BBB | Story | 3 | English | 01/04/2022 | India | Documentry
```

Multiple Inheritance using interface: Example#3

- If you have two interfaces with the same method signature and a class implements both interfaces, it can raise an ambiguity issue.
- However, if these methods are abstract (i.e., not default methods), the implementing class simply provides one implementation, and there is no ambiguity because there is only one method signature to implement.
- However, if both interfaces have default methods with the same signature, then it does create an ambiguity issue.
- In such cases, you must explicitly specify which default method implementation you want to use in the implementing class.

Multiple Inheritance using interface: Example#3

```
// Define the first interface with a default shape() method
interface Shape1 {
default void shape() {
System.out.println("Shape from Shape1");
}
}


// Define the second interface with a default shape() method
interface Shape2 {
default void shape() {
System.out.println("Shape from Shape2");
}
}
```

Multiple Inheritance using interface: Example#3

```
// Implement both interfaces in the MyShape class
class MyShape implements Shape1, Shape2 {
// Override the shape() method to resolve ambiguity
@Override
public void shape() {
// You must choose which default implementation to use or provide your own
Shape1.super.shape(); // Or you can choose Shape2.super.shape()
}

// Provide a method to explicitly call the shape() method from Shape1
public void shapeFromShape1() {
Shape1.super.shape();
}

// Provide a method to explicitly call the shape() method from Shape2
public void shapeFromShape2() {
Shape2.super.shape();
}
}
```

Multiple Inheritance using interface: Example#3

```
// Main class to test the implementations
public class Main {
public static void main(String[] args) {
MyShape myShape = new MyShape();


// Call the overridden shape() method
myShape.shape();


// Call the shape() method from Shape1 explicitly
myShape.shapeFromShape1();


// Call the shape() method from Shape2 explicitly
myShape.shapeFromShape2();
}
}
```

Multiple Inheritance using interface: Example#3

Output

```
Shape from Shape1
Shape from Shape1
Shape from Shape2
```

Multiple Inheritance using interface: Example#4

- If you have **static** methods instead of **default** methods in the interfaces, there will be no ambiguity when a class implements both interfaces because **static** methods belong to the interface itself and not to the instances of the implementing class.
- You can call **static** methods directly from the interface without any need for an instance of the interface. Here's how you can handle this scenario:

Multiple Inheritance using interface: Example#4

```
// Define the first interface with a static shape() method
interface Shape1 {
static void shape() {
System.out.println("Shape from Shape1");
}
}

// Define the second interface with a static shape() method
interface Shape2 {
static void shape() {
System.out.println("Shape from Shape2");
}
}

// Implement both interfaces in the MyShape class
class MyShape implements Shape1, Shape2 {
// No need to override static methods from interfaces
// Static methods are not inherited
}
```

Multiple Inheritance using interface: Example#4

```
// Main class to test the implementations
public class Main {
public static void main(String[] args) {
// Call the static shape() method from Shape1
Shape1.shape();


// Call the static shape() method from Shape2
Shape2.shape();


// You cannot call static methods on an instance of MyShape
// MyShape myShape = new MyShape();
// myShape.shape(); // This would result in a compilation error
}
}
```

Quiz

1. We have to use the concept of inheritance when there is a "IS-A" relationship between two classes. (Yes/No)

a) Yes

b) No

a) Yes

Quiz

2. What is the keyword used for inheriting a class in Java?

a) extends

b) implements

c) instanceOf

d) None

a) extends

Quiz

3.To prevent from being inherited, the _____ keyword is used before the class

a) static

b) final

c) this

d) private

b) final

Quiz

4.Constructors are not inherited in the same way methods and properties are inherited. However, when you create an instance of a subclass (derived class), the constructor of the base class is automatically invoked before the constructor of the subclass is executed.

a) Yes

b) No

a) Yes

Quiz

5. What is the term which is used to denote the concept of re-using and re-defining the method of a parent class in a subclass?

a) overloading

b) overriding

c) extending

d) None

b) overriding

Quiz

6. Which one is the correct way of inheriting class A by class B?

a) class B extends A

b) class A extends B

c) class A inherits B

d) Class B inherits A

a) class B extends A

Quiz

7. What is the output after the following code has been executed?

```
class Base
{
    int i;
    void display()
    {
        System.out.println(i);
    }
}
class Derived extends Base
{
    int j;
    void display()
    {
        System.out.println(j);
    }
}
public class inheritance_demo
{
    public static void main(String args[])
    {
        Derived obj = new Derived();
        obj.i=5;
        obj.j=10;
        obj.display();
    }
}
```

Quiz

8. What is the output after the following code has been executed?

```
class Base
{
    int i;
    void display()
    {
        System.out.println(i);
    }
}
class Derived extends Base
{
    int j;
    void display()
    {
super.display();
    System.out.println(j);

    }
}
public class inheritance_demo
{
    public static void main(String
args[])
    {
        Derived obj = new
Derived();
        obj.i=5;
        obj.j=10;
        obj.display();
    }
}
```

Quiz

9. What is the output after the following code has been executed?

```
 class Base
{
    public Base()
   {
          System.out.print("Base");
    }
  }
public class Derived extends Base
{
    public Derived()
{
          this(“Java");

  System.out.print("Derived");
    }public Derived(String s)
   {
          System.out.print(s);
    }
    public static void main(String[] args)
    {
          new Derived();
    }
}
```

Quiz

10. What is the output after the following code has been executed?

```
class Base
{
    public void diplayBase()
    {
        System.out.println(“Base class Method");
    }
}
class Derived extends Base
{
    public void displayDerived()
{
        System.out.println(“Derived class Method");
    }

public Derived(String s)
    {
        System.out.print(s);
    }
    public static void main(String[] args)
    {
        new Derived();
    }
}
```

Quiz

11. What does the name Polymorphism translate to?

a) Many forms

b) Many changes

c) Two forms

d) None of the above

a) Many forms

Quiz

12. What are the two types of Polymorphism?

a) compile time and runtime

b) Constructor and method

c) derive and base

d) encapsulation and Inheritance

a) compile time and runtime

Quiz

13. Which among the following best describes polymorphism?

I. It is the ability for a message/data to be processed in more than one form

II. It is the ability for a message/data to be processed in only 1 form

III. It is the ability for many messages/data to be processed in one way

IV. It is the ability for undefined message/data to be processed in at least one way

a) I

b) II

c) III

d) IV

a) I

Quiz

14. The "is a" relationship between super class and sub class is commonly referred as:

a) Inheritance

b) Overriding

c) Constructor

d) None

a) Inheritance

Quiz

15. When does method overloading is determined?

a) At runtime

b) At Compile time

c) At coding time

d) None

b) At Compile time

Quiz

16. Which inheritance in java programming is not supported?

a) Single Inheritance

b) Multilevel Inheritance

c) Multiple inheritance using classes

d) Multiple Inheritance using interfaces

c) Multiple inheritance using classes

Never give up +

Stay Positive +

Do your best = SUCCESS


THANK YOU
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