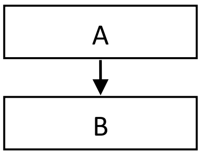
Inheritance

- **Inheritance** is the process, by which class can acquire the properties and methods of its parent class.
- The mechanism of deriving a **new child class** from **an old parent class** is called **inheritance**.
- The new class is called **derived** class and old class is called **base** class.
- When you inherit from an existing class, you can **reuse** methods and **fields** of **parent** class, and you can add new methods and fields also.
- All the properties of **superclass** except private properties can be inherit in its **subclass** using **extends** keyword.

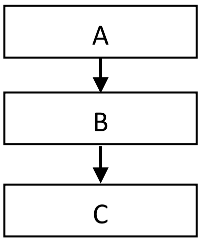
Types of Inheritance

Single Inheritance



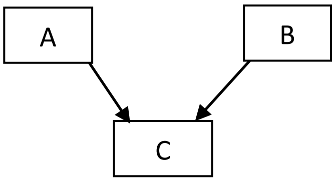
- If a class is derived from a single class then it is called **single** inheritance.
- Class **B** is derived from class **A.**

Multilevel Inheritance



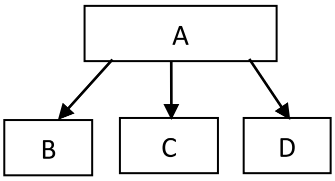
- A class is derived from a class which is derived from another class then it is called **multilevel** inheritance
- Here, class **C** is derived from class **B** and class **B** is derived from class **A**, so it is called multilevel inheritance.

Multiple Inheritance



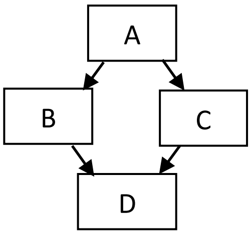
- If one class is derived from more than one class then it is called multiple inheritance.
- It is **not supported** in java through class.

Hierarchical Inheritance



- If one or more classes are derived from one class then it is called **hierarchical** inheritance.
- Here, class **B**, class **C** and class **D** are derived from class **A**.

Hybrid Inheritance



- Hybrid inheritance is combination of **single** and **multiple** inheritance.
- But java doesn't support multiple inheritance, so the hybrid inheritance is also **not possible**.

Example

```
class A
{
        public  void displayA()
        {
                System.out.println("class A method");
        }
}
class B extends A               //Single Inheritance - class B is derived from class A
{
        public  void displayB()
        {
                System.out.println("class B method");
        }
}
class C extends B               // Multilevel Inheritance - class C is derived from class B
{
        public  void displayC()
        {
                System.out.println("class C method");
        }
}
class D extends A       //Hierarchical Inheritance - Class B and Class D are derived from Class A
{
        public  void displayD()
        {
                System.out.println("class D method");
        }
}
class  Trial
{
        public  static  void  main(String []args)
        {
                B b=new B();
                C c=new C();
                D d=new D();
                b.displayB();
                c.displayC();
                d.displayD();
        }
}
```

- Class **B** and class **D** are derived from class **A** so it is example of **Hierarchal Inheritance**.

Method Overriding

- When a method in a **subclass** has the **same name and type signature** as method in its **superclass**, then the method in the **subclass** is said to **override the method** of the superclass.
- The **benefit** of overriding is: Ability to define a behavior that's specific to the **subclass** type. Which means a subclass can implement a superclass method based on its requirement.
- Method overriding is used for **runtime** polymorphism.
- In object oriented terms, overriding means to **override the functionality** of any existing method.

Example:

```
class A
{
        public void display()
        {
                System.out.println("Class A");
        }
}
class B extends A
{
        public void display()
        {
                System.out.println("Class B");
        }
}
class Trial
{
        public static void main(String args[])
        {
                A a = new A();          // A reference and object
                A b = new B();          // A reference but B object
                a.display();            // Runs the method in A class
                b.display();            // Runs the method in B class
        }
}
```

Output:

```
Class A
Class B
```

- In the above example you can see that even though **b** is a type of **A** it runs the **display()** method of the **B** class.
- Because, at **compile** time reference type of object is checked. However, at the **runtime** JVM figure out the object type and execute the method that belongs to that particular **object**.

Rules for method overriding

- The **argument list** should be exactly the **same** as that of the overridden method.

- The **return type** should be the **same** as the return type declared in the original overridden method in the superclass.
- **Instance methods** can be overridden only if they are **inherited** by the **subclass**.
- A method declared **final** cannot be overridden.
- A method declared **static** cannot be overridden but can be re-declared.
- If a method cannot be **inherited** then it cannot be **overridden**.
- A subclass within the same package as the instance's superclass can override any superclass method that is not declared private or final.
- A subclass in a different package can only override the non-final methods declared public or protected.
- **Constructors** cannot be overridden.

super keyword

- The **super** keyword in java is a reference variable that is used to refer **immediate parent** class object.

super to access superclass members

- If your method overrides one of its superclass methods, you can invoke the **overridden** method through the use of the keyword **super**.

Example:

```
class A
{
        String name = "Class A";
        public  void  display()
        {
                System.out.println("Class A display method called..");
        }
}
class B extends A
{
        String name = "Class B";
        public  void  display()
        {
                System.out.println("Class B display method called..");
        }
        void  printName()
        {
                //this will print value of name from subclass(B)
                System.out.println("Name from subclass : " + name);

                // this will print value of name from superclass(A)
                System.out.println("Name from Superclass: " + super.name);

                //invoke display() method of Class B method
                display();

                // invoke display() method of class A(superclass) using super
                super.display();
        }
}
class SuperDemo
{
        public static void main(String args[])
        {
                B b1 = new B();
                b1.printName();
        }
}
```

Output:

```
Name from subclass : Class B
Name from Superclass: Class A
Class B display method called..
Class A display method called..
```

- Here, **display()** method of **subclass** overrides the **display()** method of its **superclass**.
- So, to call **superclass(A)** members within **subclass(B) super** keyword is used.

super to call superclass constructor

- Every time a parameterized or non-parameterized constructor of a **subclass** is created, by default a default constructor of **superclass** is called **implicitly**.
- The syntax for calling a **superclass** constructor is:

```
        super();
          OR
        super(parameter list);
```

- The following example shows how to use the **super** keyword to invoke a superclass's constructor.

Example:

```
class A
{
        A()
        {
                System.out.println("Super class default constructor called..");
        }
        A(String s1)
        {
                System.out.println("Super class parameterized constructor called: "+s1);
        }
}
class B extends A
{
        // Implicitly default constructor of superclass(A) will be called. Whether you define
super or  not in subclass(B) constructor
```

```
        B()
        {
                System.out.println("Sub class default constructor called..");
        }
        // To call a parameterized constructor of superclass(A) you must write super() with
same number of arguments
        B(String s1)
        {
                super("Class A");
                System.out.println("Sub class parameterized constructor called: " + s1);
         }
}
class SuperConDemo
{
        public static void main(String args[])
        {
                B b1 = new B();
                B b2 = new B("Class B");
        }
}
```

Output:

```
Super class default constructor called..
Sub class default constructor called..
Super class parameterized constructor called: Class A
Sub class parameterized constructor called: Class B
```

- Here, implicitly a default constructor of **superclass** is called not a parameterized one. To call a **parameterized** constructor of a **superclass** we must use **'super(parameters..)'** with matching parameters.

Dynamic Method Dispatch

- Dynamic method dispatch is the mechanism by which a call to an overridden method is resolved at run time, rather than compile time.
- It is also known as **run-time polymorphism**.
- A **superclass** reference variable can refer to a **subclass object**. It is known as **Upcasting**.
- When an overridden method is called through a **superclass reference**, the determination of the method to be called is based on **the object being referred** to by the reference variable.
- This determination is made at **run time**.

Example:

```
class   A
{
        void callme()
        {
                System.out.println("Inside A's callme method");
        }
}
```

```
class B extends A
{
        void callme()
        {
                System.out.println("Inside B's callme method");
        }
}
class C extends A
{
        void callme()
        {
                System.out.println("Inside C's callme method");
        }
}
class DispatchDemo
{
        public static void main(String args[])
        {
                A a = new A();          // object of type A
                B b = new B();          // object of type B
                C c = new C();          // object of type C
                A r;                    // obtain r a reference of type A
                r = a;                  // r refers to an A object
                r.callme();             // calls A's version of callme()
                r = b;                  // r refers to a B object
                r.callme();             // calls B's version of callme()
                r = c;                  // r refers to a C object
                r.callme();             // calls C's version of callme()
        }
}
```

Output:

```
Inside A's callme method
Inside B's callme method
Inside C's callme method
```

Object Class

- The **Object class** is the **parent** class (java.lang.Object) of all the classes **in java bydefault**.
- The Object class provides some common behaviors to all the objects must have, such as object can be compared, object can be converted to a string, object can be notified etc..
- **Some Java object class methods are given below:**

Method	**Description**
equals()	To compare two objects for equality.
getClass()	Returns **a runtime representation of the class** of this object. By using this class object we can get information about class such as its name, its superclass etc.
toString()	Returns a **string representation** of the object.

notify()	Wakes up **single thread**, waiting on this object's monitor.
notifyAll()	Wakes up **all the threads**, waiting on this object's monitor.
wait()	Causes the **current thread to wait**, until another thread notifies.

Example:

```
class parent
{
        int i = 10;
        Integer i1 = new Integer(i);
        void PrintClassName(Object obj)     // Pass object of class as an argument
        {
                System.out.println("The Object's class name is :: " + obj.getClass().getName());
        }
}
class  ObjectClassDemo
{
        public static void main(String args[])
        {
                parent  a1 = new  parent();
                a1.PrintClassName(a1);
                System.out.println("String representation of object i1 is :: "+a1.i1.toString());

        }
}
```

Output:

```
The Object's class name is :: parent
String representation of object i1 is :: 10
```

Packages

- A **java package** is a group of similar types of **classes, interfaces and sub-packages**.
- Packages are used to **prevent naming conflicts** and provides **access protection**.
- It is also used to **categorize the classes and interfaces** so that they can be easily **maintained**.
- We can also **categorize the package** further by using concept of **subpackage**. Package inside the package is called the **subpackage**.
- Package can be categorized in two form : **built-in package** and **user-defined package**.
  - **built-in packages :** Existing Java package such as **java.lang, java.util, java.io, java.net, java.awt**
  - **User-defined-package :** Java package created by **user** to categorized **classes** and **interface**
- Programmers can define their own packages to bundle group of **classes,interfaces** etc.

Creating a package

- To create a package, **package** statement followed by **the name of the package**.
- The **package** statement should be the first line in the source file. There can be only **one package statement** in each source file.

- If a package statement is **not used** then the class, interfaces etc. will be put into an unnamed package.

  Example:

  ```
  package mypack;
  class Book
  {
          String bookname;
          String author;
          Book()
          {
                  bookname = "Complete Reference";
                  author = "Herbert";
          }
          void show()
          {
                  System.out.println("Book name is :: "+bookname+"\nand author name is :: "+
                   author);
          }
  }
  class DemoPackage
  {
          public static void main(String[] args)
          {
                  Book b1 = new Book();
                  b1.show();
          }
  }
  ```

  Compile: javac -d . DemoPackage.java

  To run the program : java mypack.DemoPackage

  Output:

  ```
  Book name is :: Complete Reference
  and author name is :: Herbert
  ```

  - The **-d** is a switch that tells the compiler where to put the class file. **Like**, /home (Linux), d:/abc (windows) etc.
  - The . (dot) represents the **current folder**.

Import Package

- **import** keyword is used to import **built-in and user-defined** packages into your java source file.
- If a **class** wants to use **another class** in the **same package**, no need to import the package.
- But, if a **class** wants to use **another class** that is **not exist in same package** then **import** keyword is used to import that package into your java source file.
- A class file can contain **any number of import** statements.
- **There are three ways to access the package from outside the package:**
  1) import package.*;
  2) import package.classname;
  3) fully qualified name

1) **Using packagename.* :**
   - If you use **packagename.*** then all the **classes and interfaces** of this package will be accessible but **not subpackages**.
     Syntax: import packagename.*;

2) **Using packagename.classname :**
   - If you use **packagename.classname** then only declared **class** of this package will be accessible.
     Syntax: import packagename.**classname**;

3) **Using fully qualified name :**
   - If you use **fully qualified name** then only **declared class** of this package will be accessible. So, no need to import the package.
   - But you need to use **fully qualified name every time** when you are accessing the class or interface.
   - It is generally used when two packages have **same class name** e.g. java.util and java.sql packages contain **Date** class.

Example:

File 1: **A.java**

```
package  pack;
public  class A
{
        public void display()
        {
                System.out.println("Welcome to package pack...");
        }
}
```

File 2: **Q.java**

```
package  pack;
public  class Q
{
        public void Q_display()
        {
                System.out.println("Welcome to package pack through qualified
                                        name...");
        }
}
```

File 3: **B.java**

```
package  mypack;
import  pack.*;            // Here, you can also use   import pack.A ;
class  B
{
        public static void main(String args[])
        {
                A a1 = new A();
                pack.Q  q1= new  pack.Q();
/*Here Q  is class in package A. If you want to access Q_display() method of class Q
using fully qualified name then no need to import package named pack */
```

```
                        a1.display();
                        q1.Q_display();
                }
        }
```

Output: **java mypack.B**

```
Welcome to package pack...
Welcome to package pack through qualified name...
```

- In above example, **class A, class Q and all its methods** must be declared as **public** otherwise they can be access in **class B**.

Visibility and Access Rights

class \ have access to	Private	Default	Protected	Public
own class	yes	yes	yes	yes
subclass - same package	no	yes	yes	yes
subclass - another package	no	no	yes	yes
class - another package	no	no	no	yes

Interfaces

- An **interface** is a collection of **abstract methods**. An interface is not a **class**.
- When you **create** an interface it defines what a class can do without saying anything about how the class will do it.
- Interface contains only **static constants** and **abstract methods** only.
- The interface in java is **a mechanism to achieve fully abstraction**. There can be only abstract methods in the java interface not method body.
- By default (Implicitly), an interface is **abstract**, Interface **fields** (data members) are **public, static and final** and **methods** are **public and abstract.**
- It is **used** to achieve fully **abstraction** and **multiple inheritance** in Java.
- **Similarity between class and interface are given below:**
  - An interface can contain any **number of methods**.
  - An interface is written in a file with a **.java** extension, with the name of the interface matching the name of the file.
  - The **bytecode** of an interface appears in a .**class** file.
- **Difference between class and interface are given below:**

Class	Interface
You can **instantiate** class.	You cannot **instantiate** an interface.
It contains default as well as **parameterize constructors**.	It does **not** contain any **constructors**.
All the methods should have **definition** otherwise declare method as abstract explicitly.	All the methods in an interface are **abstract** by default.
All the **variables** are **instance by default**.	All the **variables** are **static final by default**, and a value needs to be assigned at the time of

	definition.
A class can **inherit** only **one Class** and can implement **many interfaces**.	An interface cannot **inherit** any **class** while it can **extend many interfaces.**

Declaring Interfaces

- The **interface** keyword is used to **declare** an interface.

Syntax: NameOfInterface.java

```
import java.lang.*;
public  interface  NameOfInterface
{
            //Any number of final, static fields
            //Any number of abstract method declarations
}
```

Example: DemoInterface.java

```
interface  DemoInterface
{
          int  i = 10;
          void  demo();
}
```

- In above example, name of interface is **DemoInterface** and it contains a variable **speed** of integer type and an abstract method named **move()**.

Implementing Interfaces

- A **class** uses the **implements** keyword to implement an **interface**.
- A **class** implements **an interface** means, you can think of the class as signing a contract, agreeing to perform the **specific behaviors** of the interface.
- If a class **does not perform all the behaviors** of the interface, the class must declare itself as **abstract**.

Example: DemoInterfaceImp.java

```
public class DemoInterfaceImp implements DemoInterface
{
          public void demo ()
          {
                    System.out.println("Value of i is :: "+ i);
          }
          public static void main(String args[])
          {
                    DemoInterfaceImp  d = new DemoInterfaceImp ();
                    d.demo();
          }
}
```

Output:

```
Value of i is :: 10
```

Inheritance on Interfaces

- We all knows a class can extend another class. Same way an **interface can extend another interface.**
- The **extends** keyword is used to extend an interface, and the **child interface** inherits the methods of the **parent interface**.

Example:

```
public interface A
{
        void getdata(String name);
}
public interface B extends A
{
        void setdata();
}
class InheritInterface implements B
{
        String display;
        public void getdata(String name)
        {
                display = name;
        }
        public void setdata()
        {
                System.out.println(display);
        }
        public static void main(String args[])
        {
                InheritInterface obj = new InheritInterface();
                obj.getdata("Welcome TO Heaven");
                obj.setdata();
        }
}
```

Output:

```
Welcome TO Heaven
```

- The interface **B** has one method, but it **inherits** one from interface **A**; thus, a class **InheritInterface** that implements **B** needs to implement **two methods**.

Multiple Inheritance using Interface

- If a **class** implements **multiple interfaces**, or an **interface** extends **multiple interfaces** known as **multiple inheritance**.
- A java **class** can only extend **one parent class**. Multiple inheritances are not allowed. However, an **interface** can extend **more than one parent interface**.
- The **extends** keyword is used once, and the **parent interfaces** are declared in a **comma-separated list.**

Example:

```
public  interface  A
{
        void  getdata(String name);
}
public  interface  B   // Here we can also extends multiple interface like  interface B extends
                          A,C
{
        void  setdata();
}
class  InheritInterface  implements  A, B
{
        String  display;
        public  void  getdata(String  name)
        {
                display = name;
        }
        public  void  setdata()
        {
                System.out.println(display);
        }
        public  static  void  main(String args[])
        {
                InheritInterface  obj = new  InheritInterface();
                obj.getdata("Welcome TO Heaven");
                obj.setdata();
        }
}
```

Output:

```
Welcome TO Heaven
```

Abstract Class

- A **class** that is declared with **abstract** keyword, is known as an **abstract class** in java. It can have **abstract** and **non-abstract methods** (method with body).
- It needs to be **extended** and its method implemented. It cannot be instantiated means we can't create object of it.
- Any class that extends an **abstract** class must implement all the **abstract methods** declared by the super class.

  Syntax:

  ```
  abstract  class  class_name
  {
          //Number of abstract as well as non-abstract methods.
  }
  ```
- A **method** that is declared as **abstract** and does not have implementation is known as **abstract method.**
- The method body will be defined by its **subclass**. Abstract method can never be **final** and **static**.

Syntax:

```
abstract return_type function_name ();      // No definition
```

Example:

```
abstract class A
{
        abstract void abs_method();
        public void display()
        {
                System.out.println("This is concrete method..");
        }
}
class DemoAbstract extends A
{
        void abs_method()
        {
                System.out.println("This is an abstract method..");
        }
        public static void main(String[] args)
        {
                DemoAbstract  abs = new DemoAbstract ();
                abs.abs_method();
                abs.display();
        }
}
```

Output:

```
This is an abstract method..
This is concrete method..
```

Final Keyword

- The **final keyword** in java is used to restrict the user. The java final keyword can be used with:
  1) variable
  2) method
  3) class
- **Final Variable:** If you make any variable as **final**, you cannot change the value of that final variable (It will be constant).
  - A variable that is declared as **final** and **not initialized** is called a **blank final** variable. A blank final variable forces the **constructors to initialize it**.
- **Final Method:** Methods declared as **final** cannot be **overridden**.
- **Final Class:** Java classes declared as final cannot be extended means cannot **inherit**.
- If you declare any parameter as **final**, you cannot change the value of it.

Example:

```
class DemoBase
{
        final int i = 1;          //final variable must be initialize.
        final void display()
        {
                System.out.println("Value of i is :: "+ i);
```

```
		}
	}
	class  DemoFinal  extends  DemoBase
	{
		/*void display()		// Compilation error final method cannot override.
		{
			System.out.println("Value of i is :: "+ i);
		}*/
		public  static  void  main(String args[])
		{
			DemoFinal  obj = new  DemoFinal();
			obj.display();
		}
	}
```

Output:

```
Value of i is :: 1
```

Difference between Method Overloading and overriding

Overriding	Overloading
The **argument list** must exactly match that of the overridden method.	Overloaded methods MUST change the **argument list**.
The **return type** must be the same as overridden method in the super class.	Overloaded methods CAN change the **return type**.
Private and **final** methods cannot be overridden.	**Private** and **final** methods can be overloaded.
Method overriding occurs in two classes that have inheritance.	Method overloading is performed within class.
Dynamic binding is being used for overridden methods.	**Static binding** is being used for overloaded methods.
Method overriding is the example of **run time polymorphism**.	Method overloading is the example of **compile time polymorphism**.

Difference between Interface and Abstract class

Interface	Abstract class
Interface can have **only abstract** methods.	Abstract class can **have abstract and non-abstract** methods.
Interface **supports multiple inheritance**.	Abstract class **doesn't support multiple inheritance**.
Interface **can't have static methods, main method or constructor**.	Abstract class **can have static methods, main method and constructor**.
In interface all method should be define in a class in which we implement them.	This is not applicable for abstract classes.
Interface **can't provide the implementation of abstract class**.	Abstract class **can provide the implementation of interface**.