Java Notes Prepared By Prof Bhujbal V N
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Chapter 1 Introduction to Java

Features of java:-

1. Simple
2. Object-Oriented
3. Architecture neutral
4. High Performance
5. Distributed
6. Multithreade
7. Platform independent
8. Secured
9. Robust
10. Portable
11. Dynamic

Simple

According to Sun, Java language is simple because:

syntax is based on C++ (so easier for programmers to learn it after C++).

removed many confusing and/or rarely-used features e.g., explicit pointers, operator overloading etc.

No need to remove unreferenced objects because there is Automatic Garbage Collection in java.

Object-oriented

Object-oriented means we organize our software as a combination of different types of objects that incorporates both data and behaviour.

Object-oriented programming(OOPs) is a methodology that simplify software development and maintenance by providing some rules.

Basic concepts of OOPs are:

1. Object
2. Class
3. Inheritance
4. Polymorphism
5. Abstraction
6. Encapsulation

Architecture-neutral

There is no implementation dependent features e.g. size of primitive types is fixed.
In C programming, int data type occupies 2 bytes of memory for 32-bit architecture and 4 bytes of memory for 64-bit architecture. But in java, it occupies 4 bytes of memory for both 32 and 64 bit architectures.

High-performance

Java is faster than traditional interpretation since byte code is "close" to native code still somewhat slower than a compiled language (e.g., C++)

Distributed

We can create distributed applications in java. RMI and EJB are used for creating distributed applications. We may access files by calling the methods from any machine on the internet.

Multi-threaded

A thread is like a separate program, executing concurrently. We can write Java programs that deal with many tasks at once by defining multiple threads. The main advantage of multi-threading is that it doesn't occupy memory for each thread. It shares a common memory area. Threads are important for multi-media, Web applications etc.

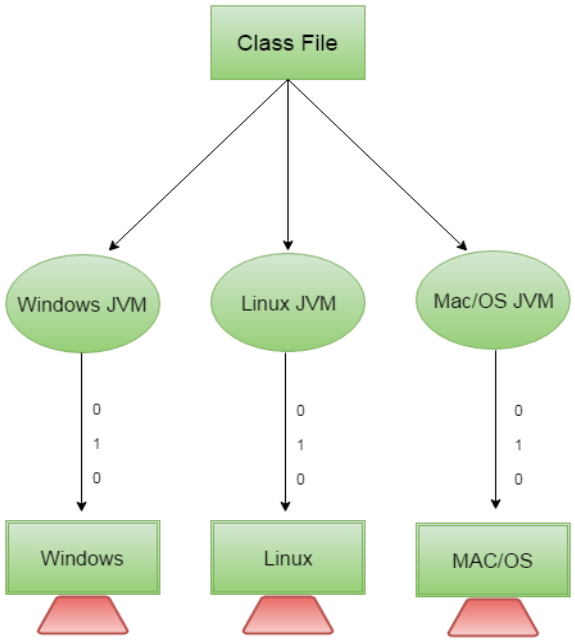
Platform Independent

A platform is the hardware or software environment in which a program runs.

There are two types of platforms software-based and hardware-based. Java provides software-based platform.

The Java platform differs from most other platforms in the sense that it is a software-based platform that runs on the top of other hardware-based platforms. It has two components:

1. Runtime Environment
2. API(Application Programming Interface)



Java code can be run on multiple platforms e.g. Windows, Linux, Sun Solaris, Mac/OS etc. Java code is compiled by the compiler and converted into bytecode. This bytecode is a platform-independent code because it can be run on multiple platforms i.e. Write Once and Run Anywhere(WORA).

Secured

Java is secured because:

- **No explicit pointer**
- **Java Programs run inside virtual machine sandbox**
- **Classloader:** adds security by separating the package for the classes of the local file system from those that are imported from network sources.
- **Bytecode Verifier:** checks the code fragments for illegal code that can violate access right to objects.

- **Security Manager:** determines what resources a class can access such as reading and writing to the local disk.

Robust

Robust simply means strong. Java uses strong memory management. There are lack of pointers that avoids security problem. There is automatic garbage collection in java. There is exception handling and type checking mechanism in java. All these points makes java robust.

Portable

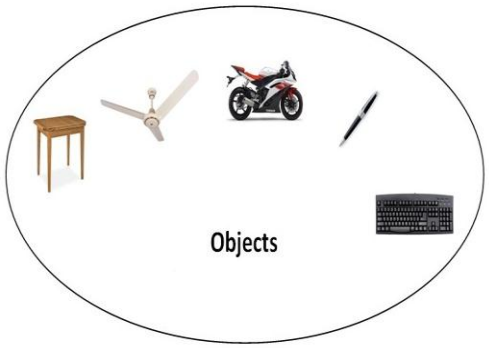
We may carry the java bytecode to any platform.

ava Tool	Description
appletviewer	To run applets outside of a web browser.
jar	To aggregate and compress multiple files into a singe JAR file.
java	To launch Java applications.
javac	To compile Java source files to binary class files.
javadoc	To generate API documentation out of Java source files.
javah	To generate C language header and stubs while writing native methods.
javap	To disassemble Java class files.
java-rmi	To generate stubs, skeletons and other RMI related tasks.
jdb	To debug a Java class
rmic	To generate stubs and skeletons for Java remote objects

OOPs (Object Oriented Programming System)

Object means a real word entity such as pen, chair, table etc.**Object-Oriented Programming** is a methodology or paradigm to design a program using classes and objects. It simplifies the software development and maintenance by providing some concepts:

- Object
- Class
- Inheritance
- Polymorphism
- Abstraction
- Encapsulation



Object

Any entity that has state and behavior is known as an object. For example: chair, pen, table, keyboard, bike etc. It can be physical and logical.

Class

Collection of objects is called class. It is a logical entity.

Inheritance

When one object acquires all the properties and behaviours of parent object i.e. known as inheritance. It provides code reusability. It is used to achieve runtime polymorphism.

Polymorphism

When **one task is performed by different ways** i.e. known as polymorphism. For example: to convince the customer differently, to draw something e.g. shape or rectangle etc.

In java, we use method overloading and method overriding to achieve polymorphism.

Another example can be to speak something e.g. cat speaks meaw, dog barks woof etc.

Abstraction

Hiding internal details and showing functionality is known as abstraction. For example: phone call, we don't know the internal processing.

In java, we use abstract class and interface to achieve abstraction.

Encapsulation

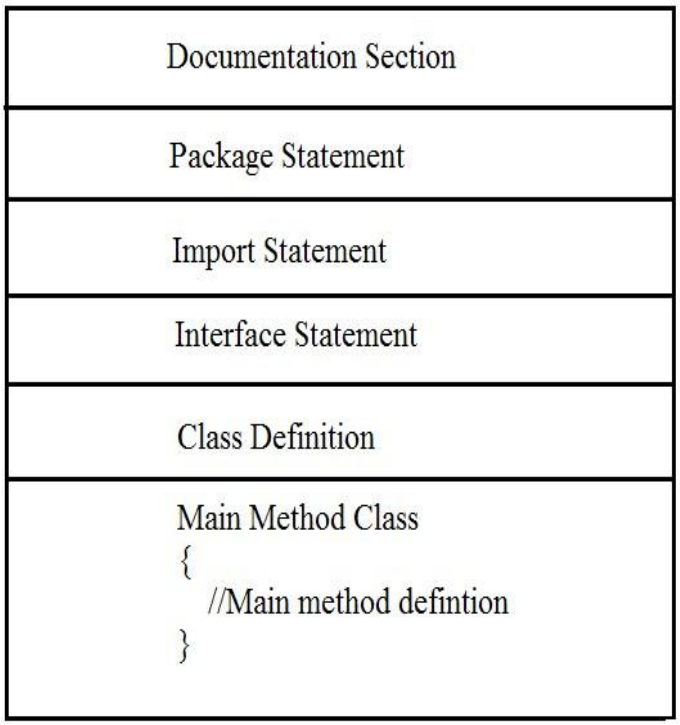
Binding (or wrapping) code and data together into a single unit is known as encapsulation. For example: capsule, it is wrapped with different medicines.A java class is the example of encapsulation. Java bean is the fully encapsulated class because all the data members are private here.


Capsule

Difference between C++ and JAVA

Comparison Index	C++	Java
Platform-independent	C++ is platform-dependent.	Java is platform-independent.
Mainly used for	C++ is mainly used for system programming.	Java is mainly used for application programming. It is widely used in window, web-based, enterprise and mobile applications.
Goto	C++ supports goto statement.	Java doesn't support goto statement.
Multiple inheritance	C++ supports multiple inheritance.	Java doesn't support multiple inheritance through class. It can be achieved by interfaces in java.
Operator Overloading	C++ supports operator overloading.	Java doesn't support operator overloading.
Pointers	C++ supports pointers. You can write pointer program in C++.	Java supports pointer internally. But you can't write the pointer program in java. It means java has restricted pointer support in java.
Compiler and Interpreter	C++ uses compiler only.	Java uses compiler and interpreter both.
Call by Value and Call by reference	C++ supports both call by value and call by reference.	Java supports call by value only. There is no call by reference in java.
Structure and Union	C++ supports structures and unions.	Java doesn't support structures and unions.
Thread Support	C++ doesn't have built-in support for threads. It relies on third-party libraries for thread support.	Java has built-in thread support.
Documentation comment	C++ doesn't support documentation comment.	Java supports documentation comment (/** ... */) to create documentation for java source code.
Virtual Keyword	C++ supports virtual keyword so that we can decide whether or not override a function.	Java has no virtual keyword. We can override all non-static methods by default. In other words, non-static methods are virtual by default.
Inheritance Tree	C++ creates a new inheritance tree always.	Java uses single inheritance tree always because all classes are the child of Object class in java. Object class is the root of inheritance tree in java.

Structure of java program



A Java program consists of different sections. Some of them are mandatory but some are optional. The optional section can be excluded from the program depending upon the requirements of the programmer.

Documentation Section

It includes the comments to tell the program's purpose. It improves the readability of the program.

Package Statement

It includes statement that provides a package declaration. e.g package Student

Import statements

It includes statements used for referring classes and interfaces that are declared in other packages. e.g import java.io.*;

Interface Section

Interface like class but includes group of methods declaration .Used when we want to implement multiple inheritance feature. It is similar to a class but only includes constants, method declaration.

Class Section: The Class section describes the information about user-defined classes present in the program. A class is a collection of fields (data variables) and methods that operate on the fields. Every program in Java consists of at least one class, the one that contains the main method. The main () method which is from where the execution of program actually starts and follow the statements in the order specified.

The class section is mandatory.

Main Method class:

Java stand alone program requires main method as starting point.
This is essential part of program
Main method creates object of various classes.

After discussing the structure of programs in Java, we shall now discuss a program that displays a string Hello Java on the screen.

```
// Program to display message on the screen
class HelloJava
{
      public static void main(String args[])
   {
        System.out.println("Hello Java");
    }
}
```

Data Types

Data Type	Default Value	Default size
boolean	false	1 bit
char	'\u0000'	2 byte
byte	0	1 byte
short	0	2 byte
int	0	4 byte
long	0L	8 byte
float	0.0f	4 byte
double	0.0d	8 byte

Java Naming conventions

Java **naming convention** is a rule to follow as you decide what to name your identifiers such as class, package, variable, constant, method etc.
But, it is not forced to follow. So, it is known as convention not rule.
All the classes, interfaces, packages, methods and fields of java programming language are given according to java naming convention.

Advantage of naming conventions in java

By using standard Java naming conventions, you make your code easier to read for yourself and for other programmers. Readability of Java program is very important. It indicates that **less time** is spent to figure out what the code does.

Name	Convention
class name	should start with uppercase letter and be a noun e.g. String, Color, Button, System, Thread etc.
interface name	should start with uppercase letter and be an adjective e.g. Runnable, Remote, ActionListener etc.
method name	should start with lowercase letter and be a verb e.g. actionPerformed(), main(), print(), println() etc.
variable name	should start with lowercase letter e.g. firstName, orderNumber etc.
package name	should be in lowercase letter e.g. java, lang, sql, util etc.
constants	should be in uppercase letter. e.g. RED, YELLOW, MAX_PRIORITY etc.

name	

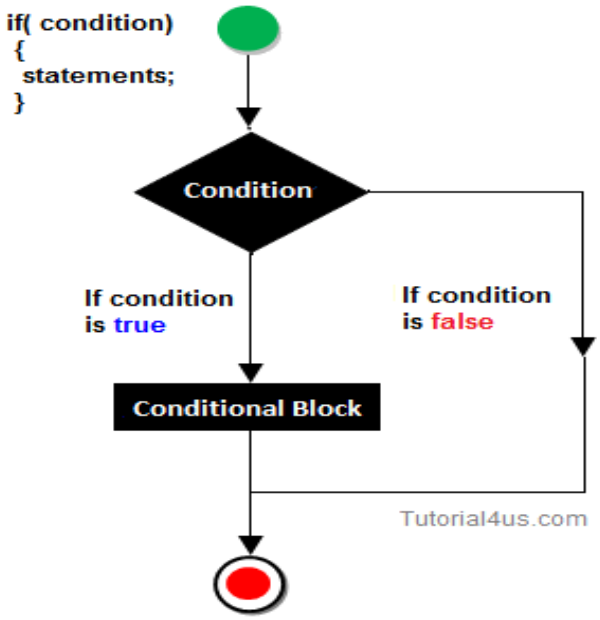
Decision Making

Decision making statement statements is also called selection statement. That is depending on the condition block need to be executed or not which is decided by condition. If the condition is "true" statement block will be executed, if condition is "false" then statement block will not be executed. In java there are three types of decision making statement.

- if
- if-else
- switch

if-then Statement

if-then is most basic statement of Decision making statement. It tells to program to execute a certain part of code only if particular condition is true.



Syntax

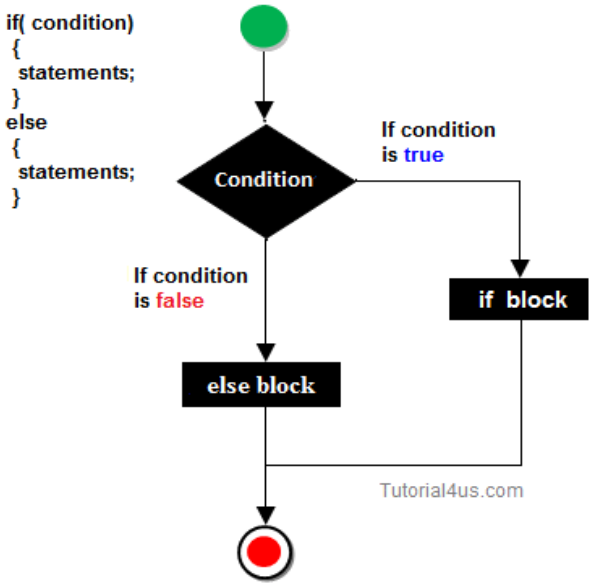
```
if(condition)
 {
   Statement(s)
 }
e.g
class Hello
{
  int a=10;
  public static void main(String[] args)
 {
   if(a<15)
  {
     System.out.println("Hello good morning!");
  }
 }
}
```

if-else statement

In general it can be used to execute one block of statement among two blocks, in java language **if** and **else** are the keyword in java

Syntax

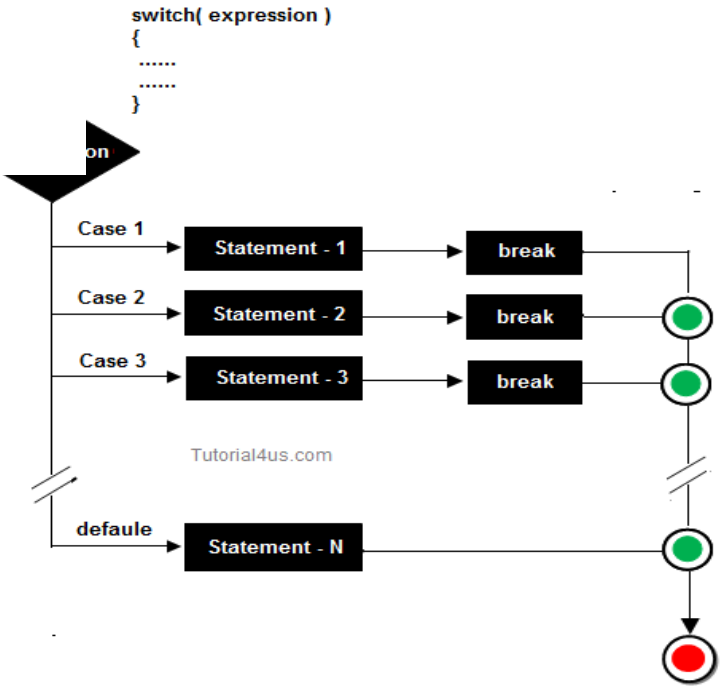
```
if(condition)
 {
  Statement(s)
 }
 else
 {
  Statement(s)
 }
```



Switch Statement

The **switch** statement in java language is used to execute the code from multiple conditions or case. It is same like if else-if ladder statement.

A switch statement work with byte, short, char and int primitive data type, it also works with enumerated types and string.



Type Casting

Well, all **casting** really means is taking an Object of one particular type and "turning it into" another Object type. This process is called **casting** a variable. This topic is not specific to **Java**, as many other programming languages support **casting** of their variable types.

The process of converting one data type to another is called **casting**. Casting is often necessary when a function returns a data of type in different form then we need to perform an operation. Under

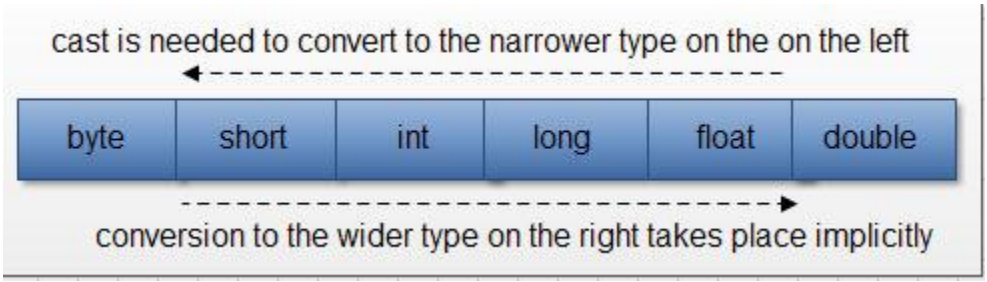
certain circumstances Type conversion can be carried out automatically, in other cases it must be "forced" manually (explicitly). For example, the read() member function of the standard input stream (System.in) returns an int.

In some cases, the data type of the *expression* is changed *automatically* to the *variable's* data type. For example, suppose that i is an integer variable declared as follows:

int i = 10;

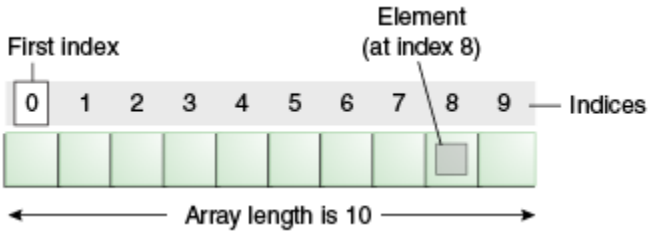
Even though d is a variable of type double, the following assignment is valid:

double d = i; // valid, i is converted to type double



Java Array

Normally, array is a collection of similar type of elements that have contiguous memory location. **Java array** is an object the contains elements of similar data type. It is a data structure where we store similar elements. We can store only fixed set of elements in a java array.
Array in java is index based, first element of the array is stored at 0 index.



Advantage of Java Array

- **Code Optimization:** It makes the code optimized, we can retrieve or sort the data easily.
- **Random access:** We can get any data located at any index position.

Disadvantage of Java Array

- **Size Limit:** We can store only fixed size of elements in the array. It doesn't grow its size at runtime. To solve this problem, collection framework is used in java.

Types of Array in java

There are two types of array.

- Single Dimensional Array
- Multidimensional Array

Single/One Dimensional Array in java

Syntax to Declare an Array in java

1. dataType[] arr; (or)
2. dataType []arr; (or)
3. dataType arr[];

Example of single dimensional java array

Let's see the simple example of java array, where we are going to declare, instantiate, initialize and traverse an array.

```
class Testarray
{
   public static void main(String args[])
  {
        int a[]=new int[5];//declaration and instantiation
        a[0]=10;//initialization
        a[1]=20;
        a[2]=70;
        a[3]=40;
        a[4]=50;
        //printing array
        for(int i=0;i<a.length;i++)//length is the property of array
        System.out.println(a[i]);
  }
}
```

Output:

```
10
20
70
40
50
```

Multidimensional array in java/Two Dimensional Array

In such case, data is stored in row and column based index (also known as matrix form).

Syntax to Declare Multidimensional Array in java

1. dataType[][] arrayRefVar; (or)
2. dataType [][]arrayRefVar; (or)

3. dataType arrayRefVar[][]; (or)
4. dataType []arrayRefVar[];

Example to instantiate Multidimensional Array in java

1. int[][] arr=new int[3][3];//3 row and 3 column

Example to initialize Multidimensional Array in java

1. arr[0][0]=1;
2. arr[0][1]=2;
3. arr[0][2]=3;
4. arr[1][0]=4;
5. arr[1][1]=5;
6. arr[1][2]=6;
7. arr[2][0]=7;
8. arr[2][1]=8;
9. arr[2][2]=9;

Example of Multidimensional java array

Let's see the simple example to declare, instantiate, initialize and print the 2Dimensional array.

```
class Testarray3
{
	public static void main(String args[])
	{

		//declaring and initializing 2D array
		int arr[][]={{1,2,3},{2,4,5},{4,4,5}};
		//printing 2D array
		for(int i=0;i<3;i++)
		{
			 for(int j=0;j<3;j++)
			{
				System.out.print(arr[i][j]+" ");
			 }
			 System.out.println();
		}
	}
}
```

Output:
```
1 2 3
2 4 5
4 4 5
```

Java String

1)

In java, string is basically an object that represents sequence of char values. An array of characters works same as java string. For example:

```
char[] ch={'j','a','v','a','t','p','o','i','n','t'};
String s=new String(ch);
```

is same as:

1. String s="ACS College";

2) By new keyword

1. String s=new String("Welcome");//creates two objects and one reference variable

Java String Example

```
public class StringExample
{
 public static void main(String args[])
 {
      String s1="java";//creating string by java string literal
      char ch[]={'s','t','r','i','n','g','s'};
      String s2=new String(ch);//converting char array to string
      String s3=new String("example");//creating java string by new keyword
      System.out.println(s1);
      System.out.println(s2);
      System.out.println(s3);
 }
}
```

Output

```
java
strings
example
```

Java String class methods

The java.lang.String class provides a lot of methods to work on string. By the help of these methods, we can perform operations on string such as trimming, concatenating, converting, comparing, replacing strings etc.

Java String is a powerful concept because everything is treated as a string if you submit any form in window based, web based or mobile application.

Let's see the important methods of String class.

Java String Methods

String charAt(), String compareTo(), String concat() ,String contains() ,String endsWith(), String equals() ,equalsIgnoreCase() ,String format() ,String getBytes() ,String getChars(), String indexOf() , String isEmpty(), String join(), String lastIndexOf(), String length() ,String replace() ,String replaceAll() , String startsWith() String substring(), String toCharArray(), String toLowerCase(), String toUpperCase() ,String trim() ,String valueOf().

Java String toUpperCase() and toLowerCase() method

The java string toUpperCase() method converts this string into uppercase letter and string toLowerCase() method into lowercase letter.

```
1. String s="Sachin";
2. System.out.println(s.toUpperCase());//SACHIN
3. System.out.println(s.toLowerCase());//sachin
4. System.out.println(s);//Sachin(no change in original)
```

Output

```
SACHIN
sachin
Sachin
```

Java String trim() method

The string trim() method eliminates white spaces before and after string.

```
1. String s="  Sachin  ";
2. System.out.println(s);//  Sachin
3. System.out.println(s.trim());//Sachin
```

Output

```
  Sachin
Sachin
```

Java String startsWith() and endsWith() method

```
1. String s="Sachin";
2.  System.out.println(s.startsWith("Sa"));//true
3.  System.out.println(s.endsWith("n"));//true
```

Output

```
true
true
```

Java String charAt() method

The string charAt() method returns a character at specified index.

```
1. String s="Sachin";
2. System.out.println(s.charAt(0));//S
3. System.out.println(s.charAt(3));//h
```

Output

```
S
h
```

Java String length() method

The string length() method returns length of the string.

```
1. String s="Sachin";
2. System.out.println(s.length());//6
```

Output

```
6
```

Java String replace() method

The string replace() method replaces all occurrence of first sequence of character with second sequence of character.

```
1. String s1="Java is a programming language. Java is a platform. Java is an Island.";
2. String replaceString=s1.replace("Java","Kava");//replaces all occurrences of "Java" to "Kava
   "
3. System.out.println(replaceString);
```

Output:

```
Kava is a programming language. Kava is a platform. Kava is an Island.
```

Java String valueOf() method

The string valueOf() method coverts given type such as int, long, float, double, boolean, char and char array into string.

```
1. int a=10;
2. String s=String.valueOf(a);
3. System.out.println(s+10);
```

Output:

```
1010
```

Java StringBuffer class

Java StringBuffer class is used to created mutable (modifiable) string. The StringBuffer class in java is same as String class except it is mutable i.e. it can be changed.

Important Constructors of StringBuffer class

1. **StringBuffer():** creates an empty string buffer with the initial capacity of 16.
2. **StringBuffer(String str):** creates a string buffer with the specified string.
3. **StringBuffer(int capacity):** creates an empty string buffer with the specified capacity as length.

Important methods of StringBuffer class

1. **public synchronized StringBuffer append(String s):** is used to append the specified string with this string. The append() method is overloaded like append(char), append(boolean), append(int), append(float), append(double) etc.
2. **public synchronized StringBuffer insert(int offset, String s):** is used to insert the specified string with this string at the specified position. The insert() method is overloaded like insert(int, char), insert(int, boolean), insert(int, int), insert(int, float), insert(int, double) etc.
3. **public synchronized StringBuffer replace(int startIndex, int endIndex, String str):** is used to replace the string from specified startIndex and endIndex.
4. **public synchronized StringBuffer delete(int startIndex, int endIndex):** is used to delete the string from specified startIndex and endIndex.
5. **public synchronized StringBuffer reverse():** is used to reverse the string.
6. **public int capacity():** is used to return the current capacity.
7. **public void ensureCapacity(int minimumCapacity):** is used to ensure the capacity at least equal to the given minimum.
8. **public char charAt(int index):** is used to return the character at the specified position.
9. **public int length():** is used to return the length of the string i.e. total number of characters.
10. **public String substring(int beginIndex):** is used to return the substring from the specified beginIndex.
11. **public String substring(int beginIndex, int endIndex):** is used to return the substring from the specified beginIndex and endIndex.

Difference between String and StringBuffer

No.	String	StringBuffer
1)	String class is immutable.	StringBuffer class is mutable.
2)	String is slow and consumes more memory when you concat too many strings because every time it creates new instance.	StringBuffer is fast and consumes less memory when you cancat strings.
3)	String class overrides the equals() method of Object class. So you can compare the contents of two strings by	StringBuffer class doesn't override the equals() method of Object class.

	equals() method.	

Chapter 2 Classes and Objects

Class in Java

A class is a group of objects that has common properties. It is a template or blueprint from which objects are created.

A class in java can contain:

- **data member**
- **method**
- **constructor**
- **block**
- **class and interface**

Syntax to declare a class:

```
1. class <class_name>{
2.     data member;
3.     method;
4. }
```

Object in Java

An entity that has state and behavior is known as an object e.g. chair, bike, marker, pen, table, car etc. It can be physical or logical (tengible and intengible). The example of integible object is banking system.

An object has three characteristics:

- **state:** represents data (value) of an object.
- **behavior:** represents the behavior (functionality) of an object such as deposit, withdraw etc.
- **identity:** Object identity is typically implemented via a unique ID. The value of the ID is not visible to the external user. But,it is used internally by the JVM to identify each object uniquely.

Object is an instance of a class. Class is a template or blueprint from which objects are created. So object is the instance(result) of a class.

Simple Example of Object and Class

In this example, we have created a Student class that have two data members id and name. We are creating the object of the Student class by new keyword and printing the objects value.

```
1.  class Student1{
2.   int id;//data member (also instance variable)
3.   String name;//data member(also instance variable)
4.
5.   public static void main(String args[]){
6.    Student1 s1=new Student1();//creating an object of Student
7.    System.out.println(s1.id);
8.    System.out.println(s1.name);
9.   }
10. }
```

```
Output:0 null
```

new keyword

The new keyword is used to allocate memory at runtime.

Example of Object and class that maintains the records of students

In this example, we are creating the two objects of Student class and initializing the value to these objects by invoking the insertRecord method on it. Here, we are displaying the state (data) of the objects by invoking the displayInformation method.

```
1.  class Student2
2.  {   int rollno;
3.      String name;
4.        void insertRecord(int r, String n){  //method
5.       rollno=r;
6.      name=n;
7.   }
8.   void displayInformation()
9.  {     System.out.println(rollno+" "+name);}//method
10.       public static void main(String args[]){
11.       Student2 s1=new Student2();
```

```
12.       Student2 s2=new Student2();
13.       s1.insertRecord(111,"Karan");
14.       s2.insertRecord(222,"Aryan");
15.      s1.displayInformation();
16.       s2.displayInformation();
17.  }
18. }
```

Output

```
111 Karan
222 Aryan
```

Java Garbage Collection

In java, garbage means unreferenced objects.

Garbage Collection is process of reclaiming the runtime unused memory automatically. In other words, it is a way to destroy the unused objects.

To do so, we were using free() function in C language and delete() in C++. But, in java it is performed automatically. So, java provides better memory management.

Advantage of Garbage Collection

- It makes java **memory efficient** because garbage collector removes the unreferenced objects from heap memory.
- It is **automatically done** by the garbage collector(a part of JVM) so we don't need to make extra efforts.

Constructor in Java

1. Types of constructors
    1. Default Constructor
    2. Parameterized Constructor
2. Constructor Overloading
3. Does constructor return any value
4. Copying the values of one object into another
5. Does constructor perform other task instead initialization

Constructor in java is a *special type of method* that is used to initialize the object.

Java constructor is *invoked at the time of object creation*. It constructs the values i.e. provides data for the object that is why it is known as constructor.

Rules for creating java constructor

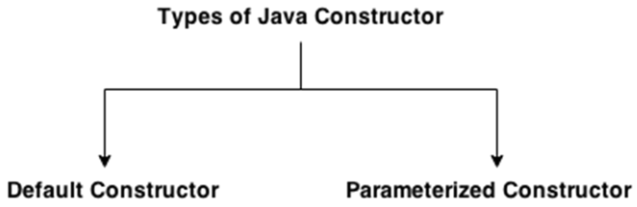
There are basically two rules defined for the constructor.

1. Constructor name must be same as its class name
2. Constructor must have no explicit return type

Types of java constructors

There are two types of constructors:

1. Default constructor (no-arg constructor)
2. Parameterized constructor



Java Default Constructor

A constructor that have no parameter is known as default constructor.

Syntax of default constructor:

1. <class_name>(){}

Example of default constructor

In this example, we are creating the no-arg constructor in the Bike class. It will be invoked at the time of object creation.

```
1. class Bike1{
2. Bike1(){System.out.println("Bike is created");}
3. public static void main(String args[]){
4. Bike1 b=new Bike1();
5. }
6. }
```

Output:

```
Bike is created
```

Q) What is the purpose of default constructor?

Default constructor provides the default values to the object like 0, null etc. depending on the type.

Example of default constructor that displays the default values

```
class Student3{
int id;
String name;
void display(){System.out.println(id+" "+name);}
public static void main(String args[]){
Student3 s1=new Student3();
Student3 s2=new Student3();
s1.display();
s2.display();
}
}
```

Output:

```
0 null
0 null
```

Java parameterized constructor

A constructor that have parameters is known as parameterized constructor.

Why use parameterized constructor?

Parameterized constructor is used to provide different values to the distinct objects.

Example of parameterized constructor

In this example, we have created the constructor of Student class that have two parameters. We can have any number of parameters in the constructor.

```
1.  class Student4{
2.      int id;
3.      String name;
4.
5.      Student4(int i,String n){
6.      id = i;
7.      name = n;
8.      }
9.      void display(){System.out.println(id+" "+name);}
10.
11.     public static void main(String args[]){
12.     Student4 s1 = new Student4(111,"Karan");
13.     Student4 s2 = new Student4(222,"Aryan");
14.     s1.display();
15.     s2.display();
16.     } }
```

Output:

```
111 Karan
222 Aryan
```

Constructor Overloading in Java

Constructor overloading is a technique in Java in which a class can have any number of constructors that differ in parameter lists.The compiler differentiates these constructors by taking into account the number of parameters in the list and their type.

Example of Constructor Overloading

```
class Student5{
   int id;
   String name;
   int age;
   Student5(int i,String n){
   id = i;
   name = n;
   }
   Student5(int i,String n,int a){
   id = i;
```

```
name = n;
  age=a;
  }
  void display(){System.out.println(id+" "+name+" "+age);}
  public static void main(String args[]){
  Student5 s1 = new Student5(111,"Karan");
  Student5 s2 = new Student5(222,"Aryan",25);
  s1.display();
  s2.display();
 } }
```

Output:

```
111 Karan 0
222 Aryan 25
```

Java Copy Constructor

There is no copy constructor in java. But, we can copy the values of one object to another like copy constructor in C++.

There are many ways to copy the values of one object into another in java. They are:

- By constructor
- By assigning the values of one object into another
- By clone() method of Object class

In this example, we are going to copy the values of one object into another using java constructor.

```
1.  class Student6{
2.      int id;
3.      String name;
4.      Student6(int i,String n){
5.      id = i;
6.      name = n;
7.      }
8.
9.      Student6(Student6 s){
10.     id = s.id;
11.     name =s.name;
12.     }
13.     void display(){System.out.println(id+" "+name);}
14.
15.     public static void main(String args[]){
16.     Student6 s1 = new Student6(111,"Karan");
17.     Student6 s2 = new Student6(s1);
18.     s1.display();
19.     s2.display();
20.    }
21. }
```

Output:

```
111 Karan
111 Karan
```

Inheritance in Java

Inheritance in java is a mechanism in which one object acquires all the properties and behaviors of parent object.

The idea behind inheritance in java is that you can create new classes that are built upon existing classes. 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.

Inheritance represents the **IS-A relationship**, also known as *parent-child* relationship.

Why use inheritance in java

- For Method Overriding (so runtime polymorphism can be achieved).
- For Code Reusability.

Syntax of Java Inheritance

```
1. class Subclass-name extends Superclass-name
2. {
3.   //methods and fields
4. }
```

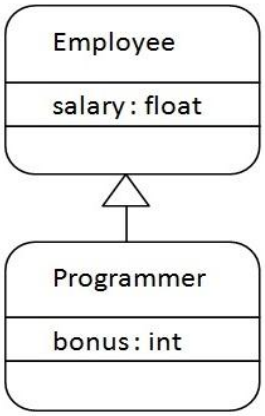
The **extends keyword** indicates that you are making a new class that derives from an existing class.

In the terminology of Java, a class that is inherited is called a super class. The new class is called a subclass.

```
class Employee{
 float salary=40000;
}
class Programmer extends Employee{
 int bonus=10000;
 public static void main(String args[]){
   Programmer p=new Programmer();
   System.out.println("Programmer salary is:"+p.salary);
   System.out.println("Bonus of Programmer is:"+p.bonus);
}
}
```

Output

```
Programmer salary is:40000.0
Bonus of programmer is:10000
```

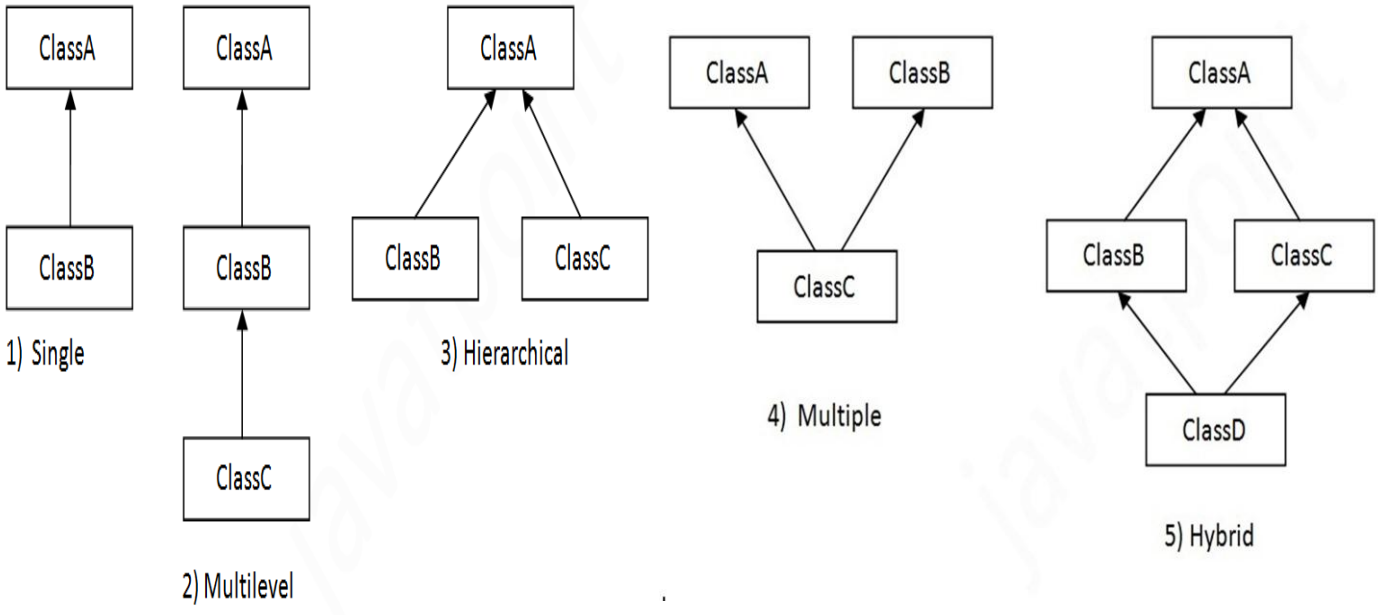


Types of inheritance in java

On the basis of class, there can be three types of inheritance in java: single, multilevel and hierarchical.

In java programming, multiple and hybrid inheritance is supported through interface only. We will learn about interfaces later.

Note: Multiple inheritance is not supported in java through class



Q) Why multiple inheritance is not supported in java?

To reduce the complexity and simplify the language, multiple inheritance is not supported in java.

Consider a scenario where A, B and C are three classes. The C class inherits A and B classes. If A and B classes have same method and you call it from child class object, there will be ambiguity to call method of A or B class.
Since compile time errors are better than runtime errors, java renders compile time error if you inherit 2 classes. So whether you have same method or different, there will be compile time error now.

```
        class A{
    void msg(){System.out.println("Hello");}
        }
        class B{
        void msg(){System.out.println("Welcome");}
        }
        class C extends A,B{//suppose if it were

         Public Static void main(String args[]){
           C obj=new C();
           obj.msg();//Now which msg() method would be invoked?
        }
        }
```

Output

```
Compile Time Error
```

Interface in Java

An **interface in java** is a blueprint of a class. It has 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. It is used to achieve fully abstraction and multiple inheritance in Java.

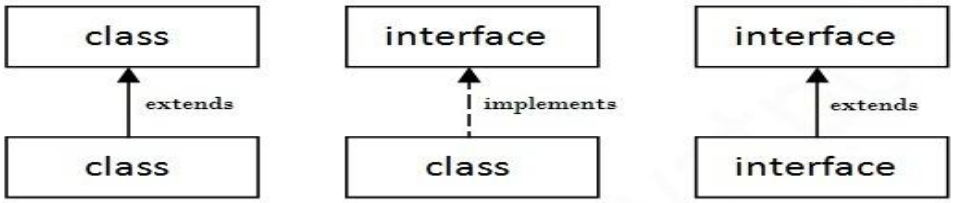
Java Interface also **represents IS-A relationship**.

It cannot be instantiated just like abstract class.

Why use Java interface?

There are mainly three reasons to use interface. They are given below.

- It is used to achieve fully abstraction.
- By interface, we can support the functionality of multiple inheritance.
- It can be used to achieve loose coupling.



Simple example of Java interface

In this example, Printable interface have only one method, its implementation is provided in the A class.

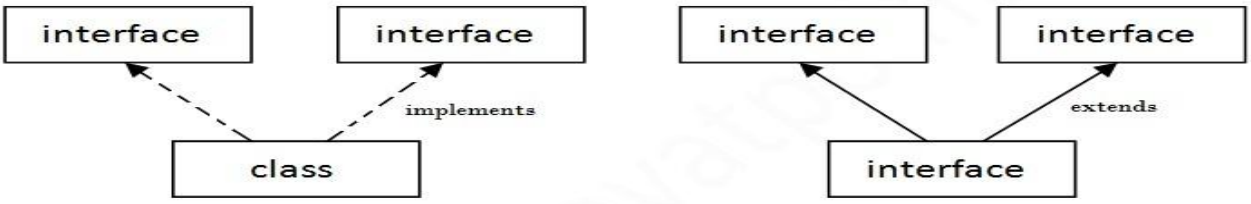
```
interface printable{
    void print();
    }

    class A6 implements printable{
    public void print(){System.out.println("Hello");}

public static void main(String args[]){
A6 obj = new A6();
    obj.print();
     }
    }
```

Output

```
Output:Hello
```

Multiple inheritance in Java by interface

If a class implements multiple interfaces, or an interface extends multiple interfaces i.e. known as multiple inheritance.



Multiple Inheritance in Java

```
interface Printable{
```

```
                    void print();
                }
    interface Showable{
                        void show();
                }
class A7 implements  Printable,Showable{

    public void print(){System.out.println("Hello");}
    public void show(){System.out.println("Welcome");}

    public static void main(String args[]){
    A7 obj = new A7();
    obj.print();
    obj.show();
     }
}
```

Output

```
Output:Hello
       Welcome
```

Abstract class in Java

A class that is declared with abstract keyword, is known as abstract class in java. It can have abstract and non-abstract methods (method with body).
Before learning java abstract class, let's understand the abstraction in java first.

Abstraction in Java

Abstraction is a process of hiding the implementation details and showing only functionality to the user.
Another way, it shows only important things to the user and hides the internal details for example sending sms, you just type the text and send the message. You don't know the internal processing about the message delivery.
Abstraction lets you focus on what the object does instead of how it does it.

Ways to achieve Abstaction

There are two ways to achieve abstraction in java

1. Abstract class (0 to 100%)
2. Interface (100%)

Abstract class in Java

A class that is declared as abstract is known as **abstract class**. It needs to be extended and its method implemented. It cannot be instantiated.

Example abstract class

1. abstract class A{}

abstract method

A method that is declared as abstract and does not have implementation is known as abstract method.

Example abstract method

1. abstract void printStatus();//no body and abstract

Example of abstract class that has abstract method

In this example, Bike the abstract class that contains only one abstract method run. It implementation is provided by the Honda class.

```
1. abstract class Bike{
2.   abstract void run();
3. }
4. class Honda4 extends Bike{
5. void run(){System.out.println("running safely..");}
6. public static void main(String args[]){
7.  Bike obj = new Honda4();
8.  obj.run();
9. }
10. }
```

Output

```
running safely..
```

interface

Abstract class and interface both are used to achieve abstraction where we can declare the abstract methods. Abstract class and interface both can't be instantiated.
But there are many differences between abstract class and interface that are given below.

Abstract class	Interface
1) Abstract class can **have abstract and non-abstract** methods.	Interface can have **only abstract** methods.
2) Abstract class **doesn't support multiple inheritance**.	Interface **supports multiple inheritance**.
3) Abstract class **can have final, non-final, static and non-static variables**.	Interface has **only static and final variables**.
4) Abstract class **can have static methods, main method and constructor**.	Interface **can't have static methods, main method or constructor**.
5) Abstract class **can provide the implementation of interface**.	Interface **can't provide the implementation of abstract class**.
6) The **abstract keyword** is used to declare abstract class.	The **interface keyword** is used to declare interface.

7) **Example:**
public abstract class Shape{
public abstract void draw();
}
	Example:
	public interface Drawable{
	void draw();
	}

Example of Java Runtime Polymorphism

In this example, we are creating two classes Bike and Splendar. Splendar class extends Bike class and overrides its run() method. We are calling the run method by the reference variable of Parent class. Since it refers to the subclass object and subclass method overrides the Parent class method, subclass method is invoked at runtime.
Since method invocation is determined by the JVM not compiler, it is known as runtime polymorphism.

```
1.  class Bike{
2.    void run(){System.out.println("running");}
3.  }
4.  class Splender extends Bike{
5.    void run(){System.out.println("running safely with 60km");}
6.
7.    public static void main(String args[]){
8.      Bike b = new Splender();//upcasting
9.      b.run();
10.   }
11. }
```

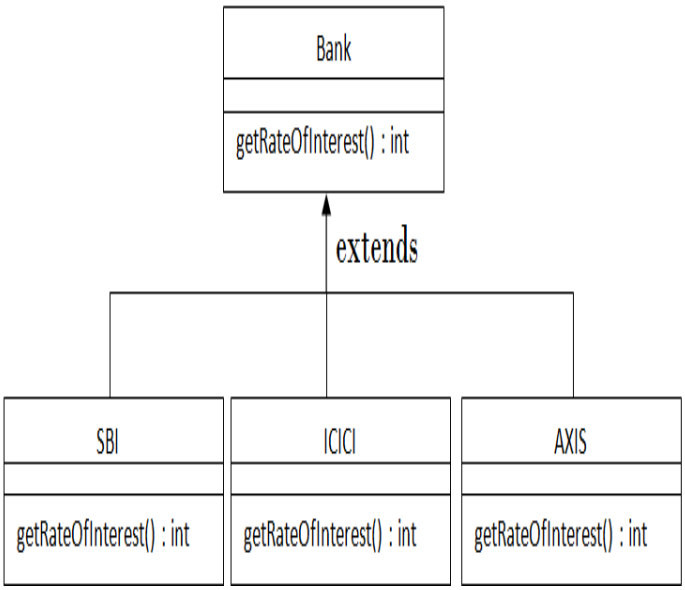
Output

```
Output:running safely with 60km.
```

Real example of Java Runtime Polymorphism

Consider a scenario, Bank is a class that provides method to get the rate of interest. But, rate of interest may differ according to banks. For example, SBI, ICICI and AXIS banks could provide 8%, 7% and 9% rate of interest.

```
class Bank{
        int getRateOfInterest(){return 0;}
        }
        class SBI extends Bank{
        int getRateOfInterest(){return 8;}
        }
        class ICICI extends Bank{
        int getRateOfInterest(){return 7;}
        }
        class AXIS extends Bank{
        int getRateOfInterest(){return 9;}
        }
    class Test3{
    public static void main(String args[]){
        Bank b1=new SBI();
    Bank b2=new ICICI();
        Bank b3=new AXIS();
        System.out.println("SBI Rate of Interest: "+b1.getRateOfInterest());
```



```
System.out.println("ICICI Rate of Interest: "+b2.getRateOfInterest());
System.out.println("AXIS Rate of Interest: "+b3.getRateOfInterest());
}
}
```

Output:

```
SBI Rate of Interest: 8
ICICI Rate of Interest: 7
AXIS Rate of Interest: 9
```

Method Overriding in Java

If subclass (child class) has the same method as declared in the parent class, it is known as **method overriding in java**. other words, If subclass provides the specific implementation of the method that has been provided by one of its parent class, it is known as method overriding.

Usage of Java Method Overriding

- Method overriding is used to provide specific implementation of a method that is already provided by its super class.
- Method overriding is used for runtime polymorphism

Rules for Java Method Overriding

1. method must have same name as in the parent class
2. method must have same parameter as in the parent class.
3. must be IS-A relationship (inheritance).

Example of method overriding

In this example, we have defined the run method in the subclass as defined in the parent class but it has some specific implementation. The name and parameter of the method is same and there is IS-A relationship between the classes, so there is method overriding.

```
class Vehicle{
void run(){System.out.println("Vehicle is running");}
}
class Bike2 extends Vehicle{
void run(){System.out.println("Bike is running safely");}

public static void main(String args[]){
Bike2 obj = new Bike2();
obj.run();
}
```

Output

```
Output:Bike is running safel
```

Method Overloading in Java

If a class have multiple methods by same name but different parameters, it is known as **Method Overloading**.
If we have to perform only one operation, having same name of the methods increases the readability of the program.
Suppose you have to perform addition of the given numbers but there can be any number of arguments, if you write the method such as a(int,int) for two parameters, and b (int,int,int) for three parameters then it may be difficult for you as well as other programmers to understand the behavior of the method because its name differs. So, we perform method overloading to figure out the program quickly.

Advantage of method overloading?

Method overloading **increases the readability of the program**.

Different ways to overload the method

There are two ways to overload the method in java

1. By changing number of arguments
2. By changing the data type

Example of Method Overloading by changing the no. of arguments

In this example, we have created two overloaded methods, first sum method performs addition of two numbers and second sum method performs addition of three numbers.

```
class Calculation{
  void sum(int a,int b){System.out.println(a+b);}
  void sum(int a,int b,int c){System.out.println(a+b+c);}
  public static void main(String args[]){
  Calculation obj=new Calculation();
  obj.sum(10,10,10);
  obj.sum(20,20);

 }
}
```

Output: 30

40

No.	Method Overloading	Method Overriding
1)	Method overloading is used *to increase the readability* of the program.	Method overriding is used *to provide the specific implementation* of the method that is already provided by its super class.
2)	Method overloading is performed *within class*.	Method overriding occurs *in two classes* that have IS-A (inheritance) relationship.
3)	In case of method overloading, *parameter must be different*.	In case of method overriding, *parameter must be same*.
4)	Method overloading is the example of *compile time polymorphism*.	Method overriding is the example of *run time polymorphism*.
5)	In java, method overloading can't be performed by changing return type of the method only. *Return type can be same or different* in method overloading. But you must have to change the parameter.	*Return type must be same or covariant* in method overriding.

Java Inner Class

Java inner class or nested class is a class i.e. declared inside the class or interface.
We use inner classes to logically group classes and interfaces in one place so that it can be more readable and maintainable.
Additionally, it can access all the members of outer class including private data members and methods.

Syntax of Inner class

```
class Java_Outer_class
{
        //code
         class Java_Inner_class
        {
                //code
         }
}
```

Advantage of java inner classes

There are basically three advantages of inner classes in java. They are as follows:
1) Nested classes represent a special type of relationship that is **it can access all the members (data members and methods) of outer class** including private.
2) Nested classes are used **to develop more readable and maintainable code** because it logically group classes and interfaces in one place only.

3) **Code Optimization**: It requires less code to write.

Example

```
class Outer_Demo {
   int num;
   // inner class
   private class Inner_Demo {
      public void print() {
         System.out.println("This is an inner class");
      }
   }
   // Accessing he inner class from the method within
   void display_Inner() {
      Inner_Demo inner = new Inner_Demo();
      inner.print();
   }
}
public class My_class {
   public static void main(String args[]) {
      // Instantiating the outer class
      Outer_Demo outer = new Outer_Demo();
      // Accessing the display_Inner() method.
      outer.display_Inner();
   }
}
```

Output

```
This is an inner class.
```

Access Modifiers in java

There are two types of modifiers in java: **access modifiers** and **non-access modifiers**.
The access modifiers in java specifies accessibility (scope) of a data member, method, constructor or class.
There are 4 types of java access modifiers:

1. private
2. default
3. protected
4. public

1) private access modifier

The private access modifier is accessible only within class.

2) default access modifier

If you don't use any modifier, it is treated as **default** bydefault. The default modifier is accessible only within package

3) protected access modifier

The **protected access modifier** is accessible within package and outside the package but through inheritance only. The protected access modifier can be applied on the data member, method and constructor. It can't be applied on the class.

4) public access modifier

The **public access modifier** is accessible everywhere. It has the widest scope among all other modifiers.

Understanding all java access modifiers

Let's understand the access modifiers by a simple table.

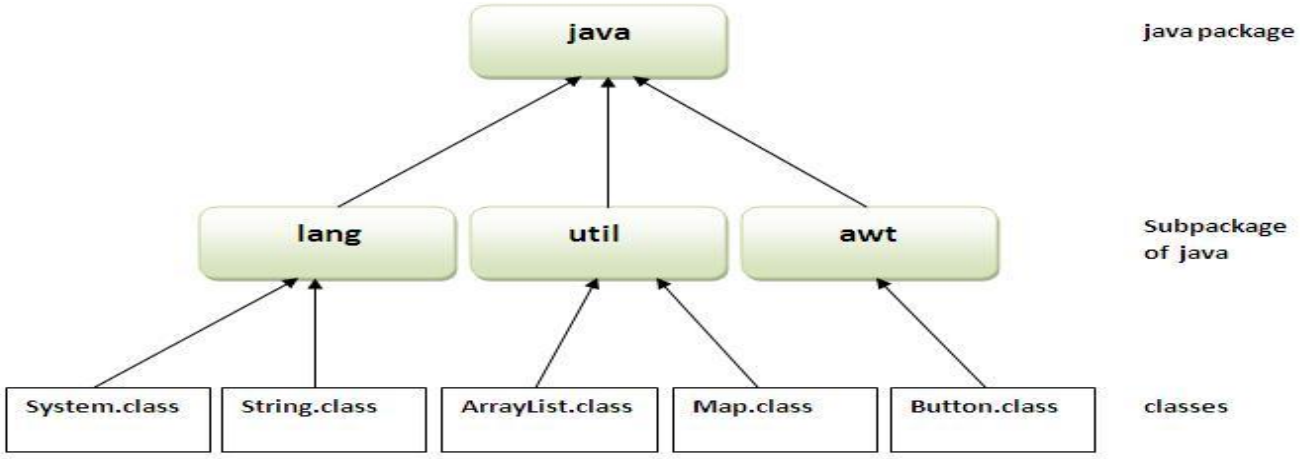
Access Modifier	within class	within package	outside package by subclass only	outside package
Private	Y	N	N	N
Default	Y	Y	N	N
Protected	Y	Y	Y	N
Public	Y	Y	Y	Y

java package:-

A **java package** is a group of similar types of classes, interfaces and sub-packages.
Package in java can be categorized in two form, built-in package and user-defined package.
There are many built-in packages such as java, lang, awt, javax, swing, net, io, util, sql etc.
Here, we will have the detailed learning of creating and using user-defined packages.

Advantage of Java Package

1) Java package is used to categorize the classes and interfaces so that they can be easily maintained.
2) Java package provides access protection.
3) Java package removes naming collision.



How to access package from another package?

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 package.* then all the classes and interfaces of this package will be accessible but not subpackages.

The import keyword is used to make the classes and interface of another package accessible to the current package.

Example of package that import the packagename.*

```
//save by A.java
package pack;
public class A{
  public void msg(){System.out.println("Hello");}
}
//save by B.java
package mypack;
import pack.*;
class B{
  public static void main(String args[]){
    A obj = new A();
    obj.msg();
  }
```

```
Output:Hello
```

STEPS for developing a User Defined PACKAGE:

1. Choose the appropriate package name, the package name must be a JAVA valid variable name
   and we showed ensure the package statement must be first executable statement.
2. Choose the appropriate class name or interface name and whose modifier must be public. The modifier of Constructors of a class must be public.
3. The modifier of the methods of class name or interface name must be public.
4. At any point of time we should place either a class or an interface in a package and give the file
5. name as class name or interface name with extension .java

Built-in Packages

These packages consists of a large number of classes which are a part of Java **API**. For e.g, we have used **java.io** package previously which contain classes to support input / output operations in Java. Similarly, there are other packages which provides different functionality.

Some of the commonly used built-in packages are shown in the table below :

Package Name	**Description**

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

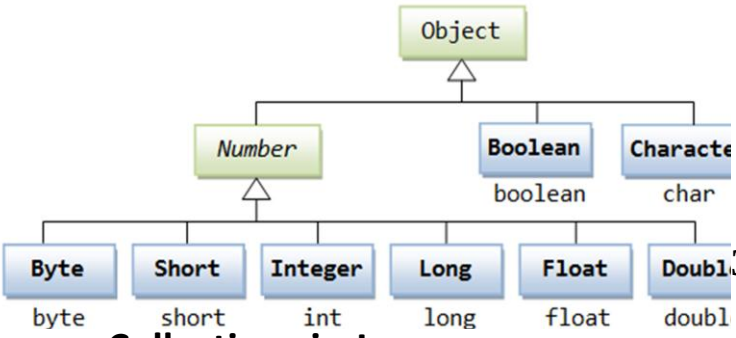
Accessing classes in a package

Consider the following statements :

import java.util.*;

Wrapper class in Java

Wrapper class in java provides the mechanism *to convert primitive into object and object into primitive*



Primitive Type	Wrapper class	Primitive Type	Wrapper class
boolean	Boolean	int	Integer
char	Character	long	Long
byte	Byte	float	Float
short	Short	double	Double

3 Collection

Collections in Java

Collections in java is a framework that provides an architecture to store and manipulate the group of objects.

All the operations that you perform on a data such as searching, sorting, insertion, manipulation, deletion etc. can be performed by Java Collections.

Java Collection simply means a single unit of objects. Java Collection framework provides many interfaces (Set, List, Queue, Deque etc.) and classes (ArrayList, Vector, LinkedList, PriorityQueue, HashSet, LinkedHashSet, TreeSet etc).

What is Collection in java

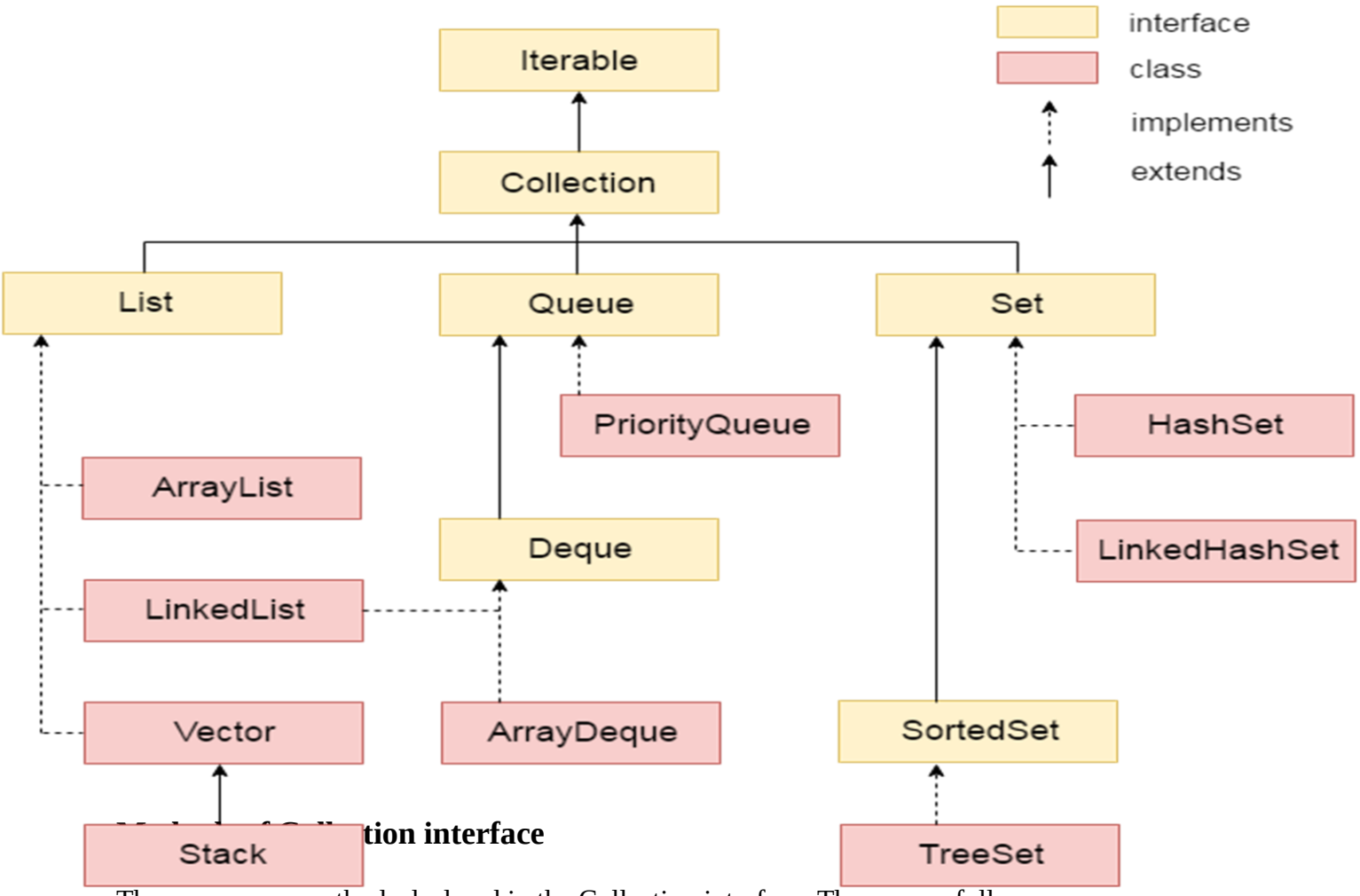
Collection represents a single unit of objects i.e. a group.

What is framework in java

- provides readymade architecture.
- represents set of classes and interface.

Hierarchy of Collection Framework

Let us see the hierarchy of collection framework.The **java.util** package contains all the classes and interfaces for Collection framework.



tion interface

There are many methods declared in the Collection interface. They are as follows:

No.	Method	Description
1	public boolean add(Object element)	is used to insert an element in this collection.
2	public boolean addAll(Collection c)	is used to insert the specified collection elements in the invoking collection.
3	public boolean remove(Object element)	is used to delete an element from this collection.
4	public boolean removeAll(Collection c)	is used to delete all the elements of specified collection from the invoking collection.

5	public boolean retainAll(Collection c)	is used to delete all the elements of invoking collection except the specified collection.
6	public int size()	return the total number of elements in the collection.
7	public void clear()	removes the total no of element from the collection.
8	public boolean contains(Object element)	is used to search an element.
9	public boolean containsAll(Collection c)	is used to search the specified collection in this collection.
10	public Iterator iterator()	returns an iterator.
11	public Object[] toArray()	converts collection into array.
12	public boolean isEmpty()	checks if collection is empty.
13	public boolean equals(Object element)	matches two collection.
14	public int hashCode()	returns the hashcode number for collection.

Iterator interface

Iterator interface provides the facility of iterating the elements in forward direction only.

Methods of Iterator interface

There are only three methods in the Iterator interface. They are:

1. **public boolean hasNext()** it returns true if iterator has more elements.
2. **public object next()** it returns the element and moves the cursor pointer to the next element.
3. **public void remove()** it removes the last elements returned by the iterator. It is rarely used.

Java ArrayList class

Java ArrayList class uses a dynamic array for storing the elements. It inherits AbstractList class and implements List interface.

The important points about Java ArrayList class are:

- Java ArrayList class can contain duplicate elements.
- Java ArrayList class maintains insertion order.
- Java ArrayList class is non synchronized.
- Java ArrayList allows random access because array works at the index basis.
- In Java ArrayList class, manipulation is slow because a lot of shifting needs to be occurred if any element is removed from the array list.

Constructors of Java ArrayList

Constructor	Description
ArrayList()	It is used to build an empty array list.

ArrayList(Collection c)	It is used to build an array list that is initialized with the elements of the collection c.
ArrayList(int capacity)	It is used to build an array list that has the specified initial capacity.

Methods of Java ArrayList

Method	Description
void add(int index, Object element)	It is used to insert the specified element at the specified position index in a list.
boolean addAll(Collection c)	It is used to append all of the elements in the specified collection to the end of this list, in the order that they are returned by the specified collection's iterator.
void clear()	It is used to remove all of the elements from this list.
int lastIndexOf(Object o)	It is used to return the index in this list of the last occurrence of the specified element, or -1 if the list does not contain this element.
Object[] toArray()	It is used to return an array containing all of the elements in this list in the correct order.
boolean add(Object o)	It is used to append the specified element to the end of a list.
boolean addAll(int index, Collection c)	It is used to insert all of the elements in the specified collection into this list, starting at the specified position.
int indexOf(Object o)	It is used to return the index in this list of the first occurrence of the specified element, or -1 if the List does not contain this element.

Java ArrayList Example

```
import java.util.*;
class TestCollection1
{
 public static void main(String args[])
{
          ArrayList<String> list=new ArrayList<String>();//Creating arraylist
           list.add("Ravi");//Adding object in arraylist
           list.add("Vijay");
           list.add("Ravi");
           list.add("Ajay");
           //Traversing list through Iterator
          System.out.println( list);
                //     OR
```

```
        Iterator itr=list.iterator();
        while(itr.hasNext())
       {
              System.out.println(itr.next());
        }
 }
}
```

Output
```
Ravi
Vijay
Ravi
Ajay
```

Java LinkedList class

Java LinkedList class uses doubly linked list to store the elements. It provides a linked-list data structure. It inherits the AbstractList class and implements List and Deque interfaces.
The important points about Java LinkedList are:

- Java LinkedList class can contain duplicate elements.
- Java LinkedList class maintains insertion order.
- Java LinkedList class is non synchronized.
- In Java LinkedList class, manipulation is fast because no shifting needs to be occurred.
- Java LinkedList class can be used as list, stack or queue.

Constructors of Java LinkedList

Constructor	Description
LinkedList()	It is used to construct an empty list.
LinkedList(Collection c)	It is used to construct a list containing the elements of the specified collection, in the order they are returned by the collection's iterator.

Methods of Java LinkedList

Method	Description
void add(int index, Object element)	It is used to insert the specified element at the specified position index in a list.
void addFirst(Object o)	It is used to insert the given element at the beginning of a list.
void addLast(Object o)	It is used to append the given element to the end of a list.
int size()	It is used to return the number of elements in a list

boolean add(Object o)	It is used to append the specified element to the end of a list.
boolean contains(Object o)	It is used to return true if the list contains a specified element.
boolean remove(Object o)	It is used to remove the first occurence of the specified element in a list.
Object getFirst()	It is used to return the first element in a list.
Object getLast()	It is used to return the last element in a list.
int indexOf(Object o)	It is used to return the index in a list of the first occurrence of the specified element, or -1 if the list does not contain any element.
int lastIndexOf(Object o)	It is used to return the index in a list of the last occurrence of the specified element, or -1 if the list does not contain any element.

Linked List Example

```
 import java.util.*;
public class TestCollection7
{
 public static void main(String args[])
{
   LinkedList<String> al=new LinkedList<String>();
   al.add("Ravi");
   al.add("Vijay");
   al.add("Ravi");
   al.add("Ajay");
   Iterator<String> itr=al.iterator();
   while(itr.hasNext())
 {       System.out.println(itr.next());
  }
 }
}
```

```
Output:Ravi
       Vijay
       Ravi
       Ajay
```

Java ListIterator Interface

ListIterator Interface is used to traverse the element in backward and forward direction.

ListIterator Interface declaration

1. public interface ListIterator<E> extends Iterator<E>

Methods of Java ListIterator Interface:

Method	Description

boolean hasNext()	This method return true if the list iterator has more elements when traversing the list in the forward direction.
Object next()	This method return the next element in the list and advances the cursor position.
boolean hasPrevious()	This method return true if this list iterator has more elements when traversing the list in the reverse direction.
Object previous()	This method return the previous element in the list and moves the cursor position backwards.

```
import java.util.*;
public class TestCollection8{
    public static void main(String args[]){

    ArrayList<String> al=new ArrayList<String>();
    al.add("Amit");
    al.add("Vijay");
    al.add("Kumar");
    al.add(1,"Sachin");
    System.out.println("element at 2nd position: "+al.get(2));
    ListIterator<String> itr=al.listIterator();
    System.out.println("traversing elements in forward direction...");
    while(itr.hasNext()){
    System.out.println(itr.next());
     }
    System.out.println("traversing elements in backward direction...");
    while(itr.hasPrevious()){
    System.out.println(itr.previous());
     }
    }
    }
```

Output:

```
element at 2nd position: Vijay
        traversing elements in forward
direction...
        Amit
        Sachin
        Vijay
        Kumar
        traversing elements in backward
direction...
        Kumar
        Vijay
        Sachin
        Amit
```

Difference between ArrayList and Vector

ArrayList and Vector both implements List interface and maintains insertion order.

But there are many differences between ArrayList and Vector classes that are given below.

ArrayList	Vector

1) ArrayList is **not synchronized**.	Vector is **synchronized**.
2) ArrayList **increments 50%** of current array size if number of element exceeds from its capacity.	Vector **increments 100%** means doubles the array size if total number of element exceeds than its capacity.
3) ArrayList is **not a legacy** class, it is introduced in JDK 1.2.	Vector is a **legacy** class.
4) ArrayList is **fast** because it is non-synchronized.	Vector is **slow** because it is synchronized i.e. in multithreading environment, it will hold the other threads in runnable or non-runnable state until current thread releases the lock of object.
5) ArrayList uses **Iterator** interface to traverse the elements.	Vector uses **Enumeration** interface to traverse the elements. But it can use Iterator also.

Example of Java Vector Using Enumeration

Let's see a simple example of java Vector class that uses Enumeration interface.

```
    import java.util.*;
    class TestVector1{
public static void main(String args[]){
     Vector<String> v=new Vector<String>();//creating vector
     v.add("umesh");//method of Collection
 v.addElement("irfan");//method of Vector
     v.addElement("kumar");
     //traversing elements using Enumeration
 Enumeration e=v.elements();
     while(e.hasMoreElements()){
      System.out.println(e.nextElement());
}
    }
    }
```

Output:

```
umesh
irfan
kumar
```

Java HashSet class

Java HashSet class is used to create a collection that uses a hash table for storage. It inherits the AbstractSet class and implements Set interface.

The important points about Java HashSet class are:

- HashSet stores the elements by using a mechanism called **hashing.**

- HashSet contains unique elements only.

Difference between List and Set

List can contain duplicate elements whereas Set contains unique elements only.

Constructors of Java HashSet class:

Constructor	Description
HashSet()	It is used to construct a default HashSet.
HashSet(Collection c)	It is used to initialize the hash set by using the elements of the collection c.
HashSet(int capacity)	It is used to initialize the capacity of the hash set to the given integer value capacity. The capacity grows automatically as elements are added to the HashSet.

Methods of Java HashSet class:

Method	Description
void clear()	It is used to remove all of the elements from this set.
boolean contains(Object o)	It is used to return true if this set contains the specified element.
boolean add(Object o)	It is used to adds the specified element to this set if it is not already present.
boolean isEmpty()	It is used to return true if this set contains no elements.
boolean remove(Object o)	It is used to remove the specified element from this set if it is present.
Iterator iterator()	It is used to return an iterator over the elements in this set.
int size()	It is used to return the number of elements in this set.

Java HashSet Example

```
import java.util.*;
class TestCollection9{
```

```
public static void main(String args[]){
 //Creating HashSet and adding elements
 HashSet<String> set=new HashSet<String>();
 set.add("Ravi");
 set.add("Vijay");
 set.add("Ravi");
 set.add("Ajay");
 //Traversing elements
 Iterator<String> itr=set.iterator();
 while(itr.hasNext()){
  System.out.println(itr.next());
 }
}
}
```

Output

```
Ajay
Vijay
Ravi
```

Java LinkedHashSet class

Java LinkedHashSet class is a Hash table and Linked list implementation of the set interface. It inherits HashSet class and implements Set interface.

The important points about Java LinkedHashSet class are:

- Contains unique elements only like HashSet.
- Provides all optional set operations, and permits null elements.
- Maintains insertion order.

Constructor	Description
HashSet()	It is used to construct a default HashSet.
HashSet(Collection c)	It is used to initialize the hash set by using the elements of the collection c.
LinkedHashSet(int capacity)	It is used initialize the capacity of the linkedhashset to the given integer value capacity.
LinkedHashSet(int capacity, float fillRatio)	It is used to initialize both the capacity and the fill ratio (also called load capacity) of the hash set from its argument.

Example of LinkedHashSet class:

```
import java.util.*;
class TestCollection10{
 public static void main(String args[]){
  LinkedHashSet<String> al=new LinkedHashSet<String>();
 al.add("Ravi");
  al.add("Vijay");
 al.add("Ravi");
  al.add("Ajay");
  Iterator<String> itr=al.iterator();
  while(itr.hasNext()){
   System.out.println(itr.next());
```

```
        }
    }
       }
```

Output

```
Ravi
Vijay
Ajay
```

Java TreeSet class

Java TreeSet class implements the Set interface that uses a tree for storage. It inherits AbstractSet class and implements NavigableSet interface. The objects of TreeSet class are stored in ascending order.

The important points about Java TreeSet class are:

- Contains unique elements only like HashSet.
- Access and retrieval times are quiet fast.
- Maintains ascending order.

Constructor	Description
TreeSet()	It is used to construct an empty tree set that will be sorted in an ascending order according to the natural order of the tree set.
TreeSet(Collection c)	It is used to build a new tree set that contains the elements of the collection c.
TreeSet(Comparator comp)	It is used to construct an empty tree set that will be sorted according to given comparator.
TreeSet(SortedSet ss)	It is used to build a TreeSet that contains the elements of the given SortedSet.

Methods of Java TreeSet class

Method	Description
boolean addAll(Collection c)	It is used to add all of the elements in the specified collection to this set.
boolean contains(Object o)	It is used to return true if this set contains the specified element.
boolean isEmpty()	It is used to return true if this set contains no elements.
boolean remove(Object o)	It is used to remove the specified element from this set if it is present.
void add(Object o)	It is used to add the specified element to this set if it is not already present.

void clear()	It is used to remove all of the elements from this set.
Object first()	It is used to return the first (lowest) element currently in this sorted set.
Object last()	It is used to return the last (highest) element currently in this sorted set.
int size()	It is used to return the number of elements in this set.

Java TreeSet Example

```
import java.util.*;
class TestCollection11{
 public static void main(String args[]){
  //Creating and adding elements
  TreeSet<String> al=new TreeSet<String>();
  al.add("Ravi");
  al.add("Vijay");
  al.add("Ravi");
  al.add("Ajay");
  //Traversing elements
  Iterator<String> itr=al.iterator();
  while(itr.hasNext()){
   System.out.println(itr.next());
  }
 }
}
```

Output:

```
Ajay
Ravi
Vijay
```

Java Queue Interface

Java Queue interface orders the element in FIFO(First In First Out) manner. In FIFO, first element is removed first and last element is removed at last.

Methods of Java Queue Interface

Method	Description
boolean add(object)	It is used to insert the specified element into this queue and return true upon success.

Object remove()	It is used to retrieves and removes the head of this queue.
Object poll()	It is used to retrieves and removes the head of this queue, or returns null if this queue is empty.
Object element()	It is used to retrieves, but does not remove, the head of this queue.
Object peek()	It is used to retrieves, but does not remove, the head of this queue, or returns null if this queue is empty.

Java PriorityQueue Example

```
    import java.util.*;
class TestCollection12{
    public static void main(String args[]){
    PriorityQueue<String> queue=new PriorityQueue<String>();
   queue.add("Amit");
    queue.add("Vijay");
    queue.add("Karan");
    queue.add("Jai");
    queue.add("Rahul");
    System.out.println("head:"+queue.element());
    System.out.println("head:"+queue.peek());
    System.out.println("iterating the queue elements:");
    Iterator itr=queue.iterator();
    while(itr.hasNext()){
    System.out.println(itr.next());
    }
    queue.remove();
    queue.poll();
    System.out.println("after removing two elements:");
    Iterator<String> itr2=queue.iterator();
  while(itr2.hasNext()){
  System.out.println(itr2.next());
   }
    }
    }
```

```
Output:head:Amit
       head:Amit
       iterating the queue
elements:
       Amit
       Jai
       Karan
       Vijay
       Rahul
       after removing two
elements:
       Karan
       Rahul
       Vijay
```

Java Map Interface

A map contains values on the basis of key i.e. key and value pair. Each key and value pair is known as an entry. Map contains only unique keys.
Map is useful if you have to search, update or delete elements on the basis of key.

Useful methods of Map interface

Method	Description
Object put(Object key, Object value)	It is used to insert an entry in this map.
void putAll(Map map)	It is used to insert the specified map in this map.
Object remove(Object key)	It is used to delete an entry for the specified key.
Object get(Object key)	It is used to return the value for the specified key.
boolean containsKey(Object key)	It is used to search the specified key from this map.

Map.Entry Interface

Entry is the sub interface of Map. So we will be accessed it by Map.Entry name. It provides methods to get key and value.

Methods of Map.Entry interface

Method	Description
Object getKey()	It is used to obtain key.
Object getValue()	It is used to obtain value.

Java Map Example: Generic (New Style)

```
import java.util.*;
class MapInterfaceExample{
 public static void main(String args[]){
  Map<Integer,String> map=new HashMap<Integer,String>();
  map.put(100,"Amit");
  map.put(101,"Vijay");
  map.put(102,"Rahul");
  for(Map.Entry m:map.entrySet()){
   System.out.println(m.getKey()+" "+m.getValue());
  }
```

```
 }
}
```

Output:

```
102 Rahul
100 Amit
101 Vijay
```

Java HashMap class

Java HashMap class implements the map interface by using a hashtable. It inherits AbstractMap class and implements Map interface.
The important points about Java HashMap class are:

- A HashMap contains values based on the key.
- It contains only unique elements.
- It may have one null key and multiple null values.
- It maintains no order.

HashMap class Parameters

Let's see the Parameters for java.util.HashMap class.

- **K**: It is the type of keys maintained by this map.
- **V**: It is the type of mapped values.

Constructors of Java HashMap class

Constructor	Description
HashMap()	It is used to construct a default HashMap.
HashMap(Map m)	It is used to initializes the hash map by using the elements of the given Map object m.
HashMap(int capacity)	It is used to initializes the capacity of the hash map to the given integer value, capacity.

Method	Description
void clear()	It is used to remove all of the mappings from this map.
boolean containsKey(Object key)	It is used to return true if this map contains a mapping for the specified key.
boolean containsValue(Object value)	It is used to return true if this Map maps one or more keys to the specified value.
boolean isEmpty()	It is used to return true if this map contains no key-value mappings.
Set keySet()	It is used to return a set view of the keys contained in this map.
int size()	It is used to return the number of key-value mappings in this map.

Java HashMap Example

```
import java.util.*;
class TestCollection13{
 public static void main(String args[]){
  HashMap<Integer,String> hm=new HashMap<Integer,String>();
  hm.put(100,"Amit");
  hm.put(101,"Vijay");
  hm.put(102,"Rahul");
  for(Map.Entry m:hm.entrySet()){
   System.out.println(m.getKey()+" "+m.getValue());
  // Remove value for key 102
 hm.remove(102);
System.out.println("Values after remove: "+ hm);

  }
 }
}
```

Java LinkedHashMap class

Java LinkedHashMap class is Hash table and Linked list implementation of the Map interface, with predictable iteration order. It inherits HashMap class and implements the Map interface.
The important points about Java HashMap class are:

- A LinkedHashMap contains values based on the key.
- It contains only unique elements.
- It may have one null key and multiple null values.
- It is same as HashMap instead maintains insertion order.

LinkedHashMap class Parameters

Let's see the Parameters for java.util.LinkedHashMap class.

- **K**: It is the type of keys maintained by this map.
- **V**: It is the type of mapped values.

Constructors of Java LinkedHashMap class

Constructor	Description
LinkedHashMap()	It is used to construct a default LinkedHashMap.
LinkedHashMap(int capacity)	It is used to initialize a LinkedHashMap with the given capacity.
LinkedHashMap(Map m)	It is used to initialize the LinkedHashMap with the elements from the given Map class m.

Methods of Java LinkedHashMap class

Method	Description
Object get(Object key)	It is used to return the value to which this map maps the specified key.
void clear()	It is used to remove all mappings from this map.
boolean containsKey(Object key)	It is used to return true if this map maps one or more keys to the specified value.

Java LinkedHashMap Example

```
    import java.util.*;
    class TestCollection14{
     public static void main(String args[]){
      LinkedHashMap<Integer,String> hm=new LinkedHashMap<Integer,String>();
  hm.put(100,"Amit");
       hm.put(101,"Vijay");
       hm.put(102,"Rahul");
for(Map.Entry m:hm.entrySet()){
  System.out.println(m.getKey()+" "+m.getValue());
 // Remove value for key 102
   hm.remove(102);
   System.out.println("Values after remove: "+ hm);
    } } }
```

Java TreeMap class

Java TreeMap class implements the Map interface by using a tree. It provides an efficient means of storing key/value pairs in sorted order.
The important points about Java TreeMap class are:

- A TreeMap contains values based on the key. It implements the NavigableMap interface and extends AbstractMap class.
- It contains only unique elements.
- It cannot have null key but can have multiple null values.
- It is same as HashMap instead maintains ascending order.

TreeMap class Parameters

Let's see the Parameters for java.util.TreeMap class.

- **K**: It is the type of keys maintained by this map.
- **V**: It is the type of mapped values.

Constructors of Java TreeMap class

Constructor	Description
TreeMap()	It is used to construct an empty tree map that will be sorted using the natural order of its key.
TreeMap(Map m)	It is used to initialize a tree map with the entries from **m**, which will be sorted using the natural order of the keys.
TreeMap(SortedMap sm)	It is used to initialize a tree map with the entries from the SortedMap **sm**, which will be sorted in the same order as **sm.**

Methods of Java TreeMap class

Method	Description
boolean containsKey(Object key)	It is used to return true if this map contains a mapping for the specified key.
boolean containsValue(Object value)	It is used to return true if this map maps one or more keys to the specified value.
Object firstKey()	It is used to return the first (lowest) key currently in this sorted map.
Object get(Object key)	It is used to return the value to which this map maps the specified key.
Object lastKey()	It is used to return the last (highest) key currently in this sorted map.
Object remove(Object key)	It is used to remove the mapping for this key from this TreeMap if present.
void putAll(Map map)	It is used to copy all of the mappings from the specified map to this map.
int size()	It is used to return the number of key-value mappings in this map.
Collection values()	It is used to return a collection view of the values contained in this map.

Java TreeMap Example:

```
import java.util.*;
class TestCollection15{
 public static void main(String args[]){
  TreeMap<Integer,String> hm=new TreeMap<Integer,String>();
  hm.put(100,"Amit");
  hm.put(102,"Ravi");
  hm.put(101,"Vijay");
  hm.put(103,"Rahul");
  for(Map.Entry m:hm.entrySet()){
   System.out.println(m.getKey()+" "+m.getValue());
// Remove value for key 102
  hm.remove(102);
  System.out.println("Values after remove: "+ hm);

   }
  }
 }
```

What is difference between HashMap and TreeMap?

HashMap	TreeMap
1) HashMap can contain one null key.	TreeMap can not contain any null key.
2) HashMap maintains no order.	TreeMap maintains ascending order.

Java Hashtable class

Java Hashtable class implements a hashtable, which maps keys to values. It inherits Dictionary class and implements the Map interface.
The important points about Java Hashtable class are:

- A Hashtable is an array of list. Each list is known as a bucket. The position of bucket is identified by calling the hashcode() method. A Hashtable contains values based on the key.
- It contains only unique elements.
- It may have not have any null key or value.
- It is synchronized.

Hashtable class Parameters

Let's see the Parameters for java.util.Hashtable class.

- **K**: It is the type of keys maintained by this map.

- **V**: It is the type of mapped values.

Constructors of Java Hashtable class

Constructor	Description
Hashtable()	It is the default constructor of hash table it instantiates the Hashtable class.
Hashtable(int size)	It is used to accept an integer parameter and creates a hash table that has an initial size specified by integer value size.

Java Hashtable Example

```
import java.util.*;
class TestCollection16{
 public static void main(String args[]){
  Hashtable<Integer,String> hm=new Hashtable<Integer,String>();
  hm.put(100,"Amit");
  hm.put(102,"Ravi");
  hm.put(101,"Vijay");
  hm.put(103,"Rahul");
  for(Map.Entry m:hm.entrySet()){
   System.out.println(m.getKey()+" "+m.getValue());
 // Remove value for key 102
   hm.remove(102);
   System.out.println("Values after remove: "+ hm);
  }
 }
}
```

Chapter 4 File and Exception Handling

Exception Handling in Java

The **exception handling in java** is one of the powerful *mechanism to handle the runtime errors* so that normal flow of the application can be maintained.

In this page, we will learn about java exception, its type and the difference between checked and unchecked exceptions.

What is exception

Dictionary Meaning: Exception is an abnormal condition.
In java, exception is an event that disrupts the normal flow of the program. It is an object which is thrown at runtime.

What is exception handling

Exception Handling is a mechanism to handle runtime errors such as ClassNotFound, IO, SQL, Remote etc.

Types of Exception

There are mainly two types of exceptions: checked and unchecked where error is considered as unchecked exception. The sun microsystem says there are three types of exceptions:

1. Checked Exception
2. Unchecked Exception
3. Error

1) Checked Exception

The classes that extend Throwable class except RuntimeException and Error are known as checked exceptions e.g.IOException, SQLException etc. Checked exceptions are checked at compile-time.

2) Unchecked Exception

The classes that extend RuntimeException are known as unchecked exceptions e.g. ArithmeticException, NullPointerException, ArrayIndexOutOfBoundsException etc. Unchecked exceptions are not checked at compile-time rather they are checked at runtime.

3) Error

Error is irrecoverable e.g. OutOfMemoryError, VirtualMachineError, AssertionError etc.

Java Exception Handling Keywords

There are 5 keywords used in java exception handling.

1. try
2. catch
3. finally
4. throw
5. throws

Java try block

Java try block is used to enclose the code that might throw an exception. It must be used within the method.
Java try block must be followed by either catch or finally block.

Syntax of java try-catch

```
try{
        //code that may throw exception
  }catch(Exception ref){}
```

syntax of try-finally block

```
try{
        //code that may throw exception
}finally{}
```

Java catch block

Java catch block is used to handle the Exception. It must be used after the try block only.
You can use multiple catch block with a single try.

Problem without exception handling

Let's try to understand the problem if we don't use try-catch block.

```
public class Testtrycatch1{
  public static void main(String args[]){
    int data=50/0;//may throw exception
    System.out.println("rest of the code...");
}
```

```
    }
```

Output:

```
Exception in thread main java.lang.ArithmeticException:/ by zero
```

Solution by exception handling

Let's see the solution of above problem by java try-catch block.

```
    public class Testtrycatch2{
      public static void main(String args[]){
       try{
          int data=50/0;
       }catch(ArithmeticException e){System.out.println(e);}
       System.out.println("rest of the code...");
    }
    }
```

Output:

```
Exception in thread main java.lang.ArithmeticException:/ by zero
rest of the code...
```

Java Multi catch block

If you have to perform different tasks at the occurrence of different Exceptions, use java multi catch block.

Let's see a simple example of java multi-catch block.

```
public class TestMultipleCatchBlock{
  public static void main(String args[]){
   try{
    int a[]=new int[5];
    a[5]=30/0;
        }
        catch(ArithmeticException e){System.out.println("task1 is completed");}
        catch(ArrayIndexOutOfBoundsException e){System.out.println("task 2 completed");}
        catch(Exception e){System.out.println("common task completed");}
        System.out.println("rest of the code...");
     }
    }
Output:task1 completed
```

```
        rest of the code...
```

Java Nested try block

The try block within a try block is known as nested try block in java.

Why use nested try block

Sometimes a situation may arise where a part of a block may cause one error and the entire block itself may cause another error. In such cases, exception handlers have to be nested.

Syntax:

```
....
try
{
   statement 1;
   statement 2;
   try
   {
      statement 1;
      statement 2;
   }
   catch(Exception e)
   {
   }
}
catch(Exception e)
{
}
....
```

Difference between throw and throws in Java

There are many differences between throw and throws keywords. A list of differences between throw and throws are given below:

No.	throw	throws
1)	Java throw keyword is used to explicitly throw an exception.	Java throws keyword is used to declare an exception.

2)	Checked exception cannot be propagated using throw only.	Checked exception can be propagated with throws.
3)	Throw is followed by an instance.	Throws is followed by class.
4)	Throw is used within the method.	Throws is used with the method signature.
5)	You cannot throw multiple exceptions.	You can declare multiple exceptions e.g. public void method()throws IOException,SQLException.

Java throw example

```
void m(){
throw new ArithmeticException("sorry");
}
```

Java throws example

```
void m()throws ArithmeticException{
//method code
}
```

Java throw and throws example

```
void m()throws ArithmeticException{
throw new ArithmeticException("sorry");
}
```

Java throws keyword

The **Java throws keyword** is used to declare an exception. It gives an information to the programmer that there may occur an exception so it is better for the programmer to provide the exception handling code so that normal flow can be maintained.

Exception Handling is mainly used to handle the checked exceptions. If there occurs any unchecked exception such as NullPointerException, it is programmers fault that he is not performing check up before the code being used.

Syntax of java throws

```
return_type method_name() throws exception_class_name{
//method code
}
```

Which exception should be declared

Ans) checked exception only, because:

- **unchecked Exception:** under your control so correct your code.

- **error:** beyond your control e.g. you are unable to do anything if there occurs VirtualMachineError or StackOverflowError.

Advantage of Java throws keyword

Now Checked Exception can be propagated (forwarded in call stack).
It provides information to the caller of the method about the exception.

Java throws example

Let's see the example of java throws clause which describes that checked exceptions can be propagated by throws keyword.

```
import java.io.IOException;
class Testthrows1{
  void m()throws IOException{
    throw new IOException("device error");//checked exception
  }
  void n()throws IOException{
    m();
  }
  void p(){
   try{
    n();
   }catch(Exception e){System.out.println("exception handled");}
  }
  public static void main(String args[]){
   Testthrows1 obj=new Testthrows1();
   obj.p();
   System.out.println("normal flow...");
  }
}
```

Output:

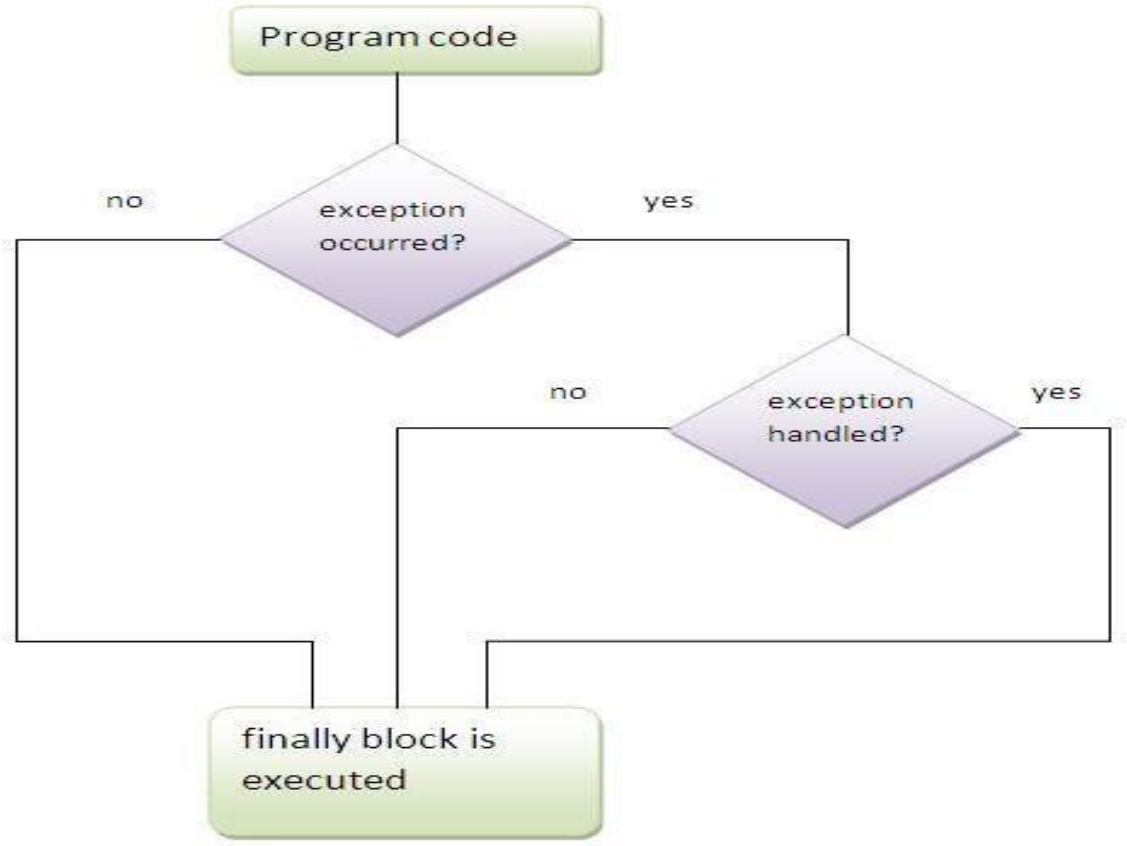
```
exception handled
normal flow...
```

Java finally block

Java finally block is a block that is used *to execute important code* such as closing connection, stream etc.

Java finally block is always executed whether exception is handled or not.

Java finally block follows try or catch block.



Why use java finally

- Finally block in java can be used to put "cleanup" code such as closing a file, closing connection etc.

Usage of Java finally

Let's see the different cases where java finally block can be used.

Case 1

Let's see the java finally example where **exception doesn't occur**.

```
class TestFinallyBlock{
      public static void main(String args[]){
  try{
       int data=25/5;
       System.out.println(data);
      }
      catch(NullPointerException e){System.out.println(e);}
      finally{System.out.println("finally block is always executed");}
      System.out.println("rest of the code...");
      }
    }
Output:5
       finally block is always executed
       rest of the code...
```

Case 2

Let's see the java finally example where **exception occurs and not handled**.

```
    class TestFinallyBlock1{
      public static void main(String args[]){
      try{
       int data=25/0;
   System.out.println(data);
      }
  catch(NullPointerException e){System.out.println(e);}
      finally{System.out.println("finally block is always executed");}
      System.out.println("rest of the code...");
      }
    }
Output:finally block is always executed
       Exception in thread main java.lang.ArithmeticException:/ by zero
```

Java Custom Exception Creating user defined Exceptions

If you are creating your own Exception that is known as custom exception or user-defined exception. Java custom exceptions are used to customize the exception according to user need.

By the help of custom exception, you can have your own exception and message.

Let's see a simple example of java custom exception.

```
class InvalidAgeException extends Exception{
     InvalidAgeException(String s){
      super(s);
     }
    }

class TestCustomException1{

       static void validate(int age)throws InvalidAgeException{
         if(age<18)
          throw new InvalidAgeException("not valid");
         else
          System.out.println("welcome to vote");
       }

       public static void main(String args[]){
          try{
          validate(13);
          }catch(Exception m){System.out.println("Exception occured: "+m);}

          System.out.println("rest of the code...");
      }
    }
Output:Exception occured: InvalidAgeException:not valid
       rest of the code...
```

File Handling

Some important Byte stream classes.

Stream class	Description
BufferedInputStream	Used for Buffered Input Stream.
BufferedOutputStream	Used for Buffered Output Stream.
DataInputStream	Contains method for reading java standard datatype
DataOutputStream	An output stream that contain method for writing java standard data type

FileInputStream	Input stream that reads from a file
FileOutputStream	Output stream that write to a file.
InputStream	Abstract class that describe stream input.
OutputStream	Abstract class that describe stream output.

Java I/O (Input and Output) is used *to process the input* and *produce the output*.

Java uses the concept of stream to make I/O operation fast. The java.io package contains all the classes required for input and output operations.

We can perform **file handling in java** by Java I/O API.

Stream

A stream is a sequence of data.In Java a stream is composed of bytes. It's called a stream because it is like a stream of water that continues to flow.

In java, 3 streams are created for us automatically. All these streams are attached with console.

1) System.out: standard output stream
2) System.in: standard input stream
3) System.err: standard error stream

Let's see the code to print **output and error** message to the console.

```
1. System.out.println("simple message");
2. System.err.println("error message");
```

OutputStream vs InputStream

The explanation of OutputStream and InputStream classes are given below:

OutputStream

Java application uses an output stream to write data to a destination, it may be a file, an array, peripheral device or socket.

InputStream

Java application uses an input stream to read data from a source, it may be a file, an array, peripheral device or socket.

Let's understand working of Java OutputStream and InputStream by the figure given below.

OutputStream Hierarchy

FileOutputStream class methods

Method	Description
protected void finalize()	It is sued to clean up the connection with the file output stream.
void write(byte[] ary)	It is used to write ary.length bytes from the byte array to the file output stream.

void write(int b)	It is used to write the specified byte to the file output stream.
FileDescriptor getFD()	It is used to return the file descriptor associated with the stream.
void close()	It is used to closes the file output stream.

Java FileOutputStream Example 1: write byte

```
import java.io.*;
public class FileOutputStreamExample {
   public static void main(String args[]){
        try{
          FileOutputStream fout=new FileOutputStream("testout.txt");
          fout.write(65);
          fout.close();
          System.out.println("success...");
         }catch(Exception e){System.out.println(e);}
    }
}
```

Output:

```
Success...
```

The content of a text file **testout.txt** is set with the data **A**.

testout.txt

```
A
```

Java FileOutputStream example 2: write string

```
import java.io.FileOutputStream;
public class FileOutputStreamExample {
   public static void main(String args[]){
        try{
          FileOutputStream fout=new FileOutputStream("testout.txt");
          String s="Welcome to javaTpoint.";
          byte b[]=s.getBytes();//converting string into byte array
          fout.write(b);
          fout.close();
          System.out.println("success...");
         }catch(Exception e){System.out.println(e);}
    }
```

```
}
```

Output:

```
Success...
```

Java FileInputStream Class

Java FileInputStream class obtains input bytes from a file. It is used for reading byte-oriented data (streams of raw bytes) such as image data, audio, video etc. You can also read character-stream data. But, for reading streams of characters, it is recommended to use FileReader class.

```
import java.io.FileInputStream;
public class DataStreamExample {
    public static void main(String args[]){
        try{
          FileInputStream fin=new FileInputStream("testout.txt");
          int i=0;
          while((i=fin.read())!=-1){
           System.out.print((char)i);
          }
          fin.close();
         }catch(Exception e){System.out.println(e);}
        }
       }
```

Output:

```
Welcome
```

Java BufferedOutputStream Class

Java BufferedOutputStream class is used for buffering an output stream. It internally uses buffer to store data. It adds more efficiency than to write data directly into a stream. So, it makes the performance fast.

For adding the buffer in an OutputStream, use the BufferedOutputStream class. Let's see the syntax for adding the buffer in an OutputStream:

1. OutputStream os= **new** BufferedOutputStream(**new** FileOutputStream("testout.txt"));

Java BufferedOutputStream class constructors

Constructor	Description
BufferedOutputStream(OutputStream os)	It creates the new buffered output stream which is used for writing

	the data to the specified output stream.
BufferedOutputStream(OutputStream os, int size)	It creates the new buffered output stream which is used for writing the data to the specified output stream with a specified buffer size.

```
import java.io.*;
public class BufferedOutputStreamExample{
public static void main(String args[])throws Exception{
    FileOutputStream fout=new FileOutputStream("testout.txt");
    BufferedOutputStream bout=new BufferedOutputStream(fout);
    String s="Welcome .";
    byte b[]=s.getBytes();
    bout.write(b);
    bout.flush();
    bout.close();
    fout.close();
    System.out.println("success");
}
}
```

Output:

```
Success
```

testout.txt

```
Welcome
```

Java BufferedInputStream Class

Java BufferedInputStream class is used to read information from stream. It internally uses buffer mechanism to make the performance fast.
The important points about BufferedInputStream are:

- When the bytes from the stream are skipped or read, the internal buffer automatically refilled from the contained input stream, many bytes at a time.
- When a BufferedInputStream is created, an internal buffer array is created.

Java BufferedInputStream class declaration

Let's see the declaration for Java.io.BufferedInputStream class:

1. **public class** BufferedInputStream **extends** FilterInputStream

Java BufferedInputStream class constructors

Constructor	Description
BufferedInputStream(InputStream IS)	It creates the BufferedInputStream and saves it argument, the input stream IS, for later use.

BufferedInputStream(InputStream IS, int size)	It creates the BufferedInputStream with a specified buffer size and saves it argument, the input stream IS, for later use.

```
import java.io.*;
public class BufferedInputStreamExample{
 public static void main(String args[]){
  try{
    FileInputStream fin=new FileInputStream("D:\\testout.txt");
    BufferedInputStream bin=new BufferedInputStream(fin);
    int i;
    while((i=bin.read())!=-1){
     System.out.print((char)i);
    }
    bin.close();
    fin.close();
  }catch(Exception e){System.out.println(e);}
 }
}
```

Here, we are assuming that you have following data in **"testout.txt"** file:

```
Welcome
```

Output:

```
Welcome
```

Java ByteArrayOutputStream Class

Java ByteArrayOutputStream class is used to **write common data** into multiple files. In this stream, the data is written into a byte array which can be written to multiple streams later.

The ByteArrayOutputStream holds a copy of data and forwards it to multiple streams.

The buffer of ByteArrayOutputStream automatically grows according to data.

Java ByteArrayOutputStream class constructors

Constructor	Description
ByteArrayOutputStream()	Creates a new byte array output stream with the initial capacity of 32 bytes, though its size increases if necessary.

ByteArrayOutputStream(int size)	Creates a new byte array output stream, with a buffer capacity of the specified size, in bytes.

Example of Java ByteArrayOutputStream

Let's see a simple example of java ByteArrayOutputStream class to write common data into 2 files: f1.txt and f2.txt.

```
import java.io.*;
    public class DataStreamExample {
    public static void main(String args[])throws Exception{
        FileOutputStream fout1=new FileOutputStream("f1.txt");
        FileOutputStream fout2=new FileOutputStream("f2.txt");
        ByteArrayOutputStream bout=new ByteArrayOutputStream();
        bout.write(65);
        bout.writeTo(fout1);
        bout.writeTo(fout2);

        bout.flush();
        bout.close();//has no effect
        System.out.println("Success...");
       }
      }
```

Java DataOutputStream Class

Java DataOutputStream class allows an application to write primitive Java data types to the output stream in a machine-independent way.

Java application generally uses the data output stream to write data that can later be read by a data input stream.

```
    import java.io.*;
    public class OutputExample {
       public static void main(String[] args) throws IOException {
          FileOutputStream file = new FileOutputStream(testout.txt);
          DataOutputStream data = new DataOutputStream(file);
          data.writeInt(65);
          data.flush();
          data.close();
          System.out.println("Succcess...");
```

```
    }
}
```

Java DataInputStream Class

Java DataInputStream class allows an application to read primitive data from the input stream in a machine-independent way.

Java application generally uses the data output stream to write data that can later be read by a data input stream.

```
import java.io.*;
public class DataStreamExample {
  public static void main(String[] args) throws IOException {
    InputStream input = new FileInputStream("testout.txt");
    DataInputStream inst = new DataInputStream(input);
    int count = input.available();
    byte[] ary = new byte[count];
    inst.read(ary);
    for (byte bt : ary) {
      char k = (char) bt;
      System.out.print(k+"-");
    }
  }
}
```

Here, we are assuming that you have following data in **"testout.txt"** file:

```
JAVA
```

Output:

```
J-A-V-A
```

Character Streams

Java FileWriter class

Java FileWriter class is used to write character-oriented data to the file.

Constructors of FileWriter class

Constructor	Description
FileWriter(String file)	creates a new file. It gets file name in string.
FileWriter(File file)	creates a new file. It gets file name in File object.

Java FileWriter Example

In this example, we are writing the data in the file abc.txt.

```
import java.io.*;
class Simple{
 public static void main(String args[]){
  try{
   FileWriter fw=new FileWriter("abc.txt");
   fw.write("my name is sachin");
   fw.close();
  }catch(Exception e){System.out.println(e);}
  System.out.println("success");
 }
}
```

Java FileReader class

Java FileReader class is used to read data from the file. It returns data in byte format like FileInputStream class.

Constructors of FileWriter class

Constructor	Description
FileReader(String file)	It gets filename in string. It opens the given file in read mode. If file doesn't exist, it throws FileNotFoundException.
FileReader(File file)	It gets filename in file instance. It opens the given file in read mode. If file doesn't exist, it throws FileNotFoundException.

Methods of FileReader class

Method	Description
1) public int read()	returns a character in ASCII form. It returns -1 at the end of file.

2) public void close()	closes FileReader.

Java FileReader Example

In this example, we are reading the data from the file abc.txt file.

```
import java.io.*;
class Simple{
 public static void main(String args[])throws Exception{
  FileReader fr=new FileReader("abc.txt");
  int i;
  while((i=fr.read())!=-1)
  System.out.println((char)i);

  fr.close();
 }
}
```

Chapter 5 Applet, AWT and Swing Programming

Applet

An **applet** is a Java program that runs in a Web browser. An applet can be a fully functional Java application because it has the entire Java API at its disposal.

There are some important differences between an applet and a standalone Java application, including the following −

- An applet is a Java class that extends the java.applet.Applet class.
- A main() method is not invoked on an applet, and an applet class will not define main().
- Applets are designed to be embedded within an HTML page.
- When a user views an HTML page that contains an applet, the code for the applet is downloaded to the user's machine.

- A JVM is required to view an applet. The JVM can be either a plug-in of the Web browser or a separate runtime environment.
- The JVM on the user's machine creates an instance of the applet class and invokes various methods during the applet's lifetime.
- Applets have strict security rules that are enforced by the Web browser. The security of an applet is often referred to as sandbox security, comparing the applet to a child playing in a sandbox with various rules that must be followed.

Java Applet

Applet is a special type of program that is embedded in the webpage to generate the dynamic content. It runs inside the browser and works at client side.

Advantage of Applet

There are many advantages of applet. They are as follows:

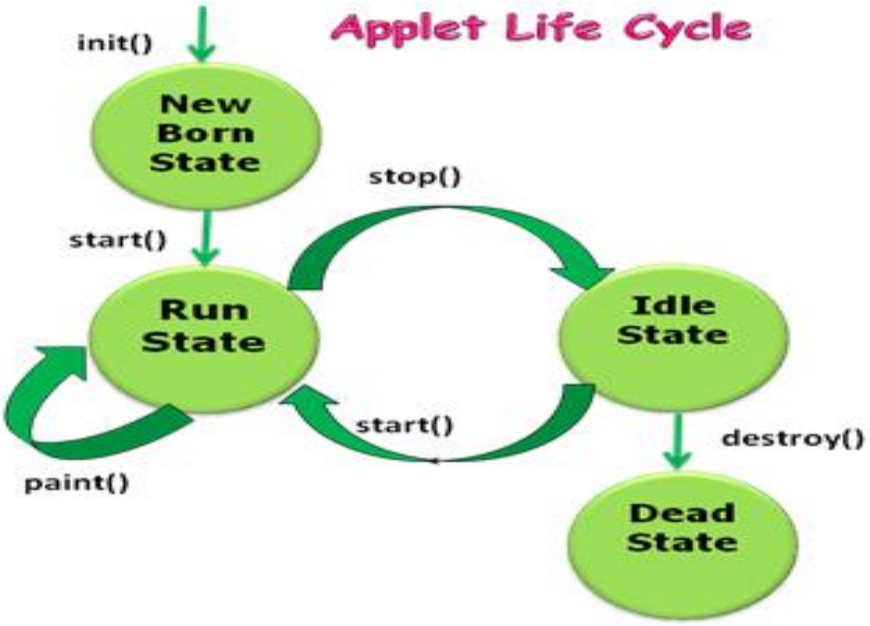
- It works at client side so less response time.
- Secured
- It can be executed by browsers running under many plateforms, including Linux, Windows, Mac Os etc.

Drawback of Applet

- Plugin is required at client browser to execute applet.

Lifecycle of Java Applet

1. Applet is initialized.
2. Applet is started.
3. Applet is painted.
4. Applet is stopped.
5. Applet is destroyed.



Lifecycle methods for Applet:

The java.applet.Applet class 4 life cycle methods and java.awt.Component class provides 1 life cycle methods for an applet.

java.applet.Applet class

For creating any applet java.applet.Applet class must be inherited. It provides 4 life cycle methods of applet.

1. **public void init():** is used to initialized the Applet. It is invoked only once.
2. **public void start():** is invoked after the init() method or browser is maximized. It is used to start the Applet.
3. **public void stop():** is used to stop the Applet. It is invoked when Applet is stop or browser is minimized.
4. **public void destroy():** is used to destroy the Applet. It is invoked only once.

Life Cycle of an Applet

Four methods in the Applet class gives you the framework on which you build any serious applet –

- **init** – This method is intended for whatever initialization is needed for your applet. It is called after the param tags inside the applet tag have been processed.

- **start** – This method is automatically called after the browser calls the init method. It is also called whenever the user returns to the page containing the applet after having gone off to other pages.
- **stop** – This method is automatically called when the user moves off the page on which the applet sits. It can, therefore, be called repeatedly in the same applet.
- **destroy** – This method is only called when the browser shuts down normally. Because applets are meant to live on an HTML page, you should not normally leave resources behind after a user leaves the page that contains the applet.
- **paint** – Invoked immediately after the start() method, and also any time the applet needs to repaint itself in the browser. The paint() method is actually inherited from the java.awt.

Simple example of Applet by html file:

To execute the applet by html file, create an applet and compile it. After that create an html file and place the applet code in html file. Now click the html file.

```
//First.java
import java.applet.Applet;
import java.awt.Graphics;
public class First extends Applet{

public void paint(Graphics g){
g.drawString("welcome",150,150);
}

}
```

myapplet.html

```
<html>
<body>
<applet code="First.class" width="300" height="300">
</applet>
</body>
</html>
```

Simple example of Applet by appletviewer tool:

To execute the applet by appletviewer tool, create an applet that contains applet tag in comment and compile it. After that run it by: appletviewer First.java. Now Html file is not required but it is for testing purpose only.

```
//First.java
import java.applet.Applet;
import java.awt.Graphics;
public class First extends Applet{

public void paint(Graphics g){
g.drawString("welcome to applet",150,150);
}

}
/*
<applet code="First.class" width="300" height="300">
</applet>
*/
```

To execute the applet by appletviewer tool, write in command prompt:

```
c:\>javac First.java
c:\>appletviewer First.java
```

Commonly used methods of Graphics class:

1. **public abstract void drawString(String str, int x, int y):** is used to draw the specified string.
2. **public void drawRect(int x, int y, int width, int height):** draws a rectangle with the specified width and height.
3. **public abstract void fillRect(int x, int y, int width, int height):** is used to fill rectangle with the default color and specified width and height.
4. **public abstract void drawOval(int x, int y, int width, int height):** is used to draw oval with the specified width and height.
5. **public abstract void fillOval(int x, int y, int width, int height):** is used to fill oval with the default color and specified width and height.

6. **public abstract void drawLine(int x1, int y1, int x2, int y2):** is used to draw line between the points(x1, y1) and (x2, y2).
7. **public abstract boolean drawImage(Image img, int x, int y, ImageObserver observer):** is used draw the specified image.
8. **public abstract void drawArc(int x, int y, int width, int height, int startAngle, int arcAngle):** is used draw a circular or elliptical arc.
9. **public abstract void fillArc(int x, int y, int width, int height, int startAngle, int arcAngle):** is used to fill a circular or elliptical arc.
10. **public abstract void setColor(Color c):** is used to set the graphics current color to the specified color.
11. **public abstract void setFont(Font font):** is used to set the graphics current font to the specified font.

Color

Following example demonstrates how to create an applet which will have fill color in a rectangle using setColor(), fillRect() methods of Graphics class to fill color in a Rectangle.

```
import java.applet.*;
import java.awt.*;

public class fillColor extends Applet {
   public void paint(Graphics g) {
      g.drawRect(300,150,200,100);
      g.setColor(Color.yellow);
      g.fillRect( 300,150, 200, 100 );
      g.setColor(Color.magenta);
      g.drawString("Rectangle",500,150);
   }
}
```

Java AWT

Java AWT (Abstract Window Toolkit) is *an API to develop GUI or window-based applications* in java.

Java AWT components are platform-dependent i.e. components are displayed according to the view of operating system. AWT is heavyweight i.e. its components are using the resources of OS.

The java.awt package provides classes for AWT api such as TextField, Label, TextArea, RadioButton, CheckBox, Choice, List etc.

Container

The Container is a component in AWT that can contain another components like buttons, textfields, labels etc. The classes that extends Container class are known as container such as Frame, Dialog and Panel.

Window

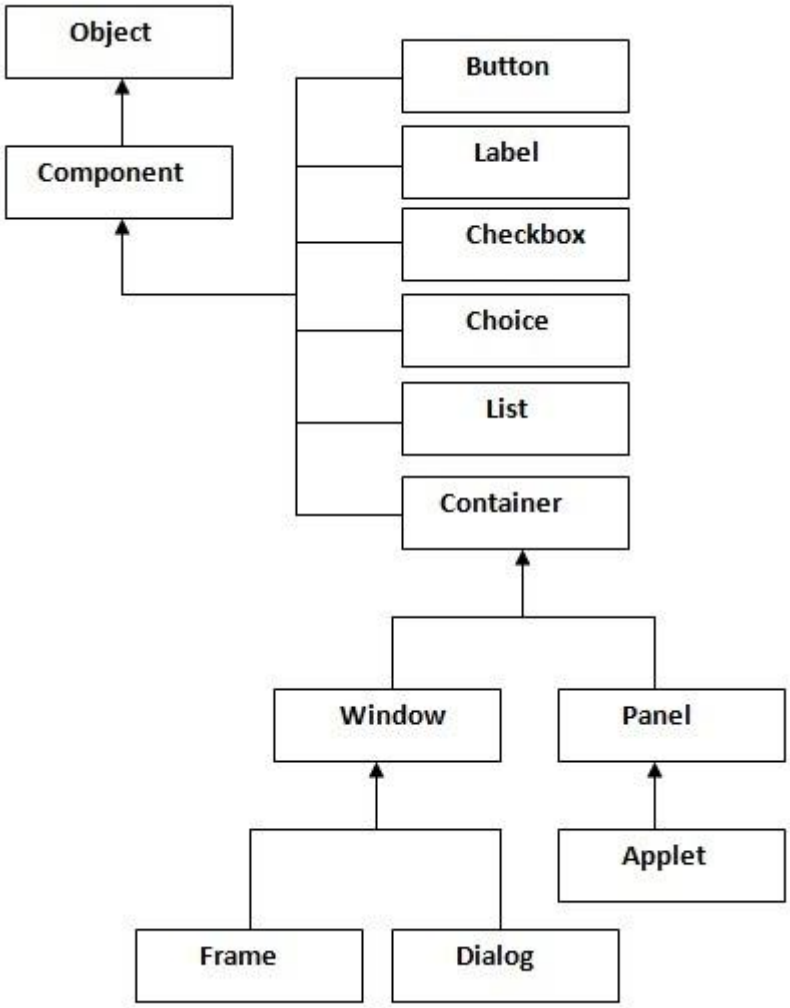
The window is the container that have no borders and menu bars. You must use frame, dialog or another window for creating a window.

The Panel is the container Panel

that doesn't contain title bar and menu bars. It can have other components like button, textfield etc.

Frame

The Frame is the container that contain title bar and can have menu bars. It can have other components like button, textfield etc.



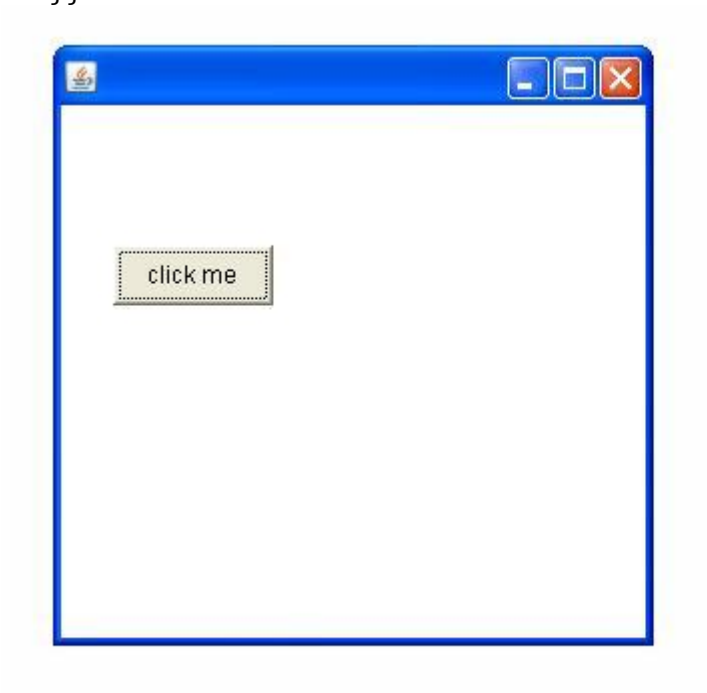
Useful Methods of Component class

Method	Description
public void add(Component c)	inserts a component on this component.
public void setSize(int width,int height)	sets the size (width and height) of the component.
public void setLayout(LayoutManager m)	defines the layout manager for the component.
public void setVisible(boolean status)	changes the visibility of the component, by default false.

AWT Example by Inheritance

Let's see a simple example of AWT where we are inheriting Frame class. Here, we are showing Button component on the Frame.

```
import java.awt.*;
class First extends Frame{
First(){
Button b=new Button("click me");
b.setBounds(30,100,80,30);// setting button position
add(b);//adding button into frame
setSize(300,300);//frame size 300 width and 300 height
setLayout(null);//no layout manager
setVisible(true);//now frame will be visible, by default not visible
}
public static void main(String args[]){
First f=new First();
}}
```



LayoutManagers:

The LayoutManagers are used to arrange components in a particular manner. LayoutManager is an interface that is implemented by all the classes of layout managers. There are following classes that represents the layout managers:

1. java.awt.BorderLayout

2. java.awt.FlowLayout
3. java.awt.GridLayout
4. java.awt.CardLayout

1.BorderLayout


```
import java.awt.*;
import javax.swing.*;

public class Border {
JFrame f;
Border(){
   f=new JFrame();

   JButton b1=new JButton("NORTH");;
   JButton b2=new JButton("SOUTH");;
   JButton b3=new JButton("EAST");;
   JButton b4=new JButton("WEST");;
   JButton b5=new JButton("CENTER");;
```

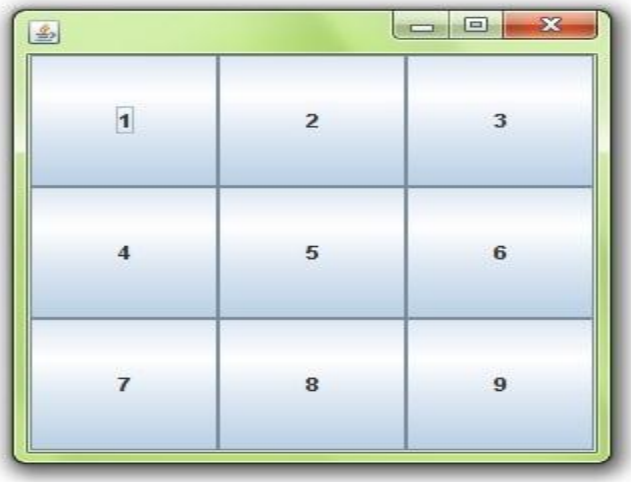
```
    f.add(b1,BorderLayout.NORTH);
    f.add(b2,BorderLayout.SOUTH);
    f.add(b3,BorderLayout.EAST);
    f.add(b4,BorderLayout.WEST);
    f.add(b5,BorderLayout.CENTER);

    f.setSize(300,300);
    f.setVisible(true);
  }
  public static void main(String[] args) {
    new Border();
  }
  }
```

GridLayout

The GridLayout is used to arrange the components in rectangular grid. One component is displayed in each rectangle.

Constructors of GridLayout class:

1. **GridLayout():** creates a grid layout with one column per component in a row.
2. **GridLayout(int rows, int columns):** creates a grid layout with the given rows and columns but no gaps between the components.
3. **GridLayout(int rows, int columns, int hgap, int vgap):** creates a grid layout with the given rows and columns alongwith given horizontal and vertical gaps



```
import java.awt.*;
import javax.swing.*;

public class MyGridLayout{
JFrame f;
MyGridLayout(){
   f=new JFrame();

   JButton b1=new JButton("1");
   JButton b2=new JButton("2");
   JButton b3=new JButton("3");
   JButton b4=new JButton("4");
   JButton b5=new JButton("5");
      JButton b6=new JButton("6");
      JButton b7=new JButton("7");
   JButton b8=new JButton("8");
      JButton b9=new JButton("9");

   f.add(b1);f.add(b2);f.add(b3);f.add(b4);f.add(b5);
   f.add(b6);f.add(b7);f.add(b8);f.add(b9);

   f.setLayout(new GridLayout(3,3));
   //setting grid layout of 3 rows and 3 columns

   f.setSize(300,300);
   f.setVisible(true);
}
public static void main(String[] args) {
   new MyGridLayout();
}
}
```

FlowLayout

The FlowLayout is used to arrange the components in a line, one after another (in a flow). It is the default layout of applet or panel.


```
import java.awt.*;
import javax.swing.*;

public class MyFlowLayout{
JFrame f;
MyFlowLayout(){
   f=new JFrame();

   JButton b1=new JButton("1");
   JButton b2=new JButton("2");
   JButton b3=new JButton("3");
```

```
    JButton b4=new JButton("4");
    JButton b5=new JButton("5");

    f.add(b1);f.add(b2);f.add(b3);f.add(b4);f.add(b5);

    f.setLayout(new FlowLayout(FlowLayout.RIGHT));
    //setting flow layout of right alignment

    f.setSize(300,300);
    f.setVisible(true);
}
public static void main(String[] args) {
    new MyFlowLayout();
}
}
```

Java Adapter Classes

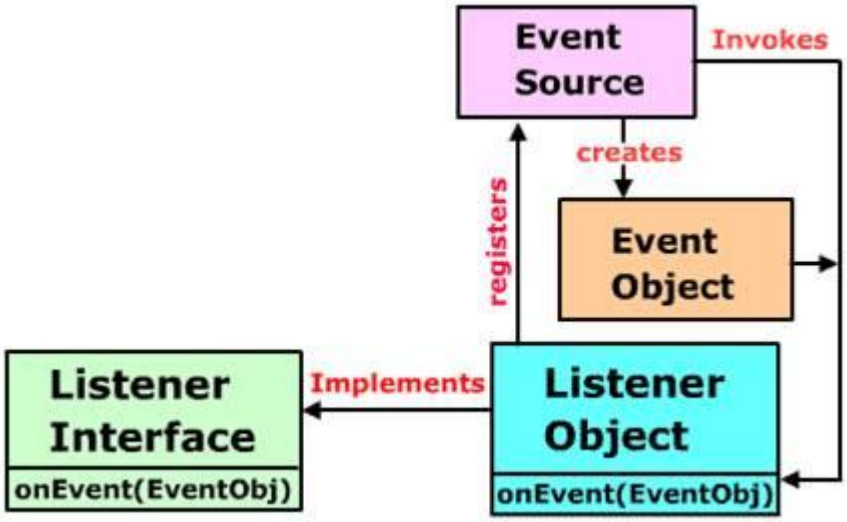
Java adapter classes *provide the default implementation of listener interfaces*. If you inherit the adapter class, you will not be forced to provide the implementation of all the methods of listener interfaces. So it *saves code*.

The adapter classes are found in **java.awt.event**, **java.awt.dnd** and **javax.swing.event** packages. The Adapter classes with their corresponding listener interfaces are given below.

java.awt.event Adapter classes

Adapter class	Listener interface
WindowAdapter	WindowListener
KeyAdapter	KeyListener
MouseAdapter	MouseListener
MouseMotionAdapter	MouseMotionListener
FocusAdapter	FocusListener
ComponentAdapter	ComponentListener
ContainerAdapter	ContainerListener
HierarchyBoundsAdapter	HierarchyBoundsListener

Event Delegation model



Difference between AWT and Swing

There are many differences between java awt and swing that are given below.

No.	Java AWT	Java Swing
1)	AWT components are **platform-dependent**.	Java swing components are **platform-independent**.
2)	AWT components are **heavyweight**.	Swing components are **lightweight**.
3)	AWT **doesn't support pluggable look and feel**.	Swing **supports pluggable look and feel**.
4)	AWT provides **less components** than Swing.	Swing provides **more powerful components** such as tables, lists, scrollpanes, colorchooser, tabbedpane etc.
5)	AWT **doesn't follows MVC**(Model View Controller) where model represents data, view represents presentation and controller acts as an interface between model and view.	Swing **follows MVC**.

Java's delegation event model

The event model is based on the Event Source and Event Listeners. Event Listener is an object that receives the messages / events. The Event Source is any object which creates the message / event. The Event Delegation model is based on – The Event Classes, The Event Listeners, Event Objects. There are three participants in event delegation model in Java;

- Event Source – the class which broadcasts the events
- Event Listeners – the classes which receive notifications of events
- Event Object – the class object which describes the event.

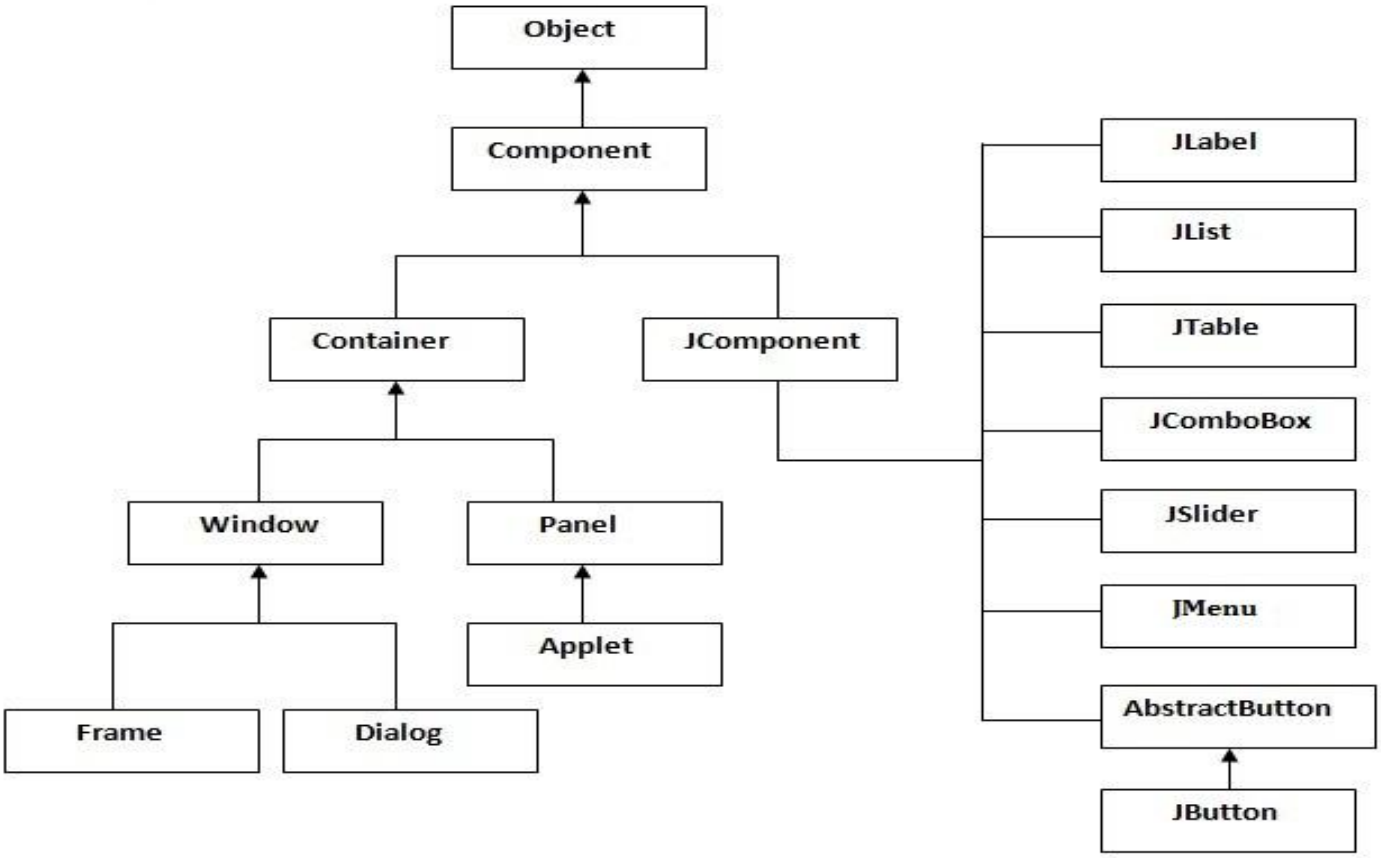
Java Swing Tutorial

Java Swing tutorial is a part of Java Foundation Classes (JFC) that is *used to create window-based applications*. It is built on the top of AWT (Abstract Windowing Toolkit) API and entirely written in java.

Unlike AWT, Java Swing provides platform-independent and lightweight components.

The javax.swing package provides classes for java swing API such as JButton, JTextField, JTextArea, JRadioButton, JCheckbox, JMenu, JColorChooser etc.

Hierarchy of Java Swing classes



Simple Java Swing Example

Let's see a simple swing example where we are creating one button and adding it on the JFrame object inside the main() method.

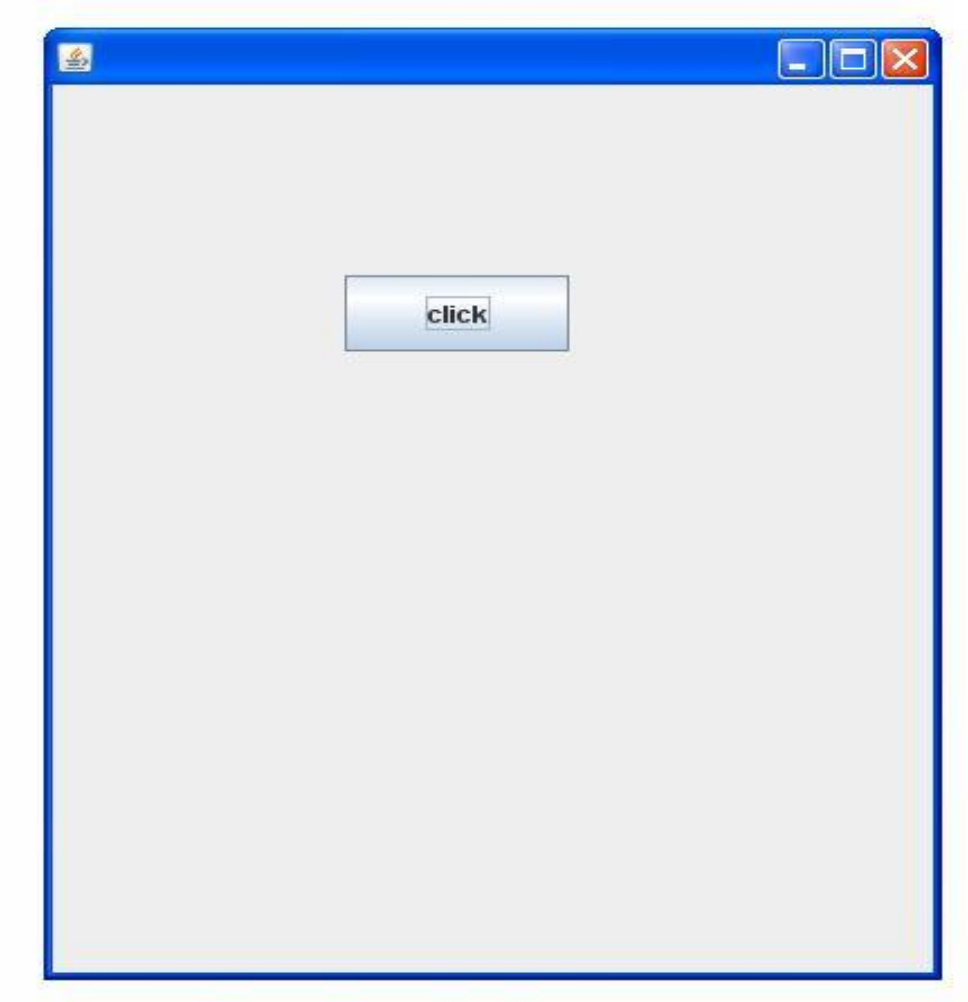
File: FirstSwingExample.java

```
import javax.swing.*;
public class FirstSwingExample {
public static void main(String[] args) {
JFrame f=new JFrame();//creating instance of JFrame

JButton b=new JButton("click");//creating instance of JButton
b.setBounds(130,100,100, 40);//x axis, y axis, width, height
```

```
f.add(b);//adding button in JFrame

f.setSize(400,500);//400 width and 500 height
f.setLayout(null);//using no layout managers
f.setVisible(true);//making the frame visible
}
}
```

OR

```
    import javax.swing.*;
public class Simple2 extends JFrame{//inheriting JFrame
JFrame f;
Simple2(){
JButton b=new JButton("click");//create button
b.setBounds(130,100,100, 40);

add(b);//adding button on frame
setSize(400,500);
setLayout(null);
setVisible(true);
}
public static void main(String[] args) {
new Simple2();
}}
```


click