



CORE JAVA MATERIAL  
BY  
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## Java History

### Java Details

Home	:SUN Mc Systems.[ Oracle Corporation]
Author	:James Gosling.
Objective	:To prepare simple electronic consumer goods.
Project	:Green
First Version	:JDK1.0 [1996,Jan-23rd]
Used version	:some org JDK5.0, some other JAVA6, JAVA7
Latest Version	: JAVA7,JAVA8, This April- JAVA9
Type of Software	:open source software.
Strong Features	:Object-oriented, Platform Independent, Robust, Portable, Dynamic, Secure.....

Version	Code Name	Enhancements
1.JDK1.0[Jan,23,1996] Beans,Inner classes	OAK	Language Introduction
2.JDK1.1[Feb,19,1997]	---	RMI,JDBC,Reflection API ,Java
3.JDK1.2[Dec,8,1998]	Playground	Strictfp, Swing, CORBA, Collection Framework
4.JDK1.3[May,8,2000]	Kestrel	Updations on RMI,JNDI
5.JDK1.4[Feb,6,2002]	Merlin	Regular Expression, NIO, assert Keyword, JAXP,...
6.JDK5.0[Sep,30,2004]	Tiger	Autoboxing, var-arg method, static import, Annotations ,..
7.JAVA SE6[Dec,11,2006]	Mustang	JDBC4.0, GUI updatons, Console
8.JAVA SE7[Jul,28,2011]	Dolphin	Strings in switch, '_' symbol in literals, try-with-resources
9.JAVA SE8[Mar,18,2014]	spider	Interface improvements, Lambda Expression, Date-Time API, Updations on Collections

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## Differences between Java and others[C and C++]?

1.C and C++ are static programming languages but JAVA is dynamic programming language:

If any programming language allows memory allocation for primitive data types at compilation time [Static Time] then that programming language is called as Static Programming language.

**EX:** C and C++.

In C and C++ applications, memory will be allocated for primitive data types at compilation time only, not at runtime.

If any programming language allows memory allocation for primitive data types at runtime, not at compilation time then that programming language is called as Dynamic Programming Language.

**EX:** JAVA

In java applications, memory will be allocated for primitive data types at runtime only, not at compilation time.

**Note:** In Java applications, memory will be allocated for primitive data types at the time of creating objects only, in java applications, objects are created at runtime only.

2.Pre-Processor is required in C and C++ , but, Pre-Processor is not required in Java:

In case of C and C++, the complete predefined library is provided in the form of header files

**EX:**

```
stdio.h  
conio.h  
math.h  
---  
---
```

If we want to use predefined library in C and C++ applications, we have to include header files in C and C++ applications, for this, we have to use #include<> statement.

**EX:**

```
#include<stdio.h>  
#include<conio.h>  
#include<math.h>
```

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If we compile C and C++ applications then Pre-Processor will perform the following actions.

- 1.Pre-Processor will recognize all #include<> statement.
- 2.Pre-Processor will take all the specified header files from #include<> statements.
- 3.Pre-Processor will check whether the specified header files are existed or not in C and C++ softwares.
- 4.If the specified header files are not existed the Pre-Processor will generate some error messages.
- 5.If the specified header files are existed then Pre-Processor will load the specified header files to the memory, this type of loading predefined library at compilation time is called as "Static Loading".

In C and C++ applications, Pre-Processor is required to recognize #include<> statements inorder to load header files to the memory.

--- Diagram-1-----

In java , the complete predefined library is provided in the form of classes and interfaces in packages

**EX:**

```
java.io  
java.util  
java.sql
```

If we want to use predefined library in java applications then we have to include packages in java application, for this we have to use "import" statements

**EX:**

```
import java.io.*;  
import java.util.*;  
import java.sql.*;
```

If we compile java program then compiler will perform the following actions.

- 1.Compiler will recognize all the import statements.
- 2.Compiler will take the specified package names from import statements.
- 3.Compiler will check whether the specified packages are existed or not in java software.
- 4.If the specified packages are not existed in java predefined library then compiler will rise an error "package xxx does not exist".
- 5.If the specified packages are existed in java predefined library then Compiler will not rise any error and compiler will not load any package content to the memory.

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While executing java program, when JVM[Java Virtual Machine] encounter any class or interface from the specified package then only JVM will load the required classes and interfaces to the memory at runtime, loading predefined library at runtime is called as "Dynamic Loading".

Pre-Processor is not required in JAVA , because, java does not include header files and #include<> statements, alternatively, JAVA has classes and interfaces in the form of packages and import statements.

--- Diagram-2---

Q)What are the differences between #include<> statement and import statement?

**Ans:**

1. #include<> statement is available upto C and C++.  
import statement is available upto JAVA.
2. #include<> statements are used to include the predefined library which is available in the form of header files.  
import statements are used to include the predefined library which are available in the form of packages.
3. #include<> statement is providing static loading.  
import statement is providing dynamic loading.
4. #include<> statements are recognized by Pre-Processor.  
import statements are recognized by both Compiler and JVM.
5. By using Single #include<> statement we are able to include only one header file.

**EX:**

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
```

By using single import statement we are able to include more than one class or more than one interface of the same package.

**EX:**

```
import java.io.*;
```

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3.C and C++ are platform dependent programming languages, but, JAVA is platform Independent programming language:

Q)What are the differences between .exe file and .class file?

**Ans:**

1. .exe file is available upto C and C++ only.  
.class file is available upto Java.
2. .exe file contains directly executable code.  
.class file contains bytecode, it is not executable code directly, it is an intermediate code.
3. .exe file is platform dependent file.  
.class file is platform independent file.
4. .exe file is less secured file.  
.class file is more secured file.

\*\*\*\*\* Completed Upto This\*\*\*\*\*

4.Pointers are existed in C and C++, but, Pointers are not existed in Java:

Q)What are the differences between pointer variables and referece variables?

**Ans:**

1. Pointer variables are available upto C and C++.  
Reference variables are available upto JAVA mainly.
2. Pointer variables are able to refer a block of memory by storing its address locations.

Reference variables are able to refer a block of memory[Object] by storing object reference values, where Object reference value is hexa decimal form of hashcode, where hashcode is an unique identity provided by Heap manager.

3. Pointer variables are recognized and initialized at compilation time.
4. Reference variables are recognized and initialized at runtime.

- 5.Multiple inheritance is not possible in Java:
- 1.Single Inheritance
  - 2.Multiple Inheritance

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6.Destructors are required in C++, but, Destructors are not required in JAVA:

Create Objects----> Constructors

Destroy object----> Destructors

C++: To destroy objects developers must use destructors.

Java: Garbage Collector

**Note:** Developers are able to destroy objects explicitly also

7.Operator Overloading is not supported in Java:

Object Oriented Features

- 1.Class
- 2.Object
- 3.Encapsulation
- 4.Abstraction
- 5.Inheritance
- 6.Polymorphism
- 7.Message Passing

#### **Polymorphism:**

If one thing is existed in more than one form then it is called as Polymorphism.

Polymorphism is a Greek word, where Poly means many and morphism means structures or forms.

- 1.Static Polymorphism
- 2.Dynamic Polymorphism

#### **1.Static Polymorphism:**

If polymorphism is existed at compilation time then it is called as Static Polymorphism.

**EX:** Overloading.

#### **2.Dynamic Polymorphism:**

If the polymorphism is existed at runtime then that polymorphism is called as Dynamic Polymorphism.

**EX:** Overriding

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**Overloading:**

- 1.Method Overloading
- 2.Operator Overloading

**1.Method Overloading:**

If we declare more than one method with the same name and with the different parameter list then it is called as Method Overloading

**EX:**

```
class A{  
    void add(int i, int j){  
  
    }  
    void add(float f1, float f2){  
  
    }  
    void add(String str1, String str2){  
  
    }  
}
```

**2.Operator Overloading:**

If we define more than one functionality for any single operator then it is called as Operator Overloading.

**EX:**

```
int a=10;  
int b=20;  
int c=a+b;// + is for Arithmetic Addition.  
System.out.println(c);// 30  
  
String str1="abc";  
String str2="def";  
String str3=str1+str2;// + is for String concatenation.  
System.out.println(str3);// abcdef
```

1.Operator overloading is very rarely used feature in application development.

2.Operator overloading is a bit confusion oriented feature.

**Note:**

In java programming language, some of the few predefined operators are declared as overloaded operators with fixed functionalities implicitly as per JAVA requirement, but, JAVA has not provided any environment explicitly to perform operator overloading at developers level.

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**EX:** +, \*, %,....

8.C and C++ are following Call By Value and Call by reference parameter passing mechanisms, but, JAVA is following only call by value parameter passing mechanism:

**primitive data:** byte, short, int, long, float, double, boolean, char

Address locations

**Pointer variable:** Call by reference

JAVA: ref var call by value only,-->

9.In C and C++ , integers will take only 2 bytes of memory and characters will take 1 byte of memory, but, in JAVA integers will take 4 bytes of memory and characters will take 2 bytes of memory:

C and C++:

Memory allocation for primitive data types is variable depending on the OS which we used.

**JAVA:**

Memory allocation for primitive data types is fixed irrespective of the operating system which we used.

Primitives Sizes

-----	-----
byte ----->	1 byte
short----->	2 bytes
int----->	4 bytes
long----->	8 bytes
float----->	4 bytes
double----->	8 bytes
char----->	2 bytes
boolean---->	1 bit

Q)In case of C and C++, characters will take only 1 byte of memory then what is the required for JAVA to assign two bytes of memory for characters?

**Ans:**

In case of C and C++, all the characters are represented in the form of ASCII values, here to store ASCII values one byte of memory is sufficient.

In case of JAVA, all the characters are represented in the form UNICODE values, to store UNICODE value 2 bytes of memory is required.

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Q)What is UNICODE and What is the purpose of UNICODE?

**Ans:**

UNICODE is one of the character representation, it is universally accepted code and it able to represent all the alphabet from all the natural languages like English, Hindi, Marati, chinees, italian,..... and it will provide very good Internationalization[I18N] support.

**Note:** Designing java applications w.r.t the local conventions is called as Internationalization[I18N].

### **Java Features:**

To show the nature of java programming language, JAVA has provided the following features.

- 1.Simple
- 2.Object Oriented
- 3.Platform independent
- 4.Arch Nuetral
- 5.Portable
- 6.Robust
- 7.Secure
- 8.Dynamic
- 9.Distributed
- 10.Multi Threadded
- 11.Interpretive
- 12.High Performance

#### **1. Simple:**

Java is simple programming language, because,  
1.Java applications will take less memory and less execution time.  
2.Java has removed all most all the confusion oriented features like pointers, multiple inheritance,.....  
3.Java is using all the simplified syntaxes from C and C++.

#### **2. Object Oriented:**

Java is an object oriented programming language, because, JAVA is able to store data in the form of Objects only.

#### **3. Platform Independent:**

Java is platform independent programming Language, because, Java allows its applications to compile on one operating system and to execute on another operating system.

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#### 4. Arch Nuetral:

Java is an Arch Nuetral Programming language, because, Java allows its applications to compile on one H/W Arch and to execute on another H/W Arch.

#### 5. Portable:

Java is a portable programming language, because, JAVA is able to run its applications under all the operating systems and under all the H/W Systems.

#### 6. Robust:

Java is Robust programming language, because,

1.JAVA is having very good memory management system in the form of heap memory Management SYstem, it is a dynamic memory management system, it allocates and deallocates memory for the objects at runtime.

2.JAVA is having very good Exception Handling mechanisms, because, Java has provided very good predefined library to represent and handle almost all the frequently generated exceptions in java applications.

#### 7. Secure:

Java is very good Secure programming language, because,

1.JAVA has provided an implicit component inside JVM in the form of "Security Manager" to provide implicit security.

2.JAVA has provided a seperate middleware service in the form of JAAS [Java Authetication And Authorization Service] inorder to provide web security.

3.Java has provided very good predefined implementations for almost all well known network security alg.

#### 8. Dynamic:

If any programming language allows memory allocation for primitive data types at RUNTIME then that programming language is called as Dynamic Programming Language.

JAVA is a dynamic programming language, because, JAVA allows memory allocation for primitive data types at RUNTIME.

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## 9. Distributed:

By using JAVA we are able to prepare two types of applications

- a)Standalone Applications
- b)Distributed Applications

### a)Standalone Applications:

If we design any java application with out using client-Server arch then that java application is called as Standalone application.

### b)Distributed Applications:

If we design any java application on the basis of client-server arch then that java application is called as Distributed application.

To prepare Distributed applications, JAVA has provided a seperate module that is "J2EE/JAVA EE".

## 10. Multi Threaded:

Thread is a flow of execution to perform a particular task.

There are two thread models

- a)Single Thread Model
- b)Multi Thread Model

### a)Single Thread Model:

It able to allow only one thread to execute the complete application,it follows sequential execution, it will take more execution time, it will reduce application performance.

### b)Multi Thread Model:

It able to allow more than one thread to execute application, It follows parallel execution, it will reduce execution time, it will improve application performance.

JAVA is following Multi Thread Model, JAVA is able to provide very good environment to create and execute more than one thread at a time, due to this reason, JAVA is Multi threaded Programming Language.

## 11. Interpretive:

JAVA is both compilative programming language and Interpretive programming language.

- 1.To check developers mistakes in java applications and to translate java program from High level representations to low level representation we need to compile java programs
- 2.To execute java programs , we need an interpreter inside JVM.

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## 12. High Performance:

JAVA is high performance programming language due to its rich set of features like Platform independent, Arch Neutral, Portable, Robust, Dynamic,.....

### JAVA Naming Conventions:

Java is a case sensitive programming language, where in java applications, there is a separate recognition for lower case letters and for upper case letters.

To use lower case letters and Upper case letters separately in java applications, JAVA has provided the following conventions.

1. All class names , abstract class names, interface names and enum names must be started with upper case letter and the subsequent symbols must also be upper case letters.

#### EX:

String  
StringBuffer  
InputStreamReader

2. All java variables must be started with lower case letters, but, the subsequent symbols must be upper case letters.

#### EX:

in, out, err  
pageContext, bodyContent

3. All java methods must start with lower case letter , but, the subsequent symbols must be upper case letters

#### EX:

concat()  
forName()  
getInputStream()

4. All java Constant variables must be provided in Upper Case letters.

#### EX:

MIN\_PRIORITY  
NORM\_PRIORITY  
MAX\_PRIORITY

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5.All java package names must be provided in lower case letters

**EX:**

```
java.util  
java.lang.reflect  
javax.servlet.jsp.tagext
```

**Note:** All the above conventions are mandatory for predefined library, they are optional form User defined library, but, suggestible.

**EX:**

```
1)String str=new String("abc"); ----> Valid  
2)string str=new string("abc");-----> Invalid  
  
3)class Employee{ ----> Valid and Suggestible  
---  
}  
  
4)class student{ ---> valid, but, not suggestible  
---  
}
```

### **Java Programming Format:**

- 1.Comment Section
- 2.Package Section
- 3.Import Section
- 4.Classes/Interfaces Section
- 5.Main Class Section

#### **1.Comment Section:**

Before starting implementation part, it is convention to provide some description about our implementation, here to provide description about our implementation we have to use Comment Section. Description includes author name, Objective, project details, module details, client details,.....

To provide the above specified description in comment section, we will use comments.

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There are three types of comments.

- 1.Single Line Comments
- 2.Multi Line Comments
- 3.Documentation Comments.

#### **1.Single Line Comment:**

It allows the description with in a single line.

##### **Syntax:**

// --- description-----

#### **2.Multi Line Comment:**

It allows description in more than one line

##### **Syntax:**

```
/*
---
--description-----
*/
```

#### **3.Documentation Comment.**

It allows description in more than one page.

##### **Syntax:**

```
-----
/*
*-----
*-----
*-----
*-----
*-----
*/
```

**Note:** We will use documentation comments to prepare API kind of documentations, but, it is not suggestible.

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**API kind of documentation:**

It is a document in the form of .txt file or .doc file or .pdf file or .html it includes the complete declarative information about our programming elements like variables, methods, classes,..... which we have used in our java file.

**EX:**

```
Employee.java
public class Employee extends Person implements Serializable, Cloneable{
    public String eid;
    public String ename;
    public float esal;
    public String eaddr;

    public Employee(String eid, String ename, float esal, String eaddr){
    }
    public Employee(String eid, String ename, float esal){
    }
    public Employee(String eid, String ename){
    }

    public void add(String eid, String ename, float esal, String eaddr){
    ---}
    public String search(String eid){
        return "success";
    }
    public void delete(String eid){
    ---}
}
```

Employee.txt[html/pdf]

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**Class : Name:** Employee

**Super Class:** Person

**Interfaces:** Serializable, Cloneable

**Variables:** 1) Name : eid

    DataType : String

    Access Mod : public

2) Name : ename

    Data Type: String

    Access Mod: public

----

----

**Methods:** 1) Name : add

    Return type: void

    access mod: public

    parameters : eid, ename, esal, eaddr

-----

**Constructors:** 1) Employee

----

To simplify API documentation for JAVA applications, JAVA has provided an implicit command , that is, "javadoc".

**EX:** D:\javaapps\ Employee.java

```
public class Employee implements java.io.Serializable, Cloneable{  
    public String eid;  
    public String ename;  
    public float esal;  
    public String eaddr;  
    public Employee(String eid, String ename, float esal, String eaddr){  
    }  
    public Employee(String eid, String ename, float esal){  
    }  
    public Employee(String eid, String ename){  
    }  
  
    public void add(String eid, String ename, float esal, String eaddr){  
    }  
    public String search(String eid){  
        return "success";  
    }  
    public void delete(String eid){  
    }  
}
```

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**On Command Prompt:**

```
D:\javaapps>javadoc Employee.java  
--- Generating xxx.html files---
```

To provide description[Metadata] in java programs, JDK5.0 version has provided a new feature that is "Annotations".

Q) In java applications, to provide description we have already comments then what is the requirement to use Annotations?

**Ans:**

If we provide description along with comments in java program then "Lexical Analysis" phase will remove comments and their description which we provided in java program as part of Compilation. As per the requirement, if we want to make available our description upto .java file, upto .class file and upto RUNTIME of our applications there we have to use "Annotations".

**Note:** If we provide metadata with comments then we are unable to access that metadata programmatically, but, if we provide metadata with Annotations then we are able to access that metadata through java program.

Q) In java applications, to provide metadata at RUNTIME we are able to use XML documents then what is the requirement to use "Annotations".

**Ans:**

If we use XMI documents to provide description then we are able to get the following problems.

1. We have to learn XML tech.
2. Every time we have to check whether XML documents are located properly or not.
3. Every time, we have to check whether XML documents are formatted properly or not.
4. Every time we have to check whether we are using right parsing mechanisms or not to read data from XML documents.

To overcome all the above problems we need a java alternative , that is, Annotations.

**Note:** IN JAVA/J2EE applicatios, we can utilize Annotations as an alternative to XML documents.

**XML Based Tech****Annotation Based Tech[XML documents Optional]**

- |                |                    |
|----------------|--------------------|
| 1.Upto JDK1.4  | 1.JDK5.0 and above |
| 2.Upto JDBC3.0 | 2.JDBC4.0          |
| 3.Servlets2.5  | 3.Servlets3.0      |
| 4.Struts1.x    | 4.Struts2.x        |
| 5.JSF1.x       | 5.JSF2.x           |
| 6.EJBs2.x      | 6.EJBs3.x          |
| 7.Spring2.x    | 7.Spring3.x        |

-----

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**Package Section:**

- 1.Package is the collection of related classes and interfaces as a single unit.
- 2.Package is a folder contains .class files representing related classes and interfaces.

Packages are able to provide some advantages in java applications

- 1.Modularity
- 2.Abstraction
- 3.Security
- 4.Reusability
- 5.Sharability

There are two types of packages in java

- 1.Predefined Packages
- 2.User defined Packages

**1.Predefined Packages:**

These packages are provided by Java programming language along with java software.

**EX:** java.io

java.util

java.sql

----

----

**2.User defined Packages:**

These packages are defined by the developers as per their application requirements.

**Syntax:**

package package\_Name;

where package name may be

1.directly a single name

2.sub package names with . operator

**EX:**

package p1;

package p1.p2.p3;

If we want to use package declaration statement in java files then we have to use the following two condition.

- 1.Package declaration statement must be the first statement in java file after the comment section.
- 2.Package name must be unique, it must not be sharable and it must not be duplicated.

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Q) Is it possible to declare more than one package statement with in a single java file?

**Ans:**

No, it is not possible to declare more than one package declaration statement with in a single java file, because, package declaration statement must be first statement, in java files only one package declaration statement must be provided as first statement.

abc.java

```
package p1;--> Valid  
package p2;--> Invalid  
package p3;--> INvalid  
--  
---
```

To provide package names, JAVA has given a convention like to include our company domain name in reverse in package names.

**EX:** www.durgasoft.com

```
durgasoft.com  
com.durgasoft  
package com.durgasoft.icici.transactions.deposit;  
com.durgasoft--> company domain name in reverse.  
icici -----> project name/ client name  
transactions----> module name  
deposit-----> sub module
```

**3.Import Section:**

The main intention of "import" statement is to make available classes and interfaces of a particular package into the present JAVA file inorder to use in present java file.

**Syntax1:**

```
import package_Name.*;
```

--> It able to import all the classes and interfaces of the specified package into the present java file.

**EX:** import java.io.\*;

**Syntax2:**

```
import package_Name.Member_Name;
```

--> It able to import only the specified member from the specified package into the present java file.

**EX:** import java.io.BufferedReader;

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Q) Is it possible to write more than one "import" statement with in a single java file?

**Ans:**

Yes, In a single java file, we are able to provide atmost one package declaration statement, but, we are able to provide any no of import statements.

abc.java

```
package p1;  
//package p2;----> Error  
//package p3;----> Error  
import java.io.*;  
import java.util.*;--> No Error  
import java.sql.*;---> No Error  
---  
---  
---
```

Q) Is it possible to use classes and interfaces of a particular package with out importing that package?

**Ans:**

Yes, it is possible to use classes and interfaces of a particular package in the present java file with out importing the respective package, but, just by using fully qualified names of the classes.

**Note:** Specifying class names or interface names along with their respective package names is called as "Fully Qualified Names".

**EX:**   java.io.BufferedReader  
          java.util.ArrayList  
          java.sql.Connection

**A java program with import statement:**

```
import java.io.*;  
---  
---  
BufferedReader br=new BufferedReader(new InputStreamReader(System.in));  
---  
---
```

**A Java program with out import statement:**

```
java.io.BufferedReader br=new java.io.BufferedReader(new  
java.io.InputStreamReader(System.in));
```

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#### 4.Classes/Interfaces Section:

The main intention of classes and interfaces is to represent all real world entities in the form of coding part.

**EX:** Account, Employee, Product, Customer, Student,.....

**Note:** No restrictions for no of classes in a java file or in a java application, depending on the application requirement, we are able to write any no of classes and interfaces in java applications.

#### 5.Main Class Section:

Main Class is a java class ,it includes main() method.

The main intention of main() method is,

- 1.To manage application logic which we want to execute by JVM directly we have to use main() method.
- 2.To define starting point and ending point to the application execution we have to use main() method.

#### Syntax:

```
public static void main(String[] args){  
    ---instructions---  
}
```

**Note:**main() method is a conventional method with fixed prototype and with user defined implementation part.

#### Steps to prepare First Java Application:

- 1.Install Java Software
- 2.Select Java Editor
- 3.Write Java Program
- 4.Save Java File
- 5.Compile Java File
- 6.Execute Java Application

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### 1. Install Java Software:

- a) Download jdk-8-windows-i586.exe file from internet.
- b) Double click on jdk-8-windows-i586.exe file
- c) Click on "Yes" button.
- d) Click On "Next" button.
- e) Change JDK installation location from "C:\Program Files(x86)\Java\jdk1.8.0" to "C:\Java\jdk1.8.0" by clicking on "Change" button and "OK" button.
- f ) Click on "Next" button.
- g) Change JRE installation location from "C:\Program Files(x86)\Java\jre8" to "C:\Java\jre8" by clicking on "Change" button and "OK" button.
- h) Click on "Next" button.
- i) Click on "Close" button.

After installation of JAVA software, we have to set "path" environment variable to the location where all JDK commands are existed that is "C:\Java\JDK1.8.0\bin" inorder to make available all JAVA commands to Operating System.

#### On command Prompt:

```
set path=C:\Java\JDK1.8.0\bin;
```

If we provide "path" set up like above on the command prompt then this set up is available upto the present command prompt only, it is not available to all the command prompts.

If we want to set "path" environment variable permanently then we have to use the following steps.

1. Right Click on "Computers" or "This PC" on desktop .
2. Select "Properties".
3. Select "Advanced System Settings" hyper link.
4. Click on "Advanced" Tab[Bydefault Selected].
5. Click on "Environment Variables.." button.
6. Goto User Variables part and click on "New" button.
7. Provide the following details.  
variable name: path  
variable value: C:\Java\jdk1.8.0\bin";
8. Click on "Ok" button.
9. Click on "OK" button.
10. Click on "OK" button.

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Q) If we set all three versions [JAVA6, JAVA7, JAVA8] to the "path" environment variable then which version will come to the command prompt?

**Ans:**

If set all JAVA6, JAVA7, JAVA8 versions to "path" environment variable then Command prompt will take the java version which we provided as first one to the path environment variable in the order.

**EX:**

path=C:\Java\jdk1.6.0\bin;C:\Java\jdk1.7.0\bin;C:\Java\jdk1.8.0\bin;  
On Command Prompt:

D:\javaapps>java -version --> Enter  
Java - Version: JDK1.6.0

If we want to switch java from one version to another version in simplified manner as per the requirement then we have to use batch files.

- a) Take a text file.
- b) provide the required "path" command.
- c) Save file with "file\_Name.bat" .
- d) Open Command prompt and goto the location where bat files are saved.
- e) write bat file name and click on enter button.

D:\java9\java6.bat  
set path=C:\Java\jdk1.6.0\bin;

D:\java9\java7.bat  
set path=C:\Java\jdk1.7.0\bin;

D:\java9\java8.bat  
set path=C:\Java\jdk1.8.0\bin;

**On Command Prompt:**

D:\java9>java6.bat ---> Enter button  
--- we will get java6 setup----

D:\java9>java7.bat ---> Enter button  
--- we will get java7 setup----

D:\java9>java8.bat ---> Enter button  
--- we will get java8 setup----

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## 2. Select Java Editor:

Editor is a software, it will provide very good env to write java programs and to save java programs in our system.

**EX:** Notepad, Notepadplus, Editplus,.....

**Note:** In real time application development, it is not suggestible to use Editors, it is always suggestible to use IDEs[Integrated Development Environment].

**EX:** Eclipse, MyEclipse, Netbeans,.....

## 3. Write Java Program:

To write java program we have to use some predefined library provided by JAVA API[Application Programming Interface].

**EX**

D:\javaapps\ Test.java

```
class Test{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

## 4. Save Java File:

To save java file in our system, we have to follow the following two conditions.

1. If the present java file contains any public element[class, abstract class, interface, enum] then we must save java file with public element name only. If we violate this condition then compiler will rise an error.

2. If no public element is identified in our java file then it is possible to save java file with any name like abc.java or xyz.java, but, it is suggestible to save java file with main() method class name.

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Q) Is it possible to provide more than one public class with in a single java file?

**Ans:**

No, it is not possible to provide more than one public class with in a single java file, because, if we provide more than one class as public then we must save that java file with more than one name, it is not possible in all the operating systems.

**EX1:** File Name: abc.java

```
class FirstApp{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

**Status:** No Compilation Error, but not suggestible.

**EX2:** File Name: FirstApp.java

```
class FirstApp{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

**Status:** No Compilation Error, it is suggestible.

**EX3:** File Name: FirstApp.java

```
public class A{  
}  
class FirstApp{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

**Status:** Compilation Error.

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**EX4:** File Name: A.java

```
public class A{  
}  
class FirstApp{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

**Status:** No Compilation Error.**EX5:** File Name: A.java

```
public class A{  
}  
public class B{  
}  
class FirstApp{  
    public static void main(String[] args){  
        System.out.println("First Java Application");  
    }  
}
```

**Status:** Compilation Error**5.Compile Java File:**

1. The main purpose of compiling JAVA file is to convert JAVA programme from High Level Representation to LowLevelRepresentation.

2. To Check compilation errors.

To compile JAVA file, we have to use the following command on command prompt from the location where JAVA File is Saved

```
javac File_Name.java
```

**EX:**

```
d:\java9>javac FirstApp.java
```

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If we use the above command on command prompt then operating System will perform the following actions.

- 1.Operating System will take "javac" command from command prompt and search for it at its predefined commands lists and at the locations referred by "path" environment variable.
- 2.If the required "javac" program is not available at the above two locations then operating System will give a message on command prompt.

"javac can not be recognized as an internal command,external command or operable program and a batch file"

**NOTE:**To make available all JDK tools like javac,java...to the operating System we have to set "path" environment variable to "c:\java\jdk1.7.0\bin" location.

D:\java9>set path=C:\Java\jdk1.7.0\bin;

- 3.If the required "javac" program is identified at "c:\java\jdk1.7.0\bin" location through "path" environment variable then operating System will execute "javac" program and activate "Java Compiler" software.
- 4.When Java Complier Software is activated then Java Complier will perform the following tasks.
  - a)Compiler will take java File name from command prompt.
  - b)Compiler will search java file at current location.
  - c)If the required java file is not available at current location then compiler will provide the following message on command prompt.  
  
javac : file not found : FirstApp.java
  - d)If the required java file is available at current location then compiler will start compilation from starting point to ending point of the java file.
  - e)In compilation process,if any syntax violations are identified then compiler will generate error messages on command prompt.
  - f)In compilation process,if no syntax errors are identified then compiler will generate .class files at the same current location.

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**NOTE:** Generating no of .class files is completely depending on the no of classes, no of abstract classes, no of interfaces, no of enums and no of inner classes which we used in the present java File

If we want to compile java file from current location and if we want to send the generated .class Files to some other target location then we have to use the following command on command prompt

```
javac -d target_location File_Name.java
```

**EX:**

```
d:\java9>javac -d c:\abc FirstApp.java
```

If we use package declaration statement in java file and if we want to store the generated .class files by creating directory structure w.r.t the package name in compilation process then we have to use "-d" option along with "javac" command.

**EX:** File Name :D:\java9\FirstApp.java

```
package com.durgasoft.core;
enum E{
}
interface I{
}
abstract class A{
}
class B{
    class C{
}
}
class FirstApp{
    public static void main(String[] args){
}
}
```

```
D:\java9>javac -d c:\abc FirstApp.java
```

Compiler will compile FirstApp.java File from "D:\java9" location and it will generate E.class, I.class, A.class, B.class, B\$C.class, FirstApp.class files at the specified target location "C:\abc" by creating directory structure w.r.t the package name "com.durgasoft.core".

If we want to compile all the java files which are available at current location then we have to use the following command.

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D:\java9>javac \*.java

If we want to compile all the java files which are prefixed with a word then we have to use the following command.

D:\java9>javac Employee\*.java

If we want to compile all the java files which are postfixed with a common word then we have to use the following command.

D:\java9>javac \*Address.java

If we want to compile all the java Files which contain particular word then we have to use the following command

D:\java9>javac \*Account\*.java

D:\java9>javac -d C:\abc \*Account\*.java

### Execute JAVA Application:

If we want to execute java program then we have to use the following command prompt.

java Main\_Class\_Name

#### EX:

d:\java9>java FirstApp

If we use the above command on command prompt then operating System will execute "java" operable program at "C:\java\jdk1.7.0\bin",with this,JVM software will be activated and JVM will perform the following actions.

1. JVM will take Main\_Class name from command prompt.
2. JVM will search for Main\_Class at current location,at Java predefined library and at the locations referred by "classpath" environment variable.
3. If the required Main\_Class .class file is not available at all the above locations then JVM will provide the following.

**JAVA6:** java.lang.NoClassDefFoundError:FirstApp

**JAVA7:** Error:Could not find or load main class FirstApp

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**NOTE:**If main class .class file is available at some other location then to make available main class.class file to JVM we have to set "classpath" environment variable.

D:\java7>set classpath=E:\XYZ;

4. If the required main class .class file is available at either of the above locations then JVM will load main class bytecode to the memory by using "Class Loaders".
5. After loading main class bytecode to the memory,JVM will search for main() method.
6. If main() method is not available at main class byteCode then JVM will provide the following.

**JAVA6:** java.lang.NoSuchMethodError:main

**JAVA7:** Error:Main method not found in class FirstApp,please define main      method as:  
public static void main(String args[])

7. If main() method is available at main class bytecode then JVM will access main() method by creating a thread called as "Main thread".
8. JVM will access main() method to start application execution by using main thread,when main thread reached to the ending point of main() method then main thread will be in destroyed/dead state.
9. When main Thread is in dead state then JVM will stop all of its internal processes and JVM will go to ShutDown mode.

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## Language Fundamentals:

To prepare java applications , we need some fundamentals provided by Java programming language.

1. Tokens
2. Data Types
3. Type Casting
4. Java Statements
5. Arrays

### 1. Tokens:

Smallest logical unit in java programming is called as "Lexeme".

The Collection of Lexemes come under a particular group is called as "Token"

```
int a=b+c*d;
```

Lexemes: int, a, =, b, +, c, \*, d, ;-----> 9

#### Tokens:

- 1)Data Types: int
- 2)Identifiers: a, b, c, d
- 3)Operators: =, +, "\*
- 4)Special Symbol: ;

#### Types of tokens: 4

To prepare java applications, java has provided the following list of tokens.

- 1.Identifiers
- 2.Literals
- 3.Keywords/ Reserved Words
- 4.Operators

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## 1. Identifiers

Identifier is a name assigned to the programming elements like variables, methods, classes, abstract classes, interfaces,.....

### EX:

```
int a=10;  
int ----> Data Types  
a -----> variable[Identifier]  
= -----> Operator  
10 -----> constant  
; -----> Terminator
```

To provide identifiers in java programming, we have to use the following rules and regulations.

- Identifiers should not be started with any number, identifiers may be started with an alphabet, '\_' symbol, '\$' symbol, but, the subsequent symbols may be a number, an alphabet, '\_' symbol, '\$' symbol.

```
int eno=111;-----> Valid  
int 9eno=999;-----> Invalid  
String _eaddr="Hyd";---> Valid  
float $esal=50000.0f;----> valid  
String emp9No="E-9999";----> Valid  
String emp_Name="Durga";----> Valid  
float emp$Sal=50000.0f;----> Valid
```

- Identifiers are not allowing all operators and all special symbols except '\_' and '\$' symbols.

```
int empNo=111; -----> valid  
int emp+No=111;-----> Invalid  
String emp*Name="Durga";----> Invalid  
String #eaddr="Hyd";--->Invalid  
String emp@Hyd="Durga";----> Invalid  
float emp.Sal=50000.0f;----> Invalid  
String emp-Addr="Hyd";-----> Invalid  
String emp_Adr="Hyd";-----> Valid
```

- Identifiers are not allowing spaces in the middle.

```
concat(--)----> Valid  
forName(--)----> Valid  
for Name()----> Invalid  
getInputStream()--> valid  
get Input Stream()----> Invalid
```

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4. Identifiers should not be duplicated with in the same scope, identifiers may be duplicated in two different scopes.

```
class A{  
    int i=10;----> Class level  
    short i=20;----> Error  
    double f=33.33---> No Error  
    void m1(){  
        float f=22.22f; -----> local variable  
        double f=33.33;---> Error  
        long i=30;---> No Error  
    }  
}
```

5. In java applications, we can use all predefined class names and interface names as identifiers.

**EX1:**

```
int Exception=10;  
System.out.println(Exception);
```

**Status:** No Compilation Error

**OP:** 10

**EX2:**

```
String String="String";  
System.out.println(String);
```

**Status:** No Compilation Error

**OP:** String

**EX3:**

```
int System=10;  
System.out.println(System);
```

**Status:** Compilation Error

**Reason:** Once if we declare "System"[Class Name] as an integer variable then we must use that "System" name as integer variable only in the remaining program, in the remaining program if we use "System" as class name then compiler will rise an error.

In the above context, if we want to use "System" as class name then we have to use its fully qualified .

**Note:** Specifying class names and interface names along with package names is called as Fully Qualified Name.

**EX:** `java.io.BufferedReader`  
`java.util.ArrayList`

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**EX:**

```
int System=10;  
java.lang.System.out.println(System);  
System=System+10;  
java.lang.System.out.println(System);  
System=System+10;  
java.lang.System.out.println(System);
```

**Status:** No Compilation Error**OP:** 10

20

30

Along with the above rules and regulations, JAVA has provided a set of suggestions to use identifiers in java programs

1. In java applications, it is suggestible to provide identifiers with a particular meaning.

**EX:**

```
String xxx="abc123";----> Not Suggestible  
String accNo="abc123";----> Suggestible
```

2. In java applications, we dont have any restrictions over the length of the identifiers, we can declare identifiers with any length, but, it is suggestible to provide length of the identifiers around 10 symbols.

**EX:**

```
String permanentemployeeaddress="Hyd";----> Not Suggestible  
String permEmpAddr="Hyd";----> Suggestible
```

3. If we have multiple words with in a single identifier then it is suggestible to seperate multiple words with special notations like '\_' symbols.

**EX:**

```
String permEmpAddr="Hyd";----> Not Suggestible  
String perm_Emp_Addr="Hyd";----> Suggestible
```

**2. Literals:**

Literal is a constant assigned to the variables .

**EX:**

```
int a=10;  
int ----> data types  
a -----> variables/ identifier  
= -----> Operator  
10 -----> constant[Literal].  
; -----> Special symbol.
```

To prepare java programs, JAVA has provioded the following set of literals.

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**1. Integer / Integral Literals:**

byte, short, int, long ----> 10, 20, 30,....  
char ----> 'A','B',.....

**2. Floating Point Literals:**

float ----> 10.22f, 23.345f,.....  
double----> 11.123, 456.345,....

**3. Boolean Literals:**

boolean ----> true, false

**4. String Literals:**

String ---> "abc", "def",.....

**Note:** JAVA7 has given a flexibility like to include '\_' symbols in the middle of the literals inorder to improve readability.

**EX:**

```
float f=12345678.2345f;  
float f=1_23_45_678.2345f;
```

If we provide '\_' symbols in the literals then compiler will remove all '\_' symbols which we provided, compiler will reformat that number as original number and compiler will process that number as original number.

**Number Systems in Java:**

IN general, in any programming language, to represent numbers we have to use a particular system .

There are four types of number systems in programming languages.

1. Binary Number Systems[BASE-2]
2. Octal Number Systems[BASE-8]
3. Decimal Number Systems[BASE-10]
4. Hexa Decimal Number Systems[BASE-16]

In java , all number systems are allowed, but, the default number system in java applications is "Decimal Number Systems".

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### 1. Binary Number Systems[BASE-2]:

If we want to represent numbers in Binary number system then we have to use 0's and 1's, but, the number must be prefixed with either '0b' or '0B'.

```
int a=10;----> It is not binary number, it is decimal num.  
int b=0b10;---> valid  
int c=0B1010;---> valid  
int d=0b1012;---> Invalid, 2 symbol is not binary numbers alphabet.
```

**Note:** Binary Number system is not supported by all the java versions upto JAVA6, but , JAVA7 and above versions are supporting Binary Number Systems, because, it is a new feature introduced in JAVA7 version.

### 2. Octal Number Systems[BASE-8]:

If we want to prepare numbers in Octal number System then we have to use the symbols like 0,1,2,3,4,5,6 and 7, but, the number must be prefixed with '0'[zero].

**EX:**

```
int a=10; -----> It is decimal number, it is not octal number.  
int b=012345;---> Valid  
int c=O234567;---> Invalid, number is prefixed with O, not zero  
int d=04567;---> Valid  
int e=05678;---> Invalid, 8 is not octal number systems alphabet.
```

### 3. Decimal Number Systems[BASE-10]:

If we want to represent numbers in Decimal number system then we have to use the symbols like 0,1,2,3,4,5,6,7,8 and 9 and number must not be prefixed with any symbols.

**EX:**

```
int a=10;----> Valid  
int b=20;----> Valid  
int c=30;----> valid
```

### 4. Hexa Decimal Number Systems[BASE-16]:

If we want to prepare numbers in Hexa decimal number system then we have to use the symbols like 0,1,2,3,4,5,6,7,8,9, a,b,c,d,e and f, but the number must be prefixed with either '0x' or '0X'.

**EX:** int a=10;----> It is not hexa decimal number, it is decimal number.

```
int b=0x102345;---> Valid  
int c=0X56789;---> Valid  
int d=0x89abcd;---> valid  
int e=0x9abcdefg;----> Invalid, 'g' is not in hexa decimal alphabet.
```

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**Note:** If we provide numbers in all the above number systems in java applications then compiler will recognize all the numbers and their number systems on the basis of their prefix values , compiler will convert these numbers into decimal system and compilers will process that numbers as decimal numbers.

### **Keywords/ Reserved Words:**

If any predefined word having both word recognition and internal functionality then that predefined word is called as Keyword.

If any predefined word having only word recognition with out internal functionality then that predefined word is called as Reserved word.

**EX:** goto const.

To prepare java applications, Java has provided the following list of keywords.

#### **1.Data types and Return types:**

bytes, short, int, long, float, double, char, boolean, void.

#### **5. Access Modifiers:**

public, protected, private, static, final, abstract, native, volatile, transient, synchronized, strictfp,.....

#### **6. Flow Controllers:**

if, else, switch, case, default, for, while, do, break, continue, return,....

#### **7. Class/ Object Related:**

class,enum, extends, interface, implements, package, import, new, this, super,....

#### **8. Exception Handling Related Keywords:**

throw, throws, try, catch, finally

### **Operators:**

Operator is a symbol, it will perform a particular operation over the provided operands.

To prepare java applications, JAVA has provided the following list of operators.

#### **1. Arithmetic Operators:**

+, -, \*, /, %, ++, --

#### **2. Assignment Operators:**

=, +=, -=, \*=, /=, %=,.....

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**3. Comparision Operators:**`==, !=, <, >, <=, >=,.....`**4. Boolean Logical Operators:**`&, |, ^`**5. Bitwise Logical Operators:**`&, |, ^, <<, >>,...`**6. Short-Circuit Operators:**`&&, ||`**7. Ternary Operator:**`Expr1? Expr2: Expr3;`**Ex1:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=10;
        System.out.println(a);
        System.out.println(a++);
        System.out.println(++a);
        System.out.println(a--);
        System.out.println(--a);
        System.out.println(a);
    }
}
```

**Status:** No Compilation Error**OP:**  
10  
10  
12  
12  
10  
10**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28 **US NUM:** , 4433326786**Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO: 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,**

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=5;
        System.out.println(++a--);
    }
}
```

**Status:** No Compilation Error**OP:** -1**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=5;
        System.out.println((-a--)* (++a-a--) + (-a+a--)*(++a+a++));
    }
}
```

**Status:** No Compilation Error**OP:** 16

A	B	A&B	A B	A^B
T	T	T	T	F
T	F	F	T	T
F	T	F	T	T
F	F	F	F	F

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**EX: class Test**

```
{  
    public static void main(String[] args)  
    {  
        boolean b1=true;  
        boolean b2=false;  
  
        System.out.println(b1&b1);//true  
        System.out.println(b1&b2);//false  
        System.out.println(b2&b1);//false  
        System.out.println(b2&b2);//false  
  
        System.out.println(b1|b1);//true  
        System.out.println(b1|b2);//true  
        System.out.println(b2|b1);//true  
        System.out.println(b2|b2);//false  
  
        System.out.println(b1^b1);//false  
        System.out.println(b1^b2);//true  
        System.out.println(b2^b1);//true  
        System.out.println(b2^b2);//false  
    }  
}
```

A	B	A&B	A B	A^B
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

T---> 1  
F---> 0

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=10;
        int b=2;
        System.out.println(a&b);
        System.out.println(a|b);
        System.out.println(a^b);
        System.out.println(a<<b);
        System.out.println(a>>b);
    }
}
```

int a=10;----> 1010  
int b=2;----> 0010

a&b--->10&2--> 0010----> 2  
a|b--->10|2--> 1010----> 10  
a^b--->10^2--> 1000----> 8

a<<b ---> 10<<2 ----> 00001010  
                  00101000---> 40

--> Remove 2 symbols at leftside and append 2 0's at right side.

a>>b ---> 10>>2 ----> 00001010  
                  00000010

--> Remove 2 symbols at right side and append 2 0's at left side.

**Note:** Removable Symbols may be 0's and 1's but appendable symbols must be 0's.

**Short-Circuit Operators:**

The main intention of Short-Circuit operators is to improve java applications performance.

**EX:** 1.&& 2.||

| Vs ||

In the case of Logical-OR operator, if the first operand value is true then it is not required to check second operand value, directly, we can predict the result of overall expression is true.

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In the case of '|' operator, even first operand value is true , still, JVM evaluates second operand value then only JVM will get the result of overall expression is true, here evaluating second operand value is unnecessary, it will increase execution time and it will reduce application performance.

In the case of '||' operator, if the first operand value is true then JVM will get the overall expression result is true with out evaluating second operand value, here JVM is not evaluating second operand expression unnecessarily, it will reduce execution time and it will improve application performance.

**Note:** If the first operand value is false then it is mandatory for JVM to evaluate second operand value inorder to get overall expression result.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=10;
        int b=10;
        if( (a++ == 10) | (b++ == 10) )
        {
            System.out.println(a+" "+b);//OP: 11 11
        }
        int c=10;
        int d=10;
        if( (c++ == 10) || (d++ == 10) )
        {
            System.out.println(c+" "+d);//OP: 11 10
        }
    }
}
```

**& Vs &&**

In the case of Logical-AND operator, if the first operand value is false then it is not required to check second operand value, directly, we can predict the result of overall expression is false.

In the case of '&' operator, even first operand value is false , still, JVM evaluates second operand value then only JVM will get the result of overall expression is false, here evaluating second operand value is unnecessary, it will increase execution time and it will reduce application performance.

In the case of '&&' operator, if the first operand value is false then JVM will get the overall expression result is false with out evaluating second operand value, here JVM is not evaluating second operand expression unnecessarily, it will reduce execution time and it will improve application performance.

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**Note:** If the first operand value is true then it is mandatory for JVM to evaluate second operand value inorder to get overall expression result.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int a=10;
        int b=10;
        if( (a++ != 10) & (b++ != 10) )
        {
        }
        System.out.println(a+" "+b);//OP: 11 11
        int c=10;
        int d=10;
        if( (c++ != 10) && (d++ != 10) )
        {
        }
        System.out.println(c+" "+d);//OP: 11 10
    }
}
```

**5. Data Types:**

Java is strictly a typed programming language, where in java applicatins before representing data first we have to confirm which type of data we representing. In this context, to represent type of data we have to use "data types".

**EX:** `i = 10;`----> invalid, no data type representation.

`int i=10;`--> Valid, type is represented then data is represented.

In java applications , data types are able to provide the following advatages.

1. We are able to identify memory sizes to store data.

**EX:** `int i=10;`--> int will provide 4 bytes of memory to store 10 value.

2.We are able to identify range values to the variable to assign.

**EX:** `byte b=130;`--> Invalid

`byte b=125;`--> Valid

**Reason:** 'byte' data type is providing a particular range for its values to byte variables.

variables like -128 to 127, in

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To prepare java applications, JAVA has provided the following data types.

## 1. Primitive Data Types / Primary Data types

### 1. Numeric Data Types

#### 1. Integral data types/ Integer Data types:

byte -----> 1 bytes -----> 0  
short-----> 2 bytes-----> 0  
int-----> 4 bytes-----> 0  
long-----> 8 bytes-----> 0

#### 2. Non-Integral Data Types:

float-----> 4 bytes----> 0.0f  
double-----> 8 bytes----> 0.0

#### 1. Non-Numeric Data types:

char -----> 2 bytes---> '' [single space]  
boolean-----> 1 bit----> false

## 2. User defined data types / Secondary Data types

All classes, all abstract classes, all interfaces, all arrays,.....

No fixed memory allocation for User defined data types

If we want to identify range values for variables onthe basis of data types then we have to use the following formula.

$n-1$        $n-1$   
 $-2$       to     $2 - 1$   
Where 'n' is no of bits.

**EX:** Data Type: byte , size= 1 byte = 8 bits.

$8-1$        $8-1$   
 $-2$       to     $2 - 1$   
 $7$        $7$   
 $-2$       to     $2 - 1$

-128 to 128 - 1

-128 to 127

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**Note:** This formula is applicable upto Integral data types, not applicable for other data types.

To identify "min value" and "max value" for each and every data type, JAVA has provided the following two constant variables from all the wrapper classes.

MIN\_VALUE and MAX\_VALUE

**Note:** Classes representation of primitive data types are called as Wrapper Classes

Primitive data types      Wrapper Classes

-----	-----
byte ----->	java.lang.Byte
short ----->	java.lang.Short
int ----->	java.lang.Integer
long ----->	java.lang.Long
float ----->	java.lang.Float
double----->	java.lang.Double
char----->	java.lang.Character
boolean----->	java.lang.Boolean

**EX:**

```
class Test{  
    public static void main(String[] args){  
        System.out.println(Byte.MIN_VALUE+"---->"+Byte.MAX_VALUE);  
        System.out.println(Short.MIN_VALUE+"---->"+Short.MAX_VALUE);  
        System.out.println(Integer.MIN_VALUE+"---->"+Integer.MAX_VALUE);  
        System.out.println(Long.MIN_VALUE+"---->"+Long.MAX_VALUE);  
        System.out.println(Float.MIN_VALUE+"---->"+Float.MAX_VALUE);  
        System.out.println(Double.MIN_VALUE+"---->"+Double.MAX_VALUE);  
        System.out.println(Character.MIN_VALUE+"---->"+Character.MAX_VALUE);  
        //System.out.println(Boolean.MIN_VALUE+"---->"+Boolean.MAX_VALUE);---> Error  
    }  
}
```

### Type Casting:

The process of converting data from one data type to another data type is called as "Type Casting". There are two types of type castings are existed in java.

- 1.Primitive data Types Type Casting
- 2.User defined Data Types Type Casting

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**Note:** To perform User defined data types type casting we need either "extends" relation or "implements" relation between user defined data types.

### 1. Primitive data Types Type Casting:

The process of converting data from one primitive data type to another primitive data type is called as Primitive data types type casting.

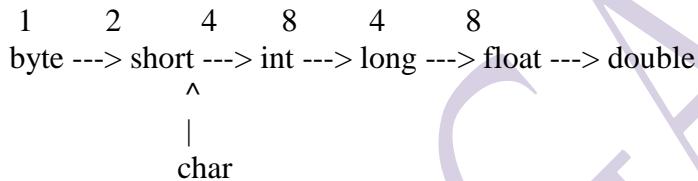
There are two types of primitive data types type castings.

1. Implicit Type Casting
2. Explicit Type Casting

#### 1. Implicit Type Casting:

The process of converting data from lower data type to higher data type is called as Implicit Type Casting.

To cover all the possibilities of implicit type casting JAVA has provided the following chart.



If we want to perform implicit type casting in java applications then we have to assign lower data type variables to higher data type variables.

#### EX:

```
byte b=10;
int i = b;
System.out.println(b+ " "+i);
```

**Status:** No Compilation Error

**OP:** 10 10

If we compile the above code, when compiler encounter the above assignment stattement then compiler will check whether right side variable data type is compatible with left side variable data type or not, if not, compiler will rise an error like "possible loss of precision". If right side variable data type is compatible with left side variable data type then compiler will not rise any error and compiler will not perform any type casting.

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When we execute the above code, when JVM encounter the above assignment statement then JVM will perform the following two actions.

- 1.JVM will convert right side variable data type to left side variable data type implicitly[Implicit Type Casting]
- 2.JVM will copy the value from right side variable to left side variable.

**Note:** Type Checking is the responsibility of compiler and Type Casting is the responsibility of JVM.

**EX2:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        byte b=i;
        System.out.println(i+" "+b);
    }
}
```

**Status:** Compilation Error, Possible loss of precision.

**EX3:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b=65;
        char c=b;
        System.out.println(b+" "+c);
    }
}
```

**Status:** Compilation Error

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**EX4:**

```
class Test
{
    public static void main(String[] args)
    {
        char c='A';
        short s=c;
        System.out.println(c+" "+s);
    }
}
```

**Status:** Compilation Error, Possible loss of precision.

**Reason:** byte and short internal data representations are not compatible to convert into char.

**EX5:**

```
class Test
{
    public static void main(String[] args)
    {
        char c='A';
        int i=c;
        System.out.println(c+" "+i);
    }
}
```

**Status:** No Compilation Error

**OP:** A 65

**Reason:** Char internal data representation is compatible with int.

**EX6:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b=128;
        System.out.println(b);
    }
}
```

**Status:** Compilation Error,possible loss of precision.

**Reason:** When we assign a value to a variable of data type, if the value is greater the max limit of the left side variable data type then that value is treated as of the next higher data type value.

**Note:** For both byte and short next higher data type is int only.

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**EX7:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b1=60;
        byte b2=70;
        byte b=b1+b2;
        System.out.println(b);
    }
}
```

**Status:** Compilation Error, possible loss of precision.

**EX8:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b1=30;
        byte b2=30;
        byte b=b1+b2;
        System.out.println(b);
    }
}
```

**Status:** Compilation Error, Possible loss of precision.

**Reason:** X,Y and Z are three primitive data types.

X+Y=Z

- 1.If X and Y belongs to {byte, short, int} then Z should be int.
- 2.If either X or Y or both X and Y belongs to {long, float, double} then Z should be higher(X,Y).

byte+byte=int  
byte+short=int  
short+int=int  
byte+long=long  
long+float=float  
float+double=double

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**EX9:**

```
class Test
{
    public static void main(String[] args)
    {
        long l=10;
        float f=l;
        System.out.println(l+" "+f);
    }
}
```

**Status:** No Compilation Error

**OP:** 10 10.0

**EX10:**

```
class Test
{
    public static void main(String[] args)
    {
        float f=22.22f;
        long l=f;
        System.out.println(f+" "+l);
    }
}
```

**Status:** Compilation Error, possible loss of precision.

**Reason:**

two class rooms

Class Room A: 25[Size] banches---> 3 members per bench---> 75

Class Room B: 50[Size] banches---> 1 member per bench----> 50

long---> 8 bytes--> less data as per its internal data arrangement.

float--> 4 bytes--> more data as per its internal data arrangement.

Due to the above reason, float data type is higher when compared with long data type so that, we are able to assign long variable to float variable directly, but, we are unable to assign float variable to long variable directly.

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## 2. Explicit Type Casting:

The process of converting data from higher data type to lower data type is called as Explicit Type Casting.

To perform explicit type casting we have to use the following pattern.

P a = (Q) b;

(Q)---> Cast operator

Where P and Q are two primitive data types, where Q must be either same as P or lower than P as per implicit type casting chart.

### EX1:

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        byte b=(byte)i;
        System.out.println(i+" "+b);
    }
}
```

**Status:** No Compilation Error

**OP:** 10 10

When we compile the above code, when compiler encounter the above assignment statement, compiler will check whether cast operator provided data type is compatible with left side variable data type or not, if not, compiler will rise an error like "Possible loss of precision". If cast operator provided data type is compatible with left side variable data type then compiler will not rise any error and compiler will not perform type casting.

When we execute the above program, when JVM encounter the above assignment statement then JVM will perform two actions.

- 1.JVM will convert right side variable data type to cast operator provided data type.
- 2.JVM will copy value from right side variable to left side variable.

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**EX2:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        short s=(byte)i;
        System.out.println(i+" "+s);
    }
}
```

**Status:** No Compilation Error**OP:** 10 10**EX3:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b=65;
        char c=(char)b;
        System.out.println(b+" "+c);
    }
}
```

**Status:** No Compilation Error**OP:** 65 A**EX4:**

```
class Test
{
    public static void main(String[] args)
    {
        char c='A';
        short s=(short)c;
        System.out.println(c+" "+s);
    }
}
```

**Status:** No Compilation Error**OP:** A 65**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28 **US NUM:** , 4433326786**Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO: 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,**



**Note:** In Implicit type casting, conversions are not possible between char and byte, short and char, but, in explicit type casting conversions are possible in between char and byte, char and short, why because, explicit type casting is forceable type casting.

**EX5:**

```
class Test
{
    public static void main(String[] args)
    {
        short s=65;
        char c=(byte)s;
        System.out.println(s+" "+c);
    }
}
```

**Status:** Compilation Error.

**EX6:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b1=30;
        byte b2=30;
        byte b=(byte)b1+b2;
        System.out.println(b);
    }
}
```

**Status:** Compilation Error

**EX7:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b1=30;
        byte b2=30;
        byte b=(byte)(b1+b2);
        System.out.println(b);
    }
}
```

**Status:** No Compilation Error

**OP:** 60

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**EX8:**

```
class Test
{
    public static void main(String[] args)
    {
        double d=22.22;
        byte b=(byte)(short)(int)(long)(float)d;
        System.out.println(b);
    }
}
```

**Status:** No Compilation Error

**OP:** 22

**EX9:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=130;
        byte b=(byte)i;
        System.out.println(b);
    }
}
```

**Status:** No Compilation Error

**OP:** -126

**Reason:** REf Diagram

**Java Statements:**

Statement is the collection of expressions.

To design java applications JAVA has provided the following statements.

**1. General Purpose Statements**

Declaring variables, methods, classes,....

Creating objects, accessing variables, methods,.....

**2. Conditional Statements:**

1. if
- 2.switch

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**3. Iterative Statements:**

- 1.for
- 2.while
- 3.do-while

**4. Transfer statements:**

- 1.break
- 2.continue
- 3.return

**5. Exception Handling statements:**

throw, try-catch-finally

**6. Synchronized statements:**

- 1.synchronized methods
- 2.synchronized blocks

**Conditional Statements:**

These statements are able to allow to execute a block of instructions under a particular condition.

**EX:**

- 1. if
- 2.switch

**1. if:****syntax-1:**

```
if(condition)
{
    ---instructions---
}
```

**Syntax-2:**

```
if(condition)
{
    ---instructions---
}
else
{
    ---instructions---
}
```

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**Syntax-3:**

```
if(condition)
{
    ---instructions---
}
else if(condition)
{
    ---instruction---
}
else if(condition)
{
    ---instructions---
}
else
{
    ---instructions---
}
```

**EX1:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        int j;
        if(i==10)
        {
            j=20;
        }
        System.out.println(j);
    }
}
```

**Status:** Compilation Error, Variable j might not have been initialized.

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**EX2:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        int j;
        if(i==10)
        {
            j=20;
        }
        else
        {
            j=30;
        }
        System.out.println(j);
    }
}
```

**Status:** No Compilation Error**OP:** 20**EX3:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        int j;
        if(i==10)
        {
            j=20;
        }
        else if(i==20)
        {
            j=30;
        }
        System.out.println(j);
    }
}
```

**Status:** Compilation Error, Variable j might not have been initialized.**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28

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**EX4:** class Test

```
{  
    public static void main(String[] args)  
    {  
        int i=10;  
        int j;  
        if(i==10)  
        {  
            j=20;  
        }  
        else if(i==20)  
        {  
            j=30;  
        }  
        else  
        {  
            j=40;  
        }  
        System.out.println(j);  
    }  
}
```

**Status:** no Compilation Error**OP:** 20**EX5:**

```
class Test  
{  
    public static void main(String[] args)  
    {  
        final int i=10;  
        int j;  
        if(i == 10)  
        {  
            j=20;  
        }  
        System.out.println(j);  
    }  
}
```

**Status:** No Compilation Error**OP:** 20**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28

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**EX6:**

```
class Test
{
    public static void main(String[] args)
    {
        int j;
        if(true)
        {
            j=20;
        }
        System.out.println(j);
    }
}
```

**Status:** No Compilation Error

**Reasons:**

1. In java applications, only class level variables are having default values, local variables are not having default values. If we declare local variables in java applications then we must provide initializations for that local variables explicitly, if we access any local variable without having initialization explicitly then compiler will raise an error like "Variable x might not have been initialized".

**EX:**

```
class A{
    int i;----> class level variable, default value is 0..
    void m1(){
        int j;----> local variable, no default value.
        System.out.println(i); // OP: 0
        //System.out.println(j);--> Error
        j=20;
        System.out.println(j);--> No Error
    }
}
```

**Note:** Local variables must be declared inside methods, blocks, if conditions,... and these variables are having scope upto that method only, not having scope outside of that method. Class level variables are declared at class level that is inside the methods, blocks,... these variables are having scope throughout the class that is in all methods, in all blocks which we provided in the respective class.

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2. In java, there are two types of conditional Expressions.

1. Constant Expressions
2. Variable Expressions

### 1. Constant Expressions:

These expressions includes only constants including final variables and these expressions would be evaluated by "Compiler" only, not by JVM.

**EX:**

- 1.if( 10 == 10){ } ----> Constant Expression
- 2.if( true ){ } -----> Constant Expression
- 3.final int i=10;  
if( i == 10 ){ } ----> Constant Expression

**Note:** If we declare any variable as final variable with a value then compiler will replace final variables with their values in the remaining program, this process is called "Constant Folding", it is one of the code optimization tech followed by Compiler.

### 2. Variable Expressions:

These expressions are including atleast one variable [not including final variables] and these expressions are evaluated by JVM, not by Compiler.

**EX:**

- 1.int i=10;  
int j=10;  
if( i == j ){ } ----> variable expression.
- 2.int i=10;  
if( i == 10 ){ } ----> Variable expression

switch

'if' is able to provide single condition checking bydefault, but, switch is able to provide multiple conditions checkings.

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**Syntax:**

```
switch(Var)
{
    case 1:
        ----instructions-----
        break;
    case 2:
        ----instructions-----
        break;
    ----
    ----
    case n:
        ----instructions-----
        break;
    default:
        ----instructions-----
        break;
}
```

**Note:** We will utilize switch programming element in "Menu Driven" Applications.

**Stack Operations**

- 1.PUSH
- 2.POP
- 3.PEEK
- 4.EXIT

Enter Your Option: 1

Enter element to PUSH: A

PUSH operation success

**Stack Operations**

- 1.PUSH
- 2.POP
- 3.PEEK
- 4.EXIT

Enter Your Option:2

POP operation success.

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**Stack Operations**

- 1.PUSH
- 2.POP
- 3.PEEK
- 4.EXIT

Enter Your Option:3

PEEK Operation Success, TOP: A

**Stack Operations**

- 1.PUSH
- 2.POP
- 3.PEEK
- 4.EXIT

Enter Your Option:4

Thanks for using STACK Operations.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        switch(i)
        {
            case 5:
                System.out.println("Five");
                break;
            case 10:
                System.out.println("Ten");
                break;
            case 15:
                System.out.println("Fifteen");
                break;
            case 20:
                System.out.println("Twenty");
                break;
            default:
                System.out.println("Default");
                break;
        }
    }
}
```

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### Rules to write switch:

1. switch is able to allow the data types like byte, short, int and char.

**EX:** byte b=10;  
switch(b)  
{  
----  
}

**Status:** No Compilation Error

**EX:** long l=10;  
switch(l)  
{  
----  
}

**Status:** Compilatiopn Error.

**EX:** class Test

```
{  
    public static void main(String[] args)  
    {  
        char c='B';  
        switch(c)  
        {  
            case 'A':  
                System.out.println("Five");  
                break;  
            case 'B':  
                System.out.println("Ten");  
                break;  
            case 'C':  
                System.out.println("Fifteen");  
                break;  
            case 'D':  
                System.out.println("Twenty");  
                break;  
            default:  
                System.out.println("Default");  
                break;  
        }  
    }  
}
```

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**Status:** no Compilation Error

**Note:**

Upto JAVA6 version, switch is not allowing "String" data type as parameter, "JAVA7" version onwards switch is able to allow String data type.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        String str="BBB";
        switch(str)
        {
            case "AAA":
                System.out.println("AAA");
                break;
            case "BBB":
                System.out.println("BBB");
                break;
            case "CCC":
                System.out.println("CCC");
                break;
            case "DDD":
                System.out.println("DDD");
                break;
            default:
                System.out.println("Default");
                break;
        }
    }
}
```

**Status:** No Compilation Error

**OP:** BBB

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2. In switch, all cases and default are optional, we can write switch with out cases and with default, we can write switch with cases and with out default, we can write switch with out both cases and default.

**EX:**

```
int i=10;  
switch(i)  
{  
}  
}
```

**Status:** No Compilation Error

**OP:** No Output.

**EX:**

```
class Test  
{  
    public static void main(String[] args)  
    {  
        int i=10;  
        switch(i)  
        {  
            default:  
                System.out.println("Default");  
            break;  
        }  
    }  
}
```

**Status:** No Compilation Error

**OP:** Default

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        switch(i)
        {
            case 5:
                System.out.println("Five");
                break;
            case 10:
                System.out.println("Ten");
                break;
            case 15:
                System.out.println("Fifteen");
                break;
            case 20:
                System.out.println("Twenty");
                break;
        }
    }
}
```

**Status:** No Compilation Error**OP:** Ten**CONTACT US:****Mobile:** +91- 8885 25 26 27

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=50;
        switch(i)
        {
            case 5:
                System.out.println("Five");
                break;
            case 10:
                System.out.println("Ten");
                break;
            case 15:
                System.out.println("Fifteen");
                break;
            case 20:
                System.out.println("Twenty");
                break;
        }
    }
}
```

**Status:** No Compilation Error**OP:** No Output**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28**US NUM:** , 4433326786**Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO:** 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,



3. In switch, "break" statement is optional, we can write switch with out break statement, in this context, JVM will execute all the instructions continuously right from matched case untill it encounter either break statement or end of switch.

**EX:** class Test

```
{  
    public static void main(String[] args)  
    {  
        int i=10;  
        switch(i)  
        {  
            case 5:  
                System.out.println("Five");  
  
            case 10:  
                System.out.println("Ten");  
  
            case 15:  
                System.out.println("Fifteen");  
  
            case 20:  
                System.out.println("Twenty");  
  
            default:  
                System.out.println("Default");  
        }  
    }  
}
```

**Status:** No Compilation Error

**OP:**  
Ten  
Fifteen  
Twenty  
Default

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4. In switch, all case values must be provided with in the range of the data type which we provided as parameter to switch.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        byte b=126;
        switch(b)
        {
            case 125:
                System.out.println("125");
                break;
            case 126:
                System.out.println("126");
                break;
            case 127:
                System.out.println("127");
                break;
            case 128:
                System.out.println("128");
                break;
            default:
                System.out.println("Default");
                break;
        }
    }
}
```

**Status:** Compilation Error**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28

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5. In switch, all case values must be constants including final variables, they should not be normal variables.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        final int i=5,j=10,k=15,l=20;
        switch(10)
        {
            case i:
                System.out.println("Five");
                break;
            case j:
                System.out.println("Ten");
                break;
            case k:
                System.out.println("Fifteen");
                break;
            case l:
                System.out.println("Twenty");
                break;
            default:
                System.out.println("Default");
                break;
        }
    }
}
```

**Status:** No Compilation Error

**OP:** 10

**Note:** in the above example, if we remove final keyword then compiler will rise an error.

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**Iterative Statements:**

These statements are able to allow JVM to execute a set of instructions repeatedly on the basis of a particular condition.

**EX:** 1.for 2.while 3.do-while

**1.for****Syntax:**

```
for(Expr1; Expr2; Expr3)
{
    ----instructions-----
}
```

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            System.out.println(i);
        }
    }
}
```

**Status:** No Compilation Error

**OP:**

0

1

---

---

9

Expr1----> 1 time

Expr2----> 11 times

Expr3----> 10 times

Body -----> 10 times

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=0;
        for(i<10;i++)
        {
            System.out.println(i);
        }
    }
}
```

**Status:** No Compilation Error**OP:** 0 ---- 9**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=0;
        for(System.out.println("Hello");i<10;i++)
        {
            System.out.println(i);
        }
    }
}
```

**Status:** No Compilation Error**OP:** Hello 0 1 ---- 9**Reason:**

In for loop, Expr1 is optional, we can write for loop even with out Expr1 , we can write any statement like System.out.println(--i) as Expr1, but, always, it is suggestible to provide loop variable declaration and initialization kind of statements as Expr1.

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0, float f=0.0f ;i<10 && f<10.0f; i++,f++)
        {
            System.out.println(i+" "+f);
        }
    }
}
```

**Status:** Compilation Error**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0, int j=0 ;i<10 && j<10; i++,j++)
        {
            System.out.println(i+" "+j);
        }
    }
}
```

**Status:** Compilation Error**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0, j=0 ;i<10 && j<10; i++,j++)
        {
            System.out.println(i+" "+j);
        }
    }
}
```

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**Status:** No Compilation Error**OP:** 0 0

1 1

2 2

-----

-----

9 9

**Reason:**

In for loop, Expr1 is able to allow atmost one declarative statement, it will not allow more than one declarative statement, we can declare more than one variable with in a single declarative statement.

**EX:** class Test

```
{  
    public static void main(String[] args)  
    {  
        for(int i=0; ;i++)  
        {  
            System.out.println(i);  
        }  
    }  
}
```

**Status:** No Compilation Error**OP:** Infinite Loop**EX:** class Test

```
{  
    public static void main(String[] args)  
    {  
        for(int i=0; System.out.println("Hello") ;i++)  
        {  
            System.out.println(i);  
        }  
    }  
}
```

**Status:** Compilation Error

**Reason:** In for loop, Expr2 is optional, we can write for loop even with out Expr2, if we write for loop with out Expr2 then for loop will take "true" value as Expr2 and it will make for loop as an infinite loop. If we want to write any statement as Expr2 then that statement must be boolean statement, it must return either true value or false value.

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        for(int i=0;i<=0 || i>=0 ;i++)
        {
            System.out.println("Inside Loop");
        }
        System.out.println("After Loop");
    }
}
```

**Status:** No Compilation Error**OP:** Before Loop  
Inside Loop

---

---

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        for(int i=0; true ;i++)
        {
            System.out.println("Inside Loop");
        }
        System.out.println("After Loop");
    }
}
```

**Status:** Compilation Error, Unreachable Statement**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        for(int i=0;;i++)
        {
            System.out.println("Inside Loop");
        }
        System.out.println("After Loop");
    }
}
```

**Status:** Compilation Error, Unreachable Statement

**Reasons:**

In java applications, if we provide any statement immediately after infinite loop then that statement is called as "Unreachable Statement". If compiler identifies the provided loop as an infinite loop and if compiler identifies any followed statement for that infinite loop then compiler will rise an error like "Unreachable Statement". If compiler does not aware the provided loop as an infinite loop then there is no chance for compiler to rise "Unreachable Statement Error".

**Note:** Deciding whether a loop as an infinite loop or not is completely depending on the conditional expression, if the conditional expression is constant expression and it returns true value always then compiler will recognize the provided loop as an infinite loop. If the conditional expression is variable expression then compiler will not recognize the provided loop as an infinite loop even the loop is really infinite loop.

```
int i=0;
for(int i=10; i<10;i++)
{}
```

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;
        {
            System.out.println(i);
            i=i+1;
        }
    }
}
```

**Status:** No Compilation Error**OP:** 0 ,1 ..... 9**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;System.out.println("Hello"))
        {
            System.out.println(i);
            i=i+1;
        }
    }
}
```

**Status:** No Compilation Error**OP:**  
0  
Hello  
1  
Hello  
----  
----  
9  
Hello

**Note:** In for loop, Expr3 is optional, we can write for loop with out expr3, we can provide any statement as expr3, but, it is suggestible to provide loop variable increment/decrement kind of statements as expr3.

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(;;)
    }
}
```

**Status:** Compilation Error**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(;;);
    }
}
```

**Status:** No Compilation Error**OP:** No Output, but, JVM will be in infinite loop**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(;;)
    }
}
```

**Status:** No Compilation Error**OP:** No Output, but, JVM will be in infinite loop**Reason:** In for loop, if we want to write single statement in body then curly braces

[{} ] are optional , if we dont want to write any statement as body then we must provide either ; or curly braces to the for loop.

In general, we will utilize for loop when we aware no of iterations in advance before writing loop.

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**EX:**

```
int[] a={1,2,3,4,5};  
int size=a.length;  
for(int i=0; i<size; i++)  
{  
    System.out.println(a[i]);  
}
```

If we use above for loop to retrieve elements from arrays and from Collection objects then we are able to get the following problems.

- 1.We have to manage a separate loop variable.
- 2.At each and every iteration we have to execute a conditional expression that is expr2, which is more strenghful operation and it may consume more no of system resources[Memory and execution time].
- 3.At each and every iteration we have to perform either increment operation or decrement operation explicitly.
- 4.In this approach, we are retrieving elements from arrays on the basis of the index value , if it is not proper then there may be a chance to get an exception like "java.lang.ArrayIndexOutOfBoundsException".

The above drawbacks are able to reduce java application performance.

To overcome the above problems and to improve java application performance explicitly we have to use "for-Each" loop provided by JDK5.0 version.

**syntax:**

```
for(Array_Data_Type var: Array_Ref_Var)  
{  
    ----  
}
```

**EX:**

```
int[] a={1,2,3,4,5};  
for(int x: a)  
{  
    System.out.println(x);  
}
```

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int[] a={1,2,3,4,5};
        for(int i=0;i<a.length;i++)
        {
            System.out.println(a[i]);
        }
        System.out.println();
        for(int x: a)
        {
            System.out.println(x);
        }
    }
}
```

**Status:** No Compilation Error**OP:**

```
1
2
3
4
5
```

```
1
2
3
4
5
```

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## 2. While loop:

In java applications, when we are not aware the no of iterations in advance before writing loop there we have to utilize 'while' loop.

### EX:

```
D:\javaapps>java Insert.java
Enter Employee Number : 111
Enter Employee Name : AAA
Enter Employee Salary : 5000
Enter Employee Address: Hyd
Employee Inserted Successfully
One more Employee[yes/no]? :yes
```

```
Enter Employee Number : 222
Enter Employee Name : BBB
Enter Employee Salary : 6000
Enter Employee Address: Hyd
Employee Inserted Successfully
One more Employee[yes/no]? : yes
```

```
Enter Employee Number : 333
Enter Employee Name : CCC
Enter Employee Salary : 7000
Enter Employee Address: Hyd
Employee Inserted Successfully
One more Employee[yes/no]? no
```

--- Thank You for using this appl.---

### Syntax:

```
while(Condition)
{
    ---instructions-----
}
```

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=0;
        while(i<10)
        {
            System.out.println(i);
            i=i+1;
        }
    }
}
```

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=0;
        while()
        {
            System.out.println(i);
            i=i+1;
        }
    }
}
```

**Status:** Compilation Error**Reason:** Conditional Expression is mandatory.**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        while(true)
        {
            System.out.println("Inside Loop");
        }
        System.out.println("After Loop");
    }
}
```

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**Status:** Compilation Error, Unreachable Statement.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        int i=0;
        while(i<=0 || i>=0)
        {
            System.out.println("Inside Loop");
        }
        System.out.println("After Loop");
    }
}
```

**do-while:**

Q) What are the differences between while loop and do-while loop?

**Ans:**

1. While loop is not giving any guarantee to execute loop body minimum one time.

do-while loop will give guarantee to execute loop body minimum one time.

2. In case of while, first, conditional expression will be executes, if it returns true then only loop body will be executed.

In case of do-while loop, first loop body will be executed then condition will be executed.

3. In case of while loop, condition will be executed for the present iteration.

In case of do-while loop, condition will be executed for the next iteration.

**Syntaxes:**

```
while(Condition)
{
    ---instructions---
}
```

```
do
{
    ---instructions---
}
```

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**While(Condition):****EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=0;
        do
        {
            System.out.println(i);
            i=i+1;
        }
        while (i<10);
    }
}
```

**Status:** No Compilation Error**OP:** 0, 1, 2,..., 9**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before Loop");
        do
        {
            System.out.println("Inside Loop");
        }
        while (true);
        System.out.println("After Loop");
    }
}
```

**Status:** Compilation Error, Unreachable Statement**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28 **US NUM:** , 4433326786**Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO: 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,**



## Transfer Statements:

These statements are able to bypass flow of execution from one instruction to another instruction.

**EX:** 1.break   2.continue   3.return

### 1.break:

break statement will bypass flow of execution to outside of the loops or outside of the blocks by skipping the remaining instructions in the current iteration and by skipping all the remaining iterations.

### EX:

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            if(i==5)
            {
                break;
            }
            System.out.println(i);
        }
    }
}
```

**Status:** No Compilation Error

**OP:**

0  
1  
2  
3  
4

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("Before loop");
        for(int i=0;i<10;i++)
        {
            if(i==5)
            {
                System.out.println("Inside loop, before break");
                break;
                System.out.println("Inside loop, after break");
            }
        }
        System.out.println("After Loop");
    }
}
```

**Status:** Compilation Error, unreachable Statement

**Reason:** If we provide any statement immediately after break statement then that statement is Unreachable Statement, where compiler will rise an error.

**EX:** class Test

```
{}
public static void main(String[] args)
{
    for(int i=0;i<10;i++)// Outer loop
    {
        for(int j=0;j<10;j++)// Nested Loop
        {
            if(j==5)
            {
                break;
            }
            System.out.println(i+" "+j);
        }
        // Out side of nested Loop
    }
}
```

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**Status:** No Compilation Error

**OP:**

0	0
0	1
0	2
0	3
0	4
-----	
-----	
-----	
9	0
9	1
9	2
9	3
9	4

**Note:** If we provide "break" statement in nested loop then that break statement is applicable for only nested loop, it will not give any effect to outer loop.

In the above context, if we want to give break statement effect to outer loop , not to the nested loop then we have to use "Labelled break" statement.

**Syntax:**

break label;

Where the provided label must be marked with the respective outer loop.

Continue.....

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)// Outer loop
        {
            for(int j=0;j<10;j++)// Nested Loop
            {
                if(j==5)
                {
                    break 11;
                }
                System.out.println(i+" "+j);
            }
            // Out side of nested Loop
        }
        //Out side of outer loop
    }
}
```

**Status:** no Compilation Error**OP:** 0 00 1  
0 2  
0 3  
0 4**2. Continue:**

This transfer statement will bypass flow of execution to starting point of the loop by skipping all the remaining instructions in the current iteration inorder to continue with next iteration.

Continue....

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            if(i == 5)
            {
                continue;
            }
            System.out.println(i);
        }
    }
}
```

**Status:** No Compilation Error**OP:**

```
0
1
2
3
4
6
7
8
9
```

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        System.out.println("before Loop");
        for(int i=0;i<10;i++)
        {
            if(i == 5)
            {
                System.out.println("Inside Loop, before continue");
                continue;
                System.out.println("Inside Loop, After continue");
            }
        }
        System.out.println("After loop");
    }
}
```

**Status:** Compilation Error, Unreachable Statement.

**Reason:** If we provide any statement immediately after continue statement then that statement is unreachable statement, where compiler will rise an error.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            for(int j=0;j<10;j++)
            {
                if(j==5)
                {
                    continue;
                }
                System.out.println(i+" "+j);
            }
        }
    }
}
```

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**Status:** No Compilation Error

**OP:**

---

--

---

--

If we provide continue statement in nested loop then continue statement will give effect to nested loop only, it will not give effect to outer loop

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            for(int j=0;j<10;j++)
            {
                if(j==5)
                {
                    continue;
                }
                System.out.println(i+" "+j);
            }
        }
    }
}
```

In the above context, if we want to give continue statement effect to outer loop, not to the nested loop then we have to use labelled continue statement.

**Syntax:**

**continue label;**

Where the provided label must be marked with the respective outer loop.

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        for(int i=0;i<10;i++)
        {
            for(int j=0;j<10;j++)
            {
                if(j==5)
                {
                    continue 11;
                }
                System.out.println(i+" "+j);
            }
        }
    }
}
```

**Status:** No Compilation Error**OP:**

```
0 0
0 1
0 2
0 3
0 4
1 0
1 1
1 2
1 3
1 4
---
---
9 0
0 1
9 2
9 3
9 4
```

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## OOPS

To prepare applications we have to select a particular type of programming language from the following.

- 1.Unstructured Programming Languages
- 2.Structered Programming Languages
- 3.Object Oriented Programming Languages
- 4.Aspect Oriented Programming Languages

Q)What are the differences between Unstructured Programming Languages and Structered Programming Languages?

**Ans:**

1. Unstructured Programming Languages are out dated programming languages, they were introduced at starting point of computers and these programming languages are not suitable for our at present application requirements.

**EX:** BASIC, FOTRAN,.....

Structered Programming languages are not out dated programming languages, these programming languages are utilized for our at present application requirements.

**EX:** C , PASCAL,....

2. Unstructured Programming Languages are not following any proper strucer to prepare applications.

Structered Programming Languages are following a particular strucer to prepare applications.

3. Unstructured Programming languages are using mnemonic[ ADD, SUB, MUL,..][ low level code] codes to prepare applications, which are available in very less number and which may provide very less no of features to prepare applications.

Structered Programming Languages are using high level syntaxes, which are available in more number and which may provide more no of features to the applications.

4.Unstructured Programming Languages are using only "goto" statement to define flow of execution , which is not sufficient to provide very good flow of execution in applications.

Structered Programming Languages are using more and more no of flow controllers like if, switch, for, while, do-while, break,..... to defined very good flow of execution in applications.

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5. Unstructured Programming languages are not having functions feature, it will increase code redundancy[Code duplication], it is not suggestible in application development.

Structured Programming languages are having functions feature to improve code reusability.

Q) What are the differences between Structured Programming Languages and Object Oriented Programming Languages?

**Ans:**

1. Structured Programming Languages are providing difficult approach to prepare applications.

**EX:** C , PASCAL,...

Object Oriented Programming Languages are providing very simplified approach to prepare applications.

**EX:** JAVA, C++,....

2. Structured Programming languages are not having modularity.

Object Oriented Programming Languages are having very good modularity.

3. Structured Programming languages are not having very good abstraction.

Object Oriented Programming Languages are having very good abstraction levels.

4. Structured Programming languages are not providing very good security for the applications.

Object Oriented programming Languages are providing very good security for the application data.

5. Structured Programming languages are not providing very good sharability.

Object Oriented programming Languages are providing very good sharability.

6. Structured Programming Languages are not providing very good code reusability.

Object Oriented programming languages are providing very good code reusability.

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### Aspect Oriented Programming Languages:

If we want to prepare applications by using Object orientation then we have to provide both business logic and Services logic in combined manner, it will provide tightly coupled design , it will reduce sharability and code reusability.

To overcome the above problem we have to use Aspect Orientation. Aspect Orientation is a methodology or a set of rules and regulations or a set of guid lines which are applied on object oriented programming to get loosely coupled design inorder to improve sharability and code reusability.

In case of Aspect orientation, we will separate all services from business logic, we will declare each and every service as an aspect and we will inject these services to the applications at runtime as per the requirement.

### Object Oriented Features:

To show the nature of Object orientation, Object Orientation has provided the following features.

- 1.Class
- 2.Object
- 3.Encapsulation
- 4.Abstraction
- 5.Inheritance
- 6.Polymorphism
- 7.Message Passing

There are two types of programming languages on the basis of object oriented features.

- 1.Object Oriented Programming Languages
- 2.Object based Programming Languages

Q)What is the difference between Object Oriented Programming Languages and Object Based programming languages?

#### Ans:

Object Oriented Programming languages are able to allow all the object oriented features including "Inheritance".

#### EX: Java

Object based programming languages are able to allow all the object oriented features excluding "Inheritance".

#### EX: Java Script

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Q) What are the differences between class and Object?

**Ans:**

1. Class is a group of elements having common properties and behaviours.  
Object is an individual element among the group of elements having physical behaviours and physical properties
2. Class is virtual.  
Object is real
3. Class is virtual encapsulation of properties and behaviours.  
Object is physical encapsulation of properties and behaviours.
4. Class is Generalization.  
Object is Specialization.
5. Class is Model or Blue Print for the objects.  
Object is an instance of the class.

Q) What is the difference between Encapsulation and Abstraction?

**Ans:**

The process of binding data and coding part is called as "Encapsulation".

The process showing necessary data or implementation and hiding unnecessary data or implementation is called as "Abstraction".

**Note:** In Object Oriented programming languages, both encapsulation and abstraction are improving "Security".

#### **5. Inheritance:**

The process of getting variables and methods from one class to another class is called as "Inheritance".

The main objective of inheritance is "Code Reusability".

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**EX:**

```
class Employee{  
    String eid;  
    String ename;  
    String eaddr;  
    ---  
    ---  
    void getEmpDetails(){  
    ---  
    }  
    }  
  
class Manager extends Employee{  
--- Reuse variables and methods of Employee class---  
}  
  
class Accountent extends Employee{  
--- Reuse variables and methods of Employee class here----  
}  
  
class Engineer extends Employee{  
--- Reuse variables and methods of Employee class here----  
}
```

**6.Polymorphism:**

Polymorphism is "Greak" word, where poly means many and morphism means structeres[forms].

If one thing is existed in multiple forms then it is called as Polymorphism.

The main advantage of Polymorphism is "Flexibility" to design application.

**7.Message Passing:**

The process of transferring data along with flow of execution from one instruction to another instructions is called as Messsage passing.

The main advantage of message passing is to improve "Communication" between entities and "data navigation" between entities.

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## Containers in Java:

- 1.Class
- 2.Abstract Class
- 3.Interface

### 1.Class:

#### Syntax:

```
[Access_Modifiers] class Class_Name [extends Super_Class_Name][implements  
interface_List]  
{  
    --- variables----  
    -- methods-----  
    ----constructors----  
    ----blocks-----  
    ---classes-----  
    ---abstract classes----  
    ---interfaces-----  
    --- enums-----  
}
```

#### Access Modifiers:

There are two types of Access modifiers

1.To define scopes to the programming elements, there are four types of access modifiers. public, protected, <default> and private.

Where public and <default> are allowed for classes, protected and private are not allowed for classes.

**Note:** All public, protected , <default> and private are allowed for inner classes.

**Note:** Where private and protected access modifiers are defined on the basis of classes boundaries, so that, they are not applicable for classes, they are applicable for members of the classes including inner classes.

2.To define some extra nature to the programming elements , we have the following access modifiers.

static, final, abstract, native, volatile, transient, synchronized, strictfp,.....

Where final, abstract and strictfp are allowed for the classes.

**Note:** The access modifiers like static, abstract, final and strictfp are allowed for inner classes.

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**Note:** Where static keyword was defined on the basis of classes origin, so that, it is not applicable for classes, it is applicable for members of the classes including inner classes.

Where 'class' is a java keyword, it can be used to represent 'Class' object oriented feature.

Where 'Class\_Name' is name is an identifier, it can be used to recognize the classes individually.

Where 'extends' keyword is able to specify a particular super class name in class syntax inorder to get variables and methods from the specified super class to the present java class.

**Note:** In class syntax, 'extends' keyword is able to allow only one super class name, it will not allow more than one super class, because, it will represent multiple inheritance, it is not possible in Java.

Where 'implements' keyword is able to specify one or more no of interfaces in class syntax inorder to provide implementation for all abstract methods of that interfaces in the present class.

**Note:** In class syntax, extends keyword is able to allow only one super class, but, implements keyword is able to allow more than one interface.

**Note:** In class syntax, 'extends' and 'implements' keywords are optional, we can write a class with extends keyword and without implements keyword, we can write a class with implements keyword and without extends keyword, we can write a class with both extends and implements keywords, if we want to write both extends and implements keywords first we have to write extends keyword then only we have to write implements keyword, we must not interchange extends and implements keywords.

- 1.class A{ } ----> valid
- 2.public class A{ }----> valid
- 3.private class A{ }----> Invalid
- 4.protected class A{ }----> Invalid
- 5.class A{ public class B{ } }----> valid
- 6.class A{ private class B{ } }----> valid
- 7.class A{ protected class B { } }----> valid
- 8.class A{ class B{ } }----> valid
- 9.static class A{ }----> Invalid
- 10.final class A{ }----> valid
- 11.abstract class A{ }----> valid
- 12.synchronized class A{ }----> Invalid
- 13.native class A{ }----> Invalid
- 14.class A{ static class B{ } }----> valid
- 15.class A{ abstract class B{ } }----> valid
- 16.class A{ strictfp class B{ } }----> valid
- 17.class A{ native class B{ } }----> Invalid
- 18.class A extends B{ }----> valid

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- 19.class A extends A{ }----> Invalid, cyclic inheritance Error
- 20.class A extends B, C{ }----> Invalid
- 21.class A implements I{ }----> valid
- 22.class A implements I1, I2{ }----> valid
- 23.class A implements I extends B{ }----> Invalid
- 24.class A extends B implements I{ }----> valid
- 25.class A extends B implements I1, I2{ }----> valid

**Procedure to write classes in java applications:**

- 1.Declare a class by using 'class' keyword.
- 2.Declare variables and methods in class as per the requirement.
- 3.In main class and in main() method , create object for the respective class.
- 4.Access members of the class by using the generated reference variable.

Entities[Student, Customer, Employee,...]----> classes  
Entities data[sid, sname, saddr,...] ----> variables  
Entities actions or behaviours[add, search, delete,..] ----> methods

**EX:**

```
class Employee
{
    String eid="E-111";
    String ename="Durga";
    float esal=25000.0f;
    String eaddr="Hyderabad";
    String eemail="durga@durgasoft.com";
    String emobile="91-9988776655";

    public void display_Emp_Details()
    {
        System.out.println("Employee Details");
        System.out.println("-----");
        System.out.println("Employee Id :"+eid);
        System.out.println("Employee Name :"+ename);
        System.out.println("Employee Saslary:"+esal);
        System.out.println("Employee Address:"+eaddr);
        System.out.println("Employee Email :" +eemail);
        System.out.println("Employee Mobile :" +emobile);
    }
}

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

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```
Employee emp = new Employee();
emp.display_Emp_Details();
}
}
```

There are two types of methods.

1. Concreate methods
2. Abstract methods

Q) What are the differences between Concreate methods and abstract methods?

**Ans:**

1. Concreate method is a method, it will have both method declaration and method implementation.

**EX:** void add(int i, int j)// Method Declaration  
  {// Method implementation started here  
  int k=i+j;  
  System.out.println(k);  
  }// Method Implementation ended here

Abstract method is a method, it will have only method declaration.

**EX:** abstract void add(int i, int j);

2. To declare concreate methods , no need to use any special keyword.

To declare abstract method , we must use abstract keyword.

3. Concreate methods are allowed in classes and in abstract classes.  
abstract methods are allowed in abstract classes and interfaces.

4. Concreate methods will provide less sharability.  
Abstract methods will provide more sharability.

## 2. Abstract Classes:

Abstract class is a java class, it able to allow zero or more no of concreate methods and zero or more no of abstract methods.

**Note:** To declare abstract classes, it is not at all mandatory condition to have atleast one abstract method, we can declare abstract classes with 0 no of abstract methods, but, if we want to declare a method as an abstract method then the respective class must be abstract class.

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For abstract classes, we are able to create only reference variables, we are unable to create objects.

```
abstract class A{  
----  
}  
  
A a = new A();--> Error  
A a=null;----> No Error
```

Abstract classes are able to provide more sharability when compared with classes.

#### Procedure to use abstract classes:

- Declare an abstract class with "abstract".
- Declare concreate methods and abstract methods in abstract class as per the requirement.
- Declare sub class for abstract class.
- Implement abstract methods in sub class.
- in main class and in main() method, create object for sub class and declare reference variable either for abstract class or for sub class.
- Access abstract class members.

**Note:** If we declare reference variable for abstract class then we are able to access only abstract class members, but, if we declare reference variable for sub class then we are able to access bothe abstract class members and sub class members.

#### EX: abstract class A

```
{  
    void m1()  
    {  
        System.out.println("m1-A");  
    }  
    abstract void m2();  
    abstract void m3();  
}  
  
class B extends A  
{  
    void m2()  
    {  
        System.out.println("m2-B");  
    }  
    void m3()  
    {  
        System.out.println("m3-B");  
    }  
}
```

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```
        }
        void m4()
        {
            System.out.println("m4-B");
        }
    }
class Test
{
    public static void main(String[] args)
    {
        //A a=new A();--> Error
        A a = new B();
        a.m1();
        a.m2();
        a.m3();
        //a.m4();--> Error
        B b = new B();
        b.m1();
        b.m2();
        b.m3();
        b.m4();
    }
}
```

Q)What are the differences between concrete classes and abstract classes?

**Ans:**

1.Classes are able to allow only concrete methods.

Abstract classes are able to allow both concrete methods and abstract methods.

2.To declare concrete classes, only, 'class' keyword is sufficient.

To declare abstract classes we need to use 'abstract[' keyword along with class keyword.

3.For classes, we are able to create both reference variables and objects,

For abstract classes, we are able to create only reference variables, we are unable to create objects.

4.Concrete classes will provide less sharability.

Abstract classes will provide more sharability.

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### 3. Interfaces:

Interface is a java feature, it able to allow zero or more nof abstract methods only.

For interfaces, we are able to declare only reference variables, we are unable to create objects.

In case of interfaces, bydefault, all the variables as "public static final".

In case of interfaces, bydefault, all the methods are "public and abstract".

When compared with classes and abstract classes, iterfaces will provide more sharability.

#### Procedure to Use interfaces in Java applications:

- Declare an interface with "inetrface" keyword.
- Declare variables and methods in interface as per the requirement.
- Declare an implementation class for interface by including "implements" keyword.
- Provide implementation for abstract methods in implementation class which are declared in interface.
- In main class, in main() method, create object for implementation class ,but, declare reference variable either for interface or for implementation class.
- Access interface members.

**Note:** If declare reference variable for interface then we are able to access only interface members, we arew unable to access implementation class own members.If we declare reference variable for implementation class then we are able to access both interface members and implementation class own members.

#### Example:

```
interface I
{
    int x=20;// public static final
    void m1();// public and abstract
    void m2();// public and abstract
    void m3();// public and abstract
}
class A implements I
{
    public void m1()
    {
        System.out.println("m1-A");
    }
    public void m2()
    {
        System.out.println("m2-A");
    }
}
```

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```
public void m3()
{
    System.out.println("m3-A");
}
public void m4()
{
    System.out.println("m4-A");
}
}
class Test
{
    public static void main(String[] args)
    {
        //I i=new I();---> Error
        I i=new A();
        System.out.println(i.x);
        System.out.println(i.x);
        i.m1();
        i.m2();
        i.m3();
        //i.m4();----> Error
        A a=new A();
        System.out.println(a.x);
        System.out.println(A.x);
        a.m1();
        a.m2();
        a.m3();
        a.m4();
    }
}
```

Q)What are the differences between Class, abstract class and interface?

**Ans:**

1. class is able to allow concrete methods only.

Abstract class is able to allow both concrete methods and abstract methods  
interface is able to allow abstract methods only.

2. To declare class, only, class keyword is sufficient.

To declare abstract class, we have to use "abstract" keyword along with class keyword.

To declare interface we have to use "interface" keyword explicitly.

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3. For classes only, we are able to create both reference variables and objects.  
For abstract classes and interfaces , we are able to declare reference variables , we are unable to create objects.
4. In case of interfaces, bydefault, all variables are "public static final".  
In case of classes and abstract classes, no default cases for variables.
5. In case of interfaces, bydefault, all methods are "public and abstract".  
In case of classes and abstract classes, no default cases for methods.
6. Constructors are allowed in classes and abstract classes.  
Constructors are not allowed in interfaces.
7. Classes are able to provide less sharability.  
Abstract classes are able to provide moddle level sharability.  
Interfaces are able to provide more sharability.

### Methods In Java:

Method is a set of instructions, it will represent a particular action in java applications.

#### Syntax:

```
[Access_Modifiers] return_Type method_Name([param_List])[throws Exception_List]
{
    ----- instructions to represent a particular action-----
}
```

Java methods are able to allow the access modifiers like public, protected, <default> and private.  
Java methods are able to allow the access modifiers like static, final, abstract, native, synchronized, strictfp.

Where the purpose of return\_Type is to specify which type of data the present method is returning.In java applications, all primitive data types, all user defined data types and 'void' are allowed for methods as return types.

**Note:** 'void' return type is representing "Nothing is returned" from methods.

Where "method\_name" is an identifier, it can be used to recognize the methods individually.

Where param\_List can be used to pass some input data to the methods inorder to perform an action.In java applications, we are able to provide all primitive data types and all user defied data types as parameter types.

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Where "throws" keyword can be used to bypass or delegate the generated exception from present method to caller method of the present method

To describe method information, there are two approaches.

- 1.Method Signature
- 2.Method Prototype

Q)What is the difference between Method Signature and method prototype?

**Ans:**

Method signature is the description of the method, it includes method name and parameter list.

**EX:** forName(String Class\_Name)

Method prototype is the description of the method, it will include access modifiers list, return type, method name, parameters list, throws exception list.

**EX:**public static Class forName(String class\_Name)throws ClassNotFoundException

There are two types of methods in Java w.r.t the Object state manipulations.

- 1.Mutator Methods
- 2.Accessor Methods

Q)What are the differences between Mutator methods and Accessor methods?

**Ans:**

Mutator methods are the java methods, which are used to set/modify data in Objects.

**EX:** All setXXX(--) methods in Java Bean classes are mutator methods.

Accessor methods are the java methods, which are used to get/access data from Objects.

**EX:** All getXXX() methods in java bean classes are Accessor methods

--- Diagram mutatorNAccessormethods.png-----

**Note:** Java bean is a normal java class, it will include properties and the respective setXXX(-) methods and getXXX() methods.

Variable-Argument Method[Var-Ag method]

In general, in java applications, if we declare any method with 'n' no of parameters then we must access that method with the same 'n' no of parameter values , it is not possible to access that method by passing 'n+1' no of parameter values and 'n-1' no of parameter values.

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**EX:**

```
class A
{
    void add(int i, int j)
    {
        System.out.println(i+j);
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        a.add(10,20);// Valid.
        //a.add();--> Invalid
        //a.add(10);--> Invalid
        //a.add(10,20,30);--> Invalid
    }
}
```

As per the requirement, we want to access a method with variable no of parameter values[0 no of params or 1 no of params or 2 no of params,...]

To achieve this requirement we have to use "Var-Ag Method" provided by JDK5.0 version.

Var-Ag method is a java method including Var-Ag parameter.

Syntax for Var-Ag Parameter:

Data\_Type ... Var\_Name

EX for var-Ag method:

```
void m1(int ... a)//int[] a={---- argumentvalues-----}
{
    -----
}
```

When we access Var-Ag method with 'n' no of parameter values then all these 'n' no of parameter values are stored in the form of Array which is generated from var-ARg parameter.

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**EX:**

```
class A
{
    void add(int ... a)// int[] a={--- listof arguments---}
    {
        System.out.println("No Of Arguments :" + a.length);
        int result=0;
        System.out.print("Argument List :");
        for(int i=0;i<a.length;i++)
        {
            System.out.print(a[i] + " ");
            result=result+a[i];
        }
        System.out.println();
        System.out.println("Addition :" + result);
        System.out.println("-----");
    }
}

class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        a.add();
        a.add(10);
        a.add(10,20);
        a.add(10,20,30);
    }
}
```

**Note:** In Var-Ag methods, normal parameters are allowed along with Var-ARg parameter but they must be provided before var-Ag parameter, not after var-Ag parameter, because, var-Ag parameter must be last parameter in var-Ag method.

**Note:** Due to the above reason, Var-Ag methods are able to allow atmost one Var-Ag parameter, not allowing more tha one Var-Ag parameters.

**EX:**

- 1.void m1(int ... i, float f){ } ----> Invalid
- 2.void m1(float f, int ... i){ } ----> valid
- 3.void m1(int ... i, float ... f){ } --->Invalid

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### Object Creation Statement:

Q) What is the requirement to create Objects in Java?

**Ans:**

1. To store entities data temporarily in java applications we need objects.
2. To Access the members of any particular class we need objects.

If we want to create Objects we have to use the following syntax.

```
Class_Name ref_Var = new Class_Name([param_List]);
```

**EX:**

```
class A{  
----  
}  
  
A a = new A();
```

When JVM encounter the above instruction, JVM will perform the following actions.

1. Creating memory for the Object
2. Generating Identities for the object
3. Providing initializations inside the Object

#### 1. Creating Memory for the object:

When JVM encounter "new" keyword in Object creation statement then JVM will check to which class we are creating object on the basis of constructor name then JVM will load the respective class bytecode to the memory [Method Area]

After loading class bytecode, JVM will identify minimal object memory size by recognizing all the instance variables and their data types

After getting memory size, JVM will send a request to Heap manager about to creat an object with the specified minimal memory.

As per JVM requirement, Heap Manager will create the required block of memory at Heap Memory.

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## 2. Generating Identities for the Object:

After creating a block of memory[Object] for JVM requirements, Heap manager will assign an integer value as an identity for the object called as "HashCode".

After getting HashCode value, Heap Manager will send that hashCode value to JVM, where JVM will convert that hashCode value to its Hexa Decimal form called as "Reference Value".

After getting Object reference value, JVM will assign that reference value to a variable called as "Reference Variable".

## 3. Providing initializations inside the Object:

After creating object and its identities, JVM will allocate memory for all the instance variables inside the object on the basis of their data types.

After getting memory for the instance variables, JVM will provide initial values to the instance variables by searching initializations at class level declaration and at constructor.

If any instance variable is not having initialization at both constructor and at class level declaration then JVM will store default value on the basis of their datatype as initial value inside the object.

--- Diagram [ObjectCreation.png] ---

**Note:** In java applications, when a class bytecode is loaded to the memory, automatically, JVM will create java.lang.Class object at heap memory with the metadata of the loaded class.

**Note:** In java application, when we create a thread[Main Thread or User Thread], automatically, a stack will be created at stack memory and it able to store methods details in the form of Frames which are accessed by the respective thread.

To get hashCode value and reference value of an object we have to use the following two methods.

```
public native int hashCode()  
public String toString()
```

**Note:** Native method is a java method, declared in java, but, implemented in non java programming languages may be C, ASL, .....

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**EX:**

```
class A
{
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        int hashCode=a.hashCode();
        System.out.println("Object HashCode :" +hashCode);
        String ref=a.toString();
        System.out.println("Object Reference :" +ref);
    }
}
```

**OP:**

Object Hashcode : 31168322  
Object Reference : A@adb9742

In Java applications, there is a common and default super class for each and every java class[predefined classes and user defined classes] that is "java.lang.Object" class, where java.lang.Object class contains the following 11 methods inorder to share to all java classes.

- 1.hashCode()
- 2.toString()
- 3.getClass()
- 4.clone()
- 5.equals(Object obj)
- 6.finalize()
- 7.wait()
- 8.wait(long time)
- 9.wait(long time, int time)
- 10.notify()
- 11.notifyAll()

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Q) If we extend a class to some other class explicitly then the respective sub class is having two super classes [default super class [Object] and explicit super class], it represents multiple inheritance, how can we say multiple inheritance is not possible in JAVA?

**Ans:**

In java, `java.lang.Object` class is common and default super class for every class when that class is not extending from any other super class explicitly. If our class is extending some other class explicitly then `Object` class is not directly super class to the respective sub class, `Object` class is indirectly super class to the respective sub class through the explicit super class, that is, `Object` class is not super class to the respective sub class through Multiple Inheritance, that is through Multi Level Inheritance.

**EX:**

```
class A{  
---  
}  
class B extends A{  
---  
}
```

Note : Here `Object` class is super class to `A` , `A` is super class to `B`  
`Object<--- A<--- B`

In java applications, when we pass a particular class object reference variable as parameter to `System.out.println()` method then JVM will access `toString()` over the provided reference variable internally.

**EX:**

```
class A  
{  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        A a=new A();  
  
        String ref=a.toString();  
        System.out.println(ref);  
  
        System.out.println(a.toString());  
  
        System.out.println(a);//System.out.println(a.toString());  
    }  
}
```

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**OP:**

A@1db9742  
A@1db9742  
A@1db9742

In the above program, when we access `toString()` method internally or externally , first, JVM has to execute `toString()`, to execute `toString()` method JVM will search for `toString()` method in the respective class whose reference variable we passed as parameter to `System.out.println()` method, if the required `toString()` method is not existed in the respective class then JVM will search for `toString()` method in its super class, here if super class is not existed then JVM will search for `toString()` method in the common and default super class `Object` class. In `Object` class, `toString()` method was implemented insuch a way to return a string contains "Class\_Name@ref\_Val" .

As per the requirement, if we want to display our own data instead of Object reference value when we pass reference variable as parameter to `System.out.println()` method then we have to provide our own `toString()` method in the respective class.

**EX:**

```
class Employee
{
    String eid="E-111";
    String ename="Durga";
    float esal=50000.0f;
    String eaddr="Hyd";
    String eemail="durga@durgasoft.com";
    String emobile="91-9988776655";

    public String toString()
    {
        System.out.println("Employee Details");
        System.out.println("-----");
        System.out.println("Employee Id :"+eid);
        System.out.println("Employee Name :"+ename);
        System.out.println("Employee Salary :"+esal);
        System.out.println("Employee Address :"+eaddr);
        System.out.println("Employee Email :"+eemail);
        System.out.println("Employee Mobile :"+emobile);
        return "";
    }
}

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

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```
{  
    Employee emp=new Employee();  
    System.out.println(emp);  
}  
}
```

**OP:**

--- Employee details-----

**Note:** In Java, some predefined classes like String, StringBuffer, Exception, Thread, all wrapper classes, all Collection classes are not depending on Object class `toString()` method, they are having their own `toString()` method inorder to display their own data.

**EX:**

```
class Test  
{  
    public static void main(String[] args)  
    {  
        String str=new String("abc");  
        System.out.println(str);  
  
        Exception e=new Exception("My Own Exception");  
        System.out.println(e);  
  
        Thread t=new Thread();  
        System.out.println(t);  
  
        Integer in=new Integer(10);  
        System.out.println(in);  
  
        java.util.ArrayList al=new java.util.ArrayList();  
        al.add("AAA");  
        al.add("BBB");  
        al.add("CCC");  
        al.add("DDD");  
        System.out.println(al);  
    }  
}
```

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**OP:**

abc  
java.lang.Exception: My Own Exception  
Thread[Thread-0,5,main]  
10  
[AAA,BBB,CCC,DDD]

In JAVA, there are two types of Objects.

- 1.Immutable Objects
- 2.Mutable Objects

Q)What is the difference between Immutable object and mutable object?

**Ans:**

Immutable Objects are Java objects, they will not allow modifications on their content. If we are trying to perform operations over immutable objects content then data is allowed for operations, but, the resultant data is not stored back in original object, the modified data will be stored by creating new Object.

**EX:** All String class objects are immutable objects.

All Wrapper class objects are immutable Objects.

Mutable Objects are java objects, they will allow modifications on their content directly.

**EX:** By default, all JAVA objects are mutable objects.

**EX:** StringBuffer

Q)What is the differernce between String and StringBuffer?

**Ans:**

----- Same above answer for this question also-----

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**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        String str1=new String("Durga ");
        String str2=str1.concat("Software ");
        String str3=str2.concat("Solutions");
        System.out.println(str1);
        System.out.println(str2);
        System.out.println(str3);
        System.out.println();
        StringBuffer sb1=new StringBuffer("Durga ");
        StringBuffer sb2=sb1.append("Software ");
        StringBuffer sb3=sb2.append("Solutions");
        System.out.println(sb1);
        System.out.println(sb2);
        System.out.println(sb3);
    }
}
```

**OP:**

Durga  
Durga Software  
Durga Software Solutions

Durga Software Solutions  
Durga Software Solutions  
Durga Software Solutions

Q)What is the difference between Object and insrstance?

**Ans:**

Object is a memory unit to store data.

Instance is a copy or layer of values existed in an object at a particular point of time.

---- Digram: ObjectnInstance.png-----

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## Constructors:

1. Constructor is a java feature, it can be used to create Object.
2. The role of the constructors in Object creation is to provide initial values inside the object.
3. In java applications, Constructors are executed exactly at the time of creating objects, not before creating objects and not after creating objects.
4. The main utilization of constructors is to provide initializations for class level variables mainly instance variable.
5. Constructors must have same name of the respective class.
6. Constructors are not having return types.
7. Constructors are not allowing the access modifiers like static, final,...
8. Constructors are able to allow the access modifiers like public, protected, <default> and private.
9. Constructors are allowing 'throws' keyword in its syntax to bypass exceptions from present constructor to the caller .

## Syntax:

```
[Access_Modifier] Class_Name([Param_List])[throws Exception_List]
{
    -----
}
```

## Note1:

If we provide constructor name other than class name then compiler will rise an error like "Invalid Method declaration, return type required", because, compiler has treated the provided constructor as normal java method with out the return type, but, for methods return is mandatory.

## EX:

```
class A
{
    B()
    {
        System.out.println("A-Con");
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
    }
}
```

**Status:** Compilation Error.

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**Note2:**

If we provide return type to the constructors then Compiler will not rise any error and JVM will not rise any exception and JVM will not provide any output, because, the provided constructor is converted as normal java method. In this context, if we access the provided constructor as normal java method then it will be executed as like normal java method.

**EX: class A**

```
{  
    void A()  
    {  
        System.out.println("A-Con");  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        A a=new A();  
        a.A();  
    }  
}
```

**Status:** No Compilation Error**OP:** A-Con**Note3:**

If we provide the access modifiers like static, final,... to the constructors then Compiler will rise an error like "modifier xxx not allowed here".

**EX: class A**

```
{  
    static A()  
    {  
        System.out.println("A-Con");  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        A a=new A();  
    }  
}
```

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**Status:** Compilation Error.

**Note4:**

If we declare constructor as "private" then that constructor is available upto the respective class only, not available to out side of the respective class.

In this context, If we want to create object for the respective class then it is possible inside the same class only.

**EX:** class A

```
{  
    private A()  
    {  
        System.out.println("A-Con");  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        A a=new A();  
    }  
}
```

**Status:** Compilation Error

There are two types constructors in java

- 1.Default Constructors
- 2.User Defined Constructors

**1.Default Constructors:**

If we have not provided any constructor explicitly in java class then compiler will provide a 0-arg constructor automatically, here the compiler provided 0-arg constructor is called as "Default Constructor".

If we provide any constructor explicitly then compiler will not provide any default constructor.

```
D:\javaapps\ Test.java  
public class Test{  
}
```

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**On Command Prompt:**

```
D:\javaapps>javac Test.java
D:\javaapps>javap Test
Compiled from Test.java
public class Test{
    public Test() { ----> Default constructor
    }
}
```

**Note:** Default Constructors are having the same scope of the respective class.

**2. User Defined Constructors:**

These constructors are provided by the developers as per their application requirements.

If we provide any constructor explicitly with out parameters then that constructor is called as 0-arg constructor.

If we provide any constructor with atleast one parameter then that constructor is called as parameterized Constructor.

**Note:** By default, all the default constructors are 0-arg constructors, but, all 0-arg constructors are not default constructors, some 0-arg constructors are provided by the compiler are called as Default Constructors and some other 0-arg constructors are provided by the users they are called as User defined constructors.

**EX:**

```
class Employee
{
    String eid;
    String ename;
    float esal;
    String eaddr;

    Employee()
    {
        eid="E-111";
        ename="Durga";
        esal=50000.0f;
        eaddr="Hyd";
    }

    public void getEmpDetails()
    {
```

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```
        System.out.println("Employee Details");
        System.out.println("-----");
        System.out.println("Employee Id    :" + eid);
        System.out.println("Employee Name   :" + ename);
        System.out.println("Employee Salary  :" + esal);
        System.out.println("Employee Address :" + eaddr);
    }
}
class Test
{
    public static void main(String[] args)
    {
        Employee emp=new Employee();
        emp.getEmpDetails();
    }
}
```

In the above program, if we create more than one object for the Employee class by executing 0-arg constructor then same data will be stored in all multiple objects of the Employee.

As per the requirement, if we want to create multiple Employee objects with different data then we have to provide data to the Objects explicitly, for this we have to use parameterized constructor.

**EX:**

```
class Employee
{
    String eid;
    String ename;
    float esal;
    String eaddr;

    Employee(String emp_Id, String emp_Name, float emp_Sal, String      emp_Addr)
    {
        eid=emp_Id;
        ename=emp_Name;
        esal=emp_Sal;
        eaddr=emp_Addr;
    }

    public void getEmpDetails()
    {
        System.out.println("Employee Details");
        System.out.println("-----");
        System.out.println("Employee Id    :" + eid);
    }
}
```

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```
        System.out.println("Employee Name : "+ename);
        System.out.println("Employee Salary : "+esal);
        System.out.println("Employee Address : "+eaddr);
    }
}
class Test
{
    public static void main(String[] args)
    {
        Employee emp1=new Employee("E-111", "Durga", 50000.0f, "Hyd");
        emp1.getEmpDetails();
        System.out.println();
        Employee emp2=new Employee("E-222", "Anil", 60000.0f, "Hyd");
        emp2.getEmpDetails();
        System.out.println();
        Employee emp3=new Employee("E-333", "Rahul", 80000.0f, "Hyd");
        emp3.getEmpDetails();
    }
}
```

### Constructor Overloading:

If we declare more than one constructor with the same name and with the different parameter list then it is called as "Constructor Overloading".

#### EX:

```
class A
{
    int i,j,k;
    A()
    {
    }
    A(int i1)
    {
        i=i1;
    }
    A(int i1, int j1)
    {
        i=i1;
        j=j1;
    }
    A(int i1, int j1, int k1)
    {
        i=i1;
        j=j1;
    }
}
```

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```
        k=k1;
    }
    void add()
    {
        System.out.println("Addition :" +(i+j+k));
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a1=new A();
        a1.add();
        A a2=new A(10);
        a2.add();
        A a3=new A(10,20);
        a3.add();
        A a4=new A(10,20,30);
        a4.add();
    }
}
```

**Note:** If we declare more than one method with the same name and with different parameter list then it is called as "Method Overloading"

#### **Instance Context/Instance Flow of execution:**

In Java, for every class loading a separate context will be created called as Static Context and for every Object a separate context will be created called as Instance context.

In Java, instance context is represented in the form of the following elements.

1. Instance Variables
2. Instance Methods
3. Instance Blocks

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### 1.Instance Variables:

Instance Variable is a normal Java variable,whose values will be varied from one instance to another instance of an object.

Instance Variable is a variable,which will be recognized and initialized just before executing the respective class constructor.

In Java applications,instance variables must be declared at class level and non-static, instance variables never be declared as local variables and static variables.

In Java applications, instance variables data will be stored in Object memory that is in "Heap Memory".

### 2.Instance Methods:

Instance Method is a normal Java method,it is a set of instructions,it will represent an action of an entity.

In Java applications,instance methods will be executed when we access that method.In Java applications,all the methods wont be executed with out the method call.

#### EX:

```
class A{  
    int i=m1();  
    A(){  
        System.out.println("A-Con");  
    }  
    int m1(){  
        System.out.println("M1-A");  
        return 10;  
    }  
}  
class Test{  
    public static void main(String args[]){  
        A a =new A();  
    }  
}
```

#### OP:

M1-A  
A-con

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**EX:**

```
class A {  
    int j=m1();  
    int m2(){  
        System.out.println("m2-A");  
        return 10;  
    }  
    A(){  
        System.out.println("A-con");  
    }  
    int m1(){  
        System.out.println("m1-A");  
        return 20;  
    }  
    int i=m2();  
}  
class Test{  
    public static void main(String args[]){  
        A a =new A();  
    }  
}
```

**OP:**  
m1-A  
m2-A  
A-con**3.Instance Block:**

Instance Block is a set of instructions which will be recognized and executed just before executing the respective class constructors.

Instance Block as are having the same power of constructors,it can be used as like constructors.

**Syntax:**

```
{  
---instructions---  
}
```

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**EX:**

```
class A {  
    A(){  
        System.out.println("A-CON");  
    }  
    {  
        System.out.println("IB-A");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        A a=new A();  
    }  
}
```

**OP:**

IB-A  
A-CON

**EX:**

```
class A {  
    A(){  
        System.out.println("A-CON");  
    }  
    {  
        System.out.println("IB-A");  
    }  
    int m1(){  
        System.out.println("m1-A");  
        return 10;  
    }  
    int i=m1();  
}  
class Test{  
    public static void main(String args[]){  
        A a=new A();  
    }  
}
```

**OP:** IB-A  
m1-A  
A-CON

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**EX:**

```
class A{
    int m1(){
        System.out.println("m1-A");
        return 10;
    }
    {
        System.out.println("IB-A");
    }
    int i=m2();
    A(){
        System.out.println("A-con");
    }
    int i=m1();
    {
        System.out.println("IB1-A");
    }
    int m2();
    {
        System.out.println("m2-A");
        return 20;
    }
}
class Test{
    public static void main(String args[]){
        A a1=new A();
        A a2=new A();
    }
}
```

**OP:**

IB-A  
m2-A  
m1-A  
IB1-A  
A-con  
IB-A  
m2-A  
m1-A  
IB1-A  
A-con

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### 'this' keyword:

'this' is a Java keyword,it can be used to represent current class object.

In Java applications,we are able to utilize 'this' keyword in the following four ways.

- 1.To refer current class variable
- 2.To refer current class methods
- 3.To refer current class constructors
- 4.To refer current class object

#### 1.To refer current class variables:

If we want to refer current class variables by using 'this' keyword then we have to use the following syntax.

this.var\_Name

**NOTE:**In Java applications,if we provide same set of variables at local and at class level and if we access that variables then JVM will give first priority for local variables,if local variables are not available then JVM will search for that variables at class level, even at class level also if that variables are not available then JVM will search at super class level.At all the above locations,if the specified variables are not available then compiler will rise an error.

**NOTE:**In Java applications,if we have same set of variables at local and at class level then to access class level variables over local variables we have to use 'this' keyword.

#### EX:

```
class A{  
    int i=10;  
    int j=20;  
    A(int i,int j) {  
        System.out.println(i+" "+j);  
        System.out.println(this.i+" "+this.j);  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        A a=new A(30,40);  
    } }
```

#### OP:

30 40  
10 20

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**NOTE:**In general,in enterprise applications,we are able to write no. of Java bean classes as per application requirement.In Java bean classes,we are able to provide variables and their setter methods and getter methods.In Java bean classes,in setter methods, we have to declare parameter variable with the same name of the respective class level variable, here we have to transfer data from local variabe to class level variable, for this, we have to assign local variable to class level variable.In this context, to refer class level variable over local variable seperately we have to use 'this' keyword. In getter methods,always,we have to return class level variables only , so that, it is not required to use 'this' keyword.

**EX:** class User{  
    private String uname;  
    private String upwd;  
    public void setUname(String uname) {  
        this.uname=uname;  
    }  
    public void setUpwd(String upwd) {  
        this.upwd=upwd;  
    }  
    public getUname() {  
        return uname;  
    }  
    public getUpwd(){  
    }  
    }  
    class Test{  
        public static void main(String[] args){  
            User u=new User();  
            u.setUname("abc");  
            u.setUpwd("abc123");  
            System.out.println("User Login Details");  
            System.out.println("-----");  
            System.out.println("User Name :"+u.getUname());  
            System.out.println("Password :"+getEaddr());  
        }  
    }

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**EX:** class Employee

```
{  
    private String eid;  
    private String ename;  
    private float esal;  
    private String eaddr;  
  
    public void setEid(String eid)  
    {  
        this.eid=eid;  
    }  
    public void setEname(String ename)  
    {  
        this.ename=ename;  
    }  
    public void setEsal(float esal)  
    {  
        this.esal=esal;  
    }  
    public void setEaddr(String eaddr)  
    {  
        this.eaddr=eaddr;  
    }  
  
    public String getEid()  
    {  
        return eid;  
    }  
    public String getEname()  
    {  
        return ename;  
    }  
    public float getEsal()  
    {  
        return esal;  
    }  
    public String getEaddr()  
    {  
        return eaddr;  
    }  
}  
class Test  
{
```

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```
public static void main(String[] args)
{
    Employee emp=new Employee();
    emp.setEid("E-111");
    emp.setEname("AAA");
    emp.setEsal(5000.0f);
    emp.setEaddr("Hyd");

    System.out.println("Employee Details");
    System.out.println("-----");
    System.out.println("Employee Id :"+emp.getEid());
    System.out.println("Employee Name :"+emp.getEname());
    System.out.println("Employee Salary :"+emp.getEsal());
    System.out.println("Employee Address :"+emp.getEaddr());
}
}
```

## 2.To refer current class method:

If we want to refer current class method by using 'this' keyword then we have to use the following syntax.

```
this.method_Name([param_List]);
```

**Note:** To access current class methods, it is not required to use any reference variable and any keyword including 'this', directly we can access.

### EX:

```
class A{
    void m1(){
        System.out.println("m1-A");
    }
    void m2(){
        System.out.println("m2-A");
        m1();
        this.m1();
    }
}
class Test{
    public static void main(String args[]){
        A a=new A();
        a.m2();
    }
}
```

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**OP:**

m2-A  
m1-A  
m1-A

**3.To refer current class constructors:**

If we want to refer current class constructor by using 'this' keyword then we have to use the following syntax.

this([param\_List]);

**EX:**

```
class A{  
A(){  
this(10);  
System.out.println("A-0-arg-con");  
}  
A(int i){  
this(22.22f);  
System.out.println("A-int-param-con");  
}  
A(float f){  
this(33.3333);  
System.out.println("A-float-param-con");  
}  
A(double d){  
System.out.println("A-double-param-con");  
}  
}  
class Test{  
public static void main(String args[]){  
A a=new A();  
}
```

**OP:**

A-double-param-con  
A-float-param-con  
A-int-param-con  
A-0-arg-con

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**NOTE:** In the above program we have provided more than one constructor with the same name and with the different parameter list, this process is called as "Constructor Overloading".

In the above program, we have called all the current class constructors by using 'this' keyword in chain fashion, this process is called as "Constructor Chaining".

**NOTE:** If we want to access current class constructor by using 'this' keyword then the respective 'this' statement must be provided as first statement, if we have not provided 'this' statement as first statement then compiler will rise an error like 'call to this must be first statement in constructor'.

**EX:**

```
class A{  
A(){  
  
System.out.println("A-0-arg-con");  
this(10);  
}  
A(int i){  
  
System.out.println("A-int-param-con");  
this(22.22f);  
}  
A(float f){  
  
System.out.println("A-float-param-con");  
this(33.3333);  
}  
A(double d){  
System.out.println("A-double-param-con");  
}  
}  
class Test{  
public static void main(String args[]){  
A a=new A();  
}  
}
```

**Status:** Compilation Error

**NOTE:** If we want to refer current class constructor by using 'this' keyword then the respective 'this' statement must be provided in the current class another constructor only, not in normal Java methods. If we violate this condition then compiler will rise an error like 'call to this must be first statement in constructors'.

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**EX:**

```
class A
{
    A()
    {
        System.out.println("A-0-arg-con");
    }
    A(int i)
    {
        System.out.println("A-int-param-con");
    }
    void m1()
    {
        this(10);
        System.out.println("m1-A");
    }
}
class Test
{
    public static void main(String args[])
    {
        A a=new A();
        a.m1();
    }
}
```

**Status:** Compilation Error.

**Q)** Is it possible to refer more than one current class constructors by using 'this' keyword from a single current class constructor?

**Ans:**

No, It is not possible to refer more than one current class constructors by using 'this' keyword, because, in constructors, 'this' statement must be first statement while referring current class constructors. If we provide more than one time this(---) statement then only one this() statement is first statement among multiple this statements,in this case, compiler will rise an error like 'call to this must be first statement'.

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**EX:**

```
class A
{
    A()
    {
        this(10);
        this(22.22f);
        System.out.println("A-0-arg-con");
    }
    A(int i)
    {
        System.out.println("A-int-param-con");
    }
    A(float f)
    {
        System.out.println("A-float-param-con");
    }
}
class Test
{
    public static void main(String args[])
    {
        A a=new A();
    }
}
```

**Status:** Compilation Error.**CONTACT US:****Mobile:** +91- 8885 25 26 27

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**4.To return Current class Object:**

To return current class object by using 'this' keyword thn we have to use the followng syntax.

return this;

**EX:**

```
class A{
A getRef1(){
A a=new A();
return a;
}
A getRef2(){
return this;
}
}
class Test{
public static void main(String args[]){
A a=new A();//[a=abc123]
System.out.println(a);
System.out.println();
System.out.println(a.getRef1());//[abc123.getRef1()]
System.out.println(a.getRef1());//[abc123.getRef1()]
System.out.println(a.getRef1());//[abc123.getRef1()]
System.out.println();
System.out.println(a.getRef2());//[abc123.getRef2()]
System.out.println(a.getRef2());//[abc123.getRef2()]
System.out.println(a.getRef2());//[abc123.getRef2()]
}
}
```

**OP:**

A@5e3a78ad

A@50c8d62f

A@3165d118

A@138297fe

A@5e3a78ad

A@5e3a78ad

A@5e3a78ad

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In the above program, for every call of getRef1() method JVM will encounter "new" keyword,JVM will create new Object for class A every time and JVM will return new object reference value every time.This approach will increase no. of objects in Java application,it will not provide Objects reusability, it will provide object duplication, it is not suggestible in application development.

In the above program,for every call of getRef2() method JVM will encounter "return this" statement,JVM will not create new Object for class A every time,JVM will return the same reference value on which we have called getRef2() method.This approach will increase Objects reusability.

#### 'static' keyword:

'static' is a Java keyword,it will improve sharability in Java applications.

In Java applications, static keyword will be utilized in the following four ways.

- 1.Static variables
- 2.Static methods
- 3.Static blocks
- 4.Static import

#### 1.Static variables:

Static variables are normal Java variables,which will be recognized and executed exactly at the time of loading the respective class bytecode to the memory.

Static variables are normal java variables,they will share their last modified values to the future objects and to the past objects of the respective class.

In Java applications,static variables will be accessed either by using the respective class reference variable or by using the respective class name directly.

**NOTE:**To access static variables we can use the respective class reference variable which may or may not have reference value.To access static variables it is sufficient to take a reference variable with null value.

**NOTE:**If we access any non-static variable by using a reference variable with null value then JVM will rise an exception like "java.lang.NullPointerException". If we access static variable by using a reference variable contains null value then JVM will not rise any exception.

In Java applications,static variables must be declared as class level variables only ,they never be declared as local variables.

In Java applications,static variable vlaues will be stored in method area, not in Stack memory and not in Heap Memory.

In Java applications,to access current class static variables we can use "this" keyword.

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**EX:**

```
class A{
    static int i=10;
    int j=10;
    void m1(){
        //static int k=30;--->error
        System.out.println("m1-A");
        System.out.println(this.i);
    }
}
class Test{
    public static void main(String args[]){
        A a=new A();
        System.out.println(a.i);
        System.out.println(A.i);
        a.m1();
        A a1=null;
        //System.out.println(a1.j);--->NullPointerException
        System.out.println(a1.i);
    }
}
```

**OP:**

```
10
10
m1-A
10
10
```

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**EX:**

```
class A{
    static int i=10;
    int j=10;
}
class Test{
    public static void main(String args[]){
        A a1=new A();
        System.out.println(a1.i+" "+a1.j);
        a1.i=a1.i+1;
        a1.j=a1.j+1;
        System.out.println(a1.i+" "+a1.j);
        A a2=new A();
        System.out.println(a2.i+" "+a2.j);
        a2.i=a2.i+1;
        a2.j=a2.j+1;
        System.out.println(a1.i+" "+a1.j);
        System.out.println(a2.i+" "+a2.j);
        A a3=new A();
        System.out.println(a3.i+" "+a3.j);
        a3.i=a3.i+1;
        a3.j=a3.j+1;
        System.out.println(a1.i+" "+a1.j);
        System.out.println(a2.i+" "+a2.j);
        System.out.println(a3.i+" "+a3.j);
    }
}
```

**OP:**

```
10 10
11 11
11 10
12 11
12 11
12 11
12 10
13 11
13 11
13 11
```

**NOTE:** In Java applications, Instance variable is specific to each and every object that is a separate copy of instance variables will be maintained by each and every object but static variable is common to every object that is the same copy of static variable will be maintained by all the objects of the respective class.

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**Note:** In Java, for a particular, class Byte-Code will be loaded only one time but we can create any no.of objects.

## 2.Static Methods:

Static method is a normal java method,it will be recognized and executed the time when we access that method.

Static methods will be accessed either by using reference variable or by using the respective class name directly.

**Note:** In the case of accessing static methods by using reference variables,reference variable may or may not have object reference value,it is possible to access static methods with the reference variables having 'null' value. If we access non-static method by using a reference variable contains null value then JVM

will rise an exception like "java.lang.NullPointerException".

Static methods will allow only static members of the current class,static methods will not allow non-static members of the current class directly.

**Note:**If we want to access non-static members of the current class in static methods then we have to create an object for the current class and we have to use the generated reference variable.

Static methods are not allowing 'this' keyword in its body but to access current class static methods we are able to use 'this' keyword.

### EX:

```
class A{  
    int i=10;  
    static int j=20;  
    static void m1(){  
        System.out.println("m1-A");  
        System.out.println(j);  
        //System.out.println(i);---->error  
        //System.out.println(this.j);----->error  
        A a=new A();  
        System.out.println(a.i);  
    }  
    void m2(){  
        System.out.println("m2-A");  
        this.m1();  
    }  
}  
class Test{
```

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```
public static void main(String[] args){  
    A a=new A();  
    a.m1();  
    a=null;  
    a.m1();  
    A.m1();  
}  
}
```

**OP:**

```
m1-A  
20  
10  
m1-A  
20  
10  
m1-A  
20  
10
```

Q) Is it possible to print a line of text on command prompt with out using main() method?

**Ans:**

Yes, it is possible to display a line of text on command prompt with out using main() method, but, by using static variable and static method combination.

**EX:**

```
class Test{  
    static int i=m1();  
    static int m1(){  
        System.out.println("Welcome to durga software soultions");  
        System.exit(0); //to terminate the application  
        return 10;  
    }  
}
```

**OP:**

Welcome to durga software soultions

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If we provide 'Test' class name along with 'java' command on command prompt then JVM will take main class from command prompt, JVM will search for its .class file, if it is available then JVM will load main class bytecode to the memory that is Test class bytecode. At the time of loading Test class bytecode to the memory, JVM will recognize and initialize static variable, as part of initialization, JVM will execute static method. By the execution of static method, JVM will display the required message on command prompt, when JVM encounter System.exit(0) statement then JVM will terminate the application.

**NOTE:** The above question and answer are valid upto JAVA6 version, it is invalid from JAVA7 version, because, In JAVA6 version JVM will load main class bytecode to the memory irrespective of main() method availability. In JAVA7, first, JVM will check whether main() method is existed or not in main class, if main() method is available then only JVM will load main class bytecode to the memory, if main() method is not available in main class then JVM will not load main class bytecode to the memory and JVM will provide the following error message.

**Error:** Main Method not found in class Test, please define the main method as:

```
public static void main(String args[])
```

### 3. Static Block:

Static Block is a set of instructions, which will be recognized and executed at the time of loading the respective class bytecode to the memory.

Static blocks are able to allow static members of the current class directly, Static blocks are not allowing non-static members of the current class directly.

**Note:** If we want to access non-static members of the current class in static block then we must create object for the respective class and we have to use the generated reference variable.

Static blocks are not allowing 'this' keyword in its body.

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**EX:**

```
class A{  
    int i=10;  
    static int j=20;  
    static{  
        System.out.println("SB-A");  
        System.out.println(i); //----->Error  
        A a=new A();  
        System.out.println(a.i);  
        System.out.println(j);  
        System.out.println(this.j); ----->Error  
    }  
}  
  
class Test{  
    public static void main(String[] args){  
        A a=new A();  
    }  
}
```

**OP:**

SB-A  
10  
20

Q) Is it Possible to print a line of text on command prompt with out using main() method,static variable and static method?

**Ans:**

Yes,it is possible to display a line of text on command prompt without using main() method,static variable,static method but by using static block.

**EX:**

```
class Test{  
    static{  
        System.out.println("Welcome to DurgaSoftware Soultions");  
        System.exit(0); //To terminate the programme  
    }  
}
```

**OP:**

Welcome to DurgaSoftware Soultions

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If we provide main class name 'Test' along with 'java' command on command prompt then JVM will take main class name i.e Test and JVM will search for its .class file. If Test.class file is identified then JVM will load its bytecode to the memory, at the time of loading main class bytecode to the memory static block will be executed, with this, the required message will be displayed on command prompt. When JVM encounter System.exit(0) then JVM will terminate the program execution.

**NOTE:** The above question and answer are valid upto JAVA6 version, they are invalid from JAVA7 version onwards, because, in JAVA6 version JVM will load main class bytecode to the memory without checking main() method availability but in JAVA7 , first, JVM will search for main() method , if it is available then only JVM will load main class bytecode to the memory, if it is not existed then JVM will provide the following Error message.

**Error:** Main method not found in class Test,please define the main method as:

```
public static void main(String args[])
```

Q) Is it possible to display a line of text on command prompt with out using main() method,static variable,static method,static block?

**Ans:**

Yes,it is possible to display a line of text on command prompt with out using main() method,a static variable,a static method and static block but by using "static Anonymous Inner class of Object class".

**EX:**

```
class Test{  
    static Object obj=new Object(){  
        {  
            System.out.println("Welcome To durga Software Solutions");  
            System.exit(0); //TO termiante the application.  
        }  
    };  
}
```

**OP:**

JAVA6:Welcome to Durga Software Soultions

JAVA7:Error:main method not found in class Test,please define the main method as:

```
public static void main(String[] args)
```

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#### 4.static import:

In Java, applications, if we import a particular package to the present java file then it is possible to access all the classes and interfaces of that package directly without using package name every time as fully qualified name.

If we want to access classes and interfaces of a particular package without importing then we must use fully Qualified name every time that is we have to use package name along with class names.

#### A java program With out import statement:

```
java.io.BufferedReader br=new java.io.BufferedReader(new java.io.InputStreamReader(System.in));
```

#### A java program With import statement:

```
import java.io.*;  
BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
```

In Java applications, if we want to access static members of a particular class in present java file then we must use either reference variable of the respective class or directly class name.

In Java applications, if we want to access static members without using the respective class name and without using the respective class reference variable then we have to import static members of that respective class in the present Java file.

To import static members of a particular class in the present java file, JDK 5.0 version has provided a new feature called as "static import".

#### Syntaxes:

- 1.import static package\_Name.Class\_Name\_Or\_Interface\_Name.\*;  
--> It will import all the static members from the specified class or interface.
- 2.import static package\_Name.Class\_Name\_Or\_Interface\_Name.member\_Name;  
It will import only the specified member from the specified class or interface.

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**EX:**

```
import static java.lang.Thread.*;
import static java.lang.System.out;
class Test{
public static void main(String args[]){
out.println(MIN_PRIORITY);
out.println(MAX_PRIORITY);
out.println(NORM_PRIORITY);
}
}
```

**OP:**

1  
10  
5

**Static Context / Static Flow of Execution:**

In Java, Static Context will be represented in the form of the following three elements.

1. Static variables.
2. Static methods.
3. Static blocks

In Java applications, instance context will be created separately for each and every object but static context will be created for each and every class.

In Java applications, static context will be recognized and executed exactly at the time of loading the respective class bytecode to the memory.

In Java applications, when we create object for a particular class, first, JVM has to access constructor, before executing constructor, JVM has to load the respective class bytecode to the memory. At the time of loading class bytecode to the memory, JVM has to recognize and execute static context.

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**EX:**

```
class A{
    static {
        System.out.println("SB-A");
    }
    static int i=m1();
    static int m1(){
        System.out.println("m1-A");
        return 10;
    }
}
class Test{
    public static void main(String args[]){
        A a=new A();
    }
}
```

**OP:**

SB-A  
m1-A

**EX:**

```
class A{
    static int i=m2();
    static int m1(){
        System.out.println("m1-A");
        return 10;
    }
    static{
        System.out.println("SB-A");
    }
    static int m2(){
        System.out.println("m2-A");
        return 20;
    }
    static int j=m1();
}
class Test{
    public static void main(String args[]){
        A a1=new A();
        A a2=new A();
    }
}
```

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**OP:**

m2-A  
SB-A  
m1-A

**EX:**

```
class A{
    static int i=m2();
    A(){
        System.out.println("A-con");
    }
    int m1(){
        System.out.println("m1-A");
        return 10;
    }
    static{
        System.out.println("SB-A");
    }
    int j=m1();
    System.out.println("IB-A");
}
static int m2(){
    System.out.println("m2-A");
    return 10;
}
}
class Test{
    public static void main(String args[]){
        A a1=new A();
        A a2=new A();
    }
}
```

**OP:**

m2-A  
SB-A  
m1-A  
IB-A  
A-con  
m1-A  
IB-A  
A-con

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**Factory Method:**

Factory Method is a method, it can be used to return the same class Object where we have declared that method.

Factory Method is an idea provided by a design pattern called as "Factory Method Design Pattern".

**NOTE:** Design pattern is a System, it will provide problem definition and its solution in order to solve design problems.

**EX:**

```
class A{
    private A(){
        System.out.println("A-con");
    }
    void m1(){
        System.out.println("m1-A");
    }
    static A getRef()//Factory Method
    {
        A a=new A();
        return a;
    }
}
class Test{
    public static void main(String args[]){
        A a=A.getRef();
        a.m1();
    }
}
```

**OP:**

A-con  
m1-A

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## There are two types of Factory Methods

- 1.Static Factory Method
- 2.Instance Factory Method

### Static Factory Method:

Static Factory Method is a static method returns the same class object.

#### EX:

```
Class c=Class.forName("--);  
NumberFormat nf=NumberFormat.getInstance(-);  
DateFormat df=DateForamt.getInstance(--);  
ResourceBundle rb=ResourceBundle.getBundle(--);
```

### Instance Factory Method:

If any non-static method returns the same class object then that method is called as "Instance Factory Method".

#### EX: Allmost all the String class methods are Instance Factory methods.

```
String str=new String("DurgaSoftware Solutions");  
String str1=str.concat(" Hyderabad");  
String str2=str.trim();  
String str3=str.toUpperCase();  
String str4=str.substring(5,14);
```

### Singleton Class:

If any JAVA class allows to create only one Object then that class is called as "Singleton Class".  
Singleton Class is an idea provided by a design pattern called as "Singleton Design Pattern".

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```
EX1: class A{
    static A a=null;
    private A(){
    }
    static A getRef(){
        if(a==null){
            a=new A();
        }
        return a;
    }
}
class Test{
    public static void main(String args[]){
        System.out.println(A.getRef());
        System.out.println(A.getRef());
        System.out.println(A.getRef());
    }
}
```

**OP:** A@a6eb38a  
A@a6eb38a  
A@a6eb38a

#### Another Alternative for Singleton Class:

```
class A{
    static A a=null;
    static{
        a=new A();
    }
    private A(){
    }
    static A getRef(){
        return a;
    }
}
class Test{
    public static void main(String args[]){
        System.out.println(A.getRef());
        System.out.println(A.getRef());
        System.out.println(A.getRef());
    }
}
```

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**OP:**

A@a6eb38a  
A@a6eb38a  
A@a6eb38a

**Alternative Logic for Singleton Class:**

```
class A{  
    static A a=new A();  
    private A(){  
    }  
    static A getRef(){  
        return a;  
    }  
}  
class Test{  
    public static void main(String args[]){  
        System.out.println(A.getRef());  
        System.out.println(A.getRef());  
        System.out.println(A.getRef());  
    }  
}
```

**OP:**

A@69cd2e5f  
A@69cd2e5f  
A@69cd2e5f

MVC is a design pattern, it will provide a standard structure to prepare web applications/GUI applications, where in MVC based applications we must use a servlet/ filter[ A Java class] as controller, a set of JSP pages/Html pages as view part and a java bean or EJB component or JDBC program or Hibernate program as Model component. As per MVC Arch rules and regulations, only one controller must be provided for application, that is, the class which we used as controller must provide one object, therefore, controller class must be singleton class.

---- Diagram: mvc.png-----

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**EX1:** Struts is MVC based Framework, where "ActionServlet" is controller, so it is Singleton class.  
**EX2:** JSF[Java Server Faces] is MVC based framework, where "FacesServlet" is controller, so it is Singleton class.

---

---

Class.forName(--)

Consider the following program

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
    A()
    {
        System.out.println("Object Creating");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        A a=new A();
    }
}
```

When we access a constructor along with "new" keyword then JVM will perform the following actions automatically.

- 1.JVM will load the respective class bytecode to the memory.
- 2.JVM will create object for the loaded class.

As per the requirement, if we want to load class byte code to the memory without creating object then we have to use the following method from java.lang.Class class.

```
public static Class.forName(String class_Name) throws ClassNotFoundException
```

**EX:** Class c=Class.forName("A");

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When JVM encounter the above instruction, JVM will perform the following actions.

- 1.JVM will take class name from `forName()` method.
- 2.JVM will serach for its .class file at current location, at java predefined library and at the locations refered by "classpath" environment variable.
- 3.If the required .class file is not available at all the above locations then JVM will rise an exception like "java.lang.ClassNotFoundException".
- 4.If the required .class file is available at either of the above locations then JVM will load its bytecode to the memory.
- 5.After loading class bytecode to the memory, JVM will take metadata of the loaded class like class name, super class details, implemented interfaces details, variables details, methods details,... and JVM will store them by creating `java.lang.Class` object in heap memory and JVM will return the generated Class object reference value from `Class.forName()`;

**EX:**

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
    A()
    {
        System.out.println("Object Creating");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        Class c=Class.forName("A");
    }
}
```

**OP:**

Class Loading

After loading class bytecode by using `Class.forName()` method, if we want to create object explicitly then we have to use the following method.

`public Object newInstance() throws InstantiationException, IllegalAccessException`

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**EX:** Object obj=c.newInstance();

When JVM encounter the above instruction, JVM will perform the following actions.

- 1.JVM will goto the loaded class bytecode and JVM will check whether 0-arg and non-private constructor is existed or not.
- 2.If 0-arg and non-private constructor is existed then JVM will execute that constructor and JVM will create object for the loaded class.
- 3.If the constructor parameterized constructor with out 0-arg constructor then JVM will rise an exception like "java.lang.InstantiationException".
- 4.If the constructor is private constructor then JVM will rise an exception like "java.lang.IllegalAccessException".

**Note:**If the constructor is both parameterized and 0-arg then JVM will rise "java.lang.InstantiationException" only.

**EX:**

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
    A()
    {
        System.out.println("Object Creating");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        Class c=Class.forName("A");
        Object obj=c.newInstance();
    }
}
```

**OP:**

Class Loading  
Object Creating

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In JDBC Appl, we are going to use Driver to map JAVA representations to Database representations and Database representations to Java representations. In Jdbc applications, we must load driver class, not to create object for Driver class, for this, we have to use "Class.forName(-)"

In general, all server side components like Servlets, JSPs, EJBs,... are executed by the server[Container] by following their lifecycle actions like loading, instantiation, initialization,..... In this context, to perform server side components loading Container will use "Class.forName(-)" method and to perform instantiation lifecycle action container will use "newInstance()" method internally.

### Final Keyword:

final is a Java Keyword it can be used to declare constant expressions.  
In java applications, 'final' keyword is able to improve security.

In Java applications, there are three ways to utilize 'final' keyword.

- 1.final variable
- 2.final method
- 3.final class

#### 1.final variable:

final variable is a variable,it will not allow modifications on its value.

#### EX:

```
final int i=10;  
i=i+10;----> Compilation Error
```

#### EX:

```
for(final int i=0;i<10;i++) ----> Compilation Error  
{  
    System.out.println(i);  
}
```

**NOTE:**In general, in bank applications, after creating an account it is possible to change the account details like account name, address details....but it is not possible to update 'accNo' value once it is created. Due to this reason, we have to declare 'accNo' variable as 'final' variable.

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**2.final method:**

final method is a Java method, it will not allow method overriding.

In method overriding, we have to provide same method with different implementation at both super class and at sub class, where super class method never be declared as final irrespective of sub class method final.

**EX1:**

```
class A{
    final void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String[] args){
        A a = new B();
        a.m1();
    }
}
```

**Status:** Compilation Error.

```
EX2: class A{
    final void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    final void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String[] args){
        A a = new B();
        a.m1();
    }
}
```

**Status:** Compilation Error.

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**EX3:**

```
class A{
    void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    final void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String[] args){
        A a = new B();
        a.m1();
    }
}
```

**Status:** No Compilation Error.

**3.final class:**

Final class is a Java class, it will not allow inheritance.

In Java applications, super classes never be declared as final classes, but sub classes may be final.

**EX:**

```
final class A
{
}
class B extends A
{
}
```

**Status:** Invalid

**EX:**

```
final class A
{
}
final class B extends A
{
}
```

**Status:** Invalid

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**EX:**

```
class A
{
}
final class B extends A
{
}
```

**Status:**Valid

In Java applications to declare constant variables Java has provided a convention like to declare constants with "public static final".

**EX:**

In System Class:

```
public static final PrintStream out;
public static final InputStream in;
public static final PrintStream err;
```

In Thread Class:

```
public static final int MIN_PRIORITY=1;
public static final int NORM_PRIORITY=5;
public static final int MAX_PRIORITY=10;
```

**EX:**

```
class User_Status{
public static final String AVAILABLE="Available";
public static final String BUSY="Busy";
public static final String IDLE="Idle";
}
class Test{
public static void main(String args[]){
System.out.println(User_Status.AVAILABLE);
System.out.println(User_Status.BUSY);
System.out.println(User_Status.IDLE);
}
}
```

**OP:**

Available  
Busy  
Idle

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To declare constant variables in Java applications if we use the above convention then we are able to get the following problems.

1. We must declare "public static final" for each and every constant variable explicitly.
2. It is possible to allow multiple data types to represent one type, it will reduce typedness in Java applications.
3. If we access constant variables then these variables will display their values, here constant variable values may or may not reflect the actual meaning of constant variables.

To overcome all the problems, we have to go for "enum".

In case of enum,

1. All the constant variables are by default "public static final", no need to declare explicitly.
2. All the constant variables are by default the same enum type, it will improve Typedness in Java applications.
3. All the constant variables are by default "Named Constants" that is, these constant variables are displaying their names instead of their values.

#### Syntax:

```
[Access_modifier] enum Enum_Name
{
    ----- List of constants-----
}
```

#### EX:

```
enum User_Status{
    AVAILABLE,BUSY,IDLE;
}
class Test{
    public static void main(String args[]){
        System.out.println(User_Status.AVAILABLE);
        System.out.println(User_Status.BUSY);
        System.out.println(User_Status.IDLE);
    }
}
```

#### OP:

Available  
Busy  
Idle

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**NOTE:**The default super class for every enum is "java.lang.Enum" class and "Object" class is Super class to "Enum" class.

If we compile the above Java file then Compiler will translate "User\_Status" enum into "User\_Status" final class like below.

```
final class User_Status extends java.lang.Enum{
    public static final MailStatus AVAILABLE;
    public static final MailStatus BUSY;
    public static final MailStatus IDLE;
    -----
}
```

**NOTE:** In Java, java.lang.Object class is common and default super class for all the classes.

Similarly,All the Java enums are having a common and default super class that is "java.lang.Enum".

**NOTE:** In Java applications,it is possible to implement inheritance between two classes but it is not possible to implement inheritance between two "enums", because, bydefault, enums are final classes.

In Java applications,we can utilize enum like as classes,where we can provide normal variables,methods,constructors....

**EX**

```
enum Apple{
    A(500),B(250),C(100);
    int price;
    Apple(int price){
        this.price=price;
    }
    public int getPrice(){
        return price;
    }
}
class Test{
    public static void main(String args[]){
        System.out.println("A-Grade Apple :"+Apple.A.getPrice());
        System.out.println("B-Grade Apple :"+Apple.B.getPrice());
        System.out.println("C-Grade Apple :"+Apple.C.getPrice());
    }
}
```

**OP:** A-Grade Apple :500  
B-Grade Apple :250  
C-Grade Apple :100

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If we compile the above programme,then compiler will translate enum into the following class:

```
final class Apple extends Enum{
    public static final Apple A=new Apple(500);
    public static final Apple B=new Apple(250);
    public static final Apple C=new Apple(100);
    int price;
    Apple(int price){
        this.price=price;
    }
    public int getPrice(){
        return price;
    }
    ----
}
```

**EX:** enum Book{  
A(500,250),B(300,150),C(200,100);  
int no\_of\_pages;  
int cost;  
Book(int no\_of\_pages,int cost){  
this.no\_of\_pages=no\_of\_pages;  
this.cost=cost;  
}  
public void getBookDetails(){  
System.out.println(no\_of\_pages+"----->"+cost);  
}  
}  
class Test{  
public static void main(String args[]){  
System.out.println("Durga Books Store");  
System.out.println("-----");  
System.out.println("No of Pages Cost");  
System.out.println("-----");  
Book.A.getBookDetails();  
Book.B.getBookDetails();  
Book.C.getBookDetails();  
}  
}

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**OP:**

Durga Books Store

---

No of Pages Cost

---

500----->250
300----->150
200----->100

If we compile the above program, then compiler will translate the enum  
Into the following class

**Translated Code for the above enum(Book):**

```
final class Book extends Enum{  
    public static final Book A=new Book(500,250);  
    public static final Book B=new Book(300,150);  
    public static final Book C=new Book(200,100);  
    int cost;  
    int no_of_pages;  
    Book(int no_of_pages,int cost){  
        this.no_of_pages=no_of_pages;  
        this.cost=cost;  
    }  
    public void getBookDetails(){  
        System.out.println(no_of_pages+"----->"+cost);  
    }  
}
```

**Importance of main() method in Java:**

The main intention of main() method in Java applications is,

1. To define application logic in Java program.
2. To define starting point and ending point for the applications execution.

**Syntax:**

```
public static void main(String args[])  
{  
    ----application logic---  
}
```

**Note:** Main() method is not predefined method and it is not user defined method, it is a conventional method with fixed prototype and with user defined implementation.

In Java, JVM is implemented in such a way to access main() method automatically in order to execute application logic.

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Q)What is the requirement to declare main() method as public?

**Ans:**

In Java applications,JVM has to access main() method inorder to start application execution. To access main() method by JVM first main() scope must be available to JVM.In this context,to bring main() method scope to JVM,we must declare main() method as "public".

**Case-1:**

If main() method is declared as "private" then main() method will be available upto the main class only ,not to JVM.

**Case-2:**

If main() method is declared as "<default>" then main() method will be available upto the package where main class is existed, not to the JVM.

**Case-3:**

If main() method is declared as "protected" then main() method will be available upto the package where main class is existed and upto child classes available in other packages but not to the JVM.

**Case-4:**

To make available main() method to JVM,only one possibility we have to take that is "public", where public members are available through out our system, so that, JVM can access main() method to start application execution.

**NOTE:**In Java applications,if we declare main() method with out "public" then compiler will not rise any error but JVM will provide the following.

JAVA6:Main Method not public.

JAVA7:Error:Main method not found in class Test,please define main method as:

```
public static void main(String args[])
```

Q)What is the requirement to declare main() method as "static"?

**Ans:**

In Java applications,to start application execution JVM has to access main() method.JVM was implemented in such a way that to access main() method by using the respective main class directly.

In Java applications, only static methods are eligible to access by using their respective class name,so that,as per the JVM predefined implementation we must declare main() method as static.

**NOTE:**In Java applications,if we declare main() method without "static" then compiler will not rise any error but JVM will provide the following.

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**JAVA6:** Java.lang.NoSuchMethodError:main

**JAVA7:** Error:Main method is not static in class Test,please define main method as:

```
public static void main(String[] args)
```

Q)What is the requirement to provide "void" as return type to main() method?

**Ans:**

In Java applications,as per Java conventions,JVM will start application execution at the starting point of main method and JVM will terminate application execution at the ending point of main() method.Due to this convention,we must start application logic at the starting point of main() method and we must terminate application logic at the ending point of main() method.To follow this Java convention we must not return any value from main() method, for this,we must provide "void" as return type.

**NOTE:**In Java applications,if we declare main() method with out void return type then compiler will not rise any error but JVM will provide the following

**JAVA6:** java.lang.NoSuchMethodError:main

**JAVA7:** Error:Main method must return a value of type void in class  
main method as:

```
public static void main(String[] args)
```

Test,please define the

**NOTE:**The name of this method "main" is to show the importance of this method.

### Main method parameters:

Q)What is the requirement to provide parameter to main() method?

**Ans:**

In Java applications,there are three ways to provide input to the Java programs.

- 1.Static Input
- 2.Dynamic Input
- 3.Command Line Input

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### 1.Static Input:

Providing input to the Java program at the time of writing Java program.

#### EX:

```
class Test
{
    int i=10;
    int j=20;
    void add()
    {
        System.out.println(i+j);
    }
}
```

### 2.Dynamic Input:

Providing Input to the Java program at runtime.

```
D:\Java7>javac Add.java
D:\java7>java Add
First value :10
Second value :20
Addition :30
```

### 3.Command Line Input:

Providing input to the Java program along with "java" command on command prompt.

#### EX:

```
D:\java7>javac Add.java
D:\java7>java Add 10 20
Addition :30
```

If we provide command line input like above in Java applications then JVM will perform the following actions.

- a)JVM will read all the command line input at the time of reading main class name from command prompt.
- b)JVM will store all the command line inputs in the form of String[]
- c)JVM will pass the generated String[] as parameter to main() method at the time of calling main() method.

Due to the above JVM actions,the main method is required parameters inorder to store all the command line inputs in the form String[] array.

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Q)What is the requirement to provide only String data type as parameter to the main() method?

**Ans:**

In general,from application to application or from developer to developer the types of command line input may be varied,here even developers are providing different types of command line input,still, our main() method must store all the command line input. In Java, only String data types is able to represent any type of data so that String data types is required as parameter to main() method.

To allow different types of command line input, main() method must require String dataType.

Q)What is the requirement to provide an array as parameter to main() method?

**Ans:**

In general,from application to application and from developer to developer no.of command line inputs may be varied,here even developers are providing variable no.of command line inputs our main() method parameter must store them.In Java,to store more than one value we have to take array.Due to this reason,main() method must require array type as parameter. main() method will take array type as parameter is to allow multiple no.of command line input.

**EX:**

```
class Test{  
    public static void main(String args[]){  
        for(int i=0;i<args.length;i++){  
            System.out.println(args[i]);  
        }  
    }  
}
```

**OP:**

```
D:\java7>javac Test.java  
D:\java7>java Test 10 "abc" 22.22f 34.345 'A' true  
10  
"abc"  
22.22f  
34.345  
'A'  
true
```

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**EX:**

```
class Test
{
    public static void main(String[] args) throws Exception
    {
        String val1=args[0];
        String val2=args[1];
        int fval=Integer.parseInt(val1);
        int sval=Integer.parseInt(val2);
        System.out.println("ADD :" +(fval+sval));
        System.out.println("SUB :" +(fval-sval));
        System.out.println("MUL :" +(fval*sval));
    }
}
```

**OP:**

```
D:\javaapps>javac Test.java
D:\javaapps>java Test 10 5
ADD :15
SUB :5
MUL :50
```

**NOTE:** If we declare main() method without String[] parameter then compiler will not rise any error but JVM will provide the following.

JAVA6:java.lang.NoSuchMethodError:main

JAVA7:Error:Main Method not found in class Test,please define main method as:

```
public static void main(String args[])
```

Q)Find the valid syntaxes of main() method from the following list?

1. public static void main(String[] args)--> Valid
2. public static void main(String[] abc)--> valid
3. public static void main(String args)---> Invalid
4. public static void main(String[][] args)-->Invalid
5. public static void main(String args[])--> Valid
6. public static void main(String []args)--> Valid
7. public static void main(string[] args)---> Invalid
8. public static void Main(String[] args)--> Invalid
9. public static int main(String[] args)---> Invalid
10. public final void main(String[] args)---> Invalid
11. public void main(String[] args)-----> Invalid
12. static void main(String[] args)-----> Invalid
13. static public void main(String[] args)--> Valid
14. public static void main(String ... args)-> Valid

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Q) Is it possible to provide more than one main() method with in a single java application?

**Ans:**

Yes,it is possible to provide more than one main() method with in a single java application,but,we have to provide more than one main() method in different classes,not in a single class.

**EX:** File Name : D:\java7\abc.java

```
class A{
public static void main(String args[]){
System.out.println("main()-A");
}
}
class B{
public static void main(String args[]){
System.out.println("main()-B");
}
}
```

**OP:**

```
D:\java7>javac abc.java
D:\java7>java A
main()-A
D:\java7>java B
main()-B
```

**NOTE:**If we compile the above abc.java file then compiler will generate two .class files[A.class,B.class].To execute the above program,we have to give a class name along with "java" command,here which class name we are providing along with "java" command that class main() method will be executed by JVM.

**NOTE:**In the above program,it is possible to access one main() method from another main() method by passing String[] as parameter and by using the respective class name as main() method is static method.

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**EX:** File name : D:\java7\abc.java

```
class A{
    public static void main(String args[]){
        System.out.println("main()-A");
        String[] str={"AAA","BBB","CCC"};
        B.main(str);
        B.main(args);
    }
}
class B{
    public static void main(String args[]){
        System.out.println("main()-B");
    }
}
```

**OP:**

```
D:\java7>javac abc.java
D:\java7>java A
main()-A
main()-B
main()-B
```

Q) Is it possible to overload main() method?

**Ans:**

Yes, In Java, it is possible to overload main() method but it is not possible to override main() method, because, in Java applications static method overloading is possible but static method overriding is not possible.

**EX:** class Test

```
{
    public static void main(String[] args)
    {
        System.out.println("String[]-param-main()");
    }
    public static void main(int[] args)
    {
        System.out.println("int[]-param-main()");
    }
    public static void main(float[] args)
    {
        System.out.println("float[]-param-main()");
    }
}
```

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**OP:**

String[]-param-main

\*\*\*\*\* Completed Upto This \*\*\*\*\*

**Relationships in JAVA:**

As part of Java application development, we have to use entities as per the application requirements.

In Java application development, if we want to provide optimizations over memory utilization, code Reusability, Execution Time, Sharability then we have to define relationships between entities.

There are three types of relationships between entities.

1. Has-A relationship
2. IS-A relationship
3. USE-A relationship

Q) What is the difference between HAS-A Relationship and IS-A relationship?

**Ans:**

Has-A relationship will define associations between entities in Java applications, here associations between entities will improve communication between entities and data navigation between entities.

IS-A Relationship is able to define inheritance between entity classes, it will improve "Code Reusability" in java applications.

**Associations in JAVA:**

There are four types of associations between entities

1. One-To-One Association
2. One-To-Many Association
3. Many-To-One Association
4. Many-To-Many Association

To achieve associations between entities, we have to declare either single reference or array of reference variables of an entity class in another entity class.

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**EX:**

```
class Address{  
----  
}  
class Student{  
----  
Address[] addr;-->It will establish One-To-Many Association  
}
```

**1. One-To-One Association:**

It is a relation between entities, where one instance of an entity should be mapped with exactly one instance of another entity.

**EX:** Every employee should have exactly one Account.

**EX:**

```
class Account{  
String accNo;  
String accName;  
String accType;  
Account(String accNo,String accName,String accType){  
this.accNo=accNo;  
this.accName=accName;  
this.accType=accType;  
}  
}  
class Employee{  
String eid;  
String ename;  
String eaddr;  
Account acc;  
Employee(String eid,String ename,String eaddr,Account acc){  
this.eid=eid;  
this.ename=ename;  
this.eaddr=eaddr;  
this.acc=acc;  
}  
public void getEmployee(){  
System.out.println("Employee Details");  
System.out.println("-----");  
System.out.println("Employee Id : "+eid);  
System.out.println("Employee Name : "+ename);  
System.out.println("Employee Address : "+eaddr);  
System.out.println();
```

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```
System.out.println("Account Details");
System.out.println("-----");
System.out.println("Account Number :"+acc.accNo);
System.out.println("Account Name :"+acc.accName);
System.out.println("Account Type :"+acc.accType);
}}
class OneToOneEx{
public static void main(String args[]){
Account acc=new Account("abc123","Durga N","Savings");
Employee emp=new Employee("E-111","Durga","Hyd",acc);
emp.getEmployee();
}
}
```

**OP:**

Employee Details

-----  
Employee Id :E-111  
Employee Name:Durga  
Employee Address:Hyd

Account Details

-----  
Account Number :abc123  
Account Name :Durga N  
Account Type :Savings

#### Data Flow Diagram on One-To-One:

##### 2. One-To-Many Association:

It is a relationship between entity classes, where one instance of an entity should be mapped with multiple instances of another entity.

**EX:** Single department has multiple employees.

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**EX:**

```
class Employee{  
    String eid;  
    String ename;  
    String eaddr;  
    Employee(String eid,String ename,String eaddr){  
        this.eid=eid;  
        this.ename=ename;  
        this.eaddr=eaddr;  
    }  
}  
class Department{  
    String did;  
    String dname;  
    Employee[] emps;  
    Department(String did,String dname,Employee[] emps){  
        this.did=did;  
        this.dname=dname;  
        this.emps=emps;  
    }  
    public void getDepartmentDetails(){  
        System.out.println("Department Details");  
        System.out.println("-----");  
        System.out.println("Department Id :" + did);  
        System.out.println("Department Name:" + dname);  
        System.out.println();  
        System.out.println("EID ENAME EADDR");  
        System.out.println("-----");  
        for(int i=0;i<emps.length;i++){  
            Employee e=emps[i];  
            System.out.println(e.eid+" "+e.ename+" "+e.eaddr);  
        }  
    }  
}  
class OneToManyEx{  
    public static void main(String args[]){  
        Employee e1=new Employee("E-111","AAA","Hyd");  
        Employee e2=new Employee("E-222","BBB","Hyd");  
        Employee e3=new Employee("E-333","CCC","Hyd");  
        Employee[] emps=new Employee[3];  
        emps[0]=e1;  
        emps[1]=e2;  
        emps[2]=e3;
```

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```
Department dept=new Department("D-111","Admin",emps);
dept.getDepartmentDetails();
}
}
```

**OP:**

Department Details

---

Department Id :D-111  
Department Name:Admin  
EID ENAME EADDR

---

E-111	AAA	Hyd
E-222	BBB	Hyd
E-333	CCC	Hyd

**Many-To-One Association:**

It is a relationship between entities, where multiple instances of an entity should be mapped with exactly one instance of another entity.

**EX:** Multiple Student have joined with a single branch.

**EX:**

```
class Branch{
String bid;
String bname;
Branch(String bid,String bname){
this.bid=bid;
this.bname=bname;
}
}
class Student{
String sid;
String sname;
String saddr;
Branch branch;
Student(String sid,String sname,String saddr,Branch branch){
this.sid=sid;
this.sname=sname;
this.saddr=saddr;
this.branch=branch;
}
public void getStudentDetails(){
System.out.println("Student Details");
}
```

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```
System.out.println("-----");
System.out.println("Student Id :"+sid);
System.out.println("Student name :" +sname);
System.out.println("Student Address:" +saddr);
System.out.println("Branch Id :" +branch.bid);
System.out.println("Branch Name :" +branch.bname);
System.out.println();
}
}
class ManyToOneEx{
public static void main(String args[]){
Branch branch=new Branch("B-111","CS");
Student std1=new Student("S-111","AAA","Hyd",branch);
Student std2=new Student("S-222","BBB","Hyd",branch);
Student std3=new Student("S-333","CCC","Hyd",branch);
std1.getStudentDetails();
std2.getStudentDetails();
std3.getStudentDetails();
}
}
```

**OP:**

Student Details

-----  
Student Id :S-111  
Student name:AAA  
Student Address:Hyd  
Branch Id :B-111  
Branch Name:CS

Student Details

-----  
Student Id :S-222  
Student name:BBB  
Student Address:Hyd  
Branch Id :B-111  
Branch Name:CS

Student Details

-----  
Student Id :S-333  
Student name:CCC  
Student Address:Hyd  
Branch Id :B-111  
Branch Name:CS

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#### 4.Many-To-Many Associations:

It is a relationship between entities, Where multiple instances of an entity should be mapped with multiple instances of another entity.

**EX:** Multiple Students Have Joined with Multiple Courses.

```
EX: class Course{
    String cid;
    String cname;
    int ccost;
    Course(String cid,String cname,int ccost){
        this.cid=cid;
        this.cname=cname;
        this.ccost=ccost;
    }
    class Student{
        String sid;
        String sname;
        String saddr;
        Course[] crs;
        Student(String sid,String sname,String saddr,Course[] crs){
            this.sid=sid;
            this.sname=sname;
            this.saddr=saddr;
            this.crs=crs;
        }
        public void getStudentDetails(){
            System.out.println("Student Details");
            System.out.println("-----");
            System.out.println("Student Id :"+sid);
            System.out.println("Student name :" +sname);
            System.out.println("Student Address:" +saddr);
            System.out.println("CID CNAME CCOST");
            System.out.println("-----");
            for(int i=0;i<crs.length;i++){
                Course c=crs[i];
                System.out.println(c.cid+" "+c.cname+" "+c.ccost);
            }
            System.out.println();
        }
    }
    class ManyToManyEx{
        public static void main(String[] args){
            Course c1=new Course("C-111","C",500);
```

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```
Course c2=new Course("C-222","C++",1000);
Course c3=new Course("C-333","JAVA",5000);
Course[] crs=new Course[3];
crs[0]=c1;
crs[1]=c2;
crs[2]=c3;
Student std1=new Student("S-111","AAA","Hyd",crs);
Student std2=new Student("S-222","BBB","Hyd",crs);
Student std3=new Student("S-333","CCC","Hyd",crs);
std1.getStudentDetails();
std2.getStudentDetails();
std3.getStudentDetails();
}}
```

**OP:**

Student Details

-----  
Student Id :S-111  
Student name :AAA  
Student Address:Hyd  
CID CNAME CCOST

-----  
C-111 C 500  
C-222 C++ 1000  
C-333 JAVA 5000

Student Details

-----  
Student Id :S-222  
Student name:BBB  
Student Address:Hyd  
CID CNAME CCOST

-----  
C-111 C 500  
C-222 C++ 1000  
C-333 JAVA 5000

Student Details

-----  
Student Id :S-333  
Student name:CCC  
Student Address:Hyd  
CID CNAME CCOST

-----  
C-111 C 500  
C-222 C++ 1000  
C-333 JAVA 5000

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In java applications, Associations are existed in the following two forms.

1. Aggregation
2. Composition

Q) What is the difference between Aggregation and Composition?

**Ans:**

1. Where Aggregation is representing weak association that is less dependency but composition is representing strong association that is more dependency.
2. In case of Aggregation, if contained object is existed even without container object.
- In case of Composition ,if contained object is not existed without container object.
3. In the case of Aggregation,the life of the contained Object is independent of the container Object life.

In the case of composition,the life of contained objects is depending on the container object life that is same as container object life.

**EX:**

If we take an association between "Library" and "Students","Library" and "Books". "Students" can exist without "Library",so that,the association between "Library" and "Student" is Aggregation."Books" can not exist without "Library",so that,the association between "Library" and "Books" is composition

**IS-A Relationship:**

It is a relationship between entity classes,it will provide inheritance between entity classes,where inheritance relationship will improve "code reusability" in Java application.

The process of getting variables and methods from one class to another class is called as Inheritance.

At the basic level of Object Orientation,There are two types of inheritances.

1. Single Inheritance
2. Multiple Inheritance

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**1.Single Inheritance:**

The process of getting variables and methods from only one super class to one or more no.of subclasses is called as Single Inheritance.

Java is able to allow Single Inheritance.

**2.Multiple Inheritance:**

The process of getting variables and methods from more than one super class to one or more no.of sub classes is called as Multiple Inheritance.

Java is not allowing Multiple Inheritance.

On the basis of Single and Multiple inheritances ,there are 3 more Inheritances.

1. Multi-Level Inheritance
2. Hierarchical Inheritance
3. Hybrid Inheritance

**1. Multi-Level Inheritance :**

It is a Combination of single inheritance in more than one level. Java is able to allow multi-level inheritance.

**EX:**

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

**2. Hierarchical Inheritance :**

It is the combination of single inheritance in a particular structure.Java is able to allow Hierarchical inheritance.

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**EX:**

```
class A{  
}  
class B extends A{  
}  
class C extends A{  
}  
class D extends B{  
}  
class E extends B{  
}  
class F extends C{  
}  
class G extends C{  
}
```

**3.Hybrid Inheritance:**

It is the combination of single inheritance and multiple inheritances.

Java is not allowing Hybrid Inheritance.

**EX:**

```
class A{  
}  
class B extends A{  
}  
class C extends A{  
}  
class D extends B,C{  
}
```

**EX:**

```
class Employee {  
    String eid;  
    String ename;  
    String eaddr;  
    public void getEmpDetails() {  
        System.out.println("Employee Id :" + eid);  
        System.out.println("Employee name :" + ename);  
        System.out.println("Employee Address :" + eaddr);  
    }  
}  
class Manager extends Employee {
```

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```
Manager(String eid1,String ename1,String eaddr1) {  
    eid=eid1;  
    ename=ename1;  
    ename=eaddr1;  
}  
public void getManagerDetails() {  
    System.out.println("manager Details");  
    System.out.println("-----");  
    getEmpDetails();  
}  
}  
  
class Accountant extends Employee {  
    Accountant (String eid1,String ename1,String eaddr1) {  
        eid=eid1;  
        ename=ename1;  
        eaddr=eaddr1;  
    }  
    public void getAccountantDetails() {  
        System.out.println("Accountant Details");  
        System.out.println("-----");  
        getEmpDetails(); } } class InheritanceEx { public static  
void main(String[] args){  
    Manager m=new Manager("E-111","AAA","Hyd");  
    m.get ManagerDetails();  
    System.out.println();  
    Accountant acc=new Accountant("E-222","BBB","Hyd"); acc.getAccountantDetails();  
}
```

On Command Prompt:

```
=====  
D:\java7>javac InheritanceEx.java  
D:\java7>java Inheritance Ex
```

Manager Details:

```
=====  
Employee Id :E-111  
Employee Name :AAA  
Employee Address :Hyd  
Accountant Details:  
=====  
Employee Id :E-222  
Employee Name :BBB  
Employee Address :Hyd
```

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**Static Context in Inheritance:**

In the case of inheritance, if we create an object for sub class then JVM has to execute sub class constructor, before executing sub class constructor, JVM has to check whether sub class bytecode is loaded already in the memory or not, if not, JVM has to load subclass bytecode to the memory.

In the above context, before loading sub class bytecode to the memory, first, JVM has to load the respective super class bytecode to the memory.

Therefore, in the case of inheritance, JVM will load all the classes bytecode right from super class to sub class order.

If we provide static context in both super class and subclass then JVM will recognize and execute static context of the respective classes at the time of loading the respective classes, that is from super class to sub class ordering.

**EX:**

```
class A{  
    static{  
        System.out.println("SB-A");  
    }  
}  
  
class B extends A{  
    static{  
        System.out.println("B-con");  
    }  
}  
  
class C extends B{  
    static{  
        System.out.println("SB-C");  
    }  
}  
  
class Test{  
    public static void main(String[] args){  
        C c=new C();  
    }  
}
```

**OP:**

SB-A  
B-con  
SB-C

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**EX:**

```
class A{
    static{
        System.out.println("SB-A");
    }
    static int m1(){
        System.out.println("m1-A");
        return 10;
    }
    static int i=m1();
}
class B extends A{
    static int j=m2();
    static{
        System.out.println("SB-B");
    }
    static int m2(){
        System.out.println("m2-B");
        return 20;
    }
}
class C extends B{
    static int m3(){
        System.out.println("m3-C");
        return 30;
    }
    static int k=m3();
    static{
        System.out.println("SB-C");
    }
}
class Test{
    public static void main(String[] args){
        C c1=new C();
        C c2=new C();
    }
}
```

**OP:**

SB-A  
m1-A  
m2-B  
SB-B  
m3-C  
SB-C

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**Instance Context in Inheritance:**

In the case of Inheritance, if we create object for sub class then JVM has to execute sub class constructor, but before executing sub class constructor JVM has to execute 0-argument constructor in the respective super class. If we provided instance context in both super class and sub class then JVM will execute the provided instance context just before executing the respective class constructor.

**EX:**

```
class A{  
    A(){  
        System.out.println("A-con");  
    }  
}  
  
class B extends A{  
    B(){  
        System.out.println("B-con");  
    }  
}  
  
class C extends B{  
    C(){  
        System.out.println("C-con");  
    }  
}  
  
class Test{  
    public static void main(String[] args){  
        C c=new C();  
    }  
}
```

**OP:**  
A-Con  
B-Con  
C-Con**CONTACT US:**

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**EX:**

```
class A{
A(){}
System.out.println("A-con");
}
}
class B extends A{
}
class C extends B{
C(){}
System.out.println("C-con");
}
}
class Test{
public static void main(String[] args){
C c=new C();
}
}
```

**OP:**

A-Con  
C-Con

**EX:**

```
class A{
A(int i){
System.out.println("A-int-param-con");
}
}
class B extends A{
B(int i){
System.out.println("B-int-param-con");
}
}
class C extends B{
C(int i){
System.out.println("C-int-param-con");
}
}
class Test{
public static void main(String[] args){
C c=new C(10);
}
}
```

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**Status:** Compilation Error

**Reason:** In case of Inheritance, super classes must have 0-argument constructors irrespective of the sub class constructors.

In the case of Inheritance, if we provide instance context at all the classes then JVM will recognize and execute them just before executing the respective class constructors.

**EX:** class A{  
    A(){  
        System.out.println("A-con");  
    }  
    int i=m1();  
    int m1(){  
        System.out.println("m1-A");  
        return 10;  
    }  
    {  
        System.out.println("IB-A");  
    }  
}  
class B extends A{  
    int j=m2();  
    int m2(){  
        System.out.println("m2-B");  
        return 20;  
    }  
    {  
        System.out.println("IB-B");  
    }  
    B(){  
        System.out.println("B-Con");  
    }  
}  
class C extends B{  
    C(){  
        System.out.println("C-con");  
    }  
    {  
        System.out.println("IB-C");  
    }  
    int k=m3();  
    int m3(){  
        System.out.println("m3-C");  
        return 30;  
    }

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```
}
```

```
}
```

```
class Test{
```

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

```
C c=new C();
```

```
}
```

```
}
```

**OP:**

m1-A  
IB-A  
A-con  
m2-B  
IB-B  
B-Con  
IB-C  
m3-C  
c-con

**EX:**

```
class A{
```

```
A(){
```

```
System.out.println("A-con");
```

```
}
```

```
static{
```

```
System.out.println("SB-A ");
```

```
}
```

```
int m1(){
```

```
System.out.println("m1-A");
```

```
return 10;
```

```
}
```

```
static int m2(){
```

```
System.out.println("m2-A ");
```

```
return 20;
```

```
}
```

```
{
```

```
System.out.println("IB-A ");
```

```
}
```

```
static int i=m2();
```

```
int j=m1();
```

```
}
```

```
class B extends A{
```

```
{
```

```
System.out.println("IB-B");
```

```
}
```

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```
int m3(){
    System.out.println("m3-B");
    return 30;
}
static{
    System.out.println("SB-B");
}
int k=m3();
B(){
    System.out.println("B-Con");
}
static int l=m4();
static int m4(){
    System.out.println("m4-B");
    return 40;
}
}
class C extends B{
static int m5(){
    System.out.println("m5-C");
    return 50;
}
int m6(){
    System.out.println("m6-C");
    return 60;
}
C(){
    System.out.println("C-con");
}
int m6();
static int n=m5();
System.out.println("IB-C");
}
static{
    System.out.println("SB-C");
}
}
class Test{
public static void main(String args[]){
    C c1=new C();
    C c2=new C();
}
}
```

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**Super Keyword:**

Super is a Java keyword, it can be used to represent super class object from sub classes.

There are three ways to utilize "super" keyword.

1. To refer super class variables
2. To refer super class constructors
3. To refer super class methods.

**1. To refer super class variables:**

If we want to refer super class variables by using 'super' keyword then we have to use the following syntax.

```
super.var_Name;
```

**NOTE:** We will utilize super keyword, to access super class variables when we have same set of variables at local, at current class and at the super class.

**EX:**

```
class A{  
    int i=100;  
    int j=200;  
}  
class B extends A{  
    int i=10;  
    int j=20;  
    B(int i,int j){  
        System.out.println(i+" "+j);  
        System.out.println(this.i+" "+this.j);  
        System.out.println(super.i+" "+super.i);  
    }  
}  
class Test{  
    public static void main(String args[]){  
        B b=new B(50,60);  
    }  
}
```

**OP:**

```
50 60  
10 20  
100 100
```

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## 2.To refer super class constructors:

If we want to refer super class constructor from sub class by using 'super' keyword then we have to use the following syntax.

```
super([Param_List]);
```

**NOTE:**In general,in inheritance,JVM will execute 0-argument constructor before executing sub class constructor.In this context,instead of executing 0-argument constructor we want to execute a parametrized constructor at super class,for this,we have to use 'super' keyword.

**EX:**

```
class A{  
    A(){  
        System.out.println("A-Con");  
    }  
    A(int i){  
        System.out.println("A-int-param-Con");  
    }  
}  
class B extends A{  
    B(){  
        super(10);  
        System.out.println("B-Con");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        B b=new B();  
    }  
}
```

**OP:**

```
A-int-param-Con  
B-Con
```

If we want to access super class constructor from subclass by using "super" keyword then the respective "super" statement must be provided as first statement.

If we want to access super class constructor from sub class by using "super" keyword then the respective "super" statement must be provided in the subclass constructors only,not in subclass normal Java methods.

If we violate any of the above conditions then compiler will rise an error like "call to super must be first statement in constructor".

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**NOTE:** Due to the above rules and regulations, it is not possible to access more than one super class constructor from a single sub class constructor by using "super" keyword.

In the case of inheritance, when we access sub class constructor then ,first, JVM will execute super class 0-arg constructor then JVM will execute sub class constructor, this flow of execution is possible in Java because of the following compiler actions over source code at the time of compilation.

- a) Compiler will goto each and every class available in the source file and checks whether any requirement to provide "default constructors".
- b) If any class is identified with out user defined constructor explicitly then compiler will add a 0-argument constructor as default constructor.
- c) After providing default constructors, compiler will goto all the constructors at each and every class and compiler will check "super" statement is provided or not by the developer explicitly to access super class constructor.
- d) If any class constructor is identified with out "super" statement explicitly then compiler will append "super()" statement in the respective constructor to access a 0- argument constructor in the respective super class.
- e) With the above compiler actions, JVM will execute super class 0-arg constructor as part of executing sub class constructor explicitly.

Write the translated code:

```
class A{  
    A(){  
        System.out.println("A-con");  
    }  
}  
  
class B extends A{  
    B(int i){  
        System.out.println("B-int-param-con");  
    }  
}  
  
class C extends B{  
    C(int i){  
        System.out.println("C-int-param-con");  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        C c=new C();  
    }  
}
```

**Status:** Compilation Error

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**EX:**

```
class A{
    A(){}
    System.out.println("A-con");
}
class B extends A{
    B(int i){
        System.out.println("B-int-param-con");
    }
}
class C extends B{
    C(int i){
        super(10);
        System.out.println("C-int-param-con");
    }
}
class Test{
    public static void main(String args[]){
        C c=new C(10);
    }
}
```

**OP:**

A-con  
B-int-param-con  
C-int-param-con

**3.To refer super class method:**

If we want to refer super class methods from sub class by using "super" keyword then we have to use the following syntax.

```
super.method_Name([Param_List]);
```

**NOTE:**In Java applications,when we have same method at both subclass and at super class,if we access that method at sub class then JVM will execute sub class method only,not super class method because JVM will give more priority for the local class methods.In this context,if we want to refer super class method over sub class method then we have to "super" keyword.

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**EX:**

```
class A{
    void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    void m2(){
        System.out.println("m2-B");
        m1();
        this.m1();
        super.m1();
    }
}
void m1(){
    System.out.println("m1-B");
}
}
class Test{
    public static void main(String args[]){
        B b=new B();
        b.m2();
    }
}
```

**Class Level Type Casting:**

The process of converting the data from one user defined data type to another user defined data type is called as User Defined Data type casting or Class level type Casting. □ If we want to perform Class Level Type Casting or User Defined data types casting then we must require either "extends" or "implements" relationship between two user defined data types.

There are two types of User defined data type casting:

- 1.UpCasting.
- 2.DownCasting.

**1.UpCasting:**

The process of converting the data from sub type to super type is called as UpCasting.

To perform Upcasting,we have to assign sub class reference variable to super class reference variable.

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**EX:**

```
class A{  
}  
class B extends A{  
}  
B b=new B();  
A a=b;
```

If we compile the above code then compiler will check whether 'b' variable data type is compatible with 'a' variable data type or not, if not, compiler will rise an error like "InCompatible Types". If "b" variable data type is compatible to "a" variable data type then compiler will not rise any error.

**NOTE:** In Java applications, always sub class types are compatible with super class types, so that we can assign sub class reference variable to super class reference variables directly.

**NOTE:** In Java, super class types are not compatible with sub class types, so that, we cannot assign super class reference variables to sub class reference variables directly, where if we want to assign super class reference variables to sub class reference variables then we must require "cast operator" explicitly, that is called as "Explicit Type Casting".

If we execute the above code then JVM will perform the following two actions.

1. JVM will convert "b" variable data type [sub class type] to "a" variable data type [Super class type] implicitly.
2. JVM will copy the reference value of "b" variable to "a" variable.

With the upcasting, we are able to access only super class members among the availability of both super class and sub class members in sub class object.

```
class A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
}  
class B extends A{  
    void m2(){  
        System.out.println("m2-B");  
    }  
}  
class Test{  
    public static void main(String[] args){  
        B b=new B();  
        b.m1();  
        b.m2();  
        A a=b;
```

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```
a.m1();
//a.m2();---->error
}
}
```

**OP:**

m1-A  
m2-B  
m1-A

**2.DownCasting:**

The process of converting the data from super type to sub type is called as "DownCasting".

If we want to perform DownCasting then we have to use the following format.

**EX:**

```
class A{
void m1(){
System.out.println("m1-A");
}
}
class B extends A{
void m2(){
System.out.println("m2-B");
}
}
class Test{
public static void main(String args[]){
case 1:
A a=new A();
B b=a;
```

**Status:**Compilation error,incompatible types

**Reason:**In Java,always,sub class types are compatible with super class types but super class types are not compatible with sub class types.It is possible to assign sub class reference variables directly but it is not possible to assign super class reference variable to sub class reference variables directly,if we assign then compiler will rise an error like "InCompatible Types error".

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### Case 2:

```
A a=new A();
```

```
B b=(B)a;
```

Status:No Compilation error,but classCastException

Reason:In Java,always,it is possible to keep subclass object reference value in super class reference variable but it is not possible to keep superclass object reference value in subclass reference variable.If we are trying to keep super class object reference value in sub class reference variable then JVM will rise an exception like "java.lang.classCastException".

### Case 3:

```
A a=new B();
```

```
B b=(B)a;
```

Status:No compilation error,no exception

```
b.m1();
```

```
b.m2();
```

```
}
```

```
}
```

### EX:

```
class A{  
}
```

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

```
class C extends B{  
}
```

```
class D extends C{  
}
```

### Ex1:

```
A a=new A();
```

```
B b=a;
```

Status:Compilation error,incompatible types

### Ex2:

```
A a=new A();
```

```
B b=(B)a;
```

Status:No Compilation error,ClassCastException

### Ex3:

```
A a=new A();
```

```
B b=(B)a;
```

Status:No Compilation error,No Exception

### Ex4:

```
A a=new C();
```

```
B b=(C)a;
```

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Status:No Compilation error,No Exception

Ex5:

```
A a=new B();
```

```
B b=(C)a;
```

Status:No Compilation Error;ClassCastException

Ex6:

```
A a=new C();
```

```
C c=(D)a;
```

Status:No Compilation Error;ClassCastException

Ex7:

```
B b=new D();
```

```
C c=(D)b;
```

Status:NO Compilation Error,No Exception

Ex8:

```
A a=new D();
```

```
D d=(D)(C)(B)a;
```

Status:No Compilation error,No Exception

Ex9:

```
A a=new C();
```

```
D d=(D)(C)(B)a;
```

Status:No Compilation Error;ClassCastException

Ex10:

```
A a=new C();
```

```
C c=(D)(C)(B)a;
```

Status:No Compilation Error;ClassCastException

### USES-A Relationship:

This is a relationship between entities,where one entity will use another entity upto a particular action or behaviour or method.

To provide USES-A Relationship in java applications,we have to provide contained Entity class reference variable as parameter to a method in Container entity class,not as class level variable.

If we declared contained entity reference variable as class level reference variable in container entity class then that relationship is "HAS-A" relationship.

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**EX:**

```
class Account{  
    String accno;  
    String accName;  
    String accType;  
    int bal=10000;  
    Account(String accNo,String accName,String accType){  
        this.accNo=accNo;  
        this.accName=accName;  
        this.accType=accType;  
    }  
    }  
    class Transaction{  
        String tx_tid;  
        String tx_Type;  
        Transaction(String tx_id,String tx_Type){  
            this.tx_Id=tx_Id;  
            this.tx_Type=tx_Type;  
        }  
        public void deposit(Account acc,int dep_Amt){  
            int initial_Amt=acc.bal;  
            int total_Avl_Amt=initial_Amt+dep_Amt;  
            acc.bal=total_Avl_Amt;  
            System.out.println("Transaction Details");  
            System.out.println("-----");  
            System.out.println("Transaction Id :" +tx_Id);  
            System.out.println("Account Number :" +acc.accNo);  
            System.out.println("Account Type :" +acc.accType);  
            System.out.println("Initial Amount :" +initial_Amt);  
            System.out.println("Deposit Amount :" +dep_Amt);  
            System.out.println("Total Avl Amount :" +total_Avl_Amt);  
            System.out.println("Transaction Status:SUCCESS");  
            System.out.println("*****THANKQ,VISIT AGAIN*****");  
        }  
    }  
    class UsesAEx{  
        public static void main(String[] args){  
            Account acc=new Account("abc123","Durga","Savings");  
            Transaction tx=new Transaction("T-111","Deposit");  
            tx.deposit(acc,5000);  
        }  
    }  
}
```

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**OP:**

Transaction Details

Transaction Id :T-111  
Account Number :abc123  
Account Type :Savings  
Initial Amount :10000  
Deposit Amount :5000  
Total Avl Amount :15000  
Transaction Status:SUCCESS

\*\*\*\*\*THANKQ,VISIT AGAIN\*\*\*\*\*

**Polymorphism:**

Polymorphism is a Greek word,where poly means many and morphism means Structures.

If one thing is existed in more than one form then it is called as Polymorphism.

The main advantage of Polymorphism is "Flexibility" to design Applications.

There are two types of Polymorphisms

- 1.Static Polymorphism or Early binding
- 2.Dynamic Polymorphism or Late Binding

**1.Static Polymorphism:**

If the Polymorphism is existed at compilation time then that Polymorphism is called as Static Polymorphism.

**EX:**Method Overloading

**2. Dynamic Polymorphism:**

If the Polymorphism is existed at runtime then that Polymorphism is called as Dynamic Polymorphism.

**EX:**Method Overriding.

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**Method Overloading:**

The process of extending the existed method functionality upto some new Functionality is called as Method Overloading.

If we declare more than one method with the same name and with the different parameter list is called as Method Overloading.

To perform method overloading, we have to declare more than one method with different method signatures that is same method name and different parameter list.

**EX:**

```
class A{  
    void add(int i,int j){  
        System.out.println(i+j);  
    }  
    void add(float f1,float f2){  
        System.out.println(f1+f2);  
    }  
    void add(String str1,String str2){  
        System.out.println(str1+str2);  
    }  
}  
  
class Test{  
    public static void main(String[] args){  
        A a=new A();  
        a.add(10,20);  
        a.add(22.22f,33.33f);  
        a.add("abc","def");  
    }  
}
```

**OP:**

```
30  
55.550003  
abcdef
```

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**EX:**

```
class Employee{  
    void gen_Salary(int basic,float hk,float pf,int ta){  
        float salary=basic+((basic*hk)/100)-((basic*pf)/100)+ta;  
        System.out.println("Salary :" +salary);  
    }  
    void gen_Salary(int basic,float hk,float pf,int ta,int bonus){  
        float salary=basic+((basic*hk)/100)-((basic*pf)/100)+ta)+bonus;  
        System.out.println("Salary :" +salary);  
    }  
}  
class Test{  
    public static void main(String[] args){  
        Employee e=new Employee();  
        e.gen_Salary(20000,25.0f,12.0f,2000);  
        e.gen_Salary(20000,25.0f,12.0f,2000,5000);  
    }  
}
```

**Method Overriding:**

The process of replacing existed method functionality with some new functionality is called as Method Overriding.

To perform Method Overriding, we must have inheritance relationship classes.

In Java applications, we will override super class method with sub class method.

In Java applications, we will override super class method with subclass method.

If we want to override super class method with sub class method then both super class method and sub class method must have same method prototype.

**Steps to perform Method Overriding:**

1. Declare a super class with a method which we want to override.
2. Declare a sub class and provide the same super class method with different implementation.
3. In main class, in main() method, prepare object for sub class and prepare reference variable for super class [UpCasting].
4. Access super class method then we will get output from sub class method.

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**EX:**

```
class Loan{  
    public float getIR(){  
        return 7.0f;  
    }  
}  
  
class GoldLoan extends Loan{  
    public float getIR(){  
        return 10.5f;  
    }  
}  
  
class StudyLoan extends Loan{  
    public float getIR(){  
        return 12.0f;  
    }  
}  
  
class CraftLoan extends Loan{  
}  
  
class Test{  
    public static void main(String[] args){  
        Loan gold_Loan=new GoldLoan();  
        System.out.println("Gold Loan IR :" +gold_Loan.getIR()+"%");  
        Loan study_Loan=new StudyLoan();  
        System.out.println("Study Loan IR :" +study_Loan.getIR()+"%");  
        Loan craft_Loan=new CraftLoan();  
        System.out.println("Craft Loan IR :" +craft_Loan.getIR()+"%");  
    }  
}
```

**NOTE:** To prove method overriding in Java, we have to access super class method but JVM will execute the respective sub class method and JVM has to provide output from the respective sub class method, not from super class method. To achieve the above requirement we must create reference variable for only super class and we must create object for sub class.

```
class A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class B extends A{  
    void m1(){  
        System.out.println("m1-B");  
    }  
}
```

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```
class Test{
    public static void main(String args[]){
        /* A a=new A();
        a.m1();
        Status:Here Method Overriding is not happened,because Method overriding must require sub
        class
        object,not super class object.
        */
        /*
        B b=new B();
        b.m1();
```

**Status:** Here method Overriding is happened, but, to prove method overriding we must require super class reference variable, not sub class reference variable, because, subclass reference variable is able to access only sub class method when we have the same method in both sub class and super class.

```
/*
A a=new B();
a.m1();
}
```

#### **Rules to perform Method Overriding:**

1. To override super class method with sub class then super class method must not be declared as private.

#### **EX:**

```
class A{
    private void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String args[]){
        A a=new A();
        a.m1();
    }
}
```

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2. To override super class method with sub class method then sub class method should have the same return type of the super class method.

**EX:**

```
class A{
    int m1(){
        System.out.println("m1-A");
        return 10;
    }
}
class B extends A{
    void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String args[]){
        A a=new B();
        a.m1();
    }
}
```

3. To override super class method with sub class method then super class method must not be declared as final sub class method may or may not be final.

**EX:**

```
class A{
    void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    final void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String[] args){
        A a=new B();
        a.m1();
    }
}
```

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4.To override superclass method with sub class method either super class method or subclass method as static then compiler will rise an error.If we declare both super and sub class method as static in method overriding compiler will not rise any error,JVM will provide output from the super class method.

**NOTE:**If we are trying to override superclass static method with sub class static method then super class static method will override subclass static method,where JVM will generate output from super class static method.

**EX:**

```
class A{
    static void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    static void m1(){
        System.out.println("m1-B");
    }
}
class Test{
    public static void main(String args[]){
        A a=new B();
        a.m1();
    }
}
```

5.To override super class method with subclass method,sub class method must have either same scope of the super class method or more scope when compared with super class method scope otherwise compiler will rise an error.

**EX:**

```
class A{
    protected void m1(){
        System.out.println("m1-A");
    }
}
class B extends A{
    public void m1(){
        System.out.println("m1-B");
    }
}
class Test{
```

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```
public static void main(String args[]){
    A a=new A();
    a.m1();
}
```

6. To override super class method with subclass method subclass method should have either same access privileges or weaker access privileges when compared with super class method access privileges.

Q) What are the differences between method overloading and method overriding?

**Ans:**

1. The process of extending the existed method functionality with new functionality is called as Method Overloading.

The process of replacing existed method functionality with new functionality is called as Method Overriding

2. In the case of method overloading, different method signatures must be provided to the methods  
In the case of method overriding same method prototypes must be provided to the methods.

3. With or without inheritance we can perform method overloading  
With inheritance only we can perform Method overriding

**EX:**

```
class DB_Driver{
    public void getDriver(){
        System.out.println("Type-1 Driver");
    }
}
class New_DB_Driver extends DB_Driver{
    public void getDriver(){
        System.out.println("Type-4-Driver");
    }
}
class Test{
    public static void main(String args[]){
        DB_Driver driver=new New_DB_Driver();
        driver.getDriver();
    }
}
```

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In the above example, method overriding is implemented, in method overriding, for super class method call JVM has to execute subclass method, not super class method. In method overriding, always JVM is executing only subclass method, not super class method. In method overriding, it is not suggestible to manage super class method body without execution, so that, we have to remove super class method body as part of code optimization. In Java applications, if we want to declare a method without body then we must declare that method as "Abstract Method".

If we want to declare abstract methods then the respective class must be abstract class.

```
abstract class DB_Driver{  
    public abstract void getDriver();  
}  
class New_DB_Driver extends DB_Driver{  
    public void getDriver(){  
        System.out.println("Type-4 Driver");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        DB_Driver driver=new New_DB_Driver();  
        driver.getDriver();  
    }  
}
```

In Java applications, if we declare any abstract class with abstract methods, then it is convention to implement all the abstract methods by taking sub class.

To access the abstract class members, we have to create object for subclass and we have to create reference variable either for abstract class or for subclass.

If we create reference variable for abstract class then we are able to access only abstract class members, we are unable to access subclass own members

If we declare reference variable for subclass then we are able to access both abstract class members and subclass members.

```
abstract class A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
    abstract void m2();  
    abstract void m3();  
}  
class B extends A{
```

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```
void m2(){  
    System.out.println("m2-B");  
}  
void m3(){  
    System.out.println("m3-B");  
}  
void m4(){  
    System.out.println("m4-B");  
}  
}  
  
class Test{  
    public static void main(String args[]){  
        A a=new B();  
        a.m1();  
        a.m2();  
        a.m3();  
        //a.m4();---error  
        B b=new B();  
        b.m1();  
        b.m2();  
        b.m3();  
        b.m4();  
    }  
}
```

In Java applications, it is not possible to create Object from abstract classes but it is possible to provide constructors in abstract classes, because, to recognize abstract class instance variables in order to store in the sub class objects.

**EX:** abstract class A{  
 A(){  
 System.out.println("A-Con");  
 }  
}  
class B extends A{  
 B(){  
 System.out.println("B-Con");  
 }  
}  
class Test{  
 public static void main(String[] args){  
 B b=new B();  
 }  
}

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In Java applications, if we declare any abstract class with abstract methods then it is mandatory to implement all the abstract methods in the respective subclass. If we implement only some of the abstract methods in the respective subclass then compiler will rise an error, where to come out from compilation error we have to declare the respective subclass as an abstract class and we have to provide implementation for the remaining abstract methods by taking another subclass in multilevel inheritance.

**EX:**

```
abstract class A{  
    abstract void m1();  
    abstract void m2();  
    abstract void m3();  
}  
  
abstract class B extends A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class C extends B{  
    void m2(){  
        System.out.println("m2-C");  
    }  
    void m3(){  
        System.out.println("m3-C");  
    }  
}  
  
class Test{  
    public static void main(String[] args){  
        A a=new C();  
        a.m1();  
        a.m2();  
        a.m3();  
    }  
}
```

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In Java applications, if we want to declare an abstract class then it is not at all mandatory condition to have atleast one abstract method, it is possible to declare abstract class without having abstract methods but if we want to declare a method as an abstract method then the respective class mustbe abstract class.

```
abstract class A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class B extends A{  
    void m2(){  
        System.out.println("m2-B");  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        A a=new B();  
        a.m1();  
        //a.m2();----->Error  
        B b=new B();  
        b.m1();  
        b.m2();  
    }  
}
```

In Java applications, it is possible to extends an abstract class to concrete class and from concrete class to abstract class.

```
class A{  
    void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
abstract class B extends A{  
    abstract void m2();  
}  
  
class C extends B{  
    void m2(){  
        System.out.println("m2-C");  
    }  
    void m3(){  
        System.out.println("m3-C");  
    }  
}
```

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```
class Test{
    public static void main(String args[]){
        A a=new C();
        a.m1();
        //a.m2();---□error
        //a.m3();---□error
        B b=new C();
        b.m1();
        b.m2();
        //b.m3();---□error
        C c=new C();
        c.m1();
        c.m2();
        c.m3();
    }
}
```

**Note:** In Java applications, it is not possible to extend a class to the same class, if we do the same then compiler will rise an error like "cyclic inheritance involving".

```
class A extends A{
}
Status: Compilation Error: "cyclic inheritance involving".
class A extends B{
}
class B extends A{}
```

**Status:** Compilation Error: "cyclic inheritance involving".

### Interfaces:

Interface is a Java Feature, it will allow only abstract methods.

In Java applications, for interfaces, we are able to create only reference variables, we are unable to create objects.

In the case of interfaces, by default, all the variables are "public static final".

In the case of interfaces, by default, all the methods are "public and abstract".

In Java applications, constructors are possible in classes and abstract classes but constructors are not possible in interfaces.

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Interfaces will provide more sharability in Java applications when compared with classes and abstract classes.

In Java applications, if we declare any interface with abstract methods then it is convention to declare an implementation class for the interface and it is convention to provide implementation for all the abstract methods in implementation class.

```
interface I{
    void m1();
    void m2();
    void m3();
}
class A implements I{
    public void m1(){
        System.out.println("m1-A");
    }
    public void m2(){
        System.out.println("m2-A");
    }
    public void m3(){
        System.out.println("m3-A");
    }
    public void m4(){
        System.out.println("m4-A");
    }
}
class Test{
    public static void main(String args[]){
        I i=new A();
        i.m1();
        i.m2();
        i.m3();
        //i.m4();----->error
        A a=new A();
        a.m1();
        a.m2();
        a.m3();
        a.m4();
    }
}
```

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In Java applications, if we declare an interface with abstract methods then it is mandatory to provide implementation for all the abstract methods in the respective implementation class. In this context if we provide implementation for some of the abstract methods at the respective implementation class then compiler will rise an error, where to come out from the compilation error we have to declare the respective implementation class as an abstract class and we have to provide implementation for the remaining abstract methods by taking a sub class for the abstract class.

```
interface I{
void m1();
void m2();
void m3();
}
abstract class A implements I{
public void m1(){
System.out.println("m1-A");
}
}
class B extends A{
public void m2(){
System.out.println("m2-B");
}
public void m3(){
System.out.println("m3-B");
}
}
class Test{
public static void main(String args[]){
I i=new I();
i.m1();
i.m2();
i.m3();
A a=new B();
a.m1();
a.m2();
a.m3();
B b=new B();
b.m1();
b.m2();
b.m3();
}
}
```

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In Java applications, it is not possible to extend more than one class to a single class but it is possible to extend more than one interface to a single interface.

**EX:**

```
interface I1{  
    void m1();  
}  
interface I2{  
    void m2();  
}  
interface I3 extends I1,I2{  
    void m3();  
}  
class A implements I3{  
    public void m1(){  
        System.out.println("m1-A");  
    }  
    public void m2(){  
        System.out.println("m2-A");  
    }  
    public void m3(){  
        System.out.println("m3-A");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        I1 i1=new A();  
        i1.m1();  
        I2 i2=new A();  
        i2.m2();  
        I3 i3=new A();  
        i3.m1();  
        i3.m2();  
        i3.m3();  
        A a=new A();  
        a.m1();  
        a.m2();  
        a.m3();  
    }  
}
```

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In Java applications, it is possible to implement more than one interface into a single implementation class.

```
interface I1{  
    void m1();  
}  
interface I2{  
    void m2();  
}  
interface I3{  
    void m3();  
}  
class A implements I1,I2,I3{  
    public void m1(){  
        System.out.println("m1-A");  
    }  
    public void m2(){  
        System.out.println("m2-A");  
    }  
    public void m3(){  
        System.out.println("m3-A");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        I1 i1=new A();  
        i1.m1();  
        I2 i2=new A();  
        i2.m2();  
        I3 i3=new A();  
        i3.m3();  
        A a=new A();  
        a.m1();  
        a.m2();  
        a.m3();  
    }  
}
```

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Q)Find Valid Syntaxes between classes,abstract classes and Interfaces from the following list of syntaxes?

class extends class --->Valid  
class extends class,class--->InValid  
class extends abstract class--->Valid  
class extends abstract class,class--->InValid  
class extends abstract class,abstract class--->InValid  
class extends interface--->InValid  
class implements interface--->Valid  
class implements interface,interface--->Valid  
class implements interface extends class--->InValid  
class implements interface extends abstract class--->InValid  
class extends class implements interface--->Valid  
class extends abstract class implements interface--->Valid  
abstract class extends class--->Valid  
abstract class extends abstract class--->Valid  
abstract class extends class,class--->InValid  
abstract class extends abstract class,abstract class--->InValid  
abstract class extends class,abstract class--->InValid  
abstract class extends interface--->InValid  
abstract class implements interface--->Valid  
abstract class implements interface,interface--->Valid  
abstract class extends class implements interface--->Valid  
abstract class extends abstract class implements interface--->Valid  
abstract class implements interface extends class-->InValid  
abstract class implements interface extends abstract class-->InValid  
interface extends interface -->Valid  
interface extends interface,interface -->Valid  
interface extends class -->InValid  
interface extends abstract class -->InValid  
interface implements interface -->InValid

**Marker Interfaces:**

Marker Interface is an Interface, it will not include any abstract method and it will provide some abilities to the objects at runtime of our Java application.

**EX:** java.io.Serializable , java.lang.Cloneable

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**java.io.Serializable:**

The process of separating the data from an object is called as Serialization.

The process of reconstructing an Object on the basis of data is called as Deserialization.

**Serialization & Deserialization**

Where java.io.Serializable interface is a marker interface, it was not declared any method but it will make eligible any object for Serialization and Deserialization.

**java.lang.Cloneable:**

The process of generating duplicate object is called as Object Cloning.

IN java applications, bydefault, all objects are not eligible for Object cloning, only the objects which implements java.lang.Cloneable interface are eligible for Object cloning.

**JAVA8 Features over Interfaces:**

- 1.Default Methods in Interfaces
- 2.Static Methods in Interfaces
- 3.Functional Interfaces

**1.Default Methods in Interfaces:**

In general, if we declare abstract methods in an interface then we have to implement all that interface methods in more no.of classes with variable implementation part.

In the above context, if we require any method implementation common to every implementation class with fixed implementation then we have to implement that method in the interface as default method.

To declare default methods in interfaces we have to use "default" keyword in method syntax like access modifier.

**EX:**

```
interface I{  
    default void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class A implements I{}  
class Test{  
    public static void main(String args[]){  
        I i=new A();  
        i.m1();  
    }  
}
```

**NOTE:**It is possible to provide more than one default methods with in a single interface.

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**EX:**

```
interface I{  
    default void m1(){  
    -----  
    }  
    default void m2(){  
    -----  
    }  
    }  
}
```

1.In JAVA8,it is possible to override default methods in the implementation classes.

```
interface I{  
    default void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class A implements I{  
    public void m1(){  
        System.out.println("m1-A");  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        I i=new A();  
        i.m1();  
    }  
}
```

**2.Static Methods in Interfaces:**

Upto JAVA7 version, static methods are not possible in interfaces but from JAVA8 version static methods are possible in interfaces in order to improve sharability.

If we declare static methods in the interfaces then it is not required to declare any implementation class to access that static method,we can use directly interface name to access static method.

**NOTE:**If we declare static methods in an interface then they will not be available to the respective implementation classes,we have to access static methods by using only interface names not even by using interface reference variable

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**EX:**

```
interface I{  
    static void m1(){  
        System.out.println("m1-1");  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        I.m1();  
    }  
}
```

**Note:** In JAVA8 version, interfaces will allow concrete methods along with either "static" keyword or "default" keyword.

**3.Functional Interface:**

If any Java interface allows only one abstract method then it is called as "Functional Interface".

To make any interface as Functional Interface then we have to use the following annotation just above of the interface.

```
@FunctionalInterface
```

**EX:** java.lang.Runnable  
java.lang.Comparable

**NOTE:** In Functional Interfaces we have to provide only one abstract method but we can provide any no.of default methods and any no.of static methods.

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```
@Functional Interface
interface I{
void m1();
//void m2();--->error
default void m3(){
System.out.println("m3-I");
}
static void m4(){
System.out.println("m4-I");
}
class A implements I{
public void m1(){
System.out.println("m1-A");
}
}
class Test{
public static void main(String args[]){
I i=new A();
i.m1();
i.m3();
//i.m4();--->error
i.m4();
//A.m4();--->error
}}
```

### Instanceof operator:

It is a boolean operator, it can be used to check whether the specified reference variable is representing the specified class object or not that is compatible or not.

```
ref_Var instanceof Class_Name
```

where ref\_Var and Class\_Name must be related otherwise compiler will rise an error like "incompatible types error".

If ref\_Var class is same as the specified Class\_Name then instanceof operator will return "true".

If ref\_Var class is subclass to the specified Class\_Name then instanceof operator will return "true".

If ref\_Var class is super class to the specified Class\_Name then instanceof operator will return "false".

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**EX:**

```
class A{  
}  
class B extends A{  
}  
class C{  
}  
class Test{  
public static void main(String args[]){  
A a=new A();  
B b=new B();  
System.out.println(a instanceof A);  
System.out.println(a instanceof B);  
System.out.println(b instanceof A);  
//System.out.println(a instanceof C);  
}}
```

**Object Cloning:**

The process of creating duplicate object for an existed object is called as Object Cloning.

If we want to perform Object Cloning in Java application then we have to use the following steps.

1. Declare an User defined Class.
2. Implement `java.lang.Cloneable` interface inorder to make eligible any object for cloning.
3. Override `Object` class `clone()` method in user defined class.  
`public Object clone() throws CloneNotSupportedException`
4. In Main class,in `main()` method,access `clone()` method over the respective object.

**EX:**

```
class Student implements Cloneable{  
String sid;  
String sname;  
String saddr;  
Student(String sid,String sname,String saddr){  
this.sid=sid;  
this.sname=sname;  
this.saddr=saddr;  
}  
public Object clone()throws CloneNotSupportedException{  
return super.clone();  
}  
public String toString(){  
System.out.println("Student details");  
}
```

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```
System.out.println("-----");
System.out.println("Student Id :" +sid);
System.out.println("Student name:" +sname);
System.out.println("Student Address:" +saddr);
return "";
}
class Test{
public static void main(String args[]){
Student std1=new Student("S-111","Durga","Hyd");
System.out.println("Student Details Before Cloning");
System.out.println(std1);
Student std2=(Student)std1.clone();
System.out.println();
System.out.println("Student Details After cloning");
System.out.println(std2);
}
}
```

There are two types clonings in Java:

- 1.Shallow Cloning/Shallow Copy
- 2.Deep Cloning/Deep Copy

### **1. Shallow Cloning/Shallow Copy:**

In this cloning mechanism,while cloning an object if any associated object is encountered then JVM will not duplicate associated object along with data duplication,where duplicated object is also refer the same associated object which was referred by original object.

**NOTE:**Shallow Cloning is default cloning mechanism in Java.

### **2. Deep Cloning/Deep Copy:**

In this cloning mechanism,while cloning an object if JVM encounter any associated object then JVM will duplicate associated object also along with data duplication.In this cloning mechanism,both original object and cloned object are having their own duplicated associated objects copy,both are not referring a single associated object

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**EX:**

```
class Account{  
    String accNo;  
    String accName;  
    String accType;  
    Account(String accNo,String accName,String accType){  
        this.accNo=accNo;  
        this.accName=accName;  
        this.accType=accType;  
    }  
}  
  
class Employee implements Cloneable{  
    String eid;  
    String ename;  
    String eaddr;  
    Account acc;  
    Employee(String eid,String ename,String eaddr,Account acc){  
        this.eid=eid;  
        this.ename=ename;  
        this.eaddr=eaddr;  
        this.acc=acc;  
    }  
    public Object clone() throws CloneNotSupportedException{  
        return super.clone();  
    }  
    public String toString(){  
        System.out.println("Employee Details");  
        System.out.println("-----");  
        System.out.println("Employee Id :" +eid);  
        System.out.println("Employee Address :" +eaddr);  
        System.out.println("Employee Name :" +ename);  
        System.out.println("Account Deatails");  
        System.out.println("-----");  
        System.out.println("Account Number:" +acc.accNo);  
        System.out.println("Account Name :" +acc.accName);  
        System.out.println("Account Type :" +acc.accType);  
        System.out.println("Account Reference: " +acc);  
        return "";  
    }  
}  
class Test{  
    public static void main(String args[]) throws Exception{  
        Account acc=new Account("abc123","Durga","Savings");  
        Employee emp1=new Employee("E-111","Durga","Hyd",acc);  
    }  
}
```

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```
System.out.println("Employee Details Before Cloning");
System.out.println(emp1);
Employee emp2=(Employee)emp1.clone();
System.out.println("Employee Details After Cloning");
System.out.println(emp2);
}
}
```

To prepare example for deep cloning provide the following clone() method in employee class in the above example of(shallow Cloning)

```
public Object clone()throws CloneNotSupportedException{
Account acc1=new Account(acc.accNo,acc.accName,acc.accType);
Employee emp=new Employee(eid,ename,eaddr,acc1);
return emp;
```

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## Inner Classes

Declaring a class inside a class is called as Inner class.

### Syntax:

```
class Outer_Class
{
    class Inner_Class
    {
    }
}
```

In java applications, Inner classes are able to provide the following advantages.

- 1.Modularity
- 2.Adstraction
- 3.Security
- 4.Sharability
- 5.Reusability

### 1.Modularity:

In java appl, we are able to improv we modularity by using packages.

If we want to devide our implementation in a class in the form of modules then we have to use Inner classes.

### EX:

```
class Account
{
    class SavingsAccount{
        ----
    }
    class CurrentAccount{
        ----
    }
}
```

### 2.Adstraction:

If we declare any variable or method in an inner class then that variable and method are having scope upto that inner class only , it is not available to other inner classes, so that, Inner classes are able to improve Abstraction.

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**EX:**

```
class A{  
    class B{  
        int i=10;  
    }  
    class C{  
        void m1(){  
            i=i+10;--> Error  
        }  
    }  
}
```

**3.Security:**

It is not possible to declare a class as private, but, it is possible to declare an inner class as private, so that , inner classes are able to improve Security.

**EX:**

```
private class A{  
}  
Status: Invalid
```

**EX:**

```
class A{  
    private class B{  
        ----  
    }  
}
```

Status: Valid.

**4.Sharability:**

It is not possible to declare a class as Static, but, it is possible to declare an inner class as static, so that, inner classes are able to improve Sharability.

**EX:**

```
static class A{  
}
```

Status: Invalid

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**EX:**

```
class A{  
    static class B{  
        }  
    }
```

**Status:** Valid

#### **5.Reusability:**

In java, inheritance feature will improve Code Reusability.

IN java applications, we can extend one inner class to another class, so that, inner classes are able to improve Code Reusability.

**EX:**

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

**Status:** Valid

There are four types of inner classes in java.

- 1.Member Inner class
- 2.Static Inner class
- 3.Method Local Inner class
- 4.Anonymous Inner class.

**Note:** If we compile java file contains inner classes then Compiler will generate a separate .class for outer class and a separate .class file will be generated for inner class.

Outer\_Class.class ---> for Outer class

Outer\_Class\$Inner\_Class.class---> For Inner class

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**1.Member Inner class:**

Declaring a normal class[Non static class] inside a class is called as member inner class.

**EX:**

```
class Outer{  
    class Inner{  
        ----  
    }  
}
```

If we want to access the members of inner class then we have to create object for the inner class, for this , we have to use the following syntax.

**Outer.Inner ref\_Var=new Outer().new Inner();**

- 1.By using outer class reference variable we are able to access only outer class members, we are unable to access inner class members.
- 2.By using Inner class reference variable we are ABle to access only inner class members we are unable to access outer class members.
- 3.Bydefault , all outer class members are available to inner class, so we can access outer class members inside the inner class, but, Inner class members are not available to outer classes, we are unable to access inner class members in outer classes.
- 4.Member inner classes are not allowing static declarations directly, but, static keyword is allowed along with final keyword.

**EX:**

```
class A  
{  
    void m1()  
    {  
        System.out.println("m1-A");  
    }  
}  
  
class B  
{  
    //static int i=10;--> Error  
    static final int j=20;  
    void m2()  
    {  
        System.out.println("m2-B");  
        System.out.println(j);  
    }  
    void m3()  
    {  
    }
```

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```
        System.out.println("m3-B");
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        a.m1();
        //a.m2();--> Error
        A.B ab=new A().new B();
        ab.m2();
        ab.m3();
        //ab.m1();--> Error
    }
}
```

In Member inner classes, we can extend one inner class to another inner class but both the inner classes must be provided with in the same outer class.

**EX:**

```
class A
{
    class B
    {
        void m1()
        {
            System.out.println("m1-B");
        }
        void m2()
        {
            System.out.println("m2-B");
        }
    }
    class C extends B
    {
        void m3()
        {
            System.out.println("m3-C");
        }
        void m4()
        {
            System.out.println("m4-C");
        }
    }
}
```

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```
        }
    }
class Test
{
    public static void main(String[] args)
    {
        A.B ab=new A().new C();
        ab.m1();
        ab.m2();
        //ab.m3();--> Error
        A.C ac=new A().new C();
        ac.m1();
        ac.m2();
        ac.m3();
        ac.m4();
    }
}
```

We can not extend one inner class to another inner class which are available in two different outer classes.

**EX:**

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

**Status:** Invalid.

We can extend an inner class from an outer class.

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**EX:**

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

**Status:** Valid

We can extend the immediate outer class to its inner class.

**EX:**

```
class A{  
    class B extends A{  
    ---  
    }  
}
```

Q) Is it possible to write an interface inside a class?

**Ans:**

Yes, it is possible to provide an interface inside a class, but, the respective implementation class must be provided with in the same outer class.

**EX:**

```
class A  
{  
    interface I  
    {  
        void m1();  
        void m2();  
        void m3();  
    }  
    class B implements I  
    {  
        public void m1()  
        {  
            System.out.println("m1-B");  
        }  
        public void m2()  
        {  
        }  
    }  
}
```

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```
        System.out.println("m2-B");
    }
    public void m3()
    {
        System.out.println("m3-B");
    }
}
class Test
{
    public static void main(String[] args)
    {
        A.I ai=new A().new B();
        ai.m1();
        ai.m2();
        ai.m3();
    }
}
```

**EX:**

```
class A
{
    abstract class B
    {
        void m1()
        {
            System.out.println("m1-B");
        }
        abstract void m2();
        abstract void m3();
    }
    class C extends B
    {
        void m2()
        {
            System.out.println("m2-C");
        }
        void m3()
        {
            System.out.println("m3-C");
        }
    }
}
```

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```
class Test
{
    public static void main(String[] args)
    {
        A.B ab=new A().new C();
        ab.m1();
        ab.m2();
        ab.m3();
    }
}
```

**Static Inner class:**

Declaring a static class inside a class is called as Static inner class.

**Syntax:**

```
class Outer
{
    static class Inner
    {
        ----
    }
}
```

If we want to access the members of static inner class we have to create object for static inner class, for this we have to use the following syntax.

**Outer.Inner ref\_Var= new Outer.Inner();**

- 1.Static inner classes are able to allow only static members of the outer class, it will not allow non static members of the outer class.
- 2.In general, inner classes are not allowing static keyword directly, but, static inner class is able to allow static declarations directly.

**EX:**

```
class A
{
    static class B
    {
        void m1()
        {
            System.out.println("m1-B");
        }
        void m2()
        {
    }
```

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```
        System.out.println("m2-B");
    }
    static void m3()
    {
        System.out.println("m3-B");
    }
}
class Test
{
    public static void main(String[] args)
    {
        A.B ab=new A.B();
        ab.m1();
        ab.m2();
        A.B.m3();
    }
}
```

Q) Is it possible to write a class inside an interface?

**Ans:**

Yes, it is possible to write a class inside an interface, If we declare a class inside an interface then that class is converted as a static inner class, we can access members of this inner class like static inner class members.

**EX:**

```
interface I
{
    class A// static class A
    {
        void m1()
        {
            System.out.println("m1-A");
        }
        void m2()
        {
            System.out.println("m2-A");
        }
    }
}
class Test
{
    public static void main(String[] args)
```

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```
{  
    I.A ia=new I.A();  
    ia.m1();  
    ia.m2();  
}  
}
```

**Note:** We can write abstract class inside an interface, but, the respective sub class must be declared in the same interface, here the declared sub class is converted as static inner class.

**EX:**

```
interface I  
{  
    abstract class A  
    {  
        void m1()  
        {  
            System.out.println("m1-A");  
        }  
        abstract void m2();  
        abstract void m3();  
    }  
    class B extends A  
    {  
        void m2()  
        {  
            System.out.println("m2-B");  
        }  
        void m3()  
        {  
            System.out.println("m3-B");  
        }  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        I.A ia=new I.B();  
        ia.m1();  
        ia.m2();  
        ia.m3();  
    }  
}
```

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**NOTE:** We can write an interface inside an interface, but, the respective implementation class must be provided with in the same outer interface.

**EX:**

```
interface I1
{
    interface I2
    {
        void m1();
        void m2();
        void m3();
    }
    class A implements I2
    {
        public void m1()
        {
            System.out.println("m1-A");
        }
        public void m2()
        {
            System.out.println("m2-A");
        }
        public void m3()
        {
            System.out.println("m3-A");
        }
    }
    class Test
    {
        public static void main(String[] args)
        {
            I1.I2 i12=new I1.A();
            i12.m1();
            i12.m2();
            i12.m3();
        }
    }
}
```

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**Method Local Inner class:**

Declaring class inside a method is called as Method Inner class.

If we declare a class inside a method then the scope of that is available upto the respective method only, we have to create object for that inner class in the respective method only, we have to access the members of that inner class inside the respective method.

**EX:**

```
class A
{
    void m1()
    {
        class B
        {
            void m2()
            {
                System.out.println("m2-B");
            }
            void m3()
            {
                System.out.println("m3-B");
            }
        }//B
        B b=new B();
        b.m2();
        b.m3();
    }//m1()
}//A
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        a.m1();
    }
}
```

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**Anonymous Inner classes:**

Anonymous inner classes are nameless inner classes, these are used to provide implementation for abstract classes and interfaces.

**Note:** For abstract class we may take sub classes and for interfaces we may take implementatin classes to provide implementations , but, here sub classes of the abstract class and implementation class of the interface are able to allow their own members and these sub classes and implementation classes objects are having their identity, not interface identity and abstract class identity.

In java applicatins, if we want to provide implementations for only abstract class members or interface members and if we want to create objects with interface identity and with abstract class identity then we have to use Anonymous inner classes.

**Syntax:**

```
abstract class Name / interface Name
{
    ---
}
class Outer{
    Name ref_Var=new Name()
    {
        ---implementation---
    };
}
```

**EX:**

```
abstract class A
{
    void m1()
    {
        System.out.println("m1-A");
    }
    abstract void m2();
    abstract void m3();
}
class Outer
{
    A a=new A()
    {
        void m2()
        {
            System.out.println("m2-AIC");
        }
        void m3()
```

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```
        {
            System.out.println("m3-AIC");
        }
    void m4()
    {
        System.out.println("m4-AIC");
    }
}
class Test
{
    public static void main(String[] args)
    {
        Outer o=new Outer();
        o.a.m1();
        o.a.m2();
        o.a.m3();
        //o.a.m4();--> Error
    }
}
```

**EX:**

```
interface I
{
    void m1();
    void m2();
    void m3();
}
class Outer
{
    I i=new I()
    {
        public void m1()
        {
            System.out.println("m1-AIC");
        }
        public void m2()
        {
            System.out.println("m2-AIC");
        }
        public void m3()
        {
            System.out.println("m3-AIC");
        }
    }
}
```

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```
public void m4()
{
    System.out.println("m4-AIC");
}
}
class Test
{
    public static void main(String[] args)
    {
        Outer o=new Outer();
        o.i.m1();
        o.i.m2();
        o.i.m3();
        //o.i.m4();--> Error
    }
}
```

IN general, we will use Anonymous Inner classes when we have requirement to pass any interface or abstract class references as parameters to the methods.

**EX:**

```
interface I
{
    void m1();
    void m2();
    void m3();
}
class A
{
    void meth(I i)
    {
        i.m1();
        i.m2();
        i.m3();
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        a.meth(new I()
    }
}
```

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```
public void m1()
{
    System.out.println("m1-AIC");
}
public void m2()
{
    System.out.println("m2-AIC");
}
public void m3()
{
    System.out.println("m3-AIC");
}
public void m4()
{
    System.out.println("m4-AIC");
}
);
}
}
```

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## Wrapper Classes

Collection is an object , it able to store a group of other objects.

In java applications, Collection objects are able to store only objects , they will not store primitive data.

JAVA has provided 8 no of wrapper classes w.r.t the 8 no of primitive data types.

Primitive DTs	Wrapper Classes
---------------	-----------------

byte ----->	java.lang.Byte
short----->	java.lang.Short
int----->	java.lang.Integer
long----->	java.lang.Long
float----->	java.lang.Float
double----->	java.lang.Double
char----->	java.lang.Character
boolean----->	java.lang.Boolean

**Note:** Java has provided all the wrapper classes in the form of immutable classes.

Conversions from Primitve Type To Object Type:

**a)By using parameterized constructors from wrapper classes.**

```
public XXX(xxx value)
XXX ----> Wrapper classes
xxx ----> Primitive types.
EX:int i=10;
      Integer in=new Integer(i);
      System.out.println(i+" "+in);
```

**OP:** 10 10

**b)By using valueOf(-) method provided by Wrapper classes:**

```
public static XXX valueOf(xxx value)
XXX ----> Wrapper classes
xxx ----> primitive data types
EX: int i=10;
      Integer in=Intreger.valueOf(i);
      System.out.println(i+" "+in);
```

**OP:** 10 10

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**c)By using Auto-Boxing approach:**

Auto-Boxing approach was provided by JDK5.0 version, in this approach no need to use predefined methods and constructor, simply, we have to assign primitive variable to wrapper class reference variable.

**EX:** int i=10;

```
Integer in=i;  
System.out.println(i+" "+in);  
OP: 10 10
```

**2. Conversions from Object type to primitive types:****a) By using xxxValue() method from wrapper classes:**

```
public xxx xxxValue()  
xxx ----> primitive data types  
EX: Integer in=new Integer(10);  
int i=in.intValue();  
System.out.println(in+" "+i);  
OP: 10 10
```

**b) By using Auto-Unboxing:**

Auto-Unboxing was provided by JDK5.0 version, in this approach no need to use any prdefined methods, simply assign wrapper class reference variables to the respective primitive variables.

```
EX: Integer in=new Integer(10);  
int i=in;  
System.out.println(in+" "+i);
```

**OP:** 10 10

**3) Conversions from String type to Object Type:****a) By using String parameterized constructors from wrapper classes:**

```
public XXX(String value)  
XXX----> Wrapper classes  
EX: String data="10";  
Integer in=new Integer(data);  
System.out.println(data+" "+in);  
OP: 10 10
```

**b) By using static valueOf(-) method from wrapper classes:**

```
public  
static XXX valueOf(String data)  
EX: String data="10";  
Integer in=Integer.valueOf(data);  
System.out.println(data+" "+in);
```

**OP:** 10 10

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#### 4. CONversions from Object type to String type:

##### a) By using `toString()` method from Wrapper classes:

```
public String toString()
```

**EX:** Integer in=new Integer(10);

```
String data=in.toString();
```

```
System.out.println(in+" "+data);
```

**OP:** 10 10

##### b) By Using '+' concatenation operator:

If we concatenate any reference variable with "" by using '+' operator then JVM will access `toString()` method over the provided reference variable.

**EX:** Integer in=new Integer(10);

```
String data=""+in;
```

```
System.out.println(in+" "+data);
```

**OP:** 10 10

#### 5. Conversions from Primitive data types to String data types:

##### a) By using static `toString()` method from wrapper classes:

```
public static String toString(xxx value)
```

xxx--> Primitive types

**EX:** int i=10;

```
String data=Integer.toString(i);
```

```
System.out.println(i+" "+data);
```

**OP:** 10 10

##### b) By using '+' concatenation operator:

If we concatenate any primitive variable with "" by using '+' operator then the resultant value will be generated in String data type.

**EX:** int i=10;

```
String data=""+i;
```

```
System.out.println(i+" "+data);
```

**OP:** 10 10

#### 6. Conversions from String type to primitive type:

##### a) By using `parseXXX()` methode from wrapper classes:

```
public static xxx parseXxx(String data)
```

**EX:** String data="10";

```
int i=Integer.parseInt(data);
```

```
System.out.println(data+" "+i);
```

**OP:** 10 10

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## Packages

package is the collection of related classes and interfaces as a single unit.

Package is a folder contains .class files representing related classes and interfaces

In java applications, packages are able to provide the following advantages.

- 1.Modularity
- 2.Abstraction
- 3.Security
- 4.Sharability
- 5.Reusability

### 1.Modularity:

Deviding a requirement set into no of pieces , providing solutions to the individual parts and combining all individual solutions to a single is called as "Modularization".

In java applications, Module is a folder contains .class files representing related classes and interfaces as a single unit.

Due to the above module definition, we can conclude that Packages are able to improve modularity.

### 2.Abstraction:

If we declare classes and interfaces in a module or in a package then that classes and interfaces are not visible in out side of the package bydefault, so that, packages are able to improve Abstraction.

### 3.Security:

IN java applications, packages are able to provide Abstraction and Encapsulation, where both are able to improve Security.

### 4.Sharability:

In java applications, if we declare packages one time then we are able to share that package content to any no of applications or modules at a time.

### 5.Reusability

In java applications, if we declare a package one time then we are able to reuse any no of times with in a single application or in more than one application.

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There are two types of packages in java .

- 1.Predefined Packages
- 2.User defined Packages

### **1.Predefined Packages:**

These packages are provided by JAVA programming language along with Java software.

#### **EX1: java.lang :**

This package is default package in java applications , no need to import this package to the present java file, when we save java file with .java extension then automatically java.lang package is imported internally.

This package is able to provide all fundamental classes and interfaces which are required to prepare basic java applications.

java.lang package includes the following classes and interfaces to prepare java applications.

String, StringBuffer, StringBuilder,....

Object, System, Class,.....

Exception , ArithmeticException, NullPointerException,...

Thread, Runnable, Cloneable, Comparable.....

Integer, Byte, Short, Float, Long,.....

#### **EX2: java.io :**

This package is able to provide predefined classes and interfaces inorder to perform Input and Output operations in Java.

This package includes the following classes and interfaces in java applications.

InputStream, ByteArrayInputStream, FileInputStream,....

OutputStream, ByteArrayOutputStream, FileOutputStream,....

Reader, CharArrayReader, FileReader, .....

Writer , CharArrayWriter, FileWriter,.....

Serializable, Externalizable,.....

#### **EX3: java.util :**

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This package is able to provide all predefined classes and interfaces which are representing data structures .

This package is able to provide classes and interfaces like below.

Collection, List, Set, Queue

ArrayList, Vector, Stack, LinkedList.

HashSet, LinkedHashSet, SortedSet, NavigableSet, TreeSet

Queue, PriorityQueue, BlockingQueue, LinkedBlockingQueue,.....

Map, HashMap, LinkedHashMap, IdentityHashMap, WeakHashMap,.....

**EX4:** java.awt :

This package is able to provide predefined classes and interfaces representing all GUI components in order to prepare GUI applications.

This package has provided the following classes and interfaces to prepare GUI applications.

Component, Label, TextField, TextArea, Button, CheckBox, List, Choice, Frame,.....

**EX5:** javax.swing :

This package is able to provide predefined library to prepare GUI applications.

Q) What are the differences between AWT[java.awt] and SWING[javax.swing]?

**Ans:**

1. AWT provided GUI components are platform dependent GUI components.

SWING provided GUI components are Platform Independent GUI Components.

2. AWT provided GUI components are heavy weight GUI components.

SWING GUI components are light weight GUI components.

3. AWT provided GUI Components are basic GUI components.

**EX:** TextField, TextArea, Label, Button,....

SWING provided GUI components are most advanced GUI components.

**EX:** JColorChooser, JFileChooser, JTable, JTree,....

4. AWT provided GUI components are able to reduce application performance.

SWING provided GUI components are able to improve application performance.

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javax.swing package has provided the following predefined classes and interfaces to design GUI applications.

JComponent, JTextField, JPasswordField, JButton, JCheckBox, JRadioButton, JFrame, JColorChooser, JFileChooser,.....

**EX6:** java.net :

If we prepare any java application with out using Client-Server Arch then that java application is called as Standalone Application.

If we prepare any java application on the basis of Client-Server Arch then that java application is called as Distributed application.

To prepare distributed applications, JAVA has provided the following distributed technologies.

- 1.Socket Programming
- 2.RMI[Remote Method Invocation]
- 3.CORBA[Common Object Request Broker Arch/Agent]
- 4.EJBs[Enterprise Java Beans]
- 5.Web Services

java.net package has provided predefined library to prepare distributed applications by using Socket Programming.

Socket  
ServerSocket  
URL, URI, URN  
URLConnection  
---  
---

**EX7:** java.rmi :

java.rmi package is able to provide predefined library to prepare Distributed applications on the basis RMI .

Remote  
RemoteException  
Naming  
---  
---

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### EX8: java.sql :

The process of interacting with database from java application is called as JDBC[Java Dayabase Connectivity].

To prepare JDBC applications, java has provided predefined library in the form of java.sql package.

java.sql package has provided the following classes and interfaces to prepare JDBC applications.

Driver, DriverManager, Connection, Statement, PreparedStatement, CallableStatement, ResultSet, ResultSetMetaData, DatabaseMetaData, ....

### User Defined Packages:

These packages are defined by the developers as per their application requirements.

**Syntax:** package package\_Name;

If we want to use package declaration statement in java applications then we have to use the following two conditions.

1.Package Declaration Statement must be first statement.

2.Package name must be unique, it must not be sharable and it must not be duplicated.

Q)Is it possible to provide more than one package declaration statement with in a single java file?

**Ans:**

No, it is not possible to provide more than one package declaration statement with in a single java file, because, package declaration statement must be provided as first statement in java files.

To provide package names in java applications, JAVA has provided a convention like to include our company domain name in reverse.

**EX:**

```
package com.durgasoft.icici.transactions.deposit;  
com.durgasoft---> Company Domain name in reverse.  
icici -----> client/project name  
transactions---> Module name  
deposit -----> sub module name
```

If we declare classes and interfaces in a package and if we want to use these classes and interfaces in the present java file then we have to import the respective package to the present java file.

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To import packages to the present java file we have to use the following syntaxes.

**import package\_Name.\*;**

--> It able to import all the classes and interfaces of the specified package.

**EX:** import java.util.\*;

**import package\_Name.member\_Name;**

--> It able to import only the specified member from the specified package.

**EX:** import java.util.ArrayList;

**Note:** In java files, we are able to provide atmost one package declaration statement, but, we are able to provide any no of import statements.

Q) Is it possible to use classes and interfaces of a particular package with out importing the respective package?

**Ans:**

Yes, it is possible to use classes and interfaces of a particular package with out importing that package, but by using fully qualified names of the respective classes and interfaces.

**Note:** Specifying class name or interface name along with package name is called as "Fully Qualified Name"

**EX:** java.io.BufferedReader

java.util.ArrayList

---

----

**A java program with import statement:**

import java.io.\*;

---

BufferedReader br=new BufferedReader(new InputStreamReader( System.in));

**A Java program with out import statement:**

java.io.BufferedReader br=new java.io.BufferedReader(new java.io.InputStreamReader(System.in));

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**Application-1:**

D:\abc

-----

Employee.java

C:\xyz

-----

com

|---durgasoft

|---core

|----Employee.class

D:\javaapps\ packages

-----

Test.java

Test.class

Employee.java

-----

package com.durgasoft.core;

public class Employee

{

String eid;

String ename;

float esal;

String eaddr;

public Employee(String eid, String ename, float esal, String eaddr)

{

this.eid=eid;

this.ename=ename;

this.esal=esal;

this.eaddr=eaddr;

}

public void getEmpDetails()

{

System.out.println("Employee Details");

System.out.println("-----");

System.out.println("Employee Id :"+eid);

System.out.println("Employee Name :"+ename);

System.out.println("Employee Salary :"+esal);

System.out.println("Employee Address:"+eaddr);

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```
}
```

On Command Prompt:  
D:\abc>javac -d C:\xyz Employee.java

Test.java

```
import com.durgasoft.core.*;  
public class Test  
{  
    public static void main(String[] args)  
    {  
        Employee emp=new Employee("E-111", "Durga", 50000.0f, "Hyderabad");  
        emp.getEmpDetails();  
    }  
}
```

On Command Prompt:

```
D:\javaapps\packages>set classpath=C:\xyz;;  
D:\javaapps\packages>javac Test.java  
D:\javaapps\packages>java Test  
--- Employee Details---
```

classpath: To specify the location where package is existed.

import com.durgasoft.core.\* : To specify in which package Employee class is existed.

#### JAR Files in JAVA:

In java applications development, moving .class files from one machine to another machine in the network , uploading .class files directly to the websites,... are not suggestible. Always, it is suggestible to prepare JAR files for the .class files inorder to move in the network and to upload applications in the websites.

To create JAR files we have to use the following Command .

```
jar -cvf File_Name.jar *.*
```

#### EX:

```
D:\javaapps>jar -cvf durgaapp.jar *.*
```

To extract JAR file we have to use the following command on command prompt.

```
jar -xvf file_Name.jar
```

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**EX:**

```
D:\javaapps>jar -xvf durgaapp.jar
```

If we want to access packages or classes or interfaces from JAR file then we have to set classpath path environment variable to JAR file directly.

**Application-2:**

```
D:\abc
```

```
-----
```

```
Account.java
```

```
C:\xyz
```

```
-----
```

```
com
```

```
|---durgasoft
```

```
  |---icici
```

```
    |---accounts
```

```
      |----Account.class
```

```
C:\xyz
```

```
-----
```

```
durga_icici.jar
```

Move durga\_icici.jar from C:\xyz location to D:\xyz location

```
D:\xyz
```

```
-----
```

```
durga_icici.jar
```

```
D:\javaapps\packages
```

```
-----
```

```
Test.java
```

```
Test.class
```

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### Account.java

```
package com.durgasoft.icici.accounts;
public class Account
{
    String accNo;
    String accName;
    String accType;
    String accBranch;
    String accBank;
    public Account(String accNo, String accName, String accType, String accBranch, String
accBank)
    {
        this.accNo=accNo;
        this.accName=accName;
        this.accType=accType;
        this.accBranch=accBranch;
        this.accBank=accBank;
    }
    public void getAccountDetails()
    {
        System.out.println("Account Details");
        System.out.println("-----");
        System.out.println("Account Number :"+accNo);
        System.out.println("Account Name :"+accName);
        System.out.println("Account Type :"+accType);
        System.out.println("Account Branch :"+accBranch);
        System.out.println("Account Bank :"+accBank);
    }
}
```

On Command Priompt:

```
D:\abc>javac -d C:\xyz Account.java
C:\xyz>jar -cvf durga_icici.jar *.*
```

Move durga\_icici.jar from C:\xyz location to D:\xyz location.

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### Test.java

```
import com.durgasoft.icici.accounts.*;
public class Test
{
    public static void main(String[] args)
    {
        Account acc=new Account("abc123", "Durga", "Savings", "S R Nagar", "ICICI");
        acc.getAccountDetails();
    }
}
```

On Command Prompt:

```
D:\javaapps\packages>set classpath=D:\xyz\durga_icici.jar;.;
D:\javaapps\packages>javac Test.java
D:\javaapps\packages>java Test
---- Account Details-----
```

### MANIFEST File in JAR :

MANIFEST.MF file is created by "jar" command at the time of creating JAR file under "META-INF" folder and it will provide metadata about the jar file in the form of Key-Value pairs.

### Executable Jar Files:

If we prepare any JAR file with main class and main() method then that jar file is called as "Executable Jar" file.

To prepare Executable JAR file we have to use the following steps.

### 1.Prepare Java application as per the requirement and Compile Java application:

EX:D:\javaapps\packages\ Test.java

```
import java.awt.*;
class LogoFrame extends Frame
{
    LogoFrame()
    {
        this.setVisible(true);
        this.setSize(900,300);
        this.setBackground(Color.green);
        this.setTitle("Logo Frame");
    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD, 40);
```

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```
        g.setFont(f);
        this.setForeground(Color.red);
        String logo="DURGA SOFTWARE SOLUTIONS";
        g.drawString(logo, 100,150);
    }
}
class Test
{
    public static void main(String[] args)
    {
        LogoFrame lf=new LogoFrame();
    }
}
```

On Command Prompt:

D:\javaapps\packages>javac Test.java

2.Prepare a text file with "Main-Class" attribute with Main class name:

D:\javaapps\packages\ abc.txt

Main-Class: Test

**Note:** The main intention to specify "Main-Class" attribute in text file is to send Main-Class attribute information to MANIFEST.MF file.

3.Create JAR file with the MANIFEST.MF file, it must include Main-Class attribute which we specified in text file.

On Command Prompt

D:\javaapps\packages>jar -cvfm durgaapp.jar abc.txt \*.\*

4.Execute JAR file

On Command prompt:

D:\javaapps\packages>java -jar durgaapp.jar

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## Internal Flow:

- 1.JVM will recognizse -jar option and JVM will take jar file name from command prompt.
- 2.JVM will search for jar file at current location, if it is available then JVM will goto MANIFEST.MF file which is available META-INF folder.
- 3.In MANIFEST.MF file, JVM will search for Main-Class attribute, if it is available then JVM will take its value that is Main Class name.
- 4.After getting Main Class name from MANIFEST.MF file JVM will execute Main Class and generate output.

If we want to execute the above application through batch file, first, we have to prepare batch file with the required execution command then double click on that batch.

durga.bat[Take Text file and save with .bat extension]

-----  
java -jar durgaapp.jar

**NOTE:** We must save both jar file and bat file at the same location.

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## String Manipulations

In C and C++ applications, to perform String operations, C and C++ programming languages have provided some predefined library in the form of the functions.

In Java, to perform String operations JAVA has provided the following predefined classes.

- 1.java.lang.String
- 2.java.lang.StringBuffer
- 3.java.lang.StringBuilder
- 4.java.util.StringTokenizer

Q)What is the difference between String and StringBuffer?

**Ans:**

1.String class objects are immutable objects, where Immutable objects are not allowing modifications over their content, if we are trying to perform modifications over immutable object content then operations are allowed , but, the resultant data will not be stored back in original object, where the resultant data will be stored by creating new object.

StringBuffer objects are mutable objects, they are able to allow modifications on their content.

Q)What are the differences between StringBuffer and StringBuilder?

**Ans:**

1.StringBuffer class was introduced in JDK1.0 version.

  StringBuilder class was introduced in JDK5.0 version.

2.StringBuffer is synchronized .

  StringBuilder is not Synchronized.

3.Almost all the methods are Synchronized in StringBuffer.

  No method is synchronized in Stringbuilder.

4.StringBuffer is able to allow only one thread to access data.

  StringBuilder is able to allow more than one thread to access data.

5.StringBuffer is following sequential execution.

  StringBuilder is following parallel execution.

6.StringBuffer will increase execution time.

  StringBuilder will reduce execution time.

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7.StringBuffer will reduce application performance.

StringBuilder will increase application performance.

8.StringBuffer is able to give guarantee for Data Consistency.

StringBuilder is unable to give guarantee for data consistency.

9.StringBuffer is threadsafe.

StringBuilder is not threadsafe.

Q)What is String tokenization and how it is possible to perform String Tokenization in java applications?

**Ans:**

The process of deviding a string into no of tokens is called as String Tokenization.

To perform String Tokenization JAVA has provided a predefined class in the form of `java.util.StringTokenizer`.

To perform String Tokenization in java applications we have to use the following steps.

### 1.Create StringTokenizer class object:

To create StringTokenizer class object we have to use the following constructor.

```
public StringTokenizer(String data)
```

**EX:** StringTokenizer st=new StringTokenizer("Durga Software Solutions");

When JVM encounter the above instruction, JVM will take the provided String , JVM will devide the provided String into no of tokens and JVM will store thegenerated tokens by creating object for StringTokenizer class.

**NOTE:** When StringTokenizer class object is created with the no of tokens then a pointer or cursor will be created before the first token.

To get no of tokens which are existed in StringTokenizer class object we have to use the following method.

```
public int countTokens()
```

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## 2.Retrieve tokens from StringTokenizer object:

To retrive tokens from StringTokenizer object we have to use the following steps for each and every token.

a)Check whether more tokens are available or not from the current cursor position by using the following method.

```
public boolean hasMoreTokens()
```

--> It will return true value if atleast next token is existed.  
--> It will return false value if no more tokens are existed.

b)If atleast next token is available then read next token and move cursor to next position by using the following method.

```
public String nextToken()
```

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        StringTokenizer st=new StringTokenizer  
        System.out.println("No Of Tokens  
        while(st.hasMoreTokens())  
        {  
            System.out.println(st.nextToken());  
        }  
    }  
}  
("Durga Software Solutions");  
:+st.countTokens());
```

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## String Class Library :

### Constructor:

1. public String()

--> It able to create an emptyy String object.

**EX:** String str=new Stirng();

2. public String(String str)

-->This constructor can be used to create String class object with the specified data.

**EX:** String str=new String("Durga Software Solutions");

System.out.println(str);

**OP:** Durga Software Solutions

Q)What is the difference between the folloowing two statements.

a)String str=new String("Durga Software Solutions");

b)String str="Durga Software Solutions";

### Ans:

To create String class object if we use first statement then one String object will be created at heap memory as per "new" keyword and another String object will be created at String Constant Pool Area inside method Area as per "".

To create String object if we use second statement then String object will be created at String COnstant Pool Area only in Method Area.

**Note:** The objects which are created in String Constant Pool Area are not eligible for Garbage Collection.The objects which are created in Heap memory are eligible for Garbage Collection.

3. public String(byte[] b)

--> This constructor can be used to create String object with the String equivalent of the specified byte[] .

**EX:** byte[] b={ 65,66,67,68,69,70};

String str=new String(b);

System.out.println(str);

**OP:** ABCDEF

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4. public String(byte[] b, int start\_index, int no\_Of\_Chars)

--> This constructor can be used to create String class object with the String equivalent of the specified byte[] starts from the specified start index and upto the specified no of elements.

**EX:** byte[] b={65,66,67,68,69,70};  
String str=new String(b,2,3);  
System.out.println(str);

**OP:** CDE

5. public String(char[] ch)

--> This constructor can be used to create String object with the String equivalent of the specified char[].

**EX:** char[] ch={'A','B','C','D','E','F'};  
String str=new String(ch);  
System.out.println(str);

**OP:** ABCDEF

6. public String(char[] ch, int start\_Index,int no\_Of\_Chars)

--> It will create String object with the String equivalent of the specified char[] starts from the specified start index and upto the specified no of element.

**EX:** char[] ch={'A','B','C','D','E','F'};  
String str=new String(ch,2,3);  
System.out.println(str);

**OP:** CDE

**Note:** Constructors 3 and 4 are used to convert data from byte[] to String and constructors 5 and 6 are used to convert data from char[] to String.

### Methods:

1. public int length()

--> This method will return an integer value representing the no of characters existed in the String including spaces.

**EX:** String str=new String("Durga Software Solutions");  
System.out.println(str.length());

**OP:** 24

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2. public String concat(String str)

--> This method will add the specified String to String object content in immutable manner.

**EX:**

```
String str1=new String("Durga ");
String str2=str1.concat("Software ");
String str3=str2.concat("Solutions");
System.out.println(str1);
System.out.println(str2);
System.out.println(str3);
```

**OP:** Durga

Durga Software

Durga Software Solutions

**EX:**

```
String str="Durga".concat("Software ").concat("Solutions");
System.out.println(str);
```

**OP:**

Durga Software Solutions

3. public boolean equals(Object obj)

--> This method will check whether the two String objects content is same or not. if two string objects content is same then equals(-) method will return "true" value otherwise equals(-) method will return "false" value.

Q) What is the difference between == operator and equals(-) method?

**Ans:**

'==' is basically a comparision operator, it will check whether the provided operand values are same or not, where operands may be normal primitive variables or object reference variables.

Initially equals(-) method was defined in java.lang.Object class , it was implemented in such a way that to provide comparision between two object reference values.

String class has overridden Object class equals(-) method in such a way that to provide comparision between two String object contents

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**EX:**

```
class A
{
}
class Test
{
    public static void main(String[] args)
    {
        A a1=new A();
        A a2=new A();

        int i=10;
        int j=10;

        String str1=new String("abc");
        String str2=new String("abc");

        System.out.println(i == j);// true
        System.out.println(a1 == a2);// false
        System.out.println(str1 == str2);// false
        System.out.println(a1.equals(a2));// false
        System.out.println(str1.equals(str2));//true
    }
}
```

**4. public boolean equalsIgnoreCase(String str)**

--> In String class, equals(-) method will perform case sensitive comparision between two String object contents, but, equalsIgnoreCase(-) method will perform case insensitive comparision between two String objects content.

**EX:**

```
String str1=new String("abc");
String str2=new String("ABC");
System.out.println(str1.equals(str2));
System.out.println(str1.equalsIgnoreCase(str2));
```

**OP:**

false  
true

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5. public int compareTo(String str)

--> This method will check whether two string objects contents are existed in dictionary order or not.

str1.compareTo(str2)

a) If str1 come first when compared with str2 in dictionary order then compareTo() method will return -ve value.

b) If str2 come first when compared with str1 in dictionary order then compareTo() method will return +ve value.

c) If str1 and str2 are available at the same position in dictionary order then compareTo() method will return 0 value.

**EX:**

```
String str1=new String("abc");
String str2=new String("def");
String str3=new String("abc");
System.out.println(str1.compareTo(str2));
System.out.println(str2.compareTo(str3)); System.out.println(str3.compareTo(str1));
```

**OP:** -3

3

0

6. public boolean startsWith(String str)

--> It will check whether the String starts with the specified String or not.

7. public boolean endsWith(String str)

--> It will check whether the String ends with the specified String or not.

8. public boolean contains(String str)

--> It will check whether String contains the specified String or not.

**EX:**

```
String str=new String("Durga Software Solutions");
System.out.println(str.startsWith("Durga"));
System.out.println(str.endsWith("Solutions"));
System.out.println(str.contains("Software"));
```

**OP:**

true

true

true

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9. public String replace(char old\_Char, char new\_Char)

--> This method will replace the specified old char with the specified new char.

10. public char charAt(int index)

--> It will return a character which is existed at the specified index value.

11. public int indexOf(String str)

--> It will return an index value where the first occurrence of the specified String.

12. public int lastIndexOf(String str)

--> It will return an index value where the last occurrence of the specified String.

**EX:**

```
String str=new String("Durga Software Solutions");
System.out.println(str);
System.out.println(str.replace('S', 's'));
System.out.println(str.charAt(6));
System.out.println(str.indexOf("So"));
System.out.println(str.lastIndexOf("So"));
```

**OP:**

```
Durga Software Solutions
Durga software solutions
S
6
15
```

13. public String substring(int start\_index)

--> This method return a substring starts from the specified index value.

14. public String substring(int start\_Index, int end\_Index)

--> This method will return a substring starts from the specified start index and upto the specified end index.

**EX:**

```
String str=new String("Durga Software Solutions");
System.out.println(str.substring(6));
System.out.println(str.substring(6,14));
```

**OP:**

```
Software Solutions
Software
```

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15. public byte[] getBytes()  
--> This method will convert data from String to byte[].

16. public char[] toCharArray()  
--> This method will convert data from String to char[].

**EX:**

```
String str=new String("Durga Software Solutions");
byte[] b=str.getBytes();
for(int i=0;i<b.length;i++)
{
    System.out.print(b[i]+" ");
}
System.out.println();
char[] ch=str.toCharArray();
for(int i=0;i<ch.length;i++)
{
    System.out.print(ch[i]+" ");
}
```

17. public String[] split(String str)  
--> It will devide the String into no pieces on the basis of the provided String.

**EX:**

```
String str=new String("Durga Software Solutions");
String[] s=str.split(" ");
for(int i=0;i<s.length;i++)
{
    System.out.println(s[i]);
}
```

18. public String trim()  
--> This method will remove pre-spaces and post-spaces of a particular String.

19. public String toLowerCase()  
--> It will convert String into lower case letters.

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20. public String toUpperCase()  
--> It will convert String into Upper case letters.

**EX:**

```
String str=new String(" Durga Software Solutions ");  
System.out.println(str);  
System.out.println(str.trim());  
String str1=new String("Durga Software Solutions");  
System.out.println(str1.toLowerCase());  
System.out.println(str1.toUpperCase());
```

**StringBuffer:****Constructors:**

1. public StringBuffer()  
--> This constructor can be used to create an empty StringBuffer object with 16 elements as initial capacity.

**EX:** StringBuffer sb=new StringBuffer();  
System.out.println(sb.capacity());

**OP:** 16

2. public StringBuffer(int capacity)  
--> This constructor can be used to create an empty StringBuffer object with the specified capacity value.

**EX:** StringBuffer sb=new StringBuffer(10);  
System.out.println(sb.capacity());

**OP:** 10

**3. public StringBuffer(String str)**

--> This constructor can be used to create StringBuffer object with the specified data .

New\_capacity=Initial\_Capacity+data\_Length;

**EX:**

```
StringBuffer sb=new StringBuffer("abc");  
System.out.println(sb);  
System.out.println(sb.capacity());
```

**OP:** abc

19

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**Methods:**

1. `public StringBuffer append(String data)`  
-->This method will append the specified data to the StringBuffer object content.

**EX:**

```
StringBuffer sb1=new StringBuffer("Durga ");
StringBuffer sb2=sb1.append("Software ");
StringBuffer sb3=sb2.append("Solutions");
System.out.println(sb1);
System.out.println(sb2);
System.out.println(sb3);
```

**OP:**

Durga Software Solutions  
Durga Software Solutions  
Durga Software Solutions

**2. `public void ensureCapacity(int capacity)`**

-->This method can be used to set a particular capacity value to StringBuffer object . If the provided capacity value is less than 16 then StringBuffer object will take 16 as capacity value. If the provided capacity value is greater than 16 and less than 34 then StringBuffer will take 34 as capacity value. If the provided capacity value is greater than 34 then StringBuffer object will take the specified value as capacity value.

**EX:**

```
StringBuffer sb=new StringBuffer();
sb.ensureCapacity(10);
System.out.println(sb.capacity());
```

**OP: 16****3. `public StringBuffer reverse()`**

-->This method will reverse the content of StringBuffer object.

**EX:**

```
StringBuffer sb=new StringBuffer("Durga Software Solutions");
System.out.println(sb);
System.out.println(sb.reverse());
```

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#### 4. **public StringBuffer delete(int start\_index, int end\_index)**

--> This method can be used to delete a string from StringBuffer object content starts from the specified start index and upto the specified end index.

**EX:**

```
StringBuffer sb=new StringBuffer("Durga Software Solutions");
System.out.println(sb);
System.out.println(sb.delete(6,14));
```

**EX:**

```
Durga Software Solutions
Durga Solutions
```

#### 5. **public StringBuffer insert(int index, String str)**

--> This method can be used to insert the specified String at the specified index in StringBuffer object.

**EX:**

```
StringBuffer sb=new StringBuffer("Durga Solutions");
System.out.println(sb);
System.out.println(sb.insert(6,"Software"));
```

**OP:**

```
Durga Solutions
Durga Software Solutions
```

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## Exception Handling

Q) What is the difference between Error and Exception?

**Ans:**

Error is a problem in java applications.  
There are two types of errors in java.

- 1.Compile time Errors
- 2.Runtime Errors

### 1. Compile time errors:

These are problems identified by the compiler at compilation time.  
In general, There are three types of compile time errors.

**1. Lexical Errors:** Mistakes in keywords,..

**EX:** int i=10; ----> Valid  
      nit i=10; ----> Invalid

**2. Syntax Errors:** Grammatical Mistakes or syntactical mistakes.

**EX:** int i=10;---> Valid  
      i int 10 ; --> Invalid

**3. Semantic Errors:** Providing operators inbetween incompatible types.

**EX:** int i=10;  
      int j=20;  
      int k=i+j; ----> Valid

**EX:** int i=10;  
      boolean b=true;  
      char c= i+b;----> Invalid.

**NOTE:** Some other errors are generated by Compiler when we violate JAVA rules and regulations in java applications.

**EX:** Unreachable Statements, valriable might not have been initialization ,possible loss of precision,....

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## 2.Runtime Errors:

These are the problems for which we are unable to provide solutions programatically and these errors are not identified by the compilers and these errors are occurred at runtime.

**EX:** Insufficient Main Memory.

Unavailability of IO Components.

JVMInternal Problems.

## 2.Exception:

Exception is a problem, for which we are able to provide solutions programatically.

**EX:** ArithmeticException

NullPointerException

ArrayIndexOutOfBoundsException

---

----

**Exception:** Exception is an unexpected event occured in java applications at runtime , which may be provided by users while entering dynamic input in java applications, provided by the Database Engines while executing sql queries in Jdbc applications, provided by Network while establish connection between local machine and remote machine,.....causes abnormal termination to the java applications.

There are two types of terminations in java applications.

1.SMOOTH TERMINATION

Terminating program at end is called as Smooth termination.

2.ABNORMAL TERMINATION

Terminating program in the middle is called as Abnormal Termination.

In general, Exceptions are providing abnormal terminations, these abnormal terminations may crash local operating systems , these abnormal terminations may provide hangedout situations to the network,.....

To overcome the above problems we have to handle exceptions properly, to handle exceptions properly we have to use "Exception Handling Mechanism".

Java is a Robust programming language, because,

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1. Java is having very good memory management system in the form of Heap Memory Management system , it is a dynamic memory management system, it allocates and deallocates memory for the objects at runtime.

2. Java is having very good exception handling mechanisms, JAVA has provided very good predefined library to represent and handle almost all the frequently generated exceptions.

There are two types of exceptions in Java.

- 1.Predefined Exceptions
- 2.User defined Exceptions

### **1.Predefined Exceptions**

These Exceptions are defined by JAVA programming language and provided along Java software.

-- Diagram----

There are two types predefined Exceptions.

- 1.Checked Exceptions
- 2.Unchecked Exceptions

Q)What is the difference between checked exceptions and Unchecked Exceptions?

**Ans:**

Checked Exception is an exception recognized at compilation time, but, not occurred at compilation time.

Unchecked Exceptions are not recognized at compilation time, these exceptions are recognized at runtime by JVM.

**Note:** In Exceptions Arch, RuntimeException and its sub classes and Error and its sub classes are the examples for Unchecked Exceptions and all the remaining classes are the examples for Checked Exceptions.

There are two types of Checked Exceptions

- 1.Pure Checked Exceptions
- 2.Partially Checked Exceptions

Q)What is the difference between Pure checked exception and Partially Checked Exceptions?

**Ans:**

If any checked exception is having only checked exceptions as sub classes then this exception is called as Pure Checked Exception.

**EX:** IOException

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If any Checked Exception contains atleast one sub class as unchecked exception then that Checked Exception is called as Partially Checked Exception.

**EX:** Exception , Throwables

Predefined Exceptions Overview:

### 1.ArithmaticException

In java applications, when we have a situation like a number is devided by zero then JVM will rise Arithmatic Exception.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int i=10;
        int j=0;
        float f=i/j;
        System.out.println(f);
    }
}
```

If we run the above program then JVM will provide ArithmaticException with the following Exception message.

Exception in thread "main" java.lang.ArithmaticException: / by zero  
at Text.main(Test.java:7)

The above exception message is devided into the following three parts.

- 1.Exception Name: java.lang.ArithmaticException
- 2.Exception Descrioptioun: / by zero
- 3.Exception Location : Test.java:7

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**2.NullPointerException:**

In java applications, when we access any instance variable and instance methods by using a reference variable contains null value then JVM will rise NullPointerException.

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        java.util.Date d=null;
        System.out.println(d.toString());
    }
}
```

If we run the above code then JVM will provide the following exception details.

- 1.Exception Name : java.lang.NullPointerException
- 2.Exception Description: --- No description----
- 3.Exception Location: Test.java:6

**3.ArrayIndexOutOfBoundsException:**

In java applications, when we insert an element to an array at a particular index value and when we are trying to access an element from an array at a particular index value and if the specified index value is outside of the arrays size then JVM will rise an exception like "ArrayIndexOutOfBoundsException".

**EX:**

```
class Test
{
    public static void main(String[] args)
    {
        int [] a={1,2,3,4,5};
        System.out.println(a[10]);
    }
}
```

If we run the above program then JVM will rise an exception with the following details.

Exception Name : java.lang.ArrayIndexOutOfBoundsException

Exception Description: 10

Exception Location: Test.java: 6

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**4. ClassCastException:**

In java applications, we are able to keep sub class object reference value in super class reference variable, but, we are unable to keep super class object reference value in sub class reference variable. If we are trying to keep super class object reference value in sub class reference variable then JVM will rise an exception like "java.lang.ClassCastException".

**EX:**

```
class A
{
}
class B extends A
{
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        B b=(B)a;
    }
}
```

If we run the above code then JVM will rise an exception with the following details.

Exception Name: java.lang.ClassCastException

Exception Description: A can not be cast to B

Exception location: Test.java: 12

**5. ClassNotFoundException:**

In java applications, if we want to load a particular class bytecode to the memory without creating object then we will use the following method from java.lang.Class class.

```
public static Class.forName(String class_Name) throws ClassNotFoundException
```

**EX:** Class c=Class.forName("A");

When JVM encounter the above instruction, JVM will search for A.class file at current location, at java predefined library and at the locations referred by "classpath" environment variable, if the required A.class file is not identified at all the locations then JVM will rise ClassNotFoundException.

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**EX:**

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        Class c=Class.forName("AAA");
    }
}
```

If we run this code the JVM will provide the following exception details.

- 1.Exception Name: java.lang.ClassNotFoundException
- 2.Exception Description: AAA
- 3.Exception Location: Test.java: 12
- 4.InstantiationException 5.IllegalArgumentException

In java applications, if we load class bytecode by using

"Class.forName(-)" method then to create object explicitly we have to use the following method from java.lang.Class class.

```
public Object newInstance()
```

**EX:** Object obj=c.newInstance()

When JVM encounter the above code then JVM will search for 0-arg constructor and non-private constructor in the loaded class. if 0-arg constructor is not availabnle, if parameterized construcvtor is existed then JVM will rise "java.lang.instantiationException". If non-private constructor is not available, if private constructor is available then JVM will rise "java.lang.IllegalAccessException".

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**EX1:**

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
    A(int i)
    {
        System.out.println("Object Creating");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        Class c=Class.forName("A");
        Object obj=c.newInstance();
    }
}
```

If run the above code then JVM will provide an exception with the following details.

- 1.Exception Name : java.lang.InstantiationException
- 2.Exception Description: A
- 3.Exception Location:Test.java: 17

**EX:**

```
class A
{
    static
    {
        System.out.println("Class Loading");
    }
    private A()
    {
        System.out.println("Object Creating");
    }
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        Class c=Class.forName("A");
    }
}
```

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```
        Object obj=c.newInstance();
    }
}
```

If we run the above code then JVM will rise an exception with the following details

- 1.Exception Name : java.lang.IllegalAccessException
- 2.Exception Description: Test class can not access the members of class A modifier "private".
- 3.Exception Location" Test.java: 17

with the

#### 'throw' keyword:

'throw' is a java keyword, it can be used to rise exceptions intentionally as per the developers application requirement.

#### Syntax:

```
throw new Exception_Name("----Exception Description----");
```

#### EX:

```
class Test
{
    public static void main(String[] args)throws Exception
    {
        String accNo=args[0];
        String accName=args[1];
        int pin_Num=Integer.parseInt(args[2]);
        String accType=args[3];
        System.out.println("Account Details");
        System.out.println("-----");
        System.out.println("Account Number   :" +accNo);
        System.out.println("Account Name    :" +accName);
        System.out.println("Account Type   :" +accType);
        System.out.println("Account PIN Number:" +pin_Num);
        if(pin_Num>=1000 && pin_Num<=9999)
        {
            System.out.println("valid PIN Number");
        }
        else
        {
            throw new RuntimeException("Invalid PIN Number, enter Valid 4 digit
PIN Number");
        }
    }
}
```

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```
D:\javaapps>javac Test.java
D:\javaapps>java Test abc123 AAA 1234 Ssavings
--- Account details with out Exception----
```

```
D:\javaapps>java Test abc123 AAA 123 Savings
--- Account details are displayed with Exception----
```

---Account details----

Exception in thread "main" java.lang.RuntimeException: Invalid PIN Number, enter valid 4 digit PIN number  
at Test.main(Test.java:17)

There are two ways to handle exceptions .

- 1.By using 'throws' keyword.
- 2.By using try-catch-finally block.

### 1.'throws' keyword:

It is a Java keyword,it can be used to bypass the generated exception from the present method or constructor to the caller method (or) constructor.

In Java applications, 'throws' keyword will be used in method declarations,not in method body.

In Java applications,"throws" keyword allows an exception class name,it should be either same as the generated exception or super class to the generated exception.It should not be subclass to the generated Exception.

'throws' keyword allows more than one exception in method prototypes.

In Java applications,"throws" keyword will be utilized mainly for checked exceptions.

**EX:**void m1() throws RuntimeException{  
throw new ArithmeticException();  
}

**Status:**Valid

**EX:**void m1() throws FileNotFoundException{  
throw new IOException();  
}

**Status:**InValid

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**EX:**

```
Void m1() throws NullPointerException,ClassNotFoundException{  
}
```

**Status:**Valid**EX:**

```
Void m1() throws IOException,FileNotFoundException  
{  
}
```

**Status:**Valid , Not Suggestible

If we specify any super exception class along with throws keyword,then it is not necessary to specify any of its child exception classes along with “throws” keyword.

**NOTE:**In any Java method,if we call some other method which is bypassing an exception by using “throws” keyword,then we must handle that exception either by using “throws” keyword in the present method[Caller Method] prototype or by using “try-catch-finally” in the body of the present method[Caller method].

**EX:**

```
Void m1() throws Exception{  
----  
----  
}  
Void m2(){  
try{  
m1();  
}  
catch(Exception e){  
e.printStackTrace();  
}  
}
```

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**EX:**

```
void m1() throws Exception{  
----  
}  
void m2() throws Exception{  
    m1();  
}
```

**EX:**

```
import java.io.*;  
class A{  
void add() throws Exception{  
concat();  
}  
Void concat() throws IOException{  
throw new IOException();  
}  
}  
class Test{  
public static void main(String args[]) throws Throwable{  
A a=new A();  
a.add();  
}  
}
```

**Internal Flow:**

If we execute the above program, then JVM will recognize throw keyword in concat() method and JVM will rise an exception in concat() method, due to throws keyword in concat() method prototype, Exception will be bypassed to concat() method call that is in add(), due to throws keyword in add() method Exception will be bypassed to add() method call, that is, in main() method, Due to 'throws' keyword in main() method Exception will be bypassed to main() method call, that is, to JVM, where JVM will activate "Default Exception Handler", where Default Exception Handler will display exception details.

Q) What are the differences between "throw" and "throws" keywords?

**Ans:**

- 1.'throw' keyword can be used to rise the exceptions intentionally as Per the application requirement.  
'throws' keyword is able to bypass the exception from the present method to the caller method.
- 2.'throw' keyword will be utilized in method body.  
'throws' keyword will be used in method declarations or in method prototype (or) in method header part.

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3.'throw' keyword allows only one exception class name.  
'throws' keyword allows more than one exception class name.

**try-catch-finally:**

In Java application "throws" keyword is not really an exception handler,because "throws" keyword will bypass the exception handling responsibility from present method to the caller method.

If we want to handle the exceptions,the location where exceptions are generated then we have to use "try-catch-finally".

**Syntax:**

```
try{  
----  
}  
catch(Exception_Name e){  
----  
}  
finally{  
----  
}
```

where the purpose of try block is to include a set of exceptions , which may rise an exception.

If JVM identify any exception inside "try" block then JVM will bypass flow of execution to "catch" block by skipping all the remaining instructions in try block and by passing the generated Exception object reference as parameter.

If no exception is identified in "try" block then JVM will execute completely "try" block,at the end of try block, JVM will bypass flow of execution to "finally" block directly.

The main purpose of catch block is to catch the exception from try block and to display exception details on command prompt.

To display exception details on command prompt,we have to use the following three approaches.

- 1.e.printStackTrace()
- 2.System.out.println(e);
- 3.System.out.println(e.getMessage());

**1.e.printStackTrace():**

It will display the exception details like Exception Name,Exception Description and Exception Location.

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## 2. **System.out.println(e):**

If we pass Exception object reference variable as parameter to System.out.println(-) method then JVM will access Exception class toString() method internally, it will display the exception details like Exception name, Exception description.

## 3. **System.out.println(e.getMessage()):**

Where getMessage() method will return a String contains the exception details like only Description of the exception.

**EX:**

```
class Test{  
    public static void main(String args[]){  
        try{  
            throw new ArithmeticException("My Arithmetic Exception");  
        }  
        catch(ArithmeticException e){  
            e.printStackTrace();  
            System.out.println();  
            System.out.println(e);  
            System.out.println();  
            System.out.println(e.getMessage());  
        }  
        finally{  
        }  
    }  
}
```

**OP:**

```
java.lang.ArithmaticException:My Arithmetic Exception  
at Test.main(Test.java:7)
```

java.lang.ArithmaticException:My Arithmetic Exception

My Arithmetic Exception

Where the main purpose of finally block is to include some Java code , it will be executed irrespective of getting exception in "try" block and irrespective of executing "catch" block.

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Q)What is the difference between "final","finally" and "finalize" in JAVA?

**Ans:**

1."final" is a keyword it can be used to declare constant expressions.  
There are three ways to use final keyword in java applications.

- a)final variable:It will not allow modifications over its value.
- b)final methods:It will not allow method overriding.
- c)final class:It will not allow inheritance, that is, sub classes.

**2.finally block:** It is part of try-catch-finally syntax,it will include some instructions,which must be executed by JVM irrespective of getting exception from try block and irrespective of executing catch block.

**3.finalize():** It is a method in java.lang.Object class,it will be executed just before destroying objects inorder to give final notification to the user about to destroy objects.

Q)Find the output from the following programs?

```
class Test{  
    public static void main(String args[]){  
        System.out.println("Before Try");  
        try{  
            System.out.println("Inside Try");  
        }  
        catch(Exception e){  
            System.out.println("Inside Catch");  
        }  
        finally{  
            System.out.println("Inside Finally");  
        }  
        System.out.println("After Finally");  
    }  
}
```

**OP:**

Before try  
Inside try  
Inside finally  
After finally

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**EX:** class Test{  
    public static void main(String args[]){  
        System.out.println("Before Try");  
        try{  
            System.out.println("Before Exception in try");  
            float f=100/0;  
            System.out.println("After Exception in try");  
        }  
        catch(Exception e){  
            System.out.println("Inside Catch");  
        }  
        finally{  
            System.out.println("Inside Finally");  
        }  
        System.out.println("After Finally");  
    }  
}

**OP:** Before try  
Before exception in try  
Inside catch  
Inside finally  
After finally

Q) Find the output from the following program?

```
class A{  
    int m1(){  
        try{  
            return 10;  
        }  
        catch(Exception e){  
            return 20;  
        }  
        finally{  
            return 30;  
        }  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        A a=new A();  
        int val=a.m1();  
        System.out.println(val);  
    }  
}
```

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**OP:**

30

**NOTE:**finally block provided return statement is the finally return statement for the method

Q) Is it possible to provide "try" block without "catch" block?

**Ans:**

Yes, it is possible to provide try block with out catch block but by using "finally" Block.

**Syntax:**

```
try{  
}  
}  
finally{  
}
```

**EX:**

```
class Test{  
public static void main(String args[]){  
System.out.println("Before try");  
try{  
System.out.println("Before Exception inside try");  
int i=100;  
int j=0;  
float f=i/j;  
System.out.println("After Exception inside try");  
}  
finally{  
System.out.println("Inside finally");  
}  
System.out.println("After Finally");  
}  
}
```

**Status:** No Compilation Error.**OP:**

```
Before try  
Before exception inside try  
Inside finally  
Exception in thread “main” java.lang.ArithmaticException:/by zero  
at Test.main(Test.java:11)
```

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**REASON:** When JVM encounter exception in try block,JVM will search for catch block,if no catch block is identified,then JVM will terminate the program abnormally after executing finally block.

Q)Is it possible to provide "try" block with out "finally" block?

**Ans:**

Yes,it is possible to provide "try" block with out "finally" block but by using "catch" block.

**Syntax:**

```
try{  
-----  
-----  
}  
catch(Exception e){  
-----  
-----  
}
```

Q)Is it possible to provide try-catch-finally

- a)inside try block,
- b)inside catch block and
- c)inside finally block

**Ans:**

Yes,it is possible to provide try-catch-finally inside try block,inside catch block and inside finally block.

**Syntax-1:**

```
try{  
try{  
}  
catch(Exception e){  
}  
finally{  
}  
}  
catch(Exception e){  
}  
finally{  
}
```

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**Syntax-2:**

```
try{  
}  
}  
catch(Exception e){  
try{  
}  
}  
catch(Exception e)  
{  
}  
}  
finally{  
}  
}  
}  
finally{  
}
```

**Syntax-3:**

```
try{  
}  
}  
catch(Exception e){  
}  
finally{  
try{  
}  
}  
catch(Exception e){  
}  
finally{  
}  
}
```

Q) Is it possible to provide more than one catch block for a single try block?

**Ans:**

Yes, it is possible to provide more than one catch block for a single try block but with the following conditions.

1. If no inheritance relation existed between exception class names which are specified along with catch blocks then it is possible to provide all the catch blocks in any order. If inheritance relation is existed between exception class names then we have to arrange all the catch blocks as per Exception classes inheritance increasing order.
2. In general, specifying an exception class along with a catch block is not giving any guarantee to rise the same exception in the corresponding try block, but if we specify any pure checked exception along with any catch block then the corresponding "try" block must rise the same pure checked exception.

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**Ex1:**

```
try{  
}  
}  
catch(ArithmeticException e){  
}  
catch(ClassCastException e){  
}  
catch(NullPointerException e){  
}
```

**Status:**Valid Combination**Ex2:**

```
try{  
}  
}  
catch(NullPointerException e){  
}  
catch(ArithmeticException e){  
}  
catch(ClassCastException e){  
}
```

**status:**Valid Combination**Ex3:**

```
try{  
}  
}  
catch(ArithmeticException e){  
}  
catch(RuntimeException e){  
}  
catch(Exception e){  
}
```

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**Ex4:**

```
try{  
}  
}  
catch(Exception e){  
}  
catch(RuntimeException e){  
}  
catch(ArithmeticException e){  
}
```

**status:** Invalid**Ex5:**

```
try{  
throws new ArithmeticException("My Exception");  
}  
catch(ArithmeticException e){  
}  
catch(IOException e){  
}  
catch(NullPointerException e){  
}
```

**Status:** Invalid**Ex6:**

```
try{  
throw new IOException("My Exception");  
}  
catch(ArithmeticException e){  
}  
catch(IOException e){  
}  
catch(NullPointerException e){  
}
```

**status:** Valid**CONTACT US:****Mobile:** +91- 8885 25 26 27 +91- 7207 21 24 27/28**US NUM:** , 4433326786**Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO: 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,**

**Custom Exceptions/User Defined Exceptions:**

Custom Exceptions are the exceptions, which would be defined by the developers as per their application requirements.

If we want to define user defined exceptions then we have to use the following steps:

1. Define User defined Exception class:

To declare user-defined Exception class, we have to take an user-defined class, which must be extended from java.lang.Exception class.

Class MyException extends Exception

```
{  
}
```

2. Declare a String parametrized constructor in User-Defined Exception class and access String parametrized super class constructor by using "super" keyword:

```
class MyException extends Exception{  
    MyException(String err_Msg){  
        super(err_Msg);  
    } }
```

3. Create and Rise exception in Java application as per the application requirement:

```
try{  
    throw new MyException("My Custom Exception");  
}  
catch(MyException me){  
    me.printStackTrace();  
}
```

```
class InsufficientFundsException extends Exception{  
    InsufficientFundsException(String err_Msg){  
        super(err_Msg);  
    } }
```

```
class Account{  
    String accNo;  
    String accName;  
    String accType;  
    int balance;
```

```
Account(String accNo, String accName, String accType, int balance){
```

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```
this.accNo=accNo;
this.accName=accName;
this.accType=accType;
this.balance=balance;
}
}
class Transaction
{
    public void withdraw(Account acc, int wd_Amt)
    {
        try
        {
            System.out.println("Transaction Details");
            System.out.println("-----");
            System.out.println("Account Number :"+acc.accNo);
            System.out.println("Account Name :"+acc.accName);
            System.out.println("Account Type :" + acc.accType);
            System.out.println("Transaction Type :WITHDRAW");
            System.out.println("Withdraw Amount :" + wd_Amt);
            if(acc.balance>wd_Amt)
            {
                acc.balance=acc.balance-wd_Amt;
                System.out.println("Total Balance :" + acc.balance);
                System.out.println("Transaction Status:SUCCESS");
            }
            else
            {
                System.out.println("Total Balance :" + acc.balance);
                System.out.println("Transaction Status:FAILURE");
                throw new InsufficientFundsException("Funds are not Sufficient in
your Account, please enter valid Withdraw Amout");
            }
        }
        catch (InsufficientFundsException e)
        {
            System.out.println(e.getMessage());
        }
        finally
        {
            System.out.println("*****ThanQ, Visit Again*****");
        }
    }
}
class Test
```

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```
{  
    public static void main(String[] args)  
    {  
        Account acc1=new Account("abc123", "Durga", "Savings", 10000);  
        Transaction tx1=new Transaction();  
        tx1.withdraw(acc1, 5000);  
        System.out.println();  
        Account acc2=new Account("xyz123", "Anil", "Savings", 10000);  
        Transaction tx2=new Transaction();  
        tx2.withdraw(acc2, 15000);  
    }  
}
```

### JAVA7 Features in Exception Handling:

1. Multi Catch block
2. Try-with-Resources/Automatic Resources Management/Auto close able Resources

#### 1. Multi Catch block:

Consider the below syntax:

```
try{  
}  
catch(Exception e){  
}
```

If we specify "Exception" class along with catch block then it able to catch and handle all the exceptions which are either same as Exception or child classes to Exception, this approach will not handling exceptions individually, it will handle all the exceptions in the common way.

If we want to handle to the Exceptions separately then we have to use multiple catch blocks for a single try block.

```
try{  
}catch(ArithmaticException e){  
}catch(NullPointerException e){  
}catch(ClassCastException e){  
}
```

If we use this approach then no.of catch blocks are increased.

In Java applications, if we want to handle all the exceptions separately and by using a single catch block then we have to use "JAVA7" provided multi- catch block

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**Syntax:**

```
try{  
}  
}  
catch(Exception1 | Exception2 |....|Exception-n e){  
}
```

where Exception1,Exception2....must not have inheritance relation otherwise Compilation error will be raised.

**EX:**

```
class Test{  
    public static void main(String args[]){  
        try{  
            /* int a=10;  
             * int b=0;  
             * float c=a/b;  
             */  
            /*java.util.Date d=null;  
             System.out.println(d.toString());  
             */  
            int[] a={1,2,3,4,5};  
            System.out.println(a[10]);  
        }  
        catch(ArithmeticException | NullPointerException | ArrayIndexOutOfBoundsException e){  
            e.printStackTrace();  
        }  
    }  
}
```

**Try-With-Resources/Auto Closeable Resources:**

In general,in Java applications,we may use the resources like Files,Streams,Database Connections....as per the application requirements.

If we want to manage the resources along with try-catch-finally in Java applications then we have to use the following conventions.

- 1.Declare all the resources before "try" block.
- 2.Create the resources inside "try" block.
- 3.Close the resources inside finally block.

The main intention to declare the resources before "try" block is to make available resources variables to "catch" block and to "finally" block to use.

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If we want to close the resources in "finally" block then we have to use close() methods, which are throwing some exceptions like IOException,SQLException depending on the resource by using "throws" keyword,to handle these exceptions we have to use "try-catch-finally" inside "finally" block.

```
//Declare the resources
File f=null;
BufferedReader br=null;
Connection con=null;
try{
//create the resources
f=new File("abc.txt");
br=new BufferedReader(new InputStreamReader(System.in));
con=DriverManager.getConnection("jdbc:odbc:nag","system","durga");
-----
-----
}
catch(Exception e){
}
finally{
//close the resources
try{
f.close();
br.close();
con.close();
}catch(Exception e){
e.printStackTrace();
}
}
```

To manage the resources in Java applications,if we use the above convention then developers have to use close() methods explicitly,Developers have to provide try-catch-finally inside "finally" block,this convention will increase no.of instructions in Java applications.

To overcome all the above problems,JAVA7 version has provided a new Feature in the form of "Try-With-Resources" or "Auto Closeable Resources".

In the case of "Try-With-Resources",just we have to declare and create the resources along with "try"[not inside try block,not before try block] and no need to close these resources inside the finally block,why because,JVM will close all the resources automatically when flow of execution is coming out from "try" block.

In the case of "Try-With-Resources",it is not required to close the resources explicitly,it is not required to use close() methods in finally block explicitly,so that it is not required to use "finally" block in try-catch-finally syntax.

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**Syntax:**

```
try(Resource1;Resource2;.....Resource-n){  
----  
----  
}  
catch(Exception e){  
----  
----  
}
```

Where all the specified Resources classes or interfaces must implement "java.io.AutoCloseable" interface.

Where if we declare resources as AutoCloseable resources along with "try" then the resources reference variables are converted as "final" variables.

**EX:**

```
try(File f=new File("abc.txt");  
BufferedReader br=new BufferedReader(new InputStreamReader(System.in));  
Connection con=DriverManager.getConnection("jdbc:odbc:nag","system","durga");)  
{  
----  
----  
}  
catch(Exception e){  
e.printStackTrace();  
}
```

**NOTE:**In Java,all the predefined Stream classes,File class,Connection interface are extends/implemented "java.io.AutoCloseable" interface predefinedly.

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## Multi Threading

Q) What is the difference between Process, Procedure and Processor?

**Ans:**

process is a flow of execution to perform a particular task.

Procedure is a set of instructions to represent a particular task.

Processor is an H/W component to generate no of processes inorder to execute applications.

At starting point of the computers we have Single Process Mechanism or Single Tasking to execute applications.

In Single Process Mechanism, System is able to allow only one task at a time to load into the memory even our system main memory is capable to manage all the tasks.

In Single Process mechanism, System is able to allow only one process to execute all the tasks which are available in our application, it will follow sequential kind of execution , it will increase application execution time and it will reduce application performance.

To overcome the above problems we have to use Multi Process Mechanism or multi tasking. IN Multi tasking system is able to allow to load more than one task at a time in main memory and it able to allow more than one process to execute application, it will follow parallel execution , it will reduce application execution time and it will improve application performance.

To execute applications by using Multi Tasking or Multi Process Mechanism we have to use the following components.

1. Main Memory: To load all the tasks.
2. Process Waiting Queue: To keep track of all process
3. Process Context Block: to manage status of all the processes execution.
4. Process Scheduler: It will take process from Process Waiting Queue and it will assign time stamps to each and every process inorder to execute.

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In the above multi processing system, controlling is switched from one process context to another process context called as "Context Switching".

There are two types of Context Switchings.

### **1.Heavy Weight Context Switching:**

It is the context switching between two heavy weight components, it will take more memory and more execution time , it will reduce application performance.

**EX:** Cotext switching between two Processes.

### **2.Light Weight Context Switching:**

It is the context switching between two light weight components, it will take less memory and less execution time and it will improve application performance.

**EX:** Context switching between two threads.

**Q)What is the difference between Process and Thread?**

#### **Ans:**

Process is heavy weight , to handle it System has to consume more memory and more execution time, it will reduce application performance.

Thread is light weight, to handle it system has to consume less memory and less execution time, it will improve application performance.

There are two thread models to execute applications.

- 1.Single Thread Model
- 2.Multi Thread Model

### **1.Single Thread Model:**

It will allow only one thread to execute application, it will follow sequential exexcution, it will increase application execution time and it will reduce application performance.

### **2.Multi Thread Model:**

It will allow more than one thread to execute application, it will follow parallel execution , it will reduce application execution time and it will improve application performance.

Java is following Multi Thread Model to execute applications and it will provide very good environment to create and execute more than one thared at a time.

In java applications, to create Threads JAVA has provided the following predefined library in the form of `java.lang` package.

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Q)What is thread and in how many ways we are able to create threads in java?

**Ans:**

Thread is a flow of execution to perform a particular task.

As per the predefined library provided by JAVA , there are two ways to create threads in java applications.

**1.Extending Thread class:**

In this approach , we have to declare a class , it must be extended from java.lang.Thread class.

```
class MyThread extends Thread  
{  
    ---implementation----  
}
```

**2.Implementing Runnable interface:**

In this approach, we have to declare a class, it must implement java.lang.Runnable interface.

```
class MyThread implements Runnable  
{  
    ---implementation----  
}
```

**Threads Design in Java:**

There are two approaches to create threads in java applications.

- a)Extending Thread class
- b)Implementing Runnable interface

**a)Extending Thread class**

- 1)Declare an user defined class.
- 2)Extend java.lang.Thread class to user defined class
- 3)Override Thread class run() method in user defined thread class with the implementation representing a particular task which we want to perform by creating a thread.
- 4)In main class, in main() method, create object for user defined class.

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5) Access Thread class provided start() method on user defined thread class object reference variable.

The main intention of start() method is to create new thread and to access run() method by passing the generated thread.

```
public void start()
```

**EX:**

```
class MyThread extends Thread
{
    public void run()
    {
        for(int i=0;i<10;i++)
        {
            System.out.println("User Thread :" +i);
        }
    }
}
class Test
{
    public static void main(String[] args)
    {
        MyThread mt=new MyThread();
        mt.start();
        for(int i=0;i<10;i++)
        {
            System.out.println("Main Thread :" +i);
        }
    }
}
```

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Q) In java applications, to create threads we have already first approach[Extending thread class] then what is the requirement to go for Second Approach[ implementing Runnable interface]?

**Ans:**

In java applications, to create threads if we use first approach then we have to declare an user defined class and it must be extended from `java.lang.Thread` class, in this context, it is not possible to extend other classes , if we extend any other class like `Frame`,.. along with `Thread` class then it will represent Multiple Inheritance, it is not possible in java .

```
class MyClass extends Frame, Thread{  
---  
}
```

To overcome the above problem, we have to use second approach to create thread , that is, implementing Runnable interface.

```
class MyClass extends Frame implements Runnable{  
---  
}
```

## 2) Implementing Runnable interface:

- a)Declare an user defined class.
- b)Implement `java.lang.Runnable` interface.
- c)Provide implementation part in `run()` method which we want to execute by creating a thread.
- d)In main class, in `main()` method, create a thread and access user defined thread class `run()` method.

To perform the above step we have to use the following cases.

```
class MyThread implements Runnable{  
public void run(){  
---  
}  
}
```

### case-1:

```
MyThread mt=new MyThread();  
mt.start();
```

**Status:** Compilation Error.

**Reason:** `start()` method was not declared in `MyThread` class and in its super class `java.lang.Object` class,  
`start()` method is existed in `java.lang.Thread` class.

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**Case-2:**

```
MyThread mt=new MyThread();
mt.run();
```

**Status:** No Compilation Error, but, only Main thread access MyThread class run() method like a normal java method, no multi threadding environment.

**Case-3:**

```
MyThread mt=new MyThread();
Thread t=new Thread();
t.start();
```

**Status:** No Compilation Error, start() method creates new thread and it access Thread class run() method, not MyThread class run() method.

**Case-4:**

```
MyThread mt=new MyThread();
Thread t=new Thread(mt);
t.start();
```

**Status:** No Compilation Error, start() method creates new thread and it will bypass new thread to MyThread class run() method.

**Thread Lifecycle:**

The collective information of a thread right from its starting point to ending point is called as "Thread Life Cycle".

In java applications, Threads are able to have the following states as part of their lifecycle.

**1.New/Born State:**

When we create Thread class object in java applications then Thread will come to New/Born state.

**2.Ready/Runnable State:**

When we access start() method Thread Schedular has to assign system resources like memory and time, here before assigninig system resources and after calling start() method is called as Ready/Runnable state.

**3.Running State:**

In java applications, after calling start() method and after getting system resources like memory and execution time is called as "Running State".

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**NOTE:** We can send a thread from Running state to Runnable state directly by accessing yield() method , but, it is not supported by Windows operating system, because, it will perform its functionality on the basis of Threads priority values, priority based operations are not supported by windows operating system.

#### 4.Dead/Destroy State:

In java applications, when we access stop() method over Running thread then that thread will come to Dead/Destroy state.

#### 5.Blocked State:

In java applications, we are able to keep a thread in Blocked state from Running state in the following situations.

- a)When we access sleep(--) method with a particular sleep time.
- b)When we access wait() method.
- c)When we access suspend() method.
- d)When we perform IO Operations.

In java applications, we are able to bring a thread from Blocked state to Ready / Runnable state in the following situations.

- a)When sleep time is over.
- b)If any other thread access notify() / notifyAll() methods.
- c)If any other thread access resume() method.
- d)When IO Operations are completed.

#### Thread class Library:

##### Constructors:

1. public Thread()

--> This constructor can be used to create thread class object with the following properties.

Thread Name: Thread-0

Thread Priority: 5

Thread group Name : main

**EX:** Thread t=new Thread();  
System.out.println(t);

**OP:** Thread[Thread-0, 5, main]

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2. public Thread(String name)

--> This constructor can be used to create Thread class object with the specified name.

**EX:** Thread t=new Thread("Core Java");

```
System.out.println(t);
```

**OP:** Thread[Core Java,5,main]

3. public Thread(Runnable r)

--> This constructor can be used to create Thread class object with the specified Runnable reference.

**EX:** Runnable r=new Thread();

```
Thread t=new Thread(r);  
System.out.println(t);
```

**OP:** Thread[Thread-1,5,main]

4. public Thread(Runnable r, String name)

--> This constructor can be used to create Thread class object with the specified Runnable reference and with the specified name.

**EX:** Runnable r=new Thread();

```
Thread t=new Thread(r, "Core Java");  
System.out.println(t);
```

**OP:** Thread[Core Java,5,main]

5. public Thread(ThreadGroup tg, Runnable r)

--> This constructor can be used to create Thread class object with the specified ThreadGroup name and with the specified thread name.

**NOTE:** To provide ThreadGroup name we have to use a predefined class like java.lang.ThreadGroup, to create ThreadGroup class object we have to use the following Constructor.

```
public ThreadGroup(String name)
```

**EX:** ThreadGroup tg=new ThreadGroup("Java");

```
Runnable r=new Thread();  
Thread t=new Thread(tg, r)  
System.out.println(t);
```

**OP:** Thread[Thread-1,5,Java]

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6. **public Thread(ThreadGroup tg, String name)**

--> This constructor can be used to create Thread class object with the specified ThreadGroup name and with the specified Thread name.

**EX:** ThreadGroup tg=new ThreadGroup("Java");  
Thread t=new Thread(tg, "Core Java");  
System.out.println(t);

**OP:** Thread[Core Java,5,Java]

7. **public Thread(ThreadGroup tg, Runnable r, String name)**

--> This constructor can be used to create Thread class object with the specified ThreadGroup name, with the Runnable reference and with the thread name.

**EX:** ThreadGroup tg=new ThreadGroup("Java");  
Runnable r=new Thread();  
Thread t=new Thread(tg, r, "Core Java");

**OP:** Thread[Core Java, 5, Java]

#### Methods:

**1. public void setName(String name)**

--> It can be used to set a particular name to the Thread explicitly.

**2. public String getName()**

--> It can be used to get thread name explicitly.

**EX:** class Test  
{  
    public static void main(String[] args)  
    {  
        Thread t=new Thread();  
        System.out.println(t.getName());  
        t.setName("Core Java");  
        System.out.println(t.getName());  
    }  
}

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### 3. **public void setPriority(int priority)**

--> It can be used to set a particular priority value to the Thread, but, here the priority value must be provided in the range from 1 to 10, if we provide any other value then JVM will rise an exception like `java.lang.IllegalArgumentException`.

To represent Thread priority values, `java.lang.Thread` class has provided the following constants.

```
public static final int MIN_PRIORITY=1;
public static final int NORM_PRIORITY=5;
public static final int MAX_PRIORITY=10;
```

### 4. **public int getPriority()**

--> It can be used to get priority value of the Thread.

#### **EX:**

```
class Test
{
    public static void main(String[] args)
    {
        Thread t=new Thread();
        System.out.println(t.getPriority());
        t.setPriority(7);
        System.out.println(t.getPriority());
        t.setPriority(Thread.MAX_PRIORITY-2);
        System.out.println(t.getPriority());
        //t.setPriority(15);-->IllegalArgumentException
    }
}
```

### 5. **public static int activeCount()**

--> It will return the no of threads which are in active.

#### **EX:**

```
class Test
{
    public static void main(String[] args)
    {
        Thread t=new Thread();
        t.start();
        System.out.println(Thread.activeCount());
    }
}
```

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**6. public boolean isAlive()**

--> This method can be used to check whether a thread is in live or not.

**EX:** class Test

```
{  
    public static void main(String[] args)  
    {  
        Thread t=new Thread();  
        System.out.println(t.isAlive());  
        t.start();  
        System.out.println(t.isAlive());  
    }  
}
```

**7. public static Thread currentThread()**

--> It can be used to get Thread object reference which is in active at present.

**EX:** class MyThread extends Thread

```
{  
    public void run()  
    {  
        for(int i=0;i<10;i++)  
        {  
            System.out.println(Thread.currentThread().getName());  
        }  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        MyThread mt1=new MyThread();  
        MyThread mt2=new MyThread();  
        MyThread mt3=new MyThread();  
  
        mt1.setName("AAA");  
        mt2.setName("BBB");  
        mt3.setName("CCC");  
  
        mt1.start();  
        mt2.start();  
        mt3.start();  
    }  
}
```

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## 8. public static void sleep(long time) throws InterruptedException

--> This method can be used to keep a running thread into sleeping state upto the specified sleep time.

In general, we will use sleep() method in run() method of user defined thread class, where to handle InterruptedException we must use try-catch-finally syntax only, we must not use "throws" keyword in run() method prototype, because, we are overriding Thread class or Runnable interface predefined run() method.

## 9. public void join() throws InterruptedException

--> This method will pause a thread to complete a thread on which we accessed join() method , after completion of the respective thread, paused thread will continue its execution part automatically.

### Daemon Threads

These threads are running internally to provided services to some other thread and it will be terminated along with the threads which are taking services.

To make a thread as daemon thread we have to use the following method.

public void setDaemon(boolean b)

--> If 'b' value is true then thread will be daemon thread.

--> If 'b' value is false then thread will not be daemon thread.

**EX:** mt.setDaemon(true);

To check whether a thread is daemon thread or not we have to use the following method.

public boolean isDaemon()

**EX:** In Java, Garbage Collector is a thread running internally inside JVM and it will provide Garbage Collection services to JVM and it will be terminated along with JVM automatically.

### Synchronization:

In java applications, if we execute more than one thread on a single data item then there may be a chance to get data inconsistency, it may generate wrong results in java applications.

IN java applications, to provide data consistency in the above situation we have to use "Synchronization".

"Synchronization" is a mechanism , it able to allow only one thread at a time , it will not allow more than one at a time, it able to allow other threads after completion of the present thread.

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In java applications, synchronization is going on the basis of Locking mechanisms. If we send multiple threads at a time to synchronized area then Lock Manager will assign lock to a thread which is having highest priority, once a thread gets lock from Lock manager then that thread is eligible to enter in synchronized area, once a thread is available in synchronized area then Lock Manager will not assign lock to other threads, when Thread completes its execution in synchronized area then that thread has to submit lock back to Lock Manager, once Lock is given back to Lock manager then Lock Manager will assign that lock to another thread which is having next priority.

In java applications, to provide synchronization JAVA has provided a keyword in the form of "synchronized".

In java applications, we are able to achieve "synchronization" in the following two ways.

- 1.synchronized method
- 2.synchronized block

#### **1.synchronized method:**

It is a normal java method, it will allow only one thread at a time to execute instructions, it will not allow more than one thread at a time, it will allow other threads after completion of the present thread execution.

#### **EX:**

```
class A
{
    synchronized void m1()
    {
        for(int i=0;i<10;i++)
        {
            String thread_Name=Thread.currentThread().getName();
            System.out.println(thread_Name);
        }
    }
}

class MyThread1 extends Thread
{
    A a;
    MyThread1(A a)
    {
        this.a=a;
    }
    public void run()
    {
        a.m1();
    }
}
```

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```
        }
    }
class MyThread2 extends Thread
{
    A a;
    MyThread2(A a)
    {
        this.a=a;
    }
    public void run()
    {
        a.m1();
    }
}
class MyThread3 extends Thread
{
    A a;
    MyThread3(A a)
    {
        this.a=a;
    }
    public void run()
    {
        a.m1();
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        MyThread1 mt1=new MyThread1(a);
        MyThread2 mt2=new MyThread2(a);
        MyThread3 mt3=new MyThread3(a);

        mt1.setName("AAA");
        mt2.setName("BBB");
        mt3.setName("CCC");

        mt1.start();
        mt2.start();
        mt3.start();
    }
}
```

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Q) In java applications, we have already synchronized methods to achieve synchronization then what is the requirement to use synchronized block?

**Ans:**

In java applications, if we use synchronized method to achieve synchronization then it will provide synchronization through out the method irrespective of the actual requirement. If we need synchronization upto a block inside the synchronized method then it will provide unnecessary synchronization for the remaining part of the method, it will increase execution time and it will reduce application performance.

In the above context, to provide synchronization upto the required part then we have to use synchronized block.

**Synchronized block:**

It is a set of instructions, it able to allow only one thread at a time to execute instructions, it will not allow more than one thread at a time, it will allow other threads after completion of the present thread execution.

**Syntax:**

```
synchronized(Object o)
{
    -----
    -----
}
```

**EX:**

```
class A
{
    void m1()
    {
        String thread_Name=Thread.currentThread().getName();
        System.out.println("Before Synchronized Block :" +thread_Name);
        synchronized(this)
        {
            for(int i=0;i<10;i++)
            {
                String thread_Name1=Thread.currentThread().getName();
                System.out.println("Inside Synchronized Block :" +thread_Name1);
            }
        }
    }
}

class MyThread1 extends Thread
```

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```
{  
    A a;  
    MyThread1(A a)  
    {  
        this.a=a;  
    }  
    public void run()  
    {  
        a.m1();  
    }  
}  
class MyThread2 extends Thread  
{  
    A a;  
    MyThread2(A a)  
    {  
        this.a=a;  
    }  
    public void run()  
    {  
        a.m1();  
    }  
}  
class MyThread3 extends Thread  
{  
    A a;  
    MyThread3(A a)  
    {  
        this.a=a;  
    }  
    public void run()  
    {  
        a.m1();  
    }  
}  
class Test  
{  
    public static void main(String[] args)  
    {  
        A a=new A();  
        MyThread1 mt1=new MyThread1(a);  
        MyThread2 mt2=new MyThread2(a);  
        MyThread3 mt3=new MyThread3(a);  
    }  
}
```

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```
        mt1.setName("AAA");
        mt2.setName("BBB");
        mt3.setName("CCC");

        mt1.start();
        mt2.start();
        mt3.start();
    }
}
```

**Inter thread Communication:**

The process of providing communication between more than one thread is called as " Inter Thread Communication".

To perform Inter Thread Communication we have to use the following methods.

- 1.wait()
- 2.notify()
- 3.notifyAll()

Where wait() method can be used to keep a thread in waiting state.

Where notify() method can be used to give a notification to a thread which is available in waiting state.

Where notifyAll() method can be used to give a notification to all the threads which are available in waiting state.

The above methods are provided by JAVA in java.lang.Object class.

If we want to use these methods in java applications then we must provide "Synchronization".

IN general, Inter Thread Communication will provide solutions for the problems like "Producer-Consumer" problems.

In Producer-Consumer problem, producer and consumer are two threads, where producer has to produce an item and consumer has to consume that item, the same sequence has to be provided infinite no of times, where Producer must not produce an item without consuming previous item by consumer and consumer must not consume an item without producing that item by producer.

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**EX:**

```
class A
{
    boolean flag=true;
    int count=0;
    public synchronized void produce()
    {
        try
        {
            while(true)
            {
                if(flag == true)
                {
                    count=count+1;
                    System.out.println("Producer Produced Item"+count);
                    flag=false;
                    notify();
                    wait();
                }
                else
                {
                    wait();
                }
            }
        catch (Exception e)
        {
            e.printStackTrace();
        }
    }
    public synchronized void consume()
    {
        try
        {
            while(true)
            {
                if(flag == true)
                {
                    wait();
                }
                else
                {
                    System.out.println("Consumer Consumed Item"+count);
                }
            }
        }
    }
}
```

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```
        flag=true;
        notify();
        wait();
    }
}
}
catch (Exception e)
{
    e.printStackTrace();
}
}
class Producer extends Thread
{
    A a;
    Producer(A a)
    {
        this.a=a;
    }
    public void run()
    {
        a.produce();
    }
}
class Consumer extends Thread
{
    A a;
    Consumer(A a)
    {
        this.a=a;
    }
    public void run()
    {
        a.consume();
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a=new A();
        Producer p=new Producer(a);
        Consumer c=new Consumer(a);
        p.start();
    }
}
```

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```
        c.start();
    }
}
```

**Dead Lock:**

Dead Lock is a situation , where more than one thread is depending on each other in circular dependency.

In java applications, once we are getting deadlock then program will stuck in the middle, so that, it will not have any recovery mechanisms, it will have only prevention mechanisms.

**EX:**

```
class Register_Course extends Thread
{
    Object course_Name;
    Object faculty_Name;
    Register_Course(Object course_Name, Object faculty_Name)
    {
        this.course_Name=course_Name;
        this.faculty_Name=faculty_Name;
    }
    public void run()
    {
        synchronized(course_Name)
        {
            System.out.println("Register_Course Thread holds course_Name resource
and waiting for faculty_Name resource.....");
            synchronized(faculty_Name)
            {
                System.out.println("Register_Course is success, because,
Register_Course thread holds both course_Name and faculty_Name resources");
            }
        }
    }
}

class Cancel_Course extends Thread
{
    Object course_Name;
    Object faculty_Name;
    Cancel_Course(Object course_Name, Object faculty_Name)
    {
        this.course_Name=course_Name;
        this.faculty_Name=faculty_Name;
    }
}
```

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```
public void run()
{
    synchronized(faculty_Name)
    {
        System.out.println("Cancel_Course Thread holds faculty_Name resource
and waiting for course_Name resource.....");
        synchronized(course_Name)
        {
            System.out.println("Cancel_Course is success, because,
Cancel_Course thread holds both faculty_Name and course_Name resources");
        }
    }
}

class Test
{
    public static void main(String[] args)
    {
        Object course_Name=new Object();
        Object faculty_Name=new Object();
        Register_Course rc=new Register_Course(course_Name, faculty_Name);
        Cancel_Course cc=new Cancel_Course(course_Name, faculty_Name);
        rc.start();
        cc.start();
    }
}
```

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## IOStreams

In any programming language,in any application,providing input to the Applications and getting output from the Applications is essential.

In case of C and C++ applications,we are able to perform input and output operations by using some predefined library in the form of printf(),scanf(),cin>>,cout<<.....

Similarly in Java Applications,to perform input and output operations we have to use streams.

Java has represented all the streams in the form of predefined classes in "java.io" package.

### Stream:

Stream is medium or channel,it will allow the data in continuous flow from input devices to java program and from Java program to output devices

In Java IOStreams are divided into following ways:

- 1.Byte oriented Streams.
- 2.Character-Oriented Streams

### 1.Byte-Oriented Streams:

These are Streams, which will allow the data in the form of bytes from input devices to Java program and from java program to output devices.

The length of the data in byte-oriented streams is 1 byte.

There are two types of Byte-Oriented Streams

- 1.InputStream
- 2.OutputStream

### 1.InputStream:

It is a byte-oriented Stream,it will allow data in the form of bytes from input devices to Java Applications.

### EX:

- ByteArrayInputStream
- FilterInputStream
- DataInputStream
- ObjectInputStream
- FileInputStream
- StringBufferInputStream
- BufferedInputStream....

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## 2.OutputStream:

It is a byte-oriented Stream,it will allow the data in the form of bytes from Java applications to output devices.

### EX:

ByteArrayOutputStream  
FilterOutputStream  
DataOutputStream  
FileOutputStream  
PrintStream  
BufferedOutputStream..

**NOTE:** All the ByteOrientedStream classes are terminated with "Stream" word.

**NOTE:** The length of data items in Byte Oriented Streams is 1 byte.

## 2.Character-Oriented Streams:

These are the Streams,which will allow the data in the form of characters from input devices to java program and form java program to output devices.

There are two bytes of character-oriented streams

- 1.Reader
- 2.Writer

### 1.Reader:

It is a character-oriented stream,it will allow the data in the form of characters from input devices to java program.

### EX:

CharArrayReader  
FilterReader  
BufferedReader  
FileReader  
InputStreamReader....

### 2.Writer:

It is a character-oriented stream,it will allow the data in the form of characters from java program to output devices.

### EX:

CharArrayWriter  
FilterWriter  
FileWriter  
PrintWriter  
BufferedWriter....

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**NOTE:**All the predefined Classes of character-oriented streams are terminated with either Reader or Writer.

**NOTE:** The length of the data in characters-oriented stream is 2 bytes.

#### **FileOutPutStream:**

It is byte-oriented Stream,it can be used to transfer the data from Java program to a particular target file.

To transfer the data from Java program to a particular target file by using FileOutPutstream we have to use the following Steps.

#### **1.Create FileOutPutStream between Java programme and target file:**

If we want to create FileOutPutStream class object then we have to use the following constructors

```
public FileOutPutStream(String target_File)  
public FileOutPutStream(String target_File,boolean b)
```

#### **EX:**

```
FileOutPutStream fos=new FileOutPutStream("abc.txt");
```

-->It will override the existed data in the target file at each and every write operation.

```
FileOutPutStream fos=new FileOutPutStream("abc.txt",true);
```

-->It will not override the existed data in the target file,it will append the specified new data to the existed data in the target file.

When JVM encounter the above instruction,JVM will perform the following tasks.

a)JVM will take the specified target file.

b)JVM will search for the specified target file at the respective location.

c)If the specified target file is available then JVM will establish FileOutPutStream from java program to target file.

d)If the specified target file is not available then JVM will create a file with the target file name and establish FileOutPutStream from Java program to target file.

#### **2)Declare the data and convert into byte[]:**

```
String data="Hello";
```

```
byte[] b=data.getBytes();
```

3)Write Byte Array data into FileOutPutStream:

To write byte[] data into FileOutPutStream,we have to use the following method.

```
public void write(byte[] b) throws IOException
```

#### **EX:**

```
fos.write(b);
```

4)Close FileOutPutStream:

```
fos.close();
```

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## 2.FileInputStream:

It is a byte-oriented Stream,it can be used to transfer the data from a particular source file to Java Program.

If we want to transfer the data from source file to java programme by using FileInputStream,we have to use the following Steps:

1.Create FileInputStream class Object:

To create FileInputStream class object,we have to use the following constructor from java.io.FileInputStream class.

```
public FileInputStream(String file_name) throws FileNotFoundException
```

### EX:

```
FileInputStream fis=new FileInputStream("abc.txt");
```

When JVM encounter the above instruction then JVM will perform the following actions.

1.JVM will take the specified source file name.

2.JVM will search for the specified source file at the respective location.

3.If the source file is not available at the respective location then JVM will raise an exception like "java.io.FileNotFoundException".

4.If the required source file is available then JVM will establish FileInputStream from source file to JAVA program.

5.After creating FileInputStream,JVM will transfer the data from source file to FileInputStream in the form bytes.

2.Get the size of the data from FileInputStream and prepare byte[] with the data size:

To get the size of the data from FileInputStream,we have to use the following method

```
public int available()
```

### EX:

```
int size=fis.available();
```

```
byte[] b=new byte[size];
```

3.Read the data from FileInputStream into byte[]:

To read the data from FileInputStream into byte[],we have to use the following method.

```
public void read(byte[] b) throws IOException
```

### EX:

```
fis.read(b);
```

4.Convert data from byte[] to String:

```
String data=new String(b);
```

```
System.out.println(data);
```

5.close FileInputStream:

```
fis.close();
```

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Write a Java program to display a particular file content on command prompt by taking filename as command line input?

```
import java.io.*;
class DisplayEx{
    public static void main(String args[]) throws Exception{
        String file_Name=args[0];
        FileInputStream fis=new FileInputStream(file_Name);
        int size=fis.available();
        byte b[]=new byte[size];
        fis.read();
        String data=new String(b);
        System.out.println(data);
        fis.close();
    }
}
```

Write a Java program to count no of words available in a particular text file and how many times the word "Durga" is repeated?

```
import java.io.*;
import java.util.*;
class Word_Count_Ex{
    public static void main(String args[]) throws Exception{
        FileInputStream fis=new FileInputStream("abc.txt");
        int size=fis.available();
        byte b[]=new byte[size];
        fis.read();
        String data=new String(b);
        StringTokenizer st=new StringTokenizer(data);
        int tokens=st.countTokens();
        System.out.println("No of words :" +tokens);
        int count=0;
        while(st.hasMoreTokens()){
            String token=st.nextToken();
            if(token.equals("Durga")){
                count=count+1;
            }
        }
        System.out.println("Durga' is repeated :" +count);
        fis.close();
    }
}
```

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Write a Java program to copy an image from a source file to a particular target file?

```
import java.io.*;  
public class Image_Copy_Ex{  
    public static void main(String args[]){  
        FileInputStream fis=new FileInputStream();  
        int size=fis.available();  
        byte[] b=new byte[size];  
        fis.read(b);  
        FileOutputStream fos=new FileOutputStream("abc.jpg");  
        fos.write(b);  
        fis.close();  
        fos.close();  
    }  
}
```

#### **FileWriter:**

This character-oriented Stream can be used to transfer the data from Java Application to a particular target File.

If we want to transfer the data from java application to a particular target file by using FileWriter then we have to use the following steps:

#### **1.Create FileWriter object:**

To create FileWriter class object,we have to use the following constructor.

```
public FileWriter(String target_File)
```

**EX:** `FileWriter fw=new FileWriter("abc.txt");`

-->It will override the existed content with the new content at each and every write operation.

```
public FileWriter(String target_File,boolean b)
```

**EX:** `FileWriter fw=new FileWriter("abc.txt",true);`

-->It will append new content to the existed content available in the file at each and every write operation.

When JVM encounter the above instructions,JVM will take the specified file and JVM search for the specified file at the respective location,if the required target file is available then JVM will establish FileWriter from Java application

to the target file.If the required target file is not available at the respective location then JVM will create a new file with the same specified file name and establish FileWriter from Java application to the target file.

2.Declare the data which we want to transfer and convert that data into char[]:

```
String data="Hello";  
char[] ch=data.toCharArray();
```

3.Write char[] data into FileWriter:

To write char[] data into FileWriter,we have to use the following method.

```
public void write(char[] ch) throws IOException
```

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**EX:** fw.write(ch);

4.Close FileWriter:  
fw.close();

**EX:**

```
import java.util.*;  
public class FileWriterEx{  
public static void main(String args[])throws Exception{  
FileWriter fw=new FileWriter("abc.txt",true);  
String data="DurgaSoftwareSolutions";  
char[] ch=data.toCharArray();  
fw.write(ch);  
fw.close();  
}  
}
```

#### **FileReader:**

This character-oriented stream can be used to transfer the data from a particular source file to Java program.

If we want to transfer the data from a particular source file to Java program by using FileReader then we have to use the following steps:

#### **1.Create FileReader class Object:**

To create FileReader class object,we have to use the following constructor.

```
public FileReader(String file_Name) throws FileNotFoundException
```

**EX:**

```
FileReader fr=new FileReader("abc.txt");
```

when JVM encounter the above instruction,JVM will perform the following steps.  
a)JVM will take source file name from FileReader constructor.  
b)JVM will check whether the specified file is available or not at the respective location.  
c)If the specified source file is not available at the respective location then JVM will rise an exception like "java.io.FileNotFoundException".  
d)If the specified file is existed at the respective location then JVM will establish FileReader from source file to Java program.  
e)After creating FileReader,JVM will transfer the content of source file to FileReader object in the form of characters.

#### **2.Read data from FileReader:**

To read data from FileReader,we have to use the following steps.

- Read character by character from FileReader in the form of ASCII values.
- Convert that ASCII values into the respective characters.
- Append the converted characters to a String variable.

Repeat the above steps upto all the characters which are available in the respective source file or upto the end-of-file character i.e "-1".

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To read an ASCII value from FileReader, we have to use the following method.

```
public int read() throws IOException  
3.Close FileReader:  
fr.close();
```

**EX:**

```
import java.util.*;  
public class FReX{  
public static void main(String args[])throws Exception{  
FileWriter fr=new FileWriter("abc.txt");  
String data="";  
int val=fr.read();  
while(val!=-1){  
data=data+(char)val;  
val=fr.read();  
}  
System.out.println(data);  
fr.close();  
}  
}
```

Write a JAVA programme to copy a document from one file to another file by using character oriented Streams?

```
import java.io.*;  
public class FileCopyEx{  
public static void main(String args[])throws Exception{  
FileReader fr=new FileReader("hibernatecfg.xml");  
String data="";  
int val=fr.read();  
while(val!=-1){  
data=data+(char)val;  
val=fr.read();  
}  
char[] ch=data.toCharArray();  
FileWriter fw=new FileWriter("abc.xml");  
fw.write(ch);  
fr.close();  
fw.close();  
}  
}
```

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### Approaches to provide dynamic input:

There are three approaches to provide dynamic input in java applications.

- 1.BufferedReader
- 2.Scanner
- 3.Console

#### 1.BufferedReader:

If we want to take dynamic input by using BufferedReader in java applications then we have to use the following statement.

```
BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
```

where "in" is static variable,it will refer a predefined "InputStream" object which is connected with command prompt.

If we provide data on command prompt then that data will be transferred to InputStream object in the form of binary data.

where "InputStreamReader" can be used to convert the data from binary representation to character representation.

where BufferedReader can be used to improve the performance of Java application while performing input operation.

To read the data from BufferedReader,we will use the following method

- 1.readLine()
- 2.read()

Q)What is the difference between readLine() method and read() method?

**Ans:**

readLine() method will read a line of text from command prompt[BufferedReader] and it will return that data in the form of String.

```
public String readLine() throws IOException
```

read() method will read a single character from command prompt[BufferedReader] and it will return that character in the form of its ASCII value.

```
public int read()throws IOException
```

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**EX:**

```
import java.io.*;
public class BufferedReaderEx{
    public static void main(String args[])throws Exception{
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
        System.out.println("Enter Text :");
        String data1=br.readLine();
        System.out.println("Enter the same text again :");
        int data2=br.read();
        System.out.println("First Entered :"+data1);
        System.out.println("Second Entered :" +data2+"--->"+(char)data2);
    }
}
```

Consider the following programme:

```
import java.io.*;
public class BufferedReaderEx{
    public static void main(String args[])throws Exception{
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
        System.out.println("First value :");
        String val1=br.readLine();
        System.out.println("Second value :");
        String val2=br.readLine();
        System.out.println("Addition :" +val1+val2);
    }
}
```

If we provide 10 and 20 as dynamic input to the above programme then the above programme will display "1020" value instead of 30 that is the above programme has performed String concatenation instead of performing Arithmetic Addition because br.readLine() method has return 10 and 20 values in the form String data.

In the above programme, if we want to perform Arithmetic operations over dynamic input then we have to convert String data into the respective primitive data, for this we have to use Wrapper Classes.

ThereFore, BufferedReader dynamic input approach is depending on wrapper classes while reading primitive data as dynamic input.

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**EX:**

```
import java.io.*;
public class BufferedReaderEx{
    public static void main(String args[])throws Exception{
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
        System.out.println("First value :");
        String val1=br.readLine();
        System.out.println("Second value :");
        String val2=br.readLine();
        int f_Val=Integer.parseInt(val1);
        int s_Val=Integer.parseInt(val2);
        System.out.println("Addition :" +(f_Val+s_Val));
    }
}
```

**Scanner:**

This class is provided by Java in `java.util` package along with JDK5.0 Version.

In java applications, if we use `BufferedReader` to dynamic input then we must use wrapper classes while reading primitive data as dynamic Input.

In java applications, if we use "Scanner" to read dynamic input then it is not required to use wrapper classes while reading primitive data as dynamic input, scanner is able to provide environment to read primitive data directly from command prompt.

If we want to use scanner in Java applications then we have to use the following steps.

**1.Create Scanner class Object:**

To create Scanner class Object,we have to use the following constructor

```
public Scanner(InputStream is)
```

**EX:** `Scanner s=new Scanner(System.in);`

**2.Read dynamic Input:**

To read String data as Dynamic input,we have to use the following method.

```
public String next()
```

To read primitive data as Dynamic input,we have to use the following method.

```
public xxx nextXXX()  
where xxx may be byte,short,int,float.....
```

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**EX:**

```
import java.util.*;
public class ScannerEx
{
    public static void main(String[] args)throws Exception
    {
        Scanner s=new Scanner(System.in);
        System.out.print("Employee Number :");
        int eno=s.nextInt();
        System.out.print("Employee Name :");
        String ename=s.next();
        System.out.print("Employee Salary :");
        float esal=s.nextFloat();
        System.out.print("Employee Address :");
        String eaddr=s.next();

        System.out.println("Employee Details");
        System.out.println("-----");
        System.out.println("Employee Number :"+eno);
        System.out.println("Employee Name :"+ename);
        System.out.println("Employee Salary :"+esal);
        System.out.println("Employee Address :"+eaddr);
    }
}
```

**EX:**

```
import java.util.*;
public class ScannerEx1
{
    public static void main(String[] args)throws Exception
    {
        Scanner s=new Scanner(System.in);
        System.out.print("Enter Text Data :");
        String data1=s.nextLine();
        System.out.print("Enter The same text data again :");
        String data2=s.next();
        System.out.println("First Entered :"+data1);
        System.out.print("Second Entered :"+data2);
    }
}
```

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**Console:**

This class is provided by Java in java.io package along with JAVA6 Version.

In Java applications,to take dynamic input,if we use BufferedReader and Scanner then we are able to get the following drawbacks:

1.We have to consume 2 instructions for each and every dynamic input[s.o.println(..) and readLine() or nextXXX() methods]

2.These are not providing security for the data like password data,pin numbers.....

To overcome the above problems,we have to use "Console" dynamic input approach.

If we want to use Console in Java applications then we have to use the following Steps:

**1.Create Console object:**

To get Console object,we have to use the following method from "System" class.

public static Console console()

**EX:**

Console c=System.console();

2.Read dynamic Input:

To read String data,we have to use the following method.

public String readLine(String msg)

To read password data,we have to use the following method.

public char[] readPassword(String msg)

**EX:**

```
import java.io.*;
public class ConsoleEx{
    public static void main(String args[])throws Exception{
        Console c=System.console();
        String uname=c.readLine("User Name :");
        char[] pwd=c.readPassword("PassWord :");
        String upwd=new String(pwd);
        if(uname.equals("durga")&&upwd.equals("durga")){
            System.out.println("Valid User");
        }
        else{
            System.out.println("InValid User");
        }
    }
}
```

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### Serialization and Deserialization:

If we design Java applications by distributing application logic over multiple [JVMS] then that Java application is called as Distributed Application.

In general, in Distributed applications, it is frequent requirement to transfer an object [Distributed Object] from one machine to another machine.

In Java, Object is a block of memory, it is not possible to transfer the object through network, where we have to transfer object data from one machine to another machine through network.

To transfer an Object through network from one machine to another machine, first we have to separate the data from an object at local machine and convert the data from system representation to network representation then transfer the data to network.

At remote machine, we have to get the data from network and convert the data from system representation to System representation and reconstruct an object on the basis of data.

---Diagram---

The process of converting the data from System representation to network representation is called as "Marshalling".

The process of converting the data from Network representation to System representation is called as "UnMarshalling".

The Process of separating the data from an Object is called as "Serialization".

The process of reconstructing an object on the basis of data is called as "Deserialization".

To perform Serialization and Deserialization in Java applications, JAVA has given two predefined byte-oriented streams like `java.io.ObjectOutputStream` for Serialization `java.io.ObjectInputStream` for Deserialization

In Standalone applications, if we want to perform Serialization and Deserialization over an object then we have to take a file[text file] to store serialized data.

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### Steps to Perform Serialization:

#### 1.Create Serializable Object:

To create Serializable Object we have to implement java.io.Serializable marker interface to the respective class.

Serializable interface is marker interface,it will make eligible any object for Serialization and Deserialization.

#### EX:

```
class Employee implements Serializable{  
    int eno=111;  
    String ename="AAA";  
    float esal=5000;  
}  
Employee e1=new Employee();
```

#### 2.Prepare FileOutPutStream with a particular target File:

```
FileOutPutStream fos=new FileOutPutStream("abc.txt");
```

#### 3.Create ObjectOutputStream:

To create ObjectOutputStream,we have to use the following constructor.

```
public ObjectOutputStream(FileOutputStream fos)
```

#### EX:

```
ObjectOutputStream oos=new ObjectOutputStream(fos);
```

#### 4.Write Serializable object to ObjectOutputStream:

To write Serializable object to ObjectOutputStream,we have to use the following method.

```
public void writeObject(Object obj) throws NotSerializableException
```

EX: oos.writeObject(e1);

### Steps To perform DeSerialization:

#### 1.Create FileInputStream object:

```
FileInputStream fis=new FileInputStream("emp.txt");
```

#### 2.Create ObjectInputStream:

To create ObjectInputStream class object,we have to use the Following constructor.

```
public ObjectInputStream(FileInputStream fis)
```

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**EX:** ObjectInputStream ois=new ObjectInputStream(fis);

3.Read DeSerialized Data from ObjectInputStream:

To read DeSerialized object from ObjectInputStream,we have to use the following method.

```
public Object readObject()
```

**EX:** Employee e2=(Employee)ois.readObject();

**EX:** import java.io.\*;

```
class Employee implements Serializable
```

```
{
```

```
    int eno;
```

```
    String ename;
```

```
    float esal;
```

```
    String eaddr;
```

```
Employee(int eno, String ename, float esal, String eaddr)
```

```
{
```

```
    this.eno=eno;
```

```
    this.ename=ename;
```

```
    this.esal=esal;
```

```
    this.eaddr=eaddr;
```

```
}
```

```
public void getEmpDetails()
```

```
{
```

```
    System.out.println("Employee Details");
```

```
    System.out.println("-----");
```

```
    System.out.println("Employee Number :" + eno);
```

```
    System.out.println("Employee Name : " + ename);
```

```
    System.out.println("Employee Salary : " + esal);
```

```
    System.out.println("Employee Address : " + eaddr);
```

```
}
```

```
class SerializationEx
```

```
{
```

```
    public static void main(String[] args) throws Exception
```

```
{
```

```
        FileOutputStream fos = new FileOutputStream("emp.txt");
```

```
        ObjectOutputStream oos = new ObjectOutputStream(fos);
```

```
        Employee emp1 = new Employee(111, "Durga", 50000, "Hyd");
```

```
        System.out.println("Employee Details before Serialization");
```

```
        emp1.getEmpDetails();
```

```
        oos.writeObject(emp1);
```

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```
        System.out.println();
        FileInputStream fis=new FileInputStream("emp.txt");
        ObjectInputStream ois=new ObjectInputStream(fis);
        Employee emp2=(Employee)ois.readObject();
        System.out.println("Employee Details After Deserialization");
        emp2.getEmpDetails();
    }
}
```

-->In Object serialization, static members are not allowed.

-->If we serialize any object having static variables then compiler will not rise any error and JVM will not rise any exception but static variables will not be listed in the serialized data in the text file.

-->In object serialization, if we do not want to allow any variable in serialization and deserialization then we have to declare that variable as "transient" variable.

```
transient int eno=111;
```

**EX:** import java.io.\*;

```
class User implements Serializable
{
    String uname;
    transient String upwd;
    String uemail;
    long umobile;
    public static final int MIN_AGE=18;
    public static final int MAX_AGE=25;

    User(String uname, String upwd, String uemail, long umobile)
    {
        this.uname=uname;
        this.upwd=upwd;
        this.uemail=uemail;
        this.umobile=umobile;
    }
}
class Test
{
    public static void main(String[] args)throws Exception
    {
        FileOutputStream fos=new FileOutputStream("abc.txt");
        ObjectOutputStream oos=new ObjectOutputStream(fos);
        User u=new User("abc", "abc123", "abc@duurgasoft.com", 998877);
        oos.writeObject(u);
    }
}
```

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-->In Java applications, if we serialize an object which is not implementing java.io.Serializable interface then JVM will rise an exception like "java.io.NotSerializableException".

```
import java.io.*;
class A{
int i=10;
int j=20;
}
class Test{
public static void main(String args[])throws Exception{
FileOutputStream fos=new FileOutputStream("abc.txt");
ObjectOutputStream oos=new ObjectOutputStream(fos);
A a=new A();
oos.writeObject(a);
}}
```

**Status:**"java.io.NotSerializableException".[Exception]

-->In Java applications, if we implement Serializable interface to the super class then automatically all the sub class objects are eligible for Serialization and Deserialization.

**EX:**

```
import java.io.*;
class A implements Serializable{
int i=10;
int j=20;
}
class B extends A{
int k=30;
int l=40;
}
class Test{
public static void main(String args[])throws Exception{
FileOutputStream fos=new FileOutputStream("abc.txt");
ObjectOutputStream oos=new ObjectOutputStream(fos);
B b=new B();
oos.writeObject(b);
}}
```

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-->In Java applications, if we implement Serializable interface in sub class then only sub class properties are allowed in Serialization and deserialization, the respective super class members are not allowed in the Serialization and deserialization.

**EX:**

```
import java.io.*;
class A {
    int i=10;
    int j=20;
}
class B extends A implements Serializable{
    int k=30;
    int l=40;
}
class Test{
    public static void main(String args[])throws Exception{
        FileOutputStream fos=new FileOutputStream("abc.txt");
        ObjectOutputStream oos=new ObjectOutputStream(fos);
        B b=new B();
        oos.writeObject(b);
    }
}
```

-->In Java applications,while Serializing an object if any associated object is available then JVM will serialize the respective associated object also but the respective associated object must implement Serializable interface otherwise JVM will rise an exception like "java.io.NotSerializableException".

**EX:**

```
import java.io.*;
class Branch implements Serializable{
    String bid;
    String bname;
    Branch(String bid,String bname){
        this.bid=bid;
        this.bname=bname;
    }
}
class Account implements Serializable{
    String accNo;
    String accName;
    Branch branch;
    Account(String accNo,String accName,Branch branch){
        this.accNo=accNo;
```

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```
this.accName=accName;
this.branch=branch;
}
}
class Employee implements Serializable{
String eid;
String ename;
Account acc;
Employee(String eid,String ename,Account acc){
this.eid=eid;
this.ename=ename;
this.acc=acc;
}
}
class Test{
public static void main(String args[])throws Exception{
FileOutputStream fos=new FileOutputStream("abc.txt");
ObjectOutputStream oos=new ObjectOutputStream(fos);
Branch branch=new Branch("B-111","S R Nagar");
Account acc=new Account("abc123","Durga",branch);
Employee emp=new Employee("E-111","Durga",acc);
oos.writeObject(emp);
}
}
```

### Externalization:

As part of object serialization and deserialization we are able to separate the data from Object and stored in a text file and we are able to retrieve that object data from text file to Object in Java application.

In Java applications, to perform serialization and deserialization Java has given "ObjectOutputStream" and "ObjectInputStream" two byte-oriented Streams.

In Java applications, to perform Serialization just we have to send Serializable object to ObjectOutputStream,it will perform serialization internally, where Developers are not having controlling over serialization process.

In Java applications, to perform deserialization just we have to create ObjectInputStream and we have to read deserialized object,where ObjectInputStream will perform deserialization internally,where developers are not having controlling over deserialization process.

In the above context to have controlling over serialization and deserialization processes inorder to provide the services like security, data compression,data decompression, data encoding.....over serialized and deserialized data we have to go for "Externalization".

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If we want to perform Externalization in java applications, we have to use the following steps.

- 1) Prepare Externalizable object
- 2) Perform Serialization and Deserialization over Externalizable object.

### 1) Prepare Externalizable object:

In Java applications, if we want to create Serializable object then the respective class must implement `java.io.Serializable` interface.

Similarly, if we want to prepare Externalizable object then the respective class must implement `java.io.Externalizable` interface.

`java.io.Externalizable` is a sub interface to `java.io.Serializable` interface.

`java.io.Serializable` interface is a marker interface, which is not having abstract methods but `java.io.Externalizable` interface is not marker interface, which includes the following methods.

```
public void writeExternal(ObjectOutput oop) throws IOException  
public void readExternal(ObjectInput oip) throws IOException, ClassNotFoundException
```

where `writeExternal()` method will be executed just before performing serialization in `ObjectOutputStream`,

where we have to perform manipulations on the data which we want to serialize.

where `readExternal()` method will be executed immediately after performing Deserialization in `ObjectInputStream`, where we can perform manipulations over the deserialized data.  
where `ObjectOutput` is stream, it will carry manipulated data for Serialization.

To put data in `ObjectOutput`, we have to use the following methods.

`public void writeXXX(xxx data)`

where `xxx` may be `byte, short, int, UTF[String]`.....

where `ObjectInput` will get serialized data from text file to perform manipulations.

To read data from `ObjectInput` we have to use the following method

`public void readXXX(xxx data)`

where `xxx` may be `byte, short, int, UTF[String]`.....

If we want to prepare Externalizable object we have to use the following steps.

- a) Declare an user defined class
  - b) Implement `java.io.Externalizable` interface.
  - c) Implement the methods `writeExternal()` and `readExternal()` of `Externalizable` interface at the user defined class.
- ```
class Employee implements Externalizable{  
    public void writeExternal(ObjectOutput oop) throws IOException{  
        ---implementation---  
    }  
}
```

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```
}

public void readExternal(ObjectInput oip) throws IOException, ClassNotFoundException{
---implementation---
}

Employee emp=new Employee();
```

## 2. Perform Serialization and Deserialization over Externalizable object by using ObjectOutputStream and ObjectOutputStream:

same as Serialization and DeSerialization

**EX:**

```
import java.util.*;
import java.io.*;
class Employee implements Externalizable{
String eid;
String ename;
String email;
String emobile;
//It will be used to construct object while performing deserialization in Externalization process
public Employee(){
}
Employee(String eid,String ename,String email,String emobile){
this.eid=eid;
this.ename=ename;
this.email=email;
this.emobile=emobile;
}
public void writeExternal(ObjectOutput oop) throws IOException{
try{
StringTokenizer st1=new StringTokenizer(eid,"-");
st1.nextToken();
int no=Integer.parseInt(st1.nextToken());
StringTokenizer st2=new StringTokenizer(email,"@");
String mail=st2.nextToken();
StringTokenizer st3=new StringTokenizer(emobile,"-");
st3.nextToken();
String mobile=st3.nextToken();
oop.writeInt(no);
oop.writeUTF(ename);
oop.writeUTF(mail);
oop.writeUTF(mobile);
}
catch(Exception e){}
```

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```
e.printStackTrace();
}
}
public void readExternal(ObjectInput oip) throws IOException, ClassNotFoundException{
eid="E-"+oip.readInt();
ename=oip.readUTF();
email=oip.readUTF()+"@durgasoft.com";
emobile="91-"+oip.readUTF();
}
public void getEmpDetails(){
System.out.println("Employee Details");
System.out.println("-----");
System.out.println("Employee Id : "+eid);
System.out.println("Employee Name : "+ename);
System.out.println("Employee Mail : "+email);
System.out.println("Employee Mobile: "+emobile);
}
}
class ExternalizableEx{
public static void main(String args[]) throws Exception{
FileOutputStream fos=new FileOutputStream("emp.txt");
ObjectOutputStream oos=new ObjectOutputStream(fos);
Employee emp1=new Employee("E- 111","Durga","durga@durgasoft.com","91-9988776655");
System.out.println("Employee Data before Serialization");
emp1.getEmpDetails();
oos.writeObject(emp1);
System.out.println();
FileInputStream fis=new FileInputStream("emp.txt");
ObjectInputStream ois=new ObjectInputStream(fis);
Employee emp2=(Employee)ois.readObject();
System.out.println("Employee Data After Deserialization");
emp2.getEmpDetails();
}
}
```

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### Files in Java:

File is a storage area to store data.  
There are two types of files in Java.

- 1.Sequential Files
- 2.RandomAccessFiles

#### 1.Sequential Files:

It will allow the user to retrieve data in Sequential manner.  
To represent Sequential files,Java has given a predefined class in the form of `java.io.File`.

To create File class object we have to use the following constructor.

```
public File(String file_Name) throws FileNotFoundException
```

**EX:** `File f=new File("c:/abc/xyz/emp.txt");`

Creating File class object is not sufficient to create a file at directory structure we have to use the following method.

```
public File createNewFile()
```

To create a Directory, we have to use the following method.

```
public File mkdir()
```

To get file / directory name we have to use the following method.

```
public String getName()
```

To get file / directory parent location, we have to use the following method.

```
public String getParent()
```

To get file / directory absolute path, we have to use the following method.

```
public String getAbsolutePath()
```

To check whether the created thing File or not, we have to use the following method.

```
public boolean isFile()
```

To check whether the created thing is directory or not we have to use the following method.

```
public boolean isDirectory()
```

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**EX:**

```
import java.io.*;
class Test{
    public static void main(String args[])throws Exception{
        File f=new File("c:/abc/xyz/emp.txt");
        f.createNewFile();
        System.out.println(f.isFile());
        System.out.println(f.isDirectory());
        File f1=new File("c:/abc/xyz/student");
        f1.mkdir();
        System.out.println(f.isFile());
        System.out.println(f.isDirectory());
        System.out.println("File Name :" +f.getName());
        System.out.println("Parent Name :" +f.getParent());
        System.out.println("Absolute Path :" +f.getAbsolutePath());
        int size=fis.available();
        byte[] b=new byte[size];
        fis.read();
        String data=new String(b);
        System.out.println(data);
    }
}
```

**RandomAccessFile:**

It is a Storage area,it will allow the user to read data from random positions.

To represent this file,java has given a predefined class in the form of "java.io.RandomAccessFile".

To create RandomAccessFile class object,we have to use the following constructor.

```
public RandomAccessFile(String file_name, String access_Privileges)
```

where access\_Privileges may be "r" [Read] or "rw" [Read and Write]

To write data into randomAccessFile,we have to use the following method.

```
public void writeXXX(xxx value)
```

where xxx may be byte,short,int,UTF[String],.....

To read data from RandomAccessFile,we have to use the following method

```
public XXX readXXX()
```

where xxx may be byte,short,int,UTF[String],.....

To move file pointer to a particular position in RandomAccessFile,we have to use the following method.

```
public void seek(int position)
```

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**EX:**

```
import java.io.*;
class Test{
    public static void main(String args[])throws Exception{
        RandomAccessFile raf=new RandomAccessFile("abc.txt","rw");
        raf.writeInt(111);
        raf.writeUTF("Durga");
        raf.writeFloat(5000.0f);
        raf.writeUTF("HYD");
        raf.seek(0);
        System.out.println("Employee Number :" +raf.readInt());
        System.out.println("Employee Name :" +raf.readUTF());
        System.out.println("Employee Salary :" +raf.readFloat());
        System.out.println("Employee Address :" +raf.readUTF ());
    }
}
```

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## Networking

By using java programming language we are able to prepare the following two types of applications.

1. Standalone Appl
2. Distributed Appl

### 1. Standalone Application:

If we prepare any java application with out using client-server arch then that java application is called as "Standalone Application".

To prepare standalone applicatins we can use Core Libraries like java.io, java.util, java.lang,....

### 2. Distributed Application:

If we prepare any java application on the basis of Client-Server arch then that java application is called as Distributed application.

To prepare Distributed applications, JAVA has provided the following set iof technologies.

1. Socket Programming
2. RMI
3. CORBA
4. EJBs
5. WebServices

### 1. Socket Programming:

If we want to prepare distributed applications by using Socket Programming then we have to use Sockets between machines to transfer data from one machine to another machine.

Socket is a Channel or medium to transfer data from one machine to another machine.

In Socket programming we have to establish Sockets on the basis of System IP Address and Port Numbers.

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Q)What is the difference between IPAddress and Port Number?

**Ans:**

IP Address is an unique identity to each and every machine over the network and which is provided by network manager at the time of network configuration.

Port Number is an unique identity to each and every process being executed with in a single machine and it would be provided by local operating system.

To prepare distributed applications by using Socket Programming the required predefined library was provided by JAVA in the form of "java.net" package.

**Socket programming Arch:**

---- Diagram-----

**Steps to prepare Client Application:**

**1.Create Socket at client machine:**

To create Socket class object we have to use the following constructor from java.net.Socket class.

```
public Socket(String server_IP_Addr, int server_Port_No)
```

**EX:** `Socket s=new Socket("localhost", 4444);`

**NOTE:** If server socket is available at the same machine then we are able to use "localhost" inplace of Server\_IP\_Addr.

**2.Get OutputStream from Socket:**

To get OutputStream from Socket we have to use the following method from java.net.Socket class.

```
public OutputStream getOutputStream()
```

**EX:** `OutputStream os=s.getOutputStream();`

**3.Create PrintStream with OutputStream:**

```
PrintStream ps=new PrintStream(os);
```

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**4.Send data to PrintStream:**

```
String data="Hello";
ps.println(data);
```

**NOTE:** With the above steps , data will be send to Server, where Server will send response data to client.

**4.Get InputStream from Socket:**

To get InputStream from Socket we have to use the following method.

```
public InputStream getInputStream()
```

**EX:** InputStream is=s.getInputStream();

**5.Create BufferedReader with InputStream:**

```
BufferedReader br=new BufferedReader(new InputStreamReader(is));
```

**6.Read data from BufferedReader:**

```
String data=br.readLine();
System.out.println(data);
```

**Steps To prepare Server Application:****1.Get InputStream from Socket:**

```
InputStream is=s.getInputStream();
```

**2.Create BufferedReader with InputStream:**

```
BufferedReader br=new BufferedReader(new InputStreamReader(is));
```

**3.Read data from BufferedReader:**

```
String data=br.readLine();
System.out.println(data);
```

**4.Get OutputStream from Socket:**

```
OutputStream os=s.getOutputStream();
```

**5.Create PrintStream with OutputStream:**

```
PrintStream ps=new PrintStream(os);
```

**6.Send Data to PrintStream:**

```
String data="Hai";
ps.println(data);
```

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**NOTE:** At Server machine, we have to create ServerSocket and it has to accept the request from client about to assign Socket from server machine inorder to establish connection .

**EX:** ServerSocket ss=new ServerSocket(4444);  
Socket s=ss.accept();

The above application provides one time communication, but, if we want to provide infinite communication then we have to use infinite loops at both client application and Server application.

### Application-2:

ClientApp.java

```
import java.io.*;  
import java.net.*;  
public class ClientApp  
{  
    public static void main(String[] args) throws Exception  
    {  
        Socket s=new Socket("localhost", 4444);  
        OutputStream os=s.getOutputStream();  
        PrintStream ps=new PrintStream(os);  
        BufferedReader br1=new BufferedReader(new InputStreamReader(System.in));  
  
        InputStream is=s.getInputStream();  
        BufferedReader br2=new BufferedReader(new InputStreamReader(is));  
  
        while(true)  
        {  
            String data1=br1.readLine();  
            ps.println(data1);  
            String data2=br2.readLine();  
            System.out.println(data2);  
  
            if(data1.equals("bye") && data2.equals("bye"))  
            {  
                System.exit(0);  
            }  
        }  
    }  
}
```

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### ServerApp.java

```
import java.io.*;
import java.net.*;
public class ServerApp
{
    public static void main(String[] args) throws Exception
    {
        ServerSocket ss = new ServerSocket(4444);
        Socket s = ss.accept();
        InputStream is = s.getInputStream();
        BufferedReader br1 = new BufferedReader(new InputStreamReader(is));

        OutputStream os = s.getOutputStream();
        PrintStream ps = new PrintStream(os);
        BufferedReader br2 = new BufferedReader(new InputStreamReader(System.in));

        while(true)
        {
            String data1 = br1.readLine();
            System.out.println(data1);
            String data2 = br2.readLine();
            ps.println(data2);

            if(data1.equals("bye") && data2.equals("bye"))
            {
                System.exit(0);
            }
        }
    }
}
```

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## Collections

Collection is an object, it able to represent a group of other objects.

Q) In java applications, to represent a group of other elements we have already arrays then what is the requirement to use Collections?

or

Q) What are the differences between Array and Collection?

**Ans:**

1. Arrays are having fixed size in nature. In case of arrays, we are able to add the elements upto the specified size only, we are unable to add the elements over its size, if we are trying to add elements over its size then JVM will rise an exception like "java.lang.ArrayIndexOutOfBoundsException".

**EX:**

```
Student[] std=new Student[3];
std[0]=new Student();
std[1]=new Student();
std[2]=new Student();
std[3]=new Student();--> ArrayIndexOutOfBoundsException
```

Collections are having dynamically Growble nature, even if we add the elements over its size then JVM will not rise any exception.

**EX:**

```
ArrayList al=new ArrayList(3);
al.add(new Student());
al.add(new Student());
al.add(new Student());
al.add(new Student());--> No Exception
```

2. In java, bydefault, Arrays are able to allow homogeneous elements, if we are trying to add the elements which are not same Array data type then Compiler will rise an error like "Incompatible Types".

**EX:**

```
Student[] std=new Student[3];
std[0]=new Student();
std[1]=new Student();
std[2]=new Customer();--> Incompatible Types Error
```

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In Java, by default, Collections are able to allow heterogeneous elements, even we add different types of elements Compiler will not rise any error.

**EX:**

```
ArrayList al=new ArrayList(3);
al.add(new Student());
al.add(new Employee());--> No Error
al.add(new Customer());----> No Error
```

3.Arrays are not having predefined methods to perform searching and sorting operations over the elements, in case of arrays to perform searching and sorting operations developers have to provide their own logic.

In case of Collections, predefined methods or predefined Collections are defined to perform Searching and Sorting operations over the elements.

**EX:** In Collections , TreeSet was provided to perform sorting order.

```
TreeSet ts=new TreeSet();
ts.add("B");
ts.add("E");
ts.add("A");
ts.add("D");
ts.add("C");
ts.add("F");
System.out.println(ts);
```

**OP:** [A,B,C,D,E,F]

4.Arrays are able to allow only one type of elements, so Arrays are able to improve Typedness in java applications and they are able to perform Typesafe operations.

Collections are able to allow different types of elements, so Collections are able to reduce typedness in java applications and they are unable to perform Typesafe operations.

5.If we know the no of elements in advance at the time of writing java applications then Arrays are better to use in java applications and they will provide very good performance in java applications, but, But Arrays are not flexible to design applications.

In java applications, Collections are able to provide less performance, but, They will provide flexibility to design applications.

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To represent Collection objects in java applications , JAVA has provided predefined classes and interfaces in the form of java.util package called as "Collection Framework".

Q)What are the classes and interfaces are existed in java.util package to represent Collections?

--- Diagram---

Q)What are the differences between Collection and Map?

**Ans:**

Collections are able to store all the elements individually, not in the form of Key-value pairs.

**EX:** To store 10 Employee objects we will use Collection.

Maps are able to store all the elements in the form of Key-value pairs.

**EX:** To represent Telephone Directory , where we are representing phone number and Customer Name we have to use Maps.

Q)What are the differences between List and Set?

**Ans:**

1.List is index based, it able to allow all the elements as per indexing.

Set is not index based, it able to allow all the elements on the basis of elements hashCode values.

2.List is able to allow duplicate elements.

Set is not allowing duplicate elements.

3.List is able to allow any no of null values.

Set is able to allow only one null value.

4.List is following insertion order.

Set is not following insertion order by default.

**Note:** LinkedHashSet is following insertion order.

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5.List is not following sorting order.

Sets are not following sorting order by default.

**Note:** SortedSet, NavigableSet and TreeSet are following Sorting order.

6.List is able to allow heterogeneous elements.

Sets are able to allow heterogeneous elements by default.

**Note:** SortedSet, NavigableSet and TreeSet are allowing only Homogeneous elements.

### Collection:

--> It is an interface provided by JAVA along with JDK1.2 version.

--> It able to represent a group of individual elements as single unit.

--> It has provided the following methods common to every implementation class.

#### 1. **public boolean add(Object obj)**

--> This method is able to add the specified element to Collection object. If the specified element is added successfully then add(-) method will return "true" value. If the specified element is not added successfully then add() method will return "false" value.

#### EX:

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashSet hs=new HashSet();
        System.out.println(hs.add("A"));
        hs.add("B");
        hs.add("C");
        hs.add("D");
        System.out.println(hs);
        System.out.println(hs.add("A"));
        System.out.println(hs);
    }
}
```

#### OP:

```
true
[A,B,C,D]
false
[A,B,C,D]
```

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**2. public boolean addAll(Collection c)**

--> This method can be used to add all the elements of the specified Collection to the present Collection object. If addition operation is success then addAll() method will return "true" value, if addition operation is failure then addAll() method will return "false" value.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashSet hs=new HashSet();
        hs.add("A");
        hs.add("B");
        hs.add("C");
        hs.add("D");
        System.out.println(hs);
        HashSet hs1=new HashSet();
        System.out.println(hs1.addAll(hs));
        System.out.println(hs1);
        System.out.println(hs1.addAll(hs));
        System.out.println(hs1);
    }
}
```

**OP:**

```
[D,A,B,C]
true
[D,A,B,C]
false
[D,A,B,C]
```

**3. public boolean remove(Object obj)**

--> This method can be used to remove the specified element from the Collection object. If remove operation is success then remove() method will return true value, if remove operation is failure then remove() method will return false value.

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**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        ArrayList al=new ArrayList();  
        al.add("A");  
        al.add("B");  
        al.add("C");  
        al.add("D");  
        System.out.println(al);  
        System.out.println(al.remove("B"));  
        System.out.println(al);  
        System.out.println(al.remove("B"));  
        System.out.println(al);  
    }  
}
```

**OP:**

[A,B,C,D]  
true  
[A,C,D]  
false  
[A,C,D]

#### **4. public boolean removeAll(Collection c)**

-->This method can be used to remove all the elements of the specified Collection from the present Collection object. If remove operation is success then removeAll() method will return true value. If remove operation is not success then removeAll() method will return false value.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        al.add("F");
        System.out.println(al);
        ArrayList al1=new ArrayList();
        al1.add("B");
        al1.add("C");
        al1.add("D");
        System.out.println(al1);
        System.out.println(al.removeAll(al1));
        System.out.println(al);
        System.out.println(al.removeAll(al1));
        System.out.println(al);
    }
}
```

**OP:**

```
[A,B,C,D,E,F]
[B,C,D]
true
[A,E,F]
false
[A,E,F]
```

### **5. public boolean contains(Object obj)**

--> This method will check whether the specified element is existed or not in the Collection object. If the specified element is existed then this method will return "true" value . If the specified element is not existed then this method will return "false" value.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        al.add("F");
        System.out.println(al);
        System.out.println(al.contains("B"));
        System.out.println(al.contains("X"));
    }
}
```

**OP:**

```
[A,B,C,D,E,F]
true
false
```

**6. public boolean containsAll(Collection c)**

--> This method will check whether all the elements of the specified Collection are available or not in the present Collection object. If all the elements are existed then containsAll() method will return true value, if atleast one element is not existed then containsAll() method will return false value.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        al.add("F");
        System.out.println(al);
        ArrayList al1=new ArrayList();
```

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```
        al1.add("B");
        al1.add("C");
        al1.add("D");
        System.out.println(al.containsAll(al1));
        al1.add("X");
        al1.add("Y");
        System.out.println(al.containsAll(al1));
    }
}
```

**OP:** [A,B,C,D,E,F]

true

false

### 7. public boolean retainAll(Collection c)

--> This method will remove all the elements from the present Collection object except the elements which are existed in the specified Collection object. If atleast one element is removed then retainAll() method will return true value. If no elements are removed then retainAll() method will return false value.

**EX:** import java.util.\*;

```
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        al.add("F");
        System.out.println(al);
        ArrayList al1=new ArrayList();
        al1.add("B");
        al1.add("C");
        al1.add("D");
        System.out.println(al1);
        System.out.println(al.retainAll(al1));
        System.out.println(al);
        System.out.println(al.retainAll(al1));
        System.out.println(al);
    }
}
```

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**OP:**

- [A,B,C,D,E,F]
- [B,C,D]
- true
- [B,C,D]
- false
- [B,C,D]

**8.public int size()**

--> This method can be used to return an integer value representing the no of elements which are existed in the Collection object.

**9.public void clear()**

--> This method can be used to remove all elements from Collection objectt.

**10.public boolean isEmpty()**

--> This method can be used to check whether Collection objectt is empty or not.If the Collection object is empty then isEmpty() method will return "true" value. If the Collection object is not empty then isEmpty() method will return "false" value.

**11.public Object[] toArray()**

--> This method will return all the elements of the Collection object in the form of Object[].

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        al.add("F");
        System.out.println(al);
        System.out.println(al.size());
        Object[] obj=al.toArray();
        for(Object o: obj)
        {
            System.out.print(o+" ");
        }
    }
}
```

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```
        System.out.println();
        System.out.println(al.isEmpty());
        al.clear();
        System.out.println(al.isEmpty());
        System.out.println(al);
    }
}
```

**OP:**

[A,B,C,D,E,F]  
6  
A B C D E F  
false  
true  
[]

**List :**

- >List is a direct child interface to Collection interface
- >List was provided by JAVA along with its JDK1.2 version
- >List is index based, it able to arrange all the elements as per indexing.
- >List is able to allow duplicate elements.
- >List is following insertion order.
- >List is not following Sorting order.
- >List is able to allow any no of null values.
- >List is able to allow heterogeneous elements.

List interface has provided the following methods common to all of its implementation classes.

**1. public void add(int index, Object obj)**

-->It able to add the specified element at the specified index value.

**2. public Object set(int index, Object obj)**

-->It able to set the specified element at the specified index value.

Q) What is the difference between add(--) method and set(--) method?

**Ans:**

add(--) method is able to perform insert operation. if any element is existed at the specified element then add() method will insert the specified new element at the specified index value and add() method will adjust the existed element to next index value. If no element is existed at the specified index then add() method add the specified element at the specified index.

set(--) method is able to perform replace operation. If any element is existed at the specified index then set() method will remove the existed element and set(-) method will add the specified element to the specified index and set() method will return the removed element. If no element is existed at the specified index value then set() method will rise an exception like java.lang.IndexOutOfBoundsException.

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**3. public Object get(int index)**

-->It will return an element available at the specified index value.

**4. public Object remove(int index)**

-->It will remove and return an element available at the specified index value.

**5. public int indexOf(Object obj)**

-->It will return an index value where the first occurrence of the specified element.

**6. public int lastIndexOf(Object obj)**

-->It will return an index value where the last occurrence of the specified element.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        System.out.println(al);
        al.add(1,"X");
        System.out.println(al);
        al.add(6,"F");
        System.out.println(al);
        al.set(3,"Y");
        System.out.println(al);
        //al.set(7,"Z");--->IndexOutOfBoundsException
        System.out.println(al.get(4));
        System.out.println(al.remove(6));
        System.out.println(al);
        al.add(6,"X");
        al.add(7,"B");
        al.add(8,"X");
        System.out.println(al);
        System.out.println(al.indexOf("X"));
        System.out.println(al.lastIndexOf("X"));
    }
}
```

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### ArrayList:

- >It was provided by JAVA along with JDK1.2 version.
- >It is a direct implementation class to List interface.
- >It is index based.
- >It allows duplicate elements.
- >It follows insertion order.
- >It will not follow sorting order.
- >It allows heterogeneous elements.
- >It allows any no of null values.
- >Its internal data structure is "Resizable Array".
- >Its initial capacity is 10 elements.
- >Its incremental capacity ratio is  
$$\text{new\_Capacity} = (\text{Current\_Capacity} * 3/2) + 1$$
- >It is best option for frequent retrieval operations.
- >It is not synchronized.
- >No method is synchronized method in ArrayList.
- >It allows more than one thread to access data.
- >It follows parallel execution.
- >It will reduce execution time.
- >It will improve application performance.
- >It will not give guarantee for data consistency.
- >It is not threadsafe.
- >It is not Legacy Collection.

### Constructors:

#### 1. public ArrayList()

-->It can be used to create an empty ArrayList object with 10 elements as default capacity value.

**EX:** ArrayList al=new ArrayList();

#### 2. public ArrayList(int capacity)

-->It can be used to create an empty ArrayList object with the specified capacity.

**EX:** ArrayList al=new ArrayList(20);

#### 3. public ArrayList(Collection c)

-->It can be used to create an ArrayList object with all the elements of the specified Collection object.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al1=new ArrayList();
        al1.add("AAA");
        al1.add("BBB");
        al1.add("CCC");
        al1.add("DDD");
        System.out.println(al1);
        ArrayList al2=new ArrayList(al1);
        System.out.println(al2);
    }
}
```

**OP:**

[AAA,BBB,CCC,DDD]  
[AAA,BBB,CCC,DDD]

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        System.out.println(al);
        al.add("B");
        System.out.println(al);
        al.add(new Integer(10));
        System.out.println(al);
        al.add(null);
        al.add(null);
        System.out.println(al);
    }
}
```

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### Vector:

- >It was introduced in JDK1.0 version.
- >It is Legacy Collection.
- >It is a direct implementation class to List interface.
- >It is index based.
- >It allows duplicate elements.
- >It follows insertion order.
- >It will not follow sorting order.
- >It allows heterogeneous elements.
- >It allows any no of null values.
- >Its internal data structure is "Resizable Array".
- >Its initial capacity is 10 elements.
- >It is best choice for frequent retrieval operations.
- >It is not good for frequent insertions and deletion operations.
- >Its incremental capacity is double the current capacity.  
    New\_capacity=2\*Current\_Capacity
- >it is synchronized element.
- >All the methods of vector class are synchronized.
- >It allows only one thread at a time.
- >It follows sequential execution.
- >It will increase execution time.
- >It will reduce application performance.
- >It is giving guarantee for data consistency.
- >It is threadsafe.

### Constructors:

#### 1. public Vector()

--> It can be used to create an empty Vector object with the initial capacity 10 elements.

**EX:** Vector v=new Vector();

```
System.out.println(v.capacity());
```

**OP:** 10

2. public Vector(int capacity)

--> It can be used to create an empty vector object with the specified capacity value.

**EX:** Vector v=new Vector(20);

```
System.out.println(v.capacity());
```

**OP:** 20

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**3. public Vector(int capacity, int incremental\_Ratio)**

-->This constructor can be used to create an empty Vector object with the specified initial capacity and with the specified incremental ratio.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        Vector v=new Vector(5,5);
        System.out.println(v.capacity());
        for(int i=1;i<=6;i++)
        {
            v.add(i);
        }
        System.out.println(v.capacity());
        for(int i=7;i<=11;i++)
        {
            v.add(i);
        }
        System.out.println(v.capacity());
    }
}
```

**OP:**

5  
10  
15

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**4.public Vector(Collection c)**

-->This constructor can be used to create Vector object with all the elements of the specified Collection object.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        Vector v=new Vector();
        v.add("A");
        v.add("B");
        v.add("C");
        v.add("D");
        System.out.println(v);
        Vector v1=new Vector(v);
        System.out.println(v1);
    }
}
```

**OP:**

```
[A,B,C,D]
[A,B,C,D]
```

**Methods:****1.public void addElement(Object obj)**

-->It will add the specified element to Vector.

**2.public Object firstElement()**

-->It will return first element of the Vector.

**3.public Object lastElement()**

-->It will return last element of the Vector.

**4.public Object elementAt(int index)**

-->It will return an element available at the specified index.

**5.public void removeElement(Object obj)**

-->It will remove the specified element from Vector.

**6.public void removeElementAt(int index)**

-->It will remove an element existed at the specified index value.

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7. public void removeAllElements()  
-->It will remove all elements from Vector.

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        Vector v=new Vector();  
        v.addElement("A");  
        v.addElement("B");  
        v.addElement("C");  
        v.addElement("D");  
        v.addElement("E");  
        System.out.println(v);  
        System.out.println(v.firstElement());  
        System.out.println(v.lastElement());  
        System.out.println(v.elementAt(3));  
        v.removeElement("D");  
        System.out.println(v);  
        v.removeElementAt(2);  
        System.out.println(v);  
        v.removeAllElements();  
        System.out.println(v);  
    }  
}
```

Q)What are the differences between ArrayList and Vector?

**Ans:**

1.ArrayList class was introduced in JDK1.2 version.

Vector class was introduced in JDK1.0 version.

2.ArrayList is not Legacy Collection.

Vector is Legacy Collection.

3.ArrayList is not synchronized.

Vector is synchronized.

4.No method is synchronized method in ArrayList.

Almost all the methods are synchronized methods in vector.

5.ArrayList allows more than one thread at a time to access data.

Vector allows only one thread at a time to access data.

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6.ArrayList follows parallel execution.

Vector follows sequential execution.

7.ArrayList is able to reduce application execution time.

Vector is able to increase application execution time.

8.ArrayList is able to improve application performance.

Vector is able to reduce application performance.

9.ArrayList is not giving guarantee for data consistency.

vector is giving guarantee for data consistency.

10.ArrayList is not threadsafe.

Vector is threadsafe.

11.ArrayList incremental capacity is  $(\text{Current\_Capacity} * 3/2) + 1$

Vector incremental capacity is

$2 * \text{Current\_Capacity}$

12.We are unable to get capacity value of ArrayList, because, no capacity() method in ArrayList class.

We can get capacity value of Vector, because, capacity() method is existed in vector class.

### Stack:

It was introduced in JDK1.0 version, it is a Legacy Collection and it is a child class to Vector class. It able to arrange all the elements as per "Last In First Out"  
[LIFO] alg.

### Constructor:

public Stack()

--> It will create an empty Stack object.

**EX:** Stack s=new Stack();

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### Methods:

public void push(Object obj)

--> It will add the specified element to Stack.

public Object pop()

--> It will remove and return top of the stack.

public Object peek()

--> It will return top of the stack.

public int search(Object obj)

--> It will check whether the specified element is existed or not in the Stack, if the specified element is not existed then it will return '-1' value, if the specified element is existed then it will return its position.

### EX:

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        Stack s=new Stack();
        s.push("A");
        s.push("B");
        s.push("C");
        s.push("D");
        s.push("E");
        System.out.println(s);
        System.out.println(s.pop());
        System.out.println(s);
        System.out.println(s.peek());
        System.out.println(s);
        System.out.println(s.search("B"));
        System.out.println(s.search("X"));
    }
}
```

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### LinkedList:

- >It was introduced in JDK1.2 version.
- >It is not Legacy Collection.
- >It is a direct implementation class to List interface.
- >It is index based.
- >It allows duplicate elements.
- >It follows insertion order.
- >It is not following sorting order.
- >It allows heterogeneous elements.
- >It allows null values in any number.
- >Its internal data structure is "Double Linked List".;
- >It is best choice for frequent insertions and deletions.
- >It is not synchronized Collection.
- >No method is synchronized in LinkedList.
- >It allows more than one thread to access data.
- >It will follow parallel execution.
- >It will decrease execution time.
- >It will improve application performance.
- >It is not giving guarantee for data consistency.
- >It is not threadsafe.

### Constructors:

1. public LinkedList()

- >It will create an empty LinkedList object.

**EX:** LinkedList ll=new LinkedList();

2. public LinkedList(Collection c)

- >It will create LinkedList object with all the elements of the specified Collection object.

**EX:**

```
LinkedList ll1=new LinkedList();
ll1.add("A");
ll1.add("B");
ll1.add("C");
ll1.add("D");
System.out.println(ll1);
LinkedList ll2=new LinkedList(ll1);
System.out.println(ll2);
```

**OP:** [A, B, C, D]

[A, B, C, D]

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**Methods:**

1. public void addFirst(Object obj)  
-->It will add the specified element as first element to LinkedList.
2. public void addLast(Object obj)  
-->It will add the specified element as last element to LinkedList.
3. public Object getFirst()  
-->It will return first element from LinkedList.
4. public Object getLast()  
-->It will return last element from LinkedList.
5. public void removeFirst()  
-->It will remove first element from LinkedList.
6. public void removeLast()  
-->It will remove last element from LinkedList.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        LinkedList ll=new LinkedList();
        ll.add("A");
        ll.add("B");
        ll.add("C");
        ll.add("D");
        ll.add("E");
        System.out.println(ll);
        ll.addFirst("X");
        ll.addLast("Y");
        System.out.println(ll);
        ll.removeFirst();
        ll.removeLast();
        System.out.println(ll);
        System.out.println(ll.getFirst());
        System.out.println(ll.getLast());
    }
}
```

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### Cursors / Iterators in Collections:

In java applications, when we pass Collection object reference variable as parameter to System.out.println() method, then, JVM will execute toString() method internally. Initially toString() method was implemented in java.lang.Object class, it was implemented in such a way that to return a String contains "Class\_Name@Ref\_val". In java applications, Collection classes are not depending on Object class toString() method, they are having their own toString() method , which are implemented in such a way to return a String contains all the elements of the Collection object by enclosed with [].

**EX:** ArrayList al=new ArrayList();  
al.add("A");  
al.add("B");  
al.add("C");  
al.add("D");  
System.out.println(al);

**OP:** [A, B, C, D]

As per the requirement, we dont want to display all the Elements at a time on command prompt, we want to retrive elements one by one individually from Collection objects and we want to display all the elements one by one on Command prompt.

To achieve the above requirment, Collection Framework has provided the following three Cursors or Iterators.

- 1.Enumeration
- 2.Iterator
- 3.ListIterator

#### 1.Enumeration:

It is a Legacy Cursor, it is applicable for only Legacy Collections to retirve elements in one by one fashion.

To retrive elements from Collections by using Enumeration we have to use the following steps.

#### 1.Create Enumeration object:

To create Enumeration object we have to use the following method from Legacy Collections.  
public Enumeration elements()

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## 2. Retrieve elements from Enumeration:

a) Check whether more elements are available or not from Current cursor position by using the following method.

```
public boolean hasMoreElements()
```

--> It will return true value if atleast next element is existed.

--> It will return false value if no element is existed from current cursor position.

b) If atleast next element is existed then read next element and move cursor to next position by using the following method.

```
public Object nextElement()
```

### EX:

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        Vector v=new Vector();
        v.add("A");
        v.add("B");
        v.add("C");
        v.add("D");
        v.add("E");
        System.out.println(v);
        Enumeration e=v.elements();
        while(e.hasMoreElements())
        {
            System.out.println(e.nextElement());
        }
    }
}
```

### Drawbacks:

1. Enumeration is applicable for only Legacy Collections.

2. Enumeration is able to allow only read operation while iterating elements.

### Iterator:

Iterator is an interface provided JAVA along with its JDK1.2 version.

Iterator can be used to retrieve all the elements from Collection objects in one by one fashion.

Iterator is applicable for all the Collection interface implementation classes to retrieve elements.

Iterator is able to allow both read and remove operations while iterating elements.

If we want to use Iterator in java applications then we have to use the following steps.

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**1.Create Iterator object:**

To create Iterator object we have to use the following method from all Collection implementation classes.

```
public Iterator iterator()
```

**EX:**Iterator it=al.iterator();

**2.Retrieve elements from Iterator:**

To retrive elements from Iterator we have to use the following steps.

- Check whether next element is existed or not from the current cursor position by using the following method.

```
public boolean hasNext()
```

-->This method will return true if next element is existed.

-->This method will return false if no element is existed from current cursor position.

- If next element is existed then read next element and move cursor to next position by using the following method.

```
public Object next()
```

**NOTE:** To remove an element available at current cursor position then we have to use the following method

```
public void remove()
```

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("A");
        al.add("B");
        al.add("C");
        al.add("D");
        al.add("E");
        System.out.println(al);
        Iterator it=al.iterator();
        while(it.hasNext())
    {
```

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```
String element=(String)it.next();
System.out.println(element);
if(element.equals("C"))
{
    it.remove();
}
}
System.out.println(al);
}
}
```

Q)What are the differences between Enumeration and Iterator?

**Ans:**

- 1.Enumeration is Legacy Cursor, it was introduced in JDK1.0 version.  
Iterator is not Legacy Cursor, it was introduced in JDK1.2 version.
- 2.Enumeration is not Universal Cursor, it is applicable for only Legacy Collections.  
Iterator is an universal Cursor, it is applicable for all Collection implementations.
- 3.Enumeration is able to allow only read operation while iterating elements.  
Iterator is able to allow both read operation and remove operation while iterating elements.

**ListIterator:**

It is an interface provided by JAVA along with JDK1.2 version.

It able to allow to read elements in both forward direction and backward direction.

It able to allow the operations like read, insert, replace and remove while iterating elements .

If we want to use ListIterator in java applications then we have to use the following steps.

**1.Create ListIterator Object:**

To create ListIterator object we have to use the following method.

```
public ListIterator listIterator()
```

**EX:** ListIterator lit=ll.listIterator();

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## 2. Retrieve Elements from ListIterator

To retriv elements from ListIterator in Forward direction then we have to use the following methods.

`public boolean hasNext()`

--> It will check whether next element is existed or not from the current cursor position.

`public Object next()`

-->It will return next element and it will move cursor to the next position in forward direction.

`public int nextIndex()`

--> It will return next index value from the current cursor position.

To retrive elements in Backward direction we have to use the following methods.

`public boolean hasPrevious()`

--> It will check whether previous element is existed or not from the current cursor position, If previous element is existed then it will return "true" value, if previous element is not existed then it will return false value.

`public Object previous()`

-->It will return previous element and it will mo ve cursor to the next previous position.

`public int previousIndex()`

-->It will return previous index value from the current cursor position.

To perform the operations like remove, insert and replace over the elements we have to use the following methods.

`public void remove()`  
`public void add(Object obj)`  
`public void set(Object obj)`

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**EX:** import java.util.\*;  
class Test  
{  
 public static void main(String[] args)  
 {  
 LinkedList ll=new LinkedList();  
 ll.add("A");  
 ll.add("B");  
 ll.add("C");  
 ll.add("D");  
 ll.add("E");  
 ll.add("F");  
 System.out.println(ll);  
 ListIterator lit=ll.listIterator();  
 System.out.println("Elements in Forward Direction");  
 while(lit.hasNext())  
 {  
 System.out.println(lit.nextIndex()+"--->"+lit.next());  
 }  
 System.out.println();  
 System.out.println("Elements in Backward Direction");  
 while(lit.hasPrevious())  
 {  
 System.out.println(lit.previousIndex()+"--->"+lit.previous());  
 }  
 }  
}

**EX:** import java.util.\*;  
class Test1  
{  
 public static void main(String[] args)  
 {  
 LinkedList ll=new LinkedList();  
 ll.add("A");  
 ll.add("B");  
 ll.add("C");  
 ll.add("D");  
 ll.add("E");  
 ll.add("F");  
 System.out.println(ll);  
 ListIterator lit=ll.listIterator();  
 while(lit.hasNext())

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```
{  
    String element=(String)lit.next();  
    if(element.equals("B"))  
    {  
        lit.add("X");  
    }  
    if(element.equals("D"))  
    {  
        lit.set("Y");  
    }  
    if(element.equals("E"))  
    {  
        lit.remove();  
    }  
    System.out.println(lit);  
}  
}
```

Q)What are the differences between Enumeration, Iterator and ListIterator?

**Ans:**

1.Enumeration is applicable for only Legacy Collections.

Iterator is applicable for all Collection implementations.

ListIterator is applicable for only List implementations.

2.Enumeration and Iterator are allowed to iterate elements in only Forward direction.

ListIterator is able to allow to iterate elements in both Forward direction and backward direction.

3.Enumeration is able to allow only read operation while iterating elements.

Iterator is able to allow both read and remove operations while iterating elements.

ListIterator is able to allow the operations like insert, replace, remove and read operations while iterating elements.

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**Set:**

- >It was introduced in JDK1.2 version.
- >It is a direct child interface to Collection interface.
- >It is not index based, it able to arrange all the elements on the basis of elements hashcode values.
- >It will not allow duplicate elements.
- >It will not follow insertion order.

**Note:** LinkedHashSet will follow insertion order.

- >It will not follow Sorting order.

**Note:** SortedSet, NavigableSet and TreeSet are following Sorting order.

- >It able to allow only one null value.

**Note:** SortedSet, NavigableSet and TreeSet are not allowing even single null value.

**HashSet:**

- > HashSet is a direct implementation class to Set interface.
- > It was introduced in JDK1.2 version.
- > It is not index based, it able to arrange all the elements on the basis of elements hashcode values.
- > It will not allow duplicate elements.
- > It will not follow insertion order.
- > It will not follow Sorting order.
- > It able to allow only one null value.
- > Its interal data strucer is "Hashtable".
- > its initial capacity is "16" elements and its initial fill\_Ratio is 75%.
- > it is not synchronized.
- > Almost all the methods are not synchronized in HashSet
- > It allows more than one thread at a time.
- > It follows parallel execution.
- > It will reduce execution time.
- > It improves performance of the applications.
- > It is not giving guarantee for data consistency.
- > It is not threadsafe.

**Constructors:**

1. public HashSet()

- > This constructor can be used to create an empty HashSet object with 16 elements as initial capacity and 75% fill ratio.

**EX:** HashSet hs=new HashSet();

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2. public HashSet(int capacity)

--> This constructor can be used to create an empty HashSet object with the specified capacity as initial capacity and with the default fill ratio 75%.

**EX:** HashSet hs=new HashSet(20);

3. public HashSet(int capacity, float fill\_Ratio)

--> This constructor can be used to create an empty HashSet object with the specified capacity and with the specified fill ratio.

**EX:** HashSet hs=new HashSet(20, 0.85f);

4. public HashSet(Collection c)

--> This constructor can be used to create HashSet object with all the elements of the specified Collection .

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashSet hs1=new HashSet();
        hs1.add("A");
        hs1.add("B");
        hs1.add("C");
        hs1.add("D");
        hs1.add("E");
        System.out.println(hs1);
        HashSet hs2=new HashSet(hs1);
        System.out.println(hs2);
    }
}
```

**OP:**

[D,E,A,B,C]  
[D,E,A,B,C]

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashSet hs=new HashSet();
        hs.add("A ");
        hs.add("B ");
        hs.add("C ");
        hs.add("D ");
        hs.add("E ");
        System.out.println(hs);
        hs.add("B ");
        System.out.println(hs);
        hs.add(null);
        hs.add(null);
        System.out.println(hs);
        hs.add(new Integer(10));
        System.out.println(hs);
    }
}
```

**LinkedHashSet:**

Q)What are the differences between HashSet and LinkedHashSet?

**Ans:**

- 1.HashSet was introduced in JDK1.2 version.  
LinkedhashSet was introduced in JDK1.4 version.
- 2.HashSet is not following insertion order.  
LinkedHashSet is following insertion order.
- 3.The internal data strucuter of HashSet is "Hashtable".  
The internal data strucuter of LinkedHashSet is "Hashtable" and "LinkedList".

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashSet hs=new HashSet();
        hs.add("A");
        hs.add("B");
        hs.add("C");
        hs.add("D");
        hs.add("E");
        System.out.println(hs);
        LinkedHashSet lhs=new LinkedHashSet();
        lhs.add("A");
        lhs.add("B");
        lhs.add("C");
        lhs.add("D");
        lhs.add("E");
        System.out.println(lhs);
    }
}
```

**OP:**

[D,E,A,B,C]  
[A,B,C,D,E]

**SortedSet:**

- >It was introduced in JDK1.2 version.
- >It is a child interface to Set interface.
- >It is not index based.
- >It is not allowing duplicate elements.
- >It is not following insertion order.
- >It follows Sorting order.
- >It allows only homogeneous elements.
- >It will not allow heterogeneous elements, if we are trying to add heterogeneous elements then JVM will rise an exception like `java.lang.ClassCastException`.
- >It will not allow null values, if we are trying to add any null value then JVM will rise an exception like `java.lang.NullPointerException`.
- >It able to allow only Comparable objects by default, if we are trying to add non comparable objects then JVM will rise an exception like `java.lang.ClassCastException`.

**Note:**If we are trying to add non comparable objects then we have to use Comparator.

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### Methods:

1. public Object first()

--> It will return first element from SortedSet.

2. public Object last()

--> It will return last element from SortedSet.

3. public SortedSet headSet(Object obj)

--> It will return SortedSet object with the elements which are less than the specified element.

4. public SortedSet tailSet(Object obj)

--> It will return SortedSet object with the elements which are greater than or equals to the specified element.

5. public SortedSet subSet(Object obj1, Object obj2)

--> It will return SortedSet object with all elements which are greater than or equals to the specified first element and which are less than the specified second element.

### EX:

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeSet ts=new TreeSet();
        ts.add("D");
        ts.add("F");
        ts.add("B");
        ts.add("E");
        ts.add("C");
        ts.add("A");
        System.out.println(ts);
        System.out.println(ts.first());
        System.out.println(ts.last());
        System.out.println(ts.headSet("D"));
        System.out.println(ts.tailSet("D"));
        System.out.println(ts.subSet("B","E"));
    }
}
```

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## NavigableSet

It was introduced in JAVA6 version, it is a child interface to SortedSet interface, it is following all the properties of SortedSet and it has define methods to provide navigations over the elements.

### Methods:

1. public Object ceiling(Object obj)

--> It will return lowest element among all the elements which are greater than or equals to the specified element.

2. public Object higher(Object obj)

--> It will return lowest element among all the elements which are greater than the specified element.

3. public Object floor(Object obj)

--> It will return highest element among all the elements which are less than or equals to the specified element.

4. Trpublic Object lower(Object obj)

--> It will return highest element among all the elements which are less than the specified element.

5. public Object pollFirst()

--> It will remove and return first element from NavigableSet.

6. public Object pollLast()

--> It will remove and return last element from NavigableSet.

7. public NavigableSet descendingSet()

--> It will return all elements in the form of NavigableSet in descending order.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeSet ts=new TreeSet();
        ts.add("D");
        ts.add("F");
        ts.add("B");
        ts.add("E");
        ts.add("C");
        ts.add("A");
        System.out.println(ts);
        System.out.println(ts.ceiling("D"));
        System.out.println(ts.higher("D"));
        System.out.println(ts.floor("D"));
        System.out.println(ts.lower("D"));
        System.out.println(ts.descendingSet());
        ts.pollFirst();
        ts.pollLast();
        System.out.println(ts);
    }
}
```

**TreeSet:**

- >It was introduced in JDK1.2 version.
- >It is not Legacy Collection.
- >It has provided implementation for Collection, Set, SortedSet and navigableSet interfaces.
- >It is not index based.
- >It is not allowing duplicate elements.
- >It is not following insertion order.
- >It follows Sorting order.
- >It allows only homogeneous elements.
- >It will not allow heterogeneous elements, if we are trying to add heterogeneous elements then JVM will rise an exception like java.lang.ClassCastException.
- >It will not allow null values, if we are trying to add any null value then JVM will rise an exception like java.lang.NullPointerException.
- >It able to allow only Comparable objects bydefault, if we are trying to add non comparable objects then JVM will rise an exception like java.lang.ClassCastException.

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**NOTE:** If we are trying to add non comparable objects then we have to use java.util.Comparator.  
-->Its internal data strucuter is "Balanced Tree".  
-->It is mainly for frequent search operations.

**Constructors:**

1. public TreeSet()

-->It can be used to create an Empty TreeSet object.

**EX:** TreeSet ts=new TreeSet();

2. public TreeSet(Comparator c)

-->It will create an empty TreeSet object with the explicit Sorting mechanism in the form of Comparator

**EX:** TreeSet ts=new TreeSet(new MyComparator());

3. public TreeSet(SortedSet ts)

-->It will create TreeSet object with all elements of the specified SortedSet.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeSet ts1=new TreeSet();
        ts1.add("B");
        ts1.add("C");
        ts1.add("F");
        ts1.add("A");
        ts1.add("E");
        ts1.add("D");
        System.out.println(ts1);
        TreeSet ts2=new TreeSet(ts1);
        System.out.println(ts2);
    }
}
```

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4. public TreeSet(Collection c)

-->It able to create TreeSet object with all the elements of the specified Collection.

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        ArrayList al=new ArrayList();
        al.add("B");
        al.add("C");
        al.add("F");
        al.add("A");
        al.add("E");
        al.add("D");
        System.out.println(al);
        TreeSet ts=new TreeSet(al);
        System.out.println(ts);
    }
}
```

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeSet ts=new TreeSet();
        ts.add("B");
        ts.add("C");
        ts.add("F");
        ts.add("A");
        ts.add("E");
        ts.add("D");
        System.out.println(ts);
        ts.add("B");
        System.out.println(ts);
        //ts.add(null);--> NullPointerException
        //ts.add(new Integer(10));-->ClassCastException
        //ts.add(new StringBuffer("BBB"));->ClassCastException
    }
}
```

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When we add elements to the TreeSet object , TreeSet object will arrange all the elements in a particular sorting order withthe following algorithm.

1.TreeSet will construct a Tree[Balanced Tree] on the basis of the elements.

To construct Balanced Tree we have to use the following steps.

a)If the element is first element to the TreeSet object then make that element as "Root Node".

b)If the element is not first element then access compareTo(--) method over the present element by passing previous elements one by one of the balanced Tree right from root node until the present element is located in Tree.

1.If compareTo(-) method returns -ve value then goto left chaild of the present node and access again compareTo(-) method by passing left chaild. If no left chaild is existed then make the present element as left chaild

2.If compareTo(-) method returns +ve value then goto right chails and access again compareTo(-) by passing right as parameter. if no right chaild is existed then make the present element as right chaild.

3.If compareTo(-) method return 0 value then discard the present element and declare that the present element is a duplicate element of the existed element.

2.TreeSet will Retrive all the elements from balanced Tree by following Inorder traversal.

In String class, compareTo(-) method was implemented like below.

```
str1.compareTo(str2);
```

1.If str1 come first when compared with str2 as per dictionary order then compareTo() method will return -ve value.

2.If str2 come first when compared with str1 in dictionary order then compareTo() method will return +ve value.

3.If str1 and str2 are same or available at same location in dictionary order then compareTo(-) method will return 0 value.

If we want to add user defined elements like Employee, Student, Customer to TreeSet then we have to use the following steps.

1.Declare an user defined class.

2.Implement java.lang.Comparable interface in User defined class.

3.Provide implementation for compareTo(-) method in user defined class.

4.In main class , in main() method , create objects for user defined class and add objects to TreeSet object..

---Program---

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If we add non-comparable objects to TreeSet object then JVM will rise an exception like java.lang.ClassCastException, because, Non-Comparable objects are not providing compareTo(-) method internally, but, it is required to the TreeSet inorder to provide sorting order over elements.

If we want to add non-Comparable objects to TreeSet object then we must provide sorting logic to TreeSet object explicitly , for this, we have to use java.util.Comparator interface.

If we want to use Comparator interface in java applications then we have to use the following steps.

1. Declare an User defined class.
2. Implement java.util.Comparator interface in user defined class.
3. Provide implementation for Comparator interface methods in user defined class.  

```
public boolean equals(Object obj)
public int compare(Object obj1, Object obj2)
```

**Note:** In User defined class it is not required to implement equals(-) method, because, equals(-) method will come from default super class Object.

4. Provide User defined Comparator object to TreeSet object

**EX:** MyComparator mc=new MyComparator();  
TreeSet ts=new TreeSet(mc);

**EX:**

```
import java.util.*;
class MyComparator implements Comparator
{
    public int compare(Object obj1, Object obj2)
    {
        StringBuffer s1=(StringBuffer)obj1;
        StringBuffer s2=(StringBuffer)obj2;

        int length1=s1.length();
        int length2=s2.length();
        int val=0;
        if(length1<length2)
        {
            val=-100;
        }
        else if(length1>length2)
        {
            val=100;
        }
        else
```

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```
        {
            val=0;
        }
        return -val;
    }
}
class Test
{
    public static void main(String[] args)
    {
        StringBuffer sb1=new StringBuffer("AAA");
        StringBuffer sb2=new StringBuffer("BB");
        StringBuffer sb3=new StringBuffer("CCCC");
        StringBuffer sb4=new StringBuffer("D");
        StringBuffer sb5=new StringBuffer("EEEEEE");
        MyComparator mc=new MyComparator();
        TreeSet ts=new TreeSet(mc);
        ts.add(sb1);
        ts.add(sb2);
        ts.add(sb3);
        ts.add(sb4);
        ts.add(sb5);
        System.out.println(ts);
    }
}
```

**EX:**

```
import java.util.*;
class MyComparator implements Comparator
{
    public int compare(Object obj1, Object obj2)
    {
        Student s1=(Student)obj1;
        Student s2=(Student)obj2;

        int val=s1.saddr.compareTo(s2.saddr);
        return -val;
    }
}
class Student
{
    String sid;
    String sname;
    String saddr;
```

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```
Student(String sid, String sname, String saddr)
{
    this.sid=sid;
    this.sname=sname;
    this.saddr=saddr;
}
public String toString()
{
    return "["+sid+","+sname+","+saddr+"]";
}
class Test
{
    public static void main(String[] args)
    {
        Student std1=new Student("S-111", "Durga", "Hyd");
        Student std2=new Student("S-222", "Anil", "Chennai");
        Student std3=new Student("S-333", "Rahul", "Banglore");
        Student std4=new Student("S-444", "Rameshh", "Pune");
        MyComparator mc=new MyComparator();
        TreeSet ts=new TreeSet(mc);
        ts.add(std1);
        ts.add(std2);
        ts.add(std3);
        ts.add(std4);
        System.out.println(ts);
    }
}
```

Q) In Java applications, if we provide both implicit Sorting through Comparable and explicit sorting through Comparator to the TreeSet object at a time then which Sorting logic would be preferred by TreeSet inorder to Sort elements?

**Ans:**

If we provide both implicit Sorting through Comparable and Explicit Sorting through Comparator to the TreeSet object at a time then TreeSet will take explicit Sorting through Comparator to sort all the elements.

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**EX:**

```
import java.util.*;
class MyComparator implements Comparator
{
    public int compare(Object obj1, Object obj2)
    {
        Customer cust1=(Customer)obj1;
        Customer cust2=(Customer)obj2;

        int val=cust1.caddr.compareTo(cust2.caddr);
        return -val;
    }
}
class Customer implements Comparable
{
    String cid;
    String cname;
    String caddr;

    Customer(String cid, String cname, String caddr)
    {
        this.cid=cid;
        this.cname=cname;
        this.caddr=caddr;
    }
    public String toString()
    {
        return "["+cid+","+cname+","+caddr+"]";
    }
    public int compareTo(Object obj)
    {
        Customer cust=(Customer)obj;
        int val=this.caddr.compareTo(cust.caddr);
        return val;
    }
}
class Test
{
    public static void main(String[] args)
    {
        Customer c1=new Customer("C-111", "Durga", "Hyd");
        Customer c2=new Customer("C-222", "Anil", "Chennai");
        Customer c3=new Customer("C-333", "Rahul", "Banglore");
    }
}
```

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```
Customer c4=new Customer("C-444", "Ramesh", "Pune");
MyComparator mc=new MyComparator();
TreeSet ts=new TreeSet(mc);
ts.add(c1);
ts.add(c2);
ts.add(c3);
ts.add(c4);
System.out.println(ts);
}
```

**Queue:**

- > It was introduced in JDK5.0 version.
- > It is a direct child interface to Collection interface.
- > It able to arrange all the elements as per FIFO [First In First Out],but, it is possible to change this algorithm as per our requirement.
- > It able to allow duplicate elements.
- > It is not following Insertion order.
- > It is following Sorting order.
- > It will not allow null values, if we add null value then JVM will rise an Exception like java.lang.NullPointerException.
- > It will not allow heterogeneous elements, if we add heterogeneous elements then JVM will rise an exception like java.lang.ClassCastException.
- > It able to allow only homogeneous elements.
- >It able to allow comparable objects by default, if we add non comparable objects then JVM will rise an exception like java.lang.ClassCastException.
- >If we want to add non comparable objects then we have to use Comparator.
- >It able to manage all elements prior to process.

**Methods:**

- 1.public void offer(Object obj)  
-->It can be used to insert the specified element to Queue.
- 2.public Object peek()  
-->It can be used to return head element of the Queue.
- 3.public Object element()  
-->It can be used to return head element of the Queue

**Note:** If we access peek() method on an empty Queue then peek() will return "null" value. If we access element() method on an empty Queue then element() method will rise an exception like java.util.NoSuchElementException

- 4.public Object poll()  
-->It can be used to return and remove head element from Queue.

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5. public Object remove()  
-->It can be used to return and remove head element from Queue.

**Note:** If we access poll() method on an empty Queue then poll() method will return "null" value. If we access remove() method on an empty Queue then remove() method will rise an exception like "java.util.NoSuchElementException".

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        PriorityQueue q=new PriorityQueue();  
        q.offer("A");  
        q.offer("B");  
        q.offer("C");  
        q.offer("D");  
        q.offer("E");  
        q.offer("F");  
        System.out.println(q);  
        System.out.println(q.peek());  
        System.out.println(q);  
        System.out.println(q.element());  
        System.out.println(q);  
        /*  
        PriorityQueue q1=new PriorityQueue();  
        System.out.println(q1.peek());--> Null  
        System.out.println(q1.element());--> Exception  
        */  
        System.out.println(q.poll());  
        System.out.println(q);  
        System.out.println(q.remove());  
        System.out.println(q);  
        /*  
        PriorityQueue q1=new PriorityQueue();  
        System.out.println(q1.poll());--> Null  
        System.out.println(q1.remove());-->Exception  
        */  
    }  
}
```

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### PriorityQueue:

- > It was introduced in JDK5.0 version.
- > It is not Legacy Collection.
- > It is a direct implementation class to Queue
- > It able to arrange all the elements prior to interface.
- > It able to allow duplicate elements.
- > It is not following Insertion order.
- > It is following Sorting order.
- > It will not allow null values, if we add null processing on the basis of the priorities.
- > java.lang.NullPointerException.
- > It will not allow heterogeneous elements, if we value then JVM will rise an Exception like
- > rise an exception like java.lang.ClassCastException.
- > It able to allow only homogeneous elements.
- > It able to allow comparable objects bydefault, add heterogeneous elements then JVM will
- > if we add non comparable objects then JVM
- > will rise an exception like java.lang.ClassCastException.
- > If we want to add non comparable objects then we have to use Comparator.
- > Its initial capacity 11 elements.
- > It is not synchronized .
- >No method is synchronized in PriorityQueue.
- >it allows more than one thread at a time to access data.
- >It follows parallel execution.
- >It able to reduce application execution time.
- >It able to improve application performance.
- >It is not giving guarantee for Data consistancy.
- >It is not threadsafe.

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## Constructors:

### 1. public PriorityQueue()

--> It able to create an empty PriorityQueue object

**EX:** PriorityQueue p=new PriorityQueue();

### 2. public PriorityQueue(int capacity)

-->It can be used to create an empty Queue with the specified capacity.

**EX:**PriorityQueue p=new PriorityQueue(20);

### 3. public PriorityQueue(int capacity, Comparator c)

--> It able to create an empty PriorityQueue with explicit sorting logic through Comparator and the specified capacity.

**EX:** MyComparator mc=new MyComparator();

PriorityQueue p=new PriorityQueue(20,mc);

### 4. public PriorityQueue(SortedSet ss)

--> It able to create PriorityQueue object with all the elements of the specified SortedSet.

**EX:** TreeSet ts=new TreeSet();

```
ts.add("B");
ts.add("E");
ts.add("C");
ts.add("A");
ts.add("D");
System.out.println(ts);
PriorityQueue p=new PriorityQueue(ts);
System.out.println(p);
```

### 5. public PriorityQueue(Collection c)

-->It able to create PriorityQueue object with all the elements of the specified Collection.

**EX:**

```
ArrayList al=new ArrayList();
al.add("A");
al.add("B");
al.add("C");
al.add("D");
System.out.println(al);
PriorityQueue p=new PriorityQueue(al);
System.out.println(p);
```

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        PriorityQueue p=new PriorityQueue();
        p.add("A ");
        p.add("D");
        p.add("B");
        p.add("C");
        p.add("F");
        p.add("E");
        System.out.println(p);
        p.add("B");
        System.out.println(p);
        //p.add(null);-->NullPointerException
        //p.add(new Integer(10));->ClassCastException
        //p.add(new StringBuffer("BBB"));->ClassCastException
    }
}
```

**Map:**

- >It was introduced in JDK1.2 version.
- >It is not child interface to Collection interface.
- >It able to arrange all the elements in the form of Key-value pairs.
- >In Map, both keys and values are objects.
- >Duplicates are not allowed at keys , but values may be duplicated.
- >Only one null value is allowed at keys side, but, any no of null values are allowed at values side.
- >Both keys and Values are able to allow heterogeneous elements.
- >Insertion order is not followed.
- >Sorting order is not followed.

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## Methods:

### 1. **public void put(Object key, Object value)**

-->It will add the specified key-value pair to Map.

### 2. **public void putAll(Map m)**

-->It will add all key-value pairs of the specified map to the present Map object.

### 3. **public Object get(Object key)**

-->It will return value of the specified key.

### 4. **public Object remove(Object key)**

-->It will remove a key-value pair from Map on the basis of the specified key.

### 5. **public int size()**

-->It will return number of key-value pairs of a Map

### 6. **public boolean containsKey(Object key)**

-->It will check whether the specified key is existed or not at keys side.

### 7. **public boolean containsValue(Object key)**

-->It will check whether the specified value is available or not at values side.

### 8. **public Set keySet()**

-->It will return all keys in the form of a Set.

### 9. **public Collection values()**

-->It will return all values in the form of a Collection object.

### 10. **public boolean isEmpty()**

-->It will check whether the Map object is empty or not, if the present map object is empty then it will return true value otherwise it will return false value.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashMap hm=new HashMap();
        hm.put("A","AAA");
        hm.put("B","BBB");
        hm.put("C","CCC");
        hm.put("D","DDD");
        hm.put("E","EEE");
        System.out.println(hm);
        HashMap hm1=new HashMap();
        hm1.put("X","XXX");
        hm1.put("Y","YYY");
        System.out.println(hm1);
        hm.putAll(hm1);
        System.out.println(hm);
        System.out.println(hm.get("B"));
        System.out.println(hm.remove("E"));
        System.out.println(hm.size());
        System.out.println(hm.isEmpty());
        System.out.println(hm.containsKey("D"));
        System.out.println(hm.containsValue("DDD"));
        System.out.println(hm.keySet());
        System.out.println(hm.values());
    }
}
```

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### HashMap:

- >It was introduced in JDK1.2 version.
- >It is not Legacy
- >It is an implementation class to Map interface.
- >It able to arrange all the elements in the form of Key-value pairs.
- >In HashMap, both keys and values are objects.
- >Duplicates are not allowed at keys , but values may be duplicated.
- >Only one null value is allowed at keys side, but, Any no of null values are allowed at values side.
- >Both keys and Values are able to allow heterogeneous elements.
- >Insertion order is not followed.
- >Sorting order is not followed.
- >Its internal data strucer is "Hashtable".
- >Its initial capacity is 16 elements.
- >It is not synchronized
- >No method is syn chronized in HashMap
- >It allows more than one thread to access data.
- >It follows parallel execution.
- >It will reduce application execution time.
- >It will improve application performance.
- >It is not giving guarantee for data consistency.
- >It is not threadsafe.

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### Constructors:

1. public HashMap()
2. public HashMap(int capacity)
3. public HashMap(int capacity, float fill\_Ratio)
4. public HashMap(Map m)

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashMap hm=new HashMap();
        hm.put("A","AAA");
        hm.put("B","BBB");
        hm.put("C","CCC");
        hm.put("D","DDD");
        hm.put("E","EEE");
        System.out.println(hm);
        hm.put("B","FFF");
        System.out.println(hm);
        hm.put("F","CCC");
        System.out.println(hm);
        hm.put(null,"GGG");
        hm.put(null,"HHH");
        hm.put("G",null);
        hm.put("H",null);
        System.out.println(hm);
        hm.put(new Integer(10), new Integer(20));
        System.out.println(hm);
    }
}
```

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### LinkedHashMap:

Q) What are the differences between HashMap and LinkedHashMap?

**Ans:**

1. HashMap was introduced in JDK1.2 version.  
LinkedHashMap was introduced in JDK1.4 version.
2. HashMap is not following insertion order.  
LinkedHashMap is following insertion order.
3. HashMap internal data structure is Hashtable.  
LinkedHashMap internal data structure is  
Hashtable+LinkedList

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        HashMap hm=new HashMap();  
        hm.put("A","AAA");  
        hm.put("B","BBB");  
        hm.put("C","CCC");  
        hm.put("D","DDD");  
        hm.put("E","EEE");  
        System.out.println(hm);  
  
        LinkedHashMap lhm=new LinkedHashMap();  
        lhm.put("A","AAA");  
        lhm.put("B","BBB");  
        lhm.put("C","CCC");  
        lhm.put("D","DDD");  
        lhm.put("E","EEE");  
        System.out.println(lhm);  
    }  
}
```

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**IdentityHashMap:**

Q) What are the differences between HashMap and IdentityHashMap?

**Ans:**

1. HashMap was introduced in JDK1.2 version.
- IdentityHashMap was introduced in JDK1.4 version.

2. HashMap and IdentityHashMap are not allowing duplicate keys, to check duplicate keys HashMap will use equals(-) method, but, IdentityHashMap will use '==' operator.

**Note:** '==' operator will perform references comparision always, but, equals() method was defined in Object class initially, later on it was overridden in String class and in all wrapper classes inorder to perform contents comparision.

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        Integer in1=new Integer(10);  
        Integer in2=new Integer(10);  
        HashMap hm=new HashMap();  
        hm.put(in1,"AAA");  
        hm.put(in2,"BBB");// in2.equals(in1)-->true  
        System.out.println(hm);// {10=BBB}  
  
        IdentityHashMap ihm=new IdentityHashMap();  
        ihm.put(in1, "AAA");  
        ihm.put(in2, "BBB");// in2 == in1 --> false  
        System.out.println(ihm);// {10=AAA, 10=BBB}  
    }  
}
```

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**WeakHashMap:**

Q) What is the difference between HashMap and WeakHashMap?

**Ans:**

Once if we add an element to HashMap then HashMap is not allowing Garbage Collector to destroy its objects.

Even if we add an element to WeakHashMap then WeakHashMap is able to allow Garbage Collector to destroy elements.

**EX:**

```
import java.util.*;
class A
{
    public String toString()
    {
        return "A";
    }
}
class Test
{
    public static void main(String[] args)
    {
        A a1=new A();
        HashMap hm=new HashMap();
        hm.put(a1, "AAA");
        System.out.println("HM Before GC :" +hm); // {A=AAA}
        a1=null;
        System.gc();
        System.out.println("HM After GC :" +hm); // {A=AA}

        A a2=new A();
        WeakHashMap whm=new WeakHashMap();
        whm.put(a2, "AAA");
        System.out.println("WHM Before GC :" +whm); // {A=AAA}
        a2=null;
        System.gc();
        System.out.println("WHM After GC :" +whm); // {}

    }
}
```

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**NOTE:** In Java applications, Garbage Collector will destroy objects internally. In java applications, it is possible to destroy objects explicitly by activating GarbageCollector , for this, we have to use the following two steps.

- 1.Nullify the respective object reference.
- 2.Access System.gc() method, it will access finalize() method internally just before destroying object.

**EX:**

```
class A{  
A(){  
System.out.println("Object Creating");  
}  
public void finalize(){  
System.out.println("Object Destroying");  
}  
}  
class Test{  
public static void main(String[] args) {  
A a=new A();  
a=null;  
System.gc();  
}  
}
```

**SortedMap:**

- >It was introduced in JDK1.2 version.
- >It is a direct child interface to Map interface
- >It able to allow elements in the form of Key-Value pairs, where both keys and values are objects.
- >It will not allow duplicate elements at keys side, but, it able to allow duplicate elements at values side.
- >It will not follow insertion order.
- >It will follow sorting order.
- >It will not allow null values at keys side. If we are trying to add null values at keys side then JVM will rise an exception like java.lang.NullPointerException.
- >It will not allow heterogeneous elements at keys side, if we are trying add heterogeneous elements then JVm will rise an exception like java.lang.ClassCastException.
- >It able to allow only comparable objects at keys side bydefault, if we are trying to add non comparable objects then JVM will rise an exception like java.lang.ClassCastException.
- >If we want to add non comparable objects then we must use Comparator.

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**Methods:**

```
public Object firstKey()
public Object lastKey()
public SortedMap headMap(Object key)
public SortedMap tailMap(Object key)
public SortedMap subMap(Object obj1, Object obj2)
```

**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeMap tm=new TreeMap();
        tm.put("B", "BBB");
        tm.put("E", "EEE");
        tm.put("D", "DDD");
        tm.put("A", "AAA");
        tm.put("F", "FFF");
        tm.put("C", "CCC");
        System.out.println(tm);
        System.out.println(tm.firstKey());
        System.out.println(tm.lastKey());
        System.out.println(tm.headMap("D"));
        System.out.println(tm.tailMap("D"));
        System.out.println(tm.subMap("B", "E"));
    }
}
```

**NavigableMap:**

It was introduced in JAVA6 version, it is a child interface to SortedMap and it has defined methods to provide navigations over the elements.

**Methods:**

1. public Object ceilingKey(Object obj)
2. public Object higherKey(Object obj)
3. public Object floorKey(Object obj)
4. public Object lowerKey(Object obj)
5. public NavigableMap descendingMap()
6. public Map.Entry pollFirstEntry()
7. public Map.Entry pollLastEntry()

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        TreeMap tm=new TreeMap();
        tm.put("A", "AAA");
        tm.put("B", "BBB");
        tm.put("C", "CCC");
        tm.put("D", "DDD");
        tm.put("E", "EEE");
        tm.put("F", "FFF");
        System.out.println(tm);
        System.out.println(tm.descendingMap());
        System.out.println(tm.ceilingKey("D"));
        System.out.println(tm.higherKey("D"));
        System.out.println(tm.floorKey("D"));
        System.out.println(tm.lowerKey("D"));
        System.out.println(tm.pollFirstEntry());
        System.out.println(tm.pollLastEntry());
        System.out.println(tm);
    }
}
```

**TreeMap:**

- >It was introduced in JDK1.2 version.
- >It is not Legacy.
- >It is an implementation class to Map, SortedMap and NavigableMap interfaces.
- >It able to allow elements in the form of Key-Value pairs, where both keys and values are objects.
- >It will not allow duplicate elements at keys side, But, it able to allow duplicate elements at values side.
- >It will not follow insertion order.
- >It will follow sorting order.
- >It will not allow null values at keys side. If we are trying to add null values at keys side then JVM will rise an exception like java.lang.NullPointerException.
- >It will not allow heterogeneous elements at keys side, if we are trying add heterogeneous elements then JVM will rise an exception like java.lang.ClassCastException.
- >It able to allow only comparable objects at keys side bydefault, if we are trying to add non comparable objects then JVM will rise an exception like java.lang.ClassCastException.
- >If we want to add non comparable objects then we must use Comparator.
- >Its internal data Structer is "Red-Black Tree".

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- >It is not synchronized.
- >No methods are synchronized in TreeMap.
- >It allows more than one thread to access data.
- >It will follow parallel execution.
- >It will reduce execution time.
- >It will improve application performance.
- >It is not giving guarantee for Data Consistency.
- >It is not threadsafe.

**Constructors:**

- 1.public TreeMap()
- 2.public TreeMap(Comparator c)
- 3.public TreeMap(SortedMap sm)
- 4.public TreeMap(Map m)

**EX:** import java.util.\*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        TreeMap tm=new TreeMap();  
        tm.put("A", "AAA");  
        tm.put("B", "BBB");  
        tm.put("C", "CCC");  
        tm.put("D", "DDD");  
        System.out.println(tm);  
        tm.put("B", "EEE");  
        System.out.println(tm);  
        tm.put("E", "CCC");  
        System.out.println(tm);  
        //tm.put(null, "EEE");-->NullPointerException  
        tm.put("F",null);  
        System.out.println(tm);  
        //tm.put(new Integer(10), new Integer(20));-->CCE  
        System.out.println(tm);  
        tm.put("G", new Integer(20));  
        System.out.println(tm);  
        //tm.put(new StringBuffer("BBB"), "GGG");-->CCE  
        tm.put("H", new StringBuffer("HHH"));  
        System.out.println(tm);  
    }  
}

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### **Hashtable:**

Q)What are the differences between HashMap and Hashtable?

#### **Ans:**

- 1.HashMap was introduced in JDK1.2 version.  
Hashtable was introduced in JDK1.0 version.
- 2.HashMap is not Legacy.  
Hashtable is Legacy.
- 3.In HashMap, one null value is allowed at keys side and any no of null values are allowed at values side.  
In case of Hashtable, null values are not allowed at both keys and values side.
- 4.HashMap is not synchronized.  
Hashtable is synchronized.
- 5.No method is synchronized in HashMap.  
Almost all the methods are synchronized in Hashtable
- 6.HashMap allows more than one thread to access data.  
Hashtable allows only one thread at a time to access data.
- 7.HashMap follows parallel execution.  
Hashtable follows sequential execution.
- 8.HashMap will reduce execution time.  
Hashtable will increase execution time.
- 9.HashMap will improve application performance.  
Hashtable will reduce application performance.
- 10.HashMap will not give guarantee for data consistency.  
Hashtable will give guarantee for data consistency
- 11.HashMap is not threadsafe.  
Hashtable is threadsafe.

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**EX:**

```
import java.util.*;
class Test
{
    public static void main(String[] args)
    {
        HashMap hm=new HashMap();
        hm.put("A", "AAA");
        hm.put("B", "BBB");
        hm.put("C", "CCC");
        hm.put("D", "DDD");
        System.out.println(hm);
        hm.put(null, "EEE");
        hm.put(null, "FFF");
        hm.put("E",null);
        hm.put("F", null);
        System.out.println(hm);
        System.out.println();
        Hashtable ht=new Hashtable();
        ht.put("A", "AAA");
        ht.put("B", "BBB");
        ht.put("C", "CCC");
        ht.put("D", "DDD");
        System.out.println(ht);
        //ht.put(null, "EEE");-->NullPointerException
        //ht.put("E", null);-->NullPointerException
    }
}
```

**Properties:**

In java applications, if we have any data which we want to change frequently then we have to manage that type of data in a properties file, otherwise we have to perform recompilation on every modification.

The main purpose of properties files in java applications is,

- 1.To manage labels of the GUI components in GUI appl.
- 2.To manage locale respective messages in I18N Appl.
- 3.To manage exception messages in Exception handling.
- 4.To manage validation messages in Data validations.

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**EX:**

user.properties

uname=User Name

upwd=User password

uname.required=User Name is Required

upwd.required=User Password is required

exception.insufficientfunds=Funds are not sufficient in your Account.

In java applications, to represent data of a particular properties file we have to use `java.util.Properties` class.

To get data from a particular properties file to Properties object we have to use the following steps.

1.Create Properties file with the data in the form of Key-value pairs.

2.Create Properties class object.

3.Create FileInputStream to get data from properties file.

4.Load data from FileInputStream to Properties object by using the following method.

public void load(FileInputStream fis)

5.Get data from Properties object by using the following method.

public String getProperty(String key)

To send data from Properties object to properties file we have to use the following steps.

1.Create Properties class object.

2.Set data to Properties object by using the following method.

public void setProperty(String key, String val)

3.Create FileOutputStream with the target file.

4.Store Properties object data to FileOutputStream by using the following method.

public void store(FileOutputStream fos, String des)

**db.properties**

driver\_Class=sun.jdbc.odbc.JdbcOdbcDriver

driver\_URL=jdbc:odbc:dsn\_name

db\_User=system

db\_Password=durga

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**Test.java**

```
import java.util.*;
import java.io.*;
class Test
{
    public static void main(String[] args) throws Exception
    {
        Properties p=new Properties();
        FileInputStream fis=new FileInputStream("db.properties");
        p.load(fis);
        System.out.println("JDBC Parameters");
        System.out.println("-----");
        System.out.println("Driver_Class : "+p.getProperty("driver_Class"));
        System.out.println("Driver_URL : "+p.getProperty("driver_URL"));
        System.out.println("DB_User : "+p.getProperty("db_User"));
        System.out.println("DB_Password : "+p.getProperty("db_Password"));
    }
}
```

**Test1.java**

```
import java.util.*;
import java.io.*;
class Test1
{
    public static void main(String[] args) throws Exception
    {
        Properties p=new Properties();
        p.setProperty("uname", "Durga");
        p.setProperty("upwd", "durga123");
        p.setProperty("uqual", "M Tech");
        p.setProperty("uemail", "durga@durgasoft.com");
        p.setProperty("umobile", "91-9988776655");

        FileOutputStream fos=new FileOutputStream("user.properties");
        p.store(fos, "User Details");
    }
}
```

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## GUI[Graphical User Interface]

By using Java programming language, we are able to prepare the following two types of applications.

- 1.CUI Applications
- 2.GUI Applications

Q)What is the difference between CUI Application and GUI Application?

**Ans:**

CUI Application is a java application, it would be designed in such a way that to take input from command prompt and to provide output on the same command prompt, where command prompt is acting as an user interface and it is supporting characters data.

GUI Application is a java application, it would be designed in such a way that to take input from the collection of Graphics components and to provide output on the same collection of Graphics components, where the collection of graphics components is acting as an user interface and it is supporting graphics data.

To prepare GUI Applications, JAVA has provided the complete predefined library in the form of the following three packages.

java.awt  
java.applet  
javax.swing

**AWT[Abstract Windowing Toolkit]**

AWT is a toolkit or collection of predefined classes and interfaces to design GUI Applications.

AWT is a framework, it can be used to prepare Desktop applications.

AWT is an API, it can be used to prepare Window based applications.

TO prepare GUI applications, AWT is able to provide support for the following GUI components.

To represent the above GUI components, java.awt package has provided the following predefined classes.

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**Frame:**

Frame is a container , it able to manage some other GUI components.

To represent Frame in GUI applications, JAVA has provided a separate predefined class in the form of `java.awt.Frame`.

To create Frame class object we have to use the following constructor from Frame class.

`public Frame()`

--> It will create a Frame with out title.

`public Frame(String title)`

--> It will create a Frame with the specified title.

In GUI applications, when we create Frame then Frame will be created with invisible mode, where to give visibility to the Frame we will use the following methods.

`public void show()`

--> It able to show the frame , it unable to hide frame and this method is deprecated method.

`public void setVisible(boolean b)`

--> If b is true then it will provide visibility to the Frame, if b is false then it will hide Frame.

In GUI applications, when we create Frame then Frame will be created with 0 width and 0 height, where to provide size to the Frame explicitly we have to use the following method.

`public void setSize(int width, int height)`

To set a particular title to the Frame explicitly we have to use the following method.

`public void setTitle(String title)`

To set a particular background color to the frame we have to use the following method.

`public void setBackground(Color clr)`

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```
EX: import java.awt.*;
public class FrameEx
{
    public static void main(String[] args)
    {
        Frame f=new Frame();
        //f.show();
        f.setVisible(true);
        f.setSize(500,500);
        f.setTitle("Frame Demo");
        f.setBackground(Color.green);
    }
}
```

In GUI applications, above approach is not suggestible to create Frames, because, we are unable to perform customizations over the Frame. To implement customizations over the Frame we have to create user defined Frames.

To create User defined frames we have to use the following steps.

1. Declare an user defined class.
2. Extend User defined class from java.awt.Frame class.
3. Declare a 0-arg constructor in user defined class.
4. Provide all Frame properties in User defined class constructor.
5. In main class, in main() method, create object for user defined Frame class.

```
EX: import java.awt.*;
class MyFrame extends Frame
{
    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Custom Frame Example");
        this.setBackground(Color.red);
    }
}
class CustomFrameEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

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If we want to display textual data on frame then we have to override paint(-) method provided by Frame class.

```
public void paint(Graphics g)
```

To define Font properties , java has provided a predefined class in the form of java.awt.Font , to craete object for Font class we have to use the following copnstructor.

```
public Font(String font_Type, int font_Style, int font_Size).
```

To set foreground color to the Frame we have to use the following methode from java.awt.Frame class.

```
public void setForeground(Color clr)
```

To set Font properties to the Graphics object we have to use the following method.

```
public void setFont(Font f)
```

**NOTE:** When we create user defined Frame class object, JVM has to access superr class 0-arg constructor, that is, Frame class 0-arg constructor, where in Frame class 0-arg constructor JVM will access repaint(-) method, where repaint() method will access paint() method.

#### EX:

```
import java.awt.*;
class LogoFrame extends Frame
{
    LogoFrame()
    {
        setVisible(true);
        setSize(700,400);
        setTitle("Paint Example");
        setBackground(Color.green);
    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD+Font.ITALIC, 35);
        g.setFont(f);
        this.setForeground(Color.red);
        g.drawString("DURGA SOFTWARE SOLUTIONS", 100,100);
    }
}
class PaintEx
{
    public static void main(String[] args)
    {
        LogoFrame lf=new LogoFrame();
    }
}
```

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### Event Handling / Event Delegation Model:

In GUI applications, we may use the GUI components like Buttons, Check boxes, radio Buttons,... When we click on button or select item in check box,.. the respective GUI components are able to rise the respective events, here GUI components are not capable to handle the generated events. In this context, to handle the generated events we have to use another component internally that is Listener.

In GUI applications, Listers will take events from GUI components , handle them , perform the required actions by executing listener methods and return the result back to GUI application. Here , the process delegating events from GUI components to Listeners inorder to handle is called as "Event Delegation Model" or Event Handling.

To implement Event handling in GUI applications, JAVA has provided the following predefined library as part of "java.awt.event" package.

### Procedure to implement Event Handling in GUI Applications:

1. Declare container class as sub class to java.awt.Frame class.
2. Declare a 0-arg constructor in container class.
3. Create the required GUI component in container class constructor.
4. Select Listener on the basis of GUI Component.
5. Declare an implemantaton class for Listener interface.
6. Provide implementation for all Listener interface methods in Listener implementation class as per the requirement.
7. Add Lisyener to the resapective GUI Component by using the following method.  
`public void addXXXListener(XXXListener l)`  
Where XXXListener may be ActionListener, ItemListener,...

**NOTE:** In GUI Applications, in general, we will take container class as implementation class for Listener interfase, in the same container class Listener interface methods must be implemented.

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**EX:**

```
class MyFrame extends Frame// Container class
{
    MyFrame()// Constructor
    {
        Button b=new Button("Submit");// GUI Comp.
        b.addActionListener(new MyActionListenerImpl());
    } // Adding Listener to GUI Component
}

class MyActionListenerImpl implements ActionListener
{// Listener Implementation class and Listener methods impl
    public void actionPerformed(ActionEvent ae)
    {
        ----implementation-----
    }
}
```

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class WindowListenerImpl implements WindowListener
{
    public void windowOpened(WindowEvent we)
    {
        System.out.println("WindowOpened");
    }
    public void windowClosed(WindowEvent we)
    {
        System.out.println("WindowClosed");
    }
    public void windowClosing(WindowEvent we)
    {
        System.out.println("WindowClosing");
        System.exit(0);
    }
    public void windowIconified(WindowEvent we)
    {
        System.out.println("WindowIconified");
    }
    public void windowDeiconified(WindowEvent we)
    {
        System.out.println("windowDeiconified");
    }
}
```

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```
        }
        public void windowActivated(WindowEvent we)
        {
            System.out.println("WindowActivated");
        }
        public void windowDeactivated(WindowEvent we)
        {
            System.out.println("WindowDeactivated");
        }
    }
    class MyFrame extends Frame
    {
        MyFrame()
        {
            this.setVisible(true);
            this.setSize(500,500);
            this.setTitle("Window Events Example");
            this.setBackground(Color.green);
            this.addWindowListener(new WindowListenerImpl());
        }
    }
    class WindowEventsEx
    {
        public static void main(String[] args)
        {
            MyFrame mf=new MyFrame();
        }
    }
}
```

In Window Events, if we want to provide only window closing option to the frame then we have to use only

windowClosing() method in the above implementation. To provide only windowClosing() method if we implement WindowListener interface then we must provide implementation for all the methods of WindowListener interface, this approach will increase unnecessary methods implementations in GUI Applications.

To overcome the above problem, to avoid unnecessary methods implementations AWT has provided an adapter class in the form of "java.awt.event.WindowAdapter abstract class.

java.awt.event.WindowAdapter abstract class is a direct implementation abstract class to WindowListener interface and it has provided empty implementation [ { } ] for all the methods of WindowListener interface.

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If we want to use WindowAdapter abstract class in GUI Applications then we have to declare an user defined class and it must extend java.awt.event.WindowAdapter abstract class , where we have to override the required method.

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class WindowListenerImpl extends WindowAdapter
{
    public void windowClosing(WindowEvent we)
    {
        System.exit(0);
    }
}
class MyFrame extends Frame
{
    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Window Events Example");
        this.setBackground(Color.green);
        this.addWindowListener(new WindowListenerImpl());
    }
}
class WindowEventsEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

To provide window closing option to the frame if we use the above approach then we have to provide a seperate class for implementing windowClosing(-) method, it will increase no of classes in GUI applications, here to remove this type of unnecessary classes we have to use anonymous inner class of WindowAdapter abstract class as parameter to addWindowListener(-) method directly.

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**EX:**

```
import java.awt.*;
import java.awt.event.*;
class MyFrame extends Frame
{
    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Window Events Example");
        this.setBackground(Color.green);
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
    }
}
class WindowEventsEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class MouseListenerImpl implements MouseListener
{
    public void mousePressed(MouseEvent me)
    {
        System.out.println("Mouse Pressed["+me.getX()+","+me.getY()+"]");
    }
    public void mouseReleased(MouseEvent me)
    {
        System.out.println("Mouse Released["+me.getX()+","+me.getY()+"]");
    }
    public void mouseClicked(MouseEvent me)
    {
```

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```
        System.out.println("Mouse Clicked["+me.getX()+","+me.getY()+"]");
    }
    public void mouseEntered(MouseEvent me)
    {
        System.out.println("Mouse Entered["+me.getX()+","+me.getY()+"]");
    }
    public void mouseExited(MouseEvent me)
    {
        System.out.println("Mouse Exited["+me.getX()+","+me.getY()+"]");
    }
}
class MyFrame extends Frame
{
    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Mouse Events Example");
        this.setBackground(Color.yellow);
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        this.addMouseListener(new MouseListenerImpl());
    }
}
class MouseEventsEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

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**EX:** import java.awt.\*;  
import java.awt.event.\*;  
class KeyListenerImpl implements KeyListener  
{  
 public void keyPressed(KeyEvent ke)  
 {  
 System.out.println("KeyPressed["+ke.getKeyChar()+""]);  
 }  
 public void keyTyped(KeyEvent ke)  
 {  
 System.out.println("KeyTyped["+ke.getKeyChar()+""]);  
 }  
 public void keyReleased(KeyEvent ke)  
 {  
 System.out.println("KeyReleased["+ke.getKeyChar()+""]);  
 }  
}  
class MyFrame extends Frame  
{  
 MyFrame()  
 {  
 this.setVisible(true);  
 this.setSize(500,500);  
 this.setTitle("Key Events Example");  
 this.setBackground(Color.green);  
 this.addWindowListener(new WindowAdapter()  
 {  
 public void windowClosing(WindowEvent we)  
 {  
 System.exit(0);  
 }  
 });  
 this.addKeyListener(new KeyListenerImpl());  
 }  
}  
class KeyEventsEx  
{  
 public static void main(String[] args)  
 {  
 MyFrame mf=new MyFrame();  
 }  
}

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### Layout Mechanisms:

The main purpose of Layout mechanism is to arrange all the GUI components in container in a particular order.

There are five layout mechanisms in AWT.

- 1.FlowLayout
- 2.BorderLayout
- 3.GridLayout
- 4.GridbagLayout
- 5.CardLayout

To set a particular Layout mechanism to the Container we have to use the following method.

```
public void setLayout(XXXLayout l)
```

Where XXXLayout may be FlowLayout, BorderLayout,....,

#### 1.FlowLayout:

It able to arrange all the GUI components in rows manner.

To represent this Layout mechanism AWT has provided a predefined class in the form of java.awtFlowLayout.

To set flow layout to the Frame we have to use the following instruction.

```
f.setLayout(new FlowLayout());
```

#### 2.BorderLayout:

It able to arrange GUI components along with borders of the containers.

To represent this Layout mechanism AWT has provided a predefined class in the form of java.awt.BorderLayout .

To set this layout mechanism, we have to use the following instruction.

```
f.setLayout(new BorderLayout());
```

To represents the locations in container , BorderLayout class has provided the constants like EAST, NORTH, SOUTH, WEST, CENTER.

In case of Border layout , if we want to add the elements to the container we have to use the following method.

```
public void add(int location, Component c)
```

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**EX:** f.add(BorderLayout.CENTER, new WelcomePanel());

### 3.GridLayout:

It able to arrange all the GUI components in rows and columns wise in the form of grids.

To represent this layout mechanism, AWT has provided a predefined class in the form of java.awt.GridLayout.

To set Grid layout mechanism we have to use the following instruction.

```
f.setLayout(new GridLayout(4,4));
```

Where 4 , 4 is no of rows and no columns.

If we want to use GridLayout in GUI applications then we must follow the following rules.

- 1.All the GUI components must have equals size.
- 2.We must not leave any empty grid in between GUI components.

### 4.GridbagLayout:

This layout mechanism is almost all same as GridLayout, but, it able to allow empty grids between the components and it able to allow the GUI components having variable sizes.

To represent this layout mechanism, AWT has provided a predefined class in the form of java.awt.GridbagLayout.

To use this layout mechanism we have to use the following instruction.

```
f.setLayout(new GridBagLayout(3,3));
```

### 5.Card Layout:

It able to arrange all the elements in the form of cards which are available in overlapped manner.

To represent this layout , AWT has provided a predefined class in the form of java.awt.cardLayout.

To use this layout mechanism we have to use the following code.

```
f.setLayout(new CardLayout(4));
```

Where 4 is no of cards.

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**Label:**

It is an output GUI component, it able to display a line of data on Frame.

To represent Label GUI component AWT has provided a predefined class in the form of `java.awt.Label`.

To create Object for Label class we ahev to use the following constructors.

```
public Label()  
public Label(String label)  
public Label(String label, int alignment)
```

Where alignment may be the constants like LEFT, RIGHT, CENTER from Label class.

**Button:**

It is an output GUI component, it able to generate ActionEvent inorder to perform a particular Action.

To repersent this GUI component AWT has provided a predefined class in the form of "java.awt.Button".

To create Button class objects we have to use the following constructors.

```
public Button()  
public Button(String label)
```

To set label to the button and to get label from Button we have to use the following methods.

```
public void setLabel(String label)  
public String getLabel()
```

To get clicked button label among the multiple buttons we have to use the following method.

```
public String getActionCommand()
```

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**EX:**

```
import java.awt.*;
import java.awt.event.*;
class ColorsFrame extends Frame implements ActionListener
{
    Button b1, b2, b3;
    ColorsFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Colors Frame");
        this.setLayout(new FlowLayout());
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        b1=new Button("Red");
        b2=new Button("Green");
        b3=new Button("Blue");

        b1.addActionListener(this);
        b2.addActionListener(this);
        b3.addActionListener(this);

        b1.setBackground(Color.red);
        b2.setBackground(Color.green);
        b3.setBackground(Color.blue);

        this.add(b1);
        this.add(b2);
        this.add(b3);
    }
    public void actionPerformed(ActionEvent ae)
    {
        String label=ae.getActionCommand();
        if(label.equals("Red"))
        {
            this.setBackground(Color.red);
        }
    }
}
```

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```
        }
        if(label.equals("Green"))
        {
            this.setBackground(Color.green);
        }
        if(label.equals("Blue"))
        {
            this.setBackground(Color.blue);
        }
    }
}
class ButtonEx
{
    public static void main(String[] args)
    {
        ColorsFrame cf=new ColorsFrame();
    }
}
```

**TextField:**

It is an input GUI component, it able to take a single line of data from User.

To represent this GUI component , AWT has provided a predefined class in the form of "java.awt.TextField".

To create TextField class object we have to use the following constructors.

```
public TextField()
public TextField(int size)
public TextField(String def_msg, int size)
```

To set data to the TextField and to get data from Text field we have to use the following methods.

```
public void setText(String text)
public String getText()
```

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**TextArea:**

It is an input GUI component, it able to take multiple lines of data from user.

To represent this GUI component, AWT has provided a predefined class in the form of "java.awt.TextArea".

To create TextArea class object AWT has provided the following constructors.

```
public TextArea()  
public TextArea(int rows, int columns)  
public TextArea(String def_Message, int rows, int cols)
```

To set data to Text Area and to get data from Text Area we have to use the following methods.

```
public void setText(String text)  
public String getText()
```

**NOTE:**If we want to prepare Password field in GUI applications then we have to take a text filed, where we have to hide data with a particular character called as Echo Character, where to set a particular Echo Character we have to use the following method.

```
public void setEchoChar(char c)
```

**EX:**

```
import java.awt.*;  
import java.awt.event.*;  
class UserFrame extends Frame implements ActionListener  
{  
    Label l1, l2, l3, l4, l5;  
    TextField tf1, tf2, tf3, tf4;  
    TextArea ta;  
    Button b;  
  
    String uname="";  
    String upwd="";  
    String uemail="";  
    String umobile="";  
    String uaddr="";  
  
    UserFrame()  
    {  
        this.setVisible(true);  
        this.setSize(500,500);
```

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```
this.setTitle("User Frame");
this.setBackground(Color.green);
this.setLayout(new FlowLayout());
this.addWindowListener(new WindowAdapter()
{
    public void windowClosing(WindowEvent we)
    {
        System.exit(0);
    }
});

l1=new Label("User Name");
l2=new Label("Password");
l3=new Label("User Email");
l4=new Label("User Mobile");
l5=new Label("User Address");

tf1=new TextField(20);
tf2=new TextField(20);
tf2.setEchoChar('*');
tf3=new TextField(20);
tf4=new TextField(20);

ta=new TextArea(3,15);
b=new Button("Registration");
b.addActionListener(this);

Font f=new Font("arial", Font.BOLD,15);
l1.setFont(f);
l2.setFont(f);
l3.setFont(f);
l4.setFont(f);
l5.setFont(f);
tf1.setFont(f);
tf2.setFont(f);
tf3.setFont(f);
tf4.setFont(f);
ta.setFont(f);
b.setFont(f);

this.add(l1); this.add(tf1);
this.add(l2); this.add(tf2);
this.add(l3); this.add(tf3);
this.add(l4); this.add(tf4);
```

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```
this.add(l5); this.add(ta);
this.add(b);

}

public void actionPerformed(ActionEvent ae)
{
    uname=tf1.getText();
    upwd=tf2.getText();
    uemail=tf3.getText();
    umobile=tf4.getText();
    uaddr=ta.getText();
    repaint();
}

public void paint(Graphics g)
{
    Font f=new Font("arial", Font.BOLD, 20);
    g.setFont(f);
    g.drawString("User Name :"+uname,50,250);
    g.drawString("Password :"+upwd,50,300);
    g.drawString("User Email :"+uemail,50,350);
    g.drawString("User Mobile :"+umobile,50,400);
    g.drawString("User Address :"+uaddr,50,450);
}

class TextFieldEx
{
    public static void main(String[] args)
    {
        UserFrame uf=new UserFrame();
    }
}
```

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**Checkbox:**

It is an input GUI component, it can be used to select an item represented by the present Checkbox.

To represent this GUI component AWT has provided a predefined class in the form of "java.awt.Checkbox".

To create Checkbox class objects we have to use the following constructors

```
public Checkbox()  
public Checkbox(String label)  
public Checkbox(String label, boolean state)  
public Checkbox(String label, CheckboxGroup cg, boolean state)
```

To set label to the Checkbox and to get label from Check box we have to use the following methods.

```
public void setLabel(String label)  
public String getLabel()
```

To get current state of the check box and to set a particular state to check box we have to use the following methods.

```
public void setState(boolean b)  
public boolean getState()
```

**Radio:**

It is an input GUI component, it able to allow to select an item.

In general, Checkboxes are able to allow multiple selections , but, Radio button is able to allow single selection.

To create radio buttons we have to use Checkbox class object with CheckboxGroup object reference.

**EX:**

```
CheckboxGroup cg=new CheckboxGroup();  
Checkbox cb1=new Checkbox("Male", cg, false);  
Checkbox cb2=new Checkbox("Female", cg, false);
```

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To set label to checkbox and to get label from Checkbox we have to use the following methods.

```
public void setLabel(String label)
public String getLabel()
```

To set a particular state to the checkbox and to get current state from checkbox we have to use the following methods.

```
public void setState(boolean b)
public boolean getState()
```

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class UserFrame extends Frame implements ItemListener
{
    Label l1, l2;
    Checkbox cb1, cb2, cb3, cb4, cb5;
    String uqual="";
    String ugender="";

    UserFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Check Box Example");
        this.setBackground(Color.green);
        this.setLayout(new FlowLayout());
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        l1=new Label("User Qualifications");
        l2=new Label("User Gender");
        cb1=new Checkbox("BSC",null, false);
        cb2=new Checkbox("MCA",null, false);
        cb3=new Checkbox("PHD",null, false);
        CheckboxGroup cg=new CheckboxGroup();
```

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```
cb4=new Checkbox("Male",cg, false);
cb5=new Checkbox("Female",cg, false);

cb1.addItemListener(this);
cb2.addItemListener(this);
cb3.addItemListener(this);
cb4.addItemListener(this);
cb5.addItemListener(this);

Font f=new Font("arial", Font.BOLD, 15);
l1.setFont(f);
l2.setFont(f);
cb1.setFont(f);
cb2.setFont(f);
cb3.setFont(f);
cb4.setFont(f);
cb5.setFont(f);

this.add(l1);
this.add(cb1);
this.add(cb2);
this.add(cb3);
this.add(l2);
this.add(cb4);
this.add(cb5);

}

public void itemStateChanged(ItemEvent ie)
{
    if(cb1.getState() == true)
    {
        uqual=uqual+cb1.getLabel()+" ";
    }
    if(cb2.getState() == true)
    {
        uqual=uqual+cb2.getLabel()+" ";
    }
    if(cb3.getState() == true)
    {
        uqual=uqual+cb3.getLabel()+" ";
    }
    if(cb4.getState() == true)
    {
        ugender=cb4.getLabel();
    }
}
```

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```
        if(cb5.getState() == true)
        {
            ugender=cb5.getLabel();
        }
        repaint();
    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD, 30);
        g.setFont(f);
        g.drawString("Qualifications :" +uqual, 50, 300);
        g.drawString("Gender   :" +ugender, 50, 350);
        uqual="";
    }
}
class CheckBoxEx
{
    public static void main(String[] args)
    {
        UserFrame uf=new UserFrame();
    }
}
```

**List:**

It is an input GUI component, It able to represent more than one element to select.

To represent this GUI component AWT has provided a predefined class `java.awt.List`

To create List class object we have to use the following constructors.

```
public List()
public List(int size)
public List(int size, boolean b)
```

To add an item to List we have to use the following method.

```
public void add(String item)
```

To get the selected item from List we have to use the following method.

```
public String getSelectedItem()
```

To get the selected items from List we have to use the following method.

```
public String[] getSelectedItems()
```

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### Choice:

List is able to allow more than one item selection but Choice is able to allow only one item selection.

To represent this GUI component AWT has provided a predefined class in the form of java.awt.Choice.

To create Object for Choice class we have to use the following constructor.

```
public Choice()
```

To add an item to Choice object we have to use the following method.

```
public void add(String item)
```

To get the selected item from Choice we have to use the following method.

```
public String getSelectedItem()
```

### EX:

```
import java.awt.*;
import java.awt.event.*;
class UserFrame extends Frame implements ItemListener
{
    Label l1, l2;
    List l;
    Choice ch;
    String utech="";
    String uprof="";

    UserFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("List Example");
        this.setBackground(Color.green);
        this.setLayout(new FlowLayout());
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        l1=new Label("User Technologies");
        l2=new Label("User Profession");
        l=new List(4,true);
    }
}
```

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```
        l.add("C");
        l.add("C++");
        l.add("JAVA");
        l.add(".NET");
        l.add("Oracle");
        l.addItemListener(this);

        ch=new Choice();
        ch.add("Student");
        ch.add("Employee");
        ch.add("Teacher");
        ch.addItemListener(this);

        this.add(l1); this.add(l);
        this.add(l2); this.add(ch);

    }
    public void itemStateChanged(ItemEvent ie)
    {
        String[] items=l.getSelectedItems();
        for(int i=0;i<items.length;i++)
        {
            utech=utech+items[i]+" ";
        }
        uprof=ch.getSelectedItem();
        repaint();
    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD, 30);
        g.setFont(f);
        g.drawString("Technologies :" +utech, 50, 300);
        g.drawString("Profession : " +uprof, 50, 350);
        utech="";
    }
}
class ListEx
{
    public static void main(String[] args)
    {
        UserFrame uf=new UserFrame();
    }
}
```

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**Menu:**

This GUI component is able to provide a list of items to select.

To represent Menu in GUI applications, AWT has provided a set of predefined classes like `java.awt.MenuBar`, `java.awt.Menu` and `java.awt.MenuItem`.

To use menu in GUI applications we have to use the following steps.

- 1.Create `MenuBar` and Add `MenuBar` to Frame.
- 2.Create `Menu` and add `Menu` to `MenuBar`.
- 3.Create `MenuItem`s and add `MenuItem`s to `Menu`.

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class MyFrame extends Frame implements ActionListener
{
    MenuBar mb;
    Menu m;
    MenuItem mi1, mi2, mi3;
    String item="";

    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Menu Example");
        this.setBackground(Color.green);
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        mb=new MenuBar();
        this.setMenuBar(mb);

        m=new Menu("File");
        mb.add(m);

        mi1=new MenuItem("New");
    }
}
```

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```
mi2=new MenuItem("Open");
mi3=new MenuItem("Save");
m.add(mi1);
m.add(mi2);
m.add(mi3);

mi1.addActionListener(this);
mi2.addActionListener(this);
mi3.addActionListener(this);

}

public void actionPerformed(ActionEvent ae)
{
    item=ae.getActionCommand();
    repaint();
}
public void paint(Graphics g)
{
    Font f=new Font("arial", Font.BOLD, 30);
    g.setFont(f);
    g.drawString("Selected Item :" +item, 50, 300);
}
class MenuEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

**Scrollbar:**

It able to move frame top to bottom or left to right inorder to visible the components.

To represent Scroll bar AWT has provided a predefined class in the from of `java.awt.Scrollbar`.

To prepare Scrollbar class object we have to use the following constructor.

```
public Scrollbar(int type)
```

Where type may be VERTICAL or HORIZONTAL constants from Scrollbar class.

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**NOTE:** Scrollbar is able to rise AdjustmentEvent and which is handled by AdjustmentListener by executing adjustmentValueChanged(--) method.

**EX:**

```
import java.awt.*;
import java.awt.event.*;
class MyFrame extends Frame implements AdjustmentListener
{
    Scrollbar sb;
    int position;

    MyFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("Scrollbar Example");
        this.setLayout(new BorderLayout());
        this.setBackground(Color.green);
        this.addWindowListener(new WindowAdapter()
        {
            public void windowClosing(WindowEvent we)
            {
                System.exit(0);
            }
        });
        sb=new Scrollbar(Scrollbar.VERTICAL);
        sb.addAdjustmentListener(this);

        this.add(BorderLayout.EAST, sb);
    }
    public void adjustmentValueChanged(AdjustmentEvent ae)
    {
        position=sb.getValue();
        repaint();
    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD, 30);
        g.setFont(f);
        g.drawString("Position :" +position, 50, 300);
    }
}
```

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```
class ScrollBarEx
{
    public static void main(String[] args)
    {
        MyFrame mf=new MyFrame();
    }
}
```

### Applets:

Applet is a container, it able to manage some other GUI components.

To represent Applet, JAVA has provided a predefined class in the from of `java.applet.Applet`.

If we want to use Applets in GUI applications then we have to use the following steps.

- 1.Create Applet class
- 2.Create Applet Configuration File
- 3.Execute Applet

#### 1.Create Applet class

- a)Declare an user defined class
- b)Extend `java.applet.Applet` class to user defined class.
- c)In user defined Applet class, override Applet lifecycle methods like

```
public void init()
public void start()
public void stop()
public void destroy()
```

#### 2.Create Applet Configuration File

The main intentin of Applet configuratino file is to declare Applet class and its location and to declare size of the Applet,.....

Applet configuratin file is an html file , which includes, `<applet>` tag.

#### Syntax:

```
<applet code="---" width="--" height="--">
</applet>
```

Where "code" attribute will take the name and location of the Applet class.

Where "width" and "hight" attributes are used to take applet size.

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### 3.Execute Applet:

There are two approaches to execute Applets.

- 1.Use "appletviewer" command on command prompt.

**EX:** D:\java830>appletviewer MyApplet.html

### 2.Use browser to execute Applet:

In this case, open Applet configuration file in browser.

**NOTE:** In general, Applets are executed by following Applet lifecycle only, Applets are not having main() method to execute.

---Diagram----

#### LogoApplet.java

```
import java.awt.*;
import java.applet.*;
public class LogoApplet extends Applet
{
    public void paint(Graphics g)
    {
        Font f=new Font("arial", Font.BOLD, 30);
        g.setFont(f);
        g.drawString("DURGA SOFTWARE
SOLUTIONS",100,100);
    }
}
```

#### LogoApplet.html

```
<applet code="LogoApplet" width="700" height="500">
</applet>
```

On Command Prompt

```
D:\java830>javac LogoApplet.java
D:\java830>appletviewer LogoApplet.html
```

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## **SWING:**

Swing is a package in java , it able to provide all GUI components to prepare GUI applications.

Q)What are the differences between AWT and SWING?

**Ans:**

1.AWT GUI components are platform dependent GUI components.

SWING GUI Components are platform Independent GUI Components.

2.AWT GUI Components are able to follow the local operating system provided Look And Feel, it is fixed upto the present operating syste,,

SWING GUI components are having Pluggable Look And Feel nature irrespective of the operating system which we used.

3.AWT GUI components are Heavy Weight GUI components, they will more execution time and much meory.

Swing GUI compoents are light weight GUI components, they will take less memory and less execution time.

4.AWT GUI compnents are able to provide less performance in GUI applications.

SWING GUI components are able to provide very good performance in GUI applicatins.

5.AWT GUI components are PEER GUI components, for every GUI component a seperate duplicate component is created at Operating System.

SWING GUI components are not PEER Gui components , no seperate duplicate component will be created at Operating System .

6.AWT is not following MVC[Model-View-Controller] design pattern internally todesign GUI applications.

SWING is following MVC design pattern to design GUI applications.

7.AWT is not providing tool tip text support.

SWING is providing Tool Tip Text Support

8.In AWT, we are able to add all the GUI components to Frame directly.

In SWING, we are able to add all the GUI components to the Panes .

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**NOTE:** There are four types of Panes in SWING

- 1.RootPane
- 2.LayeredPane
- 3.ContentPane
- 4.GlassPane.

In SWING we will use mainly ContentPane to manage GUI components , where to get ContentPane we have to use the following method.

```
public Container getContentPane()
```

To represent all GUI components in SWING , javax.swing package has provided the following predefined classes.

**NOTE:**

To close Frames in AWT we have to use WindowListener implementation class or WindowAdapter abstract class or Anonymous inner class of WindowAdapter abstract class. In case of SWING to provide window closing option to the Frame we have to use the following instruction .

```
f.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
```

**EX:**

```
import javax.swing.*;  
import javax.swing.event.*;  
import java.awt.*;  
import java.awt.event.*;  
class RegistrationFrame extends JFrame implements ActionListener  
{  
    JLabel l1,l2,l3,l4,l5,l6,l7;  
    JTextField tf;  
    JPasswordField pf;  
    JCheckBox cb1,cb2,cb3;  
    JRadioButton rb1,rb2;  
    JList l;  
    JComboBox cb;  
    JTextArea ta;  
    JButton b;  
  
    Container c;  
    String uname="";upwd="";uqual="";ugen="";utech="";uprof="";uaddr="";  
    RegistrationFrame()  
    {  
        this.setVisible(true);  
        this.setSize(500,600);  
        this.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
```

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```
c=getContentPane();
c.setBackground(Color.cyan);
//this.setForeground(Color.red);
c.setLayout(null);
l1=new JLabel("User Name");
l1.setBounds(50,100,100,10);
l2=new JLabel("Password");
l2.setBounds(50,150,100,10);
l3=new JLabel("Qualification");
l3.setBounds(50,200,100,10);
l4=new JLabel("Gender");
l4.setBounds(50,250,100,10);
l5=new JLabel("Technologies");
l5.setBounds(50,300,100,10);
l6=new JLabel("Proffession");
l6.setBounds(50,350,100,10);
l7=new JLabel("Address");
l7.setBounds(50,400,100,10);

tf=new JTextField(20);
tf.setBounds(150,90,100,30);
tf.setToolTipText("This Is Text Field");

pf=new JPasswordField(20);
pf.setBounds(150,140,100,30);
pf.setToolTipText("This Is Password Field");

cb1=new JCheckBox("BSC");
cb1.setBounds(150,190,60,30);
cb2=new JCheckBox("MCA ");
cb2.setBounds(220,190,60,30);
cb3=new JCheckBox("PHD");
cb3.setBounds(290,190,60,30);

rb1=new JRadioButton("Male");
rb1.setBounds(150,240,80,30);
rb2=new JRadioButton("Female");
rb2.setBounds(250,240,80,30);
ButtonGroup bg=new ButtonGroup();
bg.add(rb1);
bg.add(rb2);

String[] techs={"C","C++","JAVA"};
l=new JList(techs);
```

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```
l.setBounds(150,280,60,60);

String[] prof={"Student","Business","Teacher"};
cb=new JComboBox(prof);
cb.setBounds(150,340,80,30);

ta=new JTextArea(5,25);
ta.setBounds(150,380,100,40);

b=new JButton("Registration");
b.setBounds(50,450,110,40);
b.addActionListener(this);

c.add(l1);c.add(tf);
c.add(l2);c.add(pf);
c.add(l3);c.add(cb1);c.add(cb2);c.add(cb3);
c.add(l4);c.add(rb1);c.add(rb2);
c.add(l5);c.add(l);
c.add(l6);c.add(cb);
c.add(l7);c.add(ta);
c.add(b);
}

public void actionPerformed(ActionEvent ae)
{
    uname=tf.getText();
    upwd=pf.getText();
    if(cb1.isSelected()==true)
    {
        uqual=uqual+cb1.getLabel()+" ";
    }
    if(cb2.isSelected()==true)
    {
        uqual=uqual+cb2.getLabel()+" ";
    }
    if(cb3.isSelected()==true)
    {
        uqual=uqual+cb3.getLabel()+" ";
    }
    if(rb1.isSelected()==true)
    {
        ugen=rb1.getLabel();
    }
    if(rb2.isSelected()==true)
    {
```

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```
        ugen=rb2.getLabel();
    }
    Object[] techs=l.getSelectedValues();
    for(int i=0;i<techs.length;i++)
    {
        utech=utech+techs[i]+" ";
    }
    uprof=(String)cb.getSelectedItem();
    uaddr=ta.getText();

class DisplayFrame extends JFrame
{
    DisplayFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setBackground(Color.pink);

    }
    public void paint(Graphics g)
    {
        Font f=new Font("arial",Font.BOLD,25);
        g.setFont(f);
        g.drawString("User Name   :" +uname,50,100);
        g.drawString("Password   :" +upwd,50,150);
        g.drawString("Qualification :" +uqual,50,200);
        g.drawString("User Gender  :" +ugen,50,250);
        g.drawString("Technologies :" +utech,50,300);
        g.drawString("Proffession  :" +uprof,50,350);
        g.drawString("Address     :" +uaddr,50,400);
    }
}
DisplayFrame df=new DisplayFrame();

}

class RegistrationApp
{
    public static void main(String[] args)
    {
        RegistrationFrame rf=new RegistrationFrame();
    }
}
```

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### JColorChooser:

It is a swing specific GUI component, it able to display grids of colors to select.

To represent this GUI component, SWING has provided a predefined class in the form of javax.swing.JColorChooser.

To create JColorChooser class object we have to use the following constructor.

```
public JColorChooser()
```

To get the current SelectionModel from JColorChooser we have to use the following method.

```
public SelectionModel getSelectionModel()
```

In GUI applications, JColorChooser is able to rise ChangeEvent and it will be handled by ChangeListener by executing the following method.

```
public void stateChanged(ChangeEvent ce)
```

To get the selected color from JColorChooser we have to use the following method.

```
public Color getColor()
```

### EX:

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;
import javax.swing.event.*;
class ColorChooserFrame extends JFrame implements ChangeListener
{
    JColorChooser cc;
    Container c;
    ColorChooserFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        c=this.getContentPane();
        cc=new JColorChooser();
        cc.getSelectionModel().addChangeListener(this);
        c.setLayout(new FlowLayout());
        c.add(cc);
    }
}
```

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```
        }
        public void stateChanged(ChangeEvent ce)
        {
            Color clr=cc.getColor();
            JFrame f=new JFrame();
            f.setVisible(true);
            f.setSize(300,300);
            f.getContentPane().setBackground(clr);
        }
    }
class ColorChooserEx
{
    public static void main(String[] args)
    {
        ColorChooserFrame cc=new ColorChooserFrame();
    }
}
```

### JFileChooser:

It is a swing specific GUI component, it able to display all the file system which is available in our system harddisk inorder to select.

To represent this GUI component, SWING has provided a predefined class in the form of javax.swing.JFileChooser.

To create JFileChooser class object we have to use the following constructor.

```
public JFileChooser()
```

To get Selected file from JFileChooser we have to use the following method.

```
public File getSelectedFile()
```

In GUI applications, JFileChooser is able to rise ActionEvent and it would be handled by ActionListener by executing "actionPerformed(ActionEvent ae)".

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**EX:**

```
import java.awt.*;
import java.awt.event.*;
import javax.swing.*;
import javax.swing.event.*;
import java.io.*;
class FileChooserFrame extends JFrame implements ActionListener
{
    JLabel l;
    JTextField tf;
    JButton b;
    Container c;
    JFileChooser fc;
    FileChooserFrame()
    {
        this.setVisible(true);
        this.setSize(500,500);
        this.setTitle("File Chooser Example");
        this.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        c=this.getContentPane();
        c.setBackground(Color.pink);
        c.setLayout(new FlowLayout());

        l=new JLabel("Select File");
        tf=new JTextField(20);
        b=new JButton("Browse");
        b.addActionListener(this);
        c.add(l);c.add(tf);c.add(b);
    }
    public void actionPerformed(ActionEvent ae)
    {
        class FileDialogFrame extends JFrame implements ActionListener
        {
            FileDialogFrame()
            {
                this.setVisible(true);
                this.setSize(500,500);
                fc=new JFileChooser();
                fc.addActionListener(this);
                this.getContentPane().add(fc);
            }
            public void actionPerformed(ActionEvent ae)
            {
                File f=fc.getSelectedFile();
            }
        }
    }
}
```

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```
        String path=f.getAbsolutePath();
        tf.setText(path);
        this.setVisible(false);
    }
}
FileDialogFrame ff=new FileDialogFrame();
}
class FileChooserEx
{
    public static void main(String[] args)
    {
        FileChooserFrame f=new FileChooserFrame();
    }
}
```

**JTable:** It is a SWING specific GUI component, it able to display data in rows and columns.

To represent this GUI component, SWING has provided a predefined class in the form of javax.swing.JTable.

To create JTable class object we have to use the following constructor.

```
public JTable(Object[][] body, Object[] header)
```

**EX:**

```
import javax.swing.*;
import javax.swing.table.*;
import java.awt.*;
class TableEx
{
    public static void main(String[] args)
    {
        String[] header={"EID","ENAME","ESAL","EADDR"};
        Object[][] body={{"e1","AAA","5000","Hyderabad"}, {"e2","BBB","6000","Secbad"}, {"e3","CCC","7000","Vijayawada"}, {"e4","DDD","8000","Warngal"}};
        JFrame f=new JFrame();
        f.setVisible(true);
        f.setSize(500,500);
        Container c=f.getContentPane();
        c.setLayout(new BorderLayout());
        JTable t=new JTable(body,header);
        JTableHeader th=t.getTableHeader();
        c.add(th,BorderLayout.NORTH);
        c.add(t,BorderLayout.CENTER);
    }
}
```

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## Internationalization[I18N]

Designing Java applications w.r.t the local users is called as Internationalization.

Java is able to provide very good Internationalization support due to UNICODE representations in java.

UNICODE is one of the character representations following by JAVA, it able to represent all the alphabet from all the natural languages.

In java applications, if we want to provide Internationalization services , first, we have to represent a group of local users in java programs, to represent group of local users, first we have to devide all the users in no of groups .

To devide users into no of groups , we have to use the following parameters:

1.Language:It will be represented in the form of two lower case letters  
**EX:** en, hi, it,.....

2.Country: It will be represented in the hfrom of two upper case letters.  
**EX:** US, IN, IT,.....

3.System Varient[OS]: It will be represented in the form of three lower case letters.  
**EX:** win, lin, uni,.....

To represent a group of Local users in java applications, JAVA has provided a predefined class in the form of "java.util.Locale" .

To create Objects for java.util.Locale class we have to use the following consructors.

```
public Locale(String lang)
public Locale(String lang, String country)
public Locale(String lang, String country, String Sys_Var)
```

**EX:** Locale l=new Locale("en");
 Locale l=new Locale("en", "US");
 Locale l=new Locale("it", "IT", "win");

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Java is able to provide Internationalization support in the form of the following three services.

- 1.Number Formations
- 2.Date Formations
- 3.Message Formations

#### **1.Number Formations:**

From language to language, country to country number representations are varied. To represent numbers w.r.t a particular Locale JAVA has provided a predefined class in the form of "java.text.NumberFormat"

To represent number w.r.t a particular Locale by using NumberFormat class we have to use the following steps.

#### **1.Create Locale class object:**

```
Locale l=new Locale("en", "US", "win");
```

#### **2.Create NumberFormat class object:**

To create NumberFormat class object we have to use the following static Factory Method from java.text.NumberFormat class.

```
public static NumberFormat getInstance(Locale l)
```

**EX:** NumberFormat nf=NumberFormat.getInstance(l);

#### **3.Format a particular Number w.r.t a particular Locale:**

To format a number w.r.t a particular Locale we have to use the following method from java.text.NumberFormat class.

```
public String format(xxx num)
```

Where xxx may be byte, short, int,.....

**EX:** String data=nf.format(123456.2345f);

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**EX:**

```
import java.util.*;
import java.text.*;
class I18NEx
{
    public static void main(String[] args) throws Exception
    {
        Locale l=new Locale("it","IT","win");
        NumberFormat nf=NumberFormat.getInstance(l);
        System.out.println(nf.format(1234567.3456));
    }
}
```

**Date Formations:**

From language to language, country to country Date representations are varied. To represent Dates w.r.t a particular Locale JAVA has provided a predefined class in the form of "java.text.DateFormat"

To represent Date w.r.t a particular Locale by using DateFormat class we have to use the following steps.

**1.Create Locale class object:**

```
Locale l=new Locale("en", "US", "win");
```

**2.Create DateFormat class object:**

To create DateFormat class object we have to use the following static factory method from java.text.DateFormat class.

```
public static DateFormat getDateInstance(int date_Style, Locale l)
Where date_Style may be 0,1,2 and 3.
```

**EX:** DateFormat df=DateFormat.getDateinstance(0, l);

**3.Format current System Date w.r.t a particular Locale:**

To format current System Date w.r.t a particular Locale we have to use the following method from java.text.DateFormat class.

```
public String format(Date d)
```

**EX:** String date=df.format(new Date());

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**EX:**

```
import java.util.*;
import java.text.*;
class I18NEx
{
    public static void main(String[] args) throws Exception
    {
        Locale l=new Locale("it","IT","win");
        DateFormat df=DateFormat.getDateInstance(3,l);
        System.out.println(df.format(new Date()));
    }
}
```

**3.Message Formations:**

From language to language , from country to country, messages representations are varied, if we want to represent message w.r.t a particular Locale then we have to use `java.util.ResourceBundle` class provided by JAVA.

To represent messages w.r.t a particular Locale by using `ResourceBundle` class we have to use the following steps.

**1.Prepare properties files for each and every locale:**

In properties files we have to provide locale respective messages in the form of Key-Value pairs, where keys must be in english but values must be in local respective messages.

We have to provide properties files names in the following format.

File\_name\_<lang>\_<country>\_<sys\_Var>.properties

**EX1:** abc\_en\_US.properties

welcome=Welcome to en US Users.

**EX2:** abc\_it\_IT.properties

welcome=Welcome To it IT Userse.

**EX3:** abc\_hi\_IN.properties

welcome=Aap ka swagath hai.

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**2.In Java program, Create Locale object:**

```
Locale l=new Locale("en", "US");
```

**3.Prepare ResourceBundle class Object:**

The main intention of ResourceBundle object is to store the content of a particular properties file.

To create ResourceBundle Object we have to use the following method.

```
public static ResourceBundle getBundle(String base_Name, Locale l)
```

**EX:** ResourceBundle rb=ResourceBundle.getBundle("abc",l);

**4.Get Message from ResourceBundle:**

To get Message from ResourceBundle object we have to use the following method.

```
public String getString(String key)
```

```
String message=rb.getString("welcome");
```

**EX:**

```
abc_en_US.properties
```

```
welcome=Welcome to en US Users.
```

```
abc_it_IT.properties
```

```
welcome=Welcomeo Toe it IT Userse.
```

```
abc_hi_IN.properties
```

```
welcome=Aap ka swagath hai.
```

**I18NEx.java**

```
import java.util.*;
class I18NEx
{
    public static void main(String[] args) throws Exception
    {
        Locale l=new Locale("hi", "IN");
        ResourceBundle rb=ResourceBundle.getBundle("abc",l);
        System.out.println(rb.getString("welcome"));
    }
}
```

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## Reflection API

1. Introduction
2. Class
3. Method
4. Field
5. Constructor

### Reflection:

The process of analyzing all the capabilities of a particular class at runtime is called as "Reflection".

- Reflection API is a set of predefined classes provided by Java to perform reflection over a particular class.
- Reflection API is not useful in projects development, reflection API is useful in products development like Compilers, JVM's, Server's, IDE's, FrameWork's.....
- Java has provided the complete predefined library for Reflection API in the form of "java.lang" package and "java.lang.reflect" package.

### Java.lang

- Class
- java.lang.reflect
- Field
- Method
- Constructor
- Package
- Modifier

---

---

### Java.lang.Class:

- This class can be used to represent a particular class metadata which includes class name, super class details, implemented interfaces details, access modifiers.....
- To get the above class metadata, first we have to create Class Object for the respective class.
- There are three ways to create object for java.lang.Class

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### 1. Using **forName(--)** method:

- `forName()` method is defined in `java.lang.Class` to load a particular class bytecode to the memory and to get metadata of the respective loaded class in the form of `Class` object.
- `public static Class forName(String class_Name) throws ClassNotFoundException`

```
class c=Class.forName("Employee");
```

when JVM encounter the above instruction,JVM will perform the following actions.

- a)JVM will take provided class from `forName()` method.
- b)JVM will search for its .class file at current location,at java predefined library and at the locations refeered by "classpath" environment variable.
- c)If the required .class file is not available at all the above locations then JVM will rise an exception like "`java.lang.ClassNotFoundException`".
- d)If the required .class file is available at either of the above locations then JVM will load its bytecode to the memory.
- e)After loading its bytecode to the memory,JVM will collect the respective class metadata and stored in the form of `java.lang.Class` object.

### 2. Using **getClass()** method:

- In Java applications,if we create object for any class then JVM will load the respective class bytecode to the memory,JVM will get metadata of the respective class and stored in the form of `java.lang.Class` object.
- In the above context,to get the generated `Class` object,we have to use the following method from `java.lang.Object` class.
- `public Class getClass()`

#### EX:

```
Employee e=new Employee();
Class c=e.getClass();
```

### 3. Using **.class file name:**

- In Java,every .class file is representing a `java.lang.Class` Object,it will manage the metadata of the respective class.

#### EX:

```
Class c=Employee.class
```

- To get name of the class,we have to use the following method.

```
public String getName()
```

- To get super class metadata in the form of `Class` object,we have to use the following method.

```
public Class getSuperclass()
```

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- To get implemented interfaces metadata in the form of Class[] we have to use the following method.

```
public Class[] getInterfaces()
```

- To get the specified access modifiers list, we have to use the following method.

```
public int getModifiers()
```

**EX:**

```
int val=c.getModifiers()
String modifiers=Modifier.toString(val);
import java.lang.reflect.*;
public abstract class Employee implements java.io.Serializable,java.lang.Cloneable{
}
class Test{
public static void main(String args[]) throws Exception{
Class c1=Class.forName("Employee");
System.out.println(c1.getName());
Employee e=new Employee();
Class c2=e.getClass();
System.out.println(c2.getName());
Class c3=Employee.class;
System.out.println(c3.getName());
Class c=Class.forName("Employee");
System.out.println("Class Name :" +c.getName());
System.out.println("Super Class :" +c.getSuperclass().getName());
Class[] cls=c.getInterfaces();
System.out.println("Interfaces :");
for(int i=0;i<cls.length;i++){
Class cl=cls[i];
System.out.println(cl.getName()+" ");
}
System.out.println();
int val=c.getModifiers();
System.out.println("Modifiers :" +Modifier.toString(val));
}
}
```

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## Java.lang.reflect.Field:

- This class can be used to get the metadata of a particular variable which contains the name of the variable,data type of the variable,access modifiers of the variable and value of the variable.
- If we want to get all the variables metadata of a particular class first we have to get java.lang.Class object.After getting Class object,we have to get all the variables metadata in the form Field[].
- To get all the variables metadata in the form of Field[],we have to use the following two methods.

public Field[] getFields()

- This method will return all the variables metadata which are declared as public in the respective class and in the super class.

public Field[] getDeclaredFields()

- This method will return all the variables metadata which are available in the respective class only irrespective of public declaration.
- To get name of the variable,we have to use the following method.

public String getName()

- To get datatype of the variables,we have to use the following method.

public Class getType()

- To get value of the variable,we have to use the following method.

public Object get(Field f)

- To get access modifiers of a variable,we have to use the following method.

public int getModifiers()  
public static String toString(int val)

```
import java.lang.reflect.*;  
class Employee{  
    public static String eid="E-111";  
    public static String ename="Durga";  
    public static String eaddr="Hyd";  
}  
class Test{  
    public static void main(String args[])throws Exception{  
        Class c=Employee.class;  
        Field[] flds=c.getDeclaredFields();  
        for(int i=0;i<flds.length;i++){  
            Field f=flds[i];  
            System.out.println("Field Name :" +f.getName());  
            System.out.println("data Type :" +f.getType().getName());  
        }  
    }  
}
```

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```
System.out.println("value :" + f.get(f));
int val = f.getModifiers();
System.out.println("Modifiers :" + Modifier.toString(val));
System.out.println("-----");
}
}
}
```

## Java.lang.Method:

- This class can be used to represent the metadata of a particular method, which includes method name, return type, parameter types, access modifiers and exception types.
- If we want to get all the methods metadata in the form of Method[], first we have to get java.lang.Class object then we have to use either of the following methods.

```
public Method[] getMethods()
```

- It can be used to get all the methods metadata which are declared as public in the respective class and in the super class.

```
public Method[] getDecalredMethods()
```

- It can be used to get all the methods metadata which are available in the respective class irrespective of public declaration.
- To get method name, we have to use the following method.

```
public String getName()
```

- To get method return type, we have to use the following method.

```
public Class getReturnType()
```

- To get parameter data types, we have to use the following method.

```
public Class[] getParameterTypes()
```

- To get Exception types which are specified along with "throws" keyword then we have to use the following method.

```
public Class[] getExceptionTypes()
```

- To get Access modifier of a particular class, we have to use the following method.

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```
public int getModifiers()
public static String toString(int value)
import java.lang.reflect.*;
class Employee{
public void create(String eid,String ename,String eaddr) throws
ClassNotFoundException,NullPointerException{
}
public void search(String eid) throws ClassCastException
{}
public void delete(String eid) throws ClassCastException,ClassNotFoundException
{}
}
class Test{
public static void main(String args[]) throws Exception{
Class c=Employee.class;
Method[] mthds=c.getDeclaredMethods();
for(int i=0;i<mthds.length;i++){
Method m=mthds[i];
System.out.println("Method Name :"+m.getName());
System.out.println("Return Type :"+m.getReturnType());
int val=m.getModifiers();
System.out.println("Modifiers :"+modifier.toString(val));
Class[] cls=m.getParameterTypes();
System.out.println("Parameters :");
for(int j=0;j<cls.length;j++){
Class cl=cls[j];
System.out.println(cl.getName()+" ");
}
System.out.println();
Class[] cls1=m.getExceptionTypes();
System.out.println("Exception Types :");
for(int j=0;j<cls1.length;j++){
Class cl1=cls1[j];
System.out.println(cl1.getName()+" ");
}
System.out.println();
System.out.println("-----");
}
}
}
```

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## Java.lang.reflect.Constructor:

- This class can be used to get metadata of a particular constructor.
- To get all the constructors metadata of a particular class first we have to get Class object then we have to use the following methods.

```
public Constructor[] getConstructors()
```

- It will return only public constructors details from the respective class.

```
public Constructor[] getDeclaredConstructors()
```

- It will return all the constructors metadata of the respective class irrespective of their public declaration.
- Constructor class has provided the following methods to get constructor data.

```
public String getName()  
public Class[] getParameterTypes()  
public Class[] getExceptionTypes()  
public int getModifiers()  
public static String toString(int val)
```

program is same as java.lang.reflect.Method program with the above methods

```
import java.lang.reflect.*;  
class Employee{  
    public Employee(String eid,String ename,String eaddr)throws  
        ClassNotFoundException,NullPointerException{  
    }  
    public Employee(String eid,String ename) throws ClassCastException{  
    }  
    public Employee(String eid) throws ClassCastException,ClassNotFoundException{  
    }  
    }  
    class Test{  
        public static void main(String args[])throws Exception{  
            Class c=Employee.class;  
            Constructor[] con=c.getDeclaredConstructors();  
            for(int i=0;i<con.length;i++){  
                Constructor constructor =con[i];  
                System.out.println("Constructor Name : "+constructor.getName());  
                int val=constructor.getModifiers();  
                System.out.println("Modifiers : "+Modifier.toString(val));  
                Class[] cls=constructor.getParameterTypes();  
                System.out.println("Parametes :");  
                for(int j=0;j<cls.length;j++){
```

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```
Class cl=cls[j];
System.out.println(cl.getName()+" ");
}
System.out.println();
Class[] cls1=constructor.getExceptionTypes();
System.out.println("Exception Types  :");
for(int j=0;j<cls1.length;j++){
Class cl1=cls1[j];
System.out.println(cl1.getName()+" ");
}
System.out.println();
System.out.println("-----");
}
```

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## Annotations

1. Introduction
2. Comment Vs Annotations
3. XML Vs Annotations
4. Types of Annotations
5. Standard Annotations
6. Custom Annotations

### Annotation:

Annotation is a Java Feature provided by JDK 5.0 version, it can be used to represent metadata in Java applications.

Q) In java applications, to describe metadata we have already Comments then what is the requirement to go for Annotations?

**Ans:** In Java applications, if we provide metadata by using comments then "Lexical Analyzer" will remove comments metadata from Java program as part of Compilation.

As per the application requirement, if we want to bring metadata upto .java file, upto .class file and upto RUNTIME of our application then we have to use "Annotations".

Q) In Java applications, to provide metadata at runtime of Java applications we are able to use XML documents then what is the requirement to go for "Annotations"?

**Ans:** In Java applications, if we provide metadata by using XML documents then we are able to get the following problems.

1. Every time we have to check whether XML documents are located properly or not.
2. Every time we have to check whether XML documents are formatted properly or not.
3. Every time we have to check whether we are using right parsing mechanism or not to access the data from XML document.
4. First Developers must aware XML tech.

To Overcome all the above problems, we have to use Java alternative that is "Annotation".

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**EX: Servlet Configuration with XML document:**

```
web.xml
<web-app>
<servlet>
<servlet-name>ls</servlet-name>
<servlet-class>LoginServlet</servlet-name>
</servlet>
<servlet-mapping>
<servlet-name>ls</servlet-name>
<url-pattern>/login</url-pattern>
</servlet-mapping>
</web-app>
```

**Servlet Configuration with Annotation**

```
@WebServlet("/login")
public class LoginServlet extends HttpServlet{}
```

**XML-Based Tech**

JDK1.4  
JDBC3.0  
Servlets2.5  
  
JSF1.x  
Hiberante3.2.4  
EJBs2.x  
Spring2.x

**Annotation Based Tech**

JDK5.0  
JDBC4.0  
Servlets3.0  
  
Struts1.x  
  
JSF2.x  
Hibernate3.5  
EJBs3.x  
Spring3.x

**NOTE:** Annotations are not the complete alternative for XML tech, with in a Java application we can use annotations as an alternative for XML documents but when we go for distributed applications where applications are designed on different tech.standards there annotations are not possible,only we have to use XML tech.

- To process the annotations,Java has provided a predefined tool in the form of "Annotation Processing tool"[APT],it was managed by Java upto JAVA7 version,it was removed from Java in JAVA8 version.

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**Syntax to declare annotation:**

```
@interface Annotation_Name{  
    data_Type member_Name() [default] value;  
}
```

**Syntax to use Annotation:**

- @Annotation\_Name(member\_name1=value1,member\_Name2=value2,.....)
- In Java, all the annotations are interfaces by default.
- In Java, the common and default super type for all the annotations is "java.lang.annotation.Annotation".
- As per the no. of members inside annotations, there are three types of annotations.

**1.Marker Annotations:**

It is an annotation with out members.

**EX:**

```
@interface Override{  
}
```

**2.Single-Valued Annotation:**

It is an Annotation with exactly one single member

**EX:**

```
@interface SuppressWarnings{  
    String value();  
}
```

**3.Multi-Valued Annotation:**

It is an annotation with more than one member.

**EX:**

```
@interface WebServlet{  
    int loadOnStartup();  
    String[] urlPatterns();  
    -----  
}
```

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In Java Annotations are divided into the following two types as per their nature.

- 1.Standard Annotations
- 2.Custom Annotations

### **1.Standard Annotations:**

These are predefined Annotations provided by Java along with Java software.

There are two types of Standard Annotations

- 1.General Purpose Annotations
- 2.Meta Annotations

#### **1)General Purpose Annotations:**

These Annotations are commonly used Annotations in Java applications

These Annotations are provided by Java as part of java.lang package.

##### **EX:**

- @Override
- @Deprecated
- @SuppressWarnings
- @FunctionalInterface [JAVA 8]

#### **2)Meta Annotations:**

These Annotations can be used to define another Annotations.

These Annotations are provided by Java as part of java.lang.annotation package.

##### **EX:**

- @Inherited
- @Documented
- @Target
- @Retention

#### **1.@Override:**

- In Java applications if we want to perform method overriding then we have to provide a method in subclass with the same prototype of super class method.
- While performing method Overriding,if we are not providing the same super class method at sub class method then compiler will not rise any error and JVM will not rise any exception,JVM will provide super class method output.
  
- In the above context,if we want to get an error about to describe failure case of method overriding from compiler then we have to use @Override

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**EX:**

```
class JdbcApp
{
public void getDriver(){
System.out.println("Type-1 Driver");
}
}
class New_JdbcApp extends JdbcApp
{
@Override
public void getdriver(){
System.out.println("Type-4 Driver");
}
}
class Test
{
public static void main(String args[]){
JdbcApp app=new New_JdbcApp();
app.getDriver();
}
}
```

- If we compile the above programme then compiler will rise an error like "method does not override or implement a method from a SuperType".

**NOTE:If we compile the above programme,compiler will recognize @Override annotation,compiler will take sub class method name which is marked with @Override annotation,compiler will comparesub class method name with all the super class method names.If any method name is matched then compiler will not rise any error.If no super class method name is matched with sub class method name then compiler will rise an error.**

**@Deprecated:**

- The main intention of this annotation is to make a method as deprecated method and to provide deprecation message when we access that deprecated method.
- In general,Java has provided Deprecation support for only predefined methods,if we want to get deprecation support for the user defined methods we have to use @Deprecated annotation.

**NOTE:Deprecated method is an outdated method introduced in the initial versions of Java and having alternative methods in the later versions of Java.**

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```
class Employee{  
    @Deprecated  
    public void gen_Salary(int basic,float hq){  
        System.out.println("Salary is calculated on the basis of basic amount,hq");  
    }  
    public void gen_Salary(int basic,float hq,int ta,float pf){  
        System.out.println("Salary is calculated on the basis of basic amount,hq,ta,pf");  
    }  
}  
class Test{  
    public static void main(String args[]){  
        Empoloyee emp=new Employee();  
        emp.gen_Salary(25000,20.0f);  
    }  
}
```

**NOTE:** If we compile the above code then compiler will provide the following deprecation message "Note:java uses or overrides a deprecated API"

#### @SuppressWarnings(--):

In Java applications, when we perform unchecked or unsafe operations then compiler will rise some warning messages. In this context, to remove the compiler generated warning messages we have to use `@SuppressWarnings("unchecked")` annotation.

#### EX:

```
import java.util.*;  
class Bank{  
    @SuppressWarnings("unchecked")  
    public ArrayList listCustomers(){  
        ArrayList al=new ArrayList();  
        al.add("chaitu");  
        al.add("Mahesh");  
        al.add("Jr NTR");  
        al.add("Pavan");  
        return al;  
    }  
}  
class Test{  
    public static void main(String args[]){  
        Bank b=new Bank();  
        List l=b.listCustomers();  
        System.out.println(l);  
    }  
}
```

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#### @FunctionalInterface:

- In Java, if we provide any interface with out abstract methods then that interface is called as "Marker Interface".
- In Java, if we provide any interface with exactly one abstract method then that interface is called as "Functional Interface".
- To make any interface as Functional Interface and to allow exactly one abstract method in any interface then we have to use "@FunctionalInterface" annotation.

**NOTE:**This annotation is a new annotation provided by JAVA8 version.

#### **@FunctionalInterface**

```
interface Loan{  
    void getLoan();  
}  
class GoldLoan implements Loan{  
    public void getLoan(){  
        System.out.println("GoldLoan");  
    }  
}  
  
class Test{  
    public static void main(String args[]){  
        Loan l=new GoldLoan();  
        l.getLoan();  
    }  
}
```

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**@Inherited:**

In general all the annotations are not inheritable by default.

If we want to make/prepare any annotation as Inheritable annotation then we have to declare that annotation as Inheritable annotation then we have to declare that annotation with @Inherited annotation.

**EX:** @interface Persistable

```
{  
}  
@Persistable  
class Employee  
{  
}  
class Manager extends Employee{  
}  
In the above example,only Employee class objects are Persistable i.e eligible to store in database.  
@Inherited  
@interface Persistable  
{  
}  
@Persistable  
class Employee{  
}  
class Manager extends Employee{  
}
```

**NOTE:**In the above example,both Employee class objects and manager class objects are Persistable i.e eligible to store in database.

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**@Documented:**

In Java, by default all the annotations are not documentable.

In Java applications, if we want to make any annotation as documentable annotation then we have to prepare the respective annotation with @Documented annotation.

**EX:**

```
@interface Persistable
{
}
@Persistable
class Employee
{
}
javadoc Employee.java
```

If we prepare html documentation for Employee class by using "javadoc" tool then @Persistable annotation is not listed in the html documentation.

```
@Documented
@interface Persistable
{
}
@Persistable
class Employee
{
}
```

If we prepare html documentation for Employee class by using "javadoc" tool then @Persistable annotation will be listed in the html documentation.

**@Target:**

The main intention of this annotation is to define a list of target elements to which we are applying the respective annotation.

**Syntax:**

```
@Target(--list of constants from ElementType enum---)
Where ElementType enum contains FIELD,CONSTRUCTOR,METHOD,TYPE[Classes,abstract
classes,interfaces]
```

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**EX:**

```
@Target(ElementType.TYPE,ElementType.FIELD,ElementType.METHOD)
@interface persistable
{
}
@Persistable
class Employee
{
    @Persistable
    Account acc;

    @Persistable
    public Address getAddress(){}
}
```

**@Retention:**

The main intention of the annotation is to define life time of the respective annotation in Java application.

**Syntax:**

```
@Retention(---a constant from RestentionPolicy enum---)
Where RestentionPolicy enum contains the constants like SOURCE,CLASS,RUNTIME
@Retention(RetentionPolicy.RUNTIME)
@interface Persistable
{
}
@Persistable
class Employee
{
}
```

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**Custom Annotations:**

- These are the annotations defined by the developers as per their application requirements.
- To use custom annotations in java applications, we have to use the following steps.

**1) Declare user defined Annotation:**

```
Bank.java
import java.lang.annotation.*;
@Inherited
@Documented
@Target(ElementType.TYPE)
@Retention(RetentionPolicy.RUNTIME)
@interface Bank
{
    String name() default "ICICI Bank";
    String branch() default "S R Nagar";
    String phone() default "040-123456";
}
```

**2) Utilize User defined Annotations in Java applications:**

```
Account.java
@Bank(name="Axis Bank",phone="040-987654")
public class Account{
    String accNo;
    String accName;
    String accType;
    public Account(String accNo,String accName,String accType){
        this.accNo=accNo;
        this.accName=accName;
        this.accType=accType;
    }
    public void getAccountDetails(){
        System.out.println("Account Details");
        System.out.println("-----");
        System.out.println("Account Number:"+accNo);
        System.out.println("Account Name :" +accName);
        System.out.println("Account Type :" +accType);
    }
}
```

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**3)Access the data from User-Defined Annotation in main Application:**

1)If the annotation is class level annotation then use the following steps:

- a)Get java.lang.Class object of the respective class
- b)Get Annotation object by using getAnnotation(Class c) method

2)If the annotation is Field level annotation then use the following steps:

- a)Get java.lang.Class object of the respective class
- b)Get java.lang.reflect.Field class object of the respective variable from java.lang.Class by using getField(String field\_name) method
- c)Get Annotation object by using getAnnotation(Class c) method from java.lang.reflect.Field class.

3)If the annotation is Method level annotation then use the following steps:

- a)Get java.lang.Class object of the respective class
- b)Get java.lang.reflect.Method class object of the respective Method from java.lang.Class by using getMethod(String method\_name) method
- c)Get Annotation object by using getAnnotation(Class c) method from java.lang.reflect.Method class.

```
MainApp.java
import java.lang.annotation.*;
import java.lang.reflect.*;
public class MainApp{
    public static void main(String args[])throws Exception{
        Account acc=new Account("abc123","Durga","Hyd");
        acc.getAccountDetails();
        System.out.println();
        Class c=acc.getClass();
        Annotation ann=c.getAnnotation(Bank.class);
        Bank b=(Bank)ann;
        System.out.println("Bank Details");
        System.out.println("-----");
        System.out.println("Bank Name :" +b.name());
        System.out.println("Branch Name :" +b.branch());
        System.out.println("Phone " +b.phone());
    }
}
```

**NOTE:class Level Annotation****CONTACT US:****Mobile: +91- 8885 25 26 27** +91- 7207 21 24 27/28

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### Method Level Annotation

Course.java:

```
import java.lang.annotation.*;  
@Inherited  
@Documented  
@Target(ElementType.METHOD)  
@Retention(RetentionPolicy.RUNTIME)  
@interface Course{  
    String cid() default "C-111";  
    String cname() default "Java";  
    int ccost() default 5000;  
}
```

Student.java:

```
public class Student{  
    String sid;  
    String sname;  
    String saddr;  
    public Student(String sid,String sname,String saddr){  
        this.sid=sid;  
        this.sname=sname;  
        this.saddr=saddr;  
    }  
    @Course(cid="C-222",cname=".NET")  
    public void getStudentDetails(){  
        System.out.println("Student Details");  
        System.out.println("-----");  
        System.out.println("Student Id :" +sid);  
        System.out.println("Student Name :" +sname);  
        System.out.println("Student Address:" +saddr);  
    }  
}
```

ClientApp.java

```
import java.lang.annotation.*;  
import java.lang.reflect.*;  
public class ClientApp{  
    public static void main(String args[])throws Exception{  
        Student std=new Student("S-111","Durga","Hyd");  
        std.getStudentDetails();  
        System.out.println();  
        Class cl=std.getClass();  
        Method m=cl.getMethod("getStudentDetails");
```

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```
Annotation ann=m.getAnnotation(Course.clas);
Course c=(Course)ann;
System.out.println("Course Details");
System.out.println("-----");
System.out.println("Course Id :" +c.cid());
System.out.println("Course Name :" +c cname());
System.out.println("Course Cost :" +c ccost());
}
}
```

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## RMI [Remote Method Invocation]

To prepare Distributed applications, if we use Socket programming then we have to prepare ServerSocket, Client Side Socket, InputStreams, OutputStreams,..... at local machine and Remote machine explicitly, it will increase burden to the developers.

To overcome the above problems, SUN Microsystems has provided an alternative distributed tech to prepare distributed applications, that is, RMI.

In case of RMI, the complete distributed applications infrastrucuter like Server socket, socket, input streams and OutputStreams,.... are provided by RMI internally, developers are not required to provide distributed applications infrastrucuter explicitly.

RMI will use the following two components internally to provide Distributed applicatins infrastrucuter.

- 1.Stub
- 2.Skeleton

### 1.Stub:

It is a special component in RMI, it will be existed at Local Machine, it will provide Client side socket, Input and Output Streams and it is capable to perform Serialization and Deserialization, Marshalling and Unmarshalling and it able to recieve remote method calls from local machine and it will send remote method call to network, it able to recieve return values from remote method call from network and it will send that return values to client application.

### 2.Skeleton:

It is a special component in RMI, it will be existed at Remote machine, it will provide server socket, InputStreams and OutputStream, it is capable to perform Serialization and Deserialization , Marshalling and Unmarshalling and it able to reacieve remote method call from Network, it able to access remote methods and it able to carry return values of remote methods to network.

**NOTE:** To expose Remote objects in network, RMI will use a seperate Registry Software called as "RMIREgistry".

### RMI Arch:

-----  
--- Diagram---

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- 1.Create Remote object and keep Remote object in RMIRegistry "along with logical name" inorder to expose Remote object in network.
- 2.At Local machine, perform lookup operation in RMIRegistry on the basis of logical name.
- 3.RMIRegistry will return Remote object reference value to local machine or Client Application.
- 4.Access Remote method by using Remote object reference.
- 5.When we access Remote method, Remote method call will be send to Stub.
- 6.Stub will perform the required "Serialization" and "Marshalling" over the remote method call.
- 7.Stub will send remote method call to Network.
- 8.Network will transfer remote method call to Remote machine.
- 9.Skeleton will take remote method call from network.
- 10.Skeleton will perform the required "Unmarshalling" and "Deserialization" over the remote method call.
- 11.Skeleton will access remote method.
- 12.Skeleton will get return value of remote method.
- 13.Skeleton will perform the required "Serialization" and "Marshalling" over the return value.
- 14.Skeleton will send return value to Network.
- 15.Network will carry return value to Local machine.
- 16.Stub will take return value from network.
- 17.Stub will perform the required "Unmarshalling" and "Deserialization" over the return value.
- 18.Stub will send return value to Client application.

#### Steps to prepare RMI Application:

- 1.Create Remote interface
- 2.Create Remote interface implementation class
- 3.Create Registry program
- 4.Create Client Application
- 5.Execute RMI Application

#### 1.Create Remote interface:

The main intention of Remote interface is to declare all remote services in the form of abstract methods.

#### STEPS:

- a)Declare an user defined interface.
- b)Extend java.rmi.Remote interface to user defined interface.
- c)Declare remote methods in the form of abstract methods.
- d)Throws out java.rmi.RemoteException at each and every remote metod.

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**EX:**

```
public interface MyRemote extends java.rmi.Remote
{
    public String myRemoteService1()throws
        java.rmi.RemoteException;
    public String myRemoteService2()throws
        java.rmi.RemoteException;
    ----
}
```

**2)Create Remote interface implementation class:**

The main intention of Implementation class for Remote interface is to provide implementation to service methods.

**STEPS:**

- Declare an user defined class.
- Extend `java.rmi.server.UnicastRemoteObject` abstract class to user defined class inorder to make network enable.
- Implement User defined Remote interface in user defined class.
- Declare public and 0-arg constructor in user defined class with throws `java.rmi.RemoteException`.
- Provide implementation for Service methods.

**EX:**

```
public class MyRemoteImpl extends java.rmi.server.UnicastRemoteObject implements MyRemote
{
    public MyRemoteImpl()throws java.rmi.RemoteException
    {
    }
    public String myRemoteService1()throws
        java.rmi.RemoteException
    {
        ----
    }
    public String myRemoteService2()throws
        java.rmi.RemoteException
    {
        ----
    }
}
```

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### 3.Create Registry program:

The main intention of Registry program is to create Remote object and to keep Remote object in RMIRegistry with a particular logical name.

#### STEPS:

- Declare an user defined class with main() method.
- In main() method, create Objectt for Remote interface implementation class.
- Bind Remote object with a logical name in RMIRegistry by using the following method from java.rmi.Naming class.

```
public static void bind(String logical_Name, Remte r) throws RemoteException
```

#### EX: public class MyRegistry

```
{  
    public static void main(String[] args)throws Exception  
    {  
        MyRemote mr=new MyRemoteImpl();  
        java.rmi.Naming.bind("my_rem", mr);  
    }  
}
```

### 4.Create Client Application:

The main intention of Client Application is to get Remote object from RMIRegistry and to access remote methods from Local machine.

#### STEPS:

- Declare an user defined class with main() method.
  - In main() method, get Remote object from RMIRegistry by using the following method from java.rmi.Naming class.
  - Access Remote methods.
- ```
public static Remote lookup(String logical_Name)
```

#### EX: class ClientApp

```
{  
    public static void main(String[] args)  
    {  
        MyRemote mr=(MyRemote)java.rmi.Naming.lookup("my_rem");  
        mr.myRemoteService1();  
        mr.myRemoteService2();  
        ----  
        ----  
    }  
}
```

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**5.Execute RMI Application:**

- a)Compile all resources[.java files]  
D:\java830>javac \*.java
- b)Start RMIRegistry  
D:\java830>start RMIRegistry
- c)Execute Registry program  
D:\java830>start java MyRegistry
- d)Execute Client Application  
D:\java830>java ClientApp

**Application1:**

D:\java830\rmi\app1

HelloRemote.java  
HelloRemoteImpl.java  
HelloRegistry.java  
ClientApp.java

**HelloRemote.java**

```
import java.rmi.*;  
public interface HelloRemote extends Remote  
{  
    public String sayHello(String name)throws RemoteException;  
}
```

**HelloRemoteImpl.java**

```
import java.rmi.*;  
import java.rmi.server.*;  
public class HelloRemoteImpl extends UnicastRemoteObject implements HelloRemote  
{  
    public HelloRemoteImpl()throws RemoteException  
    {  
    }  
    public String sayHello(String name)throws RemoteException  
    {  
        return "Hello... "+name+"!";  
    }  
}
```

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### HelloRegistry.java

```
import java.rmi.*;  
public class HelloRegistry  
{  
    public static void main(String[] args) throws Exception  
    {  
        HelloRemote hr = new HelloRemoteImpl();  
        Naming.bind("hello", hr);  
        System.out.println("HelloRemote Object is binded with the logical 'hello' in  
        RMIREgistry");  
    }  
}
```

### ClientApp.java

```
import java.rmi.*;  
public class ClientApp  
{  
    public static void main(String[] args) throws Exception  
    {  
        HelloRemote hr = (HelloRemote) Naming.lookup("hello");  
        String msg = hr.sayHello("Durga");  
        System.out.println(msg);  
    }  
}
```

### Application2:

D:\java830\rmi\app2

CalculatorRemote.java  
CalculatorRemoteImpl.java  
CalculatorRegistry.java  
ClientApp.java

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**CalculatorRemote.java:**

```
import java.rmi.*;  
public interface CalculatorRemote extends Remote  
{  
    public int add(int i, int j) throws RemoteException;  
    public int sub(int i, int j) throws RemoteException;  
    public int mul(int i, int j) throws RemoteException;  
}
```

**CalculatorRemoteImpl.java**

```
import java.rmi.*;  
import java.rmi.server.*;  
public class CalculatorRemoteImpl extends UnicastRemoteObject implements CalculatorRemote  
{  
    public CalculatorRemoteImpl() throws RemoteException  
    {  
    }  
    public int add(int i, int j) throws RemoteException  
    {  
        return i+j;  
    }  
    public int sub(int i, int j) throws RemoteException  
    {  
        return i-j;  
    }  
    public int mul(int i, int j) throws RemoteException  
    {  
        return i*j;  
    }  
}
```

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### CalculatorRegistry.java

```
import java.rmi.*;  
public class CalculatorRegistry  
{  
    public static void main(String[] args)throws Exception  
    {  
        CalculatorRemote cr=new CalculatorRemoteImpl();  
        Naming.bind("cal", cr);  
        System.out.println("CalculatorRemote object is binded with the logical name 'cal'  
in RMIRegistry");  
    }  
}
```

### ClientApp.java

```
import java.rmi.*;  
public class ClientApp  
{  
    public static void main(String[] args)throws Exception  
    {  
        CalculatorRemote cr=(CalculatorRemote)  
        Naming.lookup("cal");  
        System.out.println("ADD :" +cr.add(10,5));  
        System.out.println("SUB :" +cr.sub(10,5));  
        System.out.println("MUL :" +cr.mul(10,5));  
    }  
}
```

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## Regular Expressions

Regular Expression is an expression which represents a group of Strings according to a particular pattern.

### EX:

- 1.We can write a Regular Expression to represent all valid mail ids.
- 2.We can write a Regular Expression to represent all valid mobile numbers.

The main important application areas of Regular Expression are:

- 1.To implement validation logic.
- 2.To develop Pattern matching applications.
- 3.To develop translators like compilers, interpreters etc.
- 4.To develop digital circuits.
- 5.To develop communication protocols like TCP/IP, UDP etc.

To represent and use Regular Expressions in Java applications, JAVA has provided predefined library in the form of a package like "java.util.regex" in JDK1.4 version.

To prepare and Use Regular Expressions in java applications we have to use the following actions.

### 1.Create `java.util.regex.Pattern` class object with a Regular Expression:

A Pattern object represents "compiled version of Regular Expression".

To create Regular Expression in the form Pattern object we have to use the following method from `java.util.regex.Pattern` class.

```
public static Pattern compile(String reg_Ex)
```

**EX:** Pattern p=Pattern.compile("ab");

### 2.Create `java.util.regex.Matcher` class object with a string which we want to compare with Regular expression:

A Matcher object can be used to match character sequences against a Regular Expression.

We can create a Matcher object by using `matcher()` method of Pattern class.

```
public Matcher matcher(String target);
```

**EX:** Matcher m=p.matcher("abbbabbaba");

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### 3.Get Matched Strings from Matcher object:

To get details about the Matches identified in Matcher object we have to use the following methods.

1.public boolean find();

--> It attempts to find next match and returns true if it is available otherwise returns false.

2.public int start();

-->Returns the start index of the match.

3.public int end();

-->Returns the offset(equalize) after the last character matched.(or)

Returns the "end+1" index of the matched.

4.public String group();

-->Returns the matched Pattern.

**EX:**

```
importjava.util.regex.*;
classRegularExpressionDemo{
public static void main(String[] args){
int count=0;
Pattern p=Pattern.compile("ab");
Matcher m=p.matcher("abbbabbaba");
while(m.find()){
count++;
System.out.println(m.start()+"----"+m.end()+"----"+m.group());
}
System.out.println("The no of occurrences :" +count);
}}
```

**OP:**

0-----2-----ab

4-----6-----ab

7-----9-----ab

The no of occurrences: 3

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To prepare Regular Expressions , we have to use the following elements.

- 1.Character Classes
- 2.Quantifiers

### Character classes:

Character classes are used to specify alphabets and digits in Regular Expressions.

- 1.[abc] -----Either 'a' or 'b' or 'c'
- 2.[^abc] -----Except 'a' and 'b' and 'c'
- 3.[a-z] -----Any lower case alphabet symbol
- 4.[A-Z] -----Any upper case alphabet symbol
- 5.[a-zA-Z] -----Any alphabet symbol
- 6.[0-9] -----Any digit from 0 to 9
- 7.[a-zA-Z0-9] -----Any alphanumeric character
- 8.[^a-zA-Z0-9] -----Any special character

### Predefined character classes:

- \s----space character
- \d----Any digit from 0 to 9[0-9]
- \w----Any word character[a-zA-Z0-9]
- . ----Any character including special characters.
- \S----any character except space character
- \D----any character except digit
- \W----any character except word character(special character)

### EX:

```
importjava.util.regex.*;
class RegularExpressionDemo{
public static void main(String[] args){
Pattern p=Pattern.compile("x");
Matcher m=p.matcher("a1b7@z#");
while(m.find())
{
System.out.println(m.start()+"-----"+m.group());
}
}
}
```

### OP:

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**EX:** importjava.util.regex.\*;  
classRegularExpressionDemo{  
public static void main(String[] args){  
Pattern p=Pattern.compile("x");  
Matcher m=p.matcher("a1b7 @z#");  
while(m.find()) {  
System.out.println(m.start()+"-----"+m.group());  
}  
}  
}  
}

### Quantifiers:

Quantifiers can be used to specify no of characters to match.

- a-----Exactly one 'a'
- a+ -----At least one 'a'
- a\* -----Any no of a's including zero number
- a? -----At most one 'a'

**EX:** importjava.util.regex.\*;  
class RegularExpressionDemo{  
public static void main(String[] args){  
Pattern p=Pattern.compile("x");  
Matcher m=p.matcher("abaabaaab");  
while(m.find()){  
System.out.println(m.start()+"-----"+m.group());  
}  
}  
}

### Pattern class split() method:

Pattern class contains split() method to split the given string against a regular expression.

**EX 1:**importjava.util.regex.\*;  
class RegularExpressionDemo{  
public static void main(String[] args){  
Pattern p=Pattern.compile("\s");  
String[] s=p.split("Durga software solutions");  
for(String s1:s){  
System.out.println(s1);  
}  
}

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**EX 2:**

```
importjava.util.regex.*;
class RegularExpressionDemo{
public static void main(String[] args){
Pattern p=Pattern.compile("\\.|."); // (or) [ . ]
String[] s=p.split("www.dugrajobs.com");
for(String s1:s){
System.out.println(s1);
}
}
}
```

String class split() method:

String class also contains split() method to split the given string against a regular expression.

Example:

```
importjava.util.regex.*;
classRegularExpressionDemo{
public static void main(String[] args){
String s="www.durgajobs.com";
String[] s1=s.split("\\.|.");
for(String s2:s1){
System.out.println(s2);
}
}
}
```

**NOTE:** String class split() method can take regular expression as argument whereas pattern class split() method can take target string as the argument.

 **StringTokenizer:**

This class present in java.util package.

It is a specially designed class to perform string tokenization.

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**EX 1:**

```
importjava.util.*;
classRegularExpressionDemo
{
    public static void main(String[] args)
    {
        StringTokenizerst=new StringTokenizer("Durga Software Solutions");
        while(st.hasMoreTokens())
        {
            System.out.println(st.nextToken());
        }
    }
}
```

The default regular expression for the StringTokenizer is space.

**Example 2:**

```
importjava.util.*;
classRegularExpressionDemo
{
    public static void main(String[] args)
    {
        StringTokenizerst=new StringTokenizer("1,99,988","","");
        while(st.hasMoreTokens())
        {
            System.out.println(st.nextToken());
        }
    }
}
```

**Requirement:**

Write a regular expression to represent all valid identifiers in java language.

**Rules:**

The allowed characters are:

- 1.a to z, A to Z, 0 to 9, -, #
- 2.The 1st character should be alphabet symbol only.
- 3.The length of the identifier should be at least 2.

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**Program:**

```
importjava.util.regex.*;
class RegularExpressionDemo
{
    public static void main(String[] args)
    {
        Pattern p=Pattern.compile("[a-zA-Z][a-zA-Z0-9-#]+"); (or)
        Pattern p=Pattern.compile("[a-zA-Z][a-zA-Z0-9-#][a-zA-Z0-9-#]*");
        Matcher m=p.matcher(args[0]);
        if(m.find()&&m.group().equals(args[0]))
        {
            System.out.println("valid identifier");
        }
        else
        {
            System.out.println("invalid identifier");
        }
    }
}
```

**Requirement:**

Write a regular expression to represent all mobile numbers.

1. Should contain exactly 10 digits.
2. The 1st digit should be 7 to 9.

**Program:** importjava.util.regex.\*;

```
classRegularExpressionDemo
{
    public static void main(String[] args)
    {
        Pattern p=Pattern.compile(
            "[7-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9]");
        //Pattern p=Pattern.compile("[7-9][0-9]{9}");
        Matcher m=p.matcher(args[0]);
        if(m.find()&&m.group().equals(args[0]))
        {
            System.out.println("valid number");
        }
        else
        {
            System.out.println("invalid number");
        }
    }
}
```

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### Analysis:

10 digits mobile:

[7-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9] (or)  
[7-9][0-9]{9}

### OP:

```
E:\javaapps>javac RegularExpressionDemo.java  
E:\javaapps>java RegularExpressionDemo 9989123456  
Valid number
```

```
E:\javaapps>java RegularExpressionDemo 6989654321  
Invalid number  
10 digits (or) 11 digits:  
(0?[7-9][0-9]{9})
```

### OP:

```
E:\javaapps>javac RegularExpressionDemo.java  
E:\javaapps>java RegularExpressionDemo 9989123456  
Valid number
```

```
E:\javaapps>java RegularExpressionDemo 09989123456  
Valid number
```

```
E:\javaapps>java RegularExpressionDemo 919989123456  
Invalid number  
10 digits (0r) 11 digit (or) 12 digits:  
(0|91)?[7-9][0-9]{9} (or)  
(91)?(0?[7-9][0-9]{9})
```

```
E:\javaapps>javac RegularExpressionDemo.java  
E:\javaapps>java RegularExpressionDemo 9989123456  
Valid number  
E:\javaapps>java RegularExpressionDemo 09989123456  
Valid number  
E:\javaapps>java RegularExpressionDemo 919989123456  
Valid number  
E:\javaapps>java RegularExpressionDemo 69989123456  
Invalid number
```

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**Requirement:**

Write a regular expression to represent all Mail Ids.

**Program:**

```
import java.util.regex.*;
class RegularExpressionDemo
{
    public static void main(String[] args)
    {
        Pattern p=Pattern.compile(
            "[a-zA-Z][a-zA-Z0-9-]*@[a-zA-Z0-9]+([.][a-zA-Z]+)+");
        Matcher m=p.matcher(args[0]);
        if(m.find()&&m.group().equals(args[0]))
        {
            System.out.println("valid mail id");
        }
        else
        {
            System.out.println("invalid mail id");
        }
    }
}
```

**OP:**

```
E:\javaapps>javac RegularExpressionDemo.java
E:\javaapps>java RegularExpressionDemo sunmicrosystem@gmail.com
Valid mail id
E:\javaapps>java RegularExpressionDemo 999sunmicrosystem@gmail.com
Invalid mail id
E:\javaapps>java RegularExpressionDemo 999sunmicrosystem@gmail.co9
Invalid mail id
```

**Requirement:**

Write a program to extract all valid mobile numbers from a file.

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**Program:**

```
import java.util.regex.*;
import java.io.*;
class RegularExpressionDemo
{
    public static void main(String[] args) throws IOException
    {
        PrintWriter out = new PrintWriter("output.txt");
        BufferedReader br = new BufferedReader(new FileReader("input.txt"));
        Pattern p = Pattern.compile("(0|91)?[7-9][0-9]{9}");
        String line = br.readLine();
        while (line != null)
        {
            Matcher m = p.matcher(line);
            while (m.find())
            {
                out.println(m.group());
            }
            line = br.readLine();
        }
        out.flush();
    }
}
```

**Requirement:**

Write a program to extract all Mail IDs from the File.

**NOTE:** In the above program replace mobile number regular expression with MAIL ID regular expression.

**Requirement:**

Write a program to display all .txt file names present in E:\javaapps folder.

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**Program:**

```
import java.util.regex.*;
import java.io.*;
class RegularExpressionDemo
{
    public static void main(String[] args) throws IOException
    {
        int count=0;
        Pattern p=Pattern.compile("[a-zA-Z0-9-$.] [+].txt");
        File f=new File("E:\\javaapps");
        String[] s=f.list();
        for(String s1:s)
        {
            Matcher m=p.matcher(s1);
            if(m.find()&&m.group().equals(s1))
            {
                count++;
                System.out.println(s1);
            }
        }
        System.out.println(count);
    }
}
```

**OP:**

input.txt  
output.txt  
outut.txt  
3

Write a regular expressions to represent valid Gmail mail id's :

[a-zA-Z0-9][a-zA-Z0-9-.]\*@gmail[.]com

Write a regular expressions to represent all Java language identifiers :

**Rules :**

1. The length of the identifier should be atleast two.
2. The allowed characters are

a-z  
A-Z  
0-9  
#  
\$

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3.The first character should be lower case alphabet symbol k-z , and second character should be a digit divisible by 3

**Ans:**

[k-z][0369][a-zA-Z0-9#\$]\*

Write a regular expressions to represent all names starts with 'a'

[aA][a-zA-Z]\*

To represent all names starts with 'A' ends with 'K'

[aA][a-zA-Z]\*[kK]

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## Garbage Collection

1. Introduction
2. Approaches to make an Object Eligible for Garbage Collection
3. Approaches for requesting garbage Collector to Run Garbage Collector
4. Finalization
5. Java Heap Memory and its Memory Areas
6. Garbage Collection in Young Generation
7. Garbage Collection in Old generation
8. Types Of Garbage Collectors for Old generation\

### Introduction:

--> In old languages like C++ programmer is responsible for both creation and destruction of objects. Usually programmer is taking very much care while creating object and neglect destruction of useless objects .Due to his negligence at certain point of time for creation of new object sufficient memory may not be available and entire application may be crashed due to memory problems.

--> But in java programmer is responsible only for creation of new object and his not responsible for destruction of objects.

--> Sun people provided one assistant which is always running in the background for destruction at useless objects. Due to this assistant the chance of failing java program is very rare because of memory problems.

--> This assistant is nothing but garbage collector. Hence the main objective of GC is to destroy useless objects.

### The ways to make an object eligible for GC:

--> Even through programmer is not responsible for destruction of objects but it is always a good programming practice to make an object eligible for GC if it is no longer required.

--> An object is eligible for GC if and only if it does not have any references.

The following are various possible ways to make an object eligible for GC:

#### 1. Nullifying the reference variable:

If an object is no longer required then we can make eligible for GC by assigning "null" to all its reference variables.

```
Student std1=new Student();
Student std2=new Student();
-----
-----
std1=null;
std2=null;
-----
-----
```

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**2. Reassign the reference variable:**

If an object is no longer required then reassign all its reference variables to some other objects then old object is by default eligible for GC.

```
Student std1=new Student();
Student std2=new Student();
---
---
std1=new Student();
---
---
std2=std1;
---
---
```

**3. Objects created inside a method:**

Objects created inside a method are by default eligible for GC once method completes.

**EX 1:**

```
class Test{
    public static void main(String[] args){
        m1();
    }
    static void m1(){
        Student std1=new Student();
        Student std2=new Student();
    }
}
```

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#### 4.Island Of Isolation:

If objects are not having explicit references or the Objects are having internal references are eligible for GC.

```
class Test{  
Test t;  
public static void main(String[] args){  
Test t1=new Test();  
Test t2=new Test();  
Test t3=new Test();  
  
t1.t=t2;  
t2.t=t3;  
t3.t=t1;  
  
t1=null;// No Object is eligible for GC.  
t2=null;// No Object is eligible for GC.  
t3=null;// All Objects are eligible GC , because, all Explicit references  
}  
}
```

are nullified.

#### The methods for requesting JVM to run GC:

- > Once we made an object eligible for GC it may not be destroyed immediately by the GC. Whenever jvm runs GC then only object will be destroyed by the GC. But when exactly JVM runs GC we can't expect ,it is vendor dependent.
- > We can request jvm to run garbage collector programmatically, but whether jvm accept our request or not there is no guaranty. But most of the times JVM will accept our request.

The following are various ways for requesting jvm to run GC:

##### 1)By System class:

System class contains a static method GC for this purpose.

**EX:** System.gc();

##### 2)By Runtime class:

A java application can communicate with jvm by using Runtime object.

Runtime class is a singleton class present in java.lang. Package.

We can create Runtime object by using factory method getRuntime().

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**EX:**

```
Runtime r=Runtime.getRuntime();
```

Once we got Runtime object we can call the following methods on that object.

freeMemory(): returns the free memory present in the heap.

totalMemory(): returns total memory of the heap.

gc(): for requesting jvm to run gc.

**EX:** import java.util.Date;

```
class RuntimeDemo
```

```
{
```

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

```
Runtime r=Runtime.getRuntime();
```

```
System.out.println("total memory of the heap :" +r.totalMemory());
```

```
System.out.println("free memory of the heap :" +r.freeMemory());
```

```
for(int i=0;i<10000;i++)
```

```
{
```

```
Date d=new Date();
```

```
d=null;
```

```
}
```

```
System.out.println("free memory of the heap :" +r.freeMemory());
```

```
r.gc();
```

```
System.out.println("free memory of the heap :" +r.freeMemory());
```

```
}
```

```
}
```

**OP:**

Total memory of the heap: 5177344

Free memory of the heap: 4994920

Free memory of the heap: 4743408

Free memory of the heap: 5049776

**NOTE:** Runtime class is a singleton class so not create the object to use constructor.

Which of the following are valid ways for requesting jvm to run GC ?

System.gc(); (valid)

Runtime.gc(); (invalid)

(new Runtime).gc(); (invalid)

Runtime.getRuntime().gc(); (valid)

**NOTE:** gc() method present in System class is static, where as it is instance method in Runtime class.

**NOTE:** Over Runtime class gc() method , System class gc() method is recommended to use.

**NOTE:** In java it is not possible to find size of an object and address of an object.

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**Finalization:**

-->Just before destroying any object gc always calls finalize() method to perform cleanup activities.

-->If the corresponding class contains finalize() method then it will be executed otherwise Object class finalize() method will be executed.

which is declared as follows.

protected void finalize() throws Throwable

**Case 1:**

Just before destroying any object GC calls finalize() method on the object which is eligible for GC then the corresponding class finalize() method will be executed.

For Example if String object is eligible for GC then String class finalize()method is executed but not Test class finalize()method.

**EX:**

```
class Test
{
    public static void main(String args[]){
        String s=new String("Durga Software Solutions");
        Test t=new Test();
        s=null;
        System.gc();
        System.out.println("End of main.");
    }
    public void finalize(){
        System.out.println("finalize() method is executed");
    }
}
```

**OP:**

End of main.

In the above program String class finalize()method got executed. Which has empty implementation.

If we replace String object with Test object then Test class finalize() method will be executed .

The following program is an Example of this.

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**EX:**

```
class Test
{
    public static void main(String args[]){
        String s=new String("Durga Software Solutions");
        Test t=new Test();
        t=null;
        System.gc();
        System.out.println("End of main.");
    }
    public void finalize(){
        System.out.println("finalize() method is executed");
    }
}
```

**OP:**

finalize() method is executed  
End of main

**Case 2:**

We can call finalize() method explicitly then it will be executed just like a normal method call and object won't be destroyed. But before destroying any object GC always calls finalize() method.

**EX:**

```
class Test
{
    public static void main(String args[]){
        Test t=new Test();
        t.finalize();
        t.finalize();
        t=null;
        System.gc();
        System.out.println("End of main.");
    }
    public void finalize(){
        System.out.println("finalize() method called");
    }
}
```

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**OP:**

finalize() method called.  
finalize() method called.  
finalize() method called.  
End of main.

In the above program finalize() method got executed 3 times in that 2 times explicitly by the programmer and one time by the gc.

**Case 3:**

finalize() method can be call either by the programmer or by the GC .  
If the programmer calls explicitly finalize() method and while executing the finalize() method if an exception raised and uncaught then the program will be terminated abnormally.

If GC calls finalize() method and while executing the finalize()method if an exception raised and uncaught then JVM simply ignores that exception and the program will be terminated normally.

**EX:**

```
class Test
{
    public static void main(String args[]){
        Test t=new Test();
        //t.finalize();-----line(1)
        t=null;
        System.gc();
        System.out.println("End of main.");
    }
    public void finalize(){
        System.out.println("finalize() method called");
        System.out.println(10/0);
    }
}
```

If we are not comment line1 then programmer calling finalize() method explicitly and while executing the finalize()method ArithmeticException raised which is uncaught hence the program terminated abnormally.

If we are comment line1 then GC calls finalize() method and JVM ignores ArithmeticException and program will be terminated normally.

Which of the following is true?

While executing finalize() method JVM ignores every exception(invalid).

While executing finalize() method JVM ignores only uncaught exception(valid).

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**Case 4:**

On any object GC calls finalize() method only once.

**EX:** classFinalizeDemo

```
{  
    staticFinalizeDemo s;  
    public static void main(String args[])throws Exception{  
        FinalizeDemo f=new FinalizeDemo();  
        System.out.println(f.hashCode());  
        f=null;  
        System.gc();  
        Thread.sleep(5000);  
        System.out.println(s.hashCode());  
        s=null;  
        System.gc();  
        Thread.sleep(5000);  
        System.out.println("end of main method");  
    }  
    public void finalize()  
    {  
        System.out.println("finalize method called");  
        s=this;  
    }  
}
```

**OP:**

```
D:\[Enum>java FinalizeDemo  
4072869  
finalize method called  
4072869  
End of main method
```

**NOTE:**

The behavior of the GC is vendor dependent and varied from JVM to JVM hence we can't expect exact answer for the following.

- 1.What is the algorithm followed by GC.
- 2.Exactly at what time JVM runs GC.
- 3.In which order GC identifies the eligible objects.
- 4.In which order GC destroys the object etc.
- 5.Whether GC destroys all eligible objects or not.

When ever the program runs with low memory then the JVM runs GC, but we can't except exactly at what time.

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### Memory Leaks:

In Java applications, if any object is not eligible for Garbage Collection and not utilized in java applications then that Objects are called as "Memory Leaks".

### Heap Memory Structer:

Heap Memory is mainly devided into the following two parts.

1. Young Generation
1. Eden Space
2. Survivor space
- S0 Survivor space
- S1 Survivor Space
2. Old Generation

When we create object newly, that object will come to Young Generation, in Young Generation , that Object will come to Eden Space, at Eden space Minor Garbage Collection will be performed, if any object is dereferenced object then Minor Garbage Collection will remove that object. In Eden Space , if any object is still live then Garbage Collector will move that live objects to Survivor space, in Survivor space , initial objects will come to S0 survivor space, there also Minor Garbage Collection will be performed, where if any object is dereferenced then Garbage Collector will remove that objects and the remaining objects are moved to S1 Survivor space, there again Minor Garbage Collection is going on, still any object is live then that object will be moved to Old Generation. In Old Generation, Major Garbage Collection will be performed.

IN Old Generation, we will perform Garbage Collection by using either of the following Garbage Collectors.

1. Serial Garbage Collector
2. Parallel Garbage Collector
3. Parallel Old Garbage Collector
4. Concurrent Mark and Sweep [CMS] Garbage Collector
5. Garbage First [G1] Garbage Collector

#### 1. Serial Garbage Collector:

This Garbage Collector will follow the following algorithm

1. Mark the Surviving objects in Old Generation.
2. Keep all marked objects at front end of the Heap and keep all the unmarked Objects at another end[Sweep].
3. Free the memory for unmarked objects[Compact]

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- > It will perform Garbage Collection by using Single Thread.
- > While performing garbage Collection, it will pause all application threads which are running in java applications.
- > It is suitable for Single Thread Model.
- > It is not suitable for Multi threaded applications.
- > It is suitable for Standalone applications.
- > It is not suitable for Server side applications.
- > To run this Garbage Collector, it will take less memory.
- > To activate this Garbage Collector we have to use the following Command.

D:\java9>java -XX:+UseSerialGC Test

## 2.Parallel Garbage Collector / Throughput garbage Collector:

- > It will use the following algorithm to perform Garbage Collection
- 1.Mark the Surviving objects in Old Generation.
- 2.Keep all marked objects at front end of the Heap and keep all the unmarked Objects at another end[Sweep].
- 3.Free the memory for unmarked objects[Compact]
- > It is default Garbage Collector in JVM.
- > It will use more than one thread to perform garbage Collection.
- > It will be used in Multi Threaded Environment.
- > It is suitable in Server side programming.
- > It will pause all the threads while performing Garbage Collection.
- > It requires more memory to perform garbage Collection when compared with Serial Garbage Collector.

To activate this Garbage Collector we will use the following command.

D:\java9>java -XX:+UseParallelGC Test

## 3.Parallel Old Garbage Collector:

- > It was introduced in JDK5.0 version.
  - > It is same as Parallel Garbage Collector, but, it will use "Mark-Summary-Compact" algorithm.
  - 1.Mark Survivor objects in Old Generation.
  - 2.Identifies all Survivor objects from the areas where Garbage Collection was performed previously.
  - 3.Delete Unmarked Objects , that is, Compact.
- > To activate this Garbage Collector we have to use the following command.

D:\java9>java -XX:+UseParallelOldGC Test

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#### 4.Concurrent Mark And Sweep[CMS] Garbage Collector:

- > It allows multiple threads to perform garbage Collection.
- > It will not freeze all the application threads while performing Garbage Collection except in the following two situations.
  - 1.While performing marking the survivor objects.
  - 2.Any changes in the heap memory while performing garbage Collection
- >It will provide very good performance when compared with Parallel Garbage Collector.
- >It is more complicated Garbage Collector and it needs more system Memory.
- >To activate this Garbage Collector we will use the following command.

D:\java9>java -XX:+UseConcMarkSweepGC Test

#### 5.Garbage First [G1] Garbage Collector:

- > It was introduced in JAVA7 version.
  - > In this mechanism, it will devide heap memory into no of regions, each region contains no of Grids, where each grid contains Objects, Here Garbage Collection will be performed over all the Grids that is Objects , if any useless object is identified then it will be removed.
  - >This mechanism is very simple and fast.
- >To activate this mechanism we have to use the following command.

D:\java9>java -XX:+UseG1GC Test

#### Garbage Collection Optimization options:

- Xms ----> Initial Heap Size.
- Xmx ----> Max Heap Size
- Xmn ----> Size of Young generation
- XX:PermSize ---> Initial Permanent Generation Size
- XX:MaxPermSize ---> Maximum Permanent Generation Size

#### EX:

D:\java9>java -Xmx12m -Xms3m -Xmn1m -XX:PermSize=20m  
-XX:MaxPermSize=20m -XX:+UseSerialGC Test

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## Virtual Machine: JVM

It is a Software Simulation of a Machine which can Perform Operations Like a Physical Machine.

**EX:**

- 1)JVM Acts as Runtime Engine to Run Java Applications
- 2)PVM (Parrot VM) Acts as Runtime Engine to Run Scripting Languages Like PEARL.
- 3)CLR (Common Language Runtime) Acts as Runtime Engine to Run .Net Based Application
- 4)KVM (Kernel Based Virtual Machine) for Linux Systems

### JVM

--->JVM is the Part of JRE.

--->JVM is Responsible to Load and Run Java Applications.

--->JVM Runs Java Byte Code by creating 5 Identical Runtime Areas to execute Class Members.

- 1.Class Loader Sub System
- 2.Memory Management System
- 3.Execution Engine
- 4.PC-Registers
- 5.Native Methods Stack

### ClassLoader Sub System:

ClassLoader Sub System is Responsible for the following 3 Activities.

- 1)Loading
- 2)Linking
- 3)Initialization

#### 1)Loading:

Loading Means Reading Class Files and Store Corresponding Binary Data in Method Area.

For Each Class File JVM will Store the following Information in Method Area.

- 1)Fully Qualified Name of the Loaded Class OR Interface OR enum.
- 2)Fully Qualified Name of its Immediate Parent Class OR Interface OR enum.
- 3)Whether .class File is related to Class OR Interface OR enum.
- 4)The Modifiers Information
- 5)Variable OR Fields Information
- 6)Method Information
- 7)Constant Pool Information and so on.

After loading .class File Immediately JVM will Creates an Object of the Type class Class to Represent Class Level Binary Information on the Heap Memory.

The Class Object used by Programmer to get Class Level Information Like Fully Qualified Name of the Class, Parent Name, Method and Variable Information Etc.

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**NOTE:** For Every Loader Time Only One Class Object will be Created Even though we are using Class Multiple Times in Our Application.

## 2)Linking:

Linking Consists of 3 Activities

- 1)Verification
- 2)Preparation
- 3)Resolution

### Verification:

- >It is the Process of ensuring that Binary Representation of a Class is Structurally Correct OR Not.
- >That is JVM will Check whether .class File generated by Valid Compiler OR Not and whether .class File is Properly Formatted OR Not.
- >Internally Byte Code Verifier which is Part of ClassLoader Sub System is Responsible for this Activity.
- >If Verification Fails then we will get Runtime Exception Saying `java.lang.VerifyError`.

### Preparation:

In this Phase JVM will Allocate Memory for the Class Level Static Variables and Assign Default Values (But Not Original Values Assign to the Variable).

**NOTE:** Original Values will be assigned in Initialization Phase.

### Resolution:

- >It is the Process of Replaced Symbolic References used by the Loaded Type with Original References.
- >Symbolic References are Resolved into Direct References by searching through Method Area to Locate the Referenced Entity.

## 3)Initialization:

In this Phase All Static Variables Assignments with Original Values and Static Block Execution will be performed from Parent Class to Child Class.

**NOTE:** While Loading, Linking and Initialization if any Error Occurs then we will get Runtime Exception Saying `LinkageError`.

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### Types of ClassLoaders:

Every ClassLoader Sub System contains the following 3 ClassLoaders.

- 1)Bootstrap ClassLoader OR Primordial ClassLoader
- 2)Extension ClassLoader
- 3)Application ClassLoader OR System ClassLoader

### Bootstrap ClassLoader:

-->This ClassLoader is Responsible for loading 4 Java API Classes.

-->That is the Classes Present in rt.jar (runtime.jar).

Location: %JAVA\_HOME%\jre\lib\rt.jar

-->This Location is Called Bootstrap Class Path.

-->That is Bootstrap ClassLoader is Responsible to Load Classes from Bootstrap Class Path.

-->Bootstrap ClassLoader is by Default Available with the JVM.

-->It is implemented in Native Languages Like C and C++.

### Extension ClassLoader:

-->It is the Child of Bootstrap ClassLoader.

-->This ClassLoader is Responsible to Load Classes from Extension Class Path.

Location: %JAVA\_HOME%\jre\lib\ext

-->This ClassLoader is implemented in Java and the corresponding .class File Name is sun.misc.Launcher\$extClassLoader.class

### Application ClassLoader OR System ClassLoader:

-->It is the Child of Extension ClassLoader.

-->This ClassLoader is Responsible to Load Classes from Application Class Path (Current Working Directory).

-->It Internally Uses Environment Variable Class Path.

-->Application ClassLoader is implemented in Java and the corresponding .class File Name is sun.misc.Launcher\$appClassLoader.class

### How ClassLoader will Work?

-->ClassLoader follows Delegation Hierarchy Principle.

-->Whenever JVM Come Across a Particular Class 1st it will Check whether the corresponding Class is Already Loaded OR Not.

-->If it is Already Loaded in Method Area then JVM will Use that Loaded Class.

-->If it is Not Already Loaded then JVM Requests ClassLoader Sub System to Load that Particular Class.

-->Then ClassLoader Sub System Handovers the Request to Application ClassLoader.

-->Application ClassLoader Delegates that Request to Extension ClassLoader and

-->ExtensionClassLoader in-turn Delegates that Request to Bootstrap ClassLoader.

-->Bootstrap ClassLoader Searches in Bootstrap Class Path for the required .class File (jdk/jre/lib)

-->If the required .class is Available, then it will be Loaded. Otherwise Bootstrap ClassLoader Delegates that Request to Extension ClassLoader.

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- >Extension ClassLoader will Search in Extension Class Path (jdk/jre/lib/ext). If the required .class File is Available then it will be Loaded, Otherwise it Delegates that Request to Application ClassLoader.
- >Application ClassLoader will Search in Application Class Path (Current Working Directory). If the specified .class is Already Available, then it will be Loaded Otherwise we will get Runtime Exception Saying ClassNotFoundException OR NoClassDefFoundError.

### **Memory Management System:**

- >While Loading and Running a Java Program JVM required Memory to Store Several Things Like Byte Code, Objects, Variables, Etc.
- >Total JVM Memory organized in the following 5 Categories:
  - 1)Method Area
  - 2)Heap Area OR Heap Memory
  - 3)Java Stacks Area
  - 4)PC Registers Area
  - 5)Native Method Stacks Area

#### **1)Method Area:**

- >Method Area will be Created at the Time of JVM Start - Up.
- >It will be Shared by All Threads (Global Memory).
- >This Memory Area Need Not be Continuous.
- >Method area shows runtime constant pool.
- >Total Class Level Binary Information including Static Variables Stored in Method Area.

#### **2)Heap Area:**

- >Programmer Point of View Heap Area is Consider as Important Memory Area.
- >Heap Area will be Created at the Time of JVM Start - Up.
- >Heap Area can be accessed by All Threads (Global OR Sharable Memory).
- >Heap Area Need Not be Continuous.
- >All Objects and corresponding Instance Variables will be stored in the Heap Area.
- >Every Array in Java is an Object and Hence Arrays Also will be stored in Heap Memory Only.
  
- >We are able to get Heap memory calculations by using java.lang.Runtime class.
- >Runtime Class Present in java.lang Package and it is a Singleton Class.
- >We can Create Runtime Object by using  
    Runtime r = Runtime.getRuntime();
- >Once we got Runtime Object we can Call the following Methods on that Object.
  - 1)maxMemory(): Returns Number of Bytes of Max Memory allocated to the Heap.
  - 2)totalMemory(): Returns Number of Bytes of Total (Initial) Memory allocated to the Heap.
  - 3)freeMemory(): Returns Number of Bytes of Free Memory Present in Heap.

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**EX:**

```
class A
{
}
class Test
{
    public static void main(String[] args) throws Exception
    {
        A a1=new A();
        A a2=new A();
        A a3=new A();

        Runtime rt=Runtime.getRuntime();
        System.out.println(rt.maxMemory());
        System.out.println(rt.totalMemory());
        System.out.println(rt.freeMemory());
        System.out.println(rt.totalMemory()-rt.freeMemory());
    }
}
```

**3)Stack Memory:**

- >For Every Thread JVM will Create a Separate Runtime Stack.
- >Runtime Stack will be Created Automatically at the Time of Thread Creation.
- >All Method Calls and corresponding Local Variables, Intermediate Results will be stored in the Stack.
- >For Every Method Call a Separate Entry will be Added to the Stack and that Entry is Called Stack Frame OR Activation Record.
- >After completing that Method Call the corresponding Entry from the Stack will be Removed.
- >After completing All Method Calls, Just Before terminating the Thread, the Runtime Stack will be destroyed by the JVM.
- >The Data stored in the Stack can be accessed by Only the corresponding Thread and it is Not Available to Other Threads.

**4)PC (Program Counter) Registers Area:**

- >For Every Thread a Separate PC Register will be Created at the Time of Thread Creation.
- >PC Registers contains Address of Current executing Instruction.
- >Once Instruction Execution Completes Automatically PC Register will be incremented to Hold Address of Next Instruction.

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### 5)Native Method Stacks:

- >For Every Thread JVM will Create a Separate Native Method Stack.
- >All Native Method Calls invoked by the Thread will be stored in the corresponding Native Method Stack.

#### NOTE:

Method Area, Heap Area and Stack Area are considered as Major Memory Areas with Respect to Programmers Point of View.

Method Area and Heap Area are for JVM. Whereas Stack Area, PC Registers Area and Native Method Stack Area are for Thread. That is

- >One Separate Heap for Every JVM
- >One Separate Method Area for Every JVM
- >One Separate Stack for Every Thread
- >One Separate PC Register for Every Thread
- >One Separate Native Method Stack for Every Thread

Static Variables will be stored in Method Area whereas Instance Variables will be stored in Heap Area and Local Variables will be stored in Stack Area.

### Execution Engine:

- >This is the Central Component of JVM.
- >Execution Engine is Responsible to Execute Java Class Files.
- >Execution Engine contains 2 Components for executing Java Classes.
  - 1)Interpreter
  - 2)JIT Compiler

### Interpreter:

- >It is Responsible to Read Byte Code and Interpret (Convert) into Machine Code (Native Code) and Execute that Machine Code Line by Line.
- >The Problem with Interpreter is it Interprets Every Time Even the Same Method Multiple Times. Which Reduces Performance of the System.
- >To Overcome this Problem SUN People Introduced JIT Compilers in 1.1 Version.

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### JIT Compiler:

- >The Main Purpose of JIT Compiler is to Improve Performance.
- >Internally JIT Compiler Maintains a Separate Count for Every Method whenever JVM Come Across any Method Call.
- >First that Method will be interpreted normally by the Interpreter and JIT Compiler Increments the corresponding Count Variable.
- >This Process will be continued for Every Method.
- >Once if any Method Count Reaches Threshold (The Starting Point for a New State) Value, then JIT Compiler Identifies that Method Repeatedly used Method (HOT SPOT).
- >Immediately JIT Compiler Compiles that Method and Generates the corresponding Native Code. Next Time JVM Come Across that Method Call then JVM Directly Use Native Code and Executes it Instead of interpreting Once Again. So that Performance of the System will be Improved.
- >The Threshold Count Value varied from JVM to JVM.
- >Profiler which is the Part of JIT Compiler is Responsible to Identify HOT SPOTS.

### NOTE:

JVM Interprets Total Program Line by Line at least Once.

JIT Compilation is Applicable Only for Repeatedly invoked Methods. But Not for Every Method.

### Java Native Interface (JNI):

JNI Acts as Bridge (Mediator) between Java Method Calls and corresponding Native Libraries.

### Java Native Library:

Java Native Library is the collection of Native methods which are required in java.

Native method is a method declared in java , but, implemented in non java programming languages like C , C++,...

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## Generics

What is the requirement to use Generics in Java applications.

1.To represent one thing if we allow only one data type then it is type safe operation.

**EX:** Arrays are providing typesafe operation.

```
Student[] std=new Student[3];
std[0]=new Student();----> Valid
std[1]=new Student();----> Valid
std[2]=new Customer();----> Invalid
```

To represent one thing if we allow more than one type then it is Type unsafe operation.

**EX:** Collection objects are providing type Unsafe operation, because, Collection objects are able to allow heterogeneous elements.

```
ArrayList al=new ArrayList();
al.add("AAA");
al.add(new Employee());
al.add(new Integer(10));
al.add(new StringBuffer("CCC"));
```

In Collections to improve typedness or to provide typesafe operations then we have to use "Generics".

2.If we add elements to the Collection object and if we want to retrieve elements from Collection objects we must perform type casting, because, get(--) methods of Collections are able to retrieve elements in the form of java.lang.Object type.

**EX:**

```
ArrayList al=new ArrayList();
al.add("A");
al.add("B");
al.add("C");
al.add("D");
System.out.println(al);
String str=al.get(2);----> Compilation Error, Incompatible types.
String str=(String)al.get(2);--> Valid
```

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If we use Generics along with Collections then it is not required to type cast while iterating elements.  
The main intention of Generics is,

1. To provide typesafe operations in Collections.
2. To avoid Type casting while retrieving elements from Collections.

Generics is a Type parameter specified along with Collections inorder to fix a particular type of elements to add.

**Syntax:**

```
Collection_Name<Generic_Type> ref=new Collection_Name<GenericType>([ Params]);
```

**EX:**

```
ArrayList<String> al=new ArrayList<String>();
```

The above ArrayList object is able to add only String type elements, if we are trying to add any other elements then Compiler will rise an error.

**EX:**

```
import java.util.*;  
class Test  
{  
    public static void main(String[] args)  
    {  
        ArrayList<String> al=new ArrayList<String>();  
        al.add("A");  
        al.add("B");  
        al.add("C");  
        al.add("D");  
        al.add("E");  
        System.out.println(al);  
        al.add(new Integer(10));---> Error  
        System.out.println(al);  
    }  
}
```

Before JDK5.0 version, ArrayList class is

```
public class ArrayList  
{  
    public void add(Object obj)  
    {  
    }  
    public Object get(int index)  
    {  
    }
```

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----  
----  
}

From JDK5.0 version ArrayList class is

```
public class ArrayList<T>
{
    public void add(T t)
    {
    }
    public T get(int index)
    {
    }
}
```

In the above ArrayList we can provide any user defined data type to T.

**EX1:** ArrayList<String> al = new ArrayList<String>();

Here ArrayList class is converted internally as

```
public class ArrayList<String>
{
    public void add(String t)
    {
    }
    public String get(int index)
    {
    }
}
```

Here add(-) method is able to take only String elements to add to the ArrayList and get() method will return only String elements.

```
al.add("A");--> Valid
al.add("B");--> Valid
al.add("C");--> Valid
al.add(new Integer(10));--> Invalid.
String str=al.get(2);
```

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**EX2:** ArrayList<Integer> al=new ArrayList<Integer>();

Here ArrayList class is converted internally like below.

```
public class ArrayList<Integer>
{
    public void add(Integer t)
    {
    }
    public Integer get(int index)
    {
    }
}
```

Here add(-) method is able to take only Integer elements to add to the ArrayList and get() method will return only Integer elements.

```
al.add(new Integer(10));--> Valid
al.add(new Integer(20));--> Valid
al.add(30);--> Valid, Autoboxing
al.add("AAA");--> Invalid.
Integer in=al.get(1);--> valid
int i=al.get(2);--> Valid, Auto-Unboxing
```

If any java class is having Generic type parameter at its declaration then that class is called as "Generic Class".

**NOTE:** "Generics" feature is provided by JAVA along with its JDK5.0 version.

**EX:**

```
class Account<T>
{
}
```

```
Account<Savings> acc=new Account<Savings>();
Account<Current> acc=new Account<Current>();
```

In the above Generic class declaration, we can use any valid java identifier as Type parameter.

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**EX:**

```
class Account<X>
{
}
```

**Status:** Valid**EX:**

```
class Account<Durga>
{
}
```

**Status:** Valid

In the above Generic class declaration, we can use any no of Type parameters by provide ';' separator.

**EX:**

```
class HashMap<K,V>
{
}
```

Where 'K' is key.  
Where 'V' is value.

**EX:**

```
class Account<T>
{
    T obj;
    public void set(T obj)
    {
        this.obj=obj;
    }
    public T get()
    {
        return obj;
    }
    public void display_Type()
    {
        System.out.println(obj.getClass().getName());
    }
}
class Test
{
```

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```
public static void main(String[] args)
{
    Account<String> acc=new Account<String>();
    acc.set("Savings_Account");
    System.out.println(acc.get());
    acc.display_Type();
}
```

**Bounded Types:**

In Generic Classes, we can bound the type parameter for a particular range by using "extends" keyword.

**EX1:**

```
class Test<T>
{
}
```

It is unbounded type, we can pass any type of parameter.

```
Test<String> t=new Test<String>();
Test<Integer> t=new Test<Integer>();
```

**EX2:**

```
class Test<T extends X>
{
}
```

If X is a class type then we can pass either X type elements or sub class elements of X type as parameter types.

**EX:**

```
class Payment
{
}
class CashPayment extends Payment
{
}
class CardPayment extends Payment
{
}
class Bill<T extends Payment>
{
}
```

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```
Bill<Payment> bill=new Bill<Payment>(); ---> Valid  
Bill<CashPayment> bill=new Bill<CashPayment>();--> Valid  
Bill<CardPayment> bill=new Bill<CardPayment>();---> Valid
```

**EX:**

```
class Test<T extends Number>  
{  
}  
Test<Number> t=new Test<Number>()---> Valid  
Test<Integer> t=new Test<Integer>();----> Valid  
Test<Float> t=new Test<Float>();-----> Valid  
Test<String> t=new Test<String>();---> Invalid
```

If 'X' is an interface then we are ABle to pass either X type elements of its implementation class types as parameter.

**EX:**

```
interface Java  
{  
}  
class CoreJava implements Java  
{  
}  
class AdvJava implements Java  
{  
}  
class Course<T extends Java>  
{  
}
```

```
Course<Java> crs1=new Course<Java>(); --->Valid  
Course<CoreJava> crs2=new Course<CoreJava>();--> Valid  
Course<AdvJava> crs3=new Course<AdvJava>();---> Valid
```

**NOTE:** Bouded parameters are not allowing "implements" keyword and "super" keyword.

```
class Test<T implements Runnable>  
{  
}
```

**Status:** Invalid

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**EX:**

```
class Test<T super String>
{
}
```

**Status:** Invalid

In Generic classes , we can use more than one type as bounded parameter by using '&' symbol.

**EX:**

```
class Test<T extends Number & Serializable>
{
}
```

Here Test class is able to allow the elements which must be either same as Number or sub classes to the number and which must be the implementations of Serializable interface.

```
Test<Integer> t=new Test<Integer>();--> Valid
Test<Float> t=new Test<Float>();--> Valid
Test<String> t=new Test<String>--> Invalid.
```

**EX:**

```
clas Test<T extends Number & Thread>
{
}
```

**Status:** Invalid**Reason:** extends keyword will not allow two class types at a time.**EX:**

```
class Test<T extends Runnbale & Serializable>
{
}
```

**Statis:** valid.**Reason:** extends keyword is able to allow more than one interface type.**CONTACT US:****Mobile:** +91- **8885 25 26 27** +91- **7207 21 24 27/28** **US NUM:** , **4433326786****Mail ID:** [durgasoftonlinetraining@gmail.com](mailto:durgasoftonlinetraining@gmail.com)**WEBSITE:** [www.durgasoftonline.com](http://www.durgasoftonline.com)**FLAT NO: 202, HMDA MYTRIVANUM, AMEERPET, HYDERABAD.,**

**EX:**

```
class Test<T extends Number & Runnable>
{
}
```

**Status:** Valid.**Reason:** Extends is able to allow both class type and interface type , but, first we have to specify class type then we ahve to specify Interface type.**EX:**

```
class Test<T extends Runnable & Number>
{
}
```

**Status:** Invalid.**Reason:** extends keyword allows first class\_Name then interface\_Name**EX:**

```
import java.util.*;
class Account
{
    String accNo;
    String accName;
    String accType;

    Account(String accNo, String accName, String accType)
    {
        this.accNo=accNo;
        this.accName=accName;
        this.accType=accType;
    }

}
class Bank
{
    public ArrayList<Account> getAccountsList(ArrayList<Account> al)
    {
        al.add(new Account("a111", "AAA", "Savings"));
        al.add(new Account("b111", "BBB", "Savings"));
        al.add(new Account("c111", "CCC", "Savings"));
        al.add(new Account("d111", "DDD", "Savings"));
    }
}
```

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```
        return al;
    }
}
class Test
{
    public static void main(String[] args)
    {
        ArrayList<Account> al=new ArrayList<Account>();
        Bank bank=new Bank();
        ArrayList<Account> acc_List=bank.getAccountsList(al);
        System.out.println("ACCNO\tACCNAME\tACCTYPE");
        System.out.println("-----");
        for(Account acc: acc_List)
        {
            System.out.println(acc.accNo+"\t"+acc.accName+"\t"+acc.accType);
        }
    }
}
```

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## JDBC

### Storage Areas:

As part of the Enterprise Application development it is essential to manage the organizations data like Employee Details, Customer Details, Products Details..etc

-->To manage the above specified data in enterprise applications we have to use storage areas (Memory elements). There are two types of Storage areas.

#### 1) Temporary Storage Areas:

These are the memory elements, which will store the data temporarily.  
Eg: Buffers, Java Objects

#### 2) Permanent Storage Objects:

These are the memory elements which will store data permanently.  
Eg: FileSystems, DBMS, DataWareHouses.

#### File Systems:

It is a System, it will be provided by the local operating System.

-->Due to the above reason File Systems are not suitable for platform independent technologies like JAVA.

- >File Systems are able to store less volume of the data.
- >File Systems are able to provide less security.
- >File Systems may increases data Redundancy.

-->In case of File Systems Query Language support is not available. So that all the database operations are complex.

#### DBMS:

- >Database Management System is very good compare to file System but still it able to store less data when compared to DataWareHouses.
- >DBMS is very good at the time of storing the data but which is not having Fast Retrieval Mechanisms.

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### DataWareHouses:

When Compared to File Systems and DBMS it is able to store large and large volumes of data.

-->Data ware houses having fast retrieval mechanisms in the form of data mining techniques.

Q) What is the difference between database and database management system?

**Ans:** DataBase is a memory element to store the data.

Database Management System is a Software System, it can be used to manage the data by storing it on database and retrieving it from Database.

Database is a collection of interrelated data as a single unit.

DBMS is a collection of interrelated data and a set of programs to access the data.

### There are three types of DBMS:

- 1) RDMS (Relational Database Management Systems)
- 2) OODBMS (Object Oriented DataBase Management Systems)
- 3) ORDBMS (Object Relational DataBase Management Systems)

#### 1) Relational Database Management Systems:

-->It is a DBMS, it can be used to represent the data in the form of tables.

-->This DBMS will use SQL3 as a Query Language to perform DataBase Operations.

#### 2) Object Oriented Database Management System:

-->It is Database Management System, It will represents the data in the form of Objects.

-->This database management system will require OQL (Object Query Language) as Query language to perform database operations.

#### 3) Object Relational DataBase Management System:

-->It is a DataBaseManagement System, it will represents some part of data in the form of Tables and some other part of the data in the form of objects

-->This DataBaseManagement System will require SQL3 as Query Language to perform database operations.

Where SQL3 is the combination of SQL2 and OQL

$$\text{SQL3} = \text{SQL2} + \text{OQL}$$

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## Query Processing System:

When we submit an SQL Query to the Database then Database Engine will perform the following Steps.

### Step1:

#### Query Tokenization:

This Phase will take SQL Query as an Input, divided into no.of tokens and Generate Stream of tokens as an output.

### Step2:

#### Query Processing:

This phase will take Stream of tokens as an Input, constructs Query Tree with the Tokens, if Query Tree Success then no Syntax error is available in the provided SQL Query. If Query Tree is not Success then there are some syntax errors in the provided SQL Query.

### Step3:

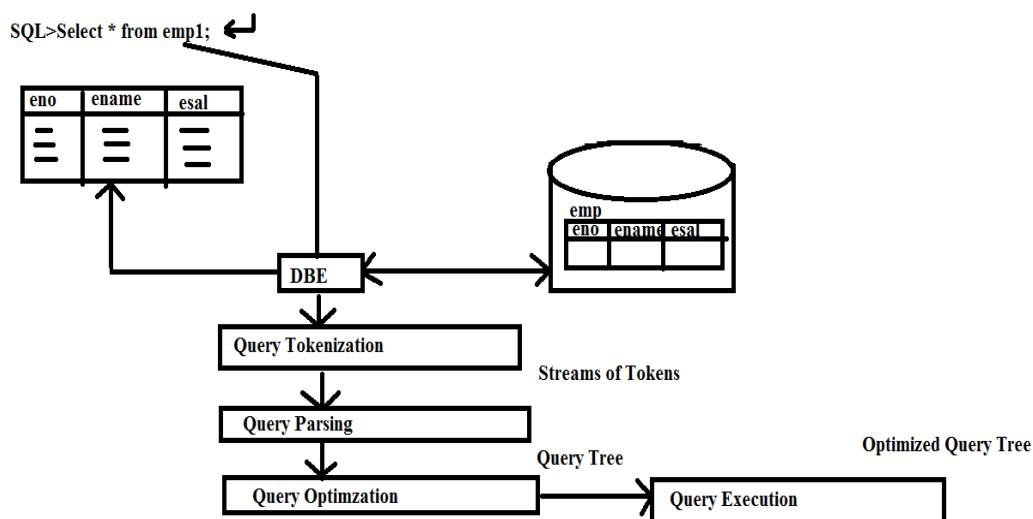
#### Query Optimization:

The main purpose of Query Optimization phase is to perform optimization on Query Tree in order to reduce execution time and to optimize memory utilization.

### Step4:

#### Query Execution:

This phase will take optimized Query Tree as an input and execute the Query by using interpreters.



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### JDBC (Java DataBase Connectivity):

-->The process of interacting with the database from Java Applications is called as JDBC.

-->JDBC is an API, which will provide very good predefined library to connect with database from JAVA Applications in order to perform the basic database operations:

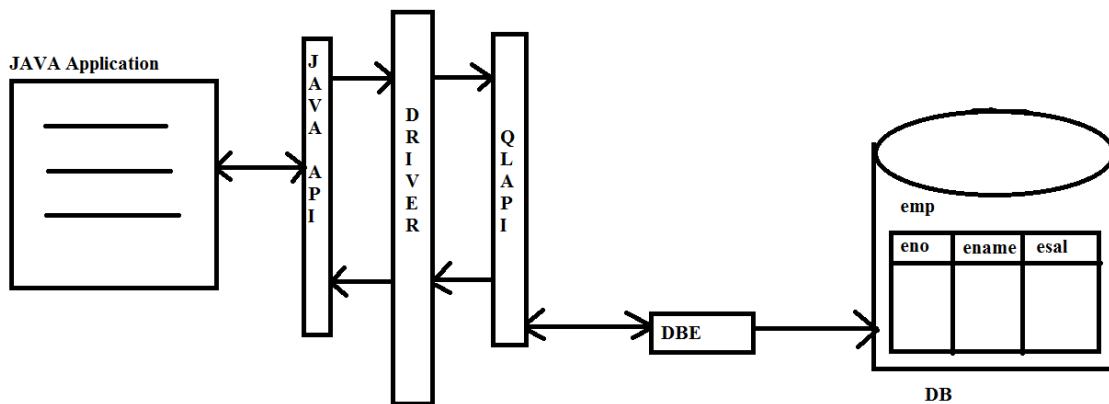
-->In case of JDBC Applications we will define the database logic and Java application and we will send a Java represented database logic to Database Engine. But database engine is unable to execute the Java represented database logic, it should required the database logic in Query Language Representations.

-->In the above context, to execute JDBC applications we should require a conversion mechanism to convert the database logic from Java representations to Query language representations and from Query language representations to Java representations.

-->In the above situation the required conversion mechanisms are available in the form of a software called as "Driver".

### Driver:

-->Driver is an interface existed between Java application and database to map Java API calls to Query language API calls and Query language API calls to Java API calls.



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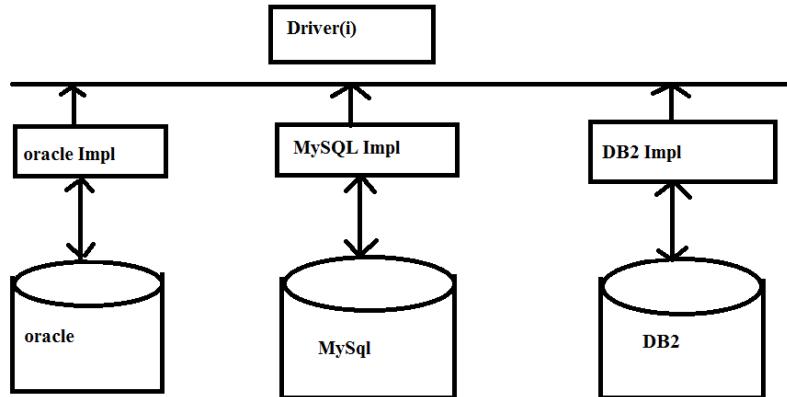
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-->To provide driver as a product Sun MicroSystems has provided Driver as an interface and Sun MicroSystems lets the database vendors to provide implementation classes to the driver interface as part of their database software's.

-->If we want to use Drivers in JDBC applications then we have to get Driver implementation from the respective database software's.



-->There are 180+ numbers of drivers but all these drivers could be classified into the following

Four types

- 1) Type 1
- 2) Type 2
- 3) Type 3
- 4) Type 4

### Type 1 Driver:

-->Type 1 Driver is also called as JDBC-ODBC Driver and Bridge Driver.

-->JDBC-ODBC Driver is a driver provided by Sun Micro Systems as an Implementation to Driver Interface.

-->Sun MicroSystems has provided JDBC-ODBC Driver with the inter dependent on the Microsoft's product ODBC Driver.

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-->ODBC Driver is a Open Specification,it will provide very good environment to interact with any type of database from JDBC-ODBC Driver.

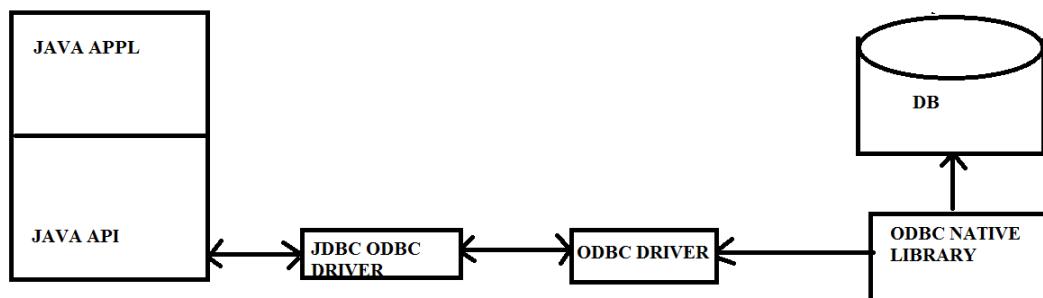
-->If we want to use JDBC-ODBC Driver in our JDBC Applications first we have to install the MicroSoft Product ODBC Driver native library.

-->To interact with the database from Java Application if we use JDBC-ODBC Driver then we should require two types conversions so that JDBC-ODBC Driver is Slower Driver.

-->JDBC-ODBC Driver is highly recommended for stand alone applications,it is not suitable for web applications,distributed applications and so on.

-->JDBC-ODBC Driver is suggestable for Simple JDBC applications,not for complex JDBC applications.

-->The portability of the JDBC-ODBC Driver is very less.



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**Type 2 Driver:**

-->Type 2 Driver is also called part java,part native driver that is Type 2 Driver was implemented by using Java implementations and the database vendor provided native library.

-->When compared to Type1 Driver Type2 Driver is faster Driver because it should not require two times conversions to interact with the Database from Java Applications.

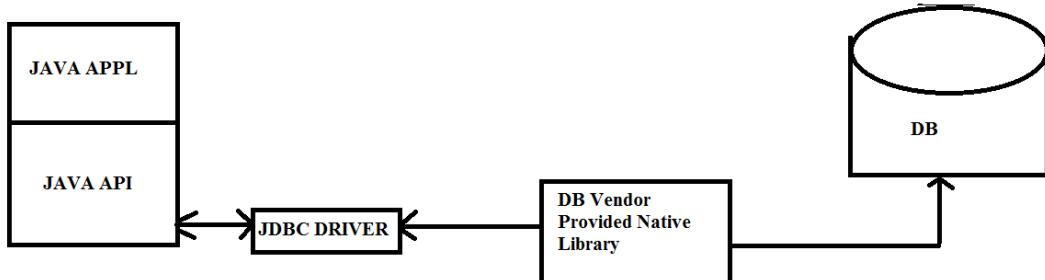
-->When compared to Type1 Driver Type2 driver portability is more.

-->Type2 Driver is still recommended for standalone application not suggestible for web applications and Enterprise applications.

-->If we want to use Type2 Driver in our Jdbc applications then we have to install the database vendor provided native library.

-->Type2 Driver is cast full Driver among all the drivers.

-->Type2 Driver's portability is not good when compared to Type3 Driver and Type4 Driver.

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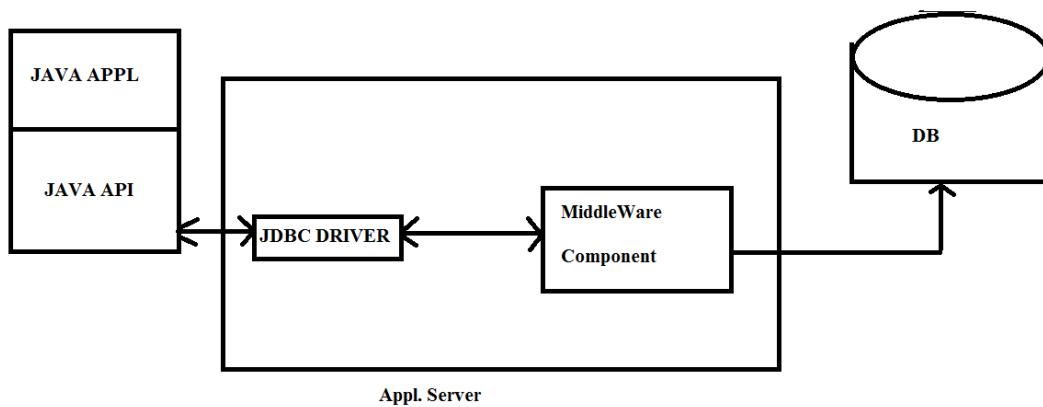
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### 3) Type 3 Driver:

- >Type 3 Driver is also called as MiddleWare DataBase Server Access Driver and NetWorkDriver.
- >Type 3 Driver is purely designed for Enterprise applications it is not suggestible for stand alone applications.
- >Type 3 Driver portability is very good when compared to Type1 and Type2 Driver's.
- >Type 3 Driver will provide very good environment to interact with multiple no.of databases.
- >Type 3 Driver will provide very good environment to switch from one database to another database without having modifications in client applications.
- >Type 3 Driver should not require any native library installations, it should require the Compatibility with the application server.
- >Type 3 Driver is fastest Driver when compared to all the Drivers.



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**4) Type 4 Driver:**

-->Type 4 Driver is also called as pure Java Driver and Thin Driver because Type 4 Driver was implemented completely by using java implementations.

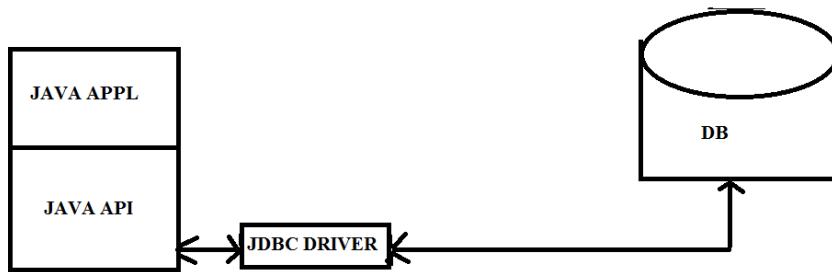
-->Type 4 Driver is the frequent used Driver when compared to all the remaining Drivers.

-->Type 4 Driver is recommended for any type application includes standalone applications, Network Applications....

-->Type 4 Driver portability is very good when compared to all the remaining Drivers.

-->Type 4 driver should not require any native library dependences and it should require one time conversion to interact with database from Java Applications.

-->Type 4 is the cheapest Driver among all.

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### Steps to design JDBC Application:

- 1) Load and register the Driver.
- 2) Establish the connection between Java Application.
- 3) Prepare either Statement or prepared Statement or CallableStatement Objects.
- 4) Write and execute SQL Queries.
- 5) Close the connection

### Load and Register the Driver:

In general Driver is an interface provided by Sun Microsystems and whose implementation classes are provided by the Database Vendors as part of their Database Softwares.

-->To load and Register the Driver first we have to make available Driver implementation to JDBC application. For this we have to set classpath environment variable to the location Where we have Driver implementation class.

-->If we want to use Type1 Driver provided by Sun MicroSystems in our JDBC applications then it is not required to set classpath environment variable because Type1 Driver was provided by Sun MicroSystems as part of Java Software in the form of **sun.jdbc.odbc.JdbcOdbcDriver**

-->If we want to use Type1 Driver in our JDBC applications then before loading we have to Configure the **Microsoft product odbc Driver**.

-->To configure Microsoft product odbc Driver we have to use the following path.

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**To setting DSN:-**

- Start
- ↓
- Control Panel
- ↓
- System and Security
- ↓
- Administrative Tools
- ↓
- Data Sources (ODBC)
- ↓
- user DSN
- ↓
- Click on Add button
- ↓
- Select Microsoft ODBC for the Oracle
- ↓
- Click on Finish button
- ↓
- Provide DSN name (provide any name)
- ↓
- Click on OK

-->To load and register Driver in our Jdbc applications we have to use the following method from class

'Class'

Public static Class forName(String class\_Name)

**EX:** Class.forName("sun.jdbc.odbc.JdbcOdbcDriver");

-->When JVM encounter the above instruction JVM will pickup the parameter that is **JDBCODbcDriver** Class name and JVM will search for its .class file in the current location,if it is not available then JVM will search for it in Java predefined library.

-->If JVM identify JDBCODBCDriver.class file in Java pre-defined library(rt.jar) then JVM will load **JdbcOdbcDriver** class byte code to the memory.

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-->At the time of loading JdbcOdbcDriver class byte code to the memory JVM will execute a static block, As part of this JVM will execute a method call like **DriverManager.registerDriver(--);** by the execution of registerDriver() method only JDBC OdbcDrvier will be available to our Jdbc applications.

-->In case of Type1 Driver if we use either Jdbc 4.0 version or Jdk 6.0 version then it is optional To perform loading and register the driver step because JVM will perform Drvier registration automatically at the time of establishing the connection between Java application and Database.

**NOTE:**To prepare Jdbc applications Java API has provided the required pre-defined library in the form of java.sql package so that we have to import this package in our Java file.

```
Import java.sql.*;
```

-->java.sql package includes the following pre-defined library to design Jdbc applications.

**java.sql package includes the following predefined library:-**  
**I----→interface                            C-----→class**

1. Driver (I)
2. DriverManager (C)
3. Connection (I)
4. Statement (I)
5. PreparedStatement (I)
6. ResultSet (I)
7. ResultSetMetaData (I)
8. DatabaseMetaData (I)
9. Savepoint(i)

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## Establish the Connection between Java application and Database:

-->To establish the connection between Java application and Database we have to use the following Method from **DriverManager class**.

```
Public static Connection getConnection(String url,String db_user_name,String db_password)
```

**EX:**Connection con=DriverManager.getConnection("jdbc:odbc:dsnName","system","durga");

-->When JVM encounter the above instruction JVM will access getConnection method,as part of the getConnection method JVM will access connect() method to establish virtual socket connection

### Between Java application and database as per the url which we provided.

-->where getConnection() method will take three parameters

- 1.Driver URL
- 2.Database username
- 3.Database password

-->In general from Driver to Driver Driver class name and Driver url will varied.

-->If we use Type1 Driver then we have to use the following Driver class name and URL

```
d-class : sun.jdbc.odbc.JdbcOdbcDriver  
url      :jdbc:odbc:dsnName
```

-->In general all the Jdbc Drivers should have an url with the following format.

#### **main-protocol: sub-protocol**

-->where main-protocol name should be Jdbc for each and every Driver but the sub protocol name should be varied from Driver to Driver.

Q) In Jdbc applications getConnection() method will establish the connection between Java application and Database and return connection object but connection is an interface how it is possible to

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### Create connection object?

**Ans:**In general in Java technology we are unable to create objects for the interfaces directly,if we want to accommodate interface data in the form of objects then we have to take either an implementation class or Anonymous Inner class.

-->If we take implementation class as an alternative then it may allow its own data a part from the data Declared in interface and implementation class object should have its own identity instead of interface identity.

-->If we want to create an object with only interface identity and to allow only interface data we have to use Anonymous inner class as an alternative.

-->In jdbc applications getConnection() method will return connection object by returning anonymous

Inner class object of connection interface.

**NOTE:** To create connection object taking an implementation class or anonymous inner class is Completely depending on the Driver Implementation.

### Create either Statement or PreparedStatement or CallableStatement objects as per the requirement:

As part of the Jdbc applications after establish the connection between Java application and Database.

We have to prepare SQL Queries,we have to transfer SQL Queries to the databaseEngine and we have to

make Database Engine to execute SQL Queries.

-->To write and execute SQL Queries we have to use same predefined library from Statement prepared Statement and callableStatement.

-->To use the above required predefined library we have to prepare either Statement or preparedStatement or CallableStatement objects.

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Q) What is the difference between Statement, PreparedStatement and Callable Statement Objects.

**Ans:**

- > In Jdbc applications when we have a requirement to execute all the SQL Queries independently we have to use Statement.
- > In jdbc applications when we have a requirement to execute the same SQL Query in the next Sequence where to improve the performance of JDBC application we will use prepared Statement.
- > In jdbc applications when we have a requirement to access stored procedures and functions available At Database from Java application we will use Callable Statement object.
- > To prepare Statement object we have to use the following method from Connection.

Public Statement createStatement()

**EX:** Statement st=con.createStatement();

Where createStatement() method will return Statement object by creating Statement interfaces Anonymous inner class object.

**Write and execute SQL Queries:**

1. ExecuteQuery()
2. ExecuteUpdate()
3. Execute()

Q) What are the differences between executeQuery(), executeUpdate() and execute() method?

**Ans:** Where executeQuery() method can be used to execute “selection group SQL Queries” in order to fetch(retrieve) data from Database.

- > when JVM encounter executeQuery() method with selection group SQL query then JVM will pickup Selection group SQL Query, send to JdbcOdbcDriver, it will send to connection. Now connection will carry that SQL Query to the database engine through Odbc Driver.
- > At database database engine will execute the selection group SQL Query by performing Query Tokenization, Query parsing, Query optimization and Query Execution.
- > By the execution of selection group SQL Query database engine will fetch the data from database and return to Java Application.

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-->As Java technology is pure object oriented,Java application will store the fetched data in the form of an object at heap memory called as “ResultSet”.

-->As per the predefined implementation of executeQuery method JVM will return the generated ResultSet object reference as return value from executeQuery() method.

Public ResultSet executeQuery(String sql\_Query) throws SQLException

**EX:** ResultSet rs=st.executeQuery("select \* from emp1");

-->where executeUpdate() method can be used to execute updation group SQLQueries in order to Perform the database operations like create,insert,update,delete,Drop....

-->when JVM encounter updation group SQL Query with executeUpdate() method the JVM will pickup That Sql Query and send to Database through Database connection. At Database side Database engine Will execute it,perform updation from Database,identify rowCount value (number of records got updated) and return to Java application.

-->As per the predefined implementation of executeUpdate() method JVM will return row count value From executeUpdate() method.

Public int executeUpdate(String sql\_Query) throws Exception

**EX:** int rowCount=st.executeUpdate("update emp1 set esal=esal+500 where esal<1000");

-->In Jdbc applications execute() method can be used to execute both selection group and updation Group SQL Queries.

-->when JVM encounter selection group SQL Query with execute() method then JVM will send selection Group SQL Query to database engine,where database engine will execute it and send back the fetched Data to Java Application.

-->In Java application ResultSet object will be created with the fetched data but as per the predefined implementation of execute() method JVM will return “true” as a Boolean value.

-->when JVM encounter updation group SQL Query as parameter to execute() method then JVM Will send it to the database engine,where database engine will perform updations on database and return row Count value to Java application.But as per the predefined implementation of execute() method JVM will return “false” as Boolean value from execute() method  
public Boolean execute(String sql\_Query) throws SQLException.

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**EX:**

```
boolean b1=st.execute ("select * from emp1");

boolean b2=st.execucte("update emp1 set esal=esal+500 where esal<10000");
```

**Close the connection:**

In Jdbc applications after the database logic it is convention to close Database connection for this we have to used the following method.

```
Public void close() throws SQLException
```

**EX:**con.close();

**JdbcApp1:** The following example demonstrate how to create a table on Database through a JDBC application by taking table name as Dynamic input.

```
//import section
import java.sql.*;
import java.io.*;
class JdbcApp1{
    public static void main(String args[]) throws Exception{

        //load a register driver

        Class.forName("sun.jdbc.odbc.JdbcOdbcDriver");

        //establish connection between Java application and database
        Connection con=DriverManager.getConnection("jdbc:odbc:nag","system","durga");

        //prepare Statement
        Statement st=con.createStatement();

        //create BufferedReader
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));

        //take table name as dynamic input

        System.out.println("Enter table name");
```

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```
String tname=br.readLine();

//prepare SQLQuery

String sql="create table " + tname + "(eno number,ename varchar2(10),esal number)";

//execute SQL Query

st.executeUpdate(sql);

System.out.println("table created successfully");

//close the connection

con.close();

}}
```

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**JdbcApp2:** The following example demonstrates how to insert no.of records on database table by taking records data as dynamic input.

```
import java.io.*;
import java.sql.*;
public class JdbcApp2 {
    public static void main(String[] args) throws Exception {
        Class.forName("oracle.jdbc.OracleDriver");
        Connection con=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:xe","system","durga");
        Statement st=con.createStatement();
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
        while(true)
        {
            System.out.print("Employee Number :");
            int eno=Integer.parseInt(br.readLine());
            System.out.print("Employee Name :");
            String ename=br.readLine();
            System.out.print("Employee Salary :");
            float esal=Float.parseFloat(br.readLine());
            System.out.print("Employee Address :");
            String eaddr=br.readLine();

            st.executeUpdate("insert into emp1 values("+eno+","+ename+","+esal+","+eaddr+ ")");
            System.out.println("Employee Inserted Successfully");
            System.out.print("Onemore Employee[Yes/No]? :");
            String option=br.readLine();
            if(option.equals("No"))
            {
                break;
            }
        }
        con.close();
    }
}
```

In Jdbc applications if we want to used Type1 driver provided by sun micro systems then we have to use the following Driver class and URL

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**driver.class:sun.jdbc.odbc.JdbcOdbcDriver**

**url:jdbc:odbc:dsnName**

-->Similarly if we want to use Type4 Driver provided by oracle we have to use the following Driver class and URL

**driver\_class:oracle.jdbc.driver.OracleDriver**

**url:jdbc:oracle:thin:@localhost:1521:xe**

-->Oracle Driver is a class provided by oracle software in the form of Ojdbc14.jar file

-->Oracle Software has provided ojdbc14.jar file at the following location

**C:\oracleexe\app\oracle\product\10.2.0\server\jdbc\lib\ojdbc.jar**

-->If we want to use Type4 Driver provided by oracle in our Jdbc applications we have to set classpath environment variable to the location where we have ojdbc14.jar

D:\jdbc4>set

classpath=%classpath%;C:\oracleexe\app\oracle\product\10.2.0\server\jdbc\lib\ojdbc14.jar

### **JdbcApp3: The following example Demonstrate how to perform updations on Database table through Jdbc Application**

```
import java.io.*;
import java.sql.*;
public class JdbcApp3 {
    public static void main(String[] args) throws Exception {
        //Class.forName("oracle.jdbc.OracleDriver");
        Connection con=DriverManager.getConnection
        ("jdbc:oracle:thin:@localhost:1521:xe","system","durga");
        Statement st=con.createStatement();
        BufferedReader br=new BufferedReader(new InputStreamReader(System.in));
        System.out.print("Bonus Amount :");
        int bonus_Amt=Integer.parseInt(br.readLine());
        System.out.print("Salary Range :");
        float sal_Range=Float.parseFloat(br.readLine());
        int rowCount=st.executeUpdate
        ("update emp1 set esal=esal+"+bonus_Amt+" where esal<"+sal_Range);
        System.out.println("Employees Updated :"+rowCount);
        con.close();
    }
}
```

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**JdbcApp4: The following example demonstrates how to delete no.of records from database table through a Jdbc application**

```
import java.io.*;
import java.sql.*;
public class JdbcApp4 {
    public static void main(String[] args) throws Exception {
        DriverManager.registerDriver(new oracle.jdbc.OracleDriver());
        Connection con = DriverManager.getConnection
        ("jdbc:oracle:thin:@localhost:1521:xe", "system", "durga");
        Statement st = con.createStatement();
        BufferedReader br = new BufferedReader(new InputStreamReader(System.in));
        System.out.print("Salary Range :");
        float sal_Range = Float.parseFloat(br.readLine());
        int rowCount = st.executeUpdate("delete from emp1 where esal<" + sal_Range);
        System.out.println("Records Deleted :" + rowCount);
        con.close();
    }
}
```

-->In jdbc application we will use executeUpdate() method to execute the Updation group SQL queries like create,insert,update,delete,drop,alter and so on.

-->If we execute the SQL Queries like insert,update and delete then really some no.of record will be updated on database table then that number will be return as rowCount value from executeUpdate().

-->If we execute the SQL Queries like create,alter,drop with executeUpdate() method then records manipulation is not available on database,in this context the return value from executeUpdate() method is completely depending on the type of Driver which we used in JDBC application.

-->In the above context if we use type1 Driver provided by SunMicroSystems the executeUpdate() method will return "-1" as rowCount value.

-->For the above requirement if we use Type4 Driver provided by oracle then executeUpdate() method will return "0" as rowCount value

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**JdbcApp5:**

```
import java.sql.*;  
public class JdbcApp5 {  
    public static void main(String[] args) throws Exception {  
        Class.forName("sun.jdbc.odbc.JdbcOdbcDriver");  
        Connection con=DriverManager.getConnection("jdbc:odbc:nag", "system", "durga");  
        Statement st=con.createStatement();  
        int rowCount1=st.executeUpdate("create table emp1(eno number)");  
        System.out.println(rowCount1);  
        int rowCount2=st.executeUpdate("drop table emp1");  
        System.out.println(rowCount2);  
        con.close();  
    }  
}
```

**JdbcApp6:**

```
import java.sql.*;  
public class JdbcApp6 {  
    public static void main(String[] args) throws Exception {  
        Class.forName("oracle.jdbc.OracleDriver");  
        Connection con=DriverManager.getConnection("jdbc:oracle:thin:@localhost:1521:xe", "system", "durga");  
        Statement st=con.createStatement();  
        int rowCount1=st.executeUpdate("create table emp1(eno number)");  
        System.out.println(rowCount1);  
        int rowCount2=st.executeUpdate("drop table emp1");  
        System.out.println(rowCount2);  
        con.close();  
    }  
}
```

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