COURSE CODE	COURSE TITLE	L	T	P	C
1151CS117	JAVA PROGRAMMING	3	0	0	3

Course Category: Program Core

A. Preamble:

Most of the software needs to develop an application which runs in cross platform. Java is the one of the pioneer software tool used for cross platform development software. Java is the most dominant software to develop web applications and distributed applications. This course provides basic concepts about Object Oriented Programming, Java Packages, Exceptions, Database connectivity, Networking, AWT and Java Servlets. After successful completion of this course learners can able to develop software modules for real world problem.

B. Pre-requisites:

Sl No	Course Code	Course Name
1	1150CS201	Problem Solving using C

C. Related Courses:

Sl No	Course Code	Course Name
1	1151CS201	Mobile Application & Development
2	1151CS117	Internet Programming

D. Course Outcomes:

Students undergoing this course are able to:

CO Nos	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To design problem solutions using Object Oriented Programming (OOP) techniques and to familiarize the Java fundamentals.	K2
CO2	Apply the concepts of java packages, inheritance and exception handling mechanisms for problem solutions.	K2
CO3	Demonstrate I/O Streams, Strings, Collections and Threads concepts.	K3
CO4	To develop simple applications using GUIs and event driven programming.	K2
CO5	Implement the database connectivity and to familiarize the advanced java programming skills and develop java based web applications.	K3

E. Correlation of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	M		M	M								
CO3	M											
CO4	M		M	L	M							
CO5	M		M	M	M							

H- High; M-Medium; L-Low

F. Course content:

UNIT I BASICS OF JAVA **9**

Introduction to object oriented programming - Features of Java - JVM- Keywords- Variables - Data types – Operators - Control statements - Classes and Methods - Objects – Access specifiers- Constructors - Method Overloading - Type Casting - this keyword- Static - Arrays.

UNIT II PACKAGE, INHERITANCE AND EXCEPTION HANDLING **9**

Package Access - Java API Packages -Basics of Inheritance - Forms of Inheritance - Sub Classes and Subclass Types -Super keyword – Final - Method Overriding - Abstract Classes - Interfaces.

Exception Handling: Java Exception Hierarchy - Exception Types - Throwing and Catching exceptions - Declaring New Exception Types.

UNIT III I/O STREAMS, STRINGS AND COLLECTIONS **9**

Character Streams - Stream I/O - Serialization – Files – String Class - String handling - java. util. Collections - Collections Frameworks - Generic Classes and Methods.

UNIT IV AWT AND THREADS **9**

Applets: Basics of applets - Applet Architecture - Life cycle of an Applet – AWT : Event Handling-Delegation event Model.

Threads: Thread priority - Thread operations - Thread states – Thread Synchronization - Basics of Java Networking.

UNIT V: JDBC AND SERVLET **9**

JDBC: JDBC Architecture - JDBC Drivers- Database connectivity in Java- HTML basics - JavaScript basics.

Servlets: Servlet Architecture - Life cycle of a Servlet - The Servlet API- Handling HTTP Request and Response- Cookies - Session Tracking-Overview of JSP.

TOTAL: 45

G. Learning Resources

i. Text Books

1. Herbert Schildt, "Java The Complete Reference", Ninth edition, Tata Mc-Graw Hill ,2014.
2. Cay S. Horstmann and Gary Cornell , "Java: Core Java 2 Vol. 1 : Fundamentals", Sun Microsystems Press, Seventh Edition .

ii. Reference Books

1. H.M.Deitel and P.J.Deitel ,"Java How to Program" , Pearson Prentice Hall Seventh Edition.
2. E. Balaguruswamy, "Programming in java" , Fourth Edition, Tata McGraw Hill,2010
3. Jason Hunter, William Crawford ,"Java Servlet Programming" , Second Edition, O'Reilly
4. Kathy Sierra , Bert Bates: "Head First Java- A Learners Guide" ,Second Edition, O'Reilly
5. Kathy Sierra , Bert Bates , "SCJP- Sun certified programmer for Java 6 study Guide", Tata Mcgraw Hill.

iii. Digital Resources

1. http://www.w3schools.com/
2. https://www.javatpoint.com/
3. https://www.tutorialspoint.com/java/
4. https://www.sanfoundry.com/java-questions-answers-freshers-experienced/
5. http://codingbat.com/java/
6. https://www.w3resource.com/java-tutorial/

UNIT I BASICS OF JAVA

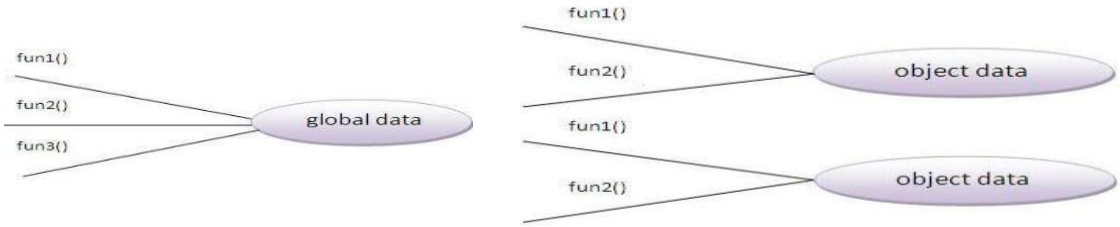
Introduction to object oriented programming - Features of Java - JVM- Keywords- Variables - Data types – Operators - Control statements - Classes and Methods - Objects – Access specifiers- Constructors - Method Overloading - Type Casting - this keyword- Static - Arrays.

Advantage of OOPs over Procedure-oriented programming language

1)OOPs makes development and maintenance easier where as in Procedure-oriented programming language it is not easy to manage if code grows as project size grows.

2)OOPs provides data hiding whereas in Procedure-oriented programming language a global data can be accessed from anywhere.

3)OOPs provides ability to simulate real-world event much more effectively. We can provide the solution of real word problem if we are using the Object-Oriented Programming language.



1.1 Introduction to object oriented programming

Object-oriented programming System(OOPs) is a programming paradigm based on the concept of "objects" that contain data and methods. The primary purpose of object-oriented programming is to increase the flexibility and maintainability of programs. Object oriented programming brings together data and its behaviour(methods) in a single location(object) makes it easier to understand how a program works.

Object Oriented Programming is a paradigm that provides many concepts such as **inheritance**, **data binding**, **polymorphism** etc. The programming paradigm where everything is represented as an object, is known as truly object-oriented programming language.

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

- Object
- Class
- Inheritance
- Polymorphism
- Abstraction
- Encapsulation
- Association Aggregation composition

Object

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

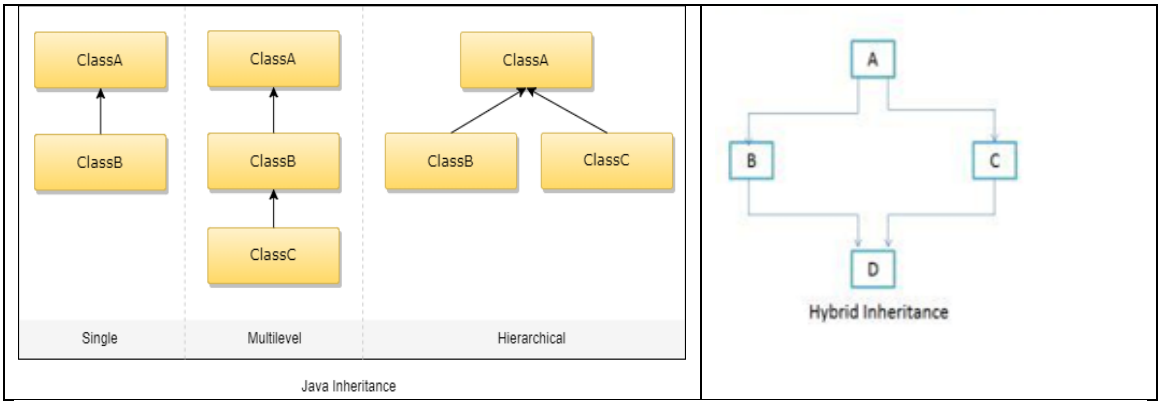
Class

A *class* is simply a representation of a type of *object*. It is the blueprint, or plan, or template, that describes the details of an *object*. A class is the blueprint from which the individual objects are created. *Class* is composed of three things: a name, attributes, and operations.

Inheritance

The process by which one class acquires the properties and functionalities of another class is called inheritance. Inheritance provides the idea of reusability of code and each sub class defines only those features that are unique to it, rest of the features can be inherited from the parent class.

1. Inheritance is a process of defining a new class based on an existing class by extending its common data members and methods.
2. Inheritance allows us to reuse of code, it improves reusability in your java application.
3. The parent class is called the **base class** or **super class**. The child class that extends the base class is called the derived class or **sub class** or **child class**.



Polymorphism

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

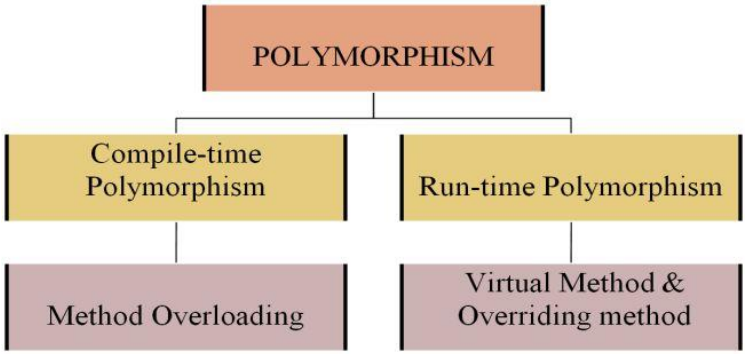
In java, we use method overloading and method overriding to achieve polymorphism.

Polymorphism principal is divided into two sub principal they are:

- Static or Compile time polymorphism
- Dynamic or Runtime polymorphism

Static polymorphism in Java is achieved by method overloading and Dynamic polymorphism in Java is achieved by method overriding

Note: Java programming does not support static polymorphism because of its limitations and java always supports dynamic polymorphism



Abstraction

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

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

Encapsulation

A class is kind of a container or capsule or a cell, which encapsulate a set of methods, attribute and properties to provide its indented functionalities to other classes. In that sense, encapsulation also allows a class to change its internal implementation without hurting the overall functioning of the system. That idea of encapsulation is to hide how a class does its business, while allowing other classes to make requests of it.

Binding (or wrapping) code and data together into a single unit is known as encapsulation. For example: capsule, it is wrapped with different medicines.

A java class is the example of encapsulation. Java bean is the fully encapsulated class because all the data members are private here. Object based programming language follows all the features of OOPs except Inheritance. JavaScript and VBScript are examples of object based programming languages.

Association is a *has-a* relationship between two classes where there is no particular ownership in place. It is just the connectivity between the two classes. When you define a variable of one class in another class, you enable first to associate functions and properties of the second class. Then again both **Aggregation** and **Composition** are types of **Association**.

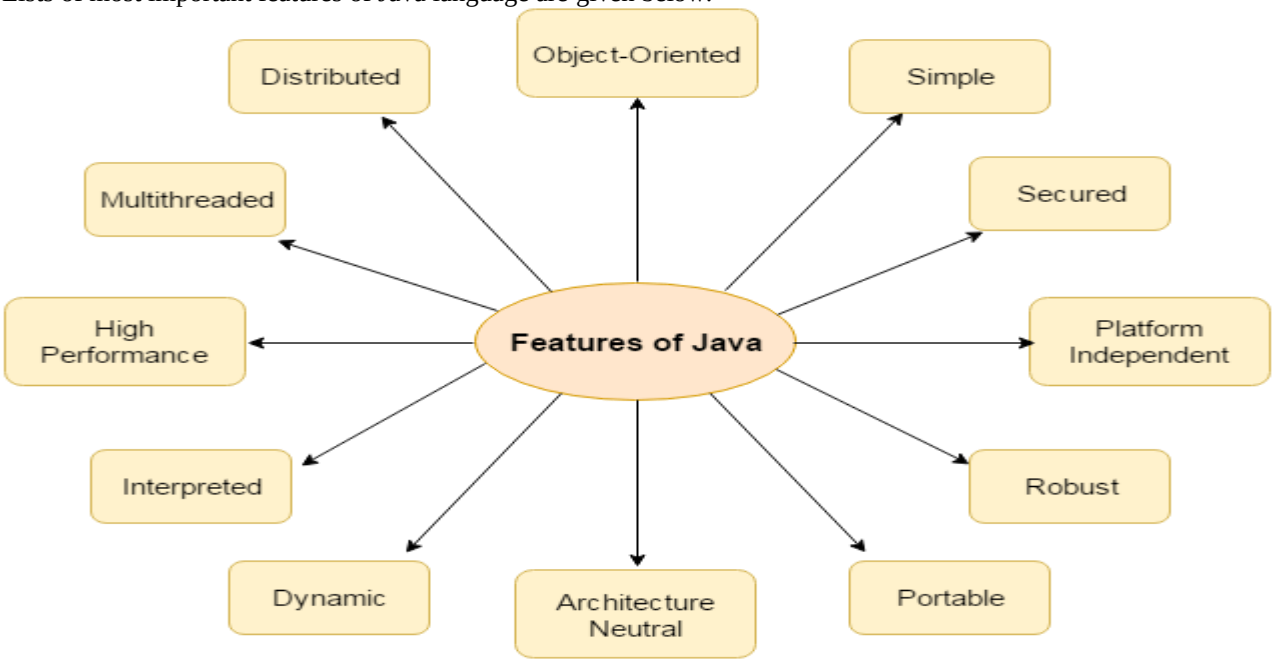
Aggregation is a *weak* type of **Association** with *partial* ownership. For an **Aggregation** relationship, we use the term *uses* to imply a *weak* *has-a* relationship. This is weak compared to Composition. Then again, weak meaning the linked components of the aggregator may survive the aggregations life-cycle without the existence of their parent objects. For example, a school department *uses* teachers. Any teacher may belong to more than one department. And so, if a department ceases to exist, the teacher will still exist.

Composition is a *strong* type of **Association** with *full* ownership. This is strong compared to the weak Aggregation. For a **Composition** relationship, we use the term *owns* to imply a *strong* *has-a*relationship. For example, a department *owns* courses, which means that the any course's life-cycle depends on the department's life-cycle. Hence, if a department ceases to exist, the underlying courses will cease to exist as well.

1.2 Features of Java

The main objective of Java programming language creation was to make it portable, simple and secure programming language. Apart from this, there are also some awesome features which play important role in the popularity of this language. The features of Java are also known as java *buzzwords*.

Lists of most important features of Java language are given below.



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

Simple

Java is very easy to learn and its syntax is simple, clean and easy to understand. According to Sun, Java language is a simple programming language because:

- Java syntax is based on C++ (so easier for programmers to learn it after C++).
- Java has removed many confusing and rarely-used features e.g. explicit pointers, operator overloading etc.
- There is no need to remove unreferenced objects because there is Automatic Garbage Collection in java.

Object-oriented

Java is object-oriented programming language. Everything in Java is an object. Object-oriented means we organize our software as a combination of different types of objects that incorporates both data and behavior. Object-oriented programming (OOPs) is a methodology that simplifies software development and maintenance by providing some rules.

Basic concepts of OOPs are:

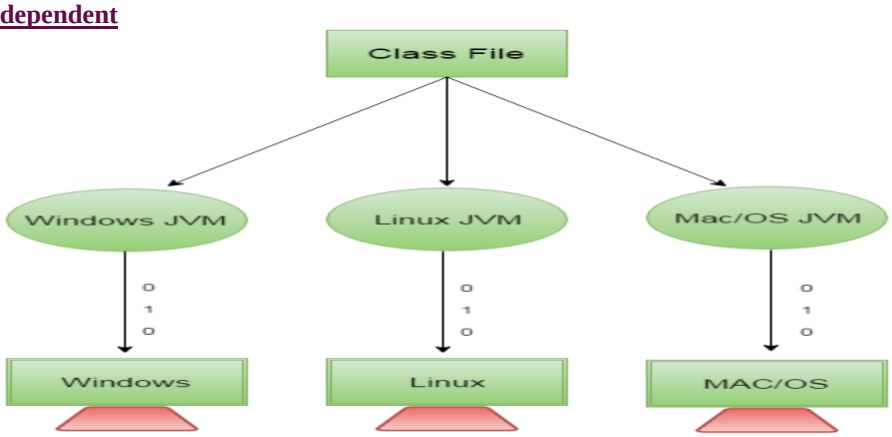
1. Object

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

Portable

Java is portable because it facilitates you to carry the java bytecode to any platform. It doesn't require any type of implementation.

Platform Independent



Java is platform independent because it is different from other languages like C, C++ etc. which are compiled into platform specific machines while Java is a write once, run anywhere language. A platform is the hardware or software environment in which a program runs.

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

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

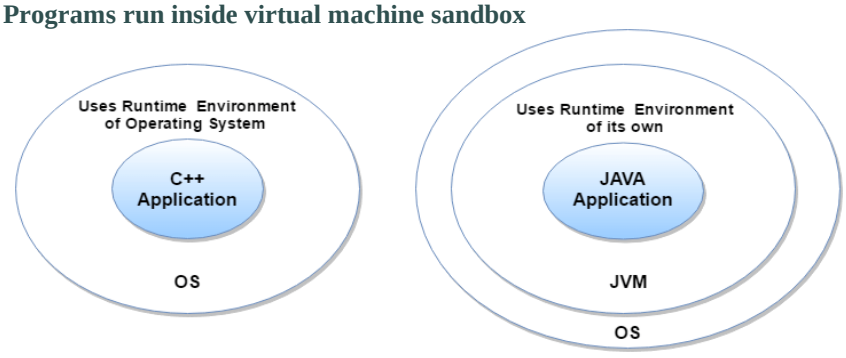
1. Runtime Environment
2. API(Application Programming Interface)

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

Secured

Java is best known for its security. With Java, we can develop virus-free systems. Java is secured because:

- **No explicit pointer**
- **Java Programs run inside virtual machine sandbox**



- **Classloader:** Classloader in Java is a part of the Java Runtime Environment(JRE) which is used to dynamically load Java classes into the Java Virtual Machine. It adds security by separating the package for the classes of the local file system from those that are imported from network sources.
- **Bytecode Verifier:** It checks the code fragments for illegal code that can violate access right to objects.
- **Security Manager:** It determines what resources a class can access such as reading and writing to the local disk.

These security are provided by java language. Some security can also be provided by application developer through SSL, JAAS, Cryptography etc.

Robust

Robust simply means strong. Java is robust because:

- It uses strong memory management.
- There is lack of pointers that avoids security problems.
- There is automatic garbage collection in java which runs on the Java Virtual Machine to get rid of objects which are not being used by a Java application anymore.
- There is exception handling and type checking mechanism in java. All these points makes java robust.

Architecture-neutral

Java is architecture neutral because there is no implementation dependent features e.g. size of primitive types is fixed.

In C programming, int data type occupies 2 bytes of memory for 32-bit architecture and 4 bytes of memory for 64-bit architecture. But in java, it occupies 4 bytes of memory for both 32 and 64 bit architectures.

High-performance

Java is faster than other traditional interpreted programming languages because Java bytecode is "close" to native code. It is still a little bit slower than a compiled language (e.g. C++). Java is an interpreted language that is why it is slower than compiled languages e.g. C, C++ etc.

Distributed

Java is distributed because it facilitates users to create distributed applications in java. RMI and EJB are used for creating distributed applications. This feature of Java makes us able to access files by calling the methods from any machine on the internet.

Multi-threaded

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

Dynamic

Java is a dynamic language. It supports dynamic loading of classes. It means classes are loaded on demand. It also supports functions from its native languages i.e. C and C++.

Java supports dynamic compilation and automatic memory management (garbage collection).

1. 3 JVM

JVM (Java Virtual Machine)

1. Java Virtual Machine
2. Internal Architecture of JVM

JVM (Java Virtual Machine) is an abstract machine. It is a specification that provides runtime environment in which java bytecode can be executed.

JVMs are available for many hardware and software platforms (i.e. JVM is platform dependent).

What is JVM

1. **A specification** where working of Java Virtual Machine is specified. But implementation provider is independent to choose the algorithm. Its implementation has been provided by Sun and other companies.
2. **An implementation.** Its implementation is known as JRE (Java Runtime Environment).
3. **Runtime Instance** Whenever you write java command on the command prompt to run the java class, an instance of JVM is created.

What it does

The JVM performs following operation:

- Loads code
- Verifies code
- Executes code
- Provides runtime environment

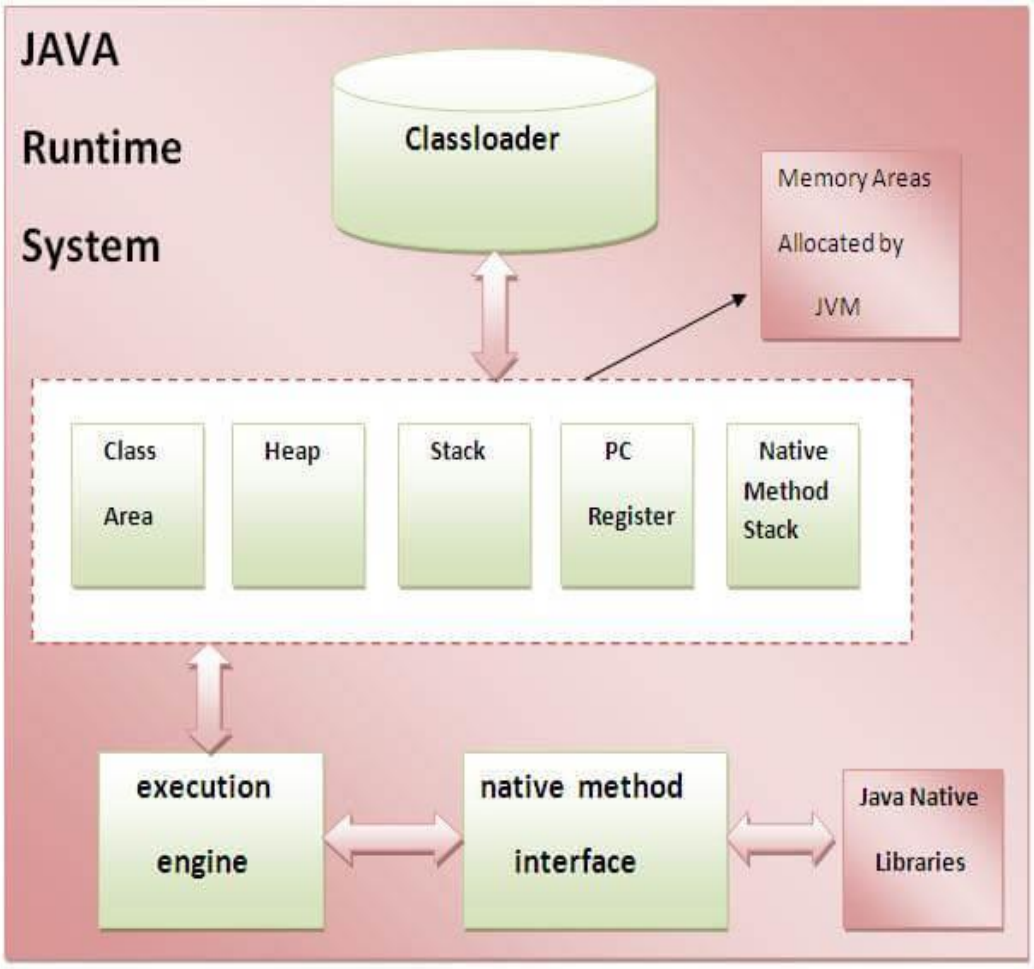
JVM provides definitions for the:

- Memory area
- Class file format
- Register set

- Garbage-collected heap
- Fatal error reporting etc.

Internal Architecture of JVM

Let's understand the internal architecture of JVM. It contains classloader, memory area, execution engine etc.



1) Classloader

Classloader is a subsystem of JVM that is used to load class files.

2) Class(Method) Area

Class(Method) Area stores per-class structures such as the runtime constant pool, field and method data, the code for methods.

3) Heap

It is the runtime data area in which objects are allocated.

4) Stack

Java Stack stores frames. It holds local variables and partial results, and plays a part in method invocation and return.

Each thread has a private JVM stack, created at the same time as thread.

A new frame is created each time a method is invoked. A frame is destroyed when its method invocation completes.

5) Program Counter Register

PC (program counter) register contains the address of the Java virtual machine instruction currently being executed.

6) Native Method Stack

It contains all the native methods used in the application.

7) Execution Engine

It contains:

1) A virtual processor

2) Interpreter: Read bytecode stream then execute the instructions.

3) Just-In-Time(JIT) compiler: It is used to improve the performance. JIT compiles parts of the byte code that have similar functionality at the same time, and hence reduces the amount of time needed for compilation. Here, the term "compiler" refers to a translator from the instruction set of a Java virtual machine (JVM) to the instruction set of a specific CPU.

1.4 Keywords

Keywords are words that have already been defined for Java compiler. They have special meaning for the compiler. Java Keywords must be in your information because it cannot be used as a variable, class or a method name.

abstract	continue	for	new	switch
assert	default	goto	package	synchronized
boolean	do	if	private	this
break	double	implements	protected	throw
byte	else	import	public	throws
case	enum	instanceof	return	transient
catch	extends	int	short	try
char	final	interface	static	void
class	finally	long	strictfp	volatile
const	float	native	super	while

1.5 Java Variables

A variable is a container which holds the value while the java program is executed. A variable is assigned with a datatype. Variable is a name of memory location. There are three types of variables in java: local, instance and static. There are two types of data types in java: primitive and non-primitive.

Variable

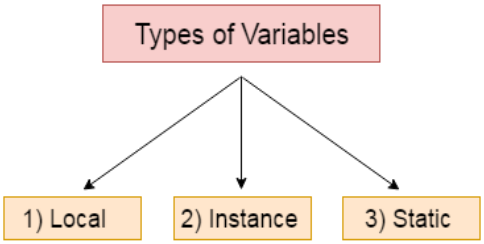
Variable is name of *reserved area allocated in memory*. In other words, it is a *name of memory location*. It is a combination of "vary + able" that means its value can be changed.

1. `int data=50;//Here data is variable`

Types of Variable

There are three types of variables in java:

- local variable
- instance variable
- static variable



1) Local Variable

A variable declared inside the body of the method is called local variable. You can use this variable only within that method and the other methods in the class aren't even aware that the variable exists.

A local variable cannot be defined with "static" keyword.

2) Instance Variable

A variable declared inside the class but outside the body of the method, is called instance variable. It is not declared as static. It is called instance variable because its value is instance specific and is not shared among instances.

3) Static variable

A variable which is declared as static is called static variable. It cannot be local. You can create a single copy of static variable and share among all the instances of the class. Memory allocation for static variable happens only once when the class is loaded in the memory.

Example to understand the types of variables in java

```
class A{
int data=50;//instance variable
static int m=100;//static variable
void method(){
int n=90;//local variable
}
}//end of class
```

Java Variable Example: Add Two Numbers

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

int a=10;
int b=10;
int c=a+b;
System.out.println(c);
}}
```

Output:

```
20
```

Java Variable Example: Widening

```
class Simple{
public static void main(String[] args)
{  int a=10;float f=a;
System.out.println(a);
System.out.println(f);
}}
```

Output:

```
10
10.0
```

Java Variable Example: Narrowing (Typecasting)

```
class Simple{
public static void main(String[] args
){ float f=10.5f;
//int a=f;//Compile time error
int a=(int)f;
System.out.println(f);
System.out.println(a);
}}
```

Output:

```
10.5
10
```

Java Variable Example: Overflow

```
class Simple{
public static void main(String[] ar
gs){
//Overflow
int a=130;
byte b=(byte)a;
System.out.println(a);
System.out.println(b);
}}
```

Output:

```
130
-126
```

Java Variable Example: Adding Lower Type

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

byte a=10;
byte b=10;
//byte c=a+b;//Compile Time Error: bec
ause a+b=20 will be int
byte c=(byte)(a+b);
System.out.println(c);
}}
```

Output:

```
20
```

1.6 Data Types in Java

Data types specify the different sizes and values that can be stored in the variable. There are two types of data types in Java:

1. **Primitive data types:** The primitive data types include Integer, Character, Boolean, and Floating Point.
2. **Non-primitive data types:** The non-primitive data types include Classes, Interfaces, and Arrays.

Java Primitive Data Types

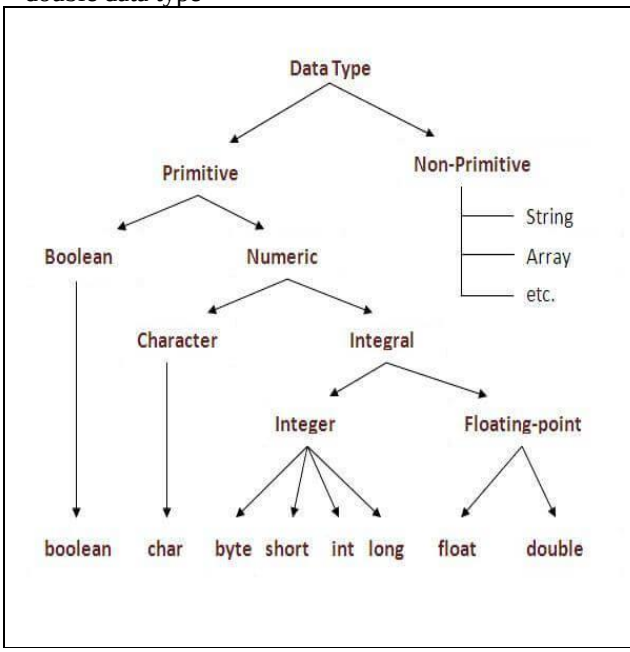
In Java language, primitive data types are the building blocks of data manipulation. These are the most basic data types available in Java language.

Java is a statically-typed programming language. It means, all variables must be declared before its use. That is why we need to declare variable's type and name.

There are 8 types of primitive data types:

- boolean data type
- byte data type
- char data type
- short data type
- int data type
- long data type
- float data type

- double data type



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

Boolean Data Type

The Boolean data type is used to store only two possible values: true and false. This data type is used for simple flags that track true/false conditions.

The Boolean data type specifies one bit of information, but its "size" can't be defined precisely.

Example: Boolean one = false

Byte Data Type

The byte data type is an example of primitive data type. It isan 8-bit signed two's complement integer. Its value-range lies between -128 to 127 (inclusive). Its minimum value is -128 and maximum value is 127. Its default value is 0.

The byte data type is used to save memory in large arrays where the memory savings is most required. It saves space because a byte is 4 times smaller than an integer. It can also be used in place of "int" data type.

Example: byte a = 10, byte b = -20

Short Data Type

The short data type is a 16-bit signed two's complement integer. Its value-range lies between -32,768 to 32,767 (inclusive). Its minimum value is -32,768 and maximum value is 32,767. Its default value is 0.

The short data type can also be used to save memory just like byte data type. A short data type is 2 times smaller than an integer.

Example: short s = 10000, short r = -5000

Int Data Type

The int data type is a 32-bit signed two's complement integer. Its value-range lies between - 2,147,483,648 (-2^31) to 2,147,483,647 (2^31 -1) (inclusive). Its minimum value is - 2,147,483,648and maximum value is 2,147,483,647. Its default value is 0.

The int data type is generally used as a default data type for integral values unless if there is no problem about memory.

Example: int a = 100000, int b = -200000

Long Data Type

The long data type is a 64-bit two's complement integer. Its value-range lies between -9,223,372,036,854,775,808(-2^63) to 9,223,372,036,854,775,807(2^63 -1)(inclusive). Its minimum value is -9,223,372,036,854,775,808and maximum value is 9,223,372,036,854,775,807. Its default value is 0. The long data type is used when you need a range of values more than those provided by int.

Example: long a = 100000L, long b = -200000L

Float Data Type

The float data type is a single-precision 32-bit IEEE 754 floating point.Its value range is unlimited. It is recommended to use a float (instead of double) if you need to save memory in large arrays of floating point numbers. The float data type should never be used for precise values, such as currency. It is generally used as the default data type for decimal values. Its default value is 0.0d.

Example: float f1 = 234.5f

Double Data Type

The double data type is a double-precision 64-bit IEEE 754 floating point. Its value range is unlimited. The double data type is generally used for decimal values just like float. The double data type also should never be used for precise values, such as currency.Its default value is 0.0d.

Example: double d1 = 12.3

Char Data Type

The char data type is a single 16-bit Unicode character. Its value-range lies between '\u0000' (or 0) to '\uffff' (or 65,535 inclusive).The char data type is used to store characters.

Example: char letterA = 'A'

Why char uses 2 byte in java and what is \u0000 ?

It is because java uses Unicode system not ASCII code system. The \u0000 is the lowest range of Unicode system.

1.7 Operators in java

Operator in java is a symbol that is used to perform operations. For example: +, -, *, / etc.

There are many types of operators in java which are given below:

- Unary Operator,
- Arithmetic Operator,
- Shift Operator,
- Relational Operator,
- Bitwise Operator,
- Logical Operator,
- Ternary Operator and
- Assignment Operator.

Java Operator Precedence

Operator Type	Category	Precedence
Unary	postfix	*expr*++ *expr*--
	prefix	++*expr* --*expr* +*expr* -*expr* ~ !
Arithmetic	multiplicative	* / %
	additive	+ -
Shift	shift	<< >> >>>
Relational	comparison	< > <= >= instanceof
	equality	== !=
Bitwise	bitwise AND	&
	bitwise exclusive OR	^
	bitwise inclusive OR	|
Logical	logical AND	&&
	logical OR	||
Ternary	ternary	? :
Assignment	assignment	= += -= *= /= %= &= ^= |= <<= >>= >>>=

Java Unary Operator

The Java unary operators require only one operand. Unary operators are used to perform various operations i.e.:

- incrementing/decrementing a value by one
- negating an expression
- inverting the value of a boolean

Java Unary Operator Example: ++ and --

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

int x=10;
System.out.println(x++);//10 (11)
System.out.println(++x);//12
System.out.println(x--);//12 (11)
System.out.println(--x);//10
}}
```

Output:

```
10
12
12
10
```

Java Unary Operator Example 2: ++ and --

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=10;
System.out.println(a++ + ++a);//10+12=22
System.out.println(b++ + b++);//10+11=21
  }}
```

Output:

```
22
21
```

Java Unary Operator Example: ~ and !

```
class OperatorExample{
public static void main(String args[]){
int a=10;  int b=-10;
boolean c=true;  boolean d=false;
System.out.println(~a);//-11 (minus of total positive value which starts from 0)
System.out.println(~b);//9 (positive of total minus, positive starts from 0)
System.out.println(!c);//false (opposite of boolean value)
System.out.println(!d);//true
}}
```

Output:

```
-11
9
false
true
```

Java Arithmetic Operators

Java arithmatic operators are used to perform addition, subtraction, multiplication, and division. They act as basic mathematical operations.

Java Arithmetic Operator Example

```
class OperatorExample{
public static void main(String args[]){
int a=10;  int b=5;
System.out.println(a+b);//15
System.out.println(a-b);//5
System.out.println(a*b);//50
System.out.println(a/b);//2
System.out.println(a%b);//0      }}
```

Output:

```
15          5          50     2          0
```

Java Arithmetic Operator Example: Expression

```
class OperatorExample{
public static void main(String args[]){
System.out.println(10*10/5+3-1*4/2);
}}
```

Output:

```
21
```

Java Left Shift Operator

The Java left shift operator << is used to shift all of the bits in a value to the left side of a specified number of times.

Java Left Shift Operator Example

```
class OperatorExample{
public static void main(String args[]){  S
ystem.out.println(10<<2);
//10*2^2=10*4=40
System.out.println(10<<3);
//10*2^3=10*8=80
System.out.println(20<<2);
//20*2^2=20*4=80
System.out.println(15<<4);
//15*2^4=15*16=240
}}
```

Output:

```
40          80
80          240
```

Java Right Shift Operator Example

```
class OperatorExample{
public static void main(String args[]){
System.out.println(10>>2);
//10/2^2=10/4=2
System.out.println(20>>2);
//20/2^2=20/4=5
System.out.println(20>>3);
//20/2^3=20/8=2
}}
```

Output:

```
2       5       2
```

Java Shift Operator Example: >> vs >>>

```
class OperatorExample{
public static void main(String args[]){
   //For positive number, >> and >>> wor
ks same
   System.out.println(20>>2);
   System.out.println(20>>>2);
   //For negative number, >>> changes par
ity bit (MSB) to 0
System.out.println(-20>>2);
   System.out.println(-20>>>2);
}}
```

Output:

```
5          5
-5         1073741819
```

Java Right Shift Operator

The Java right shift operator >> is used to move left operands value to right by the number of bits specified by the right operand.

Java AND Operator Example: Logical && and Bitwise &

The logical && operator doesn't check second condition if first condition is false. It checks second condition only if first one is true.

The bitwise & operator always checks both conditions whether first condition is true or false.

```
class OperatorExample{
public static void main(String
args[]){
int a=10;
int b=5;
int c=20;
System.out.println(a<b&&a<c)
;//false && true = false
System.out.println(a<b&a<c);//
false & true = false
}}
```

Output:

```
false
false
```

Java AND Operator Example: Logical && vs Bitwise &

```
class OperatorExample{
public static void main(String args[])
{
int a=10;
int b=5;
int c=20;
System.out.println(a<b&&a++<c);//fa
lse && true = false
System.out.println(a);//10 because sec
ond condition is not checked
System.out.println(a<b&a++<c);//fals
e && true = false
System.out.println(a);//11 because sec
ond condition is checked
}}
```

Output:

```
false
10
false
11
```

```
class OperatorExample{
public static void main(String args[
]){
int a=10;
int b=5;
int c=20;
System.out.println(a>b||a<c);
//true || true = true
System.out.println(a>b|a<c);
//true | true = true  //|| vs |
System.out.println(a>b||a++<c);
//true || true = true
System.out.println(a);
//10 because second condition is not
 checked
System.out.println(a>b|a++<c);
//true | true = true
System.out.println(a);//11 because s
econd condition is checked
}}
```

Output:

```
true
true
true
10
true
11
```

Java OR Operator Example: Logical || and Bitwise |

The logical || operator doesn't check second condition if first condition is true. It checks second condition only if first one is false. The bitwise | operator always checks both conditions whether first condition is true or false.

Java Ternary Operator

Java Ternary operator is used as one liner replacement for if-then-else statement and used a lot in java programming. it is the only conditional operator which takes three operands.

Java Ternary Operator Example

```
class OperatorExample{
public static void main(String args[]){
int a=2;
int b=5;
int min=(a<b)?a:b;
System.out.println(min);
}}
```

Output:

```
2
```

Another Example:

```
class OperatorExample{
public static void main(String args[]){
int a=10;
int b=5;
int min=(a<b)?a:b;
System.out.println(min);
}}
```

Output:

```
5
```

Java Assignment Operator

Java assignment operator is one of the most common operator. It is used to assign the value on its right to the operand on its left.

Java Assignment Operator Example

```
class OperatorExample{
public static void main(String args[])
{
int a=10;
int b=20;
a+=4;//a=a+4 (a=10+4)
b-=4;//b=b-4 (b=20-4)
System.out.println(a);
System.out.println(b);
}}
```

Output:

```
14
16
```

Java Assignment Operator Example

```
class OperatorExample{
public static void main(String[] a
rgs){
int a=10;
a+=3;//10+3
System.out.println(a);
a-=4;//13-4
System.out.println(a);
a*=2;//9*2
System.out.println(a);
a/=2;//18/2
System.out.println(a);
}}
```

Output:

```
13
9
18
9
```

Java Assignment Operator Example: Adding short

```
class OperatorExample{
public static void main(String args[]){
short a=10;
short b=10;
//a+=b;//a=a+b internally so fine
a=a+b;//Compile time error because 10+10=
20 now int
System.out.println(a);
}}
```

Output:

```
Compile time error
```

After type cast:

```
class OperatorExample{
public static void main(String args[]){
short a=10;
short b=10;
a=(short)(a+b);//20 which is int now convert
ed to short
System.out.println(a);
}}
```

Output:

```
20
```

1.8 Control statements

Java If-else Statement

The Java *if statement* is used to test the condition. It checks boolean condition: *true* or *false*. There are various types of if statement in java.

- if statement
- if-else statement
- if-else-if ladder
- nested if statement

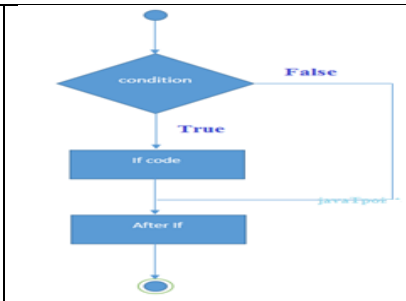
Java if Statement

The Java if statement tests the condition. It executes the *if block* if condition is true.

Syntax:

```
if(condition){
//code to be executed

}
```



Example:

```
public class IfExample {
public static void main(String[] args) {
   int age=20;
   if(age>18){
      System.out.print("Age is greater than 18");

   }
}
}
```

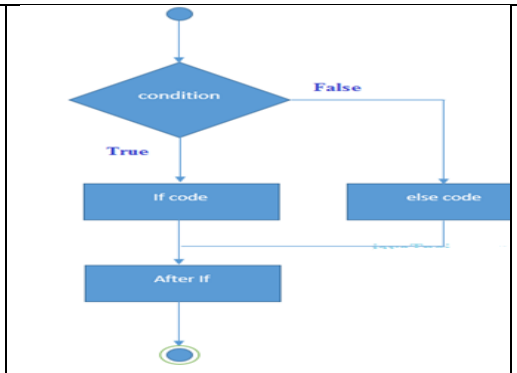
Output: Age is greater than 18

Java if-else Statement

The Java if-else statement also tests the condition. It executes the *if block* if condition is true otherwise *else block* is executed.

Syntax:

```
if(condition){
//code if condition is true
}else{
//code if condition is false
}
```



Example:

```
public class IfElseExample {
public static void main(String[] args)
{
   int number=13;
   if(number%2==0){
      System.out.println("even number
");
   }else{
      System.out.println("odd number"
);
   }
}
}
```

Output: odd number

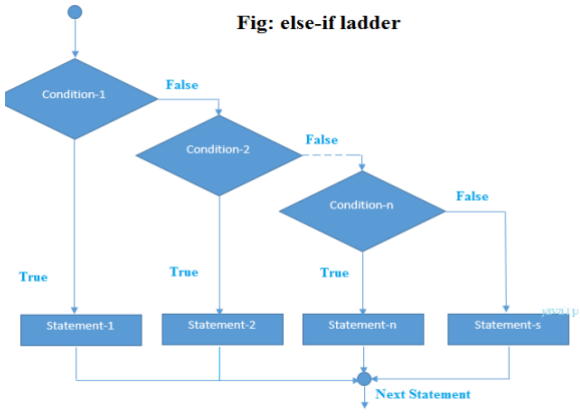
Java if-else-if ladder Statement

The if-else-if ladder statement executes one condition from multiple statements.

Syntax:

```
if(condition1){       //code to be executed if condition1 is true
}else if(condition2){     //code to be executed if condition2 is true
}
else if(condition3){     //code to be executed if condition3 is true
}
...
else{    //code to be executed if all the conditions are false  }
```

Fig: else-if ladder



Example:

```
public class IfElseIfExample {
public static void main(String[] args) {
   int marks=65;
      if(marks<50)
{        System.out.println("fail");     }
   else if(marks>=50 && marks<60)
{        System.out.println("D grade");     }
   else if(marks>=60 && marks<70)
{        System.out.println("C grade");     }
   else if(marks>=70 && marks<80)
{        System.out.println("B grade");     }
   else if(marks>=80 && marks<90)
{        System.out.println("A grade");     }
else if(marks>=90 && marks<100){
      System.out.println("A+ grade");
   }else{
      System.out.println("Invalid!");
  }  }   }
```

	Output: C grade

Java Switch Statement

The Java *switch statement* executes one statement from multiple conditions. It is like if-else-if ladder statement.

Syntax:

```
switch(expression){
case value1:
 //code to be executed;
 break;  //optional
case value2:
 //code to be executed;
 break;  //optional
.....
   default:
 code to be executed if all cases are not matched;
}
```

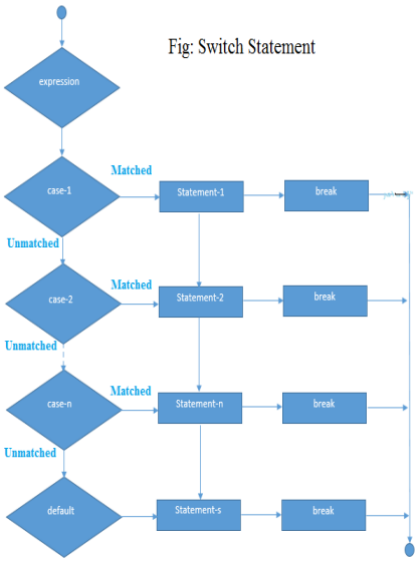


Fig: Switch Statement

Example:

```
public class SwitchExample {
public static void main(String[] args) {
   int number=20;
   switch(number){
   case 10: System.out.println("10");
break;
   case 20: System.out.println("20");
break;
   case 30: System.out.println("30");
break;
   default:System.out.println("Not in 10, 20 or 30");
   }
}
}
```

Output:
20

Java Switch Statement is fall-through

The java switch statement is fall-through. It means it executes all statement after first match if break statement is not used with switch cases.

Example:

```
public class SwitchExample2 {
public static void main(String[] args) {
   int number=20;
   switch(number){
   case 10: System.out.println("10");
   case 20: System.out.println("20");
   case 30: System.out.println("30");
   default:System.out.println("Not in 10, 20 or 30");
   }
}
}
```

Output:
20
30
Not in 10, 20 or 30

Loops in Java

In programming languages, loops are used to execute a set of instructions/functions repeatedly when some conditions become true. There are three types of loops in java.

- for loop
- while loop
- do-while loop

Java For Loop

The Java *for loop* is used to iterate a part of the program several times. If the number of iteration is fixed, it is recommended to use for loop.

There are three types of for loops in java.

- Simple For Loop
- For-each or Enhanced For Loop
- Labeled For Loop

Java Simple For Loop

The simple for loop is same as C/C++. We can initialize variable, check condition and increment/decrement value.

Syntax:

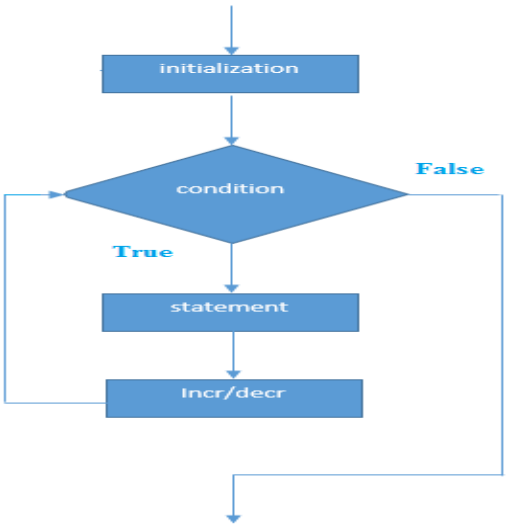
```
for(initialization;condition;incr/decr){
//code to be executed
}
```

Example:

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

Output:

```
1
2
3
4
5
6
7
8
9
 10
```



Java for-each Loop

The for-each loop is used to traverse array or collection in java. It is easier to use than simple for loop because we don't need to increment value and use subscript notation. It works on elements basis not index. It returns element one by one in the defined variable.

Syntax:

```
for(Type var:array){
//code to be executed
}
```

Example:

```
public class ForEachExample {
public static void main(String[] args) {
   int arr[]={12,23,44,56,78};
   for(int i:arr){
      System.out.println(i);
   }
}
}
```

Output:

```
12
23
44
56
78
```

Java Labeled For Loop

We can have name of each for loop. To do so, we use label before the for loop. It is useful if we have nested for loop so that we can break/continue specific for loop.

Normally, break and continue keywords breaks/continues the inner most for loop only.

Syntax:

```
labelname:
for(initialization;condition;incr/decr)
    {
     //code to be executed
    }
```

Example:

```
public class LabeledForExample {
public static void main(String[] args) {
   aa:
      for(int i=1;i<=3;i++){
         bb:
            for(int j=1;j<=3;j++){
               if(i==2&&j==2){
                  break aa;
               }
               System.out.println(i+" "+j);
            }
      }
}
}
```

Output:

```
1 1
1 2
1 3
2 1
```

```
public class LabeledForExample2 {
    public static void main(String[] args)
    {
       aa:
          for(int i=1;i<=3;i++){
             bb:
                for(int j=1;j<=3;j++){
                   if(i==2&&j==2){
                      break bb;
                   }
                System.out.println(i+" "+j);
                }
          }
    }
    }
```

Output:

```
1 1
1 2
1 3
2 1
3 1
3 2
3 3
```

If you use **break bb;**, it will break inner loop only which is the default behavior of any loop.

Java Infinitive For Loop

If you use two semicolons ;; in the for loop, it will be infinitive for loop.

Syntax:

```
for(;;){
//code to be executed
}
```

Example:

```
public class ForExample {
public static void main(String[] args) {
   for(;;){
      System.out.println("infinitive loop");
   }
}
}
```

Output:

```
infinitive loop
infinitive loop
infinitive loop
infinitive loop
infinitive loop
ctrl+c
```

Now, you need to press ctrl+c to exit from the program.

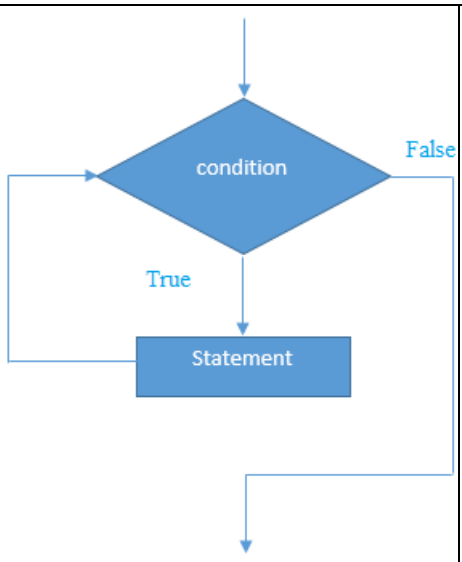
Java While Loop

The Java *while loop* is used to iterate a part of the program several times. If the number of iteration is not fixed, it is recommended to use while loop.

Syntax:

```
while(condition){
//code to be executed

}
```



Example:

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

Output:

```
1
2
3
4
5
6
7
8
9
10
```

Java Infinitive While Loop

If you pass **true** in the while loop, it will be infinitive while loop.

Syntax:

```
while(true){
//code to be executed
}
```

Example:

```
public class WhileExample2 {
public static void main(String[] args) {
   while(true){
      System.out.println("infinitive while loop");

   }
}
}
```

Output:

```
infinitive while loop
infinitive while loop
infinitive while loop
infinitive while loop
infinitive while loop
ctrl+c
```

Now, you need to press ctrl+c to exit from the program.

Java do-while Loop

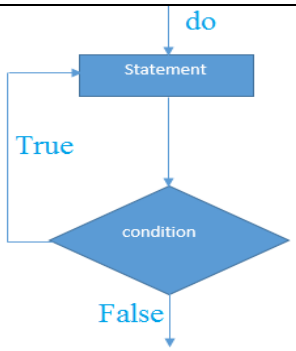
The Java *do-while loop* is used to iterate a part of the program several times. If the number of iteration is not fixed and you must have to execute the loop at least once, it is recommended to use do-while loop.

The Java *do-while loop* is executed at least once because condition is checked after loop body.

Syntax:

```
do{
//code to be executed

}while(condition);
```



Example:

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

Output:

```
1
2
3
4
5
6
7
8
9
10
```

Java Infinitive do-while Loop

If you pass **true** in the do-while loop, it will be infinitive do-while loop.

Syntax:

```
do{
//code to be executed
}while(true);
```

Example:

```
public class DoWhileExample2 {
public static void main(String[] args) {
    do{
        System.out.println("infinitive do while loop");
    }while(true);
}
}
```

Output:

```
infinitive do while loop
infinitive do while loop
infinitive do while loop
ctrl+c
```

Now, you need to press ctrl+c to program

Java Break Statement

When a break statement is encountered inside a loop, the loop is immediately terminated and the program control resumes at the next statement following the loop.

The Java *break* is used to break loop or switch statement. It breaks the current flow of the program at specified condition. In case of inner loop, it breaks only inner loop.

Syntax:

```
jump-statement;
break;
```

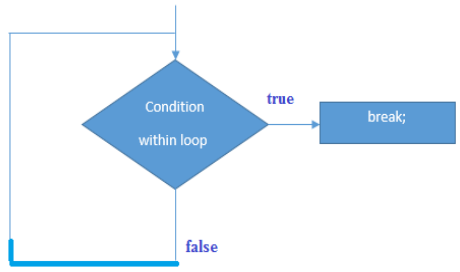


Figure: Flowchart of break statement

Java Break Statement with Loop

Example:

```
public class BreakExample {
public static void main(String[] args
) {
   for(int i=1;i<=10;i++){
      if(i==5){
         break;
      }
      System.out.println(i);
   }
}
}
```

Output:

```
1
2
3
4
```

Java Break Statement with Inner Loop

It breaks inner loop only if you use break statement inside the inner loop.

Example:

```
public class BreakExample2 {
public static void main(String[] args) {
        for(int i=1;i<=3;i++){
            for(int j=1;j<=3;j++){
                if(i==2&&j==2){
                    break;
                }
                System.out.println(i+" "+j);
            }
        }
}
}
```

Output:

```
1 1
1 2
1 3
2 1
3 1
3 2
3 3
```

Java Continue Statement

The continue statement is used in loop control structure when you need to immediately jump to the next iteration of the loop. It can be used with for loop or while loop.

The Java *continue statement* is used to continue loop. It continues the current flow of the program and skips the remaining code at specified condition. In case of inner loop, it continues only inner loop.

Syntax:

```
jump-statement;
continue;
```

Java Continue Statement Example

Example:

```
public class ContinueExample {
public static void main(String[] args) {
   for(int i=1;i<=10;i++){
      if(i==5){
         continue;
      }
      System.out.println(i);
   }
}
}
```

Output:

```
1
2
3
4
6
7
8
9
10
```

Java Continue Statement with Inner Loop

It continues inner loop only if you use continue statement inside the inner loop.

Example:

```
public class ContinueExample2 {
public static void main(String[] args) {
        for(int i=1;i<=3;i++){
              for(int j=1;j<=3;j++){
                 if(i==2&&j==2){
                    continue;
                 }
                 System.out.println(i+" "+j);
              }
        }
}
}
```

Output:

```
1 1
1 2
1 3
2 1
2 3
3 1
3 2
3 3
```

Java Comments

The java comments are statements that are not executed by the compiler and interpreter. The comments can be used to provide information or explanation about the variable, method, class or any statement. It can also be used to hide program code for specific time.

Types of Java Comments

There are 3 types of comments in java.

1. Single Line Comment
2. Multi Line Comment
3. Documentation Comment

1) Java Single Line Comment

The single line comment is used to comment only one line.

Syntax:

```
//This is single line comment
```

Example:

```
public class CommentExample1 {
public static void main(String[] args) {
   int i=10;//Here, i is a variable
   System.out.println(i);
}
}
```

Output:

```
10
```

2) Java Multi Line Comment

The multi line comment is used to comment multiple lines of code.

Syntax:

```
/*
This
is
multi line
comment
*/
```

Example:

```
public class CommentExample2 {
public static void main(String[] args
) {
/* Let's declare and
 print variable in java. */
   int i=10;
   System.out.println(i);
}
}
```

Output:

```
10
```

3) Java Documentation Comment

The documentation comment is used to create documentation API. To create documentation API, you need to use **javadoc tool**.

Syntax:

```
/**
This
is
documentation
comment
*/
```

Example:

```
/** The Calculator class provide
s methods to get addition and su
btraction of given 2 numbers.*/
public class Calculator {
/** The add() method returns ad
dition of given numbers.*/
public static int add(int a, int b
```

		){**return** a+b;} /** The sub() method returns su btraction of given numbers.*/ **public static int** sub(**int** a, **int** b) {**return** a-b;} }

1.9, 1.10, 1.11 Classes Objects and Methods

1. Object in Java
2. Class in Java
3. Instace Variable in Java
4. Method in Java
5. Example of Object and class that maintains the records of student
6. Annonymous Object

Object is the physical as well as logical entity whereas class is the logical entity only.

Object in Java

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

An object has three characteristics:

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

For Example: Pen is an object. Its name is Reynolds, color is white etc. known as its state. It is used to write, so writing is its behavior.

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

Object Definitions:

- Object is *a real world entity*.
- Object is *a run time entity*.
- Object is *an entity which has state and behavior*.
- Object is *an instance of a class*.

Class in Java

A class is a group of objects which have common properties. It is a template or blueprint from which objects are created. It is a logical entity. It can't be physical.

A class in Java can contain:

- **fields**
- **methods**
- **constructors**
- **blocks**
- **nested class and interface**

Syntax to declare a class:

```
class <class_name>{
   field;
   method;
}
```

Instance variable in Java

A variable which is created inside the class but outside the method, is known as instance variable. Instance variable doesn't get memory at compile time. It gets memory at run time when object(instance) is created. That is why, it is known as instance variable.

Method in Java

In java, a method is like function i.e. used to expose behavior of an object.

Advantage of Method

- Code Reusability
- Code Optimization

new keyword in Java

The new keyword is used to allocate memory at run time. All objects get memory in Heap memory area.

Object and Class Example: main within class

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

File: Student.java

```
class Student{
 int id;//field or data member or instance variable
 String name;
   public static void main(String args[]){
  Student s1=new Student();//creating an object of Student
  System.out.println(s1.id);//accessing member through reference variable
  System.out.println(s1.name);
 }
}
```

Output:

```
0
null
```

Object and Class Example: main outside class

In real time development, we create classes and use it from another class. It is a better approach than previous one. Let's see a simple example, where we are having main() method in another class.
We can have multiple classes in different java files or single java file. If you define multiple classes in a single java source file, it is a good idea to save the file name with the class name which has main() method.

File: TestStudent1.java

```
class Student{
 int id;
 String name;
}
class TestStudent1{
 public static void main(String args[]){
  Student s1=new Student();
  System.out.println(s1.id);
  System.out.println(s1.name);
 }
}
```

Output:

```
0
null
```

Three Ways to initialize object

There are 3 ways to initialize object in java.

1. By reference variable
2. By method
3. By constructor

1) Object and Class Example: Initialization through reference

Initializing object simply means storing data into object. Let's see a simple example where we are going to initialize object through reference variable.

File: TestStudent2.java

```
class Student{
 int id;
 String name;
}
class TestStudent2{
 public static void main(String args[]){
  Student s1=new Student();
  s1.id=101;
  s1.name="Sonoo";
  System.out.println(s1.id+" "+s1.name);//printing members with a white space
 }
}
```

Output:

```
101 Sonoo
```

We can also create multiple objects and store information in it through reference variable.

File: TestStudent3.java

```
class Student{
 int id;
 String name;
}
class TestStudent3{
 public static void main(String args[]){
  //Creating objects
  Student s1=new Student();
  Student s2=new Student();
  //Initializing objects
  s1.id=101;
  s1.name="Sonoo";
  s2.id=102;
  s2.name="Amit";
  //Printing data
  System.out.println(s1.id+" "+s1.name);
  System.out.println(s2.id+" "+s2.name);
 }
}
```

Output:

```
101 Sonoo
102 Amit
```

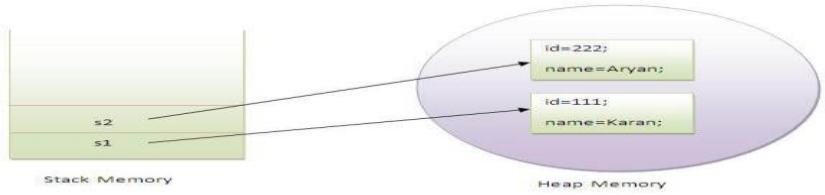
2) Object and Class Example: Initialization through method

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

File: TestStudent4.java

```
class Student{
 int rollno;
 String name;
 void insertRecord(int r, String n){
  rollno=r;
  name=n;
 }
 void displayInformation(){System.out.println(rollno+" "+name);}
}
class TestStudent4{
 public static void main(String args[]){
  Student s1=new Student();
  Student s2=new Student();
  s1.insertRecord(111,"Karan");
  s2.insertRecord(222,"Aryan");
```

```
 s1.displayInformation();
 s2.displayInformation();
 }
}
```
Output:
```
111 Karan
222 Aryan
```



As you can see in the above figure, object gets the memory in heap memory area. The reference variable refers to the object allocated in the heap memory area. Here, s1 and s2 both are reference variables that refer to the objects allocated in memory.

3) Object and Class Example: Initialization through constructor

Refer Constructor in 1.13

Object and Class Example: Employee

Let's see an example where we are maintaining records of employees.

File: TestEmployee.java

```
class Employee{
   int id;
   String name;
   float salary;
   void insert(int i, String n, float s) {
      id=i;
      name=n;
      salary=s;
   }
   void display(){System.out.println(id+" "+name+" "+salary);}
}
public class TestEmployee {
public static void main(String[] args) {
   Employee e1=new Employee();
   Employee e2=new Employee();
   Employee e3=new Employee();
   e1.insert(101,"ajeet",45000);
   e2.insert(102,"irfan",25000);
   e3.insert(103,"nakul",55000);
   e1.display();
   e2.display();
   e3.display();
}
}
```
Output:
```
101 ajeet 45000.0
102 irfan 25000.0
103 nakul 55000.0
```

Object and Class Example: Rectangle

There is given another example that maintains the records of Rectangle class.

File: TestRectangle1.java

```
class Rectangle{
 int length;
 int width;
```

```
 void insert(int l, int w){
  length=l;
  width=w;
 }
 void calculateArea(){System.out.println(length*width);}
}
class TestRectangle1{
 public static void main(String args[]){
  Rectangle r1=new Rectangle();
  Rectangle r2=new Rectangle();
  r1.insert(11,5);
  r2.insert(3,15);
  r1.calculateArea();
  r2.calculateArea();
}
}
```

Output:

```
55
45
```

What are the different ways to create an object in Java?

There are many ways to create an object in java. They are:

- By new keyword
- By newInstance() method
- By clone() method
- By deserialization
- By factory method etc.

Anonymous object

Anonymous simply means nameless. An object which has no reference is known as anonymous object. It can be used at the time of object creation only.

If you have to use an object only once, anonymous object is a good approach. For example:

```
new Calculation();//anonymous object
```

Calling method through reference:

```
Calculation c=new Calculation();
c.fact(5);
```

Calling method through anonymous object

```
new Calculation().fact(5);
```

Let's see the full example of anonymous object in java.

```
class Calculation{
 void fact(int  n){
  int fact=1;
  for(int i=1;i<=n;i++){
   fact=fact*i;
  }
 System.out.println("factorial is "+fact);
}
public static void main(String args[]){
 new Calculation().fact(5);//calling method with anonymous object
}
}
```

Output:

```
Factorial is 120
```

Creating multiple objects by one type only

We can create multiple objects by one type only as we do in case of primitives.

Initialization of primitive variables:

```
int a=10, b=20;
```

Initialization of refernce variables:

```
Rectangle r1=new Rectangle(), r2=new Rectangle();//creating two objects
```

Let's see the example:

```
class Rectangle{
 int length;
 int width;
 void insert(int l,int w){
  length=l;
  width=w;
 }
 void calculateArea(){System.out.println(length*width);}
}
class TestRectangle2{
 public static void main(String args[]){
  Rectangle r1=new Rectangle(),r2=new Rectangle();//creating two objects
  r1.insert(11,5);
  r2.insert(3,15);
  r1.calculateArea();
  r2.calculateArea();
}
}
```

Output:

```
55
45
```

Real World Example: Account

File: TestAccount.java

```
class Account{
int acc_no;
String name;
float amount;
void insert(int a,String n,float amt){
acc_no=a;
name=n;
amount=amt;
}
void deposit(float amt){
amount=amount+amt;
System.out.println(amt+" deposited");
}
void withdraw(float amt){
if(amount<amt){
System.out.println("Insufficient Balance");
}else{
amount=amount-amt;
System.out.println(amt+" withdrawn");
}
}
void checkBalance(){System.out.println("Balance is: "+amount);}
void display(){System.out.println(acc_no+" "+name+" "+amount);}
}

class TestAccount{
public static void main(String[] args){
Account a1=new Account();
a1.insert(832345,"Ankit",1000);
a1.display();
a1.checkBalance();
a1.deposit(40000);
a1.checkBalance();
a1.withdraw(15000);
a1.checkBalance();
}}
```

Output:

```
832345 Ankit 1000.0
Balance is: 1000.0
40000.0 deposited
Balance is: 41000.0
15000.0 withdrawn
Balance is: 26000.0
```

1.12 Access Specifiers

Access Modifiers in java

1. private access modifier
2. Role of private constructor
3. default access modifier
4. protected access modifier
5. public access modifier
6. Applying access modifier with method overriding

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

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

There are many non-access modifiers such as static, abstract, synchronized, native, volatile, transient etc. Here, we will learn access modifiers.

1) private access modifier

The private access modifier is accessible only within class.

Simple example of private access modifier

In this example, we have created two classes A and Simple. A class contains private data member and private method. We are accessing these private members from outside the class, so there is compile time error.

```
class A{
private int data=40;
private void msg(){System.out.println("Hello java");}
}

public class Simple{
 public static void main(String args[]){
   A obj=new A();
   System.out.println(obj.data);//Compile Time Error
   obj.msg();//Compile Time Error
   }
}
```

Role of Private Constructor

If you make any class constructor private, you cannot create the instance of that class from outside the class. For example:

```
class A{
private A(){}//private constructor
void msg(){System.out.println("Hello java");}
}
public class Simple{
 public static void main(String args[]){
   A obj=new A();//Compile Time Error
 }
}
```

Note: A class cannot be private or protected except nested class.

2) default access modifier

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

Example of default access modifier

In this example, we have created two packages pack and mypack. We are accessing the A class from outside its package, since A class is not public, so it cannot be accessed from outside the package.

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

In the above example, the scope of class A and its method msg() is default so it cannot be accessed from outside the package.

3) protected access modifier

The **protected access modifier** is accessible within package and outside the package but through inheritance only.

The protected access modifier can be applied on the data member, method and constructor. It can't be applied on the class.

Example of protected access modifier

In this example, we have created the two packages pack and mypack. The A class of pack package is public, so can be accessed from outside the package. But msg method of this package is declared as protected, so it can be accessed from outside the class only through inheritance.

```
//save by A.java
package pack;
public class A{
protected void msg(){System.out.println("Hello");}
}
//save by B.java
package mypack;
import pack.*;

class B extends A{
  public static void main(String args[]){
   B obj = new B();
   obj.msg();
  }
}
```

Output:Hello

4) public access modifier

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

Example of public access modifier

```
//save by A.java

package pack;
public class A{
public void msg(){System.out.println("Hello");}
}
//save by B.java
  package mypack;
import pack.*;
class B{
```

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

Output:Hello

Understanding all java access modifiers

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

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

Java access modifiers with method overriding

If you are overriding any method, overridden method (i.e. declared in subclass) must not be more restrictive.

```
class A{
protected void msg(){System.out.println("Hello java");}
}

public class Simple extends A{
void msg(){System.out.println("Hello java");}//C.T.Error
 public static void main(String args[]){
   Simple obj=new Simple();
   obj.msg();
   }
}
```

The default modifier is more restrictive than protected. That is why there is compile time error.

1.13 Constructor in Java

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

In Java, constructor is a block of codes similar to method. It is called when an instance of object is created and memory is allocated for the object.

It is a special type of method which is used to initialize the object.

When a constructor is called

Everytime an object is created using new() keyword, atleast one constructor is called. It is called a default constructor.

Note: It is called constructor because it constructs the values at the time of object creation. It is not necessary to write a constructor for a class. It is because java compiler creates a default constructor if your class doesn't have any.

Rules for creating java constructor

There are basically two rules defined for the constructor.

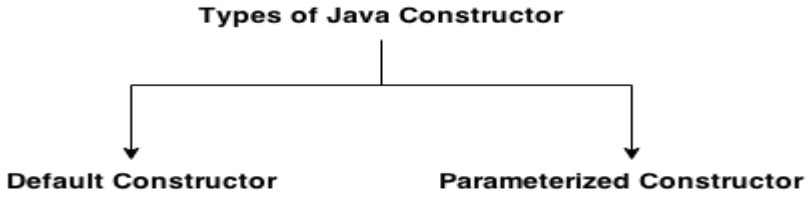
1. Constructor name must be same as its class name
2. Constructor must have no explicit return type

Types of java constructors

There are two types of constructors in java:

1. Default constructor (no-arg constructor)

2. Parameterized constructor



Java Default Constructor

A constructor is called "Default Constructor" when it doesn't have any parameter.

Syntax of default constructor:

<class_name>(){}

Example of default constructor

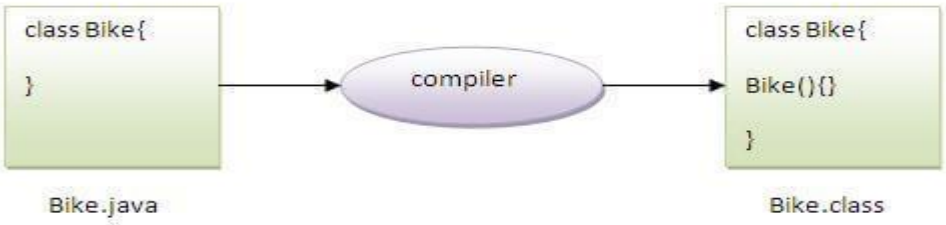
In this example, we are creating the no-arg constructor in the Bike class. It will be invoked at the time of object creation.

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

Output:

Bike is created

Rule: If there is no constructor in a class, compiler automatically creates a default constructor.



Q) What is the purpose of default constructor?

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

Example of default constructor that displays the default values

```
class Student3{
int id;
String name;

void display(){System.out.println(id+" "+name);}

public static void main(String args[]){
Student3 s1=new Student3();
Student3 s2=new Student3();
s1.display();
s2.display();
}
}
```

Output:

```
 0 null
 0 null
```

Explanation: In the above class,you are not creating any constructor so compiler provides you a default constructor.Here 0 and null values are provided by default constructor.

Java parameterized constructor

A constructor which has a specific number of parameters is called parameterized constructor.

Why use parameterized constructor?

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

Example of parameterized constructor

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

```
class Student4{
   int id;
   String name;
        Student4(int i,String n){
   id = i;
   name = n;
   }
  void display(){System.out.println(id+" "+name);}
    public static void main(String args[]){
   Student4 s1 = new Student4(111,"Karan");
   Student4 s2 = new Student4(222,"Aryan");
   s1.display();
   s2.display();
   }
}
```

Output:

```
111 Karan
222 Aryan
```

Constructor Overloading in Java

In Java, a constructor is just like a method but without return type. It can also be overloaded like Java methods. Constructor overloading in Java is a technique of having more than one constructor with different parameter lists. They are arranged in a way that each constructor performs a different task. They are differentiated by the compiler by the number of parameters in the list and their types.

Example of Constructor Overloading

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

Output:

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

Difference between constructor and method in java

There are many differences between constructors and methods. They are given below.

Java Constructor	Java Method
Constructor is used to initialize the state of an object.	Method is used to expose behaviour of an object.
Constructor must not have return type.	Method must have return type.
Constructor is invoked implicitly.	Method is invoked explicitly.
The java compiler provides a default constructor if you don't have any constructor.	Method is not provided by compiler in any case.
Constructor name must be same as the class name.	Method name may or may not be same as class name.

Java Copy Constructor

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

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

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

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

```
class Student6{
   int id;
   String name;
   Student6(int i,String n){
   id = i;
   name = n;
   }

   Student6(Student6 s){
   id = s.id;
   name =s.name;
   }
   void display(){System.out.println(id+" "+name);}

   public static void main(String args[]){
   Student6 s1 = new Student6(111,"Karan");
   Student6 s2 = new Student6(s1);
   s1.display();
   s2.display();
  }
}
```

Output:

```
111 Karan
111 Karan
```

Copying values without constructor

We can copy the values of one object into another by assigning the objects values to another object. In this case, there is no need to create the constructor.

```
class Student7{
   int id;
   String name;
```

```
    Student7(int i,String n){
    id = i;
    name = n;
    }
    Student7(){}
void display(){System.out.println(id+" "+name);}
      public static void main(String args[]){
    Student7 s1 = new Student7(111,"Karan");
    Student7 s2 = new Student7();
    s2.id=s1.id;
    s2.name=s1.name;
    s1.display();
    s2.display();
   }
}
```

Output:

```
111 Karan
111 Karan
```

Q) Does constructor return any value?

Ans:yes, that is current class instance (You cannot use return type yet it returns a value).

Can constructor perform other tasks instead of initialization?

Yes, like object creation, starting a thread, calling method etc. You can perform any operation in the constructor as you perform in the method.

1. 14 Method Overloading in Java

1. Different ways to overload the method
2. By changing the no. of arguments
3. By changing the datatype
4. Why method overloading is not possible by changing the return type
5. Can we overload the main method
6. method overloading with Type Promotion

If a class has multiple methods having same name but different in parameters, it is known as **Method Overloading**.

If we have to perform only one operation, having same name of the methods increases the readability of the program.

Suppose you have to perform addition of the given numbers but there can be any number of arguments, if you write the method such as a(int,int) for two parameters, and b(int,int,int) for three parameters then it may be difficult for you as well as other programmers to understand the behavior of the method because its name differs.

Advantage of method overloading

Method overloading *increases the readability of the program*.

Different ways to overload the method

There are two ways to overload the method in java

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

In java, Method Overloading is not possible by changing the return type of the method only.

1) Method Overloading: changing no. of arguments

In this example, we have created two methods, first add() method performs addition of two numbers and second add method performs addition of three numbers.

In this example, we are creating static methods so that we don't need to create instance for calling methods.

```
class Adder{
static int add(int a,int b){return a+b;}
static int add(int a,int b,int c){return a+b+c;}
}
class TestOverloading1{
```

```
public static void main(String[] args){
System.out.println(Adder.add(11,11));
System.out.println(Adder.add(11,11,11));
}}
```
Output:
```
22
33
```
2) Method Overloading: changing data type of arguments

In this example, we have created two methods that differs in data type. The first add method receives two integer arguments and second add method receives two double arguments.
```
class Adder{
static int add(int a, int b){return a+b;}
static double add(double a, double b){return a+b;}
}
class TestOverloading2{
public static void main(String[] args){
System.out.println(Adder.add(11,11));
System.out.println(Adder.add(12.3,12.6));
}}
```
Output:
```
22
24.9
```

Q) Why Method Overloading is not possible by changing the return type of method only?

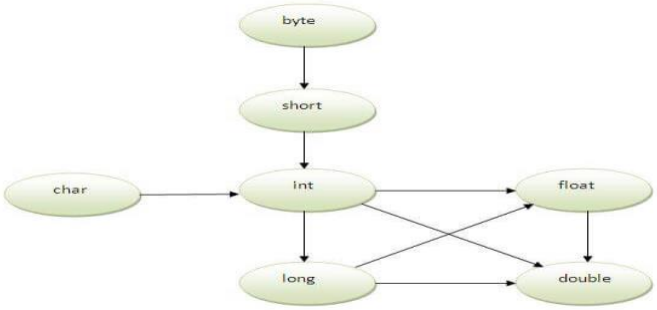
In java, method overloading is not possible by changing the return type of the method only because of ambiguity. Let's see how ambiguity may occur:
```
class Adder{
static int add(int a,int b){return a+b;}
static double add(int a,int b){return a+b;}
}
class TestOverloading3{
public static void main(String[] args){
System.out.println(Adder.add(11,11));//ambiguity
}}
```
Output:
```
Compile Time Error: method add(int,int) is already defined in class Adder
```
System.out.println(Adder.add(11,11)); //Here, how can java determine which sum() method should be called?

Note: Compile Time Error is better than Run Time Error. So, java compiler renders compiler time error if you declare the same method having same parameters.

Can we overload java main() method?

Yes, by method overloading. You can have any number of main methods in a class by method overloading. But JVM calls main() method which receives string array as arguments only. Let's see the simple example:
```
class TestOverloading4{
public static void main(String[] args){System.out.println("main with String[]");}
public static void main(String args){System.out.println("main with String");}
public static void main(){System.out.println("main without args");}
}
```
Output:
```
main with String[]
```
Method Overloading and Type Promotion

One type is promoted to another implicitly if no matching datatype is found. Let's understand the concept by the figure given below:



As displayed in the above diagram, byte can be promoted to short, int, long, float or double. The short datatype can be promoted to int,long,float or double. The char datatype can be promoted to int,long,float or double and so on.

Example of Method Overloading with TypePromotion

```
class OverloadingCalculation1{
  void sum(int a,long b){System.out.println(a+b);}
  void sum(int a,int b,int c){System.out.println(a+b+c);}
    public static void main(String args[]){
  OverloadingCalculation1 obj=new OverloadingCalculation1();
  obj.sum(20,20);//now second int literal will be promoted to long
  obj.sum(20,20,20);

  }
}
```

Output:40
60

Example of Method Overloading with Type Promotion if matching found

If there are matching type arguments in the method, type promotion is not performed.

```
class OverloadingCalculation2{
  void sum(int a,int b){System.out.println("int arg method invoked");}
  void sum(long a,long b){System.out.println("long arg method invoked");}
  public static void main(String args[]){
  OverloadingCalculation2 obj=new OverloadingCalculation2();
  obj.sum(20,20);//now int arg sum() method gets invoked
  }
}
```

Output:int arg method invoked

Example of Method Overloading with Type Promotion in case of ambiguity

If there are no matching type arguments in the method, and each method promotes similar number of arguments, there will be ambiguity.

```
class OverloadingCalculation3{
  void sum(int a,long b){System.out.println("a method invoked");}
  void sum(long a,int b){System.out.println("b method invoked");}
  public static void main(String args[]){
  OverloadingCalculation3 obj=new OverloadingCalculation3();
  obj.sum(20,20);//now ambiguity
  }
}
```

Output:Compile Time Error

One type is not de-promoted implicitly for example double cannot be depromoted to any type implicitly.

1.15 Type Casting

Type Conversion and Casting

It is fairly common to assign a value of one type to a variable of another type. If the two types are compatible, then Java will perform the conversion automatically. For example, it is always possible to assign an **int** value to a **long** variable. However, not all types are compatible, and thus, not all type conversions are implicitly allowed. For instance, there is no automatic conversion defined from **double** to **byte**. Fortunately, it is still possible to

obtain a conversion between incompatible types. To do so, you must use a *cast*, which performs an explicit conversion between incompatible types. Let's look at both automatic type conversions and casting.

Java's Automatic Conversions

When one type of data is assigned to another type of variable, an *automatic type conversion will* take place if the following two conditions are met:

• The two types are compatible.
• The destination type is larger than the source type.

When these two conditions are met, a *widening conversion* takes place. For example, the **int** type is always large enough to hold all valid **byte** values, so no explicit cast statement is required. For widening conversions, the numeric types, including integer and floating-point types, are compatible with each other. However, there are no automatic conversions from the numeric types to **char** or **boolean**. Also, **char** and **boolean** are not compatible with each other.

As mentioned earlier, Java also performs an automatic type conversion when storing a literal integer constant into variables of type **byte**, **short**, **long**, or **char**.

Casting Incompatible Types

Although the automatic type conversions are helpful, they will not fulfill all needs. For example, what if you want to assign an **int** value to a **byte** variable? This conversion will not be performed automatically, because a **byte** is smaller than an **int**. This kind of conversion is sometimes called a *narrowing conversion*, since you are explicitly making the value narrower so that it will fit into the target type.

To create a conversion between two incompatible types, you must use a cast. A *cast* is simply an explicit type conversion. It has this general form:

(target-type) value

Here, *target-type* specifies the desired type to convert the specified value to. For example, the following fragment casts an **int** to a **byte**. If the integer's value is larger than the range of a **byte**, it will be reduced modulo (the remainder of an integer division by the) **byte**'s range.

```
int a;
byte b;
// …
b = (byte) a;
```

A different type of conversion will occur when a floating-point value is assigned to an integer type: *truncation*. As you know, integers do not have fractional components. Thus when a floating-point value is assigned to an integer type, the fractional component is lost. For example, if the value 1.23 is assigned to an integer, the resulting value will simply be 1. The 0.23 will have been truncated. Of course, if the size of the whole number component is too large to fit into the target integer type, then that value will be reduced modulo the target type's range.

The following program demonstrates some type conversions that require casts:

```
// Demonstrate casts.
class Conversion {
public static void main(String args[]) {
byte b;
int i = 257;
double d = 323.142;
System.out.println("\nConversion of int to byte.");
b = (byte) i;
System.out.println("i and b " + i + " " + b);
System.out.println("\nConversion of double to int.");
i = (int) d;
System.out.println("d and i " + d + " " + i);
System.out.println("\nConversion of double to byte.");
b = (byte) d;
System.out.println("d and b " + d + " " + b);
}
}
```

This program generates the following output:

```
Conversion of int to byte.
i and b 257 1
Conversion of double to int.
d and i 323.142 323
```

Conversion of double to byte.
d and b 323.142 67
Let's look at each conversion. When the value 257 is cast into a **byte** variable, the result is the remainder of the division of 257 by 256 (the range of a **byte**), which is 1 in this case. When the **d** is converted to an **int**, its fractional component is lost. When **d** is converted to a **byte**, its fractional component is lost, *and* the value is reduced modulo 256, which in this case is 67.

Automatic Type Promotion in Expressions

In addition to assignments, there is another place where certain type conversions may occur: in expressions. To see why, consider the following. In an expression, the precision required of an intermediate value will sometimes exceed the range of either operand. For example, examine the following expression:

```
byte a = 40;
byte b = 50;
byte c = 100;
int d = a * b / c;
```

The result of the intermediate term **a * b** easily exceeds the range of either of its **byte** operands. To handle this kind of problem, Java automatically promotes each **byte**, **short** or **char** operand to **int** when evaluating an expression. This means that the subexpression **a*b** is performed using integers—not bytes. Thus, 2,000, the result of the intermediate expression, **50 * 40**, is legal even though **a** and **b** are both specified as type **byte**.
As useful as the automatic promotions are, they can cause confusing compile-time errors. For example, this seemingly correct code causes a problem:

```
byte b = 50;
b = b * 2; // Error! Cannot assign an int to a byte!
```

The code is attempting to store 50 * 2, a perfectly valid **byte** value, back into a **byte** variable. However, because the operands were automatically promoted to **int** when the expression was evaluated, the result has also been promoted to **int**. Thus, the result of the expression is now of type **int**, which cannot be assigned to a **byte** without the use of a cast. This is true even if, as in this particular case, the value being assigned would still fit in the target type.
In cases where you understand the consequences of overflow, you should use an explicit cast, such as

```
byte b = 50;
b = (byte)(b * 2);
```

which yields the correct value of 100.

The Type Promotion Rules

Java defines several *type promotion* rules that apply to expressions. They are as follows: First, all **byte**, **short**, and **char** values are promoted to **int**, as just described. Then, if one operand is a **long**, the whole expression is promoted to **long**. If one operand is a **float**, the entire expression is promoted to **float**. If any of the operands are **double**, the result is **double**.
The following program demonstrates how each value in the expression gets promoted to match the second argument to each binary operator:

```
class Promote {
public static void main(String args[]) {
byte b = 42;
char c = 'a';
short s = 1024;
int i = 50000;
float f = 5.67f;
double d = .1234;
double result = (f * b) + (i / c) - (d * s);
System.out.println((f * b) + " + " + (i / c) + " - " + (d * s));
System.out.println("result = " + result);
}
}
```

Let's look closely at the type promotions that occur in this line from the program:

```
double result = (f * b) + (i / c) - (d * s);
```

In the first subexpression, **f * b, b** is promoted to a **float** and the result of the subexpression is **float**. Next, in the subexpression **i/c, c** is promoted to **int**, and the result is of type **int**. Then, in **d * s**, the value of **s** is promoted to **double**, and the type of the subexpression is
double. Finally, these three intermediate values, **float**, **int**, and **double**, are considered. The outcome of **float** plus an **int** is a **float**. Then the resultant **float** minus the last **double** is promoted to **double**, which is the type for the final result of the expression.

1.16 this keyword in java

There can be a lot of usage of **java this keyword**. In java, this is a **reference variable** that refers to the current object.

Usage of java this keyword

Here is given the 6 usage of java this keyword.

1. this can be used to refer current class instance variable.
2. this can be used to invoke current class method (implicitly)
3. this() can be used to invoke current class constructor.
4. this can be passed as an argument in the method call.
5. this can be passed as argument in the constructor call.
6. this can be used to return the current class instance from the method.

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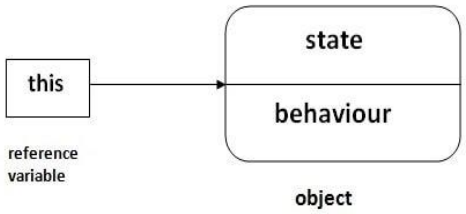


1) this: to refer current class instance variable

The this keyword can be used to refer current class instance variable. If there is ambiguity between the instance variables and parameters, this keyword resolves the problem of ambiguity.

Understanding the problem without this keyword

Let's understand the problem if we don't use this keyword by the example given below:

```
class Student{
int rollno;
String name;
float fee;
Student(int rollno,String name,float fee){
rollno=rollno;
name=name;
fee=fee;
}
void display(){System.out.println(rollno+" "+name+" "+fee);}
}
class TestThis1{
public static void main(String args[]){
Student s1=new Student(111,"ankit",5000f);
Student s2=new Student(112,"sumit",6000f);
s1.display();
s2.display();
}}
```

Output:

```
0 null 0.0
0 null 0.0
```

In the above example, parameters (formal arguments) and instance variables are same. So, we are using this keyword to distinguish local variable and instance variable.

Solution of the above problem by this keyword

```
class Student{
int rollno;
```

```
String name;
float fee;
Student(int rollno,String name,float fee){
this.rollno=rollno;
this.name=name;
this.fee=fee;
}
void display(){System.out.println(rollno+" "+name+" "+fee);}
}
 class TestThis2{
public static void main(String args[]){
Student s1=new Student(111,"ankit",5000f);
Student s2=new Student(112,"sumit",6000f);
s1.display();
s2.display();
}}
```

Output:

```
111 ankit 5000
112 sumit 6000
```

If local variables(formal arguments) and instance variables are different, there is no need to use this keyword like in the following program:

Program where this keyword is not required

```
class Student{
int rollno;
String name;
float fee;
Student(int r,String n,float f){
rollno=r;
name=n;
fee=f;
}
void display(){System.out.println(rollno+" "+name+" "+fee);}
}
  class TestThis3{
public static void main(String args[]){
Student s1=new Student(111,"ankit",5000f);
Student s2=new Student(112,"sumit",6000f);
s1.display();
s2.display();
}}
```

Output:

```
111 ankit 5000
112 sumit 6000
```

It is better approach to use meaningful names for variables. So we use same name for instance variables and parameters in real time, and always use this keyword.

2) this: to invoke current class method

You may invoke the method of the current class by using the this keyword. If you don't use the this keyword, compiler automatically adds this keyword while invoking the method. Let's see the example


```
class A{
void m(){System.out.println("hello m");}
void n(){
```

```
System.out.println("hello n");
//m();//same as this.m()
this.m();
}
}
class TestThis4{
public static void main(String args[]){
A a=new A();
a.n();
}}
```

Output:

```
hello n
hello m
```

3) this() : to invoke current class constructor

The this() constructor call can be used to invoke the current class constructor. It is used to reuse the constructor. In other words, it is used for constructor chaining.

Calling default constructor from parameterized constructor:

```
class A{
A(){System.out.println("hello a");}
A(int x){
this();
System.out.println(x);
}
}
class TestThis5{
public static void main(String args[]){
A a=new A(10);
}}
```

Output:

```
hello a
10
```

Calling parameterized constructor from default constructor:

```
class A{
A(){
this(5);
System.out.println("hello a");
}
A(int x){
System.out.println(x);
}
}
class TestThis6{
public static void main(String args[]){
A a=new A();
}}
```

Output:

```
5
hello a
```

Real usage of this() constructor call

The this() constructor call should be used to reuse the constructor from the constructor. It maintains the chain between the constructors i.e. it is used for constructor chaining. Let's see the example given below that displays the actual use of this keyword.

```
class Student{
int rollno;
String name,course;
float fee;
Student(int rollno,String name,String course){
this.rollno=rollno;
this.name=name;
```

```
this.course=course;
}
Student(int rollno,String name,String course,float fee){
this(rollno,name,course);//reusing constructor
this.fee=fee;
}
void display(){System.out.println(rollno+" "+name+" "+course+" "+fee);}
}
class TestThis7{
public static void main(String args[]){
Student s1=new Student(111,"ankit","java");
Student s2=new Student(112,"sumit","java",6000f);
s1.display();
s2.display();
}}
```

Output:

```
111 ankit java null
112 sumit java 6000
```

Rule: Call to this() must be the first statement in constructor.

```
class Student{
int rollno;
String name,course;
float fee;
Student(int rollno,String name,String course){
this.rollno=rollno;
this.name=name;
this.course=course;
}
Student(int rollno,String name,String course,float fee){
this.fee=fee;
this(rollno,name,course);//C.T.Error
}
void display(){System.out.println(rollno+" "+name+" "+course+" "+fee);}
}
class TestThis8{
public static void main(String args[]){
Student s1=new Student(111,"ankit","java");
Student s2=new Student(112,"sumit","java",6000f);
s1.display();
s2.display();
}}
```

Compile Time Error: Call to this must be first statement in constructor

4) this: to pass as an argument in the method

The this keyword can also be passed as an argument in the method. It is mainly used in the event handling. Let's see the example:

```
class S2{
  void m(S2 obj){
  System.out.println("method is invoked");
  }
  void p(){
  m(this);
  }
  static void main(String args[]){
  S2 s1 = new S2();
  s1.p();
  }
}
```

Output:

```
method is invoked
```

Application of this that can be passed as an argument:

In event handling (or) in a situation where we have to provide reference of a class to another one. It is used to reuse one object in many methods.

5) this: to pass as argument in the constructor call

We can pass the this keyword in the constructor also. It is useful if we have to use one object in multiple classes. Let's see the example:

```
class B{
  A4 obj;
  B(A4 obj){
    this.obj=obj;
  }
  void display(){
    System.out.println(obj.data);//using data member of A4 class
  }
}

class A4{
  int data=10;
  A4(){
   B b=new B(this);
   b.display();
  }
  public static void main(String args[]){
   A4 a=new A4();
  }
}
```

Output:10

6) this keyword can be used to return current class instance

We can return this keyword as an statement from the method. In such case, return type of the method must be the class type (non-primitive). Let's see the example:

Syntax of this that can be returned as a statement

```
return_type method_name(){
return this;
}
```

Example of this keyword that you return as a statement from the method

```
class A{
A getA(){
return this;
}
void msg(){System.out.println("Hello java");}
}
class Test1{
public static void main(String args[]){
new A().getA().msg();
}
}
```

Output:

Hello java

Proving this keyword

Let's prove that this keyword refers to the current class instance variable. In this program, we are printing the reference variable and this, output of both variables are same.

```
class A5{
void m(){
System.out.println(this);//prints same reference ID
}
public static void main(String args[]){
A5 obj=new A5();
System.out.println(obj);//prints the reference ID
obj.m();
```

```
}
}
```
Output:
```
A5@22b3ea59
A5@22b3ea59
```

1.17 Java static keyword

1. Static variable
2. Program of counter without static variable
3. Program of counter with static variable
4. Static method
5. Restrictions for static method
6. Why main method is static ?
7. Static block
8. Can we execute a program without main method ?

The **static keyword** in java is used for memory management mainly. We can apply java static keyword with variables, methods, blocks and nested class. The static keyword belongs to the class than instance of the class.
The static can be:

1. variable (also known as class variable)
2. method (also known as class method)
3. block
4. nested class

1) Java static variable

If you declare any variable as static, it is known static variable.

- The static variable can be used to refer the common property of all objects (that is not unique for each object) e.g. company name of employees,college name of students etc.
- The static variable gets memory only once in class area at the time of class loading.

Advantage of static variable

It makes your program **memory efficient** (i.e it saves memory).

Understanding problem without static variable

```
class Student{
    int rollno;
    String name;
    String college="ITS";
}
```

Suppose there are 500 students in my college, now all instance data members will get memory each time when object is created.All student have its unique rollno and name so instance data member is good.Here, college refers to the common property of all objects.If we make it static,this field will get memory only once.
Java static property is shared to all objects.

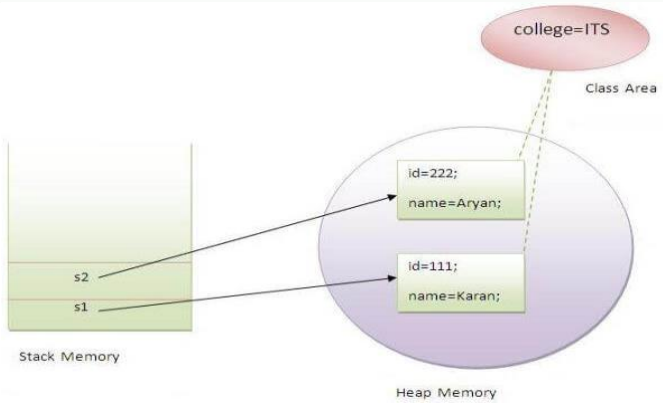
Example of static variable

```
//Program of static variable

class Student8{
  int rollno;
  String name;
  static String college ="ITS";
      Student8(int r,String n){
  rollno = r;
  name = n;
  }
 void display (){System.out.println(rollno+" "+name+" "+college);}
  public static void main(String args[]){
 Student8 s1 = new Student8(111,"Karan");
 Student8 s2 = new Student8(222,"Aryan");
   s1.display();
 s2.display();
 }
}
```

Output: 111 Karan ITS

222 Aryan ITS



Program of counter without static variable

In this example, we have created an instance variable named count which is incremented in the constructor. Since instance variable gets the memory at the time of object creation, each object will have the copy of the instance variable, if it is incremented, it won't reflect to other objects. So each objects will have the value 1 in the count variable.

```
class Counter{
int count=0;//will get memory when instance is created
  Counter(){
count++;
System.out.println(count);
}

public static void main(String args[]){
  Counter c1=new Counter();
Counter c2=new Counter();
Counter c3=new Counter();
  }
}
```

Output:1
1
1

Program of counter by static variable

As we have mentioned above, static variable will get the memory only once, if any object changes the value of the static variable, it will retain its value.

```
class Counter2{
static int count=0;//will get memory only once and retain its value
  Counter2(){
count++;
System.out.println(count);
}
  public static void main(String args[]){
  Counter2 c1=new Counter2();
Counter2 c2=new Counter2();
Counter2 c3=new Counter2();
   }
}
```

Output:1
2
3

2) Java static method

If you apply static keyword with any method, it is known as static method.

- A static method belongs to the class rather than object of a class.

- A static method can be invoked without the need for creating an instance of a class.
- static method can access static data member and can change the value of it.

Example of static method

```
//Program of changing the common property of all objects(static field).
 class Student9{
   int rollno;
   String name;
   static String college = "ITS";
       static void change(){
   college = "BBDIT";
   }
     Student9(int r, String n){
   rollno = r;
   name = n;
   }
     void display (){System.out.println(rollno+" "+name+" "+college);}
    public static void main(String args[]){
  Student9.change();
    Student9 s1 = new Student9 (111,"Karan");
  Student9 s2 = new Student9 (222,"Aryan");
  Student9 s3 = new Student9 (333,"Sonoo");
    s1.display();
  s2.display();
 s3.display();
   }
}
```

Output:111 Karan BBDIT
222 Aryan BBDIT
333 Sonoo BBDIT

Another example of static method that performs normal calculation

```
//Program to get cube of a given number by static method
class Calculate{
 static int cube(int x)
{    return x*x*x;   }
   public static void main(String args[]){
  int result=Calculate.cube(5);
  System.out.println(result);
  }
}
```

Output:125

Restrictions for static method

There are two main restrictions for the static method. They are:

1. The static method can not use non static data member or call non-static method directly.
2. this and super cannot be used in static context.

```
class A{
 int a=40;//non static

 public static void main(String args[]){
  System.out.println(a);
 }
}
```

Output:Compile Time Error

Q) why java main method is static?

Ans) because object is not required to call static method if it were non-static method, jvm create object first then call main() method that will lead the problem of extra memory allocation.

3) Java static block

- Is used to initialize the static data member.
- It is executed before main method at the time of classloading.

Example of static block

```
class A2{
  static{System.out.println("static block is invoked");}
  public static void main(String args[]){
   System.out.println("Hello main");
} }
```

Output: static block is invoked
Hello main

Q) Can we execute a program without main() method?

Ans) Yes, one of the way is static block but in previous version of JDK not in JDK 1.7.

```
class A3{
  static{
  System.out.println("static block is invoked");
  System.exit(0);
  }
}
```

Output:static block is invoked (if not JDK7)

In JDK7 and above, output will be:

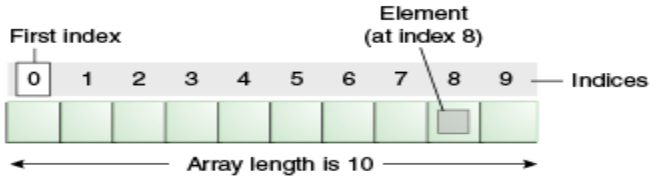
Output:Error: Main method not found in class A3, please define the main method as:
public static void main(String[] args)

1.18 Java Array

Normally, array is a collection of similar type of elements that have contiguous memory location.

Java array is an object the contains elements of similar data type. It is a data structure where we store similar elements. We can store only fixed set of elements in a java array.

Array in java is index based, first element of the array is stored at 0 index.



Advantage of Java Array

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

Disadvantage of Java Array

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

Types of Array in java

There are two types of array.

- Single Dimensional Array
- Multidimensional Array

Single Dimensional Array in java

Syntax to Declare an Array in java

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

Instantiation of an Array in java

arrayRefVar=**new** datatype[size];

Example of single dimensional java array

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

```
class Testarray{
public static void main(String args[]){
int a[]=new int[5];//declaration and instantiation
a[0]=10;//initialization
a[1]=20;
a[2]=70;
a[3]=40;
```

```
a[4]=50;
//printing array
for(int i=0;i<a.length;i++)//length is the property of array
System.out.println(a[i]);
}}
```

Output: 10
20
70
40
50

Declaration, Instantiation and Initialization of Java Array

We can declare, instantiate and initialize the java array together by:

```
int a[]={33,3,4,5};//declaration, instantiation and initialization
```

Let's see the simple example to print this array.

```
class Testarray1{
public static void main(String args[]){
  int a[]={33,3,4,5};//declaration, instantiation and initialization
  //printing array
for(int i=0;i<a.length;i++)//length is the property of array
System.out.println(a[i]);
  }}
```

Output:33
3
4
5

Passing Array to method in java

We can pass the java array to method so that we can reuse the same logic on any array.

Let's see the simple example to get minimum number of an array using method.

```
class Testarray2{
static void min(int arr[]){
int min=arr[0];
for(int i=1;i<arr.length;i++)
 if(min>arr[i])
  min=arr[i];
  System.out.println(min);
}
  public static void main(String args[]){
  int a[]={33,3,4,5};
min(a);//passing array to method
  }}
```

Output:3

Multidimensional array in java

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

Syntax to Declare Multidimensional Array in java

```
dataType[][] arrayRefVar; (or)
dataType [][]arrayRefVar; (or)
dataType arrayRefVar[][]; (or)
dataType []arrayRefVar[];
```

Example to instantiate Multidimensional Array in java

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

Example to initialize Multidimensional Array in java

```
arr[0][0]=1;
arr[0][1]=2;
```

Example of Multidimensional java array

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

```
class Testarray3{
public static void main(String args[]){
//declaring and initializing 2D array
int arr[][]={{1,2,3},{2,4,5},{4,4,5}};
```

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

}}
```

Output:1 2 3
2 4 5
4 4 5

What is the class name of java array?

In java, array is an object. For array object, an proxy class is created whose name can be obtained by getClass().getName() method on the object.

```
class Testarray4{
public static void main(String args[]){
int arr[]={4,4,5};
Class c=arr.getClass();
String name=c.getName();
System.out.println(name);
}}
```

Output:I

Copying a java array

We can copy an array to another by the arraycopy method of System class.

Syntax of arraycopy method

```
public static void arraycopy(  Object src, int srcPos,Object dest, int destPos, int length  )
```

Example of arraycopy method

```
class TestArrayCopyDemo {
   public static void main(String[] args) {
      char[] copyFrom = { 'd', 'e', 'c', 'a', 'f', 'f', 'e',
            'i', 'n', 'a', 't', 'e', 'd' };
      char[] copyTo = new char[7];

      System.arraycopy(copyFrom, 2, copyTo, 0, 7);
      System.out.println(new String(copyTo));
   }
}
```

Output:caffein

Addition of 2 matrices in java

Let's see a simple example that adds two matrices.

```
class Testarray5{
public static void main(String args[]){
//creating two matrices
int a[][]={{1,3,4},{3,4,5}};
int b[][]={{1,3,4},{3,4,5}};
  //creating another matrix to store the sum of two matrices
int c[][]=new int[2][3];
  //adding and printing addition of 2 matrices
for(int i=0;i<2;i++){
for(int j=0;j<3;j++){
c[i][j]=a[i][j]+b[i][j];
System.out.print(c[i][j]+" ");
}
System.out.println();//new line
}
  }}
```

Output:2 6 8
6 8 10