UNIT-I: Introduction to OOP & Java

Object-oriented concepts, need of Java programming, basics of Java: history, features, paradigms, programming constructs, static modifier, final modifier, difference between Java & other languages like C and C++.

Fundamentals of Classes & Objects: Identify classes and objects in real word application, declaring objects, assigning objects, reference variables, overloading methods, constructors, 'this' keyword, wrapper classes.

Applications: Object as a parameter, argument passing, command line arguments, returning object.

Nested classes: Inner classes, garbage collection, arrays.

What is Java?

Java is a **programming language** and a **platform**. Java is a high level, robust, object-oriented and secure programming language.

Java was developed by *Sun Microsystems* (which is now the subsidiary of Oracle) in the year 1995. *James Gosling* is known as the father of Java. Before Java, its name was *Oak*. Since Oak was already a registered company, so James Gosling and his team changed the name from Oak to Java.

Platform: Any hardware or software environment in which a program runs, is known as a platform. Since Java has a runtime environment (JRE) and API, it is called a platform.

Application

According to Sun, 3 billion devices run Java. There are many devices where Java is currently used. Some of them are as follows:

1. Desktop Applications such as acrobat reader, media player, antivirus, etc.
2. Web Applications such as irctc.co.in, javatpoint.com, etc.
3. Enterprise Applications such as banking applications.
4. Mobile
5. Embedded System
6. Smart Card
7. Robotics
8. Games, etc.

Types of Java Applications

There are mainly 4 types of applications that can be created using Java programming:

1) Standalone Application

Standalone applications are also known as desktop applications or window-based applications. These are traditional software that we need to install on every machine. Examples of standalone application are Media player, antivirus, etc. AWT and Swing are used in Java for creating standalone applications.

2) Web Application

An application that runs on the server side and creates a dynamic page is called a web application. Currently, Servlet, JSP, Struts, Spring, Hibernate, JSF, etc. technologies are used for creating web applications in Java.

3) Enterprise Application

An application that is distributed in nature, such as banking applications, etc. is called an enterprise application. It has advantages like high-level security, load balancing, and clustering. In Java, EJB is used for creating enterprise applications.

4) Mobile Application

An application which is created for mobile devices is called a mobile application. Currently, Android and Java ME are used for creating mobile applications.

Java Platforms / Editions

There are 4 platforms or editions of Java:

1) Java SE (Java Standard Edition)

It is a Java programming platform. It includes Java programming APIs such as java.lang, java.io, java.net, java.util, java.sql, java.math etc. It includes core topics like OOPs, String, Regex, Exception, Inner classes, Multithreading, I/O Stream, Networking, AWT, Swing, Reflection, Collection, etc.

2) Java EE (Java Enterprise Edition)

It is an enterprise platform that is mainly used to develop web and enterprise applications. It is built on top of the Java SE platform. It includes topics like Servlet, JSP, Web Services, EJB, JPA, etc.

3) Java ME (Java Micro Edition)

It is a micro platform that is dedicated to mobile applications.

4) JavaFX

It is used to develop rich internet applications. It uses a lightweight user interface API.

Features of Java

1. The primary objective of Java programming language creation was to make it portable, simple and secure programming language. Apart from this, there are also some excellent features which play an important role in the popularity of this language. The features of Java are also known as Java buzzwords. 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 Microsystem, 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 complicated and rarely-used features, for example, explicit pointers, operator overloading, etc.
- There is no need to remove unreferenced objects because there is an Automatic Garbage Collection in Jav

Object-oriented

Java is an 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 incorporate 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

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 a software-based platform.

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

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

Java code can be executed on multiple platforms, for example, 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 a virtual machine sandbox**

Robust

The English mining of Robust is strong. Java is robust because:

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

Architecture-neutral

Java is architecture neutral because there are no implementation dependent features, for example, the 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. However, it occupies 4 bytes of memory for both 32 and 64-bit architectures in Java.

Portable

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

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 the dynamic loading of classes. It means classes are loaded on demand. It also supports functions from its native languages, i.e., C and C++.

C++ vs Java

Comparison Index	C++	Java
Platform-independent	C++ is platform-dependent.	Java is platform-independent.
Mainly used for	C++ is mainly used for system programming.	Java is mainly used for application programming. It is widely used in Windows-based, web-based, enterprise, and mobile applications.
Design Goal	C++ was designed for systems and applications programming. It was an extension of the C programming language.	Java was designed and created as an interpreter for printing systems but later extended as a support network computing.

		It was designed to be easy to use and accessible to a broader audience.
Goto	C++ supports the goto statement.	Java doesn't support the goto statement.
Multiple inheritance	C++ supports multiple inheritance.	Java doesn't support multiple inheritance through class. It can be achieved by using interfaces in java.
Operator Overloading	C++ supports operator overloading.	Java doesn't support operator overloading.
Pointers	C++ supports pointers. You can write a pointer program in C++.	Java supports pointer internally. However, you can't write the pointer program in java. It means java has restricted pointer support in java.
Compiler and Interpreter	C++ uses compiler only. C++ is compiled and run using the compiler which converts source code into machine code so, C++ is platform dependent.	Java uses both compiler and interpreter. Java source code is converted into bytecode at compilation time. The interpreter executes this bytecode at runtime and produces output. Java is interpreted that is why it is platform-independent.
Call by Value and Call by reference	C++ supports both call by value and call by reference.	Java supports call by value only. There is no call by reference in java.
Structure and Union	C++ supports structures and unions.	Java doesn't support structures and unions.
Thread Support	C++ doesn't have built-in support for threads. It relies on third-party libraries for thread support.	Java has built-in thread support.
Documentation comment	C++ doesn't support documentation comments.	Java supports documentation comment (/** ... */) to create documentation for java source code.

Virtual Keyword	C++ supports virtual keyword so that we can decide whether or not to override a function.	Java has no virtual keyword. We can override all non-static methods by default. In other words, non-static methods are virtual by default.
unsigned right shift >>>	C++ doesn't support >>> operator.	Java supports unsigned right shift >>> operator that fills zero at the top for the negative numbers. For positive numbers, it works same like >> operator.
Inheritance Tree	C++ always creates a new inheritance tree.	Java always uses a single inheritance tree because all classes are the child of the Object class in Java. The Object class is the root of the inheritance tree in java.
Hardware	C++ is nearer to hardware.	Java is not so interactive with hardware.
Object-oriented	C++ is an object-oriented language. However, in the C language, a single root hierarchy is not possible.	Java is also an object-oriented language. However, everything (except fundamental types) is an object in Java. It is a single root hierarchy as everything gets derived from java.lang.Object.

Difference between JDK, JRE, and JVM

JVM (Java Virtual Machine) Architecture

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

It is:

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 Oracle 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.

JRE

JRE is an acronym for Java Runtime Environment. It is also written as Java RTE. The Java Runtime Environment is a set of software tools which are used for developing Java applications. It is used to provide the runtime environment. It is the implementation of JVM. It physically exists. It contains a set of libraries + other files that JVM uses at runtime.

The implementation of JVM is also actively released by other companies besides Sun Micro Systems.

JDK

JDK is an acronym for Java Development Kit. The Java Development Kit (JDK) is a software development environment which is used to develop Java applications and applets. It physically exists. It contains JRE + development tools.

JDK is an implementation of any one of the below given Java Platforms released by Oracle Corporation:

- Standard Edition Java Platform
- Enterprise Edition Java Platform
- Micro Edition Java Platform

The JDK contains a private Java Virtual Machine (JVM) and a few other resources such as an interpreter/loader (java), a compiler (javac), an archiver (jar), a documentation generator (Javadoc), etc. to complete the development of a Java Application

OOPs (Object-Oriented Programming System)

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

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

Apart from these concepts, there are some other terms which are used in Object-Oriented design:

- Coupling
- Cohesion
- Association
- Aggregation
- Composition

Object

- Any entity that has state and behavior is known as an object. For example, a chair, pen, table, keyboard, bike, etc. It can be physical or logical.
- An Object can be defined as an instance of a class. An object contains an address and takes up some space in memory. Objects can communicate without knowing the details

of each other's data or code. The only necessary thing is the type of message accepted and the type of response returned by the objects.

Example: A dog is an object because it has states like color, name, breed, etc. as well as behaviors like wagging the tail, barking, eating, etc.

Class

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

A class can also be defined as a blueprint from which you can create an individual object. Class doesn't consume any space.

Inheritance

Inheritance in Java is a mechanism in which one object acquires all the properties and behaviors of a parent object. It is an important part of OOPs

The idea behind inheritance in Java is that you can create new classes

that are built upon existing classes. When you inherit from an existing class, you can reuse methods and fields of the parent class. Moreover, you can add new methods and fields in your current class also.

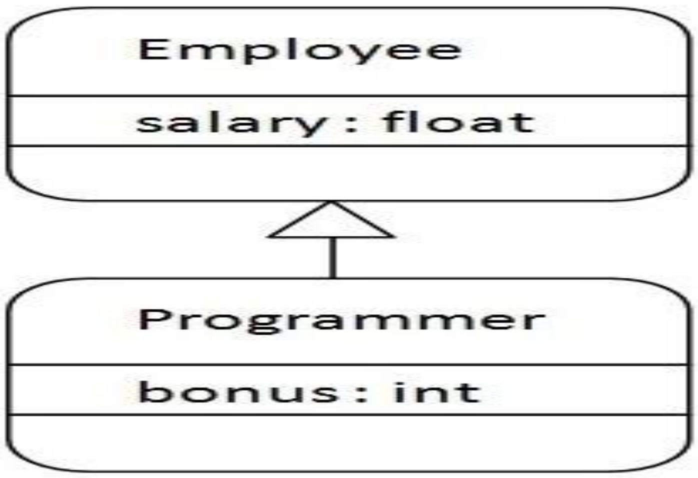
Inheritance represents the **IS-A relationship** which is also known as a *parent-child* relationship.

The syntax of Java Inheritance

```
class Subclass-name extends Superclass-name
{
   //methods and fields
}
```

The **extends keyword** indicates that you are making a new class that derives from an existing class. The meaning of "extends" is to increase the functionality.

Java Inheritance Example



As displayed in the above figure, Programmer is the subclass and Employee is the superclass. The relationship between the two classes is **Programmer IS-A Employee**. It means that Programmer is a type of Employee.

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

OUTPUT

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

In the above example, Programmer object can access the field of own class as well as of Employee class i.e. code reusability.

Polymorphism

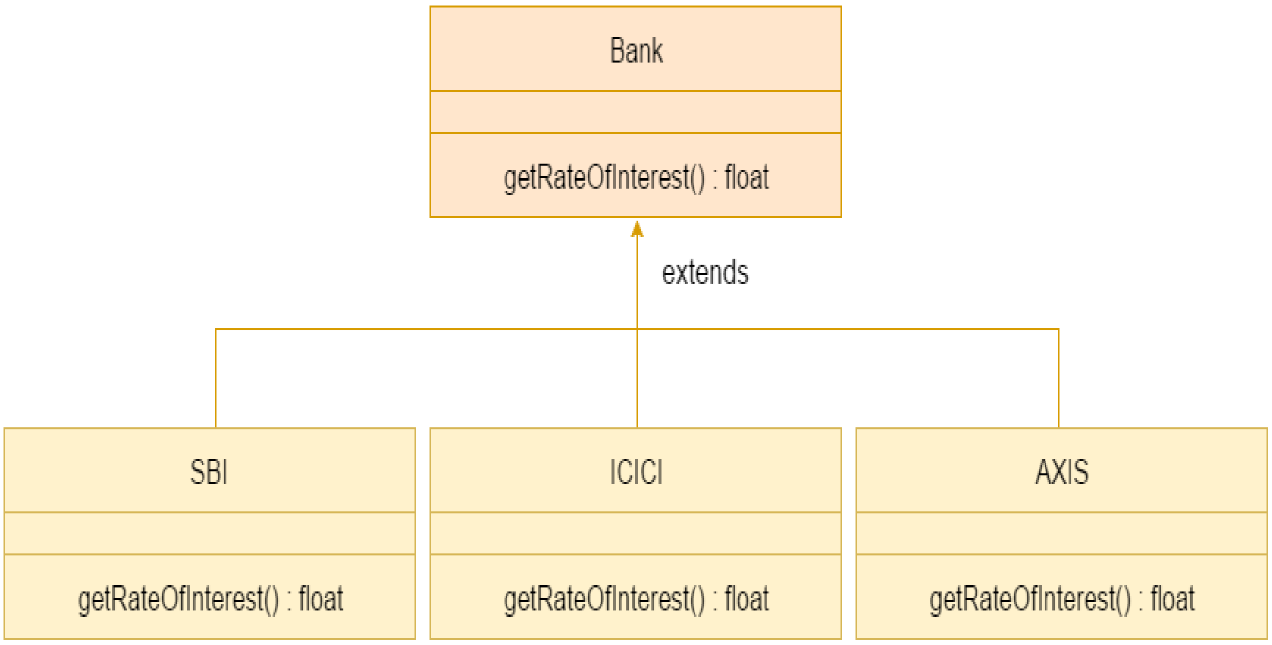
Polymorphism in Java is the task that performs a single action in different ways.

So, languages that do not support polymorphism are not ‘Object-Oriented Languages’, but, ‘Object-Based Languages’. Ada, for instance, is one such language. Since Java supports polymorphism, it is an Object-Oriented Language.

Polymorphism occurs when there is inheritance, i.e. there are many classes that are related to each other.

A real example of polymorphyism

Consider a scenario where Bank is a class that provides functionality to get the rate of interest. However, the rate of interest varies according to banks. For example, SBI, ICICI and AXIS banks could provide 8%, 7%, and 9% rate of interest.


Bank
getRateOfInterest() : float
extends
SBI
getRateOfInterest() : float
ICICI
getRateOfInterest() : float
AXIS
getRateOfInterest() : float

```java
class Bank{
int getRateOfInterest(){return 0;}
}
//Creating child classes.
class SBI extends Bank{
int getRateOfInterest(){return 8;}
}

class ICICI extends Bank{
int getRateOfInterest(){return 7;}
}
class AXIS extends Bank{
int getRateOfInterest(){return 9;}
}
//Test class to create objects and call the methods
class Test2{
public static void main(String args[]){
SBI s=new SBI();
ICICI i=new ICICI();
AXIS a=new AXIS();
System.out.println("SBI Rate of Interest: "+s.getRateOfInterest());
System.out.println("ICICI Rate of Interest: "+i.getRateOfInterest());
System.out.println("AXIS Rate of Interest: "+a.getRateOfInterest());
}
}
```

Output:

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

Abstraction.

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

In Java, we use abstract class and interface to achieve abstraction

Encapsulation

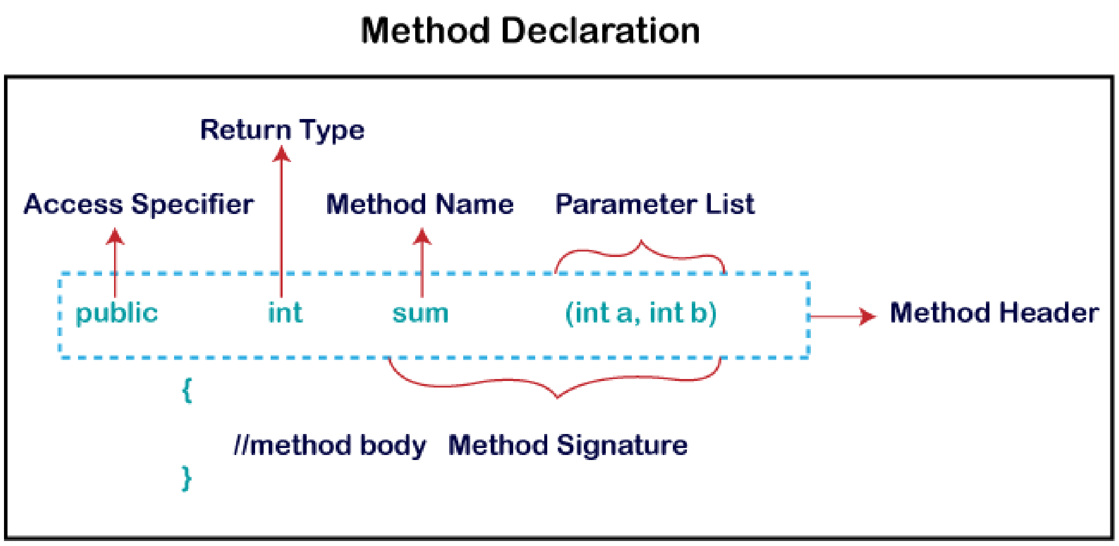
Binding (or wrapping) code and data together into a single unit are known as encapsulation. For example, a capsule, it is wrapped with different medicines.

A java class is the example of encapsulation. Java bean is the fully encapsulated class because all the data members are private here.

Method in Java

A **method** is a block of code or collection of statements or a set of code grouped together to perform a certain task or operation. It is used to achieve the **reusability** of code. We write a method once and use it many times. We do not require to write code again and again. It also provides the **easy modification** and **readability** of code, just by adding or removing a chunk of code. The method is executed only when we call or invoke it.

The most important method in Java is the main() **method**.



Types of Method

There are two types of methods in Java:

- Predefined Method/ or **built-in method**
- User-defined Method

Predefined Method

In Java, predefined methods are the method that is already defined in the Java class libraries is known as predefined methods. It is also known as the **standard library method** or **built-in method**. We can directly use these methods just by calling them in the program at any point. Some pre-defined methods are **length(), equals(),**

compareTo(), sqrt(), etc. When we call any of the predefined methods in our program, a series of codes related to the corresponding method runs in the background that is already stored in the library.

Each and every predefined method is defined inside a class. Such as **print()** method is defined in the **java.io.PrintStream** class. It prints the statement that we write inside the method. For example, **print("Java")**, it prints Java on the console.

```java
import java.util.Scanner;
public class EvenOdd
{
public static void main (String args[])
{
//creating Scanner class object
Scanner scan=new Scanner(System.in);
System.out.print("Enter the number: ");
//reading value from user
int num=scan.nextInt();
//method calling
findEvenOdd(num);
}
//user defined method
public static void findEvenOdd(int num)
{
//method body
if(num%2==0)
System.out.println(num+" is even");
else
System.out.println(num+" is odd");
}
}
```

Output 1:

```
Enter the number: 12
12 is even
```

Method Overloading in Java

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

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

Advantage of method overloading

Method overloading *increases the readability of the program*.

Different ways to overload the method

There are two ways to overload the method in java

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

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.

Note: The method that is called is determined by the compiler. Hence, it is also known as compile-time polymorphism.

```
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;
}
```

```java

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.

```java
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:

Method Overriding in Java

If subclass (child class) has the same method as declared in the parent class, it is known as **method overriding in Java**.

In other words, If a subclass provides the specific implementation of the method that has been declared by one of its parent class, it is known as method overriding.

Usage of Java Method Overriding

- Method overriding is used to provide the specific implementation of a method which is already provided by its superclass.
- Method overriding is used for runtime polymorphism

Rules for Java Method Overriding

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

```
    //Java Program to demonstrate the real scenario of Java Method Overriding
//where three classes are overriding the method of a parent class.
    //Creating a parent class.
    class Bank{
    int getRateOfInterest(){return 0;}
}
//Creating child classes.
class SBI extends Bank{
    int getRateOfInterest(){return 8;}
 }

    class ICICI extends Bank{
int getRateOfInterest(){return 7;}
}
class AXIS extends Bank{
int getRateOfInterest(){return 9;}
}
//Test class to create objects and call the methods
class Test2{
    public static void main(String args[]){
       SBI s=new SBI();
       ICICI i=new ICICI();
       AXIS a=new AXIS();
       System.out.println("SBI Rate of Interest: "+s.getRateOfInterest());
       System.out.println("ICICI Rate of Interest: "+i.getRateOfInterest());
System.out.println("AXIS Rate of Interest: "+a.getRateOfInterest());
       }
          }
```

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

Can we override static method?

No, a static method cannot be overridden. It can be proved by runtime polymorphism, so we will learn it later.

Why can we not override static method?

It is because the static method is bound with class whereas instance method is bound with an object. Static belongs to the class area, and an instance belongs to the heap area.

Can we override java main method?

No, because the main is a static method.

Difference between method Overloading and Method Overriding in java

No.	Method Overloading	Method Overriding
1)	Method overloading is used *to increase the readability* of the program.	Method overriding is used *to provide the specific implementation* of the method that is already provided by its super class.
2)	Method overloading is performed *within class*.	Method overriding occurs *in two classes* that have IS-A (inheritance) relationship.
3)	In case of method overloading, *parameter must be different*.	In case of method overriding, *parameter must be same*.

4)	Method overloading is the example of *compile time polymorphism*.	Method overriding is the example of *run time polymorphism*.
5)	In java, method overloading can't be performed by changing return type of the method only. *Return type can be same or different* in method overloading. But you must have to change the parameter.	*Return type must be same or covariant* in method overriding.

this keyword in Java

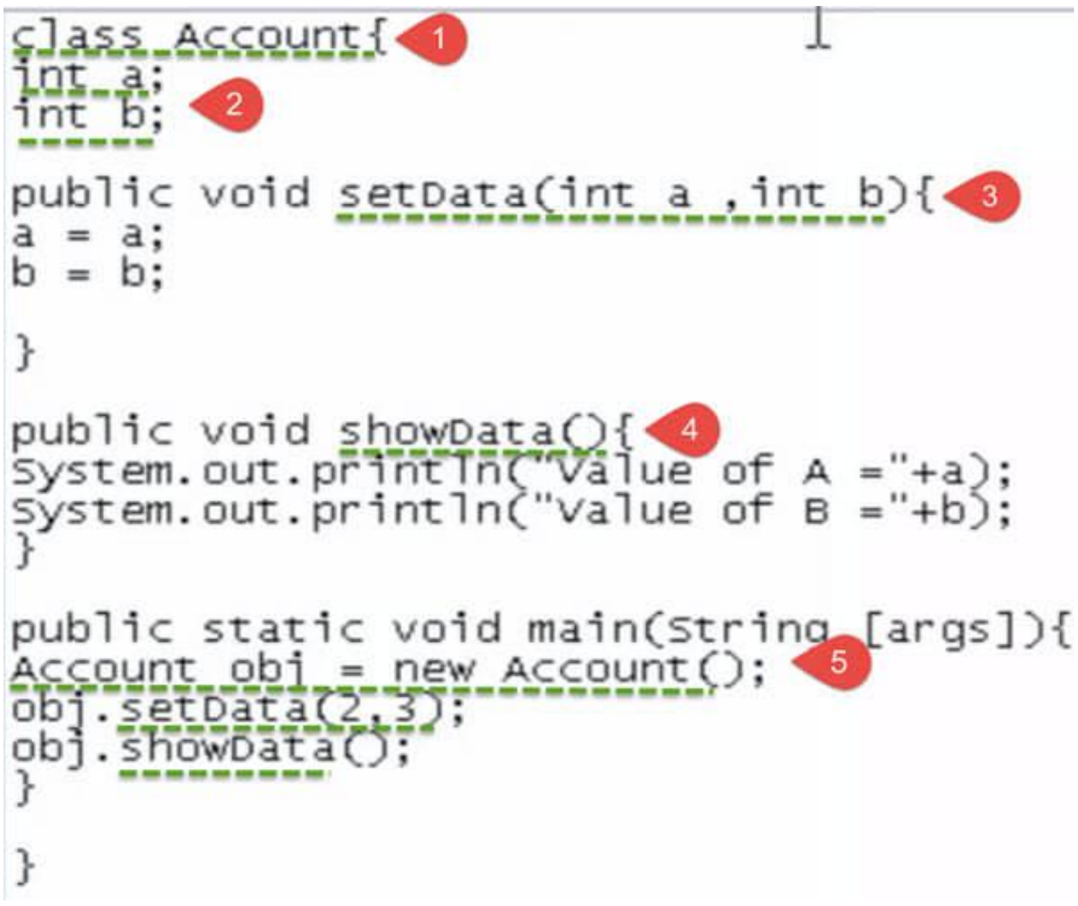
this keyword in Java is a reference variable that refers to the current object of a method or a constructor. The main purpose of using this keyword in Java is to remove the confusion between class attributes and parameters that have same names..

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.

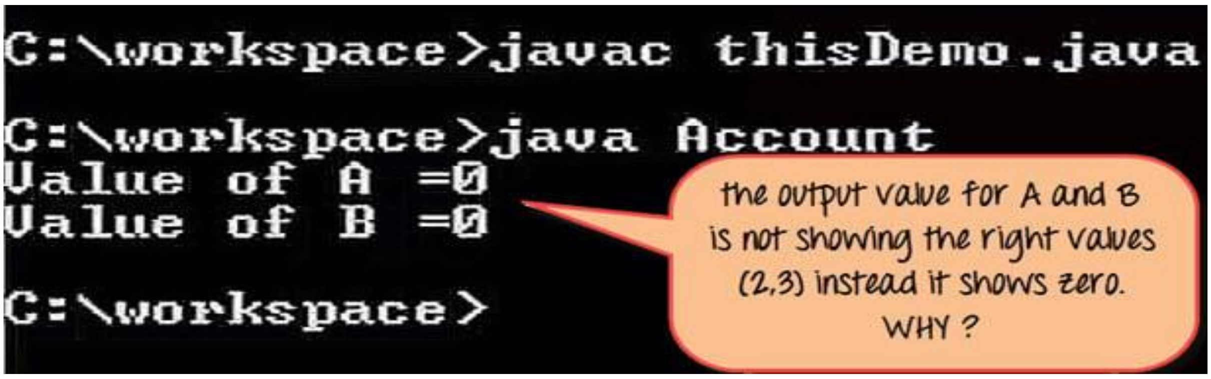
Understand 'this' keyword with an example.



```
class Account{
int a;
int b;

public void setData(int a ,int b){
a = a;
b = b;

}

public void showData(){
System.out.println("Value of A ="+a);
System.out.println("Value of B ="+b);
}

public static void main(String [args]){
Account obj = new Account();
obj.setData(2,3);
obj.showData();
}

}
```

1. **Class**: class Account
2. **Instance Variable**: a and b
3. **Method Set data**: To set the value for a and b.
4. **Method Show data**: To display the values for a and b.
5. **Main method:** where we create an object for Account class and call methods set data and show data.

Let's compile and run the code



```
C:\workspace>javac thisDemo.java

C:\workspace>java Account
Value of A =0
Value of B =0

C:\workspace>
```

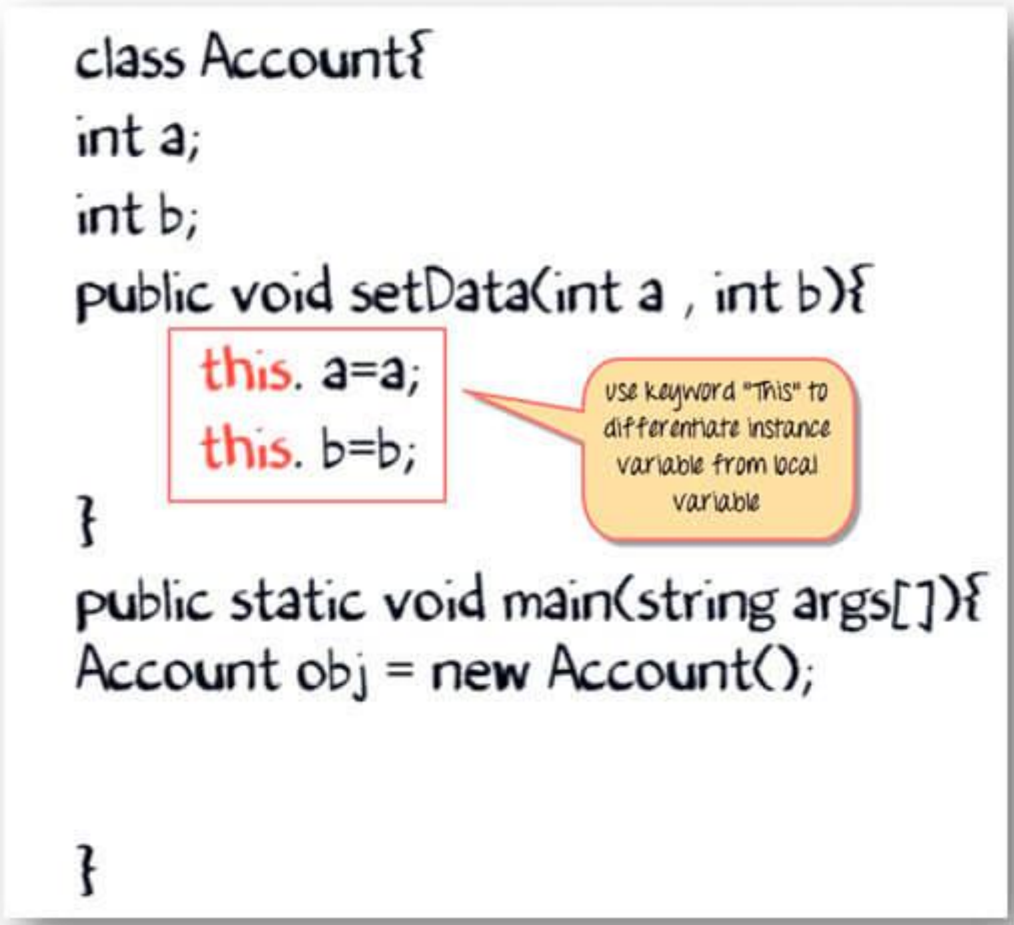
the output value for A and B is not showing the right values (2,3) instead it shows zero. WHY ?

In the method Set data, the arguments are declared as a and b, while the instance variables are also named as a and b.

During execution, the compiler is confused. Whether “a” on the left side of the assigned operator is the instance variable or the local variable. Hence, it does not set the value of ‘a’ when the method set data is called.

The solution is the “this” keyword

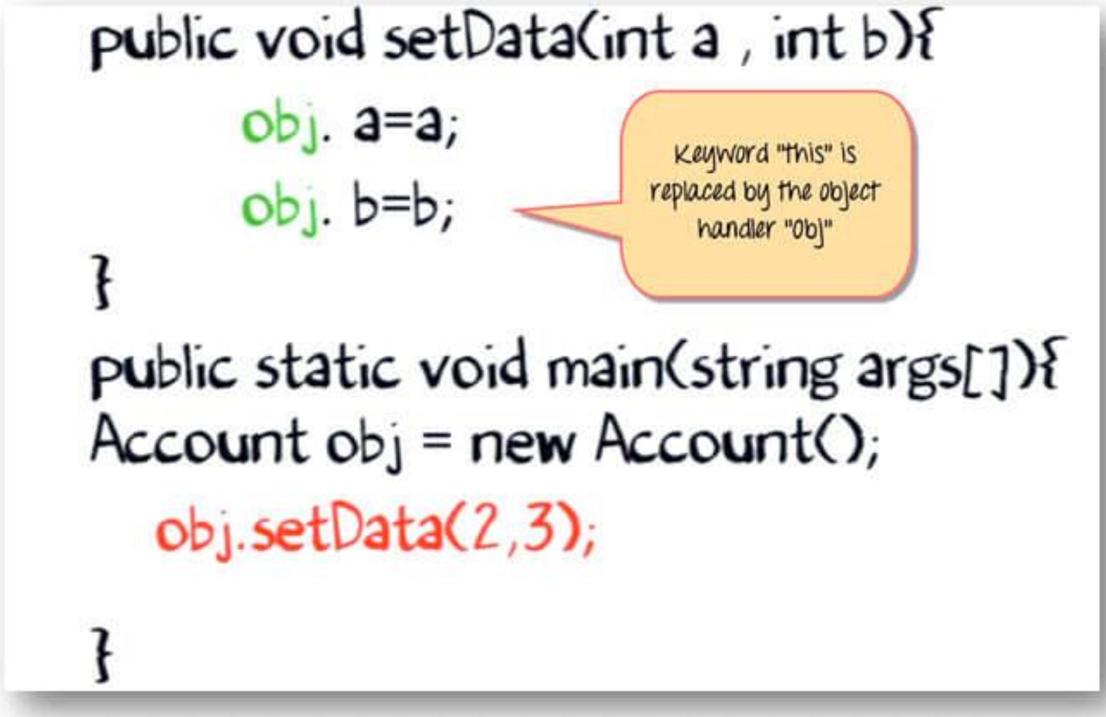
Append both ‘a’ and ‘b’ with the Java this keyword followed by a dot (.) operator.



```
class Account{
int a;
int b;
public void setData(int a , int b){
        this. a=a;
        this. b=b;
}
public static void main(string args[]){
Account obj = new Account();


}
```

use keyword "This" to differentiate instance variable from local variable

During code execution when an object calls the method ‘setdata’. The keyword ‘this’ is replaced by the object handler “obj.” (See the image below).

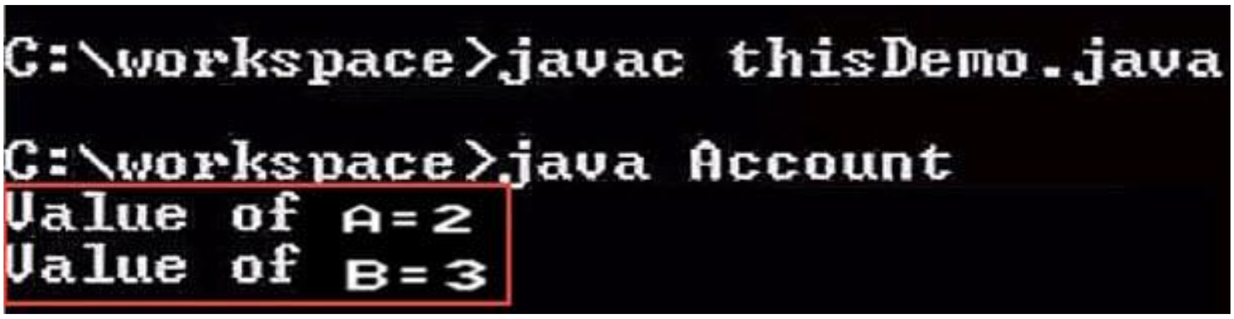


```
public void setData(int a , int b){
        obj. a=a;
        obj. b=b;
}
public static void main(string args[]){
Account obj = new Account();
    obj.setData(2,3);

}
```

So now the compiler knows,

- The ‘a’ on the left-hand side is an Instance variable.
- Whereas the ‘a’ on right-hand side is a local variable

The variables are initialized correctly, and the expected output is shown.



```
C:\workspace>javac thisDemo.java

C:\workspace>java Account
Value of A=2
Value of B=3
```

Constructors in Java

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

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

Every time an object is created using the new keyword, at least one constructor is called.

It calls a default constructor if there is no constructor available in the class. In such case, Java compiler provides a default constructor by default.

There are two types of constructors in Java: no-arg constructor, and parameterized constructor.

Rules for creating Java constructor

There are two rules defined for the constructor.

1. Constructor name must be the same as its class name
2. A Constructor must have no explicit return type
3. A Java constructor cannot be abstract, static, final, and synchronized

Types of Java constructors

There are two types of constructors in Java:

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

Example of default constructor

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

```
//Java Program to create and call a default constructor
class Bike1{
//creating a default constructor
Bike1(){
System.out.println("Bike is created");}
//main method
public static void main(String args[]){
    //calling a default constructor
    Bike1 b=new Bike1();
}
}
```

Output:

```
Bike is created
```

Java No-argument constructor

```java
class Student {
    int id;
    String name;
    //creating a parameterized constructor
    Student(){
    id = 13;
    name = “Sujata”;
    }
    //method to display the values
    void display(){System.out.println(id+" "+name);}

    public static void main(String args[]){
    //creating objects and passing values
    Student s1 = new Student(111,"Karan");
    Student s2 = new Student();
    //calling method to display the values of object
    s1.display();
    s2.display();
   }
   }
```

Output:

```
111 Karan
13  Sujata
```

Java Parameterized Constructor

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

Why use the parameterized constructor?

The parameterized constructor is used to provide different values to distinct objects. However, you can provide the same values also.

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.

```
//Java Program to demonstrate the use of the parameterized constructor.
class Student{
   int id;
   String name;
   //creating a parameterized constructor
   Student(int i,String n){
   id = i;
   name = n;
   }
   //method to display the values
   void display(){System.out.println(id+" "+name);}

   public static void main(String args[]){
   //creating objects and passing values
   Student s1 = new Student(111,"Karan");
   Student s2 = new Student(222,"Aryan");
   //calling method to display the values of object
   s1.display();
   s2.display();
  }
}
```

Output:

```
111 Karan
222 Aryan
```

Difference between constructor and method in Java

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

Java Constructor	Java Method
A constructor is used to initialize the state of an object.	A method is used to expose the behavior of an object.

A constructor must not have a return type.	A method must have a return type.
The constructor is invoked implicitly.	The method is invoked explicitly.
The Java compiler provides a default constructor if you don't have any constructor in a class.	The method is not provided by the compiler in any case.
The constructor name must be same as the class name.	The method name may or may not be same as the class name.

Java static keyword

The **static keyword** in Java

is used for memory management mainly. We can apply static keyword with variables

, methods, blocks and nested classes

. The static keyword belongs to the class than an instance of the class.

The static can be:

1. Variable (also known as a class variable)
2. Method (also known as a class method)
3. Block
4. Nested class

1) Java static variable

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

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

Understanding the 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 the object is created. All students have its unique rollno and name, so instance data member is good in such case. Here, "college" refers to the common property of all objects

. If we make it static, this field will get the memory only once.

Example of static variable

```
//Java Program to demonstrate the use of static variable
class Student{
  int rollno;//instance variable
  String name;
  static String college ="ITS";//static variable
  //constructor
  Student(int r, String n){
  rollno = r;
  name = n;
  }
  //method to display the values
  void display (){System.out.println(rollno+" "+name+" "+college);}
}
//Test class to show the values of objects
public class TestStaticVariable1{
 public static void main(String args[]){
 Student s1 = new Student(111,"Karan");
 Student s2 = new Student(222,"Aryan");
 //we can change the college of all objects by the single line of code
 //Student.college="BBDIT";
 s1.display();
 s2.display();
 }
}
```

Output:

```
111 Karan ITS
222 Aryan ITS
```

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

Example of static method

```
//Java Program to demonstrate the use of a static method.
class Student{
    int rollno;
    String name;
    static String college = "ITS";
    //static method to change the value of static variable
    static void change(){
    college = "BBDIT";
    }
    //constructor to initialize the variable
    Student(int r, String n){
    rollno = r;
    name = n;
    }
    //method to display values
    void display(){System.out.println(rollno+" "+name+" "+college);}
}
//Test class to create and display the values of object
public class TestStaticMethod{
   public static void main(String args[]){
   Student.change();//calling change method
   //creating objects
   Student s1 = new Student(111,"Karan");
   Student s2 = new Student(222,"Aryan");
   Student s3 = new Student(333,"Sonoo");
   //calling display method
   s1.display();
   s2.display();
   s3.display();
   }
}
```

Test it Now

```
Output:111 Karan BBDIT
       222 Aryan BBDIT
       333 Sonoo BBDIT
```

Restrictions for the 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

Why is the Java main method static?

Ans) It is because the object is not required to call a static method. If it were a non-static method, JVM creates an object first then call main() method that will lead the problem of extra memory allocation.

Final Keyword In Java

The **final keyword** in java is used to restrict the user. The java final keyword can be used in many context. Final can be:

1. variable
2. method
3. class

The final keyword can be applied with the variables, a final variable that have no value it is called blank final variable or uninitialized final variable. It can be initialized in the constructor only. The blank final variable can be static also which will be initialized in the static block only. We will have detailed learning of these. Let's first learn the basics of final keyword.

1) Java final variable

If you make any variable as final, you cannot change the value of final variable(It will be constant).

Example of final variable

There is a final variable speedlimit, we are going to change the value of this variable, but It can't be changed because final variable once assigned a value can never be changed.

```
class Bike9{
 final int speedlimit=90;//final variable
 void run(){
  speedlimit=400;
 }
 public static void main(String args[]){
 Bike9 obj=new  Bike9();
 obj.run();
 }
}//end of class
```

```
Output:Compile Time Error
```

2) Java final method

If you make any method as final, you cannot override it.

Example of final method

```
class Bike{
  final void run(){System.out.println("running");}
}

class Honda extends Bike{
   void run(){System.out.println("running safely with 100kmph");}

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

```
Output:Compile Time Error
```

3) Java final class

If you make any class as final, you cannot extend it.

Example of final class

```
final class Bike{}

class Honda1 extends Bike{
  void run(){System.out.println("running safely with 100kmph");}

  public static void main(String args[]){
  Honda1 honda= new Honda1();
  honda.run();
  }
}
```

```
Output:Compile Time Error
```

Q) Is final method inherited?

Ans) Yes, final method is inherited but you cannot override it. For Example:

```
class Bike{
  final void run(){System.out.println("running...");}
}
class Honda2 extends Bike{
   public static void main(String args[]){
    new Honda2().run();
   }
}
```

```
Output:running...
```

Wrapper classes in Java

Wrapper classes in Java

The **wrapper class in Java** provides the mechanism *to convert primitive into object and object into primitive*.

Since J2SE 5.0, **autoboxing** and **unboxing** feature convert primitives into objects and objects into primitives automatically. The automatic conversion of primitive into an object is known as autoboxing and vice-versa unboxing.

Use of Wrapper classes in Java

Java is an object-oriented programming language, so we need to deal with objects many times like in Collections, Serialization, Synchronization, etc. Let us see the different scenarios, where we need to use the wrapper classes.

- **Change the value in Method:** Java supports only call by value. So, if we pass a primitive value, it will not change the original value. But, if we convert the primitive value in an object, it will change the original value.
- **Serialization:** We need to convert the objects into streams to perform the serialization. If we have a primitive value, we can convert it in objects through the wrapper classes.
- **Synchronization:** Java synchronization works with objects in Multithreading.
- **java.util package:** The java.util package provides the utility classes to deal with objects.
- **Collection Framework:** Java collection framework works with objects only. All classes of the collection framework (ArrayList, LinkedList, Vector, HashSet, LinkedHashSet, TreeSet, PriorityQueue, ArrayDeque, etc.) deal with objects only.

The eight classes of the *java.lang* package are known as wrapper classes in Java. The list of eight wrapper classes are given below:

Primitive Type	Wrapper class
boolean	Boolean
char	Character
byte	Byte

short	Short
int	Integer
long	Long
float	Float
double	Double

Autoboxing

The automatic conversion of primitive data type into its corresponding wrapper class is known as autoboxing, for example, byte to Byte, char to Character, int to Integer, long to Long, float to Float, boolean to Boolean, double to Double, and short to Short.

Since Java 5, we do not need to use the valueOf() method of wrapper classes to convert the primitive into objects.

Wrapper class Example: Primitive to Wrapper

```
//Java program to convert primitive into objects
//Autoboxing example of int to Integer
public class WrapperExample1{
public static void main(String args[]){
//Converting int into Integer
int a=20;
Integer i=Integer.valueOf(a);//converting int into Integer explicitly
Integer j=a;//autoboxing, now compiler will write Integer.valueOf(a) internally

System.out.println(a+" "+i+" "+j);
}}
```

Output:

```
20 20 20
```

Unboxing

The automatic conversion of wrapper type into its corresponding primitive type is known as unboxing. It is the reverse process of autoboxing. Since Java 5, we do not need to use the intValue() method of wrapper classes to convert the wrapper type into primitives.

Wrapper class Example: Wrapper to Primitive

```java
//Java program to convert object into primitives
//Unboxing example of Integer to int
public class WrapperExample2{
public static void main(String args[]){
//Converting Integer to int
Integer a=new Integer(3);
int i=a.intValue();//converting Integer to int explicitly
int j=a;//unboxing, now compiler will write a.intValue() internally

System.out.println(a+" "+i+" "+j);
}}
```

Output:

```
3 3 3
```

Java Command Line Arguments

The java command-line argument is an argument i.e. passed at the time of running the java program.

The arguments passed from the console can be received in the java program and it can be used as an input.

So, it provides a convenient way to check the behavior of the program for the different values. You can pass **N** (1,2,3 and so on) numbers of arguments from the command prompt.

Simple example of command-line argument in java

In this example, we are receiving only one argument and printing it. To run this java program, you must pass at lea
argument from the command prompt.

```java
class CommandLineExample{
public static void main(String args[]){
System.out.println("Your first argument is: "+args[0]);
}
}
```

```
compile by > javac CommandLineExample.java
run by > java CommandLineExample sonoo
```

```
Output: Your first argument is: sonoo
```

Example of command-line argument that prints all the values

In this example, we are printing all the arguments passed from the command-line. For this purpose, we have travers
array using for loop.

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

for(int i=0;i<args.length;i++)
System.out.println(args[i]);

}
}
```

```
compile by > javac A.java
run by > java A sonoo jaiswal 1 3 abc
```

```
Output: sonoo
       jaiswal
       1
       3
       abc
```

Access Modifiers in Java

There are two types of modifiers in Java: **access modifiers** and **non-access modifiers**.

The access modifiers in Java specifies the accessibility or scope of a field, method, constructor, or class. We can change the access level of fields, constructors, methods, and class by applying the access modifier on it.

There are four types of Java access modifiers:

1. **Private**: The access level of a private modifier is only within the class. It cannot be accessed from outside the class.
2. **Default**: The access level of a default modifier is only within the package. It cannot be accessed from outside the package. If you do not specify any access level, it will be the default.
3. **Protected**: The access level of a protected modifier is within the package and outside the package through child class. If you do not make the child class, it cannot be accessed from outside the package.

4. **Public**: The access level of a public modifier is everywhere. It can be accessed from within the class, outside the class, within the package and outside the package.

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

Understanding Java Access Modifiers

Let's understand the access modifiers in Java 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

1) Private

The private access modifier is accessible only within the 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 a 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

If you don't use any modifier, it is treated as **default** by default. The default modifier is accessible only within package. It cannot be accessed from outside the package. It provides more accessibility than private. But, it is more restrictive than protected, and public.

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

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.

It provides more accessibility than the default modifer.

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

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

Example of public access modifier

```java
//save by A.java

package pack;
public class A{
public void msg(){System.out.println("Hello");}
}
```

```java
//save by B.java

package mypack;
import pack.*;

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

```
Output:Hello
```

Java Inner Classes (Nested Classes)

In Java, just like methods, variables of a class too can have another class as its member. Writing a class within another is allowed in Java. The class written within is called the nested class, and the class that holds the inner class is called the outer class.

Following is the syntax to write a nested class. Here, the class Outer_Demo is the outer class and the class Inner_Demo is the nested class.

```
Syntax of Inner class

class Java_Outer_class{

//code class Java_Inner_class{

//code }

}
```

Advantage of Java inner classes

There are three advantages of inner classes in Java. They are as follows:

1. Nested classes represent a particular type of relationship that is it can access all the members (data members and methods) of the outer class, including private.

2. Nested classes are used to develop more readable and maintainable code because it logically group classes and interfaces in one place only.

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

Need of Java Inner class

Sometimes users need to program a class in such a way so that no other class can access it. Therefore, it would be better if you include it within other classes. If all the class objects are a part of the outer object then it is easier to nest that class inside the outer class. That way all the outer class can access all the objects of the inner class.

Nested classes are divided into two types −

□ Non-static nested classes − These are the non-static members of a class.

Inner Classes (Non-static Nested Classes)

Inner classes are a security mechanism in Java. We know a class cannot be associated with the access modifier private, but if we have the class as a member of other class, then then inner class can be made private. And this is also used to access the private members of a class.

Inner classes are of three types depending on how and where you define them. They are −

** Inner Class Method-local Inner Class**

** Anonymous Inner Class**

Inner Class

Creating an inner class is quite simple. You just need to write a class within a class.
Unlike a class, an inner class can be private and once you declare an inner class private, it cannot be accessed from an object outside the class.
Following is the program to create an inner class and access it. In the given example, we make the inner class private and access the class through a method.

Example

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

Output

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

Here you can observe that Outer_Demo is the outer class, Inner_Demo is the inner

class, display_Inner() is the method inside which we are instantiating the inner class, and this method is invoked from the main method.

Another Example of inner class

```
class Outer {

  void outerMethod() {

    int x = 98;

    System.out.println("inside outerMethod");

    class Inner {

      void innerMethod() {

        System.out.println("x= "+x);

      }
    }

    Inner y = new Inner();

    y.innerMethod();

  }
}
class MethodLocalVariableDemo {

  public static void main(String[] args) {

    Outer x=new Outer();

    x.outerMethod();
  }
}
```

Output

```
inside outerMethod

x= 98
```

Java Garbage Collection

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

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

Advantage of Garbage Collection

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

How can an object be unreferenced?

There are many ways:

1) By nulling a reference:

1. Employee e=new Employee();

2. e=null;

2) By assigning a reference to another:

1. Employee e1=new Employee();

2. Employee e2=new Employee();

3. e1=e2;//now the first object referred by e1 is available for garbage collection

3) By anonymous object:

1. new Employee();

finalize() method

The finalize() method is invoked each time before the object is garbage collected. This method can be used to perform cleanup processing. This method is defined in Object class as:

1. protected void finalize(){}

Note: The Garbage collector of JVM collects only those objects that are created by new keyword. So if you have created any object without new, you can use finalize method to perform cleanup processing (destroying remaining objects).

gc() method

The gc() method is used to invoke the garbage collector to perform cleanup processing. The

gc() is found in System and Runtime classes.

1. public static void gc(){}

Note: Garbage collection is performed by a daemon thread called Garbage Collector (GC).

This thread calls the finalize() method before object is garbage collected.

Java Arrays

Java array is an object which contains elements of a similar data type. Additionally, The elements of an array are stored in a contiguous memory location. It is a data structure where we store similar elements. We can store only a fixed set of elements in a Java array.

Array in Java is index-based, the first element of the array is stored at the 0th index, 2nd element is stored on 1st index and so on.

In Java, array is an object of a dynamically generated class. Java array inherits the Object class, and implements the Serializable as well as Cloneable interfaces. We can store primitive values or objects in an array in

Java. Like C/C++, we can also create single dimensional or multidimensional arrays in Java.

Arrays are first class objects in java. An object which does not require ‘new’ operator

to create that object is called first class object.

```
int arr[]=new int [10];

int arr[]={0,1,2.......};

int []arr={0,1,2,.......};
```

Advantages

1. Code Optimization: It makes the code optimized, we can retrieve or sort the data efficiently.

2. Random access: We can get any data located at an index position.

Disadvantages

1. Size Limit: We can store only the fixed size of elements in the array. It doesn't grow its

2.size at runtime. To solve this problem, collection framework is used in Java which grows automatically.

Types of Arrays in java

There are two types of arrays.

o Single Dimensional Array

o Multidimensional Array

Single Dimensional Array in Java

Syntax to Declare an Array in Java

```
// declare an array
dataType [] arrayName;

double[] data;

// allocate memory
data = new double[10];
```

How to Initialize Arrays in Java?

In Java, we can initialize arrays during declaration. For example,

```
//declare and initialize and array
int[] age = {12, 4, 5, 2, 5};
```

Here, we have created an array named age and initialized it with the values inside the curly brackets.

Note that we have not provided the size of the array. In this case, the Java compiler automatically specifies the size by counting the number of elements in the array (i.e. 5).

In the Java array, each memory location is associated with a number. The number is known as an array index. We can also initialize arrays in Java, using the index number. For example,

```
// declare an array
int[] age = new int[5];

// initialize array
age[0] = 12;
age[1] = 4;
age[2] = 5;
..
```

How to Access Elements of an Array in Java?

We can access the element of an array using the index number. Here is the syntax for accessing elements of an array,

```
// access array elements
array[index]
```

Let's see an example of accessing array elements using index numbers.

Example: Access Array Elements

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

   // create an array
   int[] age = {12, 4, 5, 2, 5};

   // access each array elements
   System.out.println("Accessing Elements of Array:");
   System.out.println("First Element: " + age[0]);
   System.out.println("Second Element: " + age[1]);
   System.out.println("Third Element: " + age[2]);
   System.out.println("Fourth Element: " + age[3]);
   System.out.println("Fifth Element: " + age[4]);
 }
}
```
Run Code

Output

```
Accessing Elements of Array:
First Element: 12
Second Element: 4
Third Element: 5
Fourth Element: 2
Fifth Element: 5
```

Looping Through Array Elements

In Java, we can also loop through each element of the array. For example,

Example: Using For Loop

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

   // create an array
   int[] age = {12, 4, 5};

   // loop through the array
   // using for loop
   System.out.println("Using for Loop:");
   for(int i = 0; i < age.length; i++) {
     System.out.println(age[i]);
   }
 }
}
```
Run Code

Output

```
Using for Loop:
12
4
5
```

In the above example, we are using the for Loop in Java to iterate through each element of the array. Notice the expression inside the loop,

```
age.length
```

Here, we are using the `length` property of the array to get the size of the array.

We can also use the for-each loop to iterate through the elements of an array. For example,

Example: Using the for-each Loop

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

   // create an array
   int[] age = {12, 4, 5};

   // loop through the array
   // using for loop
   System.out.println("Using for-each Loop:");
   for(int a : age) {
     System.out.println(a);
   }
 }
}
```
Run Code

Output

```
Using for-each Loop:
12
4
5
```

Example: Compute Sum and Average of Array Elements

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

   int[] numbers = {2, -9, 0, 5, 12, -25, 22, 9, 8, 12};
   int sum = 0;
   Double average;

   // access all elements using for each loop
   // add each element in sum
   for (int number: numbers) {
     sum += number;
   }

   // get the total number of elements
   int arrayLength = numbers.length;

   // calculate the average
   // convert the average from int to double
   average =  ((double)sum / (double)arrayLength);

   System.out.println("Sum = " + sum);
```

```
    System.out.println("Average = " + average);
  }
}
```
Run Code

Output:

```
Sum = 36
Average = 3.6
```

In the above example, we have created an array of named `numbers`. We have used the `for...each` loop to access each element of the array.

Inside the loop, we are calculating the sum of each element. Notice the line,

```
int arrayLength = number.length;
```

Here, we are using the length attribute of the array to calculate the size of the array. We then calculate the average using:

```
average = ((double)sum / (double)arrayLength);
```

Multidimensional Arrays

Arrays we have mentioned till now are called one-dimensional arrays. However, we can declare multidimensional arrays in Java.

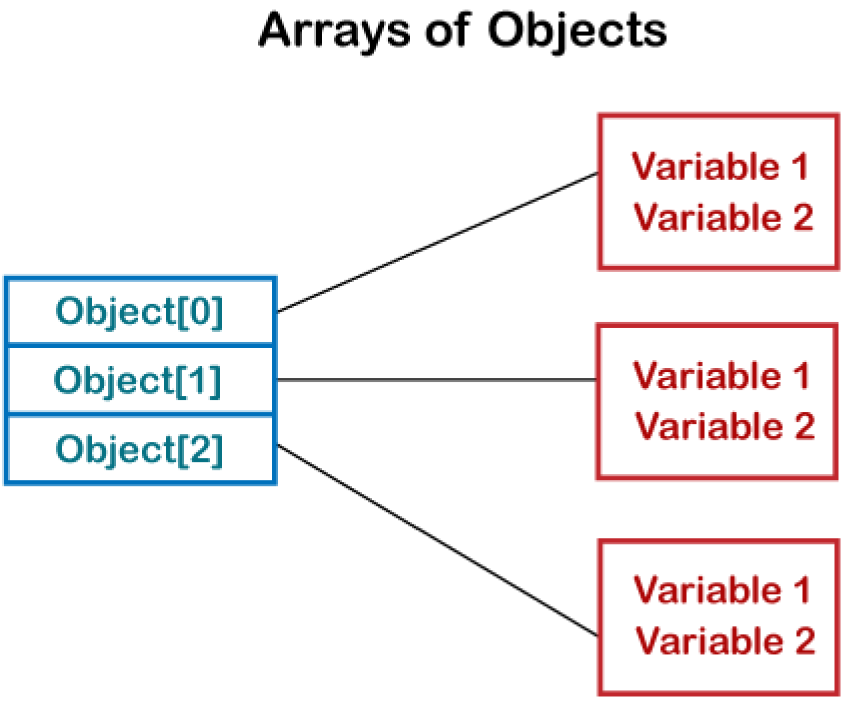
A multidimensional array is an array of arrays. That is, each element of a multidimensional array is an array itself. For example,

```
double[][] matrix = {{1.2, 4.3, 4.0},
      {4.1, -1.1}
};
```

Here, we have created a multidimensional array named matrix. It is a 2-dimensional array. To learn more, visit the Java multidimensional array.

Array of Objects in Java

Java is an object-oriented programming language. Most of the work done with the help of **objects**. We know that an array is a collection of the same data type that dynamically creates objects and can have elements of primitive types. Java allows us to store objects in an array. In Java, the class is also a user-defined data type. An array that conations **class type elements** are known as an **array of objects**. It stores the reference variable of the object.



Creating an Array of Objects

Before creating an array of objects, we must create an instance of the class by using the new keyword. We can use any of the following statements to create an array of objects.

Syntax:

```
ClassName obj[]=new ClassName[array_length]; //declare and instantiate an array of objects
```

Or

```
ClassName[] objArray;
```

Or

```
ClassName objeArray[];
```

Suppose, we have created a class named Employee. We want to keep records of 20 employees of a company having three departments. In this case, we will not create 20 separate variables. Instead of this, we will create an array of objects, as follows.

```java
Employee department1[20];
Employee department2[20];
Employee department3[20];
```

The above statements create an array of objects with 20 elements.

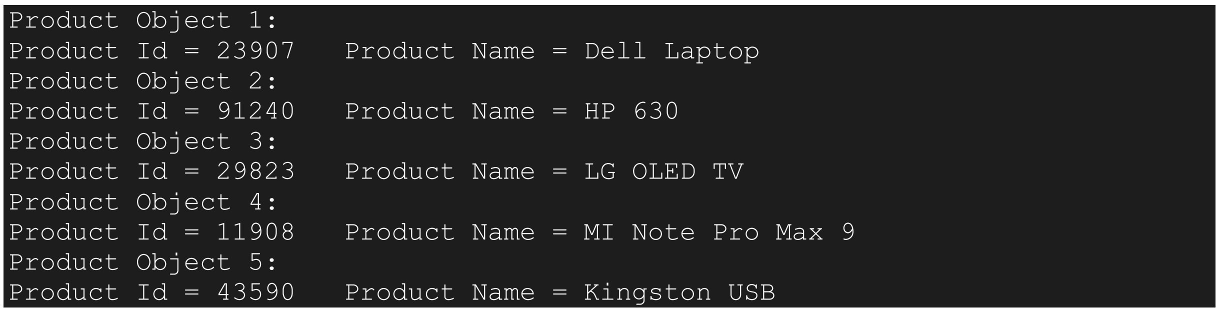
Let's create an array of objects in a Java program.

In the following program, we have created a class named Product and initialized an array of objects using the constructor. We have created a constructor of the class Product that contains product id and product name. In the main function, we have created individual objects of the class Product. After that, we have passed initial values to each of the objects using the constructor.

ArrayOfObjects.java

```java
public class ArrayOfObjects
{
public static void main(String args[])
{
//create an array of product object
Product[] obj = new Product[5] ;
//create & initialize actual product objects using constructor
obj[0] = new Product(23907,"Dell Laptop");
obj[1] = new Product(91240,"HP 630");
obj[2] = new Product(29823,"LG OLED TV");
obj[3] = new Product(11908,"MI Note Pro Max 9");
obj[4] = new Product(43590,"Kingston USB");
//display the product object data
System.out.println("Product Object 1:");
obj[0].display();
System.out.println("Product Object 2:");
obj[1].display();
System.out.println("Product Object 3:");
obj[2].display();
System.out.println("Product Object 4:");
obj[3].display();
System.out.println("Product Object 5:");
obj[4].display();
}
}
//Product class with product Id and product name as attributes
class Product
{
int pro_Id;
String pro_name;
//Product class constructor
Product(int pid, String n)
{
pro_Id = pid;
pro_name = n;
}
public void display()
{
System.out.print("Product Id = "+pro_Id + "  " + " Product Name = "+pro_name);
System.out.println();
}
}
```

Output:



```
Product Object 1:
Product Id = 23907   Product Name = Dell Laptop
Product Object 2:
Product Id = 91240   Product Name = HP 630
Product Object 3:
Product Id = 29823   Product Name = LG OLED TV
Product Object 4:
Product Id = 11908   Product Name = MI Note Pro Max 9
Product Object 5:
Product Id = 43590   Product Name = Kingston USB
```