Java OOPs Concepts

In this page, we will learn about basics of OOPs. Object Oriented Programming is a paradigm that provides many concepts such as **inheritance**, **data binding**, **polymorphism** etc.

Simula is considered as the first object-oriented programming language. The programming paradigm where everything is represented as an object, is known as truly object-oriented programming language.

Smalltalk is considered as the first truly object-oriented programming language.

OOPs (Object Oriented Programming System)

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

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

Object

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

Class

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

Inheritance

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

Polymorphism

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

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

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

Abstraction

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

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

Encapsulation

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

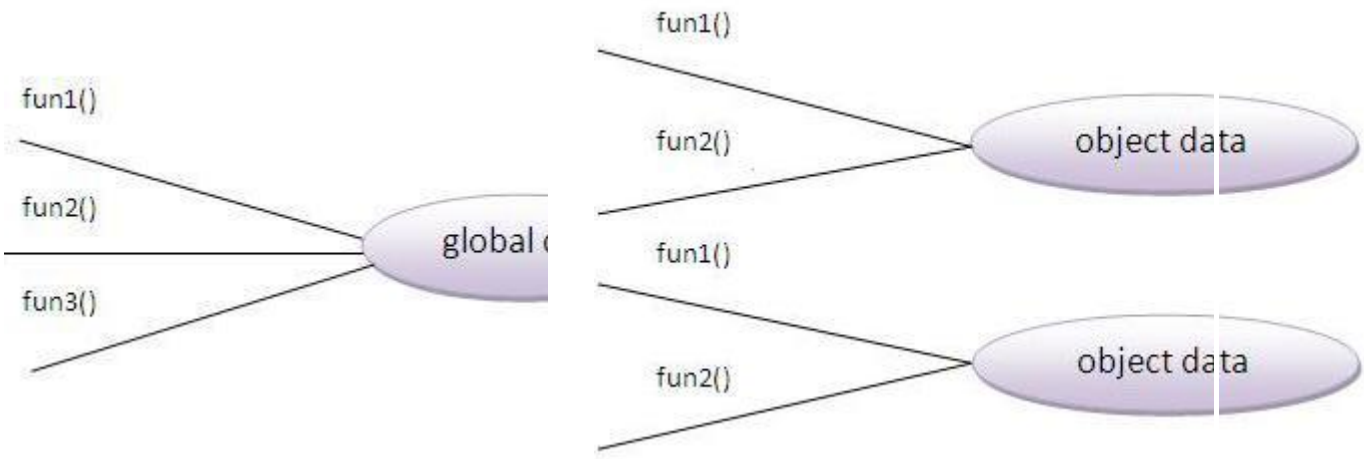
A java class is the example of encapsulation. Java bean is the fully encapsulated class because all the data members are private here.

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 prgramming 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.



What is difference between object-oriented programming language and object-based programming language?

Object based programming language follows all the features of OOPs except Inheritance. JavaScript and VBScript are examples of object based programming languages.

Java Naming conventions

Java **naming convention** is a rule to follow as you decide what to name your identifiers such as class, package, variable, constant, method etc.

But, it is not forced to follow. So, it is known as convention not rule.

All the classes, interfaces, packages, methods and fields of java programming language are given according to java naming convention.

Advantage of naming conventions in java

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

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

CamelCase in java naming conventions

Java follows camelcase syntax for naming the class, interface, method and variable.

If name is combined with two words, second word will start with uppercase letter always e.g. actionPerformed(), firstName, ActionEvent, ActionListener etc.

Object and Class in Java

In this page, we will learn about java objects and classes. In object-oriented programming technique, we design a program using objects and classes.

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 (tengible and intengible). The example of integible object is banking system.

An object has three characteristics:

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

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.

Class in Java

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

A class in java can contain:

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

Syntax to declare a class:

```
class <class_name>{
    data member;
    method;
}
```

Simple Example of Object and Class

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

```
class Student1{
 int id;//data member (also instance variable)
 String name;//data member(also instance variable)

 public static void main(String args[]){
  Student1 s1=new Student1();//creating an object of Student
  System.out.println(s1.id);
  System.out.println(s1.name);
 }
}
```

```
Output:0 null
```

Instance variable in Java

A variable that 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 runtime 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 behaviour of an object.

Advantage of Method

- Code Reusability
- Code Optimization

new keyword

The new keyword is used to allocate memory at runtime.

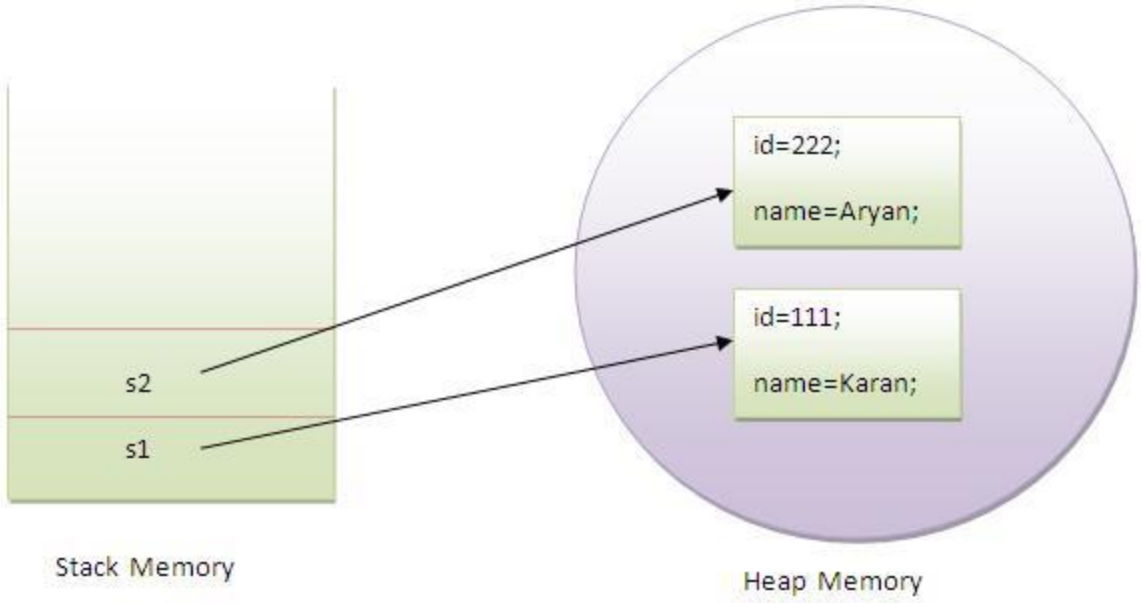
Example of Object and class that maintains the records of students

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

```
class Student2{
 int rollno;
 String name;

 void insertRecord(int r, String n){  //method
  rollno=r;
  name=n;
 }

 void displayInformation(){System.out.println(rollno+" "+name);}//method

 public static void main(String args[]){
  Student2 s1=new Student2();
  Student2 s2=new Student2();

  s1.insertRecord(111,"Karan");
  s2.insertRecord(222,"Aryan");

  s1.displayInformation();
  s2.displayInformation();

 }
}
```

```
111 Karan
```

```
222 Aryan
```



As you see in the above figure, object gets the memory in Heap area and 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.

Another Example of Object and Class

There is given another example that maintains the records of Rectangle class. Its exaplanation is same as in the above Student class example.

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

 void insert(int l,int w){
  length=l;
  width=w;
 }

 void calculateArea(){System.out.println(length*width);}

 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 factory method etc.

We will learn, these ways to create the object later.

Annonymous object

Annonymous simply means nameless.An object that have no reference is known as annonymous object.

If you have to use an object only once, annonymous object is a good approach.

```
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 annonymous 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.

1. 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);}

 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
```

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 have multiple methods by same name but different parameters, it is known as **Method Overloading**.

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

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

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

---

1)Example of Method Overloading by changing the no. of arguments

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

```
class Calculation{
  void sum(int a,int b){System.out.println(a+b);}
  void sum(int a,int b,int c){System.out.println(a+b+c);}

  public static void main(String args[]){
  Calculation obj=new Calculation();
  obj.sum(10,10,10);
  obj.sum(20,20);

  }
}
```

```
Output:30
        40
```

---

2)Example of Method Overloading by changing data type of argument

In this example, we have created two overloaded methods that differs in data type. The first sum method receives two integer arguments and second sum method receives two double arguments.

```
class Calculation2{
  void sum(int a,int b){System.out.println(a+b);}
  void sum(double a,double b){System.out.println(a+b);}

  public static void main(String args[]){
  Calculation2 obj=new Calculation2();
  obj.sum(10.5,10.5);
  obj.sum(20,20);

  }
}
```

```
Output:21.0
       40
```

Que) Why Method Overloaing is not possible by changing the return type of method?

In java, method overloading is not possible by changing the return type of the method because there may occur ambiguity. Let's see how ambiguity may occur:

because there was problem:

```
class Calculation3{
  int sum(int a,int b){System.out.println(a+b);}
  double sum(int a,int b){System.out.println(a+b);}

  public static void main(String args[]){
  Calculation3 obj=new Calculation3();
  int result=obj.sum(20,20); //Compile Time Error

  }
}
```

int result=obj.sum(20,20); //Here how can java determine which sum() method should be called

---

Can we overload main() method?

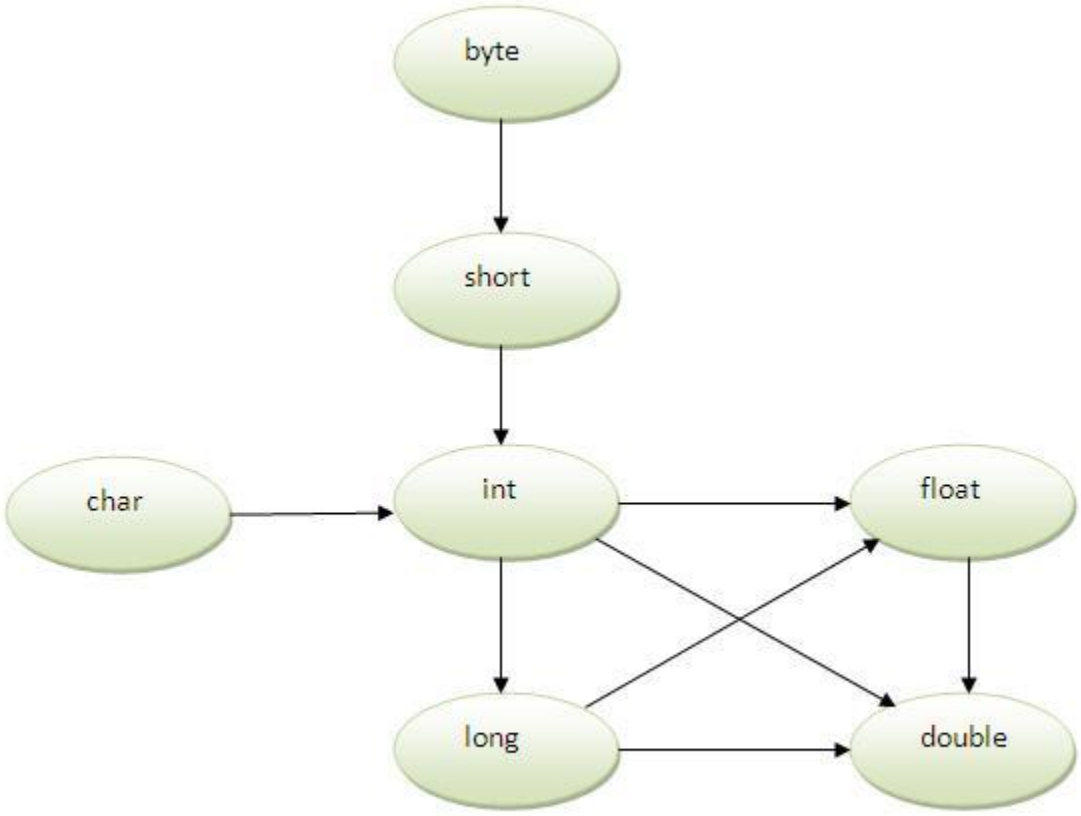
Yes, by method overloading. You can have any number of main methods in a class by method overloading. Let's see the simple example:

```
class Overloading1{
  public static void main(int a){
  System.out.println(a);
  }

  public static void main(String args[]){
  System.out.println("main() method invoked");
  main(10);
  }
}
```

```
Output:main() method invoked
       10
```

Method Overloading and TypePromotion

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 TypePromotion 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 TypePromotion in case 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
```

Constructor in Java

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

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

Rules for creating java constructor

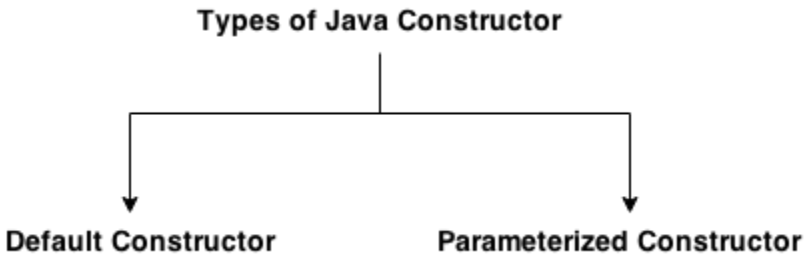
There are basically two rules defined for the constructor.

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

Types of java constructors

There are two types of constructors:

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



Java Default Constructor

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

Syntax of default constructor:

1. <class_name>(){}

Example of default constructor

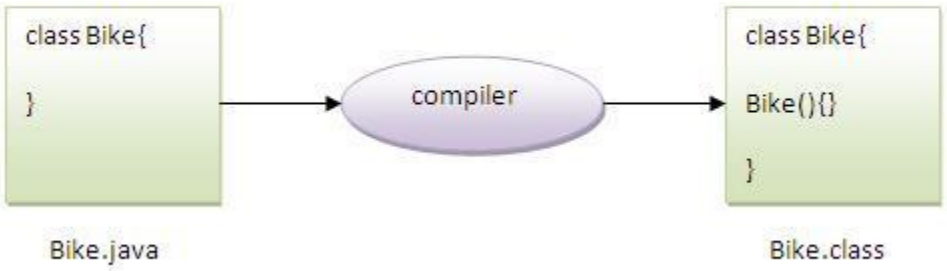
In this example, we are creating the no-arg constructor in the Bike class. It will be invoked at the time of object creation.

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

Example of default constructor that displays the default values

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

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

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

Output:

```
0 null
0 null
```

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 that have parameters is known as parameterized constructor.

Why use parameterized constructor?

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

Example of parameterized constructor

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

```
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

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

Example of Constructor Overloading

```
class Student5{
  int id;
  String name;
  int age;
  Student5(int i,String n){
  id = i;
  name = n;
  }
  Student5(int i,String n,int a){
  id = i;
  name = n;
  age=a;
  }
  void display(){System.out.println(id+" "+name+" "+age);}

  public static void main(String args[]){
  Student5 s1 = new Student5(111,"Karan");
  Student5 s2 = new Student5(222,"Aryan",25);
  s1.display();
  s2.display();
  }
}
```

Output:

```
111 Karan 0
```

```
222 Aryan 25
```

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.

Java static keyword

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";
}
```

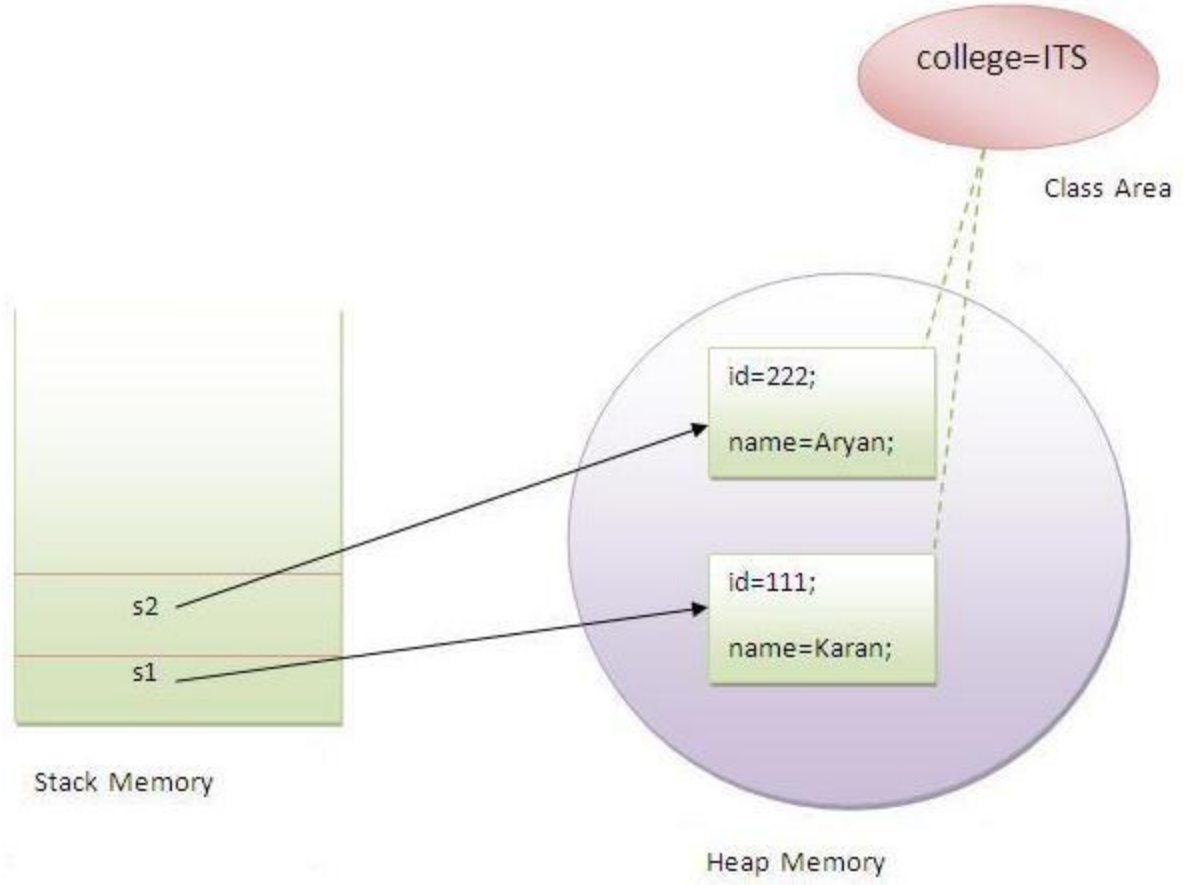
Suppose there are 500 students in my college, now all instance data members will get memory each time when object is created.All student have its unique rollno and name so instance data member is good.Here, college refers to the common property of all objects.If we make it static,this field will get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

Java static property is shared to all objects.

Example of static variable

```
1.          //Program of static variable
2.
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

```
1.          //Program of changing the common property of all objects(static field).
2.
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

```
1.          //Program to get cube of a given number by static method
2.
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)
```

this keyword in java

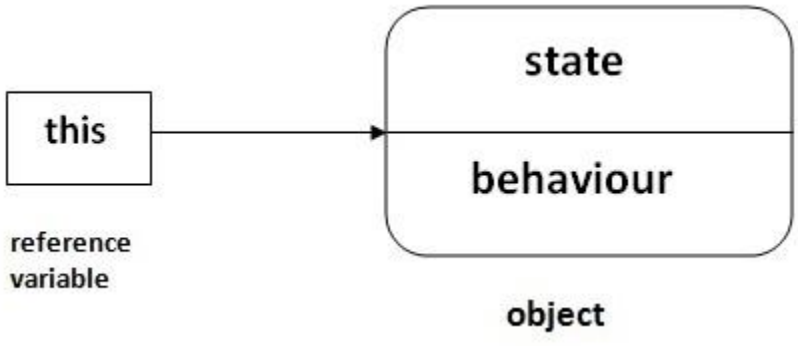
There can be a lot of usage of **java this keyword**. In java, this is a **reference variable** that refers to the current object.

Usage of java this keyword

Here is given the 6 usage of java this keyword.

1. this keyword can be used to refer current class instance variable.
2. this() can be used to invoke current class constructor.
3. this keyword can be used to invoke current class method (implicitly)
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 keyword can also be used to return the current class instance.

Suggestion: If you are beginner to java, lookup only two usage of this keyword.



1) The this keyword can be used to refer current class instance variable.

If there is ambiguity between the instance variable and parameter, 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 Student10{
    int id;
    String name;

    Student10(int id,String name){
    id = id;
    name = name;
    }
    void display(){System.out.println(id+" "+name);}

    public static void main(String args[]){
    Student10 s1 = new Student10(111,"Karan");
    Student10 s2 = new Student10(321,"Aryan");
    s1.display();
    s2.display();
    }
}
```

```
Output:0 null
       0 null
```

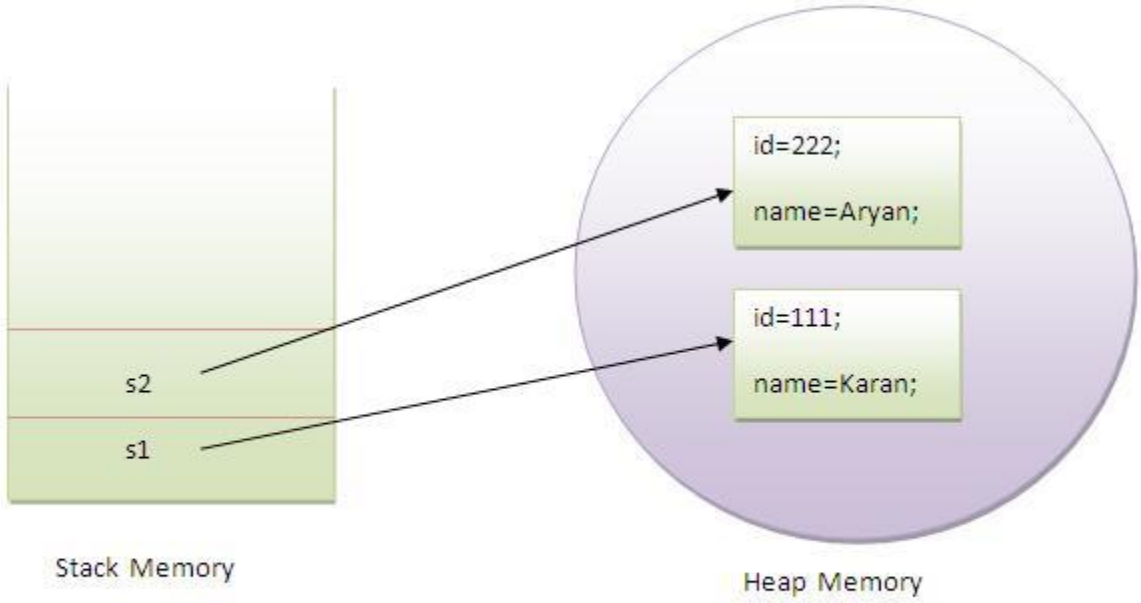
In the above example, parameter (formal arguments) and instance variables are same that is why we are using this keyword to distinguish between local variable and instance variable.

Solution of the above problem by this keyword

```
//example of this keyword
class Student11{
    int id;
    String name;

    Student11(int id,String name){
    this.id = id;
    this.name = name;
    }
    void display(){System.out.println(id+" "+name);}
    public static void main(String args[]){
    Student11 s1 = new Student11(111,"Karan");
    Student11 s2 = new Student11(222,"Aryan");
```

```
    s1.display();
    s2.display();
}
}
```

```
Output111 Karan
        222 Aryan
```



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 Student12{
    int id;
    String name;

    Student12(int i,String n){
    id = i;
    name = n;
    }
    void display(){System.out.println(id+" "+name);}
    public static void main(String args[]){
    Student12 e1 = new Student12(111,"karan");
    Student12 e2 = new Student12(222,"Aryan");
    e1.display();
    e2.display();
}
}
```

```
Output:111 Karan
       222 Aryan
```

---

2) this() can be used to invoked current class constructor.

The this() constructor call can be used to invoke the current class constructor (constructor chaining). This approach is better if you have many constructors in the class and want to reuse that constructor.

```
1.          //Program of this() constructor call (constructor chaining)

class Student13{
   int id;
   String name;
   Student13(){System.out.println("default constructor is invoked");}

   Student13(int id,String name){
   this ();//it is used to invoked current class constructor.
   this.id = id;
   this.name = name;
   }
   void display(){System.out.println(id+" "+name);}

   public static void main(String args[]){
   Student13 e1 = new Student13(111,"karan");
   Student13 e2 = new Student13(222,"Aryan");
   e1.display();
   e2.display();
  }
}
```

```
Output:
       default constructor is invoked
       default constructor is invoked
       111 Karan
       222 Aryan
```

Where to use this() constructor call?

The this() constructor call should be used to reuse the constructor in 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 Student14{
   int id;
   String name;
   String city;

   Student14(int id,String name){
   this.id = id;
```

```
    this.name = name;
    }
    Student14(int id,String name,String city){
    this(id,name);//now no need to initialize id and name
    this.city=city;
    }
    void display(){System.out.println(id+" "+name+" "+city);}

    public static void main(String args[]){
    Student14 e1 = new Student14(111,"karan");
    Student14 e2 = new Student14(222,"Aryan","delhi");
    e1.display();
    e2.display();
   }
}
```

```
Output:111 Karan null
       222 Aryan delhi
```

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

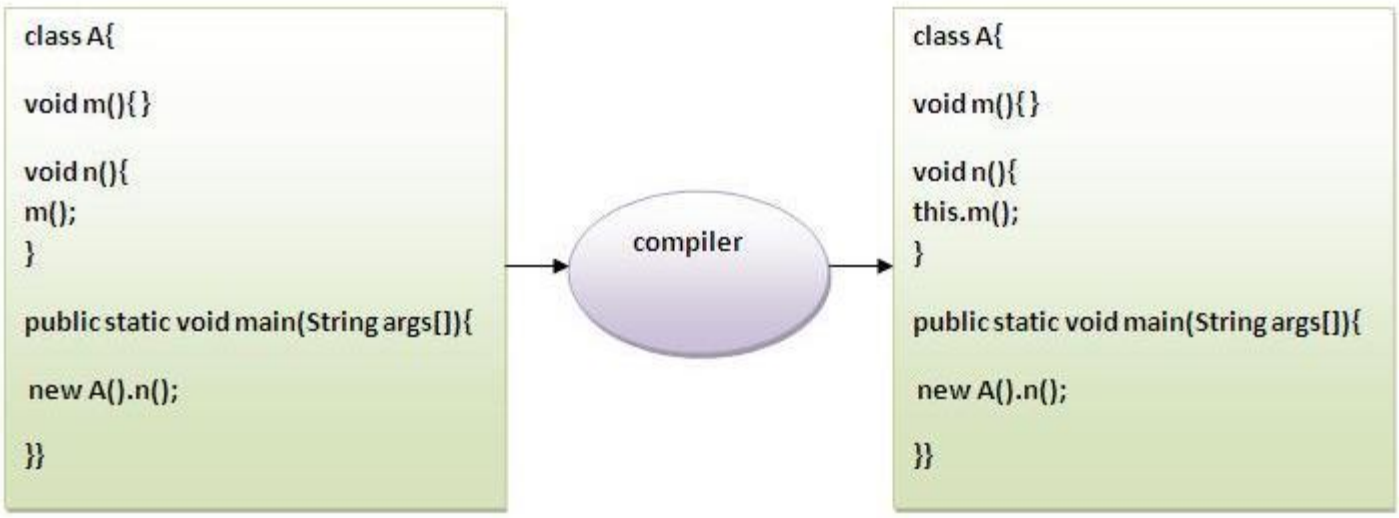
```
class Student15{
    int id;
    String name;
    Student15(){System.out.println("default constructor is invoked");}

    Student15(int id,String name){
    id = id;
    name = name;
    this ();//must be the first statement
    }
    void display(){System.out.println(id+" "+name);}

    public static void main(String args[]){
    Student15 e1 = new Student15(111,"karan");
    Student15 e2 = new Student15(222,"Aryan");
    e1.display();
    e2.display();
   }
}
```

```
Output:Compile Time Error
```

---

3)The this keyword can be used to invoke current class method (implicitly).

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 S{
  void m(){
  System.out.println("method is invoked");
  }
  void n(){
  this.m();//no need because compiler does it for you.
  }
  void p(){
  n();//complier will add this to invoke n() method as this.n()
  }
  public static void main(String args[]){
  S s1 = new S();
  s1.p();
  }
}
```

```
Output:method is invoked
```

---

4) this keyword can be passed 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);
  }

  public 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.

---

5) The this keyword can be passed 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) The this keyword can be used to return current class instance.

We can return the 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
```

Inheritance in Java

1. Inheritance
2. Types of Inheritance
3. Why multiple inheritance is not possible in java in case of class?

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

The idea behind inheritance in java is that you can create new classes that are built upon existing classes. When you inherit from an existing class, you can reuse methods and fields of parent class, and you can add new methods and fields also.

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

Why use inheritance in java

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

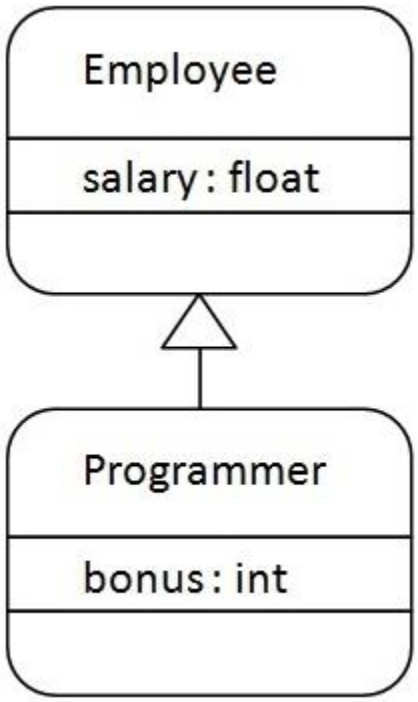
Syntax of Java Inheritance

```
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.

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

Understanding the simple example of inheritance



As displayed in the above figure, Programmer is the subclass and Employee is the superclass. Relationship between 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);
}
}
```

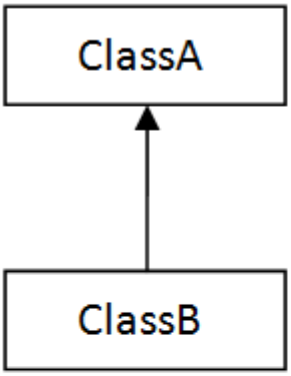
```
Programmer salary is:40000.0
Bonus of programmer is:10000
```

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

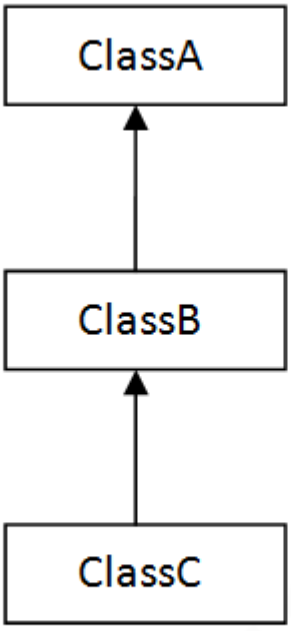
Types of inheritance in java

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

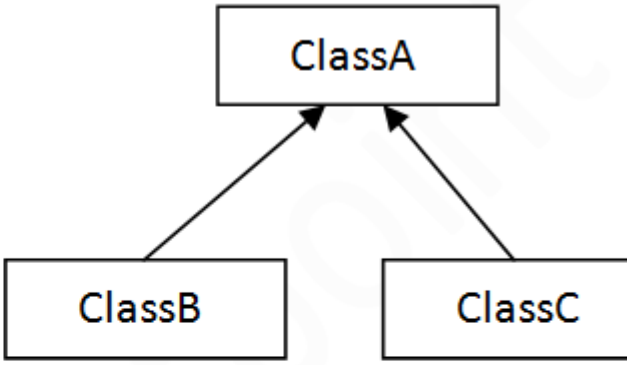
In java programming, multiple and hybrid inheritance is supported through interface only. We will learn about interfaces later.



1) Single



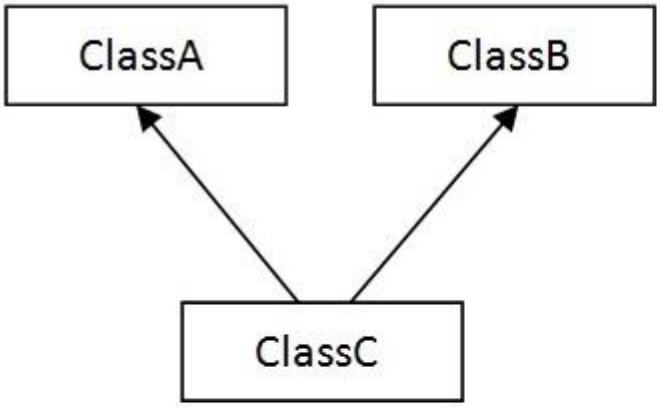
2) Multilevel



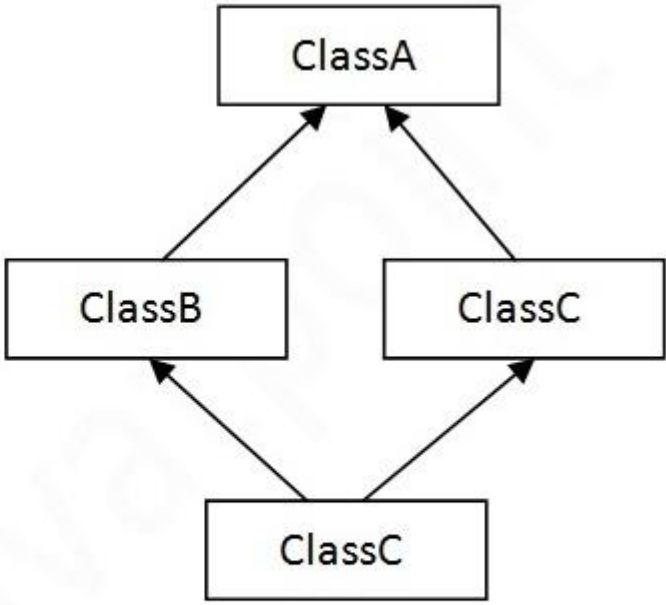
3) Hierarchical

Note: Multiple inheritance is not supported in java through class.

When a class extends multiple classes i.e. known as multiple inheritance. For Example:



4) Multiple



5) Hybrid

.

Q) Why multiple inheritance is not supported in java?

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

Consider a scenario where A, B and C are three classes. The C class inherits A and B classes. If A and B classes have same method and you call it from child class object, there will be ambiguity to call method of A or B class.

Since compile time errors are better than runtime errors, java renders compile time error if you inherit 2 classes. So whether you have same method or different, there will be compile time error now.

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

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

```
Compile Time Error
```

Aggregation in Java

If a class have an entity reference, it is known as Aggregation. Aggregation represents HAS-A relationship.

Consider a situation, Employee object contains many informations such as id, name, emailId etc. It contains one more object named address, which contains its own informations such as city, state, country, zipcode etc. as given below.

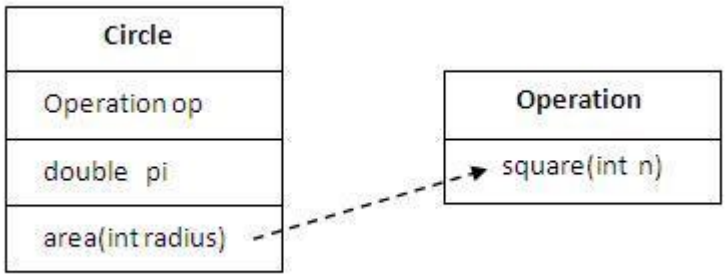
```
class Employee{
int id;
String name;
Address address;//Address is a class
...
}
```

In such case, Employee has an entity reference address, so relationship is Employee HAS-A address.

Why use Aggregation?

- For Code Reusability.

Simple Example of Aggregation



In this example, we have created the reference of Operation class in the Circle class.

```
class Operation{
 int square(int n){
  return n*n;
 }
}

class Circle{
 Operation op;//aggregation
 double pi=3.14;

 double area(int radius){
   op=new Operation();
   int rsquare=op.square(radius);//code reusability (i.e. delegates the method call).
   return pi*rsquare;
 }


 public static void main(String args[]){
   Circle c=new Circle();
   double result=c.area(5);
   System.out.println(result);
 }
}
```

```
Output:78.5
```

When use Aggregation?

- Code reuse is also best achieved by aggregation when there is no is-a relationship.

- Inheritance should be used only if the relationship is-a is maintained throughout the lifetime of the objects involved; otherwise, aggregation is the best choice.

Understanding meaningful example of Aggregation

In this example, Employee has an object of Address, address object contains its own informations such as city, state, country etc. In such case relationship is Employee HAS-A address.

Address.java

```
public class Address {
String city,state,country;

public Address(String city, String state, String country) {
   this.city = city;
   this.state = state;
   this.country = country;
}

}
```

Emp.java

```
public class Emp {
int id;
String name;
Address address;

public Emp(int id, String name,Address address) {
   this.id = id;
   this.name = name;
   this.address=address;
}

void display(){
System.out.println(id+" "+name);
System.out.println(address.city+" "+address.state+" "+address.country);
}

public static void main(String[] args) {
Address address1=new Address("gzb","UP","india");
Address address2=new Address("gno","UP","india");

Emp e=new Emp(111,"varun",address1);
Emp e2=new Emp(112,"arun",address2);

e.display();
e2.display();

}
}
```

```
Output:111 varun
       gzb UP india
       112 arun
       gno UP india
```

Method Overriding in Java

1. Understanding problem without method overriding
2. Can we override the static method
3. method overloading vs method overriding

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 subclass provides the specific implementation of the method that has been provided by one of its parent class, it is known as method overriding.

Usage of Java Method Overriding

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

Rules for Java Method Overriding

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

Understanding the problem without method overriding

Let's understand the problem that we may face in the program if we don't use method overriding.

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

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

```
Output:Vehicle is running
```

Problem is that I have to provide a specific implementation of run() method in subclass that is why we use method overriding.

Example of method overriding

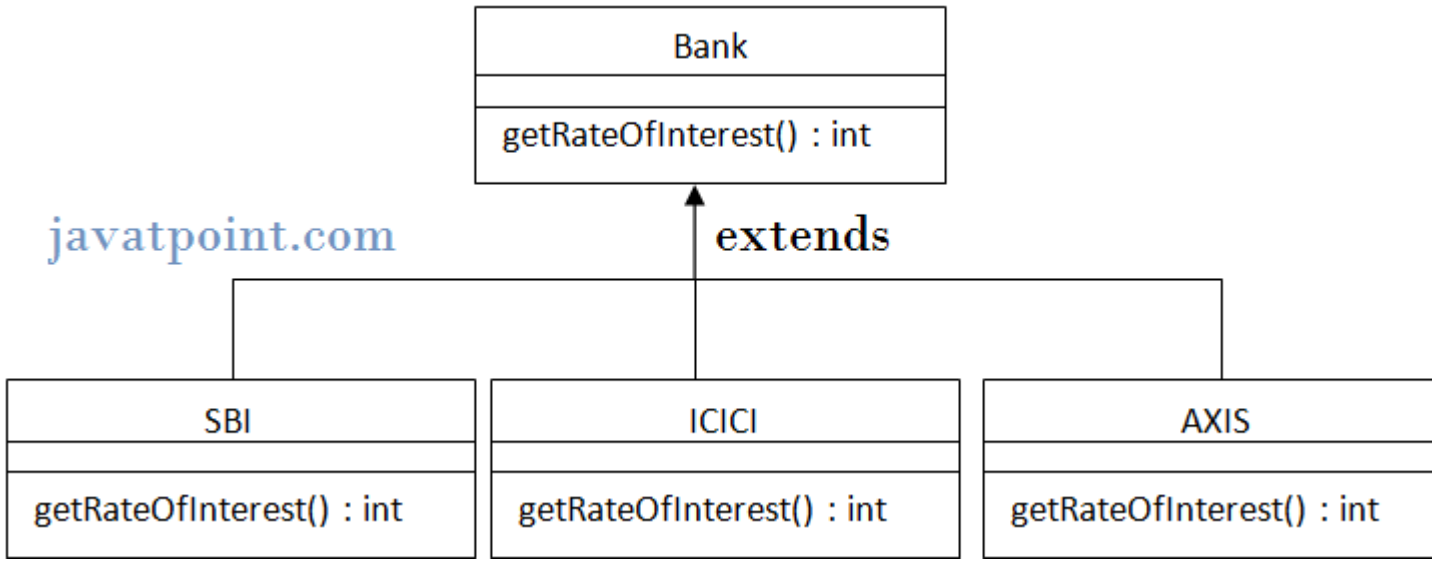
In this example, we have defined the run method in the subclass as defined in the parent class but it has some specific implementation. The name and parameter of the method is same and there is IS-A relationship between the classes, so there is method overriding.

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

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

```
Output:Bike is running safely
```

Real example of Java Method Overriding

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



```
class Bank{
int getRateOfInterest(){return 0;}
}

class SBI extends Bank{
int getRateOfInterest(){return 8;}
}

class ICICI extends Bank{
int getRateOfInterest(){return 7;}
}
class AXIS extends Bank{
int getRateOfInterest(){return 9;}
}

class 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, static method cannot be overridden. It can be proved by runtime polymorphism, so we will learn it later.

Why we cannot override static method?

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

Can we override java main method?

No, because main is a static method.

Covariant Return Type

The covariant return type specifies that the return type may vary in the same direction as the subclass.

Before Java5, it was not possible to override any method by changing the return type. But now, since Java5, it is possible to override method by changing the return type if subclass overrides any method whose return type is Non-Primitive but it changes its return type to subclass type. Let's take a simple example:

Note: If you are beginner to java, skip this topic and return to it after OOPs concepts.

Simple example of Covariant Return Type

```
class A{
A get(){return this;}
}

class B1 extends A{
B1 get(){return this;}
void message(){System.out.println("welcome to covariant return type");}

public static void main(String args[]){
new B1().get().message();
}
}
```

```
Output:welcome to covariant return type
```

As you can see in the above example, the return type of the get() method of A class is A but the return type of the get() method of B class is B. Both methods have different return type but it is method overriding. This is known as covariant return type.

super keyword in java

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

Whenever you create the instance of subclass, an instance of parent class is created implicitly i.e. referred by super reference variable.

Usage of java super Keyword

1. super is used to refer immediate parent class instance variable.
2. super() is used to invoke immediate parent class constructor.
3. super is used to invoke immediate parent class method.

1) super is used to refer immediate parent class instance variable.

Problem without super keyword

```
class Vehicle{
  int speed=50;
}
class Bike3 extends Vehicle{
  int speed=100;
  void display(){
   System.out.println(speed);//will print speed of Bike
  }
  public static void main(String args[]){
   Bike3 b=new Bike3();
   b.display();
}
}
```

```
Output:100
```

In the above example Vehicle and Bike both class have a common property speed. Instance variable of current class is refered by instance bydefault, but I have to refer parent class instance variable that is why we use super keyword to distinguish between parent class instance variable and current class instance variable.

Solution by super keyword

```
//example of super keyword

class Vehicle{
  int speed=50;
}

class Bike4 extends Vehicle{
  int speed=100;

  void display(){
   System.out.println(super.speed);//will print speed of Vehicle now
  }
  public static void main(String args[]){
   Bike4 b=new Bike4();
   b.display();

}
}
```

```
Output:50
```

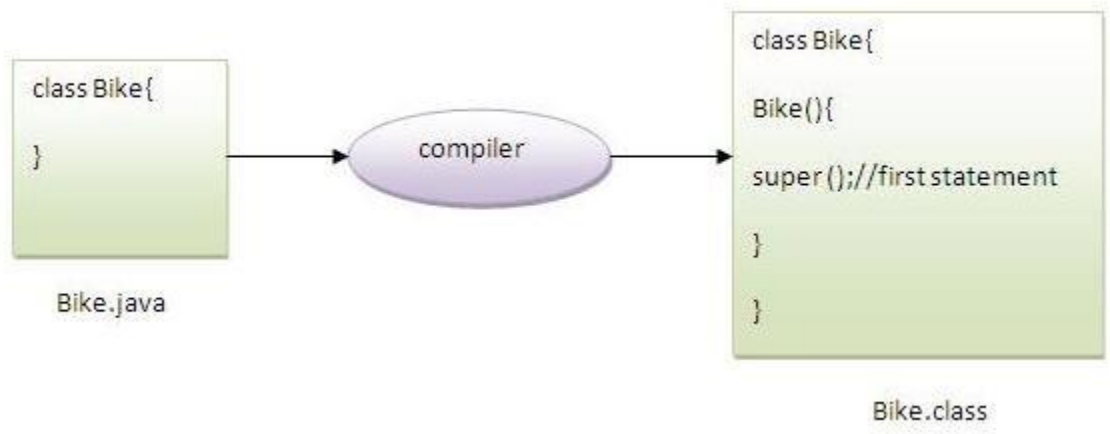
2) super is used to invoke parent class constructor.

The super keyword can also be used to invoke the parent class constructor as given below:

```
class Vehicle{
  Vehicle(){System.out.println("Vehicle is created");}
}

class Bike5 extends Vehicle{
  Bike5(){
   super();//will invoke parent class constructor
   System.out.println("Bike is created");
  }
  public static void main(String args[]){
   Bike5 b=new Bike5();

}
}
```

```
Output:Vehicle is created
       Bike is created
```

Note: super() is added in each class constructor automatically by compiler.



As we know well that default constructor is provided by compiler automatically but it also adds super() for the first statement.If you are creating your own constructor and you don't have either this() or super() as the first statement, compiler will provide super() as the first statement of the constructor.

Another example of super keyword where super() is provided by the compiler implicitly.

```
class Vehicle{
  Vehicle(){System.out.println("Vehicle is created");}
}

class Bike6 extends Vehicle{
  int speed;
  Bike6(int speed){
    this.speed=speed;
    System.out.println(speed);
```

```
 }
 public static void main(String args[]){
  Bike6 b=new Bike6(10);
 }
}
```

```
Output:Vehicle is created
       10
```

3) super can be used to invoke parent class method

The super keyword can also be used to invoke parent class method. It should be used in case subclass contains the same method as parent class as in the example given below:

```
class Person{
void message(){System.out.println("welcome");}
}

class Student16 extends Person{
void message(){System.out.println("welcome to java");}

void display(){
message();//will invoke current class message() method
super.message();//will invoke parent class message() method
}

public static void main(String args[]){
Student16 s=new Student16();
s.display();
}
}
```

```
Output:welcome to java
       welcome
```

In the above example Student and Person both classes have message() method if we call message() method from Student class, it will call the message() method of Student class not of Person class because priority is given to local.

In case there is no method in subclass as parent, there is no need to use super. In the example given below message() method is invoked from Student class but Student class does not have message() method, so you can directly call message() method.

Program in case super is not required

```
class Person{
void message(){System.out.println("welcome");}
}

class Student17 extends Person{
```

```
void display(){
message();//will invoke parent class message() method
}

public static void main(String args[]){
Student17 s=new Student17();
s.display();
}
}
```

```
Output:welcome
```

Instance initializer block:

1. Instance initializer block
2. Example of Instance initializer block
3. What is invoked firstly instance initializer block or constructor?
4. Rules for instance initializer block
5. Program of instance initializer block that is invoked after super()

Instance Initializer block is used to initialize the instance data member. It run each time when object of the class is created.

The initialization of the instance variable can be directly but there can be performed extra operations while initializing the instance variable in the instance initializer block.

Que) What is the use of instance initializer block while we can directly assign a value in instance data member? For example:

```
class Bike{
   int speed=100;
}
```

Why use instance initializer block?

Suppose I have to perform some operations while assigning value to instance data member e.g. a for loop to fill a complex array or error handling etc.

Example of instance initializer block

Let's see the simple example of instance initializer block the performs initialization.

```
class Bike7{
   int speed;

   Bike7(){System.out.println("speed is "+speed);}

   {speed=100;}
```

```
  public static void main(String args[]){
  Bike7 b1=new Bike7();
  Bike7 b2=new Bike7();
  }
}
```

```
Output:speed is 100
       speed is 100
```

There are three places in java where you can perform operations:

1. method
2. constructor
3. block

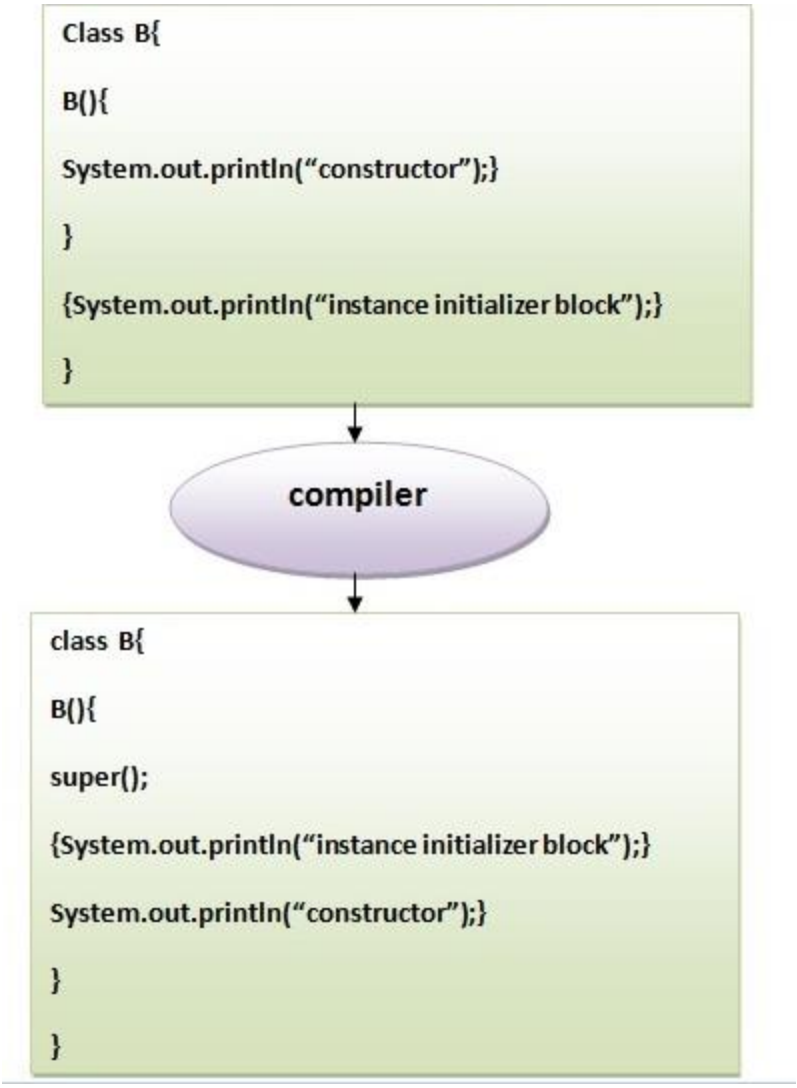
What is invoked firstly instance initializer block or constructor?

```
class Bike8{
  int speed;

  Bike8(){System.out.println("constructor is invoked");}

  {System.out.println("instance initializer block invoked");}

  public static void main(String args[]){
  Bike8 b1=new Bike8();
  Bike8 b2=new Bike8();
  }
}
```

```
Output:instance initializer block invoked
       constructor is invoked
       instance initializer block invoked
       constructor is invoked
```

In the above example, it seems that instance initializer block is firstly invoked but NO. Instance intializer block is invoked at the time of object creation. The java compiler copies the instance initializer block in the constructor after the first statement super(). So firstly, constructor is invoked. Let's understand it by the figure given below:

Note: The java compiler copies the code of instance initializer block in every constructor.



Rules for instance initializer block :

There are mainly three rules for the instance initializer block. They are as follows:

1. The instance initializer block is created when instance of the class is created.
2. The instance initializer block is invoked after the parent class constructor is invoked (i.e. after super() constructor call).
3. The instance initializer block comes in the order in which they appear.

Program of instance initializer block that is invoked after super()

```
class A{
A(){
System.out.println("parent class constructor invoked");
}
}
class B2 extends A{
B2(){
super();
System.out.println("child class constructor invoked");
```

```
}

{System.out.println("instance initializer block is invoked");}

public static void main(String args[]){
B2 b=new B2();
}
}
```

```
Output:parent class constructor invoked
       instance initializer block is invoked
       child class constructor invoked
```

Another example of instance block

```
class A{
A(){
System.out.println("parent class constructor invoked");
}
}

class B3 extends A{
B3(){
super();
System.out.println("child class constructor invoked");
}

B3(int a){
super();
System.out.println("child class constructor invoked "+a);
}

{System.out.println("instance initializer block is invoked");}

public static void main(String args[]){
B3 b1=new B3();
B3 b2=new B3(10);
}
}
```

```
Output:parent class constructor invoked
       instance initializer block is invoked
       child class constructor invoked
       parent class constructor invoked
       instance initializer block is invoked
       child class constructor invoked 10
```