Chapter 2 – Unit 1

Classes and Objects: Concepts&methods

- An object is an instance of a class. A class is a template from which objects are created.So, an object is the instance (result) of a class.
- **Object Definitions:**
  - **An object is *a real-world entity*.**
  - **An object is *a runtime entity*.**
  - **The object is *an entity which has state and behavior*.**
  - **The object is *an instance of a class*.**
- **Class Definition :**
- **A class is a group of objects which have common properties. It is a template from which objects are created. It is a logical entity. It can't be physical.**
- **A class in Java can contain:**
  - Fields
  - Methods
  - Constructors
  - Blocks
  - Nested class and interface
- **Syntax to declare a class:**

```
class <class_name>
{
fields;
methods;
}
```

- **Syntax for Creating an Object:**

  className objectname = new className();

- **Syntax for method definition in Java:**

  modifierreturntypenameofmethod(**Parameter List**)

  {

  // method body

  }

new Keyword

- The new operator is used in Java to create new objects.
- The new keyword can also be used to create an array object.
- It allocates the memory at runtime.
- All objects occupy memory in the heap area.

- **Syntax:**

  var-name = new class-name ();

- **Object and Class Example: main method within the class:**

  class Student

  {

  int id=45;//field or data member or instance variable

  String name="siva";//field or data member or instance variable

  public static void main(String args[])

  {

  Student s1=new Student();//creating an object of Student

```
System.out.println(s1.id);//accessing member through reference variable
System.out.println(s1.name);
}
}
```

Output

```
45
siva
```

- **Object and Class Example: main method outside the class:**

```
class Student
{
int id=45;
String name="siva";
}
class TestStudent
{
public static void main(String args[])
{
Student s1=new Student();
System.out.println(s1.id);
System.out.println(s1.name);
}
}
```

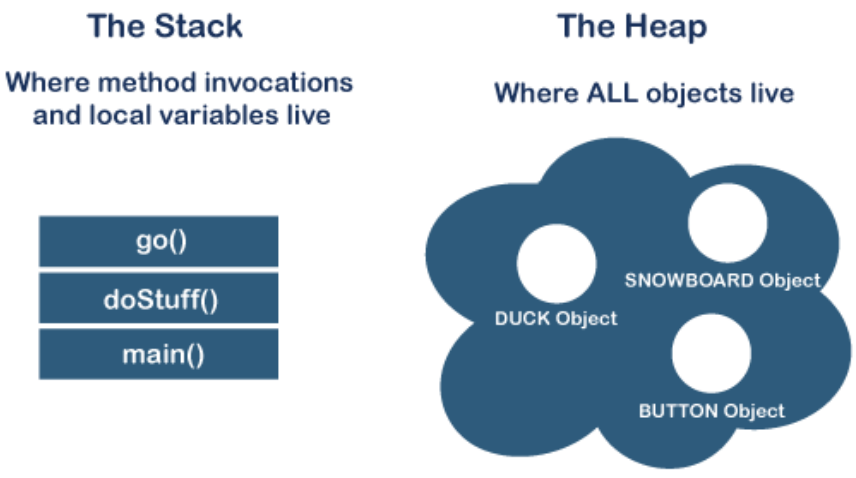
Output

45

siva

Stack Vs Heap Java

- In Java, memory management is a vital process.
- It is managed by Java automatically.
- **The JVM divides the memory into two parts: stack memory and heap memory.**
- From the perspective of Java, both are important memory areas but both are used for different purposes.
- **The major difference between Stack memory and heap memory is that the stack is used to store the order of method execution and local variables while the heap memory stores the objects and it uses dynamic memory allocation and deallocation.**
- In this section, we will discuss the differences between stack and heap in detail.



Stack Vs Heap

- The stack memory is a physical space (in RAM) allocated to each thread at run time. It is created when a thread creates. Memory management in the stack follows LIFO (Last-In-First-Out) order because it is accessible globally. It stores the variables, references to objects, and partial results. Memory allocated to stack lives until the function returns. If there is no space for creating the new objects, it throws the java.lang.StackOverFlowError. The scope of the elements is limited to their threads. The JVM creates a separate stack for each thread.
- It is created when the JVM starts up and used by the application as long as the application runs. It stores objects and JRE classes. Whenever we create objects it occupies space in the heap memory while the reference of that object creates in the stack. It does not follow any order like the stack. It dynamically handles the memory blocks. It means, we need not to handle the memory manually. For managing the memory automatically, Java provides the garbage collector that deletes the objects which are no longer being used. Memory allocated to heap lives until any one event, either program terminated or memory free does not occur. The elements are globally accessible in the application. It is a common memory space shared with all the threads. If the heap space is full, it throws the java.lang.OutOfMemoryError.

Java User Input (Scanner)

- **The Scanner class is used to get user input, and it is found in the java.util package.**

- **Syntax :**

  Scanner in = new Scanner (System.in);

  Here, to get the instance of Scanner class which reads input from the user, we need to pass the input stream (System.in) in the constructor of Scanner class.

- To use the Scanner class, create an object of the class and use any of the available methods found in the Scanner class documentation.
- **Input Types:**
- In the example above, we used the nextLine() method, which is used to read Strings. To read other types, look at the table below:

Method	Description
nextBoolean()	Reads a boolean value from the user
nextByte()	Reads a byte value from the user
nextDouble()	Reads a double value from the user
nextFloat()	Reads a float value from the user
nextInt()	Reads a int value from the user
nextLine()	Reads a String value from the user

nextLong()	Reads a long value from the user
nextShort()	Reads a short value from the user

Example 1:

```
import java.util.Scanner;
class sample
{
public static void main(String[] args)
{
Scanner s = new Scanner(System.in);

System.out.println("Enter name:");
String name = s.nextLine();

System.out.println("Enter age:");
int age =s.nextInt();

System.out.println("Enter salary:");
double salary = s.nextDouble();

System.out.println("Name: " + name);
System.out.println("Age: " + age);
System.out.println("Salary: " + salary);
```

```
}
}
```

Output

```
Enter name, age and salary:
Kumar 35 80000
Kumar
35
75000
```

Example 2:

```
import java.util.Scanner;
class student
{
String name;
int age;
double salary;
void read()
{
Scanner s = new Scanner(System.in);
System.out.println("Enter name:");
name = s.nextLine();
System.out.println("Enter age:");
age =s.nextInt();
System.out.println("Enter salary:");
salary = s.nextDouble();
```

```
}
void print()
{
System.out.println("Name: " + name);
System.out.println("Age: " + age);
System.out.println("Salary: " + salary);
}
}
class teststudent
{
public static void main(String[] args)
{
student s1=new student();
s1.read();
s1.print();
}
}
```

Output

```
Enter name, age and salary:
Kumar 35 80000
Kumar
35
75000
```

Constructors

- **A constructor is a block of codes similar to the method.**
- **Constructor 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.
- **Rules for creating Java constructor:**
    - Constructor name must be the same as its class name
    - A Constructor must have no explicit return type
    - A Java constructor cannot be abstract, static, final, and synchronized
- **Types of Java constructors:**
- There are two types of constructors in Java:
    - Default constructor (no-arg constructor)
    - Parameterized constructor

- **Default Constructor:** A constructor is called "Default Constructor" when it doesn't have any parameter.
- **Syntax of default constructor:**

```
<class_name>()
{
}
```

- **/* Here, Box uses a constructor to initialize the dimensions of a box. */**

```
class box
{
double width;
double height;
double depth;
// This is the constructor for Box.
box()
{
System.out.println("Default constructor");
width = 10;
height = 10;
depth = 10;
}
// compute and return volume
double volume()
{
return width * height * depth;
}
}
class boxdemo
{
public static void main(String args[])
{
```

```
double vol;
System.out.println("Default constructor is called");
box b1 = new box();
vol = b1.volume();
System.out.println("Volume is " + vol);

box b2 = new box();
vol = b2.volume();
System.out.println("Volume is " + vol);
}
}
```

Output

```
Default constructor is called
Volume is 1000.0
Volume is 1000.0
```

- **Parameterized Constructor:**A constructor that has parameters is known as parameterized constructor.
- If we want to initialize fields of the class with our own values, then use a parameterized constructor.
- /* Here, Box uses a parameterized constructor to initialize the dimensions of a box. */

```
class box
{
double width;
```

```
double height;
double depth;
// This is the constructor for Box.
box(double w, double h, double d)
{
width = w;
height = h;
depth = d;
}
// compute and return volume
double volume()
{
return width * height * depth;
}
}
class boxdemo
{
 public static void main(String args[])
{
double vol;
System.out.println("Parameterized constructor is called");

box b1 = new box(10, 20, 15);
vol = b1.volume();
System.out.println("Volume is " + vol);
```

```
box b2 = new box(3, 6, 9);
vol = b2.volume();
System.out.println("Volume is " + vol);
}
 }
```

Output

```
Parameterized constructor is called
Volume is 3000.0
Volume is 162.0
```

Method Overloading

- In Java it is possible to define two or more methods within the same class that share the same name, as long as their parameter declarations are different.
- When this is the case, the methods are said to be overloaded, and the process is referred to as method overloading.
- **(OR)If a class has multiple methods having same name but different in parameters, it is known as Method Overloading.**
- **Method overloading is one of the ways that Java supports polymorphism.**
- **Different ways to overload the method:**There are two ways to overload the method in java.
    - By changing number of arguments
    - By changing the data type

Example:

```
// Demonstrate method overloading.
```

```
class Overload
{
void test()
{
System.out.println("Method with No parameters");
}
void test(int a)
{
System.out.println("Method with One Integer Parameter:”);
System.out.println("a: " + a);
}
void test(int a, int b)
{
System.out.println("Method with Two Integer Parameters:”);
System.out.println("a and b: " + a + " " + b);
}
void test(double a)
{
System.out.println("Method with One Double Parameter:”);
System.out.println("double a: " + a);
}
}
class Overloaddemo
{
```

```
public static void main(String args[])
{
Overload ob = new Overload();
// call all versions of test()
ob.test();
ob.test(10);
ob.test(10, 20);
ob.test(123.35);
}
}
```

This program generates the following output:

```
Method with No parameters
Method with One integer parameter:
a: 10
Method with Two integer parameters:
a: 10 a and b: 10 20
Method with One double parameter:
double a: 123.25
```

Constructor overloading

- **In Java, we can overload constructors like methods.**
- **In constructor over loading, we create multiple constructors with the same name but with different parameters types or with different no of parameters.**

Example:

```
/* Here, Box defines three constructors to initialize the dimensions of a box
various ways. */
class Box
{
double width;
double height;
double depth;


Box()
{
System.out.println("Constructor with No parameters");
width = -1;
height = -1;
depth = -1;
}
Box(double len)
{
System.out.println("Constructor with one double type parameter");

width = height = depth = len;
}
Box(double w, double h, double d)
{
```

```
System.out.println("Constructor with three double type parameters");


width = w;
height = h;
depth = d;
}
// compute and return volume
double volume()
{
return width * height * depth;
}
}
class Overloaddemo
{
public static void main(String args[])
{
// create boxes using the various constructors

double vol;
Box b1 = new Box();
vol = b1.volume();
System.out.println("Volume of b1 is " + vol);

Box b2 = new Box(7);
box vol = b2.volume();
```

```
System.out.println("Volume of b2 is " + vol);


Box b3 = new Box(10, 20, 15);
vol = b3.volume();
System.out.println("Volume of b3 is " + vol);
}
}
```

The output produced by this program is shown here:

```
Constructor with No parameters
Volume of b1 is -1.0
Constructor with one double type parameter
Volume of b2 is 343.0
Constructor with three double type parameters
Volume of b3 is 3000.0
```

this keyword

The usage of this keyword is:

- this can be used to refer current class instance variable.
- this can be used to invoke current class method (implicitly).
- this() can be used to invoke current class constructor.
- this can be passed as an argument in the method call.
- this can be passed as argument in the constructor call.
- this can be used to return the current class instance from the method.

1) this: to refer current class instance variable

- The this keyword can be used to refer current class instance variable. If there is ambiguity between the instance variables and parameters, this keyword resolves the problem of ambiguity.
- Example : Understanding the problem without this keyword

```
class Student
{
int a,b,c;
Student(int a,intb,int c)
{
a=a;
b=b;
c=c;
}
void display()
{
System.out.println(a);
System.out.println(b);
System.out.println(c);
}
}
class TestThis1
{
```

```
public static void main(String args[])
{
Student s1=new Student(11,22,33);

s1.display();

}
}
```

The output produced by this program is shown here:

```
0
0
0
```

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

```
class Student
{
int a,b,c;
Student(int a,intb,int c)
{
this.a=a;
this.b=b;
this.c=c;
}
```

```
void display()
{
System.out.println(a);
System.out.println(b);
System.out.println(c);
}
}
class TestThis1
{
public static void main(String args[])
{
Student s1=new Student(11,22,33);

s1.display();

}
}
```

The output produced by this program is shown here:

```
11
22
33
```

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

```
class Student
{
```

```
int a1,b1,c1;
Student(int a2,int b2,int c2)
{
a1=a2;
b1=b2;
c1=c2;
}
void display()
{
System.out.println(a1);
System.out.println(b1);
System.out.println(c1);
}
}
class TestThis1
{
public static void main(String args[])
{
Student s1=new Student(11,22,33);

s1.display();


}
}
```

The output produced by this program is shown here:

```
11
22
33
```

2) this: to invoke current class method

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

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

```
A a=new A();
a.n();
}
}
```

The output produced by this program is shown here:

```
hello n
hello m
```

3) this() : to invoke current class constructor

- The this() constructor call can be used to invoke the current class constructor. It is used to reuse the constructor. In other words, it is used for constructor chaining.
- **Example1 :**Calling default constructor from parameterized constructor:

```
class A
{
A()
{
System.out.println("hello a");
}
A(int x)
{
this();
System.out.println(x);
}
}
class TestThis5
```

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

The output produced by this program is shown here:

```
hello a

10
```

- **Example 2 :** Calling parameterized constructor from default constructor:

```
class A
{
A()
{
this(5);
System.out.println("hello a");
}
A(int x)
{
System.out.println(x);
}
}
class TestThis6
```

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

The output produced by this program is shown here:

```
5
hello a
```

Type Casting or Type Conversion

- **Converting one primitive datatype into another is known as type casting (type conversion) in Java.**
- You can cast the primitive datatypes in two ways namely, Widening and, Narrowing.
- **Widening Casting (automatically)** - converting a smaller type to a larger type size.
- Widening casting is done automatically when passing a smaller size type to a larger size type:

  byte -> short -> char -> int -> long -> float -> double
- **Example :**

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

```
{
int myInt = 9;
double myDouble = myInt; // Automatic casting: int to double
System.out.println(myInt);
System.out.println(myDouble);
}
}
```

Output:

9

9.0

- **Narrowing Casting** (manually) - converting a larger type to a smaller size type.
- Narrowing casting must be done manually by placing the type in parentheses in front of the value:
  double -> float -> long -> int -> char -> short -> byte
- **Example :**

```
class sample
{
public static void main(String[] args)
{
double myDouble = 9.78d;
int myInt = (int) myDouble; // Explicit casting: double to int
```

```
System.out.println(myDouble);
System.out.println(myInt);
}
}
```

Output:

```
9.78
9
```

Usage of static

- The **static keyword** in Java is mainly used for memory management.
- The static keyword is used to share the same variable or method of a given class.
- The static keyword belongs to the class than an instance of the class.
- The static can be:
  - Blocks
  - Variables
  - Methods
  - nested classes
- To create a static member (block,variable,method,nested class), precede its declaration with the keyword static. When a member

is declared static, it can be accessed before any objects of its class are created, and without reference to any object.

1)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.

Advantages of static variable

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

2) 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.

Note : Why is the Java main method static?

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.

3) Java static block

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

Example 1 : 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 static variable
 class TestStaticVariable1
```

```
{
public static void main(String args[])
{
Student s1 = new Student(111,"siva");
Student s2 = new Student(222,"kumar");
s1.display();
s2.display();
}
}
```

Output :

111 siva ITS

222 kumar ITS

Example 2 : Java Program to demonstrate the use of static variable.(Change the college name)

```
class Student
{
  int rollno;//instance variable
  String name;
  static String college ="RVRJCCE";//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 static variable
 class TestStaticVariable1
 {
 public static void main(String args[])
 {
 Student s1 = new Student(111,"siva");
 Student s2 = new Student(222,"kumar");
Student.college="RVRJCCE";
 s1.display();
 s2.display();
 }
}
```

Output :

```
111 siva RVRJCCE

222 kumar RVRJCCE
```

Example 3 : Java Program to demonstrate the use of static variable. (Change the rollno)

```
class Student
{
  int rollno=10;//instance variable
  String name;
  static String college ="ITS";//static variable
  //constructor
Student(String n)
 {
  name = n;
  }
  //method to display the values
  void display (){System.out.println(rollno+" "+name+" "+college);}
}
//Test class to show the values of static variable
 class TestStaticVariable1
 {
 public static void main(String args[])
 {
 Student s1 = new Student("siva");
 Student s2 = new Student("kumar");
```

```
Student.rollno=12;
 s1.display();
 s2.display();
 }
}
```

Output :

```
staticVariable1.java:22: error: non-static variable rollno cannot be referenced from a static context

Student.rollno=12;
 ^
1 error
```

Example 4 :Demonstrate static variables, methods, and blocks.

```
class staticdemo
{
static int a = 3;
static int b;
static void meth(int x)
{
System.out.println("x = " + x);
System.out.println("a = " + a);
System.out.println("b = " + b);
}
```

```
static
{
System.out.println("Static block initialized.");
b = a * 4;
}
public static void main(String args[])
{
meth(42);
(or)
Staticdemo.meth(42);
(or)
staticdemo t=new TestStaticVariable1();
t.meth(42);
}
}
```

Here is the output of the program:

```
Static block initialized.
x = 42
a = 3
b = 12
```

Note : Outside of the class in which they are defined, static methods and variables can be used independently of any object. To do so, you need only specify the name of their class followed by the dot operator. **For example, if you wish to call a static method from outside its class, you can do so using the following general form: classname.method( )** Here, classname is the name of the class in which the static method is declared.

```
class UseStatic
{
static int a = 3;
static int b;
static void meth(int x)
{
System.out.println("x = " + x);
System.out.println("a = " + a);
System.out.println("b = " + b);
}
static
{
System.out.println("Static block initialized.");
b = a * 4;
}
```

```
}
class staticdemo
{
public static void main(String args[])
{
UseStatic.meth(42);
}
}
```

Here is the output of the program:

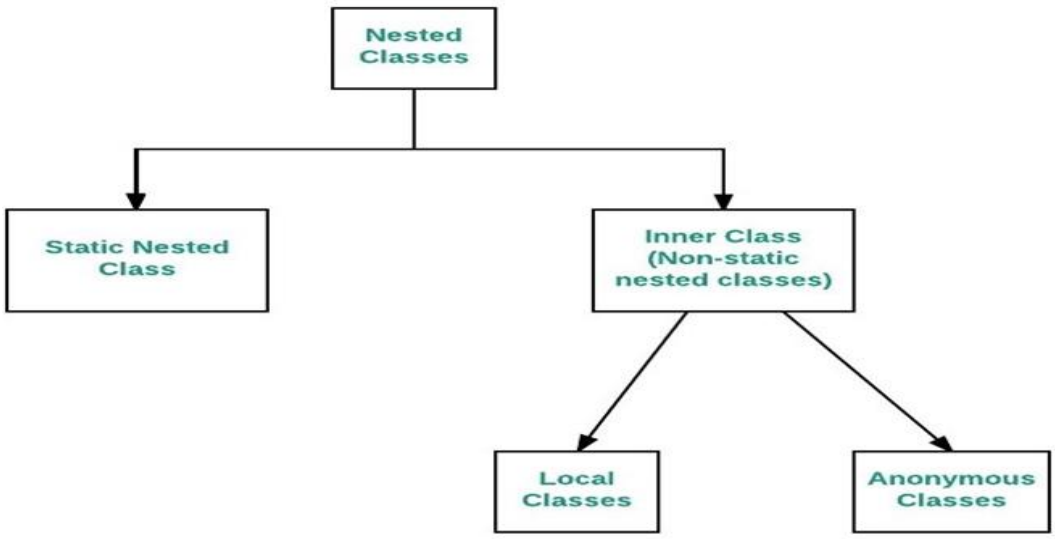
```
Static block initialized.
x = 42
a = 3
b = 12
```

Nested classes (Inner classes)

In Java, it is possible to define a class within another class, such classes are known as nested classes. They enable you to logically group classes that are only used in one place, thus this increases the use of encapsulation, and creates more readable and maintainable code.

- The scope of a nested class is bounded by the scope of its enclosing class. Thus in above example, class NestedClass does not exist independently of class OuterClass.

- A nested class has access to the members, including private members, of the class in which it is nested. However, the reverse is not true i.e., the enclosing class does not have access to the members of the nested class.
- A nested class is also a member of its enclosing class.
- As a member of its enclosing class, a nested class can be declared private, public, protected, or package private(default).
- **Nested classes are divided into two categories:**
- static nested class : Nested classes that are declared static are called static nested classes.
- inner class : An inner class is a non-static nested class.



Syntax:

```
class OuterClass
{
...
    class NestedClass
    {
        ...
    }
}
```

Static nested classes

- In the case of normal or regular inner classes, without an outer class object existing, there cannot be an inner class object. i.e., an object of the inner class is always strongly associated with an outer class object. But in the case of static nested class, Without an outer class object existing, there may be a static nested class object. i.e., an object of a static nested class is not strongly associated with the outer class object.
  As with class methods and variables, a static nested class is associated with its outer class. And like static class methods, a static nested class cannot refer directly to instance variables or methods defined in its enclosing class: it can use them only through an object reference.

- **Syntax for accessing the nested static class methods;**

  Outerclassname.staticnestedclassmethods();

- **Syntax to create an object for the static nested class:**

  Outerclassname.staticnestedclassnamestaticnestedclassobjectname =

  new outerclassname.staticnestedclassname();

```
// Java program to demonstrate accessinga static nested class

// outer class
class OuterClass
{
// static member
static int outer_x = 10;
// instance(non-static) member
int outer_y = 20;
// private member
private static int outer_private = 30;
// static nested class
static class StaticNestedClass
{
```

```
void display()
{
// can access static member of outer class
System.out.println("outer_x = " + outer_x);

// can access display private static member of outer class
System.out.println("outer_private = " + outer_private);

// The following statement will give compilation erroras static nested
class cannot directly access non-static members.
// System.out.println("outer_y = " + outer_y);

}
}
}

// Driver class
public class StaticNestedClassDemo
{
public static void main(String[] args)
{
// accessing a static nested class
```

```
OuterClass.StaticNestedClassObj= new OuterClass.StaticNestedClass();
Obj.display();


}
}
```

Output:

outer_x = 10

outer_private = 30

Inner classes

- To instantiate an inner class, you must first instantiate the outer class.
- **create the inner object within the outer object with this syntax:**

  outerclassname.innerclassnameinnerclassobject = outerclassobject.newinnerclassname();

- There are two special kinds of inner classes :
  - Local inner classes
  - Anonymous inner classes

```
// Java program to demonstrate accessingan inner class


// outer class
```

```
class OuterClass
{
// static member
static int outer_x = 10;

// instance(non-static) member
int outer_y = 20;

// private member
private int outer_private = 30;

// inner class
class InnerClass
{
void display()
{
// can access static member of outer class
System.out.println("outer_x = " + outer_x);

// can also access non-static member of outer class
System.out.println("outer_y = " + outer_y);
```

```
// can also access a private member of the outer class
System.out.println("outer_private = " + outer_private);


}
}
}
// Driver class
public class InnerClassDemo
{
public static void main(String[] args)
{
// accessing an inner class
Outerclassouterobject = new outerclass();
outerclassname.innerclassnameinnerclassobject =
outerobject.newinnerclass();
innerObject.display();
}
}
```

Output:

```
outer_x = 10
outer_y = 20
outer_private = 30
```

Parameter passing mechanisms

Java programming languages support two parameter passing techniques namely: *pass-by-value* and *pass-by-reference*.

1. **Pass By Value:** Changes made to formal parameter do not get transmitted back to the caller. Any modifications to the formal parameter variable inside the called function or method affect only the separate storage location and will not be reflected in the actual parameter in the calling environment. This method is also called as **call by value**.

   Example : In case of call by value original value is not changed. Let's take a simple example:

```
class Operation
{
int data=50;
void change(int data)
{
data=data+100;//changes will be in the local variable only
}
```

```
public static void main(String args[])
{
Operation op=new Operation();
System.out.println("before change "+op.data);
op.change(50);
System.out.println("after change "+op.data);
}
}
```

Output:

```
Before change : 50
After change :50
```

2. **Call by reference(aliasing):** Changes made to formal parameter do get transmitted back to the caller through parameter passing. Any changes to the formal parameter are reflected in the actual parameter in the calling environment as formal parameter receives a reference (or pointer) to the actual data. This method is also called as call by reference. This method is efficient in both time and space.

   Example:In case of call by reference original value is changed if we made changes in the called method. **If we pass object in place of any primitive value**, original value will be changed. In

this example we are passing object as a value. Let's take a simple example:

```
class Operation
{
int data=50;
void change(Operation op)
{
op.data=op.data+100;//changes will be in the instance variable
}
public static void main(String args[])
{
Operation op=new Operation();
System.out.println("before change "+op.data);
op.change(op);//passing object
System.out.println("after change "+op.data);
}
}
```

Output:

```
Before change : 50
After change :150
```

Note :when we pass a reference, a new reference variable to the same object is created. So we can only change members of the

object whose reference is passed. We cannot change the reference to refer to some other object as the received reference is a copy of the original reference.