Unit-III Arrays

Introduction:

- An array is a collection of similar data values with a single name.
- An array can also be defined as, a special type of variable that holds multiple values of the same data type at a time.
- In java, arrays are objects and they are created dynamically using new operator.
- Every array in java is organized using index values.
- The index value of an array starts with '0' and ends with 'size-1'.
- We use the index value to access individual elements of an array.

Declaration & Initialization of Arrays:

- Array objects occupy space in memory. Like other objects, arrays are created with keyword new.
- To create an array object, you specify the type of the array elements and the number of elements as part of an array-creation expression that uses keyword new.
- Such an expression returns a reference that can be stored in an array variable.
- The following declaration and array-creation expression create an array object containing 12 int elements and store the array's reference in array variable c.

  ```
  int [] c= new int [ 12];

  int [] c; // declare the array variable
  c = new int [ 12]; // create the array; assign to array variable.
  ```

- In the declaration, the square brackets following the type indicate that c is a variable that will refer to an array (i.e., the variable will store an array reference).
- In the assignment statement, the array variable c receives the reference to a new array of 12 int elements.

Examples using Arrays

```
 //InitArray.java
// Initializing the elements of an array to default values of zero
public class InitArray
{
  public static void main( String[] args )
     {
        int[] array; // declare array named array
```

```
          array = new int[ 10 ]; // create the array object
          System.out.println( "%s%8s\n", "Index", "Value" ); // column headings
        // output each array element's value
       for ( int counter = 0; counter < array.length; counter++ )
           System.out.println( "%5d%8d\n", counter, array[ counter ] );
         } // end main
     }// end class InitArray
```

output

```
Index Value
0      0
1      0
2      0
3      0
4      0
5      0
6      0
7      0
8      0
9      0
```

Storage of Array In Computer Memory:

- To refer to a particular element in an array, we specify

the name of the reference to the array and the position number of the element in the array.

- The position number of the element is called the element's index or subscript.
- The first element in every array has index zero and is some-
  times called the zeroth element.
- Thus, the elements of array c are c[0], c[1], c[2] and so on. The highest index in array c is 11, which is 1 less than 12—the number of elements
  in the array.

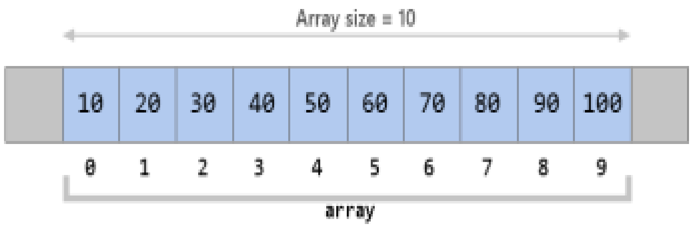
```
Name of array (c )→ c[ 0 ]
                    c[ 1 ]
                    c[ 2 ]
                    c[ 3 ]
                    c[ 4 ]
                    c[ 5 ]
```

c[6]
c[7]
c[8]
c[9]
c[10]
c[11]→Index or subscript of the element in array c

- The operator new which is a keyword, allocates memory for storing the array elements.
- For example, with the following declaration

- int [] num = new int [4];
- The compiler allocates 4 memory spaces each equal to 4 bytes for storing the int type values of elements of array numbers.

- When an array is created as above, elements of the array are automatically initialized to 0 by the compiler.
- int num [ ] = {10,20,30,40};



- A two-dimensional array may be declared and initialized as
- int [ ] [ ] num = new int [ ] [ ] ({1,2,3},{4,5,6}};
- or int [ ] [ ] num = ({1,2,3},{4,5,6}};

Accessing Elements of Array:

- we can access an array element by referring to the index number.

Example program: To access the value of the first element in cars:

```
public class Vehicles
 {
   public static void main(String[] args)
    {
   String[] cars = {"Maruthi", "BMW", "Ford", "Mazda"};
   System.out.printf(cars[0]);
  }
}
```

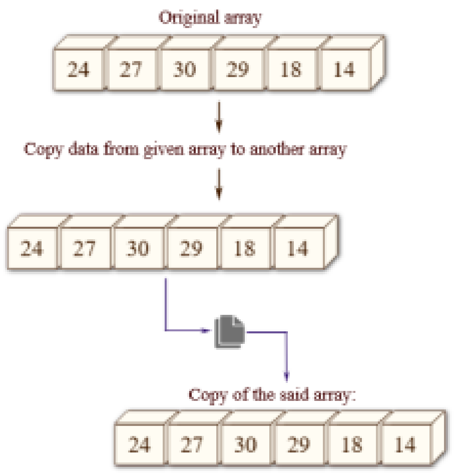
Output:

```
Maruthi
```

Note: Array indexes start with 0: [0] is the first element. [1] is the second element, element and so on…

Assigning Array to another Array:

- Unlike in C and C++ languages, in Java, an array may be assigned as a whole to another array of same data type. In this process, the second array identifier, in fact, becomes the reference to the assigned array.
- The second array is not a new array, instead only a second reference is created.



```
public class Test {
   public static void main(String[] args)
   {
      int a[] = { 1, 8, 3 };                    // Create an array b[] of same size as a[]
      int b[] = new int[a.length];         // Doesn't copy elements of a[] to b[], only makes b refer to same location
      b = a;
                 // Change to b[] will also reflect in a[] as 'a' and 'b' refer to same location.
      b[0]++;
       System.out.println("Contents of a[] ");
      for (int i = 0; i < a.length; i++)
         System.out.print(a[i] + " ");
       System.out.println("\n\nContents of b[] ");
      for (int i = 0; i < b.length; i++)
         System.out.print(b[i] + " ");
   }
}
```

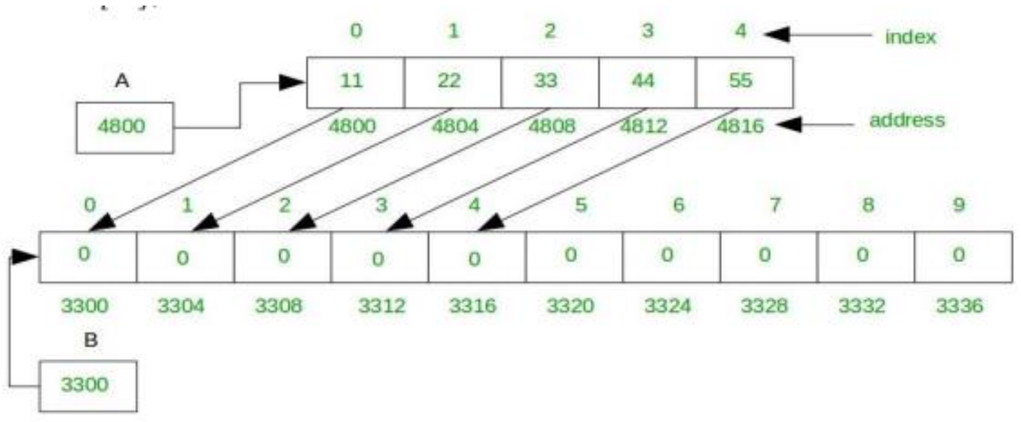
Output:

```
Contents of a[ ]
2 8 3
Contents of b[ ]
2 8 3
```

Dynamic Change of Array Size:

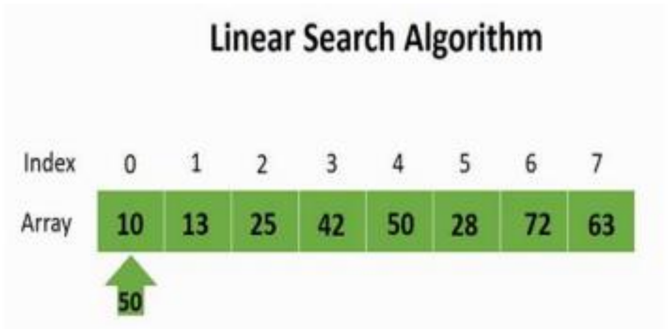
- The number of elements (size) of the array may change during the execution of the program. This feature is unlike C and C++ wherein the array once declared is of fixed size, that is, the number of elements cannot be changed.

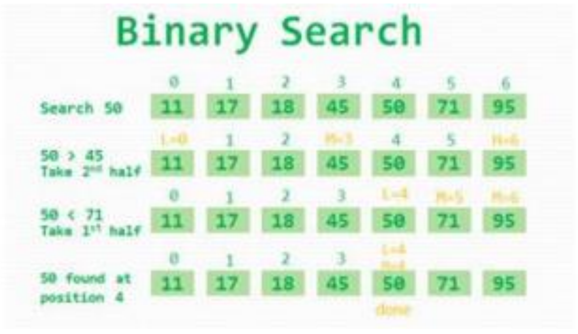
- In Java, however, you may change the number of elements by dynamically retaining the array name. In this process, the old array is destroyed along with the values of elements.
- Example:
- *int [ ] num = new int [5];*
- *num = new int [10];*



Search for Values in Array:

- Searching an array for a value is often needed. Let us consider the example of searching for your name among the reserved seats in a retail reservation chart, air travel reservation chart, searching for a book in a library, and so on.
- Two methods are employed:
- linear search and binary search for sorted arrays





Class Arrays:

- The package java.util defines the class arrays with static methods for general processes that are carried out on arrays such as sorting an array for full length of the array or for part of an array, binary search of an array for the full array or part of array, for comparing two arrays if they are equal or not, for filling a part of the full array with elements having a specified value, and for copying an array to another array.

- The sort method of arrays class is based on quick sort technique. The methods are applicable to all primitive types as well as to class objects.

- The class arrays are declared as
  public class Arrays extends Object

  Methods of Class Arrays:

- The methods of class arrays are as follows:
- Sort
- Binary Search
- Equals
- Fill
- CopyOf
- AsList
- ToString
- deepToString
- hashCode

One Dimensional Array:

- In the java programming language, an array must be created using new operator and with a specific size.

- The size must be an integer value but not a byte, short, or long.

- We use the following syntax to create an array.

  Syntax :

- data_type array_name[ ] = new data_type[size];

- (or)

- data_type[ ] array_name = new data_type[size];

• In java, an array can also be initialized at the time of its declaration.

• When an array is initialized at the time of its declaration, it need not specify the size of the array and use of the new operator.

• Here, the size is automatically decided based on the number of values that are initialized.

Example

```
int list[ ] = {10, 20, 30, 40, 50};
```

Example:

```
class Onedarray
```

```
 {
     public static void main(String args[])
       {
int a[]=new int[5];
a[0]=10;
a[1]=20;
a[2]=70;
a[3]=40;
a[4]=50;
for(int i=0;i<5;i++)
System.out.println(a[i]);
  }
}
```

Multidimensional Array :

• In java, we can create an array with multiple dimensions.

We can create 2-dimensional, 3- dimensional, or any dimensional array.

• In Java, multidimensional arrays are arrays of arrays.

• To create a multidimensional array variable, specify each additional index using another set of square brackets.

Syntax :

data_type array_name[ ][ ] = new data_type[rows][columns];

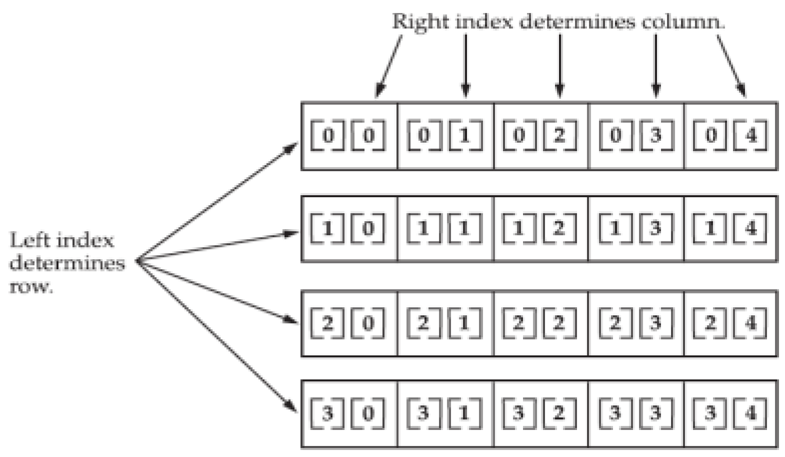
(or)

data_type[ ][ ] array_name = new data_type[rows][columns];

• When an array is initialized at the time of declaration, it need not specify the size of the array and use of the new operator.

• Here, the size is automatically decided based on the number of values that are initialized.

```
class Twodarray
{
        public static void main(String args[])
        {
                int arr[][]={{1,2,3},{2,4,5},{4,4,5}};
                for(int i=0;i<3;i++)
                {
                        for(int j=0;j<3;j++)
                        {
                                System.out.print(arr[i][j]+" ");
                        }
                        System.out.println();
                }
        }
}
```



Given: int twoD [ ] [ ] = new int [4] [5] ;

A conceptual view of a 4 by 5, two-dimensional array

Arrays as Vectors:

- Similar to arrays, vectors are another kind of data structure that is used for storing information.
- Using vector, we can implement a dynamic array.
- As we know, an array can be declared in the following way:
- int marks[ ] = new int [7];
- The basic difference between arrays and vectors is that vectors are dynamically allocated, where as arrays are static.
- The size of vector can be changed as and when required, but this is not true for arrays. The vector class is contained in java.util package.
- Vector stores pointers to the objects and not objects themselves.
- The following are the vector constructors.
- Vector vec = new Vector(5); // size of vector is

3.2.1 Introduction:

Inheritance is the technique which allows us to inherit the data members and methods from base class to derived class.

• **Base class is one which always gives its features to derived classes.**

• **Derived class is one which always takes features from base class.**

A Derived class is one which contains some of features of its own plus some of the data

members from base class.

3.2.2 Process of inheritance

Syntax for INHERITING the features from base class to derived class:

```
class <clsname-2> extends <clsname-1>
{
Variable declaration;
Method definition;
};
```

Here, **clsname-1** and **clsname-2** represents derived class and base class respectively.

Extends is a keyword which is used for inheriting the data members and methods from base class to

the derived class and it also improves functionality of derived class.

For example:

```
class c1;
{
int a;
void f1()
{
…………;
}
};
class c2 extends c1
{
int b;
void f2()
{
………..;
}
};
```

Whenever we inherit the base class members into derived class, when we creates an object of derived class, JVM always creates the memory space for base class members first and later memory space will be created for derived class members.

Example:

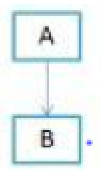
Write a JAVA program computes sum of two numbers using inheritance?

Answer:

```
class Bc
{
int a;
};
class Dc extends Bc
{
int b;
void set (int x, int y)
{
a=x;
b=y;
}
void sum ()
{
System.out.println ("SUM = "+(a+b));
}
};
class InDemo
{
public static void main (String k [])
   {
```

```
   Dc do1=new Dc ();
   do1.set (10,12);
   do1.sum ();
    }
}
```

Types of Inheritances



(a) Single Inheritance

Single Inheritance: It means when a base class acquired the properties of super class

```
class Animal
{
void eat()

{
System.out.println("eating...");
}
}
class Dog extends Animal
{
void bark()
{
System.out.println("barking...");
}
}
class TestInheritance
{
public static void main(String args[])
{
Dog d=new Dog();
```

d.bark();

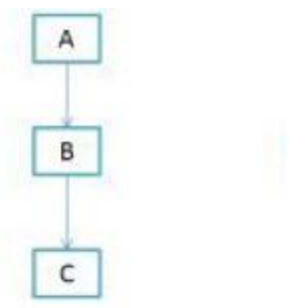
d.eat();

}

}

In this example base class is Dog and super class is Animal:

Multilevel Inheritence:



(d) Multilevel Inheritance

Multilevel inheritance refers to a mechanism in OO technology where one can inherit from a derived class, thereby making this derived class the base class for the new class.

- As you can see in below flow diagram C is subclass or child class of B and B is a child class of A

Example:

```
Class X

{

public void methodX()

   {

System.out.println("Class X method");

    }

}


Class Y extends X

{

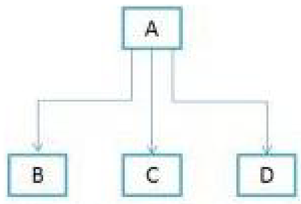
public void methodY()

{

System.out.println("class Y method");
}
}
Class Z extends Y
{
public void methodZ()
{
System.out.println("class Z method");
}
public static void main(String args[])
{
  Z obj = new Z();
   obj.methodX(); //calling grand parent class method
    obj.methodY(); //calling parent class method
    obj.methodZ(); //calling local method
   }
}
```

Hierarchical Inheritance

In such kind of inheritance one class is inherited by many sub classes. In below example class B,C and D inherits the same class A. A is parent class (or base class) of B,C & D



(c) Hierarchical Inheritance

Example:

```
class A
{
public void methodA()
{
System.out.println("method of Class A");
}
}
```

```
class B extends A
{
public void methodB()
{
System.out.println("method of Class B");
}
}
class C extends A
{
public void methodC()
{
System.out.println("method of Class C");
}
}
class D extends A
{
public void methodD()
{
System.out.println("method of Class D");}
}
class JavaExample
{
public static void main(String args[])
{
B obj1 = new B();
C obj2 = new C();
D obj3 = new D();
}
}
```

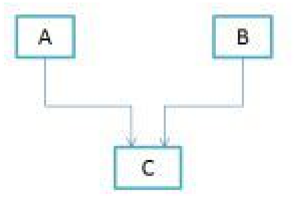
Output:

```
method of Class A
method of Class A
```

method of Class A

Multiple Inheritance:

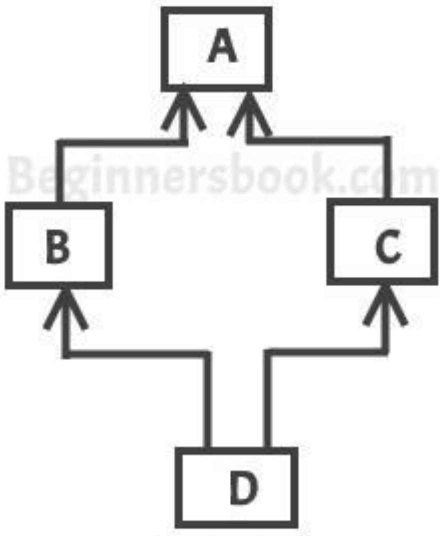
- Multiple Inheritance" refers to the concept of one class extending (Or inherits) more than one base class.
- The inheritance we learnt earlier had the concept of one base class or parent. The problem with "multiple inheritance" is that the derived class will have to manage the dependency on two base classes



(b) Multiple Inheritance

Note: Multiple Inheritance is very rarely used in software projects. Using Multiple inheritance often leads to problems in the hierarchy. This results in unwanted complexity when further extending the class.

- **Hybrid Inheritance in Java**
- A hybrid inheritance is a combination of more than one types of inheritance. For example when class A and B extends class C & another class D extends class A then this is a hybrid inheritance, because it is a combination of single and hierarchical inheritance.



Hybrid Inheritance

The diagram is just for the representation, since multiple inheritance is not possible in java

```
class C
{
public void disp()
{
System.out.println("C");
}
}
class A extends C
{
public void disp()
{
System.out.println("A");
}
}
class B extends C
{
public void disp()
{
System.out.println("B");
}
}
class D extends A
{
public void disp()
{
System.out.println("D");
}
public static void main(String args[]){
D obj = new D();
obj.disp();
}
}
```

This example is just to demonstrate the hybrid inheritance in Java. Although this example is meaningless, you would be able to see that how we have implemented two types of inheritance(single and hierarchical) together to form hybrid inheritance

Class A and B extends class C → Hierarchical inheritance

Class D extends class A → Single inheritance

Inhibiting Inheritance of Class Using Final

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 main purpose of using a class being declared as final is to prevent the class from being subclassed. If a class is marked as final then no class can inherit any feature from the final class.

Example:

```
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
```

Since class **Bike** is declared as final so the derived class **Honda** cannot extend **Bike**

Access Control and Inheritance

Although a subclass includes all of the members of its superclass, it cannot access those members of the superclass that have been declared as private.

```
class A
{
int i; // public by default
```

```
private int j; // private to A
void setij(int x, int y)
{
i = x;
j = y;
}
}
// A's j is not accessible here.
class B extends A
{
int total;
void sum()
{
total = i + j; // ERROR, j is not accessible here
}
class Access
{
public static void main(String args[])
{
B subOb = new B();
subOb.setij(10, 12);
subOb.sum();
System.out.println("Total is " + subOb.total);
}
}
```

This program will not compile because the reference to j inside the sum( ) method of B causes an access violation. Since j is declared as private, it is only accessible by other members of its own class. Subclasses have no access to it.

Application of Keyword Super

Super keyword is used for differentiating the base class features with derived class features.

Super keyword is placing an important role in three places.

- • variable level
- • method level
- • constructor level

Super at variable level:

Whenever we inherit the base class members into derived class, there is a possibility that base class members are similar to derived class members.

In order to distinguish the base class members with derived class members in the derived class, the base class members will be preceded by a keyword super.

For example:

```
class Bc
{
int a;
};
class Dc extends Bc
{
int a;
void set (int x, int y)
{
super.a=x;
a=y; //by default 'a' is preceded with 'this.' since 'this.' represents current class
}
void sum ()
{
System.out.println ("SUM = "+(super.a+a));
}
};
class InDemo1
{
public static void main (String k [])
{
```

```
Dc do1=new Dc ();
do1.set (20, 30);
do1.sum ();
}
};
```

Super at method level:

Whenever we inherit the base class methods into the derived class, there is a possibility that base class methods are similar to derived methods.

To differentiate the base class methods with derived class methods in the derived class, the base class methods must be preceded by a keyword super.

Syntax for super at method level: super. base class method name

For example:

```
class Bc
{
void display ()
{
System.out.println ("BASE CLASS - DISPLAY...");
}
};
class Dc extends Bc
{
void display ()
{
super.display (); //refers to base class display method
System.out.println ("DERIVED CLASS- DISPLAY...");
}
};
class InDemo2
{
public static void main (String k [])
{
```

```
Dc do1=new Dc ();
do1.display ();
}
};
```

Constructor Method and Inheritance

Super at constructor level:

super() can be used to invoke immediate parent class constructor.

```
class A
{
int i,j;
A(int a,int b)
{
i=a;
j=b;
}
void show()
{
System.out.println("i and j values are"+i+" "+j);
}
}
class B extends A
{
int k;
B(int a, int b, int c)
{
super(a, b);//super class constructor
k = c;
}
// display k – this overrides show() in A
void show()
{
super.show();
System.out.println("k: " + k);
}
}
class Override
{
public static void main(String args[])
{
B subOb = new B(1, 2, 3);
subOb.show(); // this calls show() in B
}
}
```

3.2.8Abstract Classes:

In JAVA we have two types of classes. They are concrete classes and abstract classes.

- **A concrete class is one which contains fully defined methods. Defined methods are also known as implemented or concrete methods. With respect to concrete class, we can create an object of that class directly.**

- **An abstract class is one which contains some defined methods and some undefined methods. Undefined methods are also known as unimplemented or abstract methods. Abstract method is one which does not contain any definition.**

To make the method as abstract we have to use a keyword called abstract before the function declaration.

Syntax for ABSTRACT CLASS: abstract return_type method_name (parameters list);

```
// A Simple demonstration of abstract.
abstract class A
{
abstract void callme();
// concrete methods are still allowed in abstract classes
void callmetoo()
{
System.out.println("This is a concrete method.");
}
}
class B extends A
```

```
{
void callme()
{
System.out.println("B's implementation of callme.");
}
}
class AbstractDemo
{
public static void main(String args[])
{
B b = new B();
b.callme();
b.callmetoo();
}
}
```

Notice that no objects of class A are declared in the program. As mentioned, it is not possible to instantiate an abstract class.

One other point: class A implements a concrete method called callmetoo

3.3 Interface in Java

3.3.1 Introduction

An interface in java is a blueprint of a class.

It has static constants and abstract methods. The interface in java is a mechanism to achieve abstraction. There can be only abstract methods in the java interface not method body.

It is used to achieve abstraction and multiple inheritance in Java.

- Using the keyword interface, you can fully abstract a class' interface from its implementation.
- That is, using interface, you can specify what a class must do, but not how it does it.
- Interfaces are syntactically similar to classes, but they lack instance variables, and their methods are declared without any body
- Variables can be declared inside of interface declarations.
- They are implicitly final and static, meaning they cannot be changed by the implementing class.
- They must also be initialized. All methods and variables are implicitly public.

3.3.2 Declaring an Interface

An interface is defined much like a class. This is the general form of an interface:

```
access interface name {
return-type method-name1(parameter-list);
return-type method-name2(parameter-list);
type final-varname1 = value;
type final-varname2 = value;
// ...
return-type method-nameN(parameter-list);
type final-varnameN = value;
}
```

Here is an example of an interface definition. It declares a simple interface that contains one method called callback( ) that takes a single integer parameter.

```
interface Callback
{
void callback(int param);
}
```

3.3.3 Implementing Interfaces

Once an interface has been defined, one or more classes can implement that interface. To implement an interface, include the implements clause in a class definition, and then create the methods defined by the interface. The general form of a class that includes the implements clause looks like this:

```
class classname [extends superclass] [implements interface [,interface...]] {
// class-body
}
```

If a class implements more than one interface, the interfaces are separated with a comma.

Here is a small example class that implements the Callback interface shown earlier.

```
class Client implements Callback
{
// Implement Callback's interface
public void callback(int p)
{
System.out.println("callback called with " + p);
}
}
```

Notice that callback( ) is declared using the public access specifier.

It is both permissible and common for classes that implement interfaces to define additional members of their own. For example, the following version of Client implements callback( ) and adds the method nonIfaceMeth( ):

```
class Client implements Callback
{
// Implement Callback's interface
public void callback(int p)
{
System.out.println("callback called with " + p);
}
void nonIfaceMeth()
{
System.out.println("Classes that implement interfaces " +
"may also define other members, too.");
}
}
```

Accessing Implementations Through Interface References:

You can declare variables as object references that use an interface rather than a class type. Any instance of any class that implements the declared interface can be referred to by such a variable. When you call a method through one of these references, the correct version will be called based on the actual instance of the interface being referred to.

The following example calls the callback( ) method via an interface reference variable:

```
class TestIface
{
public static void main(String args[])
{
Callback c = new Client();
c.callback(42);
}
}
```

The output of this program is shown here:

```
callback called with 42
```

Multiple Interfaces

Multiple inheritance in java can be achieved through interfaces:

Example:

```
interface Printable
{
void print();
}
interface Showable
{
void show();
}
class A7 implements Printable,Showable
{
public void print()
{
System.out.println("Hello");
}
public void show()
{
System.out.println("Welcome");
}
public static void main(String args[])
{
A7 obj = new A7();
obj.print();
obj.show();
}
```

}

Output: Hello

Welcome

Nested Interfaces:

An interface i.e. declared within another interface or class is known as nested interface. The nested interfaces are used to group related interfaces so that they can be easy to maintain. The nested interface must be referred by the outer interface or class. It can't be accessed directly.

There are given some points that should be remembered by the java programmer.

- o Nested interface must be public if it is declared inside the interface but it can have any access modifier if declared within the class.
- o Nested interfaces are declared static implicitly.

Example:

interface Showable

{

void show();

interface Message

{

void msg();

}

}

```
class TestNestedInterface1 implements Showable.Message
{
          public void msg()
          {
          System.out.println("Hello nested interface");
          }

 public static void main(String args[])
{
  Showable.Message message=new TestNestedInterface1();//upcasting here
  message.msg();
 }
}
```

As you can see in the above example, we are acessing the Message interface by its outer interface Showable because it cannot be accessed directly. It is just like almirah inside the room, we cannot access the almirah directly because we must enter the room first.

Inheritance of Interfaces

One interface can inherit another by use of the keyword extends. The syntax is the same as for inheriting classes. When a class implements an interface that inherits another interface, it must provide implementations for all methods defined within the interface inheritance chain.

```
// One interface can extend another.
interface A
{
void meth1();
void meth2();
}
// B now includes meth1() and meth2() -- it adds meth3().
interface B extends A
{
void meth3();
}
// This class must implement all of A and B
class MyClass implements B
{
public void meth1()
{
System.out.println("Implement meth1().");
}
public void meth2()
{
System.out.println("Implement meth2().");


}
public void meth3()
{
System.out.println("Implement meth3().");
}
}
class IFExtend
{
public static void main(String arg[])
{
MyClass ob = new MyClass();
ob.meth1();
ob.meth2();
ob.meth3();
}
}
```

Default methods in interfaces

Before Java 8, interfaces could have only abstract methods. The implementation of these methods has to be provided in a separate class. So, if a new method is to be added in an interface, then its implementation code has to be provided in the class implementing the same interface. To overcome this issue, Java 8 has introduced the concept of default methods which allow the interfaces to have methods with implementation without affecting the classes that implement the interface

```
public static void main(String args[])
{
Showable.Message message=new TestNestedInterface1();//upcasting here
message.msg();
}
}
```

As you can see in the above example, we are accessing the Message interface by its outer interface Showable because it cannot be accessed directly. It is just like almirah inside the room, we canno taccess the almirah directly because we must enter the room first.

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void meth3();
}
// This class must implement all of A and B
class MyClass implements B
{
public void meth1()
{
}
public void meth2()
{
System.out.println("Implement meth2().");
}
public void meth3()
{
System.out.println("Implement meth3().");
}
}
class IFExtend
{
public static void main(String arg[])
{
MyClass ob = new MyClass();

System.out.println("Implement meth1().");
}
public void meth2()
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System.out.println("Implement meth2().");
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}
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class IFExtend
{
public static void main(String arg[])
{
MyClass ob = new MyClass();
ob.meth1();
ob.meth2();
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}
```

```
}
```

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Example:

```
interface TestInterface
{
// abstract method
public void square(int a);
// default method
default void show()
{
 System.out.println("Default Method Executed");
}
}

class TestClass implements TestInterface
{
// implementation of square abstract method
public void square(int a)
{
System.out.println(a*a);


}
public static void main(String args[])
{
TestClass d = new TestClass();
d.square(4);
// default method executed
```

Default methods are also known as defender methods or virtual extension methods

Static methods in interfaces

The interfaces can have static methods as well which is similar to static method of classes.

Example:

```
interface TestInterface
{
// abstract method
public void square (int a);
// static method
static void show()
{
System.out.println("Static Method
Executed");
}
}
```

```
class TestClass implements TestInterface
{
// Implementation of square abstract method
public void square (int a)
{
System.out.println(a*a);
}
public static void main(String args[])
{
TestClass d = new TestClass();
d.square(4);
// Static method executed
TestInterface.show();
}
}
```

Output:

```
16
Static Method Executed
```

Functional Interfaces

A functional interface is an interface that contains only one abstract method. They can have only one functionality to exhibit. From Java 8 onwards, lambda expressions can be used to represent the instance of a functional interface.

A functional interface can have any number of default methods. Runnable, ActionListener, Comparable are some of the examples of functional interfaces.

Functional Interface annotation is used to ensure that the functional interface can't have more than one abstract method. In case more than one abstract methods are present, the compiler flags an 'Unexpected @FunctionalInterface annotation' message.

```
@FunctionalInterface
```

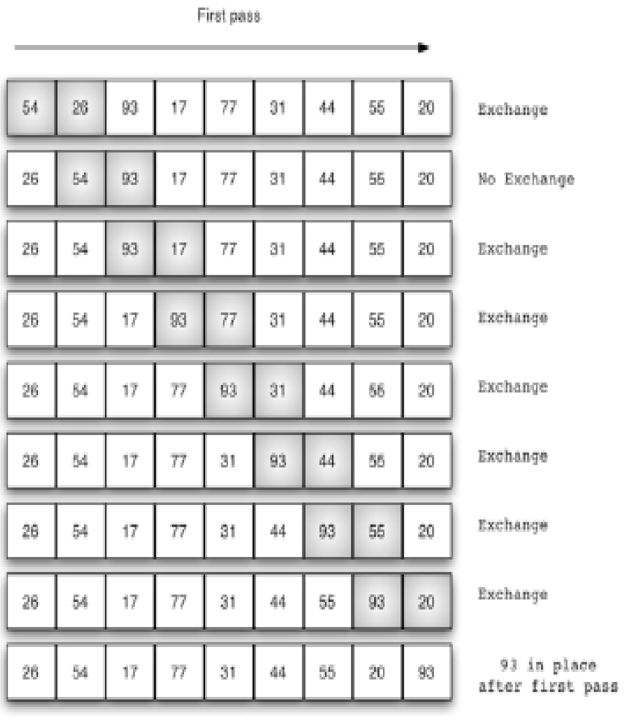
```
interface Square
{
int calculate(int x);
}
class Test
{
public static void main(String args[])
{
int a = 5;
// lambda expression to define the calculate method
Square s = (int x)->x*x;
// parameter passed and return type must be
// same as defined in the prototype
int ans = s.calculate(a);
System.out.println(ans);
}
}
```

Output:

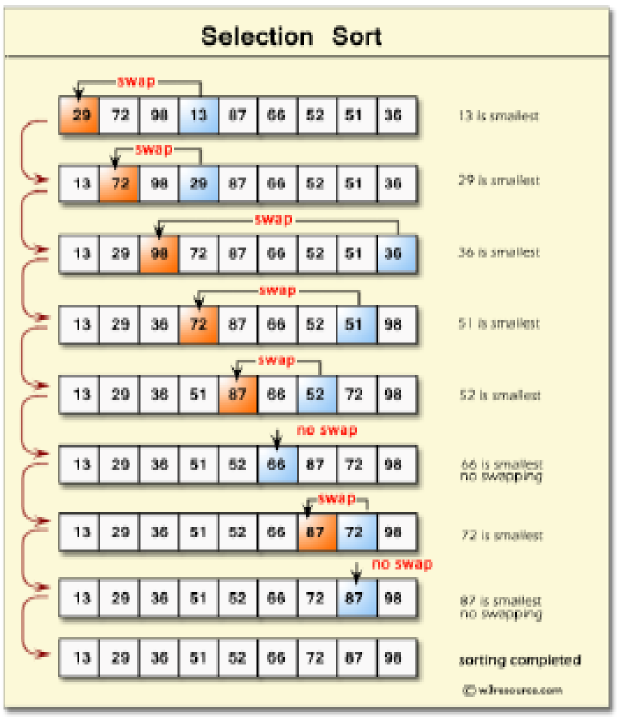
```
25
```

Sorting of arrays if often needed in many applications of arrays. For example, in the preparation of examination results, you may require to arrange the entries in order of grades acquired by students or in alphabetical order in dictionary style. The arrays may be sorted in ascending or descending order. Several methods are used for sorting the arrays that include the following:

1. Bubble sort
2. Selection sort
3. Sorting by insertion method
4. Quick sort



1. Bubble Sort



2. Selection Sort

Operations on Array Elements

An array element is a variable of the type declared with the array. All the operations that are admissible for that type of a variable can be applied to an individual array element.

- Accessing Elements or traversal
- Insertion
- Deletion

Program to show Operations on ArrayElements

```
import java.util.Arrays

public class ArrayOperations
{
   // Method to insert an element at a specified position
   public static int[] insertElement(int[] arr, int element, int position)
    {
      if (position < 0 || position > arr.length)
   {
         System.out.println("Invalid position");
         return arr; // Return the original array if position is invalid
      }

      // Create a new array with an additional space for the new element
      int[] newArr = new int[arr.length + 1];

      // Copy elements up to the insertion position
      for (int i = 0; i < position; i++)
{
         newArr[i] = arr[i];
      }

      // Insert the new element
      newArr[position] = element;

      // Copy the remaining elements
      for (int i = position; i < arr.length; i++)
{
         newArr[i + 1] = arr[i];
      }

      return newArr;
   }

   // Method to delete an element from a specified position
   public static int[] deleteElement(int[] arr, int position)
{
      if (position < 0 || position >= arr.length) {
         System.out.println("Invalid position");
```

```
            return arr; // Return the original array if position is invalid
        }

        // Create a new array with one less space
        int[] newArr = new int[arr.length - 1];

        // Copy elements up to the deletion position
        for (int i = 0; i < position; i++)
{
            newArr[i] = arr[i];
        }

        // Copy the remaining elements after the deletion position
        for (int i = position + 1; i < arr.length; i++)
       {
            newArr[i - 1] = arr[i];
        }

        return newArr;
    }

    public static void main(String[] args)
{
        int[] arr = {1, 2, 3, 4, 5};

        System.out.println("Original Array: " + Arrays.toString(arr));

        // Inserting element
        int elementToInsert = 10;
        int insertPosition = 2;
        arr = insertElement(arr, elementToInsert, insertPosition);
        System.out.println("Array after insertion: " + Arrays.toString(arr));

        // Deleting element
        int deletePosition = 3;
        arr = deleteElement(arr, deletePosition);
        System.out.println("Array after deletion: " + Arrays.toString(arr));
    }
}
```