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Object Oriented Programming with Java

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CHAPTER-1

Fundamentals - I

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Unit-1 FUNDAMENTALS - I

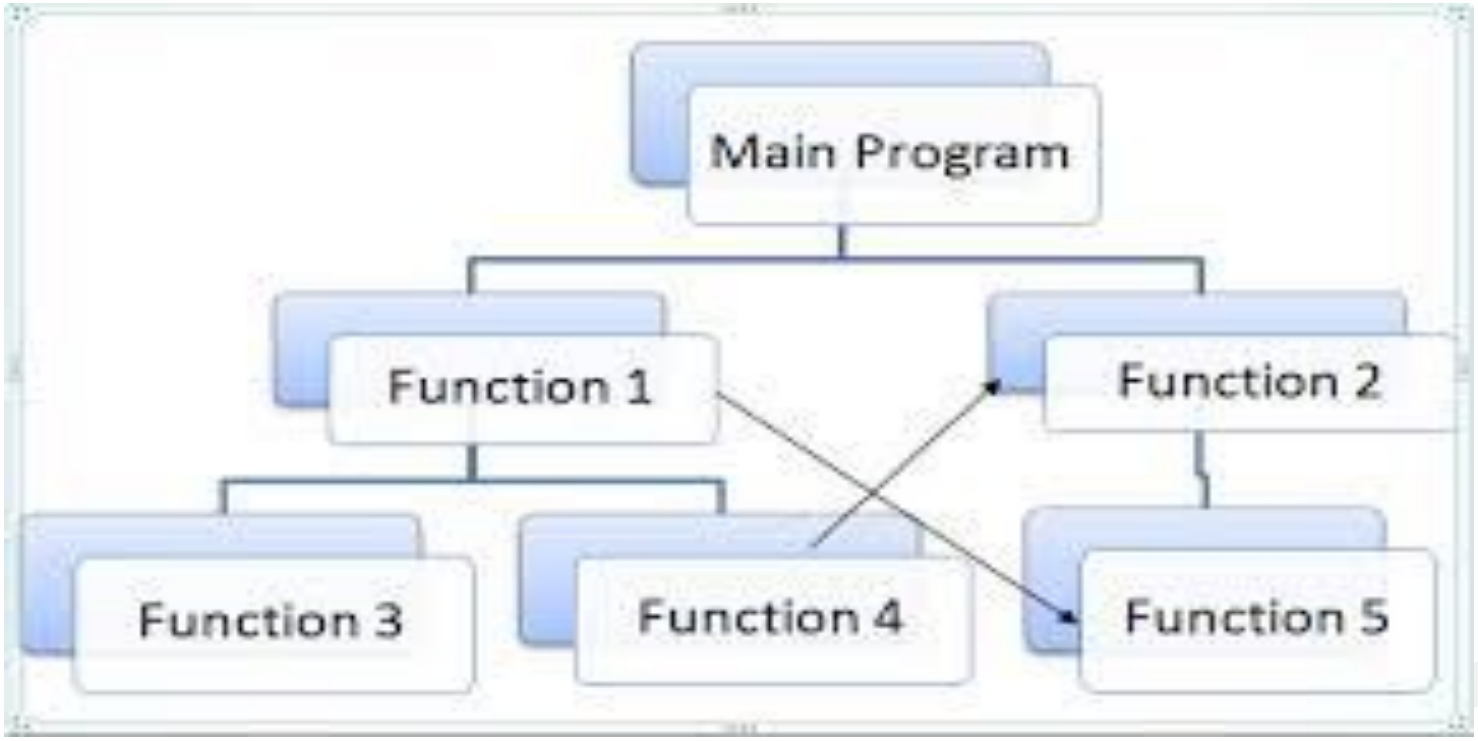
- **Topics:**

Review of OOP
Objects and classes in Java
Defining classes
Methods
Access Specifiers
Static members
Constructors
Garbage collection
Arrays
Strings
Packages

Procedural Oriented Programming (POP)

- It emphasis on **procedure** rather than data.
- It is follows a step-by-step approach to break down a task into a collection of variables and routines (or subroutines) through a sequence of instructions.
- POP the the main program is divided into small parts based on the functions and is treated as separate program for individual smaller program.
- Each step is carried out in order in a systematic manner so that a computer can understand what to do.
- It is based on the concept of a procedure call,
- It containing a series of steps to be carried out.

Key Features of Procedural Programming



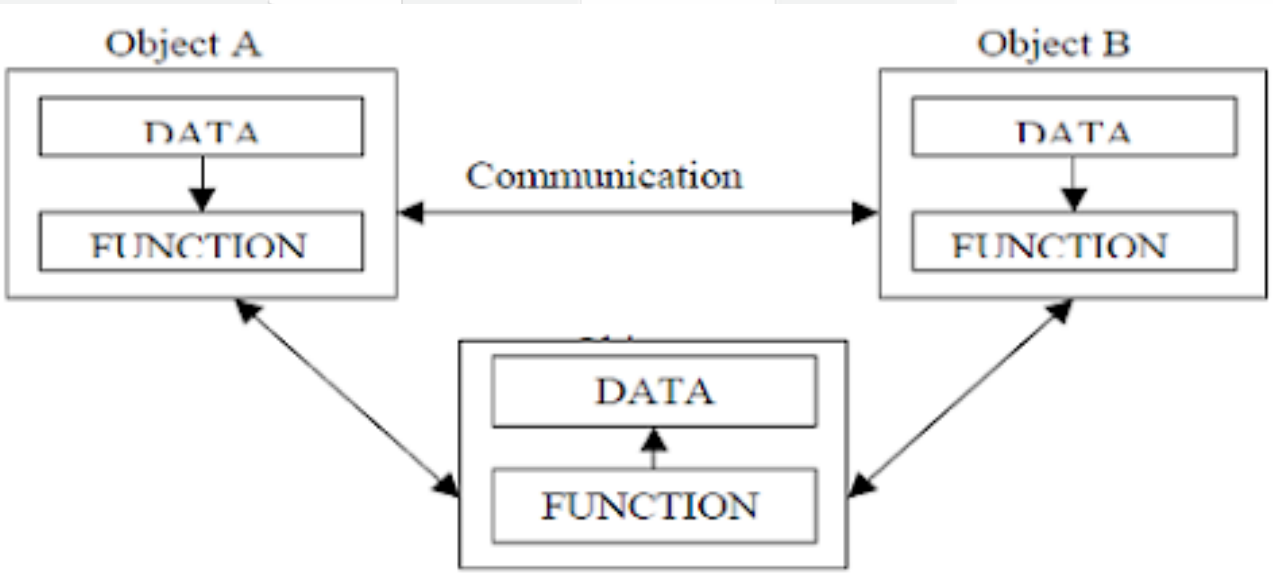
Key Features of Procedural Programming

- Predefined functions
- Local Variable
- Global Variable
- Modularity
- Parameter Passing
- No Data hiding

Object Oriented Programming

- Object-oriented Programming is a programming language that uses classes and objects to create models based on the real world environment.
- concept of objects and classes is introduced and hence the program is divided into small chunks called objects which are instances of classes.
- Due to abstraction in OOPs data hiding is possible and hence it is more secure than POP.

Object Oriented Programming



Organization of data and function in OOP

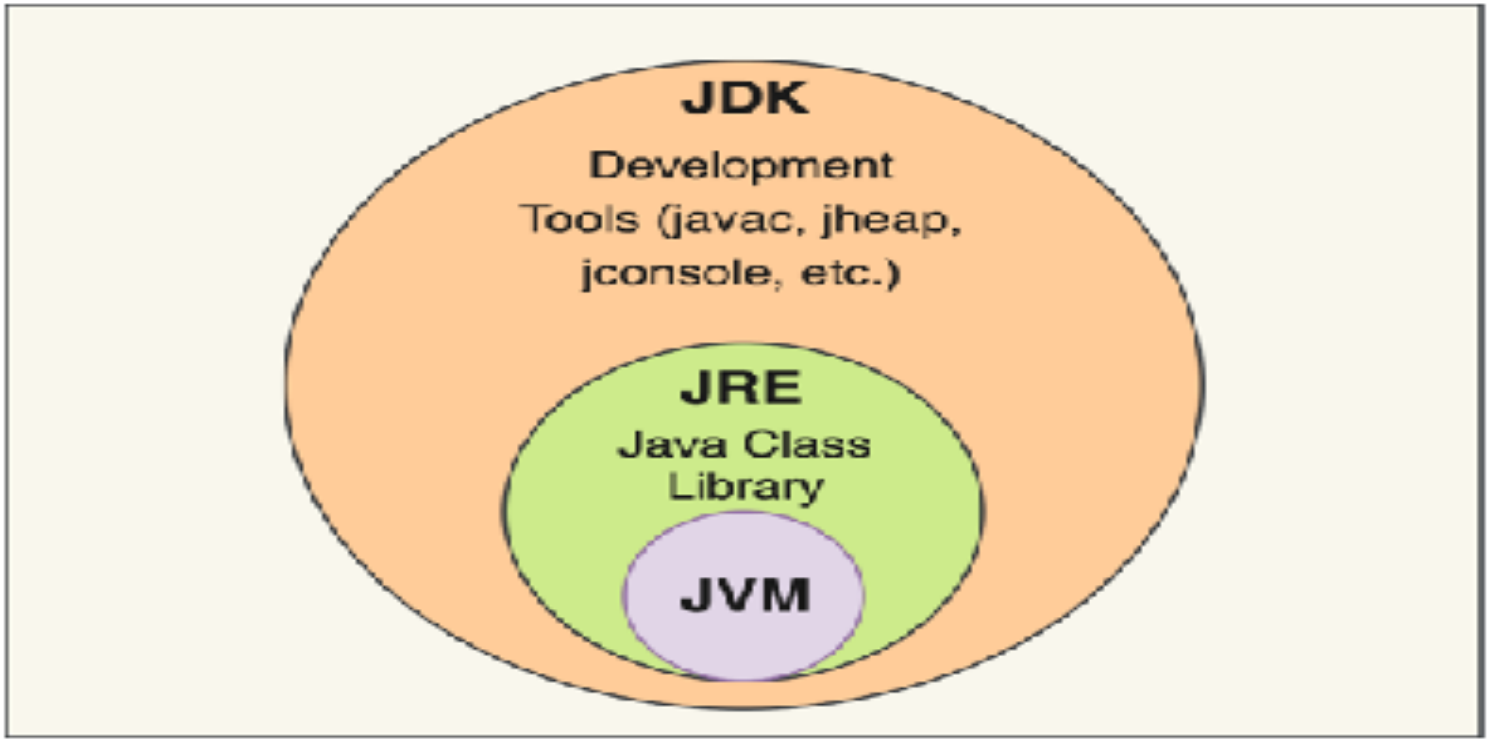
JAVA History

- Java is an island of Indonesia where the first coffee was produced (called java coffee).
- It is a kind of espresso bean. Java name was chosen by James Gosling while having coffee near his office.
- Initially developed by James Gosling at Sun Microsystems (which is now a subsidiary of Oracle Corporation) and released in 1995.
- In 1995, Time magazine called **Java one of the Ten Best Products of 1995**.

What is java?

- The Java is Object oriented programming language.
- It is derived from c and c++.
- Java programs can be either application or applets.
- Java is a platform independent language that means it can run on different OS.
- The Java platform consists of JVM and Java API (Application programming Interface).
- The API provides pre-written libraries and standard functionality with classes and interfaces.

Java Development Tools



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Java Development Tools

•In Java , Java Developer's Kit (JDK) is a software environment provided by Sun Microsystems, which contains JRE(Java Runtime Environment) + Java language development tools (compiler, interpreter, debugger, applet viewer etc..)

• **JRE=JVM + set of libraries**

•It provides set of software tools which is used for developing java application .

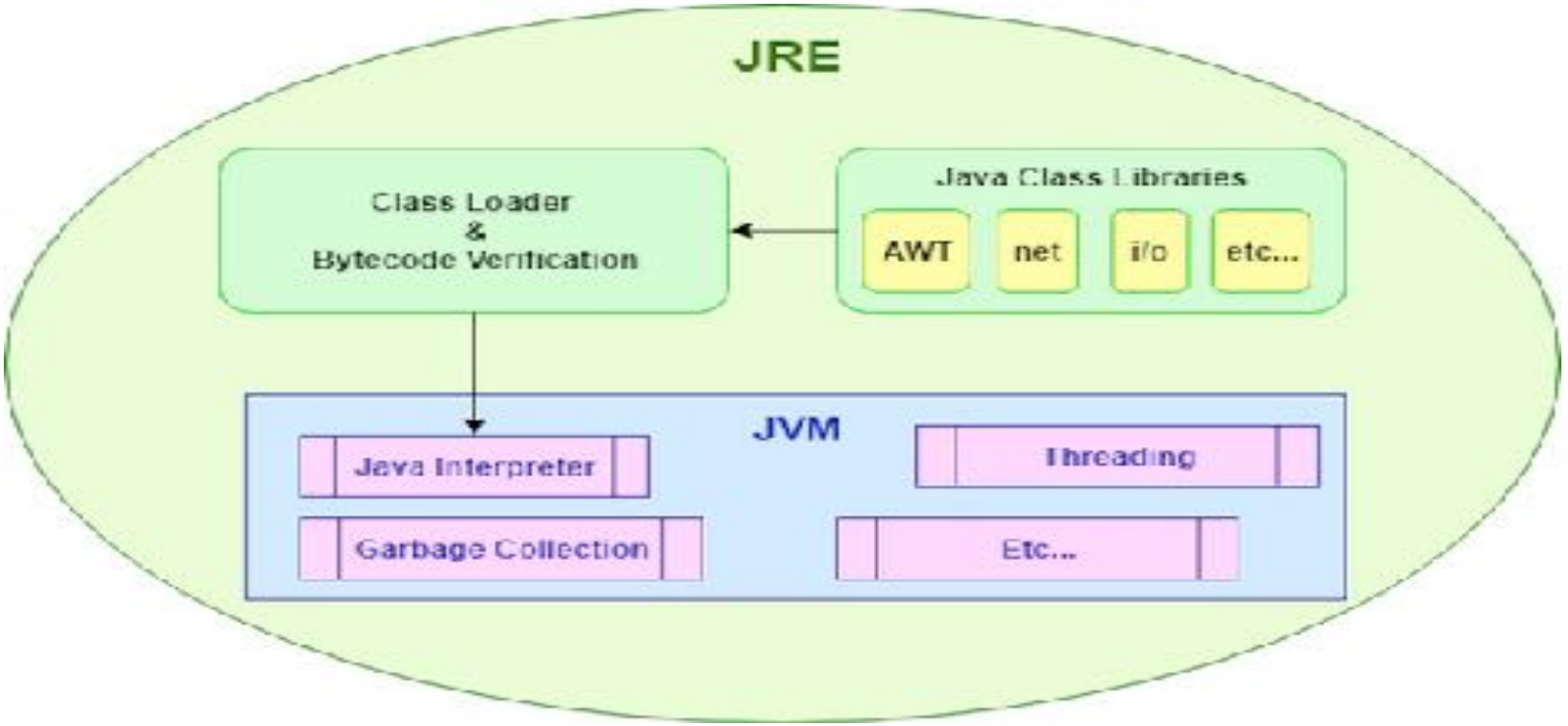
•It provides set of libraries (.jar) and other files that JVM uses Runrime.

•**JDK=JRE + Development tools**

• Used to develop java application and applet.

• JDK comes in various versions and can be downloaded free from the Sun Microsystems

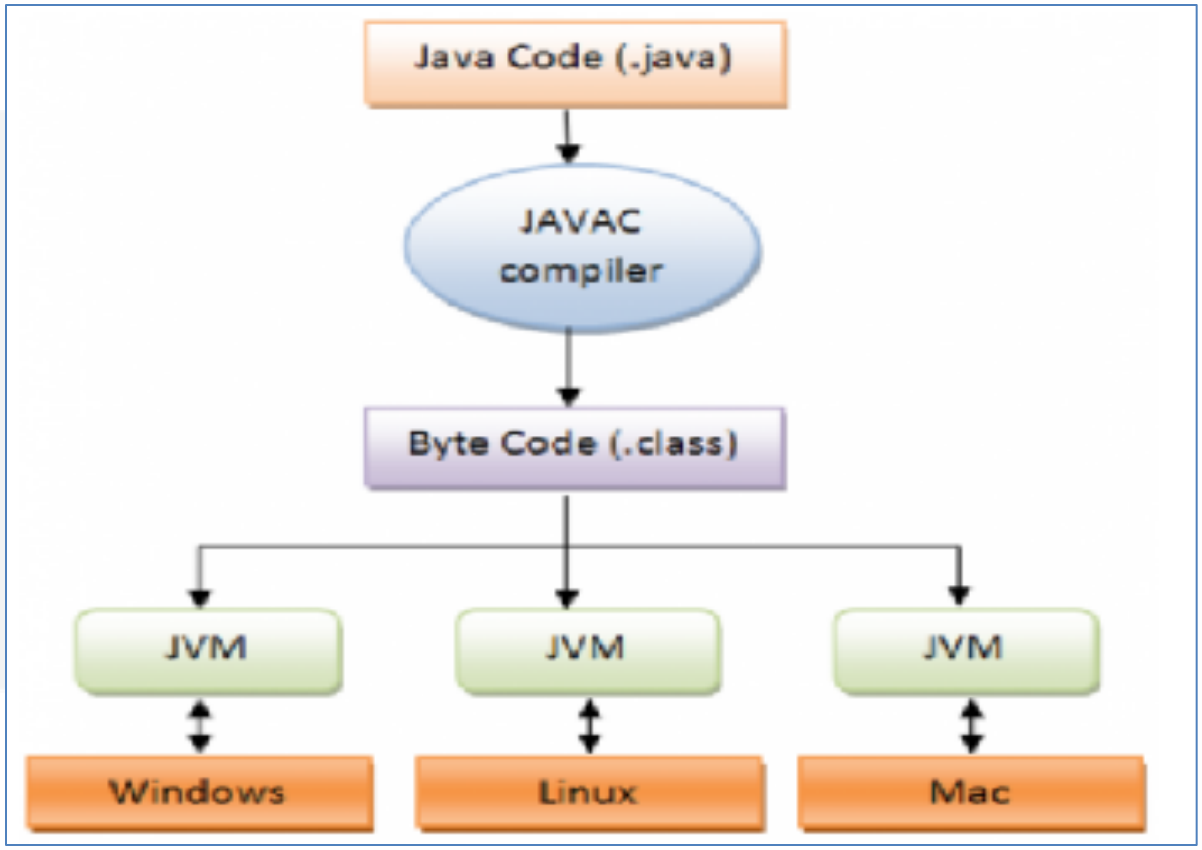
Java Development Tools



Types of programs

- **Applets**
  - Execute on HTML Browsers.
  - Have several security restrictions.
- **Servlet**
  - Execute on Sophisticated Servers.
- **GUI Applications**
  - Are Interpreted and Executed.
  - Use the current's platform's GUI widgets.
  - Mostly use Java's AWT packages.
- **CLI Applications**
  - Runs on command line

Java is Platform Independent

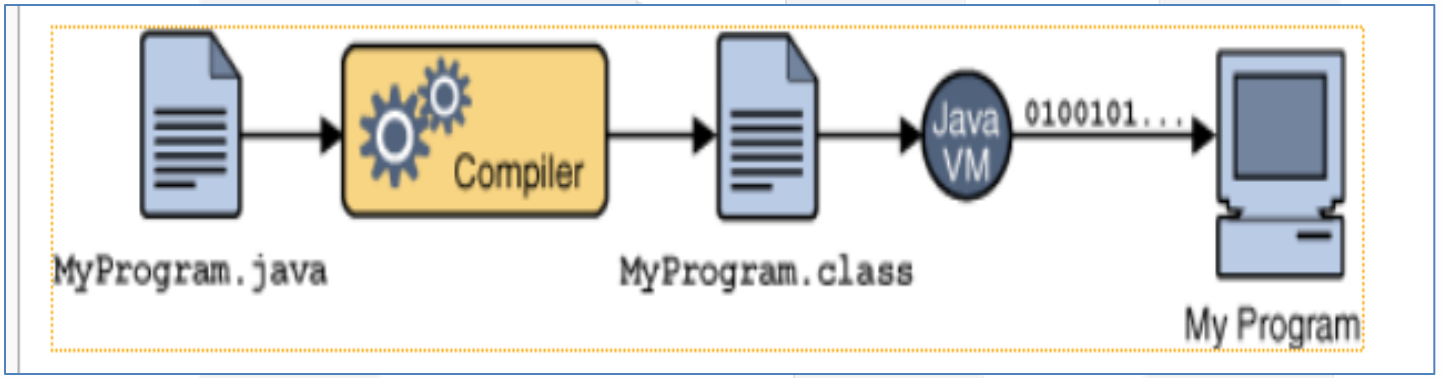


Java is Platform Independent

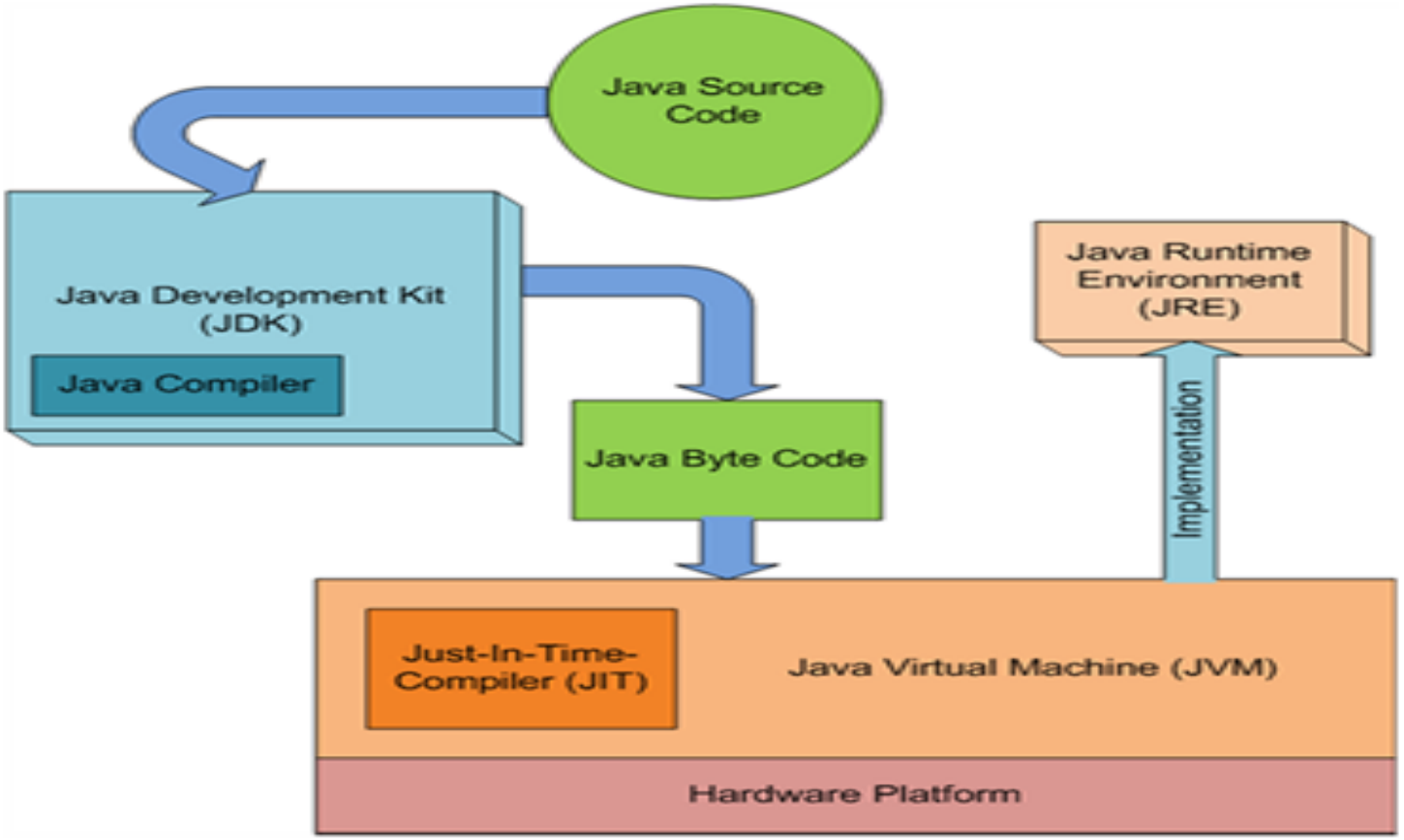
JVM:

- It does not physically exist.
- It provides Runtime environment to execute java byte code
- JVM provides:
- loading code
- Verify the code
- Execute
- Provides runtime environment
- Run program which written in other language & compiled to byte code.

WORA(Write Once Run Anywhere)



Java is Platform Independent



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Features of Java

- Java is simple
- Java is object-oriented
- Java is distributed
- Java is interpreted
- Java is robust
- Java is portable
- Java's performance
- Java is multithreaded
- Java is dynamic
- Java is Secure

Cont …

- **Java is simple:**

➢ Derived from C(syntax) & C++(features)

➢ Easy to write & Compile

- **Java is object-oriented**

➢ Class

➢ Object

➢ Inheritance

➢ Polymorphism

➢ Encapsulation

➢ Everything is an object

➢ Java supports all features of OOP:

Cont …

- **Java is distributed:**

➢Java is known as distributed language for creating application on networks

➢Java supports TCP/IP & UDP Protocol.

➢RMI

➢Support for Internet communication primitives

Cont …

- **Java is Interpreted**

➢Compiling the java source code into an intermediate representation called BYTECODE

➢It can run on every platform having Java Virtual Machine installed

➢Java Virtual Machine

  - Runtime Environment to execute java programs
  - Interprets the bytecode and converts into platform specific code
  - Secure execution of the programs without any side effects

- **Java is Portable:**

➢Write Ones Run Anywhere

Cont …

- **Java is Robust:**

➢The program should run effectively on multiple platforms

➢Strictly typed language

➢Code checking at compile time as well as run time

➢Memory management using the Garbage Collector

- ❖ Automatic deallocation of memory with unused Objects

➢Exception Handling

- ❖ Prevent program from crashing due to runtime error

Cont …

- Java is Multithreaded

➢ Multithreaded means handling multiple tasks simultaneous.

➢ Multithreading means a single program having different threads executing independently at the same time.

Cont …

•Java is dynamic

➢By connecting to the Internet, a user immediately has access to thousands of programs and other computers.

➢During the execution of a program, Java can dynamically load classes that it requires either from the local hard drive, from another computer on the local area network or from a computer somewhere on the Internet.

➢Java is capable dynamically linking in new class libraries, methods, and objects.

Cont …

- Java is Secure

➢The Java language has built-in capabilities to ensure that violations of security do not occur.

➢Threat or viruses and abuse of resources are everywhere. Java system not only verifies all memory access but also ensure that no viruses are communicated with an Applet.

➢Absence of pointer in java ensures that program cannot gain access to memory locations without proper authorization.

Java Environment

- Java includes many development tools, classes and methods
  - Development tools are part of Java Development Kit (JDK) and
  - The classes and methods are part of **Java Standard Library** (JSL), also known as **Application Programming Interface** (**API**).
- JDK constitutes of tools like java compiler, java interpreter and many.
- API includes hundreds of classes and methods grouped into several packages according to their functionality.

Other components

•JIT – improves performance of JVM by directly compiling some sensitive code (code which executes above a certain threshold) into native instruction. It caches the compiled code hence improving the performance.

•JRE -Runtime Environment

•JAR – Java Archive

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First Java Program

Example.java

```
class Example
 {
 public static void main(String args[])
    {
   System.out.println("This is a simple Java program");
    }
}
```

Source file name must match the class name - Why?

- a source file is officially called a *compilation unit*
- Java compiler requires that a source file use the **.java** filename extension
- Compilation:
  - javac Example.java
- Will create a file named **Example.class**
  - The name is **same as that of class name in source file** (except the extension!)
  - Contains the compiled **bytecode** of the **Example.java** source

Source file name must match the class name - Why?

- To actually run the program the command is
  - java Example
- specifying the name of the class that you want to execute
- **Searches for the .class file with name Example (Example.class)**
- Hence, both needs to be same

Objects and classes in Java

- Objects and classes are basic concepts of Object Oriented Programming which revolve around the real life entities.
- Class is a container for variables and methods.
- Class defines a new data type that is used to create the object of that type.
- Thus, a class is a template for an object, and an object is an instance of a class.
- A class is declared by use of the class keyword.

Class Syntax

```
class classname
{
type instance-variable1;
type instance-variable2;
// ...
type instance-variableN;
type methodname1(parameter-list)
{
// body of method
}
type methodname2(parameter-list)
{
// body of method
}
// .....................
type methodnameN(parameter-list)
{
// body of method
}
}
```

Class

- The data, or variables, defined within a class are called instance variables because each instance of the class contains its own copy of these variables.
- The data for one object is separate and unique from the data for another.
- The code is contained within methods. The methods and variables defined within a class are called members of the class.

Note: Java classes do not need to have a main( ) method. You only specify main() method if that class is the starting point for your program.

Class Example

```
class Box
{
int width,height, depth;
void set()
{
}
void set1(int a)
{
}
int set2()
{
}
int set3(int a)
{
}
}
```

Objects

- A java object is one instance of class.
- A object is a block of memory that contains space to store all the instance variables.
- Objects are created by using new operator. The new operator creates an object of the specified class in the heap area of memory and returns a reference to the object created. It is dynamically allocated memory to the object.
- Syntax:

classname objectname = new classname();

Object Example

Box b1=new Box();

· Now when we create another object reference and give to reference of previous object

Box b1; b1=new Box();

Box b2=b1

· The above stat. can not create new object in the memory but b1 and b2 will both refer to the same object.

Example: Class

```
class Box
{
int  width,depth;
}
```

In above example, class Box have two instance variables like width,depth.

```
Box b=new Box();
b.width=10; // assigning value to width
b.height=20; // assigning value to height
```

Example: Class Usage

```
class Box
{
int width,height, depth;
}
class m1
{
public static void main(String args[])
{
Box b1 = new Box();
int v1;
b1.width=10;
b1.height=20;
b1.depth=30;
v1=b1.width * b1.height * b1.depth;
System.out.println("volume of v1=" + v1);
}
}
```

Compilation and Execution

- Save your file with m1.java
- For compilation:

  javac m1.java

For Execution:

- Java m1

Variable Independence

```
class Box
{
int width,height, depth;
}
class m1
{
public static void main(String args[])
{
Box b1 = new Box();
Box b2 = new Box();
int v1 ,v2;
b1.width=10;
b1.height=20;
b1.depth=30;
b2.width=3;
b2.height=4;
b2.depth=5;
v1=b1.width * b1.height *
b1.depth;
System.out.println("volume of
v1=" + v1);
v2=b2.width * b2.height *
b2.depth;
System.out.println("volume of
v2=" + v2);
} }
```

- What are the printed volumes for both volumes v1 and v2?

output:

- volume of v1 = 6000
- volume of v2=60

OBJECTS Example

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

```
class College
{
}
class Kits
{
  Public static void main(String
   args[])
   {
      College c=new College();
   }
}
```

Declaring Objects

Obtaining object of class with two stages

1. Declaring variable of class type

Box b1;

b1 is reference to an object.

Value of b1 is null.

2.Aquire the actual, physical copy of the object and assign to the varia

Box b1=new Box();

Allocate memory for Box object and return its address.

Now address is stored in b1 object reference variable.

Box() is class constructor.

Methods

Method declaration

returntype method_name(parameter list)

{

return values…

}

Component:

Return type: type of the value return by the method

Method name: indicates name of the method

Parameter list: sequence of type identifier list seprated by commas.

Return value: what value return by the method

Example: Method

- Within class we can directly refer to member of class.

```
class Box
{
int  width, height, depth;
void volume()
{

System.out.println(width * height * depth);
}
}
```

Example: Method

When the instance variable is is accessed by code which is not of the class in which variable is defined that variable must be accessed by using object.

```
class Box
{
int  width, height, depth;
}
Box b1 = new Box();
Box b2 = new Box();
int v1 ,v2;
b1.width=10;
b1.height=20;
b1.depth=30;
b2.width=3;
b2.height=4;
b2.depth=5;
b1.volume();
b2.volume();
}
```

Value-Returning Method

If type of expression returning the value then method must be agree with return type.

Example:

```
class Box
{
double  width, height, depth;
double volume()
{
return width * height * depth;
}
}
```


```
class m1
{
public static void main(String args[])
{   Box b1 = new Box();
Box b2 = new Box();
int v1,v2;
b1.width=10;
b1.height=20;
b1.depth=30;
```

```
b2.width=3;
b2.height=4
b2.depth=5;
v1=b1.volume();
System.out.println(“volume of v1=” + v1);
v2=b2.volume();
System.out.println(“volume of v1=” + v2);

}
}
```

Parameterized Method

- Parameter increase generality and applicability of method.

(1) Method without parameter

```
class Box
{
int  width,height, depth;
double display()
{
return 10* 10 * 10;
}
```

Parameterized Method

- Parameter increase generality and applicability of method.

(1) Method with parameter

```
class Box
{
int  width,height, depth;
double display(int  i)
{
return i* i *i;
}
```

Example: Parameterized Method

```
class Box
{
int  width, height, depth;
double volume()
{
return width * height * depth;
}
void set(int w,int h ,int d)
{
     width = w;
     height = h;
     depth = d;
} }
```

```
class m1
{
public static void main(String args[])
{
double vol;
Box b1 = new Box();
Box b2=new Box();
b1.set(10,20,30);
b2.set(20,30,40);
vol=b1.volume();
System.out.println(vol);
vol=b2.volume ();
System.out.printn(vol);
```

Method overloading

```
class overloaddemo
{
void test()
{ System.out.println("no parameters."); }
void test(float a)
{ System.out.println("value of float a="+a); }
 void test(int a ,int b)
{
System.out.println("value of a="+a);
System.out.println("value of b="+b);
}
int test(int a)
{ return a*a; }
}
```

```
class m1
{
public static void main(String args[])
{
overloaddemo ob= new
overloaddemo();
ob.test();
ob.test(10.2f);
ob.test(10,20);

int r=ob.test(10);
System.out.println("value of r="+r);
}
}
```

output:

no parameters
value of float a=10.2
value of float a=10
value of float b=20
value of float r=100

Constructor

A constructor initializes the instance variables of an object.

It is called immediately after the object is created but before the new operator completes.

1) it is syntactically similar to a method:
2) it has the same name as the name of its class
3) it is written without return type; the default return type of a class constructor is the same class

When the class has no constructor, the default constructor automatically initializes all its instance variables with zero.

Constructor : Example

```
class One
   {
      One()
        {    //Initialization    }
    }

class Book
{
  Book()
  {
     // Some Initialization
   }
}
```

Example: Constructor

```
class Box
{
int width,height, depth;
Box()   //this is the constructor for Box
{    width = 10;
     height = 20;
     depth = 30;
 }
void display(){
int v1;
v1=width*height*depth;
System.out.println("volume of v1=" + v1);
}}
```

```
class m1
{
public static void main(String args[])
{
Box b1 = new Box();
Box b2= new Box();
b1.display();
b2.display();
}
}
```

Parameterized Constructor

```
class Box
{
int width,height, depth;
Box(int w, int h ,int d)
{           width = w;
            height = h;
            depth = d;
 }
void display()
{
            int v1;
v1=width * height * depth;
System.out.println("volume   of
v1=" + v1);
}
}
```

```
class m1
{
public  static  void  main(String
args[])
{
Box b1 = new Box(10,20,30);
Box b2= new Box(4,5,6);
b1.display();
b2.display();
}
}
```

output:

```
volume of v1 = 6000
volume of v1=120
```

Copy constructor

```
class student
{  int id;
  String name;
  student(int i,String n1)
   {  id = i;
      name = n1;
   }
  student (student s)
   {  id=s.id;
      name=s.name;
   }
 void display()
   {     System.out.println(id+" "+name);   } }
```

```
class m1
{
public static void main(String args[])
{
student s1 = new student(1,“Java");
student s2 = new student(s1);
s1.display();
s2.display();
}
}
```

Output:

1 Java
1 Java

Constructor overloading

```
class Box
{  int width,height, depth;
 Box()
  { width = 10;
    height = 20;
    depth = 30;
  }
 Box(int w ,int h, int d)
            {   width = w;
                 height = h;
                 depth = d;
              }
 Box(int l)
  {    width = height = depth =l   }
 int display()
  {  return width * height * depth;  }
}
```

```
class m1
{
public static void main(String args[])
{
Box b1 = new Box();
Box b2= new Box(1,2,3);
Box b3= new Box(4);
int v=b1.display();
System.out.println("volume of v=" + v);
v=b2.display();
System.out.println("volume of v=" + v);
v=b3.display();
System.out.println("volume of v=" + v);
}
}
```

output:

volume of v1 = 6000
volume of v=6
volume of v=64

Passing object as parameter

```
class test
{
  int a,b;
  test( int i ,int j)
   {
     a = i;
     b = j;
   }
  void equal(test T)
   {
    if(a==T. a && b==T.b)
      System.out.println("value of 2 objs r equal");
    else
      System.out.println("value of 2 objects r not equal");
   }
}
```

```
class m1
{
public static void main(String
args[])
  {
    test t1= new test(10,20);
    test t2= new test(10,20);
    test t3=new test(30,40);
    t1.equal(t2);
    t1.equal(t3);
  }
}
```

output:

value of 2 objects r equal
value of 2 objects r not equal

Array of Objects

- Unlike traditional array which store values like string, integer, Boolean, etc. array of objects stores objects.
- The array elements store the location of reference variables of the object.

Example:

```
class Employee
{
  int empId;
  String name;
  //Employee class constructor
  Employee(int eid, String n)
{
     empId = eid;
     name = n;
  }
public void showData()
{
   System.out.print("EmpId = "+empId + "   "
+ " Employee Name = "+name);
   System.out.println();
 }
}
```

```
class arrayObjectMain
{
   public static void main(String args[])
{
     //create array of employee object
    Employee[] obj = new Employee[2] ;

     //create & initialize actual employee object
using constructor
     obj[0] = new Employee(100,"ABC");
     obj[1] = new Employee(200,"XYZ");

     //display the employee object data
     System.out.println("Employee Object 1:");
     obj[0].showData();
     System.out.println("Employee Object 2:");
     obj[1].showData();
  }
}
```

Output:

```
D:\STOREBHUMI\java_prog\Java_Lab>javac arrayObjectMain.java

D:\STOREBHUMI\java_prog\Java_Lab>java arrayObjectMain
Employee Object 1:
EmpId = 100   Employee Name = ABC
Employee Object 2:
EmpId = 200   Employee Name = XYZ

D:\STOREBHUMI\java_prog\Java_Lab>
```

Garbage Collection

- Java Virtual Machine allocates objects on the heap dynamically using new operator.
- Other language put the burden on the programmer to free these objects using delete() or free() function when they are no longer needed.
- Java language does not provide this type of function because java runtime environment automatically reclaims the memory for objects that are no longer associated with a reference variable.
- This memory reclamation process is known as garbage collection.
- Garbage collection involves:
    1. keeping a count of all references to each object
    2. periodically reclaiming memory for all objects with a reference count to zero.

- Example :

  void a method() { Sum d1=new Sum(): }

- new operation creates an instances of Sum,its memory address is store in d1and its reference count is incremented to 1.when this method return or finishes reference variable d1 goes out of scope and reference count is decrement to 0.At this point Sum instance is reclaimed by garbage collection.
- Garbage collection is automatically runs periodically.you can manually invoke the garbage collection at any time using java.lang.System.gc() method .

system.gc()

•System.gc() is used to invoke the garbage collector and on invocation **garbage collector** will run to reclaim the unused memory space.

•It will attempt to free the memory that are occupied by the discarded objects. The **System.gc()** is a static method so it's a little bit more convenient to use.

•System.gc() is a class method

system.gc()

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- System.gc() is a class method

Runtime.gc():

- Java Runtime class is used to interact with java runtime environment.
- The **java.lang.Runtime.gc()** method runs the garbage collector.
- Calling this method suggests that the JVM (Java virtual machine) expend effort toward recycling unused objects in order to make the memory they currently occupy available for quick reuse.
- When control returns from the method call, the **virtual machine** has

Finalize() Method

A constructor helps to initialize an object just after it has been created.

In contrast, the finalize method is invoked just before the object is destroyed:

1) implemented inside a class as: Protected void finalize() { }

Finalize() is the method of Object class.

This method is called just before an object is garbage collected.

Finalize() method overrides to dispose system resources, perform clean-up activities and minimize memory leaks.

```
class abc
 { // Here overriding finalize method
     public void finalize()
     {        System.out.println("finalize method overriden");     }

    public static void main(String[] args) throws Throwable
    {  abc aa=new abc();
       aa.finalize();
        // Requesting JVM to call Garbage Collector method
        System.gc();
        System.out.println("Main Completes");
     } }
```

This keyword

- “this” keyword is used inside any instance method or constructor of class.
- “this” is a reference variable that refers to the current object whose Method or constructor is being invoked(call). It is a keyword in java language represents current class object .
- To differentiate between instance variable and formal parameter , the data member of the class must be preceded by **"this".**
- If any variable is preceded by **"this" JVM treats that variable as class variable.**
- Static method can not use “this” keyword.

problem without “this”

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

```
class a1
{
public static void main(String args[])
{
   Student s1 = new Student(1,“xyz");
   Student s2 = new Student(2,”pqr");
   s1.display();
   s2.display();
}
}
```

output:

0 null
0 null

Solution with “this”

```
class Student
{
int id;
String name;
Student(int id,String name)
{
this.id = id;
this.name = name;
}
void display()
{
System.out.println(id+" "+name);
}
}
```

```
class a1
{
public static void main(String args[]){
Student s1 = new Student(1,”xyz");
Student s2 = new Student(2,”pqr”);
s1.display();
s2.display();
}
```

Output: 1 xyz
2 pqr

output:

1 xyz
2 pqr

Static Keyword

•You cannot use the static keyword with a class unless it is an inner class. A static inner class is a nested class which is a static member of the outer class.

• It can be accessed without instantiating the outer class, using other static members. Just like static members, a static nested class does not have access to the instance variables and methods of the outer class.

Static block

static block is executed before the creation of any of the objects of the class.

The **static block** is a block of statement inside a Java class that will be executed when a class is first loaded into the JVM. A **static block helps to initialize the static data members**, just like constructors help to initialize instance members.

Syntax:

```
static
        {
         ........
         //Statements
         ........
         }
```

Static Block Example:

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

Output:

```
D:\STOREBHUMI\java_prog>javac staticblock.java

D:\STOREBHUMI\java_prog>java TestStaticBlock
static block is invoked
Hello main

D:\STOREBHUMI\java_prog>
```

Static method:

- it is refer to class rather than object.
- we can create method that we can call even if no objects are created.
- static method can only call other static methods.
- static method must only access static data and modify it.

```
public class StaticMethod
{
static void show()
{
System.out.println("It is an example of
static method.");
}
public static void main(String[] args)
{
show();
}
}
```

Output:

```
D:\STOREBHUMI\java_prog>javac StaticMethod.java

D:\STOREBHUMI\java_prog>java StaticMethod
It is an example of static method.

D:\STOREBHUMI\java_prog>
```

Access specifiers

Visibility	Public	Protected	Default	Private
From the same class	Yes	Yes	Yes	Yes
From any class in the same package	Yes	Yes	Yes	No
From a subclass in the same package	Yes	Yes *(Package, Inheritance)*	Yes *(Package)*	No
From a subclass outside the same package	Yes	Yes *(Inheritance)*	No	No
From any non-subclass class outside the package	Yes	No	No	No

Exercise

A program to create employee class. Also use it by creating objects of it

- Eno
- Ename
- baseSalary
- noofdaysworked
- Tax
- Employee() - constructor
- computeSalary()
- computeTax()
- displayEmployee()

ARRAYS

The entire array has a single name

Each value has a numeric *index*

scores

0	1	2	3	4	5	6
50	12	45	78	66	100	125

An array of size N is indexed from zero to N-1

INTEGER

- An array can be of any type.
- Specific element in an array is accessed by its index.
- Can have more than one dimension

DECLARAING ARRAYS

- The general form of **1-d** array declaration is:-

type var_name[ ];

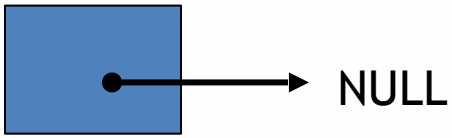
int, float, char — array name

E.g.:--- **int scores [ ];**

1. Even though an array variable "scores" is declared, but there is no array actually existing.
2. "score" is set to NULL, i.e. an array with NO VALUE.

int[] scores = new int[10];

scores



Declaring Arrays Examples

```
double[] prices = new double[500];

boolean[] flags;

flags = new boolean[20];

char[] codes = new char[1750];
```

Array using Enhanced for Loop

```
class newforloop
{
        public static void main (String [] args)
        {           String name[]= {“John",“Tom",“Sam"};
                for(String n:name)
                System.out.println(n+"\n");
                int i;
                for(i=0;i<3;i++)
                System.out.println(name[i]+"\n");
        }
}
```

Bounds Checking

- Once an array is created, it has a fixed size
- An index used in an array reference must specify a valid element
- That is, the index value must be in bounds (**0** to N-**1**)
- The Java interpreter throws an ArrayIndexOutOfBoundsException if an array index is out of bounds
- This is called *automatic bounds checking*

ARRAY LENGTH

- In JAVA, all arrays store the allocated size in a variable named ***length.***
- It is referenced using the array name:

scores.length

- Note that **length** holds the number of elements, not the largest index.
- This information will be useful in the manipulation of arrays when their sizes are not known

Jagged Arrays

- Multidimensional Arrays having different lengths of each sub array
- Ex.

```
int p[][] = { {3,5,8,3,9,0},
              {4,2,6,7,1},
              {3,1,5,6},
              {2,3}  }
```

Memory Representation of jagged array

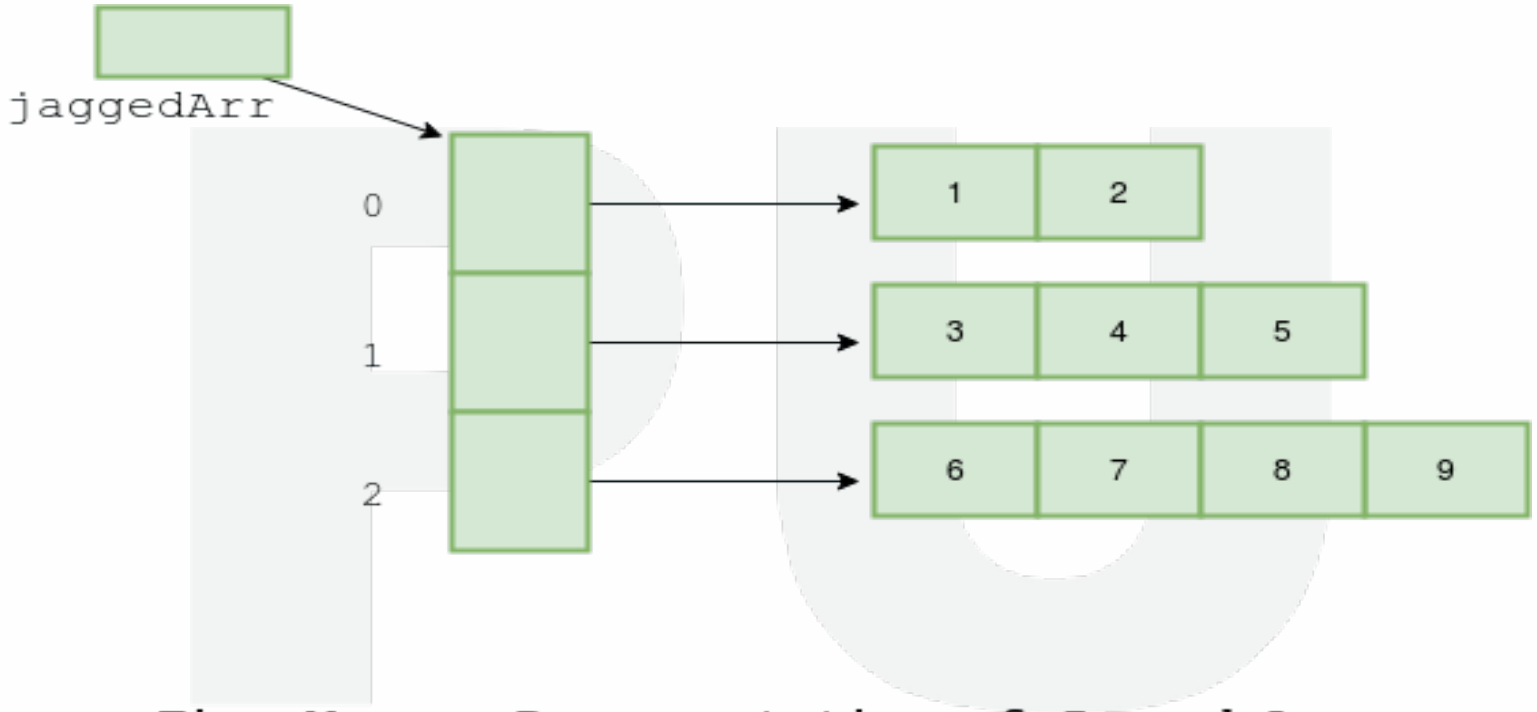


Fig: Memory Representation of Jagged Array

Example: to create a Jagged Array

```
int arr[][] = new int[2][];   // Declaring a 2D array with 2 rows
arr[0] = new int[3];          // First row with 3 elements
arr[1] = new int[2];          // Second row with 2 elements
int count = 0;       // Initializing array
  for (int i=0; i<arr.length; i++)
    for(int j=0; j<arr[i].length; j++)
      arr[i][j] = count++;
// Displaying the values of 2D Jagged array
for (int i=0; i<arr.length; i++){
          for (int j=0; j<arr[i].length; j++)
              System.out.print(arr[i][j] + " ");
          System.out.println();
       }
```

Exercise

```
class ArrayTest
{           String[] firstNames = { "Dennis", "Grace", "Bjarne", "James" };
            String[] lastNames = new String[firstNames.length];
            void printNames()
                {       for (int i = 0; i < firstNames.length; i++)
                        System.out.println(firstNames[i] + " " + lastNames[i]);
            }
            public static void main (String args[]) {
                        ArrayTest a = new ArrayTest();
                        a.printNames();
                        a.lastNames[0] = "Ritchie";
                        a.lastNames[1] = "Hopper";
                        a.lastNames[2] = "Stroustrup";
                        a.lastNames[3] = "Gosling";                a.printNames();    }}
```

```
C:\Users\PANKAJ PATEL\Desktop>javac abc.java

C:\Users\PANKAJ PATEL\Desktop>java abc
Dennis null
Grace null
Bjarne null
James null
----------
Dennis Ritchie
Grace Hopper
Bjarne Stroustrup
James Gosling
```

Exercise

- A program to find average of all numbers stored in an array
- A program to reverse the values of an array
- A program to compute the series n^2 and n^3 using an array
- A program to compute the matrix multiplication using multidimensional arrays
- A program to find the transpose of a given matrix

Strings

- In java, four predefined classes are provided that either represent strings or provide functionality to manipulate them. Those classes are:
  - String
  - StringBuffer
  - StringBuilder
- String, StringBuffer, and StringBuilder classes are defined in java.lang package and all are final.
- All three implement the CharSequence interface.

Why String is Immutable or Final?

- String has been widely used as parameter for many java classes e.g. for opening network connection we can pass hostname and port number as string ,
- we can pass database URL as string for opening database connection,
- we can open any file in Java by passing name of file as argument to File I/O classes.

- In case if String is not immutable , this would lead serious security threat , means some one can access to any file for which he has authorization and then can change the file name either deliberately or accidentally.

Why String Handling?

The internet of things(IOT) is the network of physical objects not limited to devices, vehicles, buildinString handling is required to perform following operations on some string:

- compare two strings
- search for a substring
- concatenate two strings
- change the case of letters within a string
- And many more…

Creating String objects

```
class StringDemo
{
public static void main(String args[])
{
String strOb1="Hello";
String strOb2="String";
String strOb3=strOb1 + " and " + strOb2; System.out.println(strOb1);
System.out.println(strOb2); System.out.println(strOb3);
}
}
```

String Class

String Constructor:

public String ()
public String (String s)
public String (char [] c)
public String (byte [] b)
public String (char [] c, int offset, int no_of_chars)
public String (byte [] b, int offset, int no_of _bytes)

Examples

```
char [] a = {'c', 'o', 'n', 'g', 'r', 'a', 't', 's'};
byte [] b = {65, 66, 67, 68, 69, 70, 71, 72};
String s1 = new String (a); System.out.println(s1);

 String s2 = new String (a, 1,5); System.out.println(s2);

 String s3 = new String (s1); System.out.println(s3);

String s4 = new String (b); System.out.println(s4);

 String s5 = new String (b, 4, 4); System.out.println(s5);
```

String Concatenation with Other Data Types

We can concatenate strings with other types of data.

Example:

```
int age = 9;
String s = "He is " + age + " years old."; System.out.println(s);
```

Methods of String class

String Length:
length() returns the length of the string i.e. number of characters.

int length()

Example:
char chars[] = { 'a', 'b', 'c' }; String s = new String(chars);
System.out.println(s.length());

Character Extraction

charAt(): used to obtain the character from the specified index from a string.

public char charAt (int index);

Example:

```
char ch;
ch = "abc".charAt(1);
```

Methods Cont...

public void getChars(int srhStartIndex, int srhEndIndex, char[] destArray, int destStartIndex)

Parameters:

srhStartIndex : Index of the first character in the string to copy.

srhEndIndex : Index after the last character in the string to copy.

destArray : Destination array where chars wil get copied.

destStartIndex : Index in the array starting from where the chars will be pushed into the array.

Example: String s = “MNOPQ”;

```
char b[] = new char [10];
s.getChars(0, 4, b, 4);
System.out.println(b);
```

toCharArray(): returns a character array initialized by the contents of the string.

public char [] toChar Array();

```
String s = “India”;
char c[] = s.toCharArray();
for (int i=0; i<c.length; i++)
{
System.out.print(c[i]);
}
```

String Comparison

equals(): used to compare two strings for equality. Comparison is case-sensitive.

public boolean equals (Object str)

equalsIgnoreCase( ): To perform a comparison that ignores case differences.

Note:
This method is defined in Object class and overridden in String class.

equals(), in Object class, compares the value of reference not the content.

In String class, equals method is overridden for content-wise comparison of two strings

Example

```
class equalsDemo {
public static void main(String args[])
 {          String s1 = "Hello"; String s2 = "Hello";
            String s3 = "Good-bye"; String s4 = "HELLO";
System.out.println(s1 + " equals " + s2 + " -> " + s1.equals(s2));
System.out.println(s1 + " equals " + s3 + " -> " +
s1.equals(s3));
System.out.println(s1 + " equals " + s4 + " -> " + s1.equals(s4));
System.out.println(s1 + " equalsIgnoreCase " + s4 + " -> “
+s1.equalsIgnoreCase(s4));
}
}
```

String Comparison

startsWith( ) and endsWith( ):

The startsWith( ) method determines whether a given String begins with a specified string.

Conversely, endsWith( ) determines whether the String in question ends with a specified string.

boolean startsWith(String str)
boolean endsWith(String str)

String Comparison

compareTo( ):

A string is less than another if it comes before the other in dictionary order.
A string is greater than another if it comes after the other in dictionary order.
int compareTo(String str)

Value	Meaning
Less than zero	The invoking string is less than *str*.
Greater than zero	The invoking string is greater than *str*.
Zero	The two strings are equal.

Exercise- Arrange strings in ascending order

String arr[] = {"Now", "is", "the", "time", "for", "all", "good", "men", "to", "come", "to", "the", "aid", "of", "their", "country"};

Solution

```
class SortString {
static String arr[] = {"Now", "is", "the", "time", "for", "all",    "good","men“,"to",
"come", "to", "the", "aid", "of", "their", "country"};
public static void main(String args[])
{    for(int j = 0; j < arr.length; j++)
     {  for(int i = j + 1; i < arr.length; i++)
        {  if(arr[i].compareTo(arr[j]) < 0)
           { String t = arr[j];
              arr[j] = arr[i];
              arr[i] = t;
               }
            }
            System.out.println(arr[j]);
         }    }}
```

Searching Strings

The String class provides two methods that allow us to search a string for a specified character or substring:

indexOf( ): Searches for the first occurrence of a character or substring.
int indexOf(int ch)

lastIndexOf( ): Searches for the last occurrence of a character or substring.
int lastIndexOf(int ch)

To search for the first or last occurrence of a substring, use
int indexOf(String str) int lastIndexOf(String str)

Example

String s = “MMBBNGACCR”

int index = s.indexOf(‘G’);

int index = s.indexOf(‘ ’);

int index = s.indexOf(‘m’);

int index = s.indexOf(‘C’);

int index = s.lastIndexOf(‘C’);

int index = s.lastIndexOf(‘B’);

We can specify a starting point for the search using these forms:

int indexOf(int ch, int startIndex)
int lastIndexOf(int ch, int startIndex) int indexOf(String str, int startIndex)
int lastIndexOf(String str, int startIndex)

Here, startIndex specifies the index at which point the search begins.

For indexOf( ), the search runs from startIndex to the end of the string.

For lastIndexOf( ), the search runs from startIndex to zero.

Example

```
class indexOfDemo {
public static void main(String args[])
{       String s = “Hello Students" + “Welcome to Java .";
System.out.println(s);
System.out.println("indexOf(t) = " + s.indexOf('t'));
System.out.println("lastIndexOf(t) = " + s.lastIndexOf('t'));
System.out.println("indexOf(the) = " + s.indexOf("the"));
System.out.println("lastIndexOf(the) = " + s.lastIndexOf("the"));
System.out.println("indexOf(t, 10) = " + s.indexOf('t', 10));
System.out.println("lastIndexOf(t, 60) = " + s.lastIndexOf('t', 60));
System.out.println("indexOf(the, 10) = " + s.indexOf("the", 10));
System.out.println("lastIndexOf(the, 60) = " + s.lastIndexOf("the", 60));
} }
```

Modifying a String

Because String objects are immutable, whenever we want to modify a String, it will construct a new copy of the string with modifications.
substring(): used to extract a part of a string.

public String substring (int start_index)

public String substring (int start_index, int end_index)

Example: String s = “ABCDEFG”;
String t = s.substring(2); System.out.println (t); String u =

s.substring (1, 4); System.out.println (u);

Note: Substring from start_index to end_index-1 will be returned.

concat( ): used to concatenate two strings.
String concat(String str)

- This method creates a new object that contains the invoking string with the contents of str appended to the end.
- concat( ) performs the same function as +. Example:

- String s1 = "one"; String s2 = s1.concat("two");

- It generates the same result as the following sequence:
  String s1 = "one"; String s2 = s1 + "two";

replace( ): The replace( ) method has two forms.

The first replaces all occurrences of one character in the invoking string with another character. It has the following general form:

String replace(char original, char replacement)

Here, original specifies the character to be replaced by the character specified by replacement.

Example: String s = "Hello".replace('l', 'w');

The second form of replace( ) replaces one character sequence with another. It has this general form:

String replace(CharSequence original, CharSequence replacement)

trim( )

The trim( ) method returns a copy of the invoking string from which any leading and trailing whitespace has been removed.

String trim( )

Example:

String s = " Hello World ".trim();

This puts the string “Hello World” into s.

StringBuilder class

A **mutable** sequence of characters (Unlike String which is immutable)

Constructors

StringBuilder()
Constructs a string builder with no characters in it and an initial capacity of 16 characters

StringBuilder(int capacity)
Constructs a string builder with no characters in it and an initial capacity specified by the capacity argument.

StringBuilder(String str)
Constructs a string builder initialized to the contents of the specified string

StringBuilder class – important methods

StringBuilder append(String str)
Appends the specified string to this character sequence

int capacity()
Returns the current capacity

StringBuilder delete(int start, int end)
Removes the characters in a substring of this sequence

StringBuilder insert(int offset, String str)
Inserts the string into this character sequence

Note: Can also work with other datatypes like Boolean, integer, float, double and Objects…

StringBuffer class - Constructors

A **thread-safe**, **mutable** sequence of characters

Constructors

StringBuffer()
Constructs a string builder with no characters in it and an initial capacity of 16 characters

StringBuffer(int capacity)
Constructs a string builder with no characters in it and an initial capacity specified by the capacity argument.

StringBuffer(String str)
Constructs a string builder initialized to the contents of the specified string

StringBuffer class – Important methods

All methods are synchronized

StringBuffer append(String str)
Appends the specified string to this character sequence
int capacity()
Returns the current capacity
StringBuffer delete(int start, int end)
Removes the characters in a substring of this sequence
StringBuffer insert(int offset, String str)
Inserts the string into this character sequence

Note: Can also work with other datatypes like Boolean, integer, float, double and Objects…

Packages

•Package is a container for classes.

•A **java package is a group of similar types of classes, interfaces and sub-packages.**

•Package in java can be categorized in two form:

1) built-in package :- Existing Java package (ex: java, lang, awt, javax, swing, net, io, util, sql etc)

2) user-defined package:- Java package created by user(ex: p1,mypack1,p2 etc.)

•Packages are stored in a hierarchical manner and are explicitly imported into new class definitions.

• You can define classes inside a package that are not accessible by code outside that package.

• You can also define class members that are only known to other members of the same package

Advantage of Java Package

1) Java package is used to categorize the classes and interfaces so that they can be easily maintained.

2) Java package provides access protection.

3) Java package removes naming collision.

4) To make searching/locating and usage of classes easily.

- You can create a package by just including a package command as the first statement in a Java source file. Any classes declared within that file will be the member of that specified package.
- The package statement defines a name space in which classes are stored. If you omit the package statement, the class names are put into the default package, which has no name.

Syntax: package packagename;

EX : package MyPackage;

OR package java.awt.image;

OR package packg1.packg2.packg3;

- Java uses file system directories to store packages.
- For example, if you have package MyPackage then the .class files for any classes you declare to be part of MyPackage must be stored in a directory called MyPackage.

Example of Package

```
package p1;    // Save with A.java
public class A
{
public void showA()
{
System.out.println(“I am A class of same package");
}
}
package p1;
class B   // save with B.java
{
public void showB()
{
System.out.println(‘’I am A class of same package ");
} }
```

```
package p1;
Class ABC
public static void main(String args[])
{
A a1=new A();
a1.showA();
B b1=new B();
b1.showB();

}
```

```
System.out.println(‘’I am A class of same
package ");
}
```

Output:

```
C:\Users\PANKAJ PATEL\Desktop\package eg>javac -d . a.java

C:\Users\PANKAJ PATEL\Desktop\package eg>javac -d . b.java

C:\Users\PANKAJ PATEL\Desktop\package eg>javac -d . abc.java

C:\Users\PANKAJ PATEL\Desktop\package eg>java p1/abc
I am class A of same package
I am class B of same package
```

```
C:\Users\PANKAJ PATEL\Desktop\package eg>java p1.abc
I am class A of same package
I am class B of same package
```

Import a package

Syntax:

import *pkg1[.pkg2].(classname | *);*

Ex:

builtin package: import java.util.Date;

or import java.io.*;

User define package : import p1.D;

or import p1.*;

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