MODULE-IV

Interface in Java

- **Interface**
- **Example of Interface**
- **Multiple inheritance by Interface**
- **Why multiple inheritance is supported in Interface while it is not supported in case of class.**
- **Marker Interface**
- **Nested Interface**

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.

In other words, you can say that interfaces can have abstract methods and variables. It cannot have a method body.

It cannot be instantiated just like the abstract class.

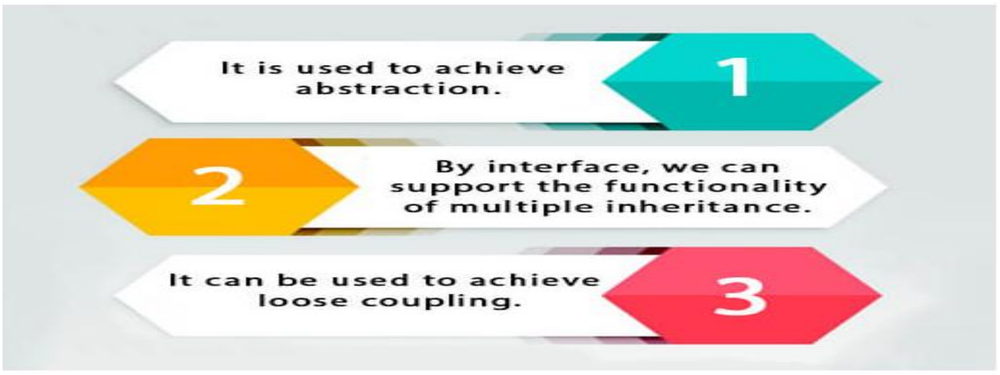
Since Java 8, we can have **default and static methods** in an interface.

Since Java 9, we can have **private methods** in an interface.

Why use Java interface?

There are mainly three reasons to use interface. They are given below.

- It is used to achieve abstraction.
- By interface, we can support the functionality of multiple inheritance.
- It can be used to achieve loose coupling.

- 
It is used to achieve abstraction.
1
2
By interface, we can support the functionality of multiple inheritance.
It can be used to achieve loose coupling.
3

How to declare an interface?

An interface is declared by using the interface keyword. It provides total abstraction; means all the methods in an interface are declared with the empty body, and all the fields are public, static and final by default. A class that implements an interface must implement all the methods declared in the interface.

Syntax:

```
interface <Interface_name>{


    // declare constant fields
    // declare methods that abstract
    // by default.
}
```

Java 8 Interface Improvement

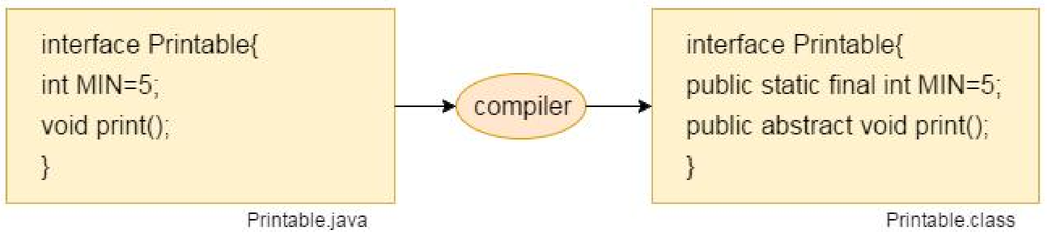
Since Java 8

, interface can have default and static methods which is discussed later.

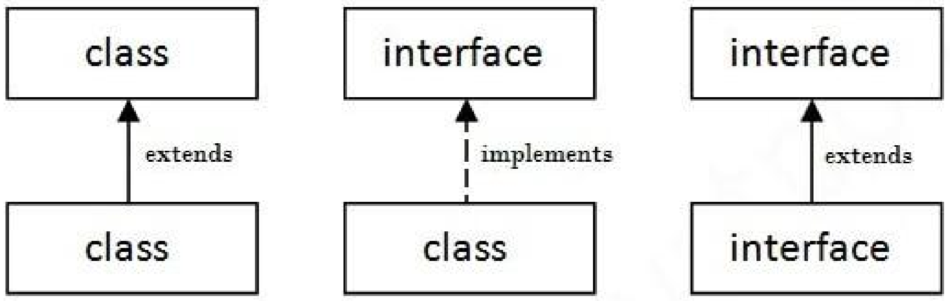
Internal addition by the compiler

The Java compiler adds public and abstract keywords before the interface method. Moreover, it adds public, static and final keywords before data members.

In other words, Interface fields are public, static and final by default, and the methods are public and abstract.



As shown in the figure given below, a class extends another class, an interface extends another interface, but a **class implements an interface**.



Java Interface Example

In this example, the Printable interface has only one method, and its implementation is provided in the A6 class.

```
interface printable{
void print();
}
class A6 implements printable{
public void print(){System.out.println("Hello");}

public static void main(String args[]){
A6 obj = new A6();
obj.print();
 }
}
```

Output:

```
Hello
```

Java Interface Example: Drawable

In this example, the Drawable interface has only one method. Its implementation is provided by Rectangle and Circle classes. In a real scenario, an interface is defined by someone else, but its implementation is provided by different implementation providers. Moreover, it is used by someone else. The implementation part is hidden by the user who uses the interface.

File: TestInterface1.java

```
//Interface declaration: by first user
interface Drawable{
void draw();
}
//Implementation: by second user
class Rectangle implements Drawable{
public void draw(){System.out.println("drawing rectangle");}
}
class Circle implements Drawable{
public void draw(){System.out.println("drawing circle");}
}
//Using interface: by third user
class TestInterface1{
public static void main(String args[]){
Drawable d=new Circle();//In real scenario, object is provided by method e.g. get
Drawable()
d.draw();
}}
```

Output:

```
drawing circle
```

Java Interface Example: Bank

Let's see another example of java interface which provides the implementation of Bank interface.

File: TestInterface2.java

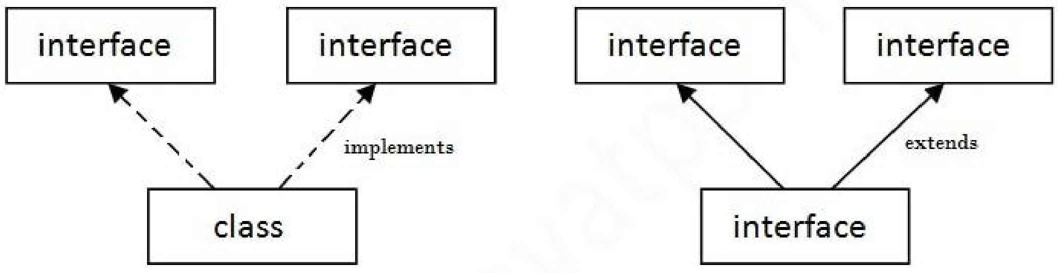
```
interface Bank{
float rateOfInterest();
}
class SBI implements Bank{
public float rateOfInterest(){return 9.15f;}
}
class PNB implements Bank{
public float rateOfInterest(){return 9.7f;}
}
class TestInterface2{
public static void main(String[] args){
Bank b=new SBI();
System.out.println("ROI: "+b.rateOfInterest());
}}
```

ROI: 9.15

```
ROI: 9.15
```

Multiple inheritance in Java by interface

If a class implements multiple interfaces, or an interface extends multiple interfaces, it is known as multiple inheritance.



Multiple Inheritance in Java

```
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
```

Q) Multiple inheritance is not supported through class in java, but it is possible by an interface, why?

As we have explained in the inheritance chapter, multiple inheritance is not supported in the case of class because of ambiguity. However, it is supported in case of an interface because there is no ambiguity. It is because its implementation is provided by the implementation class. For example:

```
interface Printable{
void print();
}
interface Showable{
void print();
}

class TestInterface3 implements Printable, Showable{
public void print(){System.out.println("Hello");}
public static void main(String args[]){
TestInterface3 obj = new TestInterface3();
obj.print();
 }
}
```

Output:

```
Hello
```

As you can see in the above example, Printable and Showable interface have same methods but its implementation is provided by class TestTnterface1, so there is no ambiguity.

Interface inheritance

A class implements an interface, but one interface extends another interface.

```
interface Printable{
void print();
}
interface Showable extends Printable{
void show();
}
class TestInterface4 implements Showable{
public void print(){System.out.println("Hello");}
public void show(){System.out.println("Welcome");}
public static void main(String args[]){
TestInterface4 obj = new TestInterface4();
obj.print();
obj.show();
 }
}
```

Output:

```
Hello
Welcome
```

Java 8 Default Method in Interface

Since Java 8, we can have method body in interface. But we need to make it default method. Let's see an example:

File: TestInterfaceDefault.java

```
interface Drawable{
void draw();
default void msg(){System.out.println("default method");}
}
class Rectangle implements Drawable{
public void draw(){System.out.println("drawing rectangle");}
}
class TestInterfaceDefault{
public static void main(String args[]){
Drawable d=new Rectangle();
d.draw();
d.msg();
}}
```

Output:

```
drawing rectangle
default method
```

Java 8 Static Method in Interface

Since Java 8, we can have static method in interface. Let's see an example:

File: TestInterfaceStatic.java

```
interface Drawable{
void draw();
static int cube(int x){return x*x*x;}
}
class Rectangle implements Drawable{
public void draw(){System.out.println("drawing rectangle");}
}
```

```
class TestInterfaceStatic{
public static void main(String args[]){
Drawable d=new Rectangle();
d.draw();
System.out.println(Drawable.cube(3));
}}
```

Output:

```
drawing rectangle
27
```

Q) What is marker or tagged interface?

An interface which has no member is known as a marker or tagged interface, for example, Serializable, Cloneable, Remote, etc. They are used to provide some essential information to the JVM so that JVM may perform some useful operation.

```
//How Serializable interface is written?
public interface Serializable{
}
```

Nested Interface in Java

```
interface printable{
 void print();
 interface MessagePrintable{
   void msg();
 }
}
```

Difference between abstract class and interface

Abstract class and interface both are used to achieve abstraction where we can declare the abstract methods. Abstract class and interface both can't be instantiated.

But there are many differences between abstract class and interface that are given below.

Abstract class	**Interface**
1) Abstract class can **have abstract and non-abstract** methods.	Interface can have **only abstract** methods. Since Java 8, it can have **default and static methods** also.
2) Abstract class **doesn't support multiple inheritance**.	Interface **supports multiple inheritance**.
3) Abstract class **can have final, non-final, static and non-static variables**.	Interface has **only static and final variables**.
4) Abstract class **can provide the implementation of interface**.	Interface **can't provide the implementation of abstract class**.
5) The **abstract keyword** is used to declare abstract class.	The **interface keyword** is used to declare interface.
6) An **abstract class** can extend another Java class and implement multiple Java interfaces.	An **interface** can extend another Java interface only.
7) An **abstract class** can be extended using keyword "extends".	An **interface** can be implemented using keyword "implements".
8) A Java **abstract class** can have class members like private, protected, etc.	Members of a Java interface are public by default.

9)**Example:**
public abstract class Shape{
public abstract void draw();
}
	Example:
	public interface Drawable{
	void draw();
	}

Simply, abstract class achieves partial abstraction (0 to 100%) whereas interface achieves fully abstraction (100%).

Thread

Java Threads | How to create a thread in Java

There are two ways to create a thread:

1. By extending Thread class
2. By implementing Runnable interface.

Thread class:

Thread class provide constructors and methods to create and perform operations on a thread.Thread class extends Object class and implements Runnable interface.

Commonly used Constructors of Thread class:

1. Thread()
2. Thread(String name)
3. Thread(Runnable r)
4. Thread(Runnable r,String name)

Commonly used methods of Thread class:

1. **public void run():** is used to perform action for a thread.
2. **public void start():** starts the execution of the thread.JVM calls the run() method on the thread.
3. **public void sleep(long miliseconds):** Causes the currently executing thread to sleep (temporarily cease execution) for the specified number of milliseconds.
4. **public void join():** waits for a thread to die.
5. **public void join(long miliseconds):** waits for a thread to die for the specified miliseconds.
6. **public int getPriority():** returns the priority of the thread.
7. **public int setPriority(int priority):** changes the priority of the thread.
8. **public String getName():** returns the name of the thread.
9. **public void setName(String name):** changes the name of the thread.
10. **public Thread currentThread():** returns the reference of currently executing thread.
11. **public int getId():** returns the id of the thread.
12. **public Thread.State getState():** returns the state of the thread.
13. **public boolean isAlive():** tests if the thread is alive.
14. **public void yield():** causes the currently executing thread object to temporarily pause and allow other threads to execute.
15. **public void suspend():** is used to suspend the thread(depricated).

16. **public void resume():** is used to resume the suspended thread(depricated).
17. **public void stop():** is used to stop the thread(depricated).
18. **public boolean isDaemon():** tests if the thread is a daemon thread.
19. **public void setDaemon(boolean b):** marks the thread as daemon or user thread.
20. **public void interrupt():** interrupts the thread.
21. **public boolean isInterrupted():** tests if the thread has been interrupted.
22. **public static boolean interrupted():** tests if the current thread has been interrupted.

Runnable interface:

The Runnable interface should be implemented by any class whose instances are intended to be executed by a thread. Runnable interface have only one method named run().

public void run(): is used to perform action for a thread.

Starting a thread:

The **start() method** of Thread class is used to start a newly created thread. It performs the following tasks:

A new thread starts(with new callstack).

The thread moves from New state to the Runnable state.

When the thread gets a chance to execute, its target run() method will run.

1) Java Thread Example by extending Thread class

FileName: Multi.java

```
class Multi extends Thread{
public void run(){
System.out.println("thread is running...");
}
public static void main(String args[]){
Multi t1=new Multi();
t1.start();
 }
}
```

Output:

```
thread is running...
```

2) Java Thread Example by implementing Runnable interface

FileName: Multi3.java

```
class Multi3 implements Runnable{
public void run(){
System.out.println("thread is running...");
}

public static void main(String args[]){
Multi3 m1=new Multi3();
Thread t1 =new Thread(m1);   // Using the constructor Thread(Runnable r)
t1.start();
 }
}
```

Output:

```
thread is running...
```

If you are not extending the Thread class, your class object would not be treated as a thread object. So you need to explicitly create the Thread class object. We are passing the object of your class that implements Runnable so that your class run() method may execute.

3) Using the Thread Class: Thread(String Name)

We can directly use the Thread class to spawn new threads using the constructors defined above.

FileName: MyThread1.java

```
public class MyThread1
{
// Main method
public static void main(String argvs[])
{
// creating an object of the Thread class using the constructor Thread(String name)

Thread t= new Thread("My first thread");

// the start() method moves the thread to the active state
t.start();
// getting the thread name by invoking the getName() method
String str = t.getName();
System.out.println(str);
}
}
```

Output:

```
My first thread
```

4) Using the Thread Class: Thread(Runnable r, String name)

Observe the following program.

FileName: MyThread2.java

```
public class MyThread2 implements Runnable
{
public void run()
{
System.out.println("Now the thread is running ...");
}

// main method
public static void main(String argvs[])
{
// creating an object of the class MyThread2
Runnable r1 = new MyThread2();

// creating an object of the class Thread using Thread(Runnable r, String name)
Thread th1 = new Thread(r1, "My new thread");

// the start() method moves the thread to the active state
th1.start();

// getting the thread name by invoking the getName() method
String str = th1.getName();
System.out.println(str);
}
}
```

Output:

```
My new thread
Now the thread is running ...
```

Multithreading in Java

- Multithreading
- Multitasking
- Process-based multitasking
- Thread-based multitasking
- What is Thread

Multithreading in Java

is a process of executing multiple threads simultaneously.

A thread is a lightweight sub-process, the smallest unit of processing. Multiprocessing and multithreading, both are used to achieve multitasking.

However, we use multithreading than multiprocessing because threads use a shared memory area. They don't allocate separate memory area so saves memory, and context-switching between the threads takes less time than process.

Java Multithreading is mostly used in games, animation, etc.

Advantages of Java Multithreading

1) It **doesn't block the user** because threads are independent and you can perform multiple operations at the same time.

2) You **can perform many operations together, so it saves time**.

3) Threads are **independent**, so it doesn't affect other threads if an exception occurs in a single thread.

Multitasking

Multitasking is a process of executing multiple tasks simultaneously. We use multitasking to utilize the CPU. Multitasking can be achieved in two ways:

- Process-based Multitasking (Multiprocessing)
- Thread-based Multitasking (Multithreading)

1) Process-based Multitasking (Multiprocessing)

- Each process has an address in memory. In other words, each process allocates a separate memory area.
- A process is heavyweight.
- Cost of communication between the process is high.
- Switching from one process to another requires some time for saving and loading registers, memory maps, updating lists, etc.

2) Thread-based Multitasking (Multithreading)

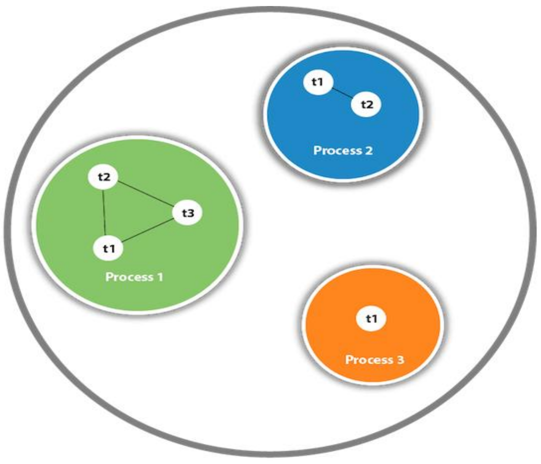
- Threads share the same address space.
- A thread is lightweight.
- Cost of communication between the thread is low.

Note: At least one process is required for each thread.

What is Thread in java

A thread is a lightweight subprocess, the smallest unit of processing. It is a separate path of execution.

Threads are independent. If there occurs exception in one thread, it doesn't affect other threads. It uses a shared memory area.



As shown in the above figure, a thread is executed inside the process. There is context-switching between the threads. There can be multiple processes inside the OS

, and one process can have multiple threads.

Note: At a time one thread is executed only.

Life cycle of a Thread (Thread States)

In Java, a thread always exists in any one of the following states. These states are:

1. New
2. Active
3. Blocked / Waiting
4. Timed Waiting
5. Terminated

New: Whenever a new thread is created, it is always in the new state. For a thread in the new state, the code has not been run yet and thus has not begun its execution.

Active: When a thread invokes the start() method, it moves from the new state to the active state. The active state contains two states within it: one is **runnable**, and the other is **running**.

- **Runnable:** A thread, that is ready to run is then moved to the runnable state. In the runnable state, the thread may be running or may be ready to run at any given instant of time. It is the duty of the thread scheduler to provide the thread time to run, i.e., moving the thread the running state.
  A program implementing multithreading acquires a fixed slice of time to each individual thread. Each and every thread runs for a short span of time and when that allocated time slice is over, the thread voluntarily gives up the CPU

to the other thread, so that the other threads can also run for their slice of time. Whenever such a scenario occurs, all those threads that are willing to run, waiting for their turn to run, lie in the runnable state. In the runnable state, there is a queue where the threads lie.

- **Running:** When the thread gets the CPU, it moves from the runnable to the running state. Generally, the most common change in the state of a thread is from runnable to running and again back to runnable.

Blocked or Waiting: Whenever a thread is inactive for a span of time (not permanently) then, either the thread is in the blocked state or is in the waiting state.

For example, a thread (let's say its name is A) may want to print some data from the printer. However, at the same time, the other thread (let's say its name is B) is using the printer to print some data. Therefore, thread A has to wait for thread B to use the printer. Thus, thread A is in the blocked state. A thread in the blocked state is unable to perform any execution and thus never consume any cycle of the Central Processing Unit (CPU). Hence, we can say that thread A remains idle until the thread scheduler reactivates thread A, which is in the waiting or blocked state.

When the main thread invokes the join() method then, it is said that the main thread is in the waiting state. The main thread then waits for the child threads to complete their tasks. When the child threads complete their job, a notification is sent to the main thread, which again moves the thread from waiting to the active state.

If there are a lot of threads in the waiting or blocked state, then it is the duty of the thread scheduler to determine which thread to choose and which one to reject, and the chosen thread is then given the opportunity to run.

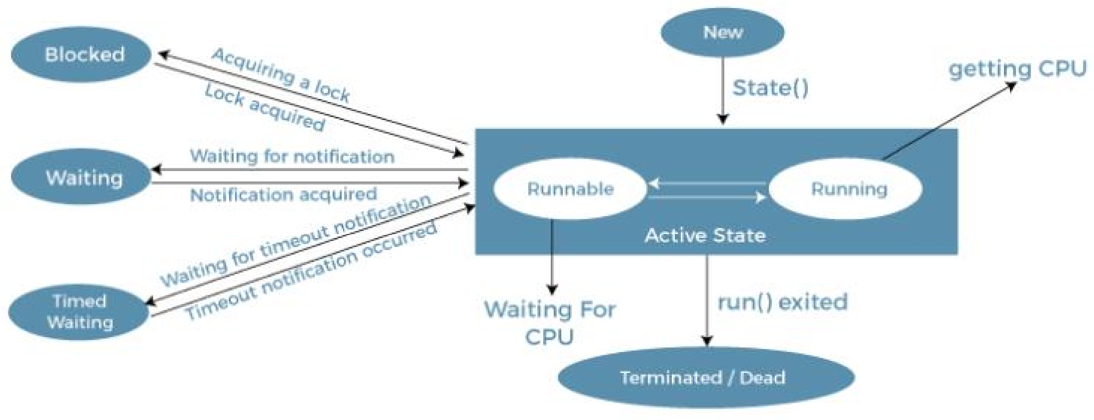
Timed Waiting: Sometimes, waiting for leads to starvation. For example, a thread (its name is A) has entered the critical section of a code and is not willing to leave that critical section. In such a scenario, another thread (its name is B) has to wait forever, which leads to starvation. To avoid such scenario, a timed waiting state is given to thread B. Thus, thread lies in the waiting state for a specific span of time, and not forever. A real example of timed waiting is when we invoke the sleep() method on a specific thread. The sleep() method puts the thread in the timed wait state. After the time runs out, the thread wakes up and start its execution from when it has left earlier.

Terminated: A thread reaches the termination state because of the following reasons:

- When a thread has finished its job, then it exists or terminates normally.
- **Abnormal termination:** It occurs when some unusual events such as an unhandled exception or segmentation fault.

A terminated thread means the thread is no more in the system. In other words, the thread is dead, and there is no way one can respawn (active after kill) the dead thread.

The following diagram shows the different states involved in the life cycle of a thread.



Life Cycle of a Thread

Synchronization in Java

Synchronization in Java is the capability to control the access of multiple threads to any shared resource.

Java Synchronization is better option where we want to allow only one thread to access the shared resource.

Why use Synchronization?

The synchronization is mainly used to

1. To prevent thread interference.
2. To prevent consistency problem.

Types of Synchronization

There are two types of synchronization

[redacted]

1. Process Synchronization
2. Thread Synchronization

Here, we will discuss only thread synchronization.

Thread Synchronization

There are two types of thread synchronization mutual exclusive and inter-thread communication.

1. Mutual Exclusive
    1. Synchronized method.
    2. Synchronized block.
    3. Static synchronization.
2. Cooperation (Inter-thread communication in java)

Mutual Exclusive

Mutual Exclusive helps keep threads from interfering with one another while sharing data. It can be achieved by using the following three ways:

1. By Using Synchronized Method
2. By Using Synchronized Block
3. By Using Static Synchronization

```
       15
       300
       20
       400
       25
       500
```

Java Synchronized Method

If you declare any method as synchronized, it is known as synchronized method.

Synchronized method is used to lock an object for any shared resource.

When a thread invokes a synchronized method, it automatically acquires the lock for that object and releases it when the thread completes its task.

TestSynchronization2.java

```
//example of java synchronized method
```

```
class Table{
 synchronized void printTable(int n){//synchronized method
   for(int i=1;i<=5;i++){
     System.out.println(n*i);
     try{
      Thread.sleep(400);
     }catch(Exception e){System.out.println(e);}
   }
```

Synchronized Block in Java

Synchronized block can be used to perform synchronization on any specific resource of the method.

Suppose we have 50 lines of code in our method, but we want to synchronize only 5 lines, in such cases, we can use synchronized block.

If we put all the codes of the method in the synchronized block, it will work same as the synchronized method.

Points to Remember

- Synchronized block is used to lock an object for any shared resource.
- Scope of synchronized block is smaller than the method.
- A Java synchronized block doesn't allow more than one JVM, to provide access control to a shared resource.
- The system performance may degrade because of the slower working of synchronized keyword.
- Java synchronized block is more efficient than Java synchronized method.

Syntax

```
synchronized (object reference expression) {
  //code block
}
```

Example of Synchronized Block

Let's see the simple example of synchronized block.

```
class Table
{
 void printTable(int n){
   synchronized(this){//synchronized block
     for(int i=1;i<=5;i++){
      System.out.println(n*i);
      try{
       Thread.sleep(400);
      }catch(Exception e){System.out.println(e);}
     }
   }
 }//end of the method
}
class MyThread1 extends Thread{
Table t;
MyThread1(Table t){
this.t=t;
}
public void run(){
t.printTable(5);
}

}
class MyThread2 extends Thread{
Table t;
MyThread2(Table t){
this.t=t;
}
public void run(){
t.printTable(100);
}
}

public class TestSynchronizedBlock1{
public static void main(String args[]){
Table obj = new Table();//only one object
MyThread1 t1=new MyThread1(obj);
MyThread2 t2=new MyThread2(obj);
t1.start();
t2.start();
}
}
```

Output:

```
5
10
15
20
25
100
200
300
400
500
```

```
public void run(){
obj.printTable(100);
}
};

t1.start();
t2.start();
}
}
```

Output:

```
5
10
15
20
25
100
200
300
400
500
```

Static Synchronization

If you make any static method as synchronized, the lock will be on the class not on object.

Problem without static synchronization

Suppose there are two objects of a shared class (e.g. Table) named object1 and object2. In case of synchronized method and synchronized block there cannot be interference between t1 and t2 or t3 and t4 because t1 and t2 both refers to a common object that have a single lock. But there can be interference between t1 and t3 or t2 and t4 because t1 acquires another lock and t3 acquires another lock. We don't want interference between t1 and t3 or t2 and t4. Static synchronization solves this problem.

Example of Static Synchronization

In this example we have used **synchronized** keyword on the static method to perform static synchronization.

TestSynchronization4.java

```
class Table
{
 synchronized static void printTable(int n){
   for(int i=1;i<=10;i++){
     System.out.println(n*i);
```

```
    try{
      Thread.sleep(400);
    }catch(Exception e){}
  }
 }
}
class MyThread1 extends Thread{
public void run(){
Table.printTable(1);
}
}
class MyThread2 extends Thread{
public void run(){
Table.printTable(10);
}
}
class MyThread3 extends Thread{
public void run(){
Table.printTable(100);
}
}
class MyThread4 extends Thread{
public void run(){
Table.printTable(1000);
}
}
public class TestSynchronization4{
public static void main(String t[]){
MyThread1 t1=new MyThread1();
MyThread2 t2=new MyThread2();
MyThread3 t3=new MyThread3();
MyThread4 t4=new MyThread4();
```

```
t1.start();
t2.start();
t3.start();
t4.start();
}
}
```

Output:

```
1
2
3
4
5
6
7
8
9
10
10
20
30
40
50
60
70
80
90
100
100
200
300
400
500
600
700
800
```

```
      900
      1000
      1000
      2000
      3000
      4000
      5000
      6000
      7000
      8000
      9000
      10000
```

Inter-thread Communication in Java

Inter-thread communication or Co-operation is all about allowing synchronized threads to communicate with each other.

Cooperation (Inter-thread communication) is a mechanism in which a thread is paused running in its critical section and another thread is allowed to enter (or lock) in the same critical section to be executed.It is implemented by following methods of Object class:

wait()

notify()

notifyAll()

1) wait() method

The wait() method causes current thread to release the lock and wait until either another thread invokes the notify() method or the notifyAll() method for this object, or a specified amount of time has elapsed.

The current thread must own this object's monitor, so it must be called from the synchronized method only otherwise it will throw exception.

Method	Description

public final void wait()throws InterruptedException	waits until object is notified.
public final void wait(long timeout)throws erruptedException	waits for the specified amount of time.

2) notify() method

The notify() method wakes up a single thread that is waiting on this object's monitor. If any threads are waiting on this object, one of them is chosen to be awakened. The choice is arbitrary and occurs at the discretion of the implementation.

Syntax:

public final void notify()

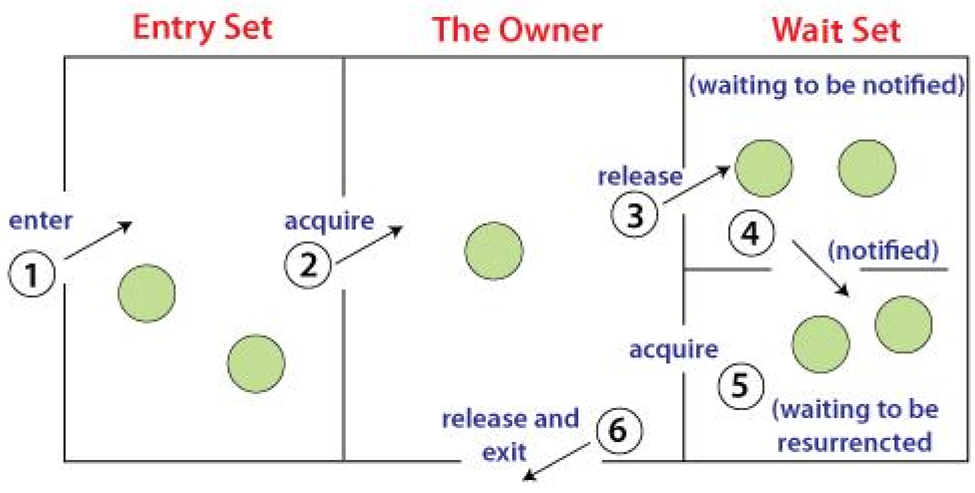
3) notifyAll() method

Wakes up all threads that are waiting on this object's monitor.

Syntax:

public final **void** notifyAll()

Understanding the process of inter-thread communication



The point to point explanation of the above diagram is as follows:

Threads enter to acquire lock.

Lock is acquired by on thread.

Now thread goes to waiting state if you call wait() method on the object. Otherwise it releases the lock and exits.

If you call notify() or notifyAll() method, thread moves to the notified state (runnable state).

Now thread is available to acquire lock.

After completion of the task, thread releases the lock and exits the monitor state of the object.

Why wait(), notify() and notifyAll() methods are defined in Object class not Thread class?

It is because they are related to lock and object has a lock.

Difference between wait and sleep?

Let's see the important differences between wait and sleep methods.

wait()	sleep()
The wait() method releases the lock.	The sleep() method doesn't release the lock.
It is a method of Object class	It is a method of Thread class
It is the non-static method	It is the static method
It should be notified by notify() or notifyAll() methods	After the specified amount of time, sleep is completed.

Example of Inter Thread Communication in Java

Let's see the simple example of inter thread communication.

Test.java

```
class Customer{

int amount=10000;
synchronized void withdraw(int amount){
System.out.println("going to withdraw...");

if(this.amount<amount){
System.out.println("Less balance; waiting for deposit...");
try{wait();}catch(Exception e){}
}
this.amount-=amount;
System.out.println("withdraw completed...");
}

synchronized void deposit(int amount){
System.out.println("going to deposit...");
this.amount+=amount;
System.out.println("deposit completed... ");
notify();
}
}

class Test{
public static void main(String args[]){
final Customer c=new Customer();
new Thread(){
public void run(){c.withdraw(15000);}
}.start();
new Thread(){
public void run(){c.deposit(10000);}
}.start();

}}
```

Output:

```
going to withdraw...
Less balance; waiting for deposit...
going to deposit...
deposit completed...
withdraw completed
```

Java Package

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

Package in java can be categorized in two form, built-in package and user-defined package.

There are many built-in packages such as java, lang, awt, javax, swing, net, io, util, sql etc.

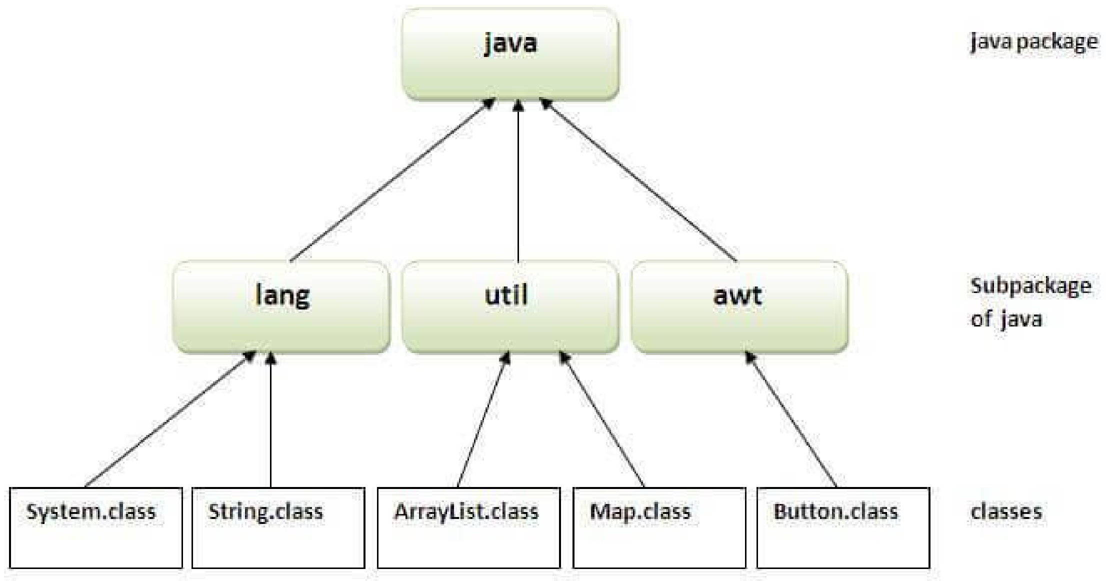
Here, we will have the detailed learning of creating and using user-defined packages.

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.



Simple example of java package

The **package keyword** is used to create a package in java.

```
//save as Simple.java
package mypack;
public class Simple{
 public static void main(String args[]){
    System.out.println("Welcome to package");
   }
}
```

How to compile java package

If you are not using any IDE, you need to follow the **syntax** given below:

```
1.          javac -d directory javafilename
```

For **example**

```
1.           javac -d . Simple.java
```

The -d switch specifies the destination where to put the generated class file. You can use any directory name like /home (in case of Linux), d:/abc (in case of windows) etc. If you want to keep the package within the same directory, you can use . (dot).

How to run java package program

You need to use fully qualified name e.g. mypack.Simple etc to run the class.

To Compile: javac -d . Simple.java

To Run: java mypack.Simple

```
Output:Welcome to package
```

The -d is a switch that tells the compiler where to put the class file i.e. it represents destination. The . r
the current folder.

How to access package from another package?

There are three ways to access the package from outside the package.

1. import package.*;
2. import package.classname;
3. fully qualified name.

1) Using packagename.*

If you use package.* then all the classes and interfaces of this package will be accessible but not subpackages.

The import keyword is used to make the classes and interface of another package accessible to the current package.

Example of package that import the packagename.*

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

```
//save by B.java
package mypack;
import pack.*;

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

```
Output:Hello
```

2) Using packagename.classname

If you import package.classname then only declared class of this package will be accessible.

Example of package by import package.classname

```
//save by A.java

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

//save by B.java
package mypack;
import pack.A;
```

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

```
Output:Hello
```

3) Using fully qualified name

If you use fully qualified name then only declared class of this package will be accessible. Now there is no need to import. But you need to use fully qualified name every time when you are accessing the class or interface.

It is generally used when two packages have same class name e.g. java.util and java.sql packages contain Date class.

Example of package by import fully qualified name

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

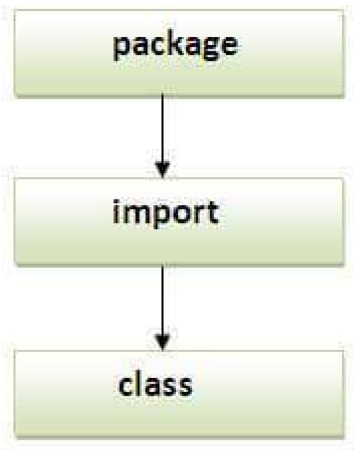
```
//save by B.java
package mypack;
class B{
  public static void main(String args[]){
   pack.A obj = new pack.A();//using fully qualified name
   obj.msg();
  }
}
```

```
Output:Hello
```

Note: If you import a package, subpackages will not be imported.

If you import a package, all the classes and interface of that package will be imported excluding the classes and interfaces of the subpackages. Hence, you need to import the subpackage as well.

Note: Sequence of the program must be package then import then class.



Subpackage in java

Package inside the package is called the **subpackage**. It should be created **to categorize the package further**.

Let's take an example, Sun Microsystem has definded a package named java that contains many classes like System, String, Reader, Writer, Socket etc. These classes represent a particular group e.g. Reader and Writer classes are for Input/Output operation, Socket and ServerSocket classes are for networking etc and so on. So, Sun has subcategorized the java package into subpackages such as lang, net, io etc. and put the Input/Output related classes in io package, Server and ServerSocket classes in net packages and so on.

The standard of defining package is domain.company.package e.g. com.javatpoint.bean or org.sssit.dao.

Example of Subpackage

```
package com.javatpoint.core;
```

```
class Simple{
  public static void main(String args[]){
   System.out.println("Hello subpackage");
  }
}
```

To Compile: javac -d . Simple.java

To Run: java com.javatpoint.core.Simple

```
Output:Hello subpackage
```

There are four access modifiers keywords in Java and they are:

Modifier	**Description**
Default	declarations are visible only within the package (package private)
Private	declarations are visible within the class only
Protected	declarations are visible within the package or all subclasses
Public	declarations are visible everywhere