Threads

In Java

Multithreading

•Multithreading in java is a process of executing multiple threads simultaneously.

•Thread is basically a lightweight sub-process, a smallest unit of processing. Multiprocessing and multithreading, both are used to achieve multitasking.

•But we use multithreading than multiprocessing because threads share a common 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 Multithreading:

1) It doesn’t block the user because threads are independent and you can perform multiple operations at 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 exception occur in a single thread.

4) A thread is a lightweight sub process, a smallest unit of processing. It is a separate path of execution.

5) Threads are independent, if there occurs exception in one thread, it doesn’t affect other threads. It shares a common memory area.

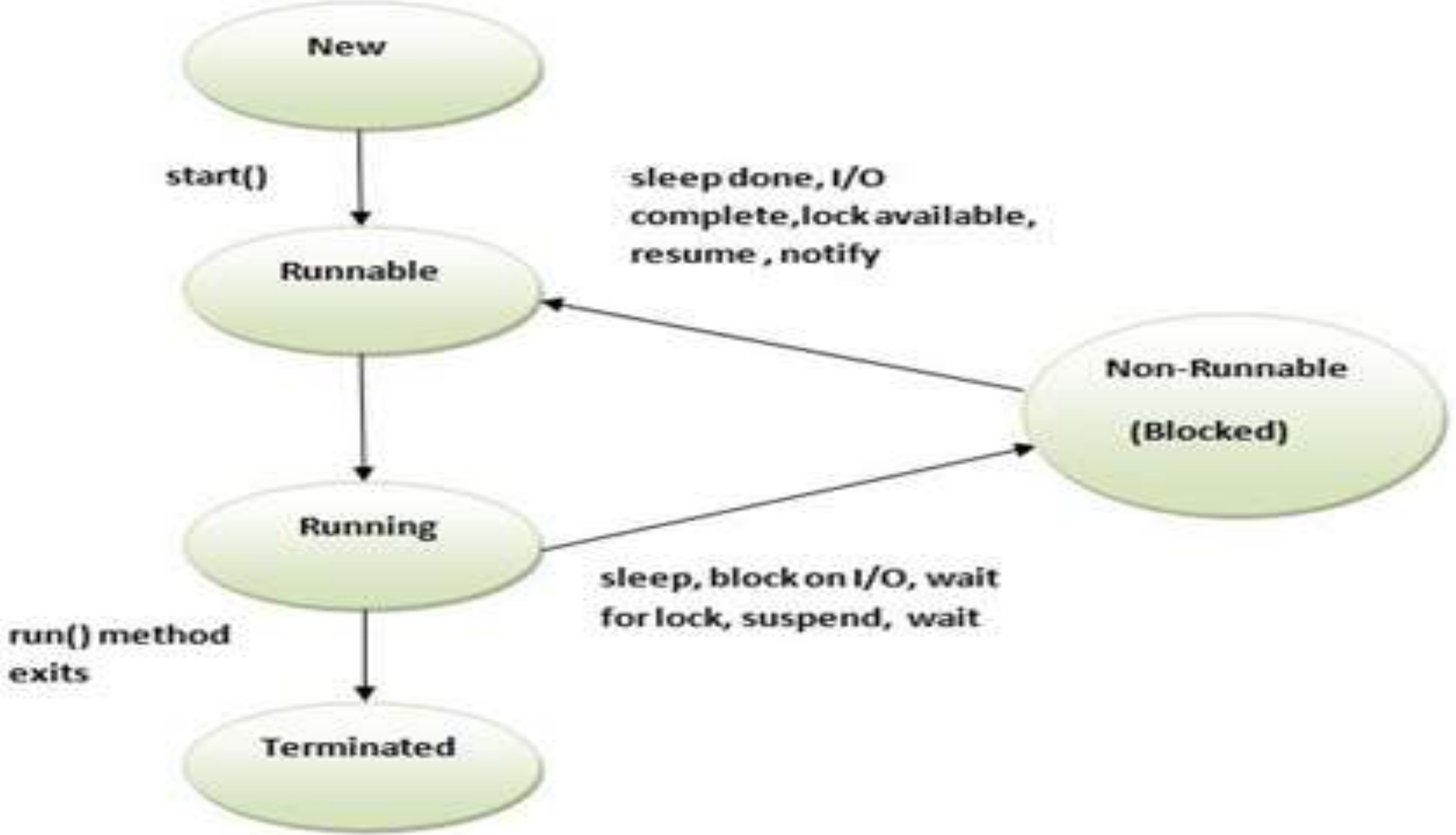
MULTI-THREADING VS MULTI-TASKING

Multithreading	Multitasking
Multithreading	Multitasking
It is a programming concept in which a program or process is divided into two or more sub programs.	It is an operating system concept in which multiple tasks are performed simultaneously.
It supports execution of multiple parts of a single program simultaneously.	It supports execution of multiple programs simultaneously.
The processor has to switch between different parts of thread or program	The processor has to switch between different programs
It is highly efficient	It is less efficient compared to multithreading
A thread is the smallest unit in multithreading	A program is smallest unit
It helps in developing efficient programs	It helps in developing efficient operating systems.

Life cycle of a Thread (Thread States)

A thread can be in one of the five states. According to sun, there is only 4 states in thread life cycle in java new, runnable, non-runnable and terminated. There is no running state. But for better understanding the threads, we are explaining it in the 5 states. The life cycle of the thread in java is controlled by JVM. The java thread states are as follows:

1. New
2. Runnable
3. Running
4. Non-Runnable (Blocked)
5. Terminated


New
start()
Runnable
sleep done, I/O complete,lock available, resume , notify
Non-Runnable (Blocked)
Running
sleep, block on I/O, wait for lock, suspend, wait
run() method exits
Terminated

1) New
The thread is in new state if you create an instance of Thread class but before the invocation of start() method.

2) Runnable
The thread is in runnable state after invocation of start() method, but the thread scheduler has not selected it to be the running thread.

3) Running
The thread is in running state if the thread scheduler has selected it.

4) Non-Runnable (Blocked)
This is the state when the thread is still alive, but is currently not eligible to run.

5) Terminated
A thread is in terminated or dead state when its run() method exits.

How to create thread

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:

•Thread()

•Thread(String name)

•Thread(Runnable r)

•Thread(Runnable r,String name)

Java Thread Example by extending Thread class

```
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…

By Implementing Runnable Interface

Java Thread Example by implementing Runnable interface

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

OUTPUT: Thread is running…

Example to create three threads

```
class Thread_A extends Thread{
public void run(){
for(int k=0;k<100;k++)
System.out.println("thread A is running...");
}
class Thread_B extends Thread{
public void run(){
for(int j=0;j<20;j++)
System.out.println("thread B is running...");
}
class Thread_C extends Thread{
public void run(){
for(int i=0;i<10;i++)
System.out.println("thread C is running...");
}
```

```
class threaddemo
{
public static void main(String ae[])
{
Thread_A a=new Thread_A();
Thread_B b=new Thread_B();
Thread_C c=new Thread_C();
a.start();
b.start();
c.start();
}
}
```

Sleep(): method causes the currently executing thread to sleep for the specified number of milliseconds, subject to the precision and accuracy of system timers and schedulers.

Example:

```
import java.lang.*;
public class ThreadDemo implements Runnable
{
  public void run() {
   for (int i = 10; i< 13; i++) {
System.out.println(Thread.currentThread().getNa
me() + "  " + i);

try {
   // thread to sleep for 1000 milliseconds
Thread.sleep(1000);
   } catch (Exception e) {
System.out.println(e);
   } }}
  public static void main(String[] args) throws
Exception {
  Thread t = new Thread(new ThreadDemo());
  // this will call run() function
t.start();
  Thread t2 = new Thread(new ThreadDemo());
  // this will call run() function
  t2.start();
  }
}
```

Expected Output:

```
Thread-0  10
Thread-1  10
Thread-0  11
Thread-1  11
Thread-0  12
Thread-1  12
```

run():

```
 public void run(){
   System.out.println("running thread name is:"+Thread.currentThread().getName());
   System.out.println("running thread priority is:"+Thread.currentThread().getPriority());
   }
 public static void main(String args[]){
  TestMultiPriority1 m1=new TestMultiPriority1();
  TestMultiPriority1 m2=new TestMultiPriority1();
  m1.setPriority(Thread.MIN_PRIORITY);
  m2.setPriority(Thread.MAX_PRIORITY);
  m1.start();
  m2.start();
    }
}
```

Output:

```
running thread name is:Thread-0
running thread priority is:10
running thread name is:Thread-1
running thread priority is:1
```

Other Thread Methods:

public void suspend()
This method puts a thread in the suspended state and can be resumed using resume() method.

public void stop()
This method stops a thread completely.

public void resume()
This method resumes a thread, which was suspended using suspend() method.

public void wait()
Causes the current thread to wait until another thread invokes the notify().

public void notify()
Wakes up a single thread that is waiting on this object's monitor.

Priority of a Thread (Thread Priority):

Each thread have a priority. Priorities are represented by a number between 1 and 10. In most cases, thread scheduler schedules the threads according to their priority (known as preemptive scheduling). But it is not guaranteed because it depends on JVM specification that which scheduling it chooses.

3 constants defined in Thread class:

- public static int MIN_PRIORITY
- public static int NORM_PRIORITY
- public static int MAX_PRIORITY

Default priority of a thread is 5 (NORM_PRIORITY).

The value of MIN_PRIORITY is 1 and the value of MAX_PRIORITY is 10.

Example:

```
class TestMultiPriority1 extends Thread{
 public void run(){
   System.out.println("running thread name
is:"+Thread.currentThread().getName());
   System.out.println("running thread priority
is:"+Thread.currentThread().getPriority());
    }
 public static void main(String args[]){
  TestMultiPriority1 m1=new TestMultiPriority1();
  TestMultiPriority1 m2=new TestMultiPriority1();
  m1.setPriority(Thread.MIN_PRIORITY);
  m2.setPriority(Thread.MAX_PRIORITY);
  m1.start();
  m2.start();
    }
}
```

```
Output:running thread name is:Thread-0
       running thread priority is:10
       running thread name is:Thread-1
       running thread priority is:1
```

Synchronization

If multiple threads are simultaneously trying to access the same resource strange results may occur. To overcome them java synchronization is used. The operations performed on the resource must be synchronized.

Monitor is the key to synchronization. A *monitor* is an object that is used as a mutually exclusive lock.Only one thread can *own* a monitor at a given time. When a thread acquires a lock, it is said to have *entered* the monitor. All other threads attempting to enter the locked monitor will be suspended until the first thread *exits* the monitor (other threads are waiting at that time) .

Code can be synchronized in two ways:

1. Using synchronized Methods
2. Using synchronized Statement

1. Using synchronized Methods :

```
synchronized void update()
{
        -      - -  -
}
```

When a method is declared as synchronized, java creates a monitor and hands it over to the thread that calls the method first time. As long as the thread holds the monitor no other thread can enter the synchronized section of code.

Example:

```
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);}
   }
}

}
```

```
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 TestSynchronization2{
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
```

2. Using synchronized Statement:

This is the general form of the synchronized statement:

```
synchronized(objRef)
{
// statements to be synchronized
}
```

objRef is a reference to the object being synchronized. A synchronized block ensures that a call to a synchronized method that is a member of objRef’s class occurs only after the current thread has successfully entered objRef’s monitor.

Example:

```
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
}
```

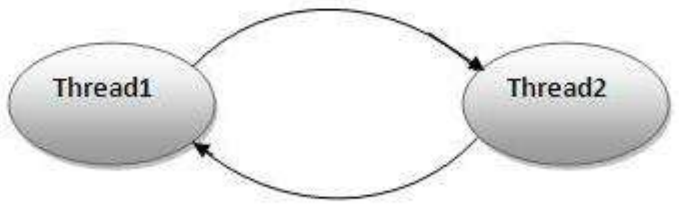
```
class MyThread1 extends Thread{
Table t;
MyThread1(Table t){
this.t=t;
}
public void run(){
t.printTable(5);
}
}
class MyThread2 extends Thread{
Table t;
MyThread2(Table t){
this.t=t;
}
public void run(){
t.printTable(100);
}
}
```

```
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
```

Deadlocks

Deadlock in java is a part of multithreading. Deadlock can occur in a situation when a thread is waiting for an object lock, that is acquired by another thread and second thread is waiting for an object lock that is acquired by first thread. Since, both threads are waiting for each other to release the lock, the condition is called deadlock



Example:

```
public class ThreadDeadlock {
    public static void main(String[] args) throws
InterruptedException {
        Object obj1 = new Object();
        Object obj2 = new Object();
        Object obj3 = new Object();

        Thread t1 = new Thread(new SyncThread(obj1, obj2),
"t1");
        Thread t2 = new Thread(new SyncThread(obj2, obj3),
"t2");
        Thread t3 = new Thread(new SyncThread(obj3, obj1),
"t3");

        t1.start();
        Thread.sleep(5000);
        t2.start();
        Thread.sleep(5000);
        t3.start();
    }
}
class SyncThread implements Runnable{
    private Object obj1;
    private Object obj2;
    public SyncThread(Object o1, Object o2){
        this.obj1=o1;
        this.obj2=o2;
    }
```

```
 public void run() {
        String name =
Thread.currentThread().getName();
        System.out.println(name + " acquiring lock on
"+obj1);
        synchronized (obj1) {
         System.out.println(name + " acquired lock on
"+obj1);
         work();
         System.out.println(name + " acquiring lock on
"+obj2);
         synchronized (obj2) {
            System.out.println(name + " acquired lock on
"+obj2);
            work();
        }
         System.out.println(name + " released lock on
"+obj2);
        }
        System.out.println(name + " released lock on
"+obj1);
        System.out.println(name + " finished execution.");
    }
 private void work() {
        try {
            Thread.sleep(30000);
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
    }
}
```

Output:

```
t1 acquiring lock on java.lang.Object@35888d06
t1 acquired lock on java.lang.Object@35888d06
t2 acquiring lock on java.lang.Object@4fc96d95
t2 acquired lock on java.lang.Object@4fc96d95
t3 acquiring lock on java.lang.Object@3894d1f3
t3 acquired lock on java.lang.Object@3894d1f3
t1 acquiring lock on java.lang.Object@4fc96d95
t2 acquiring lock on java.lang.Object@3894d1f3
t3 acquiring lock on java.lang.Object@35888d06
```