Understanding Synchronization

- Synchronization in java controls multiple threads from accessing the same shared resource in order to prevent an inconsistent state.
- Java Synchronization is done when we want to allow only one thread to access the shared resource.
- In other words Synchronization is a process of making only one thread access a resource, where multiple threads are trying to access the same resource, and moving all the remaining threads in to waiting state.

Advantage:- Resolves Thread Interference & Memory Consistency problems

Disadvantage:- Increases Thread waiting time.

- We can use Synchronization in two ways, a method can be synchronized and a block can be synchronized.
- We can't synchronize a complete class.

```
3 public class ClassA extends Thread
                                                                                 Tom-Thread has entered run()
4 {
                                                                                 Tom-Thread: 1
                                                                                Tom-Thread: 2
       @Override
6
                                                                                Tom-Thread: 3
       public void run()
                                                                                Tom-Thread: 4
8
                                                                                Tom-Thread: 5
           String name=Thread.currentThread().getName();
9
                                                                                 Tom-Thread Completed executing run()
          System.out.println(name+" has entered run()");
10
           for(int i=1;i<=5;i++)
11
               System.out.println(name+" : "+i);
12
13
14
           System.out.println(name+" Completed executing run()");
15
       public static void main(String[] args)
160
17
18
          ClassA aobj=new ClassA();
19
20
          Thread t1=new Thread(aobj);
          Thread t2=new Thread(aobj);
21
22
23
          t1.setName("Tom-Thread");
24
          t2.setName("Jerry-Thread");
25
          ₹1.start();
          //t2.start();
```

```
Jerry-Thread has entered run()
3 public class ClassA extends Thread
                                                                                   Jerry-Thread: 1
4 {
                                                                                   Jerry-Thread: 2
5⊜
       @Override
                                                                                   Jerry-Thread : 3
       public void run()
                                                                                                             Ι
                                                                                   Jerry-Thread: 4
           String name=Thread.currentThread().getName();
                                                                                   Jerry-Thread: 5
8
                                                                                   Jerry-Thread Completed executing run()
9
           System.out.println(name+" has entered run()");
10
           for(int i=1;i<=5;i++)
11
               System.out.println(name+": "+i);
12
13
           System.out.println(name+" Completed executing run()");
14
15
16e
       public static void main(String[] args)
17
18
           ClassA aobj=new ClassA();
19
20
           Thread t1=new Thread(aobj);
21
           Thread t2=new Thread(aobj);
22
23
           t1.setName("Tom-Thread");
24
           t2.setName("Jerry-Thread");
25
26
           //t1.start();
27
           t2.start();
                                                                                   Tom-Thread has entered run()
3 public class ClassA extends Thread
                                                                                   Jerry-Thread has entered run()
4 {
                                                                                  Jerry-Thread: 1
 58
       @Override
                                                                                   Jerry-Thread: 2
6
       public void run()
                                                                                  Jerry-Thread : 3
                                                                                  Jerry-Thread : 4
           String name=Thread.currentThread().getName();
                                                                                   Jerry-Thread : 5
9
           System.out.println(name+" has entered run()");
                                                                                   Jerry-Thread Completed executing run()
10
           for(int i=1;i<=5;i++)
                                                                                   Tom-Thread: 1
11
               System.out.println(name+" : "+i);
                                                                                   Tom-Thread: 2
12
                                                                                   Tom-Thread : 3
13
                                                                                   Tom-Thread: 4
14
           System.out.println(name+" Completed executing run()");
                                                                                   Tom-Thread: 5
15
       public static void main(String[] args)
                                                                                   Tom-Thread Completed executing run()
169
17
18
           ClassA aobj=new ClassA();
19
           Thread t1=new Thread(aobj);
20
           Thread t2=new Thread(aobj);
21
22
           t1.setName("Tom-Thread");
23
24
           t2.setName("Jerry-Thread");
25
           t1.start();
27
           t2.start();
```

```
Tom-Thread has entered run()
 3 public class ClassA extends Thread
                                                                                        Jerry-Thread has entered run()
 50
                                                                                        Tom-Thread: 1
       @Override
                                                                                        Jerry-Thread: 1
       public void run()
 6
                                                                                        Tom-Thread: 2
 8
            String name=Thread.currentThread().getName();
                                                                                        Jerry-Thread: 2
 9
            System.out.println(name+" has entered run()");
                                                                                        Tom-Thread: 3
                                                                                        Tom-Thread: 4
10
            for(int i=1;i<=5;i++)
                                                                                        Jerry-Thread: 3
11
12
                System.out.println(name+" : "+i);
                                                                                        Tom-Thread: 5
                                                                                        Jerry-Thread: 4
                                                                                        Jerry-Thread: 5
            System.out.println(name+" Completed executing run()");
14
15
                                                                                        Jerry-Thread Completed executing run()
                                                                                        Tom-Thread Completed executing run()
       public static void main(String[] args)
169
17
18
            ClassA aobj=new ClassA();
19
            Thread t1=new Thread(aobj);
20
21
            Thread t2=new Thread(aobj);
22
23
            t1.setName("Tom-Thread");
24
            t2.setName("Jerry-Thread");
25
26
            t1.start();
27
            t2.start();
                                                                                            Tom-Thread has entered run()
4 {
                                                                                            Tom-Thread: 1
       @Override
                                                                                           Tom-Thread: 2
6
       public void run()
                                                                                           Tom-Thread: 3
                                                                                            Tom-Thread: 4
 8
           criticalResource();
                                                                                           Tom-Thread: 5
108
       synchronized void criticalResource()
                                                                                            Tom-Thread Completed executing run()
                                                                                            Jerry-Thread has entered run()
                                                                                            Jerry-Thread: 1
           String name=Thread.currentThread().getName();
                                                                                            Jerry-Thread: 2
           System.out.println(name+" has enter
                                                                                            Jerry-Thread : 3
14
           for(int i=1;i<=5;i++)
                                                                                            Jerry-Thread: 4
                                                                                            Jerry-Thread : 5
               System.out.println(name+" : "+i);
                                                                                            Jerry-Thread Completed executing run()
           System.out.println(name+" Completed executing run()");
18
19
       public static void main(String[] args)
208
21
22
           ClassA aobj=new ClassA();
23
24
           Thread t1=new Thread(aobj);
25
           Thread t2=new Thread(aobj);
26
           t1.setName("Tom-Thread");
27
           t2.setName("Jerry-Thread");
28
                                                                                            Jerry-Thread has entered run()
4 {
                                                                                            Jerry-Thread : 1
 58
       @Override
                                                                                            Jerry-Thread : 2
6
       public void run()
                                                                                            Jerry-Thread: 3
                                                                                            Jerry-Thread: 4
 8
           criticalResource();
                                                                                            Jerry-Thread: 5
 9
                                                                                            Jerry-Thread Completed executing run()
       synchronized void criticalResource()
10≋
                                                                                            Tom-Thread has entered run()
                                                                                            Tom-Thread : 1
           String name=Thread.currentThread().getName();
                                                                                            Tom-Thread: 2
13
           System.out.println(name+" has entered run()");
                                                                                            Tom-Thread : 3
14
           for(int i=1;i<=5;i++)
                                                                                            Tom-Thread : 4
                                                                                            Tom-Thread: 5
16
               System.out.println(name+" : "+i);
                                                                                            Tom-Thread Completed executing run()
17
18
           System.out.println(name+" Completed executing run()");
19
20=
       public static void main(String[] args)
21
22
           ClassA aobj=new ClassA();
23
24
           Thread t1=new Thread(aobj);
           Thread t2=new Thread(aobj);
26
           t1.setName("Tom-Thread");
           t2.setName("Jerry-Thread");
```

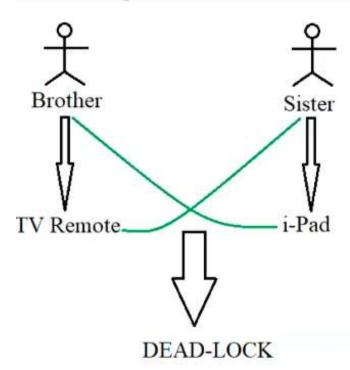
```
4 1
                                                                                     Second-Thread has entered run()
       @Override
                                                                                     First-Thread has entered run()
       public void run()
. 6
                                                                                     Second-Thread: 1
                                                                                     Second-Thread: 2
 8
           String name=Thread.currentThread().getName();
                                                                                     Second-Thread: 3
 9
           System.out.println(name+" has entered run()");
                                                                                     Second-Thread: 4
10
           for(int i=1;i<=5;i++)
                                                                                     Second-Thread: 5
11
                                                                                     Second-Thread Completed executing run()
               System.out.println(name+" : "+i);
12
                                                                                     First-Thread: 1
13
                                                                                     First-Thread: 2
14
           System.out.println(name+" Completed executing run()");
                                                                                     First-Thread : 3
15
                                                                                     First-Thread: 4
       public static void main(String[] args)
169
                                                                                     First-Thread : 5
17
                                                                                     First-Thread Completed executing run()
18
           ClassB bobj=new ClassB();
19
20
           Thread t1=new Thread(bobj);
21
           Thread t2=new Thread(bobj);
22
23
           t1.setName("First-Thread");
24
           t2.setName("Second-Thread");
25
26
           t1.start();
           t2.start();
28
                                                                                     Second-Thread has entered run()
 4 {
                                                                                     First-Thread has entered run()
 58
       @Override
                                                                                     Second-Thread: 1
 6
       public void run()
                                                                                     Second-Thread: 2
                                                                                     Second-Thread: 3
 8
           String name=Thread.currentThread().getName();
                                                                                     Second-Thread: 4
 9
           System.out.println(name+" has entered run()");
                                                                                     Second-Thread: 5
10
           synchronized (this)
{
                                                                                     First-Thread: 1
                                                                                           Thread
13
               for(int i=1;i<=5;i++)
14
15
                   System.out.println(name+" : "+i);
                                                                                     First-Thread Completed executing run()
           }
                                                                                     Second-Thread Completed executing run()
17
18
19
           System.out.println(name+" Completed executing run()");
20
       public static void main(String[] args)
218
22
23
           ClassB bobj=new ClassB();
24
25
           Thread t1=new Thread(bobj);
26
           Thread t2=new Thread(bobj);
27
           t1.setName("First-Thread");
28
```

```
First-Thread has entered run()
4 {
                                                                                     Second-Thread has entered run()
50
       @Override
       public void run()
6
8
           String name=Thread.currentThread().getName();
                                                                                       irst-Thread
           System.out.println(name+" has entered run()");
10
                                                                                     Second-Thread: 1
11
           synchronized (this)
                                                                                     Second-Thread: 2
12
                                                                                     Second-Thread: 3
13
               for(int i=1;i<=5;i++)
                                                                                     Second-Thread: 4
14
                                                                                     Second-Thread : 5
15
                   System.out.println(name+" : "+i);
                                                                                     Second-Thread Completed executing run()
16
                                                                                     First-Thread Completed executing run()
17
18
19
           System.out.println(name+" Completed executing run()");
20
210
       public static void main(String[] args)
22
           ClassB bobj=new ClassB();
23
24
25
           Thread t1=new Thread(bobj);
26
           Thread t2=new Thread(bobj);
27
           t1.setName("First-Thread");
                                                                                     Second-Thread has entered run()
                                                                                     First-Thread has entered run()
 50
       @Override
                                                                                     Second-Thread: 1
       public void run()
 6
                                                                                     Second-Thread: 2
                                                                                     Second-Thread: 3
           String name=Thread.currentThread().getName();
 8
                                                                                     Second-Thread: 4
 9
           System.out.println(name+" has entered run()");
                                                                                     Second-Thread: 5
10
                                                                                     First-Thread: 1
            synchronized (this)
                                                                                     First-Thread: 2
12
                                                                                     First-Thread : 3
                for(int i=1;i<=5;i++)
                                                                                     Second-Thread Completed executing run()
14
                                                                                     First-Thread: 4
                   System.out.println(name+" : "+i);
                                                                                     First-Thread: 5
                                                                                     First-Thread Completed executing run()
           }
17
18
19
           System.out.println(name+" Completed executing run()");
20
       public static void main(String[] args)
21⊜
22
23
           ClassB bobj=new ClassB();
24
           Thread t1=new Thread(bobj);
25
26
           Thread t2=new Thread(bobj);
27
28
           t1.setName("First-Thread");
```

```
3 public class ClassA extends Thread
                                                                   public class ClassB extends Thread
58
      @Override
                                                                       @Override
      public void run()
                                                                       public void run()
          criticalResource();
                                                                           String name=Thread.currentThread().getName();
                                                                           System.out.println(name+" has entered run()");
       synchronized void criticalResource()
108
11
                                                                           synchronized (this)
          String name=Thread.currentThread().getName();
          System.out.println(name+" has entered run()");
                                                                               for(int i=1;i<=5;i++)
          for(int i=1;i<=5;i++)
                                                                                  System.out.println(name+" : "+i);
              System.out.println(name+" : "+i);
17
18
19
          System.out.println(name+" Completed executing run()");
                                                                           System.out.println(name+" Completed executing run()");
      public static void main(String[] args)
21
22
                                                                       public static void main(String[] args)
          ClassA aobj=new ClassA();
                                                                22
23
                                                                 23
                                                                           ClassB bobj=new ClassB();
          Thread t1=new Thread(aobj);
                                                                24
25
25
          Thread t2=new Thread(aobj);
                                                                           Thread t1=new Thread(bobj);
Thread t2=new Thread(bobj);
26
                                                                 26
27
          t1.setName("Tom-Thread");
          t2.setName("Jerry-Thread");
                                                                           t1.setName("First-Thread");
                                                                 28
29
                                                                 29
                                                                           t2.setName("Second-Thread");
          t1.start();
30
31
          t2.start();
                                                                           t1.start();
20=
            public static void main(String[] args)
21
                   ClassB bobj=new ClassB();
22
23
24
                   Thread t1=new Thread(bobj);
25
                   Thread t2=new Thread(bobj);
 26
27
                   t1.setName("First-Thread");
28
                   t2.setName("Second-Thread");
 29
                   t1.start();
30
31
                   t2.start();
32
33 }
```

Understanding Deadlocks

- Deadlock describes a situation where two or more threads are blocked forever, & waiting for each other.
- In other words it is a condition which occurs when two or more threads get blocked, waiting for each other for an infinite period of time to release the resources they hold.



```
3 public class ClassD
4 {
50
       public static void main(String[] args)
 6
           final String A="Java";
 7
8
           final String B="Python";
9
109
           Thread t1=new Thread()
           { // Anononmyous Inner Class starts here
11
129
               @Override
13
               public void run()
14
                   synchronized (A)// Thread 1 is holding Java
15
16
                       System.out.println("Thread 1 locked on A");
17
18
                       try
19
                        {
                            Thread.sleep(100);
20
21
                       catch (Exception e)
22
23
24
                            e.printStackTrace();
25
                       synchronized (B)// Thread1 will be waiting for B (Python)
26
27
28
                            System.out.println("Thread 1 locked on B");
29
30
31
                        System.out.println("no dead lock");
32
33
34
           }// Anononmyous Inner Class Ends here
35
           Thread t2=new Thread()
36⊜
37
                @Override
380
39
                public void run()
40
                    synchronized (B)// Thread 2 is holding Python
41
42
                        System.out.println("Thread 2 locked on B");
43
44
                        try
45
                            Thread.sleep(100);
46
47
48
                        catch (Exception e)
49
50
                            e.printStackTrace();
```

```
synchronized (A)// Thread2 will be waiting for A (Java)
52
53
                           System.out.println("Thread 2 locked on A");
54
55
56
                   System.out.println("no dead lock");
57
               }
58
           }
59
61
           t1.start();
62
           t2.start();
       }
63
64 }
```

Refer to next class about above program