JAC444 / BTP400 Course Object-Oriented Software Development II - Java

Threads

Segment 2

Threads

In this section you will be learning about:

- Synchronization
- Synchronized Methods
- Deadlock
- Starvation and Livelock

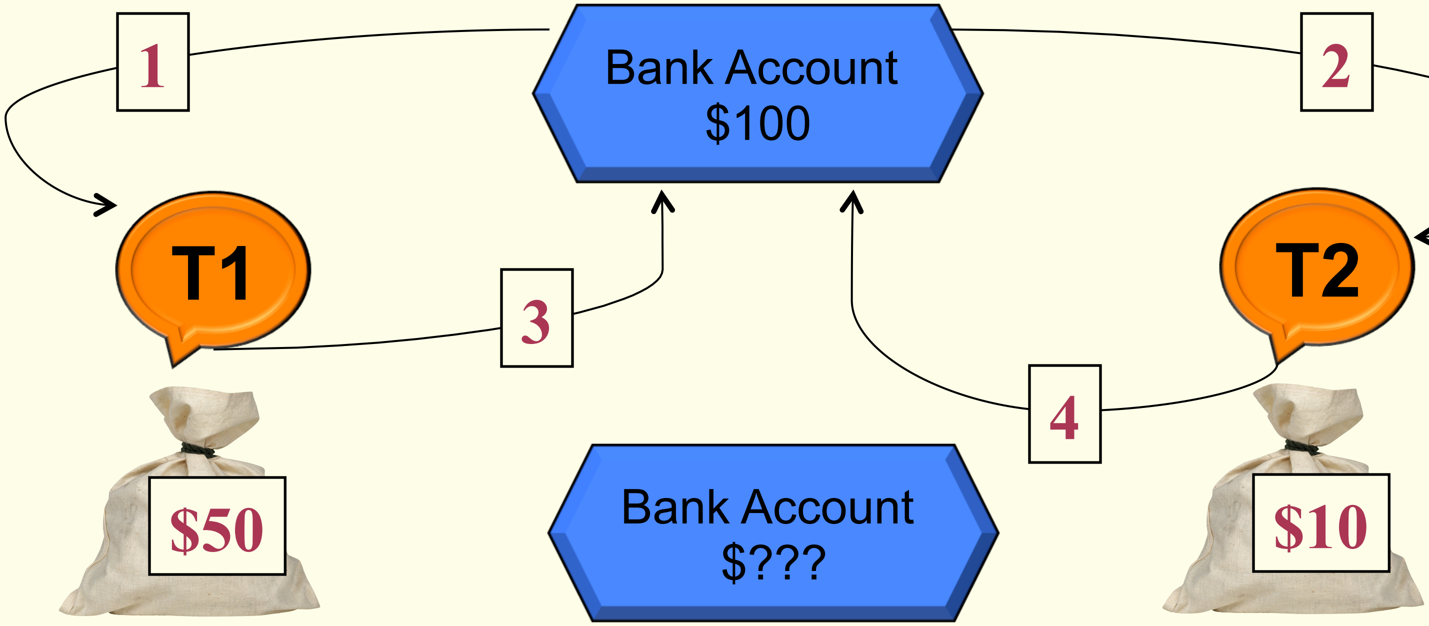
Bank Account – Race Condition

Pitfalls: <u>Race Condition</u>

```
getResource();
modifyResource();
setResource();
```

Example: Bank Account

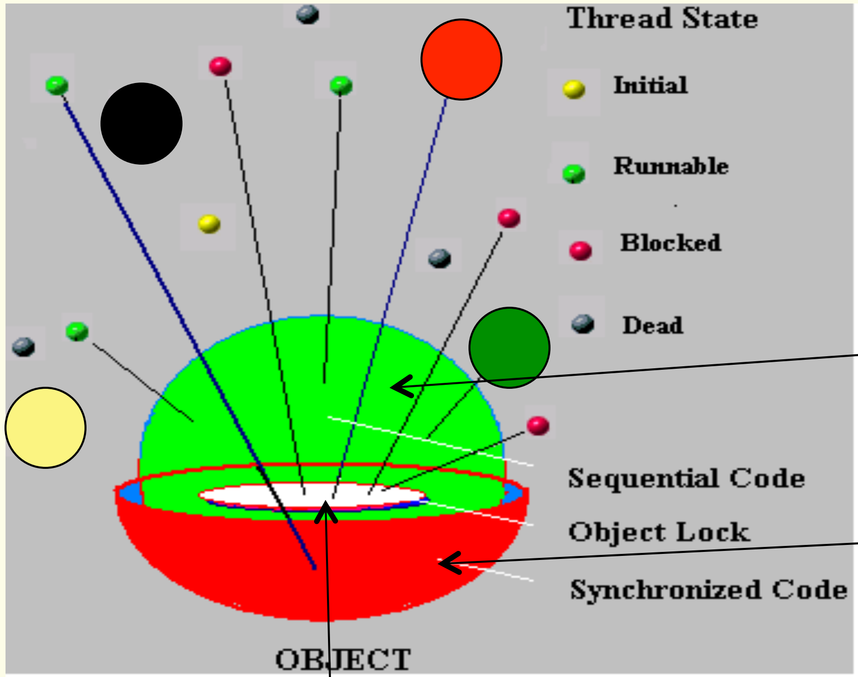
```
I.   x = account.getBalance();
II.  x = x + deposit;
III. account.setBalance(x);
```



Synchronization Concepts

- Synchronization is built around the concept known as the intrinsic lock
- Every object has an intrinsic lock associated with it
- A thread that needs access to an object's fields has to *acquire* the object's intrinsic lock
- A thread has to *release* the intrinsic lock when it's done with an object
- A thread is said to *own the intrinsic lock* since acquires until releases the object's intrinsic lock
- Any *other thread will block* when it attempts to acquire the object's intrinsic lock, if the lock is owned by another thread

Thread State and Intrinsic Lock



Unsynchronized Code

Synchronized Code

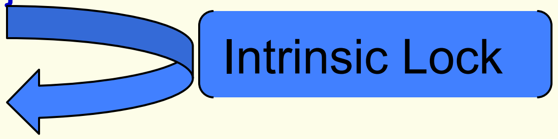
Object Intrinsic Lock

🟡	1. Initial
🟢	2. Runnable
🔴	3. Blocked
⚫	4. Dead

Synchronized Methods

- When a thread invokes a synchronized method, it automatically acquires the intrinsic lock for that method's object
- In a synchronized method, the thread releases the acquired lock when the method returns

```
class X extends Thread {
...
  synchronized void method(...) {
    ...
    return;
  }
  public static void main(...) {
    Thread t = new X();
    t.method();
  }
}
```



Synchronized Statements

- Synchronized statements must specify the object that provides the intrinsic lock
- In a synchronized statements , the thread releases the acquired lock when the last statement is executed

```
public void addName(String studentName) {
    synchronized(this) {
        lastName = studentName;
        nameCount++;
    }
    studentList.add(studentName);
}
```

Intrinsic Lock

Example Synchronized Method

```
public class SynThread implements Runnable {
  private String holdA = "This is ";
  private int[] holdB = {1,2,3,4,5,6,7,8,9,10};

  //synchronized
  public void run() {
    for(int w = 0; w < 10; w++) {
      System.out.println(holdA + holdB[w] + ".");
    }
  }

  public static void main(String args[]) {
    SynThread z = new SynThread();
    new Thread(z).start();
    new Thread(z).start();
  }
}
```

Run this code twice: 1. as is, and 2. add `synchronized` keyword to `run` method.
Do you see the difference?

Liveness

- *Liveness* is the property of a concurrent application to execute in a timely manner.

  Liveness Problems:

  1. Deadlock
  2. Starvation
  3. Livelock

Deadlock

- When two or more threads are blocked forever, waiting for each other, we define the liveness problem as being a *deadlock*

```
public class Deadlock {
  public static void main(String[] args) {

    final Object r1 = "r1";
    final Object r2 = "r2";

    Thread t1 = new Thread(() -> {synchronized(r1){
                                    synchronized(r2){}
                                  } });

    Thread t2 = new Thread(() -> {synchronized(r2){
                                    synchronized(r1){}
                                  } });
    t1.start();
    t2.start();
  }
}
```

Starvation and Livelock

- *Starvation* describes a situation where a thread is unable to gain regular access to shared resources and is unable to make progress.

- A thread often acts in response to the action of another thread. If the other thread's action is also a response to the action of another thread, then *livelock* may result.

- *Deadlock* – threads are blocked; *Livelock* – threads are alive but stuck;

- Solutions to liveness problems:

  1. Immutable Objects

  2. High Level Concurrency

Source: http://docs.oracle.com/javase/tutorial/essential/concurrency/starvelive.html

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