Lab Thread

Exercise 1

Creating a thread

1. The first approach for creating threads is implement Runnable interface (recommended)

YourTask.java

```
1  package session01.mthread;
2  /**
3   * Task thread sample
4   * @author VoVanHai
5   */
6  public class YourTask implements Runnable{
7      private String taskName;
8      private int counter;
9
10     public YourTask(String taskName, int counter) {
11         this.taskName = taskName;
12         this.counter = counter;
13     }
14
15     @Override
16     public void run() {
17         for (int i = 0; i < counter; i++) {
18             System.out.println(taskName+ "#"+i);
19         }
20     }
21 }
```

YourTask.java | TaskExecute.java

```
1  package session01.mthread;
2
3  public class TaskExecute {
4      public static void main(String[] args) {
5          Runnable r1=new YourTask("Print Task", 20);
6          Runnable r2=new YourTask("Distribute Task", 23);
7          Thread t1=new Thread(r1);
8          Thread t2=new Thread(r2);
9          t1.start();
10         t2.start();
11     }
12 }
```

Run and make a review for the result

2. The second approach for creating a thread by extending the Thread class (not recommended)

AnotherTask.java

```
1  package session01.mthread.ex02;
2
3  public class AnotherTask extends Thread{
4      private String taskName;
5      private int counter;
6
7      public AnotherTask(String taskName, int counter) {
8          this.taskName = taskName;
9          this.counter = counter;
10     }
11
12     @Override
13     public void run() {
14         for (int i = 0; i < counter; i++) {
15             System.out.println(taskName+ "#"+i);
16         }
17     }
18 }
```

AnotherTask.java | TaskRun.java

```
1  package session01.mthread.ex02;
2
3  public class TaskRun {
4      public static void main(String[] args) {
5          Runnable r1=new AnotherTask("Collect Task", 15);
6          Runnable r2=new AnotherTask("Process Task", 19);
7          Thread t1=new Thread(r1);
8          Thread t2=new Thread(r2);
9          t1.start();
10         t2.start();
11     }
12 }
```

Run and make a review for the result. Explain why this way was not a recommendation.

3. The third approach is implemented Callable interface

ComputationTask.java

```
2
3  import java.util.concurrent.Callable;
4
5  public class ComputationTask implements Callable<Long>{
6      private String taskName;
7      public ComputationTask(String taskName) {
8          this.taskName = taskName;
9      }
10
11     @Override
12     public Long call() throws Exception {
13         Long result=0L;
14         for (int i = 0; i < 1000; i++) {
15             result+=i;//simple for testing purpose
16             System.out.println(taskName + " #"+i);
17             Thread.sleep(10);
18         }
19         return result;
20     }
21 }
```

ComputationTask.java | ComputationExecutor.java

```
3  import java.util.concurrent.Callable;
4  import java.util.concurrent.FutureTask;
5
6  public class ComputationExecutor {
7      public static void main(String[] args) throws Exception{
8          Callable<Long>call=new ComputationTask("long-last-computaion");
9          FutureTask<Long> task = new FutureTask<>(call);
10         new Thread(task).start();
11
12         //Waits if necessary for the computation to complete,
13         //and then retrieves its result.
14         long result=task.get();
15         System.out.println("Result:"+result);
16     }
17 }
```

Run and make a review for the result.

4. Write a task to display the numbers from 1 to 10. Then write some code that creates and starts threads to execute the tasks.
5. Write a task to check whether x is a prime number *(x is assumed to be greater than 1)*. Then write some code that creates and starts threads to execute the tasks.

Exercise 2

Manipulate methods of thread

1. Using ***join()*** method
   Waits for this thread to die.

AnotherTask.java
```
package session01.mthread.ex04;

public class AnotherTask implements Runnable{
    private String taskName;
    private int counter;

    public AnotherTask(String taskName, int counter) {
        this.taskName = taskName;
        this.counter = counter;
    }

    @Override
    public void run() {
        for (int i = 0; i < counter; i++) {
            System.out.println(taskName+ "#"+i);
        }
    }
}
```

YourTask.java
```
package session01.mthread.ex04;

public class YourTask implements Runnable{

    @Override
    public void run() {
        try {
            Thread t=new Thread(
                    new  AnotherTask("Another task",10));
            t.start();//start another task
            for (int i = 0; i < 8; i++) {
                System.out.println("Your Task #"+i);
                if(i==5)
                    t.join();//join thread
            }
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
    }
}
```

TestJoinThread.java
```
package session01.mthread.ex04;

public class TestJoinThread {
    public static void main(String[] args) throws Exception{
        new Thread(new YourTask()).start();
    }
}
```

   Run and make a review for the result.
2. Using yield() method
   The **java.lang.Thread.yield()** method causes the currently executing thread object to temporarily pause and allow other threads to execute.

ThreadDemoUsingYieldMethod.java

```
1  package session01.mthread.ex05;
2
3  public class ThreadDemoUsingYieldMethod implements Runnable {
4      private Thread t;
5
6      public ThreadDemoUsingYieldMethod(String str) {
7          t = new Thread(this, str);
8          t.start();
9      }
10     public void run() {
11
12         for (int i = 0; i < 5; i++) {
13             // yields control to another thread every 5 iterations
14             if ((i % 5) == 0) {
15                 System.out.println(Thread.currentThread().getName() + "yielding control...");
16                 /* causes the currently executing thread object to temporarily
17                 pause and allow other threads to execute */
18                 Thread.yield();
19             }
20         }
21         System.out.println(Thread.currentThread().getName() + " has finished executing.");
22     }
23
24     public static void main(String[] args) {
25         new ThreadDemoUsingYieldMethod("Thread 1");
26         new ThreadDemoUsingYieldMethod("Thread 2");
27         new ThreadDemoUsingYieldMethod("Thread 3");
28     }
29 }
```

Run program and make a review.

3. Using daemon thread

DaemonThread.java

```
1  package session01.mthread.ex06;
2
3  public class DaemonThread extends Thread {
4      public void run() {
5          System.out.println("Entering run method");
6          try {
7              System.out.println("In run Method: currentThread() is"
8                      + Thread.currentThread());
9              while (true) {
10                 try {
11                     Thread.sleep(500);
12                 } catch (InterruptedException x) {
13                 }
14                 System.out.println("In run method: woke up again");
15             }
16         } finally {
17             System.out.println("Leaving run Method");
18         }
19     }
20     public static void main(String[] args) throws Exception{
21         System.out.println("Entering main Method");
22         DaemonThread t = new DaemonThread();
23
24         t.setDaemon(true);//turn t to daemon thread
25
26         t.start();
27         Thread.sleep(3000);
28         System.out.println("Leaving main method");
29     }
30 }
```

Run the program and observe.

Comment line 24 and run again. Make an explanation about this case.

4. *** Using the ‘wait - notify’ mechanism

Create three classes: Storage, Counter and Printer.

The Storage class should store an integer.

The Counter class should create a thread that starts counting from 0 (0, 1, 2. 3 ...) and stores each value in the Storage class.

The Printer class should create thread that keeps reading the value in the Storage class and printing it.

Create a program that creates an instance of the Storage class, and sets up a Counter and a Printer object to operate on it.

(*) Modify the program to ensure that each number was printed exactly once, by adding suitable synchronization.

a. Wrong solution

```
class MyQueue {
    int n;
    synchronized int get() {
        System.out.println("Got: " + n);
        return n;
    }
    synchronized void put(int n) {
        this.n = n;
        System.out.println("Put: " + n);
    }
}
```

```
class Producer implements Runnable {
    MyQueue q;
    Producer(MyQueue q) {
        this.q = q;
        new Thread(this, "Producer").start();
    }
    public void run() {
        int i = 0;
        while(true) { q.put(i++);}
    }
}
```

```
class Consumer implements Runnable {
    MyQueue q;
    Consumer(MyQueue q) {
        this.q = q;
        new Thread(this, "Consumer").start();
    }
    public void run() {
        while(true) { q.get();}
    }
}
```

```
public class Producer_Consumer_Demo {
    public static void main(String args[]){
        MyQueue q = new MyQueue();
        new Producer(q);
        new Consumer(q);
    }
}
```

Run, observe and explain why it was a incorrect version.

b. Correct solution

```
class MyQueue {
    int n;
    boolean valueSet = false;
    synchronized int get() {
        if(!valueSet)
            try { wait();} catch(InterruptedException e) {}
        System.out.println("Got: " + n);
        //assume that our work take a time to execute
        try{Thread.sleep(300);}catch(Exception x){}
        valueSet = false;
        notify();
        return n;
    }
    synchronized void put(int n) {
        if(valueSet)
            try { wait(); } catch(InterruptedException e) {}
        this.n = n;
        valueSet = true;
        System.out.println("Put: " + n);
        //assume that our work take a time to execute
        try{Thread.sleep(500);}catch(Exception x){}
        notify();
    }
}
```

```
class Producer implements Runnable {
    MyQueue q;
    Producer(MyQueue q) {
        this.q = q;
    }
    public void run() {
        int i = 0;
        while(true) {
            q.put(i++);
        }
    }
}
```

```
class Consumer implements Runnable {
    MyQueue q;
    Consumer(MyQueue q) {
        this.q = q;
    }
    public void run() {
        while(true) {
            q.get();
        }
    }
}
```

```
public class Producer_Consumer_Demo_Fixed {
    public static void main(String args[]) {
        System.out.println("Press Control-C to stop.");
        ExecutorService service = Executors.newFixedThreadPool(2);

        MyQueue q = new MyQueue();

        service.execute(new Producer(q));
        service.execute(new Consumer(q));
    }
}
```

Run and explain the result.

Exercise 3

When threads share access to a common object, they can conflict with each other. To demonstrate the problems that can arise, we will investigate a sample program in which multiple threads manipulate a bank account.

1/ We construct a bank account that starts out with a zero balance. We create two sets of threads:

- Each thread in the first set repeatedly deposits $100.
- Each thread in the second set repeatedly withdraws $100.

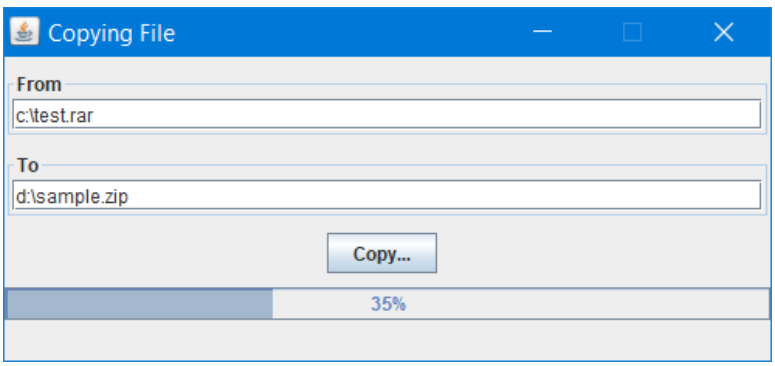
To solve this problem:

- Use a lock object
- Use method and block Synchronization

2/ Add a condition to the deposit method of the BankAccount class, restricting deposits to $100,000 *(the insurance limit of the U.S. government)*. The method should block until sufficient money has been withdrawn by another thread. Test your program with a large number of deposit threads.

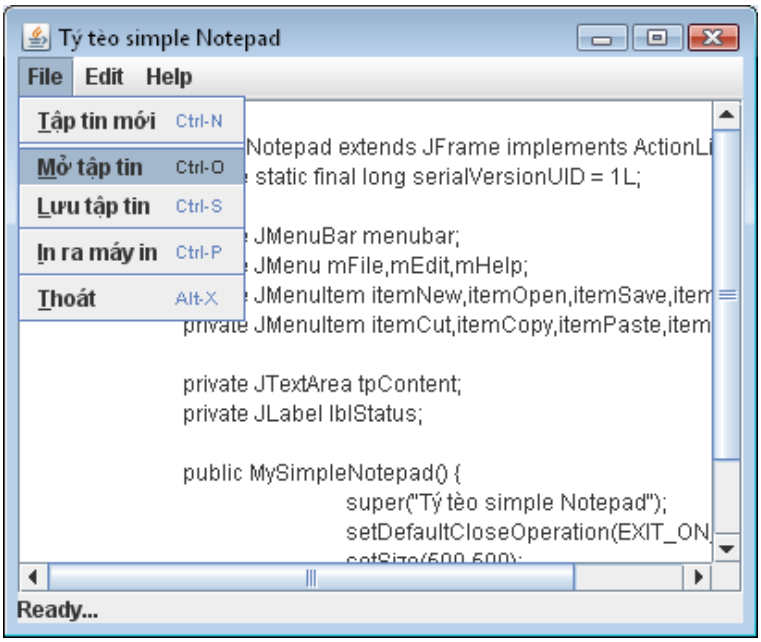
Exercise 4

Write a GUI application that copies files. A progress bar is used to display the progress of the copying operation, as shown in following figure.



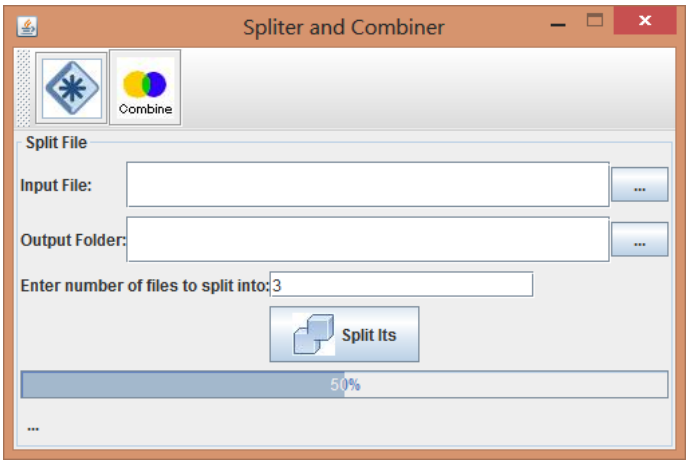
Exercise 5

Write an application simulates simple notepad Main GUI as follow: *(test with a big text file, about 20MB, and then use multi-threading to load the file)*



Exercise 6

Suppose you wish to back up a huge file (e.g., a 10-GB AVI file) to a CD-R. You can achieve it by splitting the file into smaller pieces and backing up these pieces separately. Write a utility program that splits a large file into smaller ones. (Display the percentage of work done in a progress bar, as shown in following figure)



Read more

1. https://docs.oracle.com/javase/8/docs/api/java/lang/Thread.html
2. https://docs.oracle.com/javase/tutorial/essential/concurrency/