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Laboratory 1

Title of the Laboratory Exercise: Introduction to java simulation

1. **Introduction and Purpose of Experiment**

   Computer simulation provides students to design and implement computer simulation models, conduct simulation experiments and evaluate system performance. This laboratory exercise will help the students to get familiar with using object-oriented simulation in Java.

   Java (Structured Parallel Discrete Event Simulation in Java) system is designed to incorporate the parallel programming technology into discrete event simulations. The java system adopts the approach of augmenting a general-purpose language with essential constructs to support simulation modeling based on the process-oriented modeling technology

2. **Aim and Objectives**

   Aim

   - To use Netbeans and understand using object-oriented simulation in Java

   Objectives

   At the end of this lab, the student will be able to

   - Explain the features and use of Netbeans IDE to develop java programs for simulation
   - Edit, compile and execute java programs successfully using Netbeans IDE

3. **Experimental Procedure**

   Students are given a set of programs for generating random numbers using built-in methods. Programs should be edited, compiled and executed using Netbeans IDE.

   Random number generation using inbuilt methods/manually

   Ex: coin toss, die, and cards

4. **Calculations/Computations/Algorithms**

   a. Develop and implement a java program to generate 10 random number

b. Develop and implement a java program to generate 10 random numbers in between 0 to 1

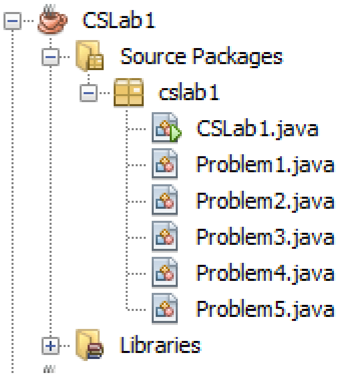
c. Develop and implement a java program to generate 10 normally distributed random numbers in between 0 to 1.

d. Develop and implement a java program to flip a coin 50 time, and count number of occurrence of head and tail and determine probability distribution of head and tail.

e. Develop and implement a java program to through a dice 200 times, and count number of occurrence of each face (1,2 …. 6) and determine probability distribution.

5. Presentation of Results

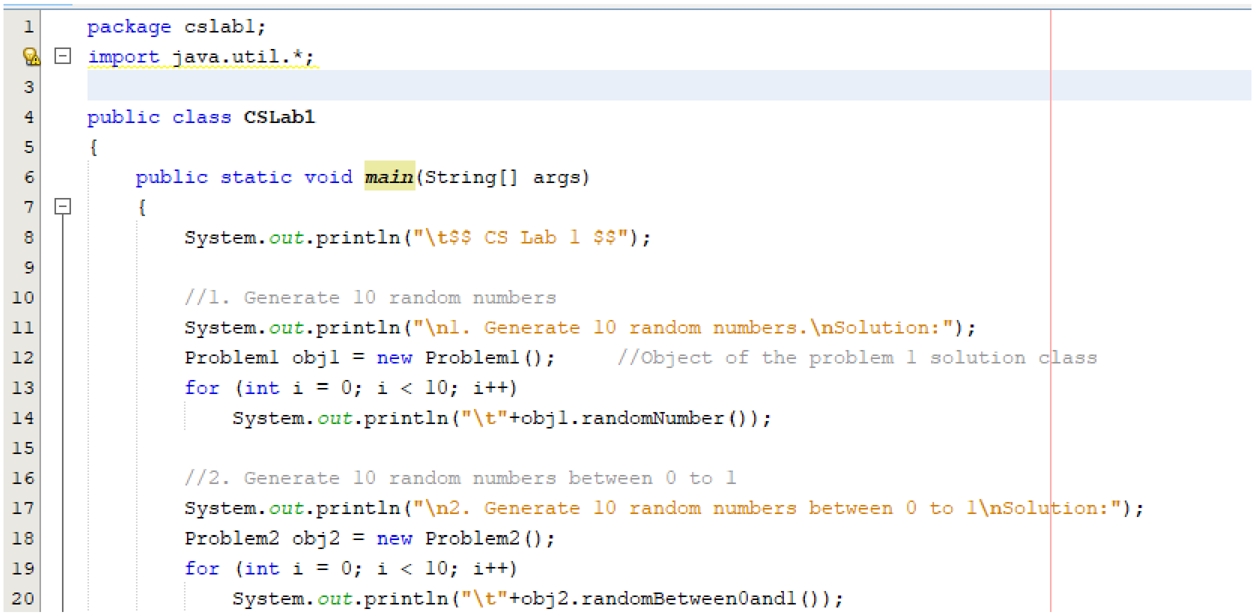
The following is the project structure:



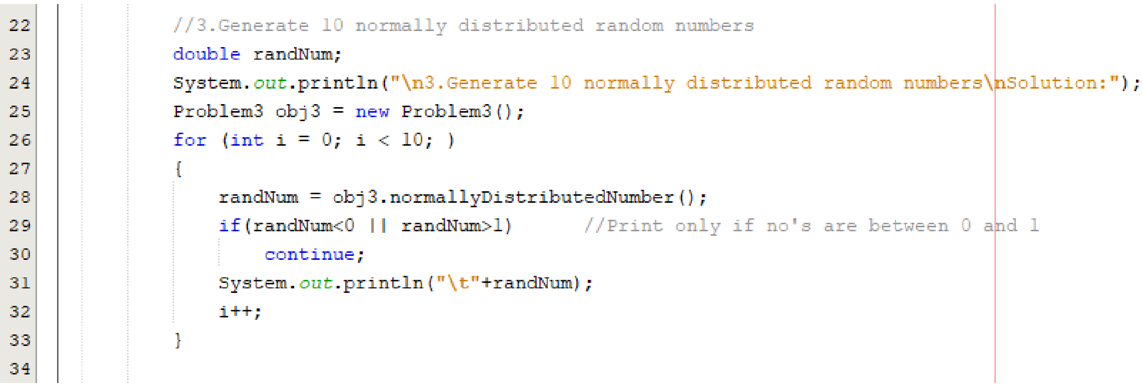
```
CSLab1
  Source Packages
    cslab1
      CSLab1.java
      Problem1.java
      Problem2.java
      Problem3.java
      Problem4.java
      Problem5.java
  Libraries
```

Problem **1** to **5** are the java files to solve the problems from **a** to **e** respectively. The **CSLab1.java** creates the objects of these classes and calls them accordingly.

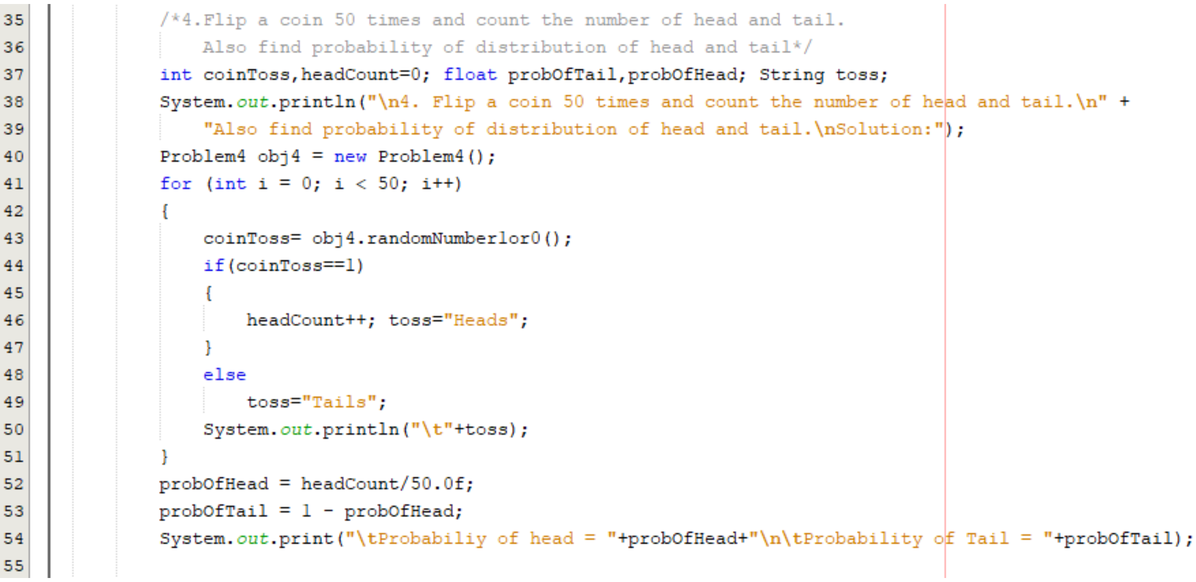
CSLab1.java :



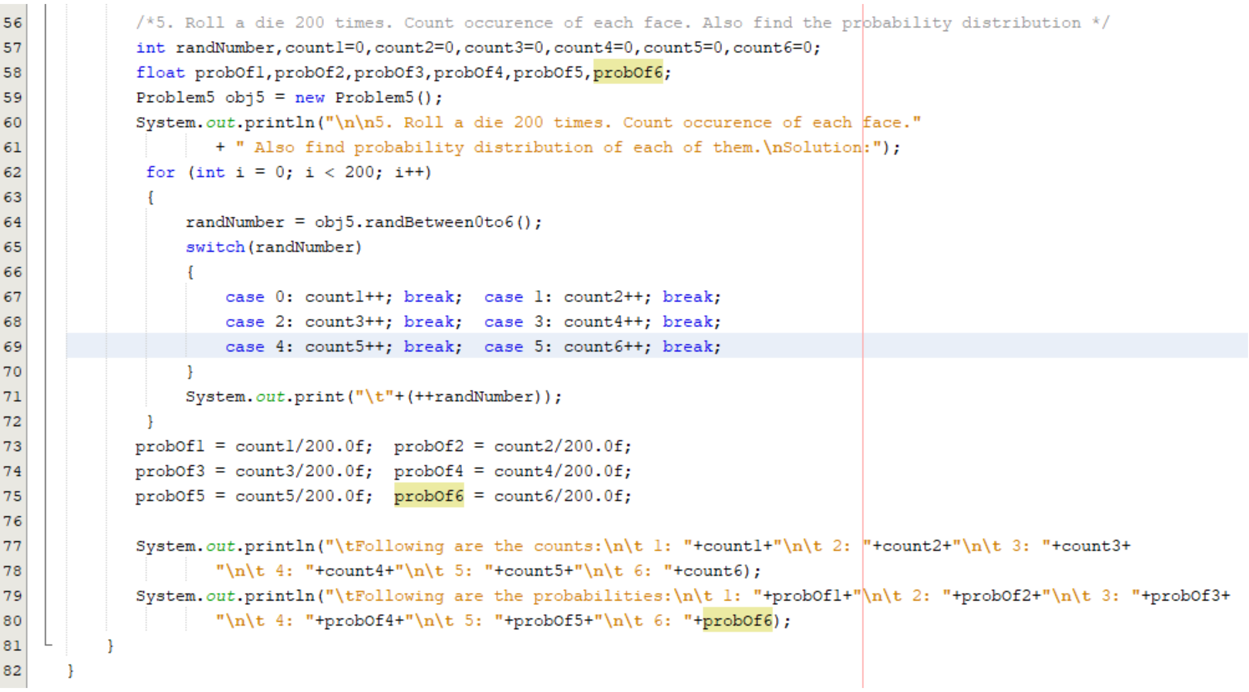
```
package cslab1;
import java.util.*;

public class CSLab1
{
    public static void main(String[] args)
    {
        System.out.println("\t$$ CS Lab 1 $$");

        //1. Generate 10 random numbers
        System.out.println("\n1. Generate 10 random numbers.\nSolution:");
        Problem1 obj1 = new Problem1();      //Object of the problem 1 solution class
        for (int i = 0; i < 10; i++)
            System.out.println("\t"+obj1.randomNumber());

        //2. Generate 10 random numbers between 0 to 1
        System.out.println("\n2. Generate 10 random numbers between 0 to 1\nSolution:");
        Problem2 obj2 = new Problem2();
        for (int i = 0; i < 10; i++)
            System.out.println("\t"+obj2.randomBetween0and1());
```



```
        //3.Generate 10 normally distributed random numbers
        double randNum;
        System.out.println("\n3.Generate 10 normally distributed random numbers\nSolution:");
        Problem3 obj3 = new Problem3();
        for (int i = 0; i < 10; )
        {
            randNum = obj3.normallyDistributedNumber();
            if(randNum<0 || randNum>1)       //Print only if no's are between 0 and 1
                continue;
            System.out.println("\t"+randNum);
            i++;
        }

```



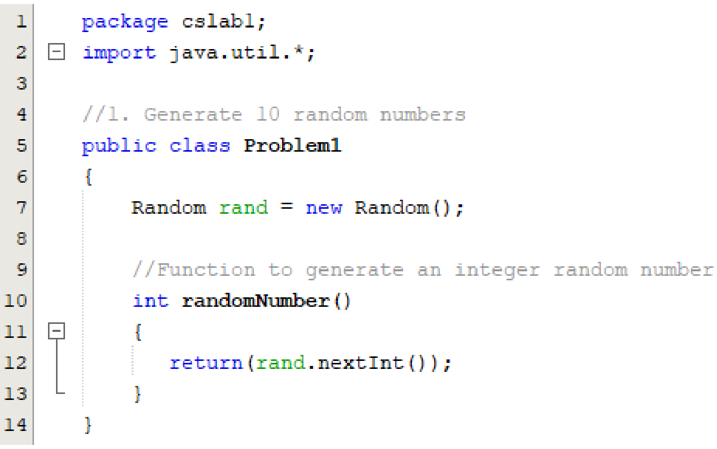
```
        /*4.Flip a coin 50 times and count the number of head and tail.
            Also find probability of distribution of head and tail*/
        int coinToss,headCount=0; float probOfTail,probOfHead; String toss;
        System.out.println("\n4. Flip a coin 50 times and count the number of head and tail.\n" +
            "Also find probability of distribution of head and tail.\nSolution:");
        Problem4 obj4 = new Problem4();
        for (int i = 0; i < 50; i++)
        {
            coinToss= obj4.randomNumber1or0();
            if(coinToss==1)
            {
                headCount++; toss="Heads";
            }
            else
                toss="Tails";
            System.out.println("\t"+toss);
        }
        probOfHead = headCount/50.0f;
        probOfTail = 1 - probOfHead;
        System.out.print("\tProbabiliy of head = "+probOfHead+"\n\tProbability of Tail = "+probOfTail);

```



```
        /*5. Roll a die 200 times. Count occurence of each face. Also find the probability distribution */
        int randNumber,count1=0,count2=0,count3=0,count4=0,count5=0,count6=0;
        float probOf1,probOf2,probOf3,probOf4,probOf5,probOf6;
        Problem5 obj5 = new Problem5();
        System.out.println("\n\n5. Roll a die 200 times. Count occurence of each face."
                + " Also find probability distribution of each of them.\nSolution:");
         for (int i = 0; i < 200; i++)
         {
            randNumber = obj5.randBetween0to6();
            switch(randNumber)
            {
                case 0: count1++; break;  case 1: count2++; break;
                case 2: count3++; break;  case 3: count4++; break;
                case 4: count5++; break;  case 5: count6++; break;
            }
            System.out.print("\t"+(++randNumber));
         }
        probOf1 = count1/200.0f;  probOf2 = count2/200.0f;
        probOf3 = count3/200.0f;  probOf4 = count4/200.0f;
        probOf5 = count5/200.0f;  probOf6 = count6/200.0f;

        System.out.println("\tFollowing are the counts:\n\t 1: "+count1+"\n\t 2: "+count2+"\n\t 3: "+count3+
                "\n\t 4: "+count4+"\n\t 5: "+count5+"\n\t 6: "+count6);
        System.out.println("\tFollowing are the probabilities:\n\t 1: "+probOf1+"\n\t 2: "+probOf2+"\n\t 3: "+probOf3+
                "\n\t 4: "+probOf4+"\n\t 5: "+probOf5+"\n\t 6: "+probOf6);
    }
}
```

Figure 1 Code containing main( ) function

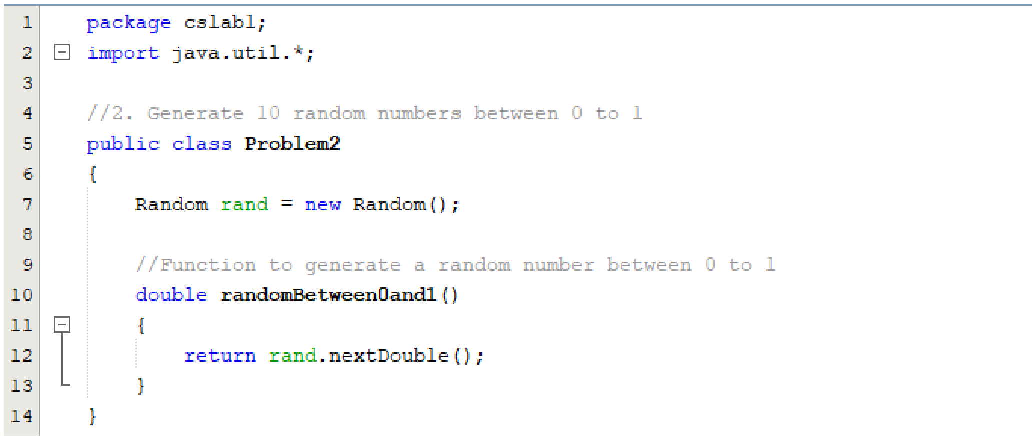
Problem 1.java :



```
package cslab1;
import java.util.*;

//1. Generate 10 random numbers
public class Problem1
{
    Random rand = new Random();

    //Function to generate an integer random number
    int randomNumber()
    {
        return(rand.nextInt());
    }
}
```

Figure 2 Code to solve problem "a"

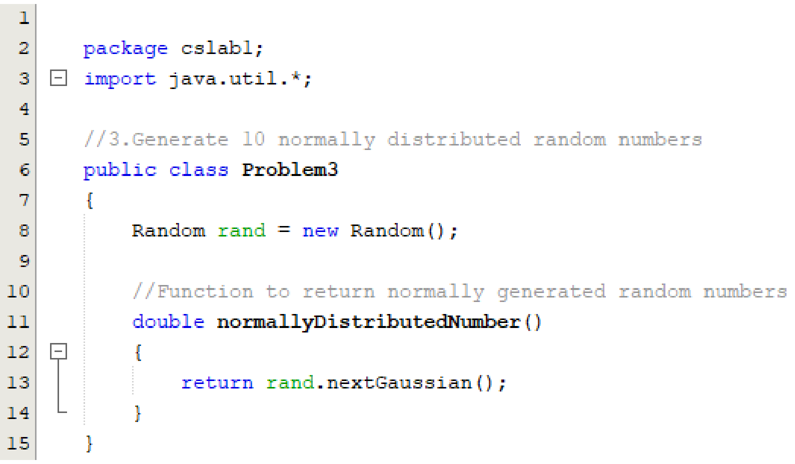
Problem 2.java :



```
package cslab1;
import java.util.*;

//2. Generate 10 random numbers between 0 to 1
public class Problem2
{
    Random rand = new Random();

    //Function to generate a random number between 0 to 1
    double randomBetween0and1()
    {
        return rand.nextDouble();
    }
}
```

Figure 3 Code to solve problem "b"

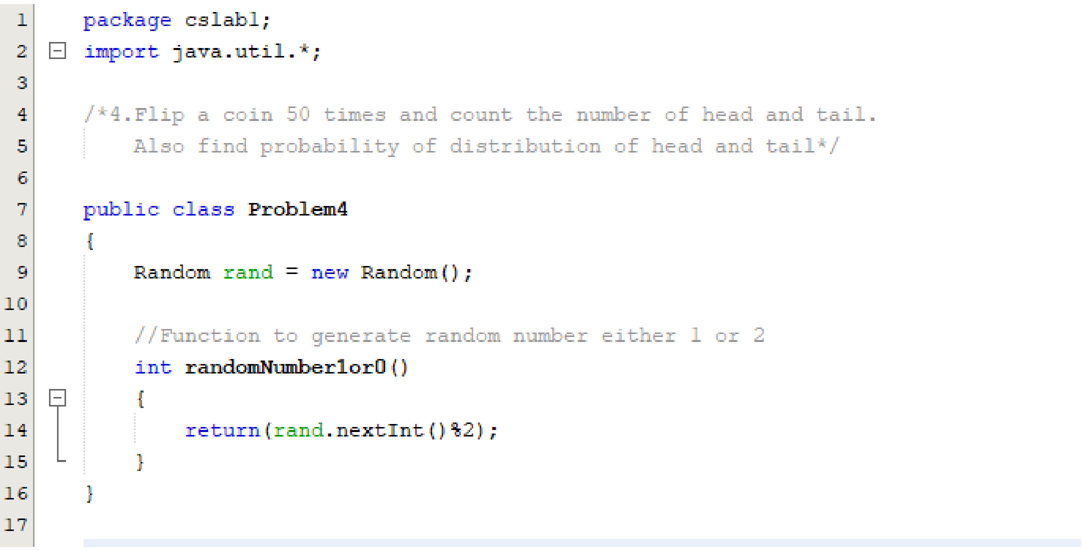
Problem 3.java :



```

package cslab1;
import java.util.*;

//3.Generate 10 normally distributed random numbers
public class Problem3
{
    Random rand = new Random();

    //Function to return normally generated random numbers
    double normallyDistributedNumber()
    {
        return rand.nextGaussian();
    }
}
```

Figure 4 Code to solve problem "c"

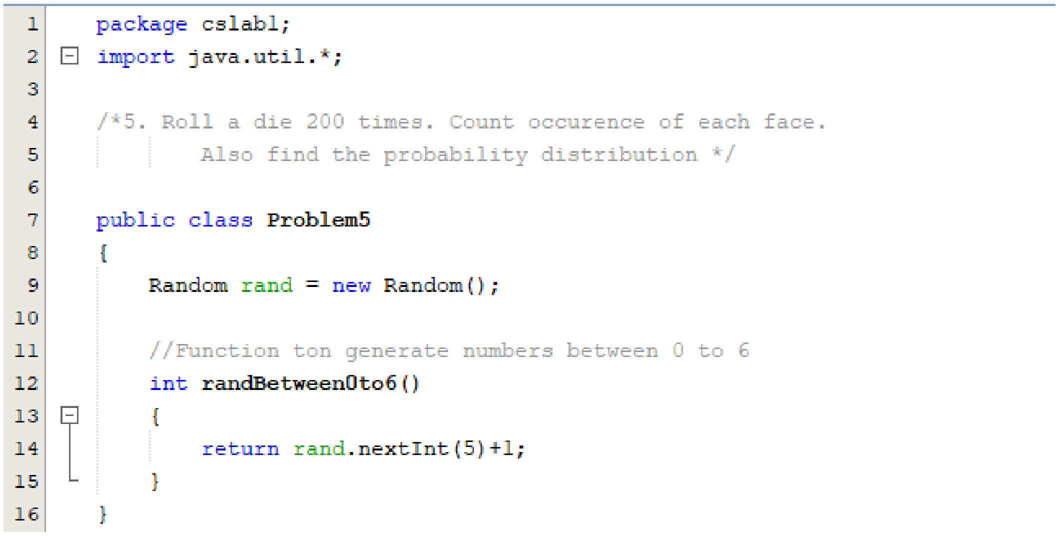
Problem 4.java :



```java
package cslab1;
import java.util.*;

/*4.Flip a coin 50 times and count the number of head and tail.
    Also find probability of distribution of head and tail*/

public class Problem4
{
    Random rand = new Random();

    //Function to generate random number either 1 or 2
    int randomNumber1or0()
    {
        return(rand.nextInt()%2);
    }
}

```

Figure 5 Code to solve problem "d"

Problem 5.java :

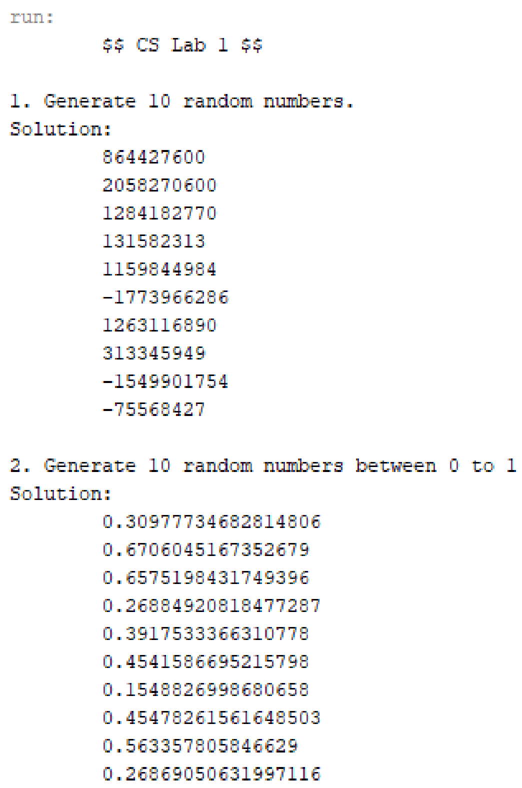


```java
package cslab1;
import java.util.*;

/*5. Roll a die 200 times. Count occurence of each face.
        Also find the probability distribution */

public class Problem5
{
    Random rand = new Random();

    //Function ton generate numbers between 0 to 6
    int randBetween0to6()
    {
        return rand.nextInt(5)+1;
    }
}
```

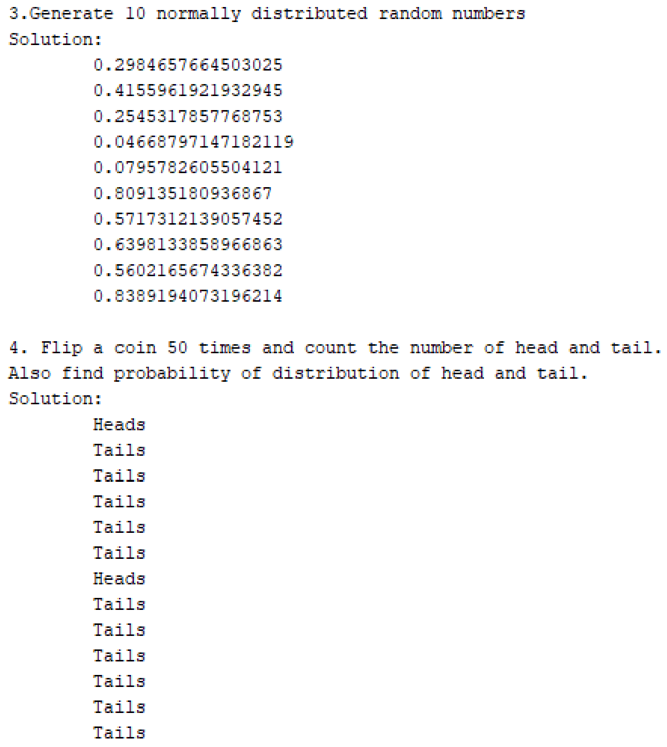
Figure 6 Code to solve problem "e"

Output:

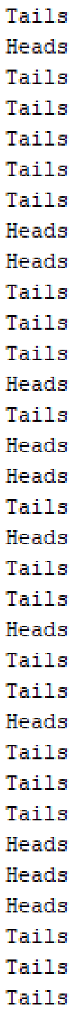
The objects of all the classes are created in **CSLab1.java** file and executed in the main( ) function as seen in the above figures.



```
run:
        $$ CS Lab 1 $$

1. Generate 10 random numbers.
Solution:
        864427600
        2058270600
        1284182770
        131582313
        1159844984
        -1773966286
        1263116890
        313345949
        -1549901754
        -75568427

2. Generate 10 random numbers between 0 to 1
Solution:
        0.30977734682814806
        0.6706045167352679
        0.6575198431749396
        0.26884920818477287
        0.3917533366310778
        0.4541586695215798
        0.1548826998680658
        0.45478261561648503
        0.563357805846629
        0.26869050631997116
```



```
3.Generate 10 normally distributed random numbers
Solution:
        0.2984657664503025
        0.4155961921932945
        0.2545317857768753
        0.04668797147182119
        0.0795782605504121
        0.809135180936867
        0.5717312139057452
        0.6398133858966863
        0.5602165674336382
        0.8389194073196214

4. Flip a coin 50 times and count the number of head and tail.
Also find probability of distribution of head and tail.
Solution:
        Heads
        Tails
        Tails
        Tails
        Tails
        Tails
        Heads
        Tails
        Tails
        Tails
        Tails
        Tails
        Tails
```



```
Tails
Heads
Tails
Tails
Tails
Tails
Tails
Heads
Heads
Tails
Tails
Tails
Heads
Tails
Heads
Heads
Tails
Heads
Tails
Tails
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Heads
Heads
Heads
Tails
Tails
Tails
```
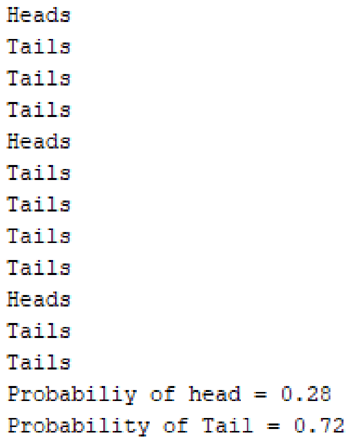
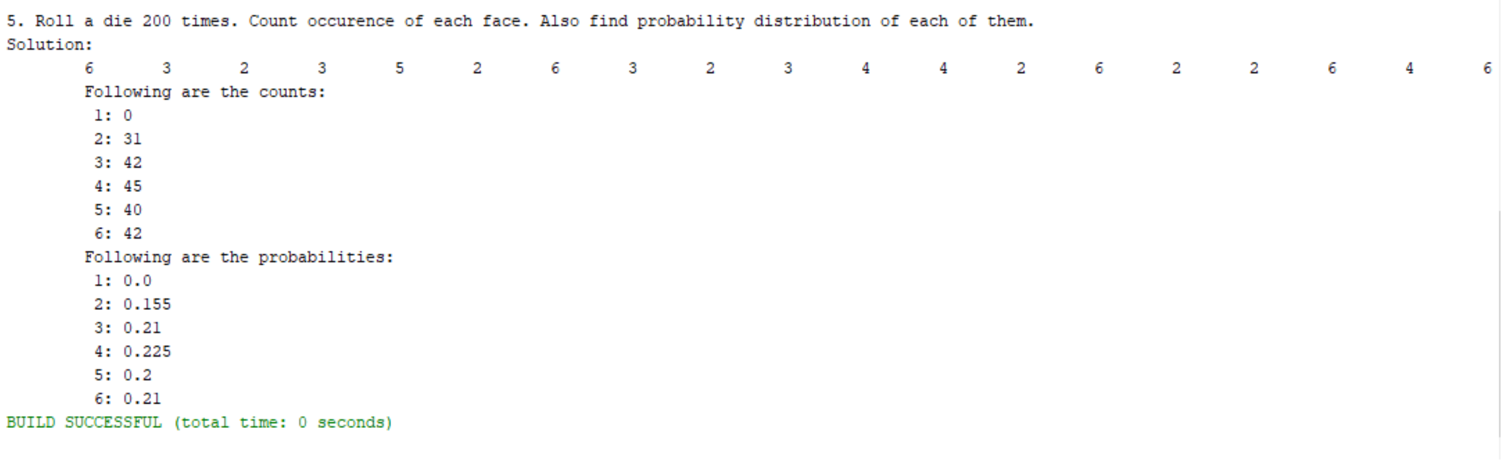



```
Heads
Tails
Tails
Tails
Heads
Tails
Tails
Tails
Tails
Heads
Tails
Tails
Probabiliy of head = 0.28
Probability of Tail = 0.72
```



```
5. Roll a die 200 times. Count occurence of each face. Also find probability distribution of each of them.
Solution:
        6       3       2       3       5       2       6       3       2       3       4       4       2       6       2       2       6       4       6
        Following are the counts:
         1: 0
         2: 31
         3: 42
         4: 45
         5: 40
         6: 42
        Following are the probabilities:
         1: 0.0
         2: 0.155
         3: 0.21
         4: 0.225
         5: 0.2
         6: 0.21
BUILD SUCCESSFUL (total time: 0 seconds)
```

6. Analysis and Discussions

Random number generation is one of the main phenomenon in computer simulation. In real world, there are many ways to generate a random number but when it comes to computer, the system has to use a predefined formula to do so.

Since the computer uses a mathematical formula to generate the random number, it needs a **seed** using which a series of random numbers are generated. If the value of seed is compromised, then the upcoming random numbers can easily be guessed.

In the current program, the java random number generation function **rand( )** from **java.util.Random** is used. In problem “e”, normally distributed random numbers are generated using **nextGaussian( )** function from the **Random** class.

7. Conclusions

Random numbers are very essential in computer simulation as we can generate as many varied numbers to test our mathematical model thus simulating the real world scenario.

8. Comments

1. Limitations of Experiments

The Random interface functions do not give much control as to on what conditions the random numbers have to be generated.

2. Limitations of Results

All the objectives of the current laboratory can be seen in the program developed.

3. Learning happened

After this laboratory, one can learn the importance of random numbers generation in simulating a real world scenario. Also, proficient knowledge can be obtained on choosing only certain set of random numbers based on the condition required by the currently simulating scenario.

4. Recommendations

None.