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ESE346

Project # 1

Brief Description of the Program

I utilized Java to complete this project. The program asks the user for the number of timeslots to be generated, and uses that to generate packets per time slot by using the Bernoulli Process method defined. This method compares the p value to a random value seeded with current time, and if p is less than the generated value, it increments succeed. If succeed is 3 or greater, the value of passed packets is set to 3. Otherwise, they're set to 0,1, or 2 based on the increments of succeed variable. The method then returns the passed packets, which are then summed and divided by the number of timeslots in order to get the average number of busy and dropped packets.

Then the user is prompted to save the data. I used the BufferedWriter class to write to a file which the user can define by simply entering the file name followed by the extension of the file(such as .csv, .xlsx, etc). This makes it easy to use Microsoft Excel for data manipulation, such as graphing to see the graph distribution of the data.

Source Code

```
/**
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 * ESE 346 Project 1
 * Switching Element simulator
 */
import java.io.BufferedWriter;
import java.io.FileWriter;
import java.io.IOException;

import java.util.Random;
import java.util.Scanner;

public class SwitchingElement {
     public static void main(String[] args) throws IOException {

           Random r = new Random(System.currentTimeMillis());
           Scanner s = new Scanner(System.in);

           System.out.print("Enter the number of time slots: ");
           int timeSlots = Integer.parseInt(s.nextLine());
           System.out.print("Enter file save name: ");
           String fileName = s.nextLine();
           BufferedWriter bw = new BufferedWriter(new
FileWriter(fileName));
           //adding the header
           bw.append("p");
           bw.append(",");
           bw.append("Avg Outputs");
           bw.append(",");
           bw.append("Avg Dropped");

           int[] outputs = new int[timeSlots]; //an array to store
outputs
           double sumPass = 0, sumDrop = 0;
           double avgOutputs[] = new double[timeSlots]; //an array to
store the average number of outputs;
           double avgDropped[] = new double[timeSlots]; //an array to
store the avg dropped packets

           for (double p = 0.05; p < 1.0; p += 0.05) { //for each
probability p
                int j = 0;
                for (int i = 0; i < timeSlots; i++) {  //for each
timeSlot at a given probability
```
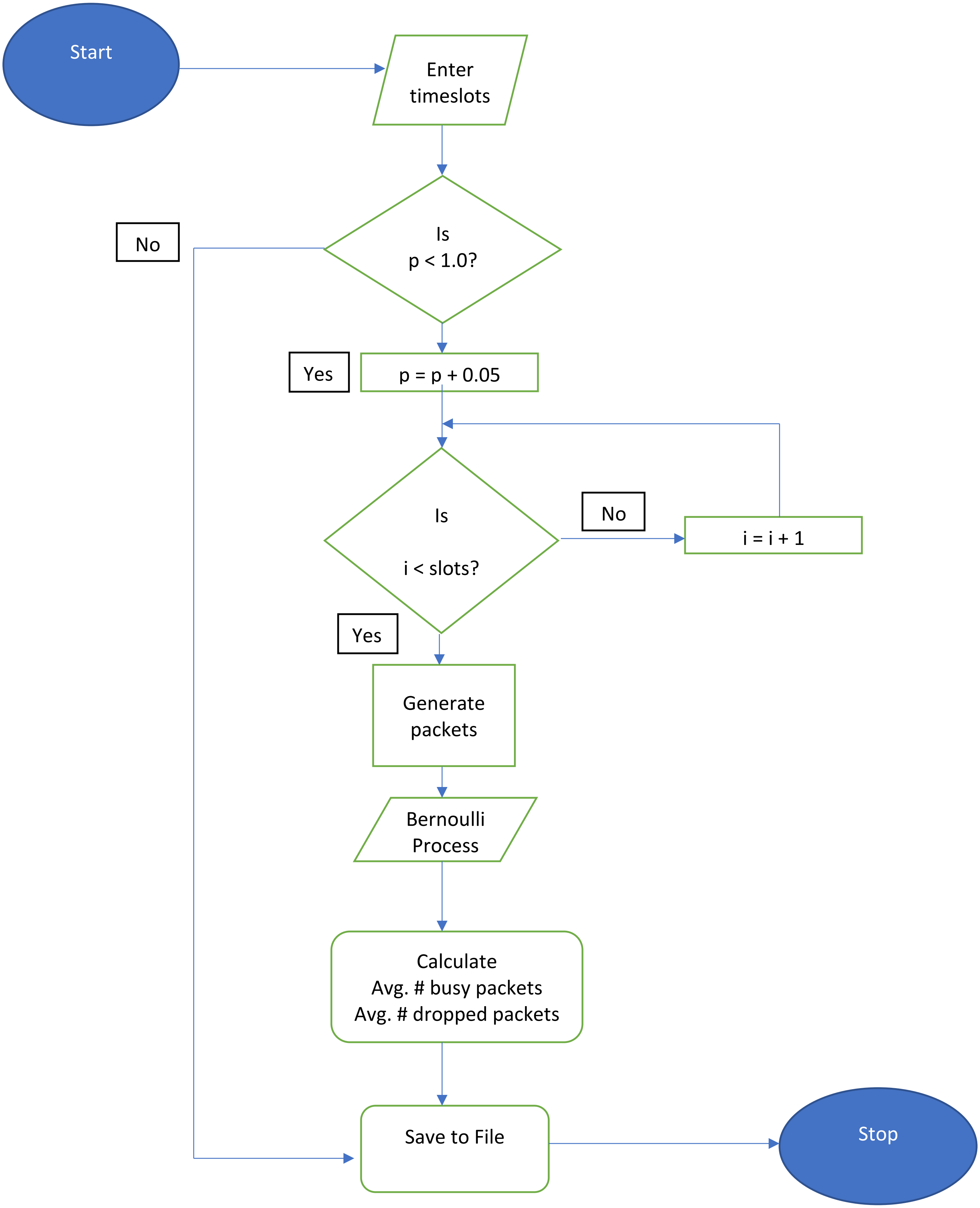
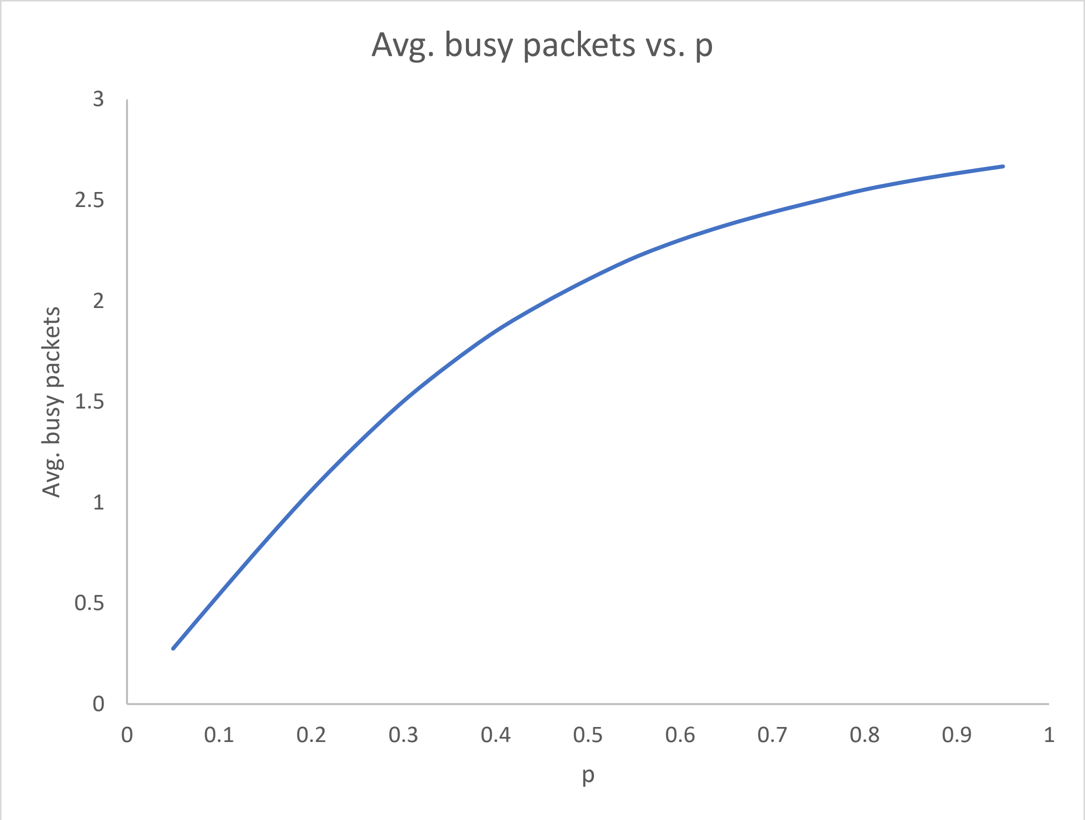
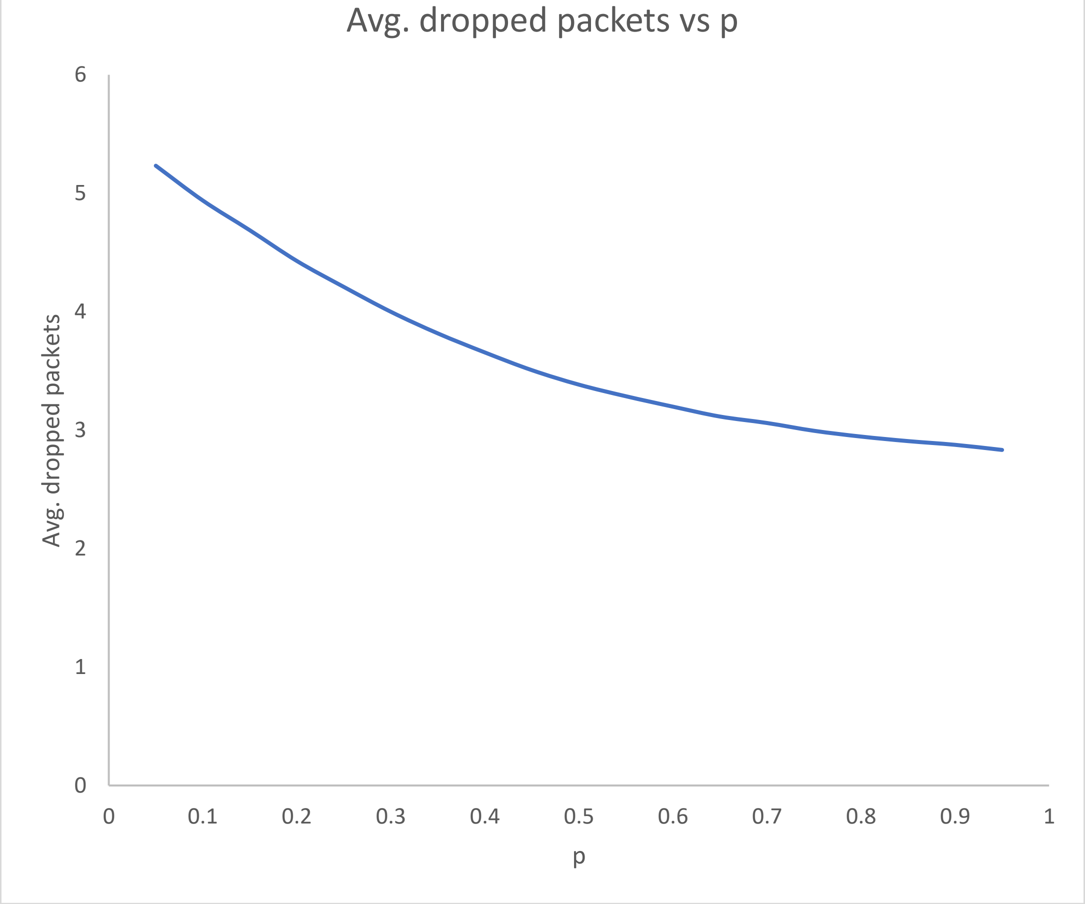

```
                int genPacket = r.nextInt(10) + 1; //generate a
random packet [1-10] inputs
                outputs[i] = BernoulliProcess(p, genPacket);
//Run the bernoulli process for that p value
                sumPass += outputs[i];                //calculate
the total passes
                sumDrop += (genPacket - outputs[i]);  //calculate
the total drops

            }
            //Calculate the average dropped / passed packets
            avgOutputs[j] = sumPass / timeSlots;
            avgDropped[j] = sumDrop / timeSlots;
            System.out.println("Avg Output: " + avgOutputs[j]);
            System.out.println("Avg Dropped: " + avgDropped[j]);
            saveToFile(bw, avgOutputs, avgDropped, p, j,
fileName);
            j++;
            sumPass = 0;
            sumDrop = 0;
        }
        bw.close();
        s.close();
    }

    public static int BernoulliProcess(double p, int genPacket) {
        int succeed = 0, passed = 0, dropped = 0;

        for (int i = 0; i < genPacket; i++) { //for each generated
packet at a given timeslot
            if (uniform() < p) //randomly generates a probability,
compares to p, and passes the packet if true
                succeed++;
        }

        if (succeed > 3)  //if the number of packets succeeded is 3
or greater
            passed = 3;    //output gets 3 (max # of outputs)
        else               //otherwise
            passed = succeed;   //outputs gets 0, 1, 2

        dropped = genPacket - passed;

        System.out.format("\nProbability: %.2f \n", p);
        System.out.println("Generated Packets: " + genPacket);
        System.out.println("Passed: " + passed);
        System.out.println("Dropped: " + dropped + "\n");

        return passed;
    }

    //save to a specifed file based on extension (e.g. .csv , .xls,
etc)
    public static void saveToFile(BufferedWriter bw, double
avgOutputs[], double avgDropped[], double p, int j,
            String fileName) throws IOException {

        try {

            for (int i = 0; i <= j; i++) {
                bw.append("\n");
                bw.append(String.valueOf(p));
                bw.append(",");
                bw.append(String.valueOf(avgOutputs[i]));
                bw.append(",");
                bw.append(String.valueOf(avgDropped[i]));

            }
            bw.flush();
            //System.out.println("Save successful!\n");
        } catch (Exception e) {
            System.out.println(e.getMessage());
        }

    }

    /**
     *Generates a random real number uniformly in [0, 1).
     */
    public static double uniform() {
        Random r = new Random();
        return r.nextDouble();
```

Flow Chart


Start
Enter timeslots
Is p < 1.0?
No
Yes
p = p + 0.05
Is i < slots?
No
i = i + 1
Yes
Generate packets
Bernoulli Process
Calculate Avg. # busy packets Avg. # dropped packets
Save to File
Stop


Avg. busy packets vs. p
Avg. busy packets
3
2.5
2
1.5
1
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
p


Avg. dropped packets vs p
Avg. dropped packets
6
5
4
3
2
1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
p

Conclusion

This project made me really think about how a switching element functions as a whole. The probability of a packet arrival at a given input modeled through a Bernoulli distribution, in combination with the redirection to output, conditions for output and discrete time simulation were the key concepts in this project.

The graphs for *average number of busy slots vs p* as well as *average number of dropped packets vs p* are shown. The former has an increasing curve which later stabilizes to almost flat, while the latter has an upward curve like an exponential function. This makes since the higher the probability of success, the more likely to get an average number 3 packets, whereas the lower the probability of success, the more likely to have dropped packets. I did a super test for a case of 100,000 timeslots and the results were as expected. The number of average busy packets increased as the probability *p* increased, and the number of average dropped packets decreased.