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Class - CSCI 270 MO1
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COMPUTER PROJECT

For Part A, we have to first find the **Size of a Monte Carlo Study.** For this we use the equation given on Page 118 of the textbook.

Size of a Monte Carlo study

In order to guarantee that $\boldsymbol{P}\{|\widehat{p} - p| > \varepsilon\} \leq \alpha$, one needs to simulate

$$N \geq p^*(1 - p^*)\left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2$$

random variables, where p^* is a preliminary estimator of p, or

$$N \geq 0.25\left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2$$

random variables, if no such estimator is available.

From the question given to us we know the values of:
$\alpha = 1 - 0.95 = 0.05$
$\varepsilon = 0.005$

So, the size of a monte carlo study is:

$$N \geq 0.25\left(\frac{Z_{\alpha/2}}{\varepsilon}\right)^2 = 0.25\left(\frac{Z_{0.05/2}}{0.005}\right)^2$$

$$= 0.25\left(\frac{1.96}{0.005}\right)^2$$ [Values are taken from table A4 as stated in the book]

$$= 38416$$

So now we know that the size of our monte carlo study has to be 38414.

Source Code For Part A, Part B, & Part C: [Also attached the MonteCarloStudy.java file]

```
/*
 * Name - Avivartta Krishna
 * ID - 126351
 * This is Part A, Part B and Part C of the Computer Project
 */

public class MonteCarloStudy
{
    public static void main(String[] arguments)
    {
        /*
         * Monte Carlo requires many trials
         * I will conduct the simulation 38416 times
         * As we find from the equation given in the book at page 118 of the
book, that the size of This MonteCarlo Study Should Be 38146
         * The Trees_Burned will keep track of trials where more than 40% of
trees are on fire
         */

        int Number = 38417; // One More Than Needed, To Complete The Loop
        int Trees_Burned = 0;

        //This array will store amount of trees on fire per trial

        int[] onFire = new int[Number];

        for (int x = 0; x < Number; x++)
        {
            /*
             * Each Trial Will Give Us A Result
             * Result We Want: Probability That More Than 40% Of Forest Burned
Down
             * We Will Store The Outcome Of Each Simulation And Then Determine
The Probability (OverAll MatchCase)
             * From The QUestion It Is Given That There Are 1200 Trees In The
Forest [40*30 Grid]
             * Each Tree Being On fire Or Not On Fire Can Be Considered A
Binomial
             * Store A 1 For Fire And 0 For No Fire In The Array
             */

            int[][] trees = new int[40][30]; /* Grid of 1200 trees */
```

```
            for (int y = 0; y < 40; y++)
            {
                for (int z = 0; z < 30; z++)
                {
                    //Given In The Question - Tree On Top Left Of Forest Is On
Fire
                    trees[0][0] = 1;

                    //From The Question We Also Know That There Are Four Ways
In Which A Tree Can Catch On Fire
                    double left = Math.random();
                    double right = Math.random();
                    double top = Math.random();
                    double below = Math.random();

                    if ((left < .85 && y != 0 && trees[y - 1][z] == 1)
                    || (right < .35 && y != 39 && trees[y + 1][z] == 1)
                    || (top < .35 && z != 29 && trees[y][z + 1] == 1)
                    || (below < .35 && z != 0 && trees[y][z - 1] == 1))
                    {
                        trees[y][z] = 1;
                    }
                    else
                        trees[y][z] = 0;
                }
            }

            int count = 0;

            //These Two For Loops Calculate How Many Trees Burn During The
Whole Process
            for (int y = 0; y < trees.length; y++)
            {
                for (int z = 0; z < trees[y].length; z++)
                {
                    if (trees[y][z] == 1)
                    {
                        count++;
                    }
                }
            }

            onFire[x] = count;
            System.out.println("Trees On Fire In Trial " + x + " = " +
onFire[x]);

            double D = new Double(count);
            double percentage = (D / 1200.0) * 100;
```

```
            System.out.println("Percentage Of Trees On Fire In Trial " + x + "
= " + percentage);
            System.out.println("");

            if (percentage > 0.4)
            {
                Trees_Burned++;
            }
        }


System.out.println("----------------------------------------------------------
---------------------------------------");
        System.out.println("");
        System.out.println("Trials Where More Than 40% Of Trees Are Burned = "
+ Trees_Burned);
        double T1 = new Double(Trees_Burned);
        double N = new Double(Number);
        double probability = (T1 / N);
        System.out.println("Probability Of More Than 40% Forest Is Burned = " +
Probability);

        int Total = 0;
        for (int z = 0; z < onFire.length; z++)
        {
            Total = Total + onFire[z];
        }
        int average = Total/Number;
        System.out.println("Average Number Of Trees On Fire From Total Trials =
" + average);

        /* To Calculate Standard Deviation, We Follow The Following Steps:
         * Step 1: Find the mean.
         * Step 2: For each data point, find the square of its distance to the
mean.
         * Step 3: Sum the values from Step 2.
         * Step 4: Divide by the number of data points.
         * Step 5: Take the square root.
         */
        double S_D1 = ((average) * (average));
        double S_D2 = (S_D1 / Number);
        double SD = Math.sqrt(S_D2);
        System.out.println("Standard Deviation Of X = " + SD);
        System.out.println("");

System.out.println("----------------------------------------------------------
---------------------------------------");
    }
}
```

OUTPUT FROM ABOVE CODE:

Trials Where More Than 40% Of Trees Are Burned = 29866
Probability Of More Than 40% Forest Is Burned = 0.7774162480152016
Average Number Of Trees On Fire From Total Trials = 492
Standard Deviation Of X = 0.6275428527336406

Part A.
Probability Of More Than 40% Forest Is Burned = 0.7774162480152016
Probability ~ 0.77742

Part B.
Average Number Of Trees On Fire From Total Trials = 492
Total Number Of Affected Trees ~ 492

Part C.
Standard Deviation Of X = 0.6275428527336406

I Calculated Standard Deviation Using The Formula:

$$\sigma = \sqrt{\frac{\Sigma(x_i - \mu)^2}{N}}$$

Where $\sigma = dataset\ standard\ deviation$
$N = the\ size\ of\ the\ dataset$
$x_i = each\ value\ from\ the\ dataset$
$\mu = the\ average$

Part D.
Taking the mean and given in the question is 40%, we can assume probability that the actual number of affected trees is equal to = (1200/100)*40 = 480.
My estimated value is 492.