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MTH 3312

Due: 12/9/2024

All code documented in the python files as well.

Q1)

Below is my output for my code for question one.

```
0 trials completed
1000 trials completed
2000 trials completed
3000 trials completed
4000 trials completed
5000 trials completed
6000 trials completed
7000 trials completed
8000 trials completed
9000 trials completed
The exact probability of leaving with $150 is 0.1332
I won 1306 times out of 10000, which is 13.06%
Using, the exact formula it should take 4001.3584 minutes
On average it took me 4048.13 minutes to leave the table
[Finished in 37.6s]
```

Using the formula given in the assignment, I got the exact probability of 0.1332. When doing 10,000 simulations of the given problem, I achieved $150 13.06% of the time, which is extremely close to the given probability. For the average time it would take, I got about 4001 minutes on average until leaving the table with $150 or with no money. When keeping track of the iterations it took and taking the average, it took me 4048 minutes (1 minute per iteration) to leave the table, which is also very showing of how close to the exact formula these simulations are.

```
0 trials completed
1000 trials completed
2000 trials completed
3000 trials completed
4000 trials completed
5000 trials completed
6000 trials completed
7000 trials completed
8000 trials completed
9000 trials completed
The exact probability of leaving with $150 is 0.1332
I won 1376 times out of 10000, which is 13.76%
Using, the exact formula it should take 4001.3584 minutes
On average it took me 4053.66 minutes to leave the table
[Finished in 38.1s]
```

Above is my program running a second time to show how the simulations I am running are truly (pseudo) random. It took just 5 minutes/iterations longer on average for this run, but when looking at the run time for the program, it took half a second longer to run, which is an interesting effect I noticed.

Q2)

```
Euler-Maruyama's Method:
The mean for timestep 0.1 at y(1) is 0.9998 and the standard deviation is 0.1274
The mean for timestep 0.01 at y(1) is 1.0003 and the standard deviation is 0.0381
The mean for timestep 0.001 at y(1) is 0.9998 and the standard deviation is 0.0124
Milstein's Method:
The mean for timestep 0.1 at y(1) is 0.5479 and the standard deviation is 0.1003
The mean for timestep 0.01 at y(1) is 0.5654 and the standard deviation is 0.0293
The mean for timestep 0.001 at y(1) is 0.5676 and the standard deviation is 0.0091
```

Above is the output for the functions of Euler-Maruyama and Milstein methods. The logic behind the code of Euler-Maruyama's is from the Stochastic slides and the logic behind the code for Milstein's is from the Wikipedia page on Milstein's method.