CS7646 Project 1: Martingale

Yuxi Chen

ychen3281@gatech.edu

1 Questions Section

1.1 Question 1

In Experiment 1, based on the experiment results calculate and provide the estimated probability of winning $80 within 1000 sequential bets. Thoroughly explain your reasoning for the answer using the experiment output. Your explanation should NOT be based on estimates from visually inspecting your plots, but from analyzing any output from your simulation.

1.2 Question 2

In Experiment 1, what is the estimated expected value of winnings after 1000 sequential bets? Thoroughly explain your reasoning for the answer.

1.3 Question 3

In Experiment 1, do the upper standard deviation line (mean + stdev) and lower standard deviation line (mean – stdev) reach a maximum (or minimum) value and then stabilize? Do the standard deviation lines converge as the number of sequential bets increases? Thoroughly explain why it does or does not.

1.4 Question 4

In Experiment 2, based on the experiment results calculate and provide the estimated probability of winning $80 within 1000 sequential bets. Thoroughly explain your reasoning for the answer using the experiment output. Your explanation should NOT be based on estimates from visually inspecting your plots, but from analyzing any output from your simulation.

1.5 Question 5

In Experiment 2, what is the estimated expected value of winnings after 1000 sequential bets? Thoroughly explain your reasoning for the answer.

1.6 Question 6

In Experiment 2, do the upper standard deviation line (mean + stdev) and lower standard deviation line (mean – stdev) reach a maximum (or minimum) value and then stabilize? Do the standard deviation lines converge as the number of sequential bets increases? Thoroughly explain why it does or does not.

1.7 Question 7

What are some of the benefits of using expected values when conducting experiments instead of simply using the result of one specific random episode?

2 Answers Section

2.1 Answer 1

Based on the experimental results from the simulation. Each episode ultimately resulted in $80 in winnings as the number of spins progressed. The probability of winning $80 within 1000 sequential bets is 100%. Since there is no limit on how much we can bet into negatives we will incrementally increase our winnings and between 150-200 spins we will reach our target goal of $80.

2.2 Answer 2

American roulette was found to differ in the probability of winning due to the additional double zero slot as well as differing sets of rules [1]. These changes give the house a 2.6% edge, if the player were to play by selecting only black. This gives the player the probability of 47.40% of winning and at 1000 bets at $1 per bet with a return of 0.474 per bet, that calculates out to $474. Or a loss of $526.

2.3 Answer 3

In Figure 2, we can see that the lines for standard deviation do not converge until the winnings plateau at $80. Since we are not given a limit of betting amounts there is a probability of continually losing and with each loss the bet amount doubles. It is not only until the player reaches a win does the bet amount reset, however, this creates a sharp change resulting in different standard deviations.

2.4 Answer 4

Based on experimental results from the simulation. The output is more closely in line with the probability of winning at 47.4%. With these odds, we see a gradual loss of winnings over the course of 1000 sequential bets. With these results, the probability of winning $80 within 1000 sequential bets is 0%.

2.5 Answer 5

The expected value of winnings after 1000 sequential bets with a limited bank roll results in a negative expected value of approximately -$150 meaning that it will be unprofitable to continue to make bets.

2.6 Answer 6

Based on Figure 4, we can see that the upper and lower standard deviation lines are slowly converging on episode winnings of -$256 as the simulation shows the player slowly losing money with each bet. However, before convergence and the maximum is reached the player double each bet creates a large gap in the standard deviation.

2.6 Answer 7

There are a multitude of benefits to using expected values. Some of these benefits include using a single value to provide an estimate, quick to calculate it involves

calculating the mean value. Expected value reduces error through a larger and multiple set of data versus a single random episode.

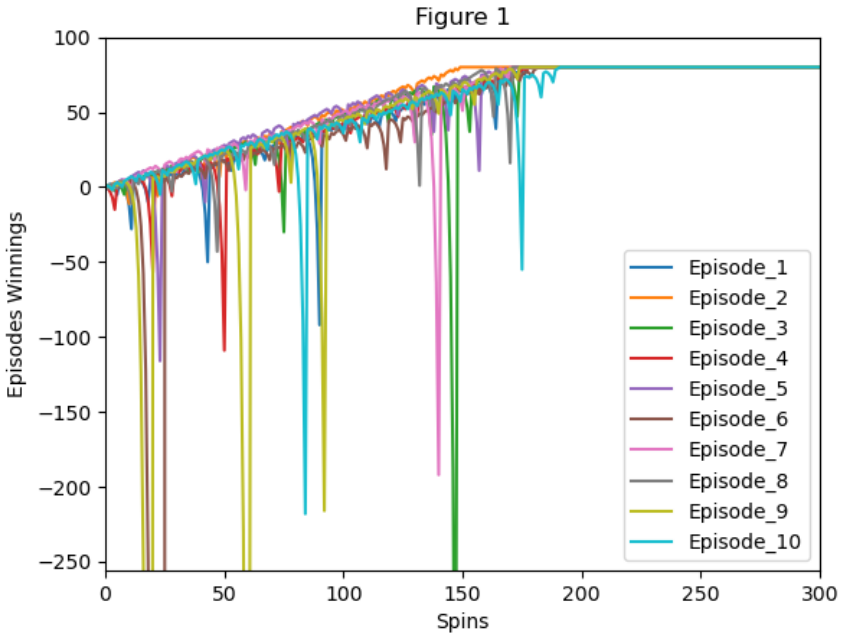

Figure 1— Ten episodes simulation of American Roulette using Experiment 1 strategy

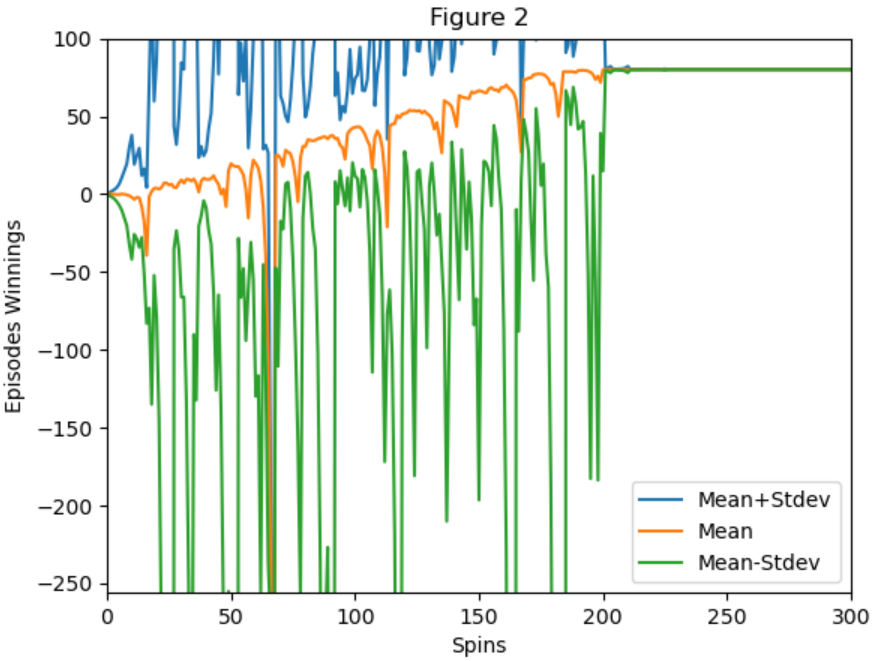

Figure 2— Mean of 1000 episodes of American Roulette using Experiment 1 strategy

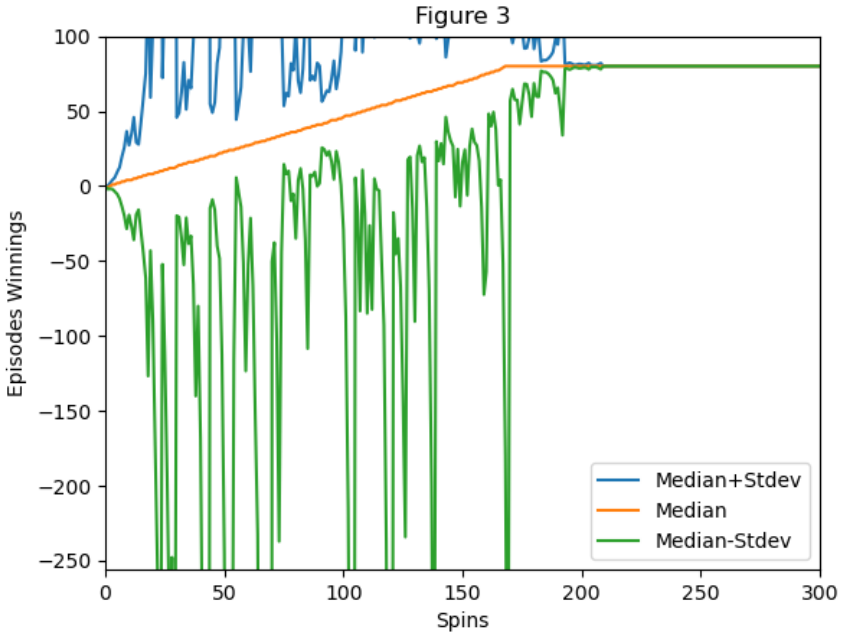

Figure 3— Median of 1000 episodes of American Roulette using Experiment 1 strategy

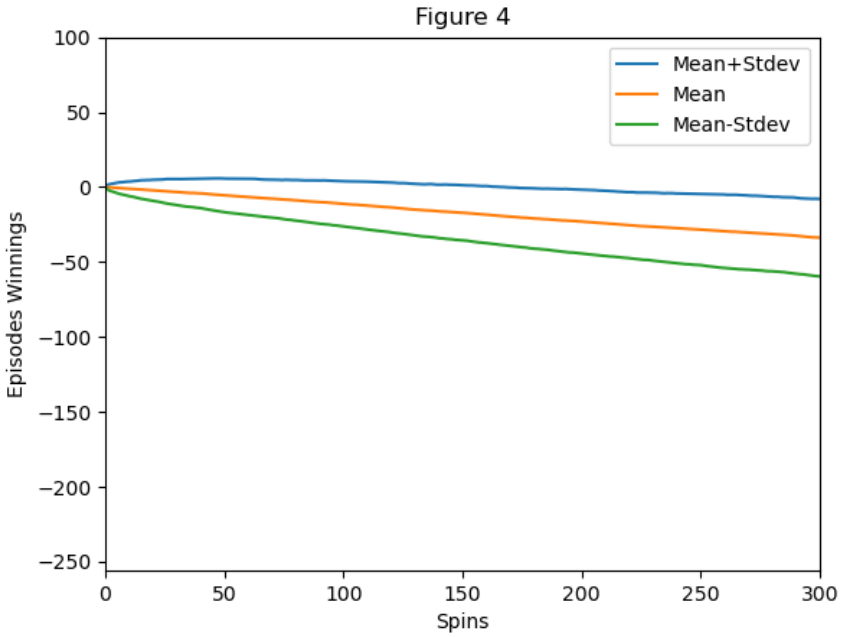

Figure 4— Mean of 1000 episodes of American Roulette using Experiment 2 strategy

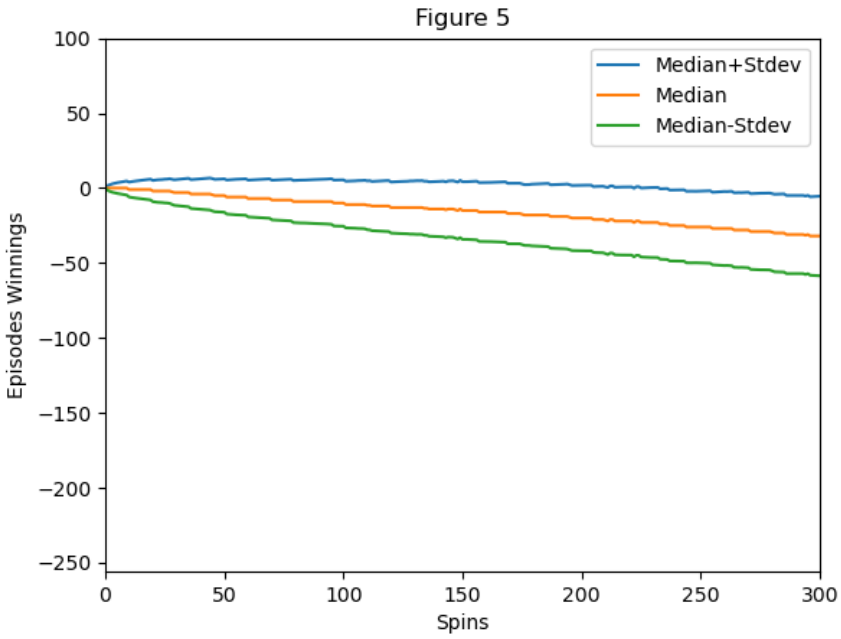

Figure 5— Median of 1000 episodes of American Roulette using Experiment 2 strategy

3 References

1. Lott, S. (2005). Building Skills in Object-Oriented Design.
2. Chen, Y. (2023). CS7646 Project 1: Martingale

4 Notes

I am submitting a similar code and report from when I previously took ML4T in the Summer term of 2023.