Project 1

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Abstract—In this report, I will answer the seven questions for Project 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.

In Experiment 1, I tried running a function that would only simulate 1000 sequential bets without outputting any graphs or other output except for cases when the episode winnings was not equal to $80. No output was printed.

I also tried running 1 million sequential bets, with the same output paradigm. Again, no output was printed indicating that a single one of the simulations resulted in anything other than episode winnings equal to $80. Therefore, it seems that the probability of winning $80 within a reasonably large number of sequential bets is close to 100%. In fact, it seems most likely that the probability is equal to exactly 100%, because there is no limit of bankroll in this experiment.

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.

In my function simulating an episode, I added a variable called `episode_losings`, which would be incremented every time a bet wasn't won (regardless of whether the bankroll was limited or not). If this question wants to take those values into consideration when calculating the estimated winnings after 1000 sequential bets, then the answer would be $0, because in every simulated run, the episode winnings was equal to the episode losings.

However, if the episode losings is not supposed to be taken into account, and the expected value of winnings is meant to be cumulative over all sequential bets, then the estimated expected value of winnings after 1000 sequential bets would be $80,000 ($80 x 1000). If, on the other hand, it is not meant to be cumulative over all sequential bets, then the estimated expected value of winnings after 1000 sequential bets would be $80.

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.

Judging by Figure 2 ("Mean of winnings with unlimited bankroll over 1000 episodes"), the "mean + standard deviation" and "mean - standard deviation" vary wildly (along with the mean of winnings) since the probability of winning is random until the total episode winnings reaches $80. At that time, the standard deviation lines converge This may be related to the fact that (as mentioned in Question 1 above) there seems to be a 100% chance that the simulated gambler in Experiment 1 will always win, because there is no limit of bankroll in this experiment.

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.

To assist with analyzing the output from my simulation, I added a print statement to output the mean at the end of the 1000 sequential bets. This output indicated that the estimated probability of winning $80 within 1000 sequential bets was approximately the sum of 1 and the additive inverse of 35.92%, or 64.08%.

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.

The estimated expected value of winnings after 1000 sequential bets in Experiment 2 can be found by multiplying the probability of winning the bets (64.08%) by the expected value of winning ($80), and subtracting the product of the probability of losing (35.02%) by the value of the given bankroll ($256). Putting it all together: (0.6408 * 80) - (0.3502 * 256) = about -$38.39.

Interestingly, even though the probability of winning is greater than 50%, the combination of the value and the probability of losses makes this bet an unwise proposition.

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.

Whereas the mean + stdev and mean - stdev in Experiment 1 did converge (as shown in Figure 2), they do not in Experiment 2. However, they do seem to reach a maximum (in the case of mean + stdev) and a minimum (in the case of mean - stdev) and then stabilize once the mean reaches its stable values in Experiment 2. This is because in Experiment 2 the limited bankroll of $256, making the standard deviation negligible in the beginning and then stabilizing once the mean reaches its stable values.

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?

One benefit of using expected values when conducting experiments instead of simply using the result of one specific random episode is that you can estimate the magnitude of the results, which can come in handy with deciding where to place the bounds of a graph to display the results. Another benefit is that using expected values instead of the result of one specific random episode means that you may have a better chance of guessing or predicting the results of experiments. Another benefit is that, with using expected values when conducting experiments, it makes it easier to determine which experiments were a success and which ones failed when you determine where the lines are..

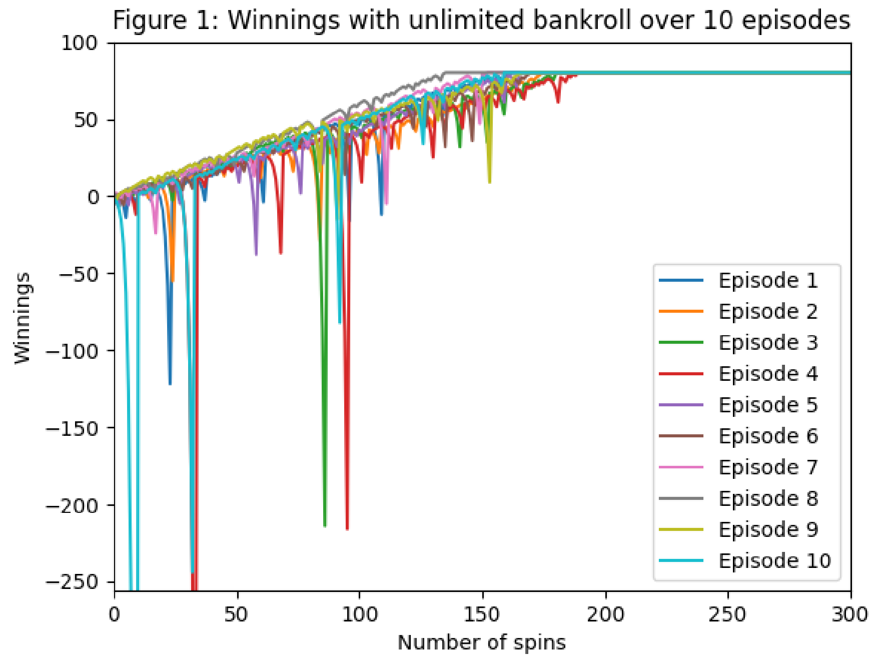

Figure 1—Winnings with unlimited bankroll over 10 episodes

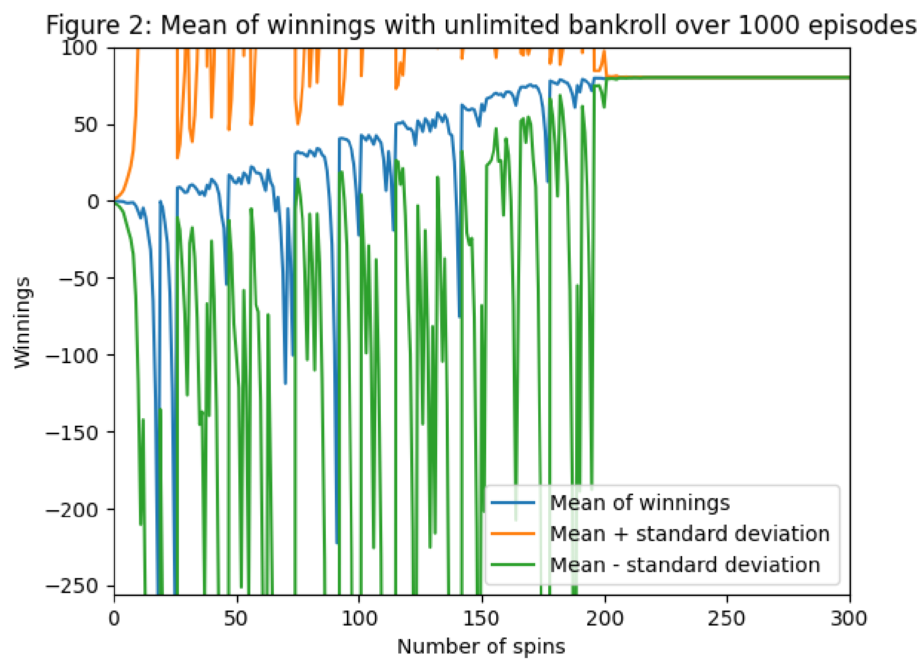

Figure 2—Mean winnings w/ unlimited bankroll over 1k episodes

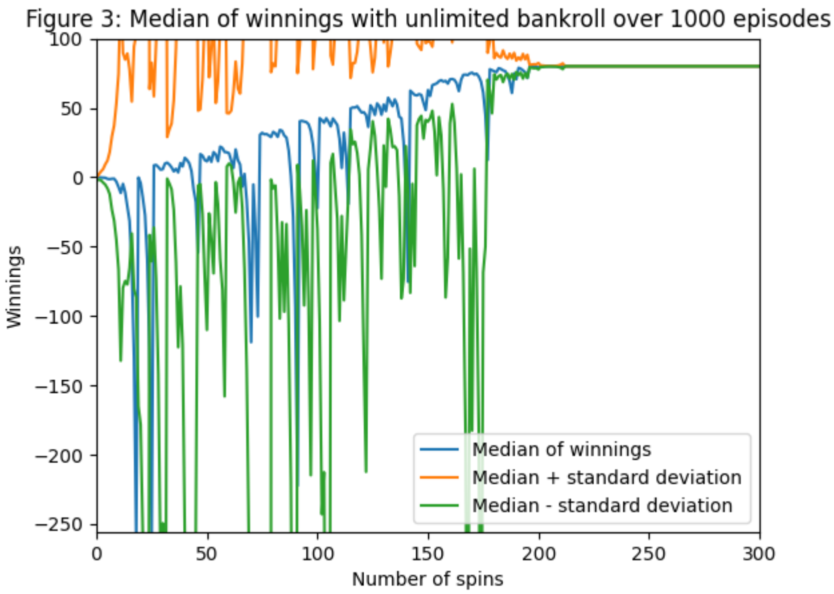

Figure 3—Median of winnings with unlimited bankroll over 1000 episodes

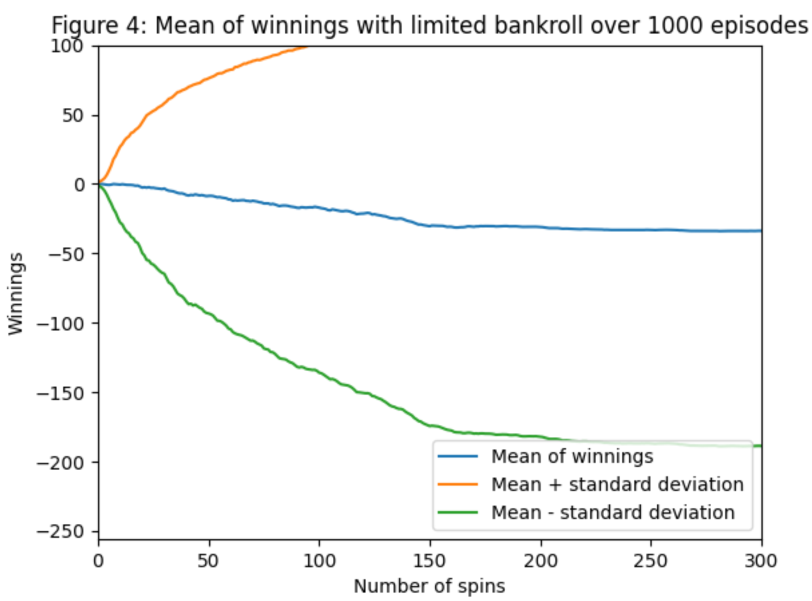

Figure 4—Mean of winnings with limited bankroll over 1000 episodes

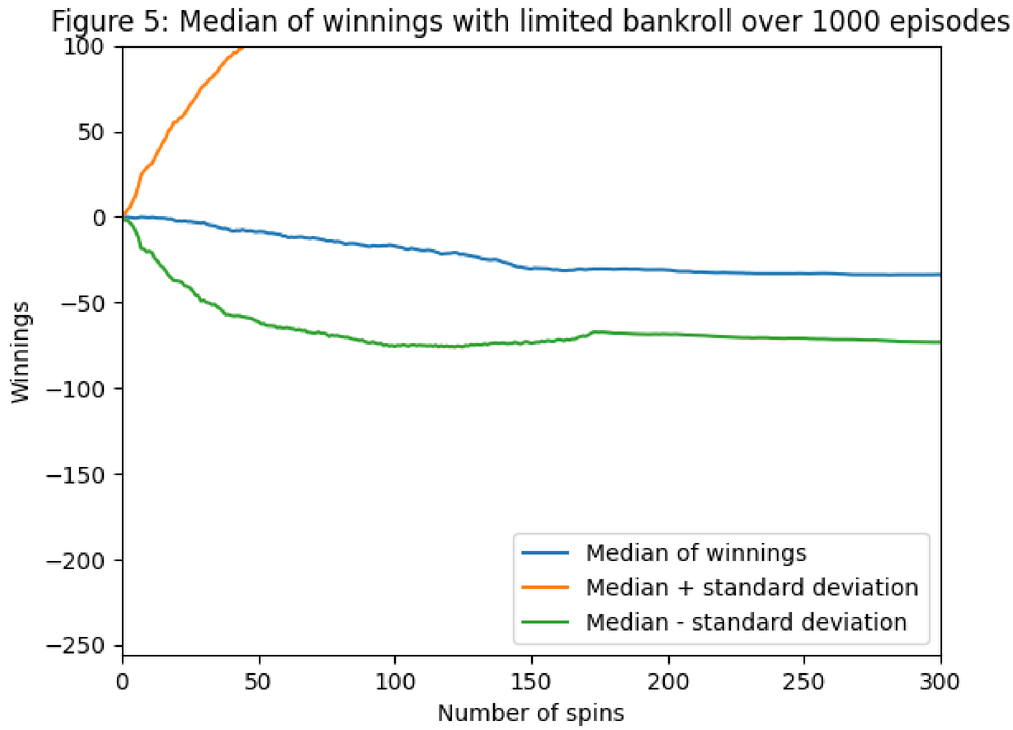

Figure 5—Median of winnings with limited bankroll over 1000 episodes