CS 7646 Project 1 -Martingale

Guangqing Tai
gtai3@gatech.edu

Abstract— The goal of this report is to using python code to build a Simple Gambling Simulator and test with different scenarios. Numpy and Matplotlib libraries have been used to build and visualize the process.

Note: This work is a resubmission of CS 7646 Summer 2024 for Fall 2024 term, which may contain partial of previous reports

1 INTRODUCTION

1.1 Martingale Betting

The Martingale betting strategy, implemented in Python programming, will demonstrate a short-term success in accumulating winnings. However, over an extended period, the strategy will fail to consistently generate profits due to the exponential increase in bet amounts following consecutive losses. The simulations will likely show initial periods of positive returns, but eventually, the player's funds will be depleted or restricted by a predetermined limit, such as reaching the target winnings or exhausting the available fund. Moreover, introducing a limited fund will further expedite the process of depleting the player's resources, highlighting the inherent risks associated with the Martingale strategy in gambling.

1.2 Code Design

The code designed for Martingale betting strategy analyze its performance through multiple episodes (10 and 1000) with $80 as max winning within each episode for first test and $256 as the bankroll for the 1000 episodes tests, then plot the results to evaluate short-term success and long-term limitations, and propose a hypothesis predicting initial gains followed by eventual depletion or restriction of funds due to the strategy's inherent risks. A typical blackjack winning odd of 18/38 was used to test the strategy.

2 RESULTS

2.1 10 episodes with $80 max winning

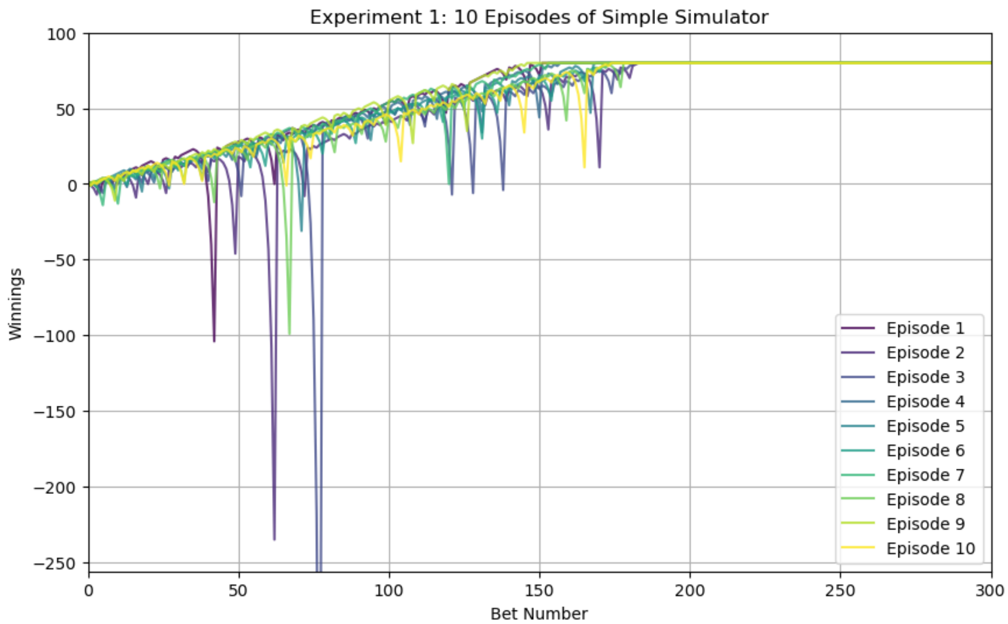

Figure 1 — 10 episodes with $80 as winning limitation

Figure 1 shows the 10 trails for Blackjack with $80 as the limitation for max winning threshold. We can see that all episodes reach $80 winning max limit before 200 betting.

2.2 1000 episodes with $80 max winning (Mean)

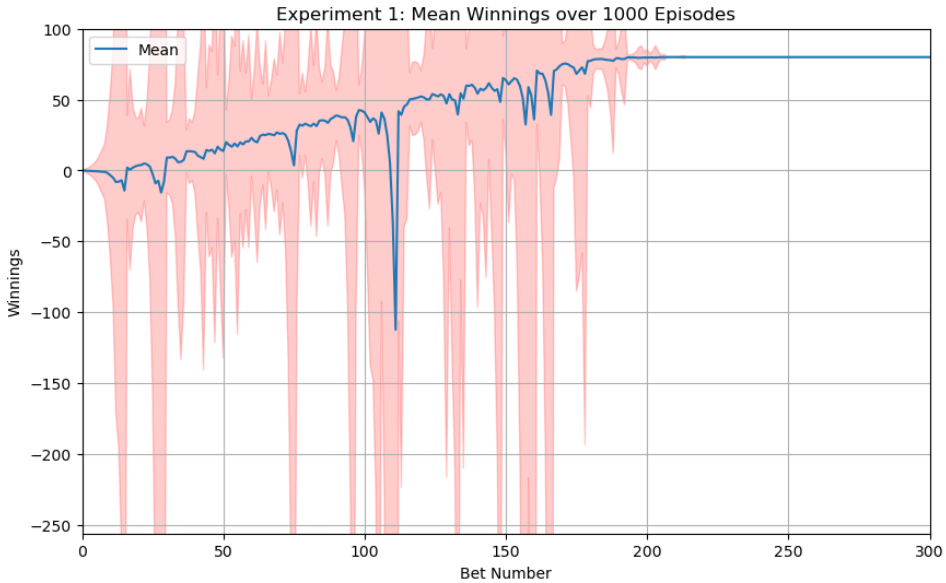

Figure 2 — 1000 episodes with $80 as winning limitation (Mean)

Figure 2 shows the 1000 episodes for Blackjack with $80 as the limitation for max winning threshold. The trend shows that this strategy will have slowly growing winning until ~ 200 betting, which stabilized around $80, the max winning limit.

2.3 1000 episodes with $80 max winning (Median)

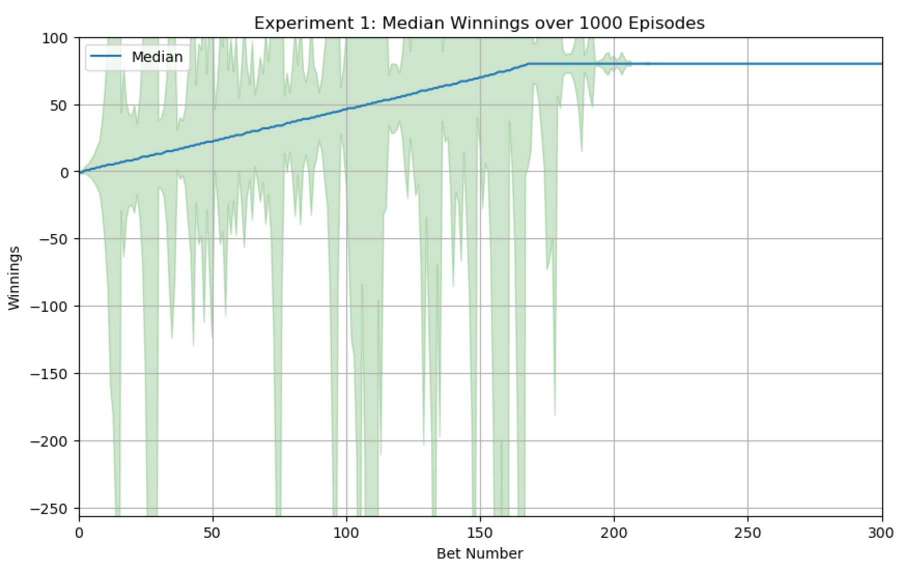

Figure 3 — 1000 episodes with $80 as max limit (Median)

Figure 3 with median datapoints shows similar results with mean graph, i.e. steady growth until reaching $80 winning limit around ~ 200 betting.

2.4 1000 episodes with $256 bankroll (Mean)

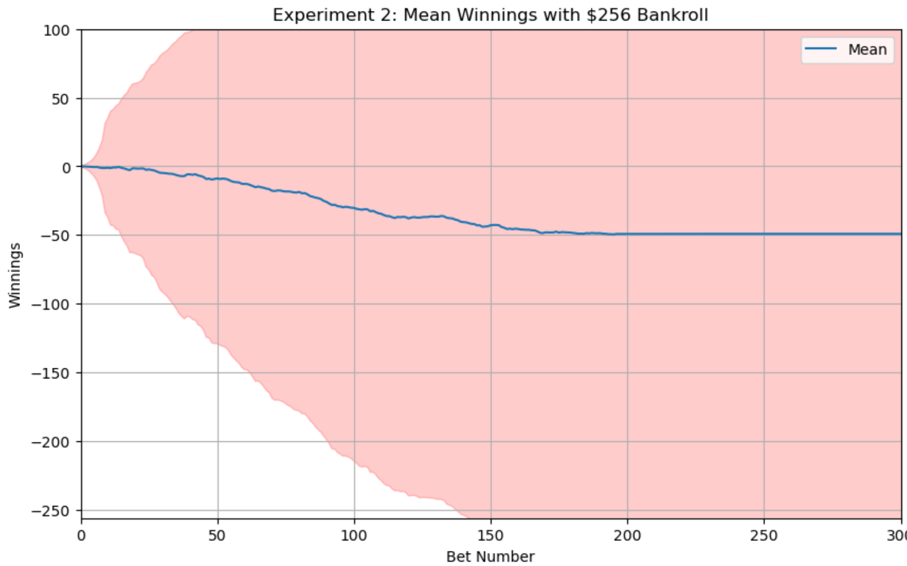

Figure 4 — 1000 episodes with $256 bankroll (Mean)

With increased bankroll, the risk of losing money increased, which leads to slowly losing money until ~200 betting with -$50 (might be less but now shown here).

2.5 1000 episodes with $256 bankroll (Median)

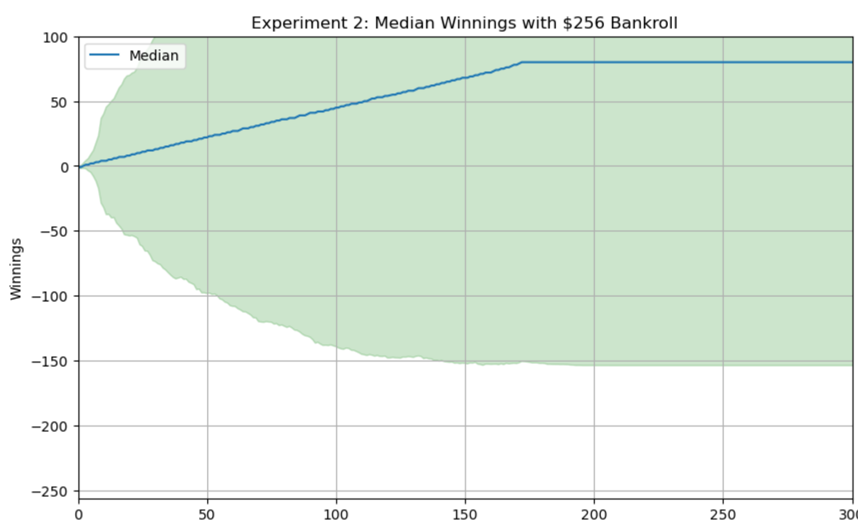

Figure 5 — 1000 episodes with $256 bankroll (Median)

Opposite to mean graph, the median trend line shows a growing fund until reaching $80 within ~180 betting (might be more but now shown here afterwards).

3 CONCLUSION

3.1 Martindale strategy

We tested Martindale betting strategy on Blackjack gambling with different scenarios. With limited max winning and no cap on negative bankroll, the strategy will always give positive results within 200 betting, which can be observed in both mean and median plots.

However, when we set a specific bankroll for both upper/lower limit, the mean and median plots shows two different results. Mean shows negative trend due to there might be extreme negative values (which can also be seen in Fig 1.), while median shows positive trends, as extreme value won't affect the median at all.

3.2 Additional questions

Question Set 1:

In Experiment 1, based on the experiment results calculate and provide the estimated probability of winning $80 within 1000 sequential bets.

Answer 1: Given the experiment 1 result, all Fig1 Fig2 and Fig3 give $80 as the final winning money before 200 betting, especially for mean and median, the stdev is zero after 200 betting for all cases, so the answer for question 1 is 100%, i.e. the probability of winning $80 within 1000 sequential bets is 100%.

Question 2:

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

Answer 2:

The same to question 1, since the stdev becomes zero after 200 bets, all episodes end up with $80 winning, so the expected value of winning after 1000 sequential bets in experiment 1 is $80 for each episode.

Question Set 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 with one another as the number of sequential bets increases? Thoroughly explain why it does or does not.

Answer 3:

Yes, they both stabilized at around 200-250 bets.

At the beginning of the process, the chance of winning and losing are kind randomized, which may cause large Stdev, while towards the end of the process, as bets number increases, the Stdev would tend to be stabilized. The main reason is as the set winning maximum is $80 within each episode, so within 1000 bets, all episodes will reach the $80, which cause the stdev stabilized as ~zero.

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.

Answer 4:

Based on the calculation of counting the final winning number that is larger than \$80, there are 766/1000, which represents 76.6% probability of winning \$80 within 1000 sequential bets.

Question 5:

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

Answer 5:

Expected value= -49.107 (refer to the code output, which is the average final winning number of all 1000 episodes)

Question Set 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 with one another as the number of sequential bets increases? Thoroughly explain why it does or does not.

Answer 6:

Yes, once the simulator loses all \$256 or win \$80 would results in stable stdev.

At the beginning of the process, the chance of winning and losing are kind randomized, which may cause large Stdev, while towards the end of the process, as bets number increases, the Stdev would tend to be stabilized. The main reason is this strategy will have higher possibility of losing all (-256) or win the max (80) after multiple bets, which will lead to high stdev in the beginning but stabilized after reaching limit.

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?

Answer 7:

Using expected values when conducting experiments offers the benefits of statistical robustness, reduced variability, improved decision-making, interpretability, and insights into long-term behavior compared to relying on the result of one specific random episode.