Project1: Gambling is a Problem

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Abstract—This assignment discusses about probability, expectation, and strategy involved in an American Roulette wheel. Particularly, I discussed and explored Professor Balch's strategy in terms of its expected value, edge case, and limitations. The two experiments I performed showed that the strategy only works in the scenario of unlimited bankroll. Such, gambling is a problem.

1 INTRODUCTION

For this project, I wrote software that will perform experiments involving an American Roulette wheel. For this project, I have developed software using the Python programming language to conduct experiments involving an American Roulette wheel. In this introduction, I will provide an overview of what an American Roulette wheel is, explain the concept of betting on black, and discuss the odds associated with this type of bet.

1.1 American Roulette Wheel

In this introduction, I will provide an overview of what an American Roulette wheel is, explain the concept of betting on black, and discuss the odds associated with this type of bet.

The American Roulette wheel is a popular gambling device found in casinos. It consists of a spinning wheel divided into numbered pockets ranging from 0 to 36. Additionally, there is an additional pocket labeled "00" (double zero) that distinguishes the American Roulette wheel from its European counterpart.

When placing a bet on the American Roulette wheel, players have various options, including betting on specific numbers, groups of numbers, or specific colors. One common bet is to wager on the color black. In this context, "betting on black" means predicting that the ball, after being spun around the wheel, will eventually come to rest in a black-colored pocket. The pockets numbered 1 to 36 are either black or red, while the 0 and 00 pockets are green.

Understanding the odds associated with betting on black is essential for making informed decisions. In American Roulette, there are a total of 18 black pockets (numbers 2, 4, 6, 8, 10, 11, 13, 15, 17, 20, 22, 24, 26, 28, 29, 31, 33, and 35) out of a possible 38 pockets (36 numbered pockets + 0 + 00). Therefore, the odds of winning a bet on black can be calculated as the ratio of black pockets to the total number of pockets, which in this case is 18/38, approximately 47.37%.

1.2 Environment

The implementation is composed and ran in a Windows Subsystem of Linux 2 system with Ubuntu 22.04 LTS. Particularly, the code ran in a ML4T environment hosted by conda. The only two packages used for this project are: Numpy and Matpolib.

1.3 Implementation

author(): Returns the GT username of the student who implemented the code.

gtid(): Returns the GT ID (Georgia Tech ID) of the student who implemented the code.

get_spin_result(win_prob): Simulates a spin of the roulette wheel and determines if it results in a win based on a given win probability.

simulator(num_episodes, num_spins, upper_limit, lower_limit): Performs a simulation of a betting strategy on the American Roulette wheel. It tracks cumulative winnings at each spin for each episode, with options for upper and lower limits.

test_code(): Runs various tests on the code and returns the test results.

1.4 Test functions

Functions that perform specific tests on aspects like upper/lower limits, betting stopping conditions, and convergence. All test cases passed.

2 REPORT AND ANALYSIS

In this section, I will provide a detailed report and analysis of the experiments conducted in this project. The report aims to answer specific questions related to the effectiveness of Professor Balch's betting strategy and the impact of realistic constraints on the strategy's performance.

Through simulations and data analysis, I will address the estimated probability of winning $80 within 1000 sequential bets, the estimated expected value of winnings after 1000 sequential bets, the convergence and stability of the strategy, and the benefits of using expected values in experiments.

The analysis will be supported by the charts generated from the simulations, including Figures 1, 2, 3, 4, and 5. These figures provide visual representations of the results and trends observed during the experiments. Additionally, I will present calculations and statistical measures to support the conclusions drawn from the data.

2.1 Experiment 1-Unlimited Bet

In Experiment 1, we conducted simulations using Professor Balch's original betting strategy with unlimited betting. The objective was to assess the effectiveness of the strategy and evaluate its performance.

We generated several charts to analyze the outcomes:

Figure 1: This chart displays the cumulative winnings for 10 episodes of the simulation. Each episode consists of 1000 sequential bets. The chart provides an overview of the winnings for each episode, starting from $0. The X-axis ranges =from 0 to 300, and the Y-axis ranges from -256 to +100.

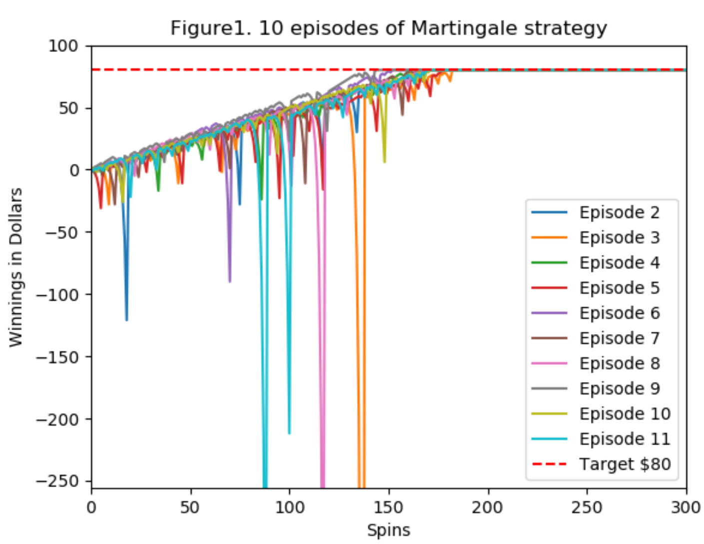


Figure 2: This chart represents the mean value of winnings for each spin round across 1000 episodes. It provides insights into the average performance of the strategy over time. Additionally, it includes lines indicating the mean plus/minus standard deviation of the winnings at each point.

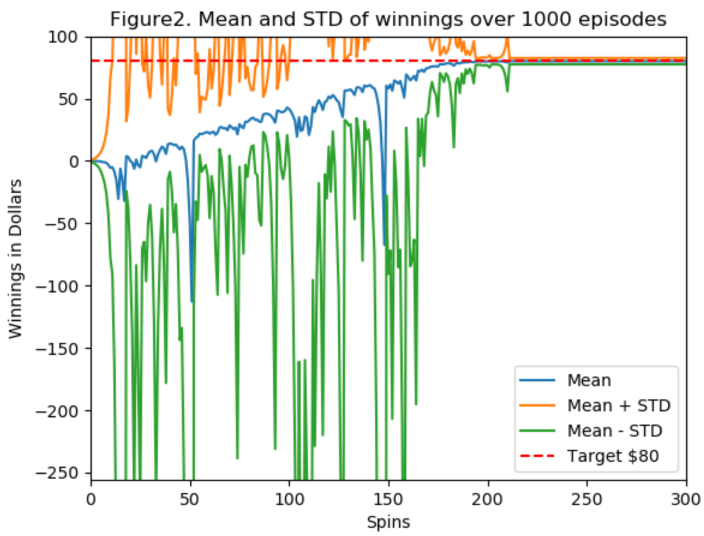
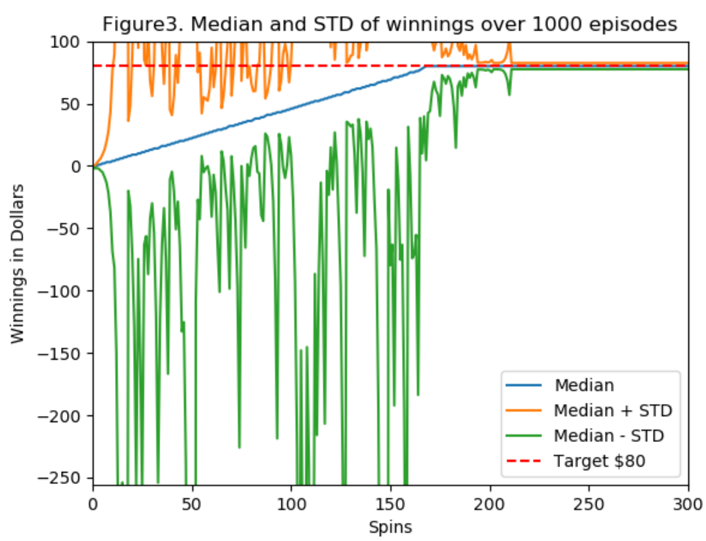


Figure 3: Similar to Figure 2, this chart presents the median value of winnings for each spin round. It offers an alternative perspective on the central tendency of the strategy's performance. Lines indicating the median plus/minus standard deviation are included.



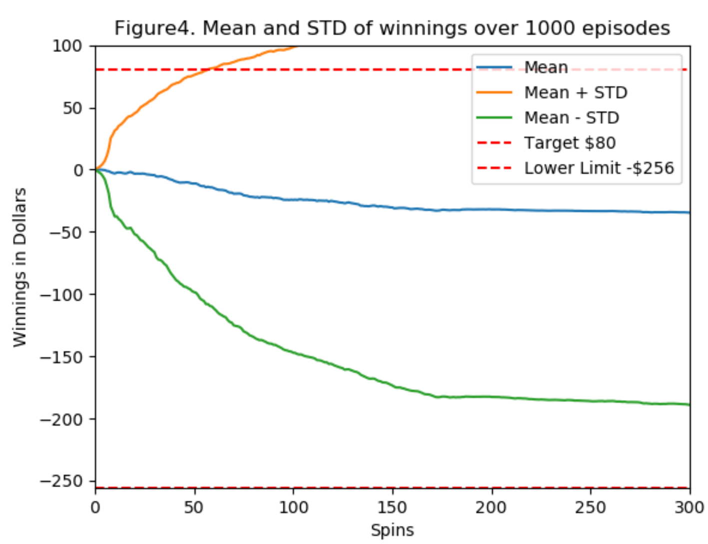
Question 1: The estimated probability of winning $80 within 1000 sequential bets in Experiment 1 is 1.00 (100%). This means that in all 1000 episodes, the player achieved winnings of $80 or more at some point during the 1000 sequential bets. This indicates a high likelihood of winning $80 within the given number of bets when using Professor Balch's original betting strategy.

Question 2: The estimated expected value of winnings after 1000 sequential bets in Experiment 1 is $79.92. This value represents the average amount of money the player can expect to win after 1000 sequential bets using the betting strategy. However, individual outcomes may vary.

Question 3: In Experiment 1, the standard deviation lines (mean + stdev and mean - stdev) reach a maximum or minimum value and stabilize. However, this stabilization is observed under the assumption of unlimited funds. In reality, when the strategy is implemented with limited funds, it fails to effectively recover from losses, resulting in a negative expected value and a higher chance of losing money. Therefore, the strategy is not viable in real-life scenarios with limited funds.

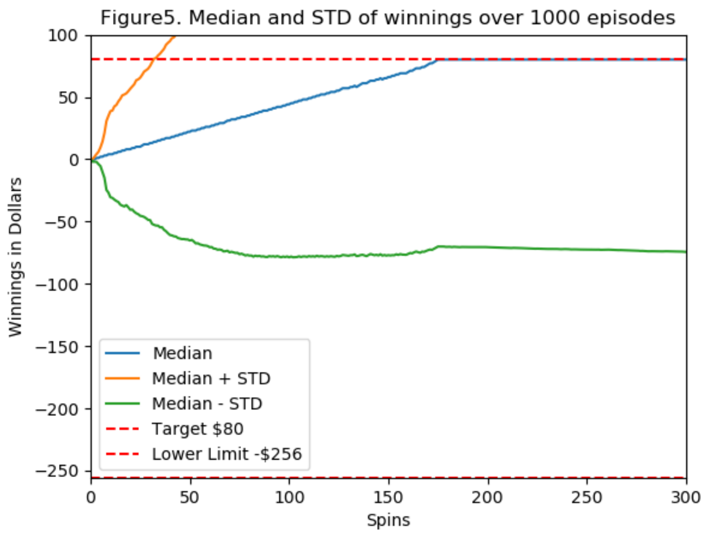
2.2 Experiment 2-Limited Bet

In In Experiment 2, we introduced a limited bankroll of $256 to the original betting strategy. This modification aimed to examine the strategy's performance under restricted betting conditions. **Figure 4**: This chart displays the mean value of winnings for each spin round across 1000 episodes. It provides insights into the



average performance of the strategy with a limited bankroll. The chart includes lines representing the mean plus/minus standard deviation of the winnings at each point.

Figure 5: In this chart, we illustrate the median value of winnings for each spin round. It offers an alternative perspective on the central tendency of the strategy's performance under limited betting conditions. Additionally, lines representing the median plus/minus standard deviation are included.



Question 4: In Experiment 2, the estimated probability of winning $80 within 1000 sequential bets is 0.63 (63%). This means that in approximately 63% of the episodes, the player was able to achieve winnings of $80 or more at some point during the 1000 sequential bets.

Question 5: The estimated expected value of winnings after 1000 sequential bets in Experiment 2 is -44.80. This indicates that, on average, the player can expect to have a net loss of approximately $44.80 after 1000 sequential bets using the modified strategy with a limited bankroll.

Question 6: In Experiment 2, the upper and lower standard deviation lines (mean + stdev and mean - stdev) continue to diverge as the number of sequential bets increases. The strategy fails to stabilize and converge due to the limited bankroll, making it ineffective in real-life scenarios where funds are not unlimited..

3 CONCLUSION AND DISCUSSION

3.1 Conclusion

First, I would like to answer to question 7 that the expected values (computed as mean in this scenario) is a good way to "ensemble" real life randomized situation to its expected value. Figure 2-4 is more useful in terms of interpretation than Figure 1. More importantly, a problem with known probability is calculable and comparable in this way.

Going back to the conclusion, Dr. Balch's strategy works only in a scenario where the person has unlimited amount of money (theoretically, as long as there is a lower limit of your money, the lose-double down strategy will make you homeless quick as you can't outrun 2^n with n). This fact is clearly yield from experiment 1 and 2's result where experiment 1's result converge to 80 and experiment 2's result didn't converge with a negative expected value (note that experiment 2 assumed that you have three times of the money ready to be lost in comparison to your expected winning -256 versus 80).

3.2 Discussion

This chapter showed us that why strategy like this can't work in real life—limited money. In addition, I want to point out that another resource is limited here—time. Note that even with unlimited money, the lane only started to converge after 260 spins (experiment1). In this case, I would assume that trying to win money from the casion (at lease in American Roulette) is basically impractical that with limited time (imaging that you can only play 100 spins) and limited money. All in all, gambling is a problem. Note that ML4T is not as ML4T is not gambling but learning with machine.

4 REFERENCES

5 APPENDICES