Martingale Strategy: An Experimental Analysis

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Abstract—This report examines the Martingale betting strategy through a series of experiments conducted using Monte Carlo simulations in both unlimited and limited bankroll scenarios.

1 INTRODUCTION

The Martingale betting strategy involves doubling the bet after each loss to ultimately recover all losses and gaining a profit matching the original stake(Hayes, 2024). This strategy is in theory, foolproof, because there is no limit on bankroll or bet size. However, its effectiveness in real scenarios, where these conditions are not met, is questionable.

In this project, we aim to evaluate this strategy via a series of simulations for both unlimited and limited bankrolls applied to American roulette. Our objectives are to calculate the probability of reaching $80 in winnings within 1000 spins, estimate the expected value of winnings after 1000 spins, and analyze the behavior of standard deviation lines over time.

1.1 Choosing the Probability: 18/38

The probability of winning a bet on black in American roulette is given by 18/38, considering the 18 black slots, 18 red slots, and 2 green slots (0 and 00) on the wheel (Grindu, 2024). This probability is important for accurately modeling the strategy and simulating a realistic gambling environment.

2 EXPERIMENTS AND RESULTS

2.1 Experiment 1: Basic Martingale Strategy

We ran 10 episodes of the basic Martingale strategy, tracking the winnings across 1000 spins for each episode. The objective was to observe the likelihood of achieving the $80 target and to analyze the fluctuations in winnings.

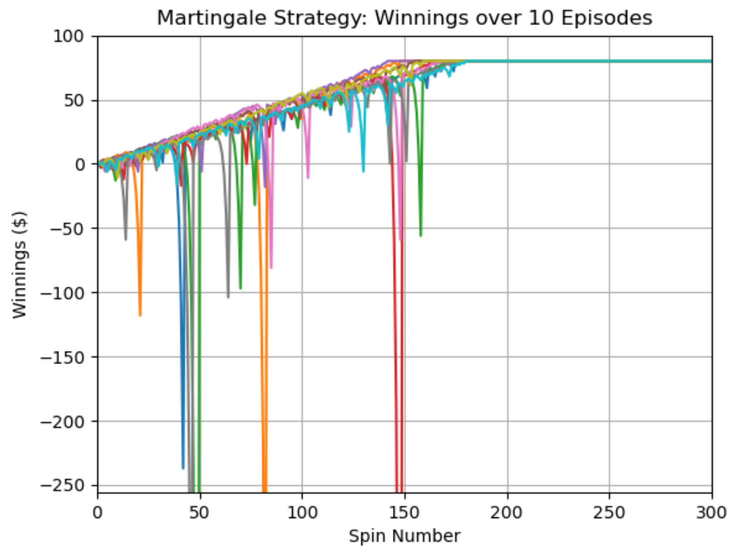

Figure 1—**Figure 1:** Winnings Across 10 Episodes Using the Basic Martingale Strategy.

2.1.1 *Question 1: Estimated Probability of Winning $80 within 1000 Sequential Bets*

Question: 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.

Answer: The probability of winning $80 within 1000 sequential bets in Experiment 1 is **1.0000** (100%). This value was obtained directly from the output of the experiment. The value of 1.0000 indicates that in every one of the 1000 episodes simulated, the Martingale strategy was successful in reaching $80 at least once within the 1000 sequential bets. This high success rate is due to the aggressive nature of the Martingale strategy, which doubles the bet after each loss, allowing it to recover and exceed the target winnings as long as there are no constraints like a bankroll limit.

2.1.2 *Question 2: Estimated Expected Value of Winnings after 1000 Sequential Bets*

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

Answer: The estimated expected value of winnings after 1000 sequential bets in Experiment 1 is **$80.00**. This value reflects the average outcome across all episodes, showing that on average, the Martingale strategy yielded $80 in winnings after 1000 bets. This is consistent with the strategy reaching the target winnings and then stopping, and so the expected value matches to the target amount.

Next, we extended the experiment to 1000 episodes to obtain robust statistics for the mean and standard deviation of winnings after each spin.

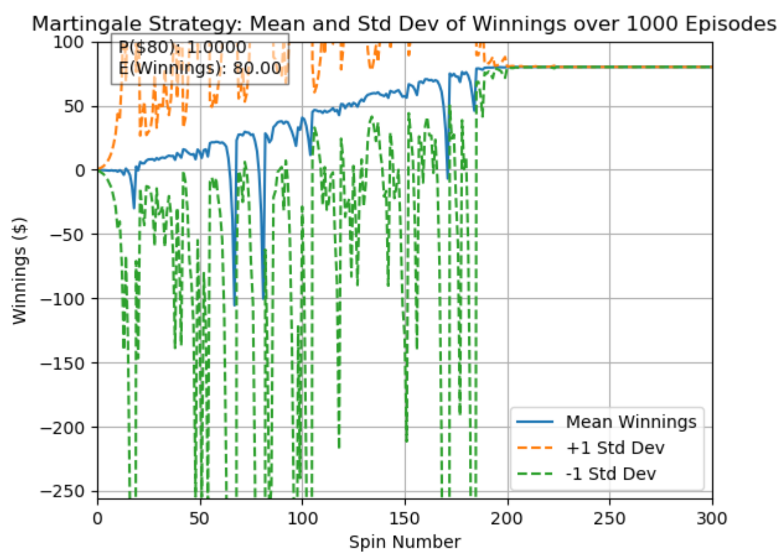

Figure 2—**Figure 2:** Mean Winnings Across 1000 Episodes with Standard Deviation (Basic Martingale Strategy).

2.1.3 *Question 3: Analysis of Standard Deviation Lines in Experiment 1*

Question: 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: - The standard deviation lines in Experiment 1 (Figure 2) reach a maximum (for the upper line) and a minimum (for the lower line) value, after which they stabilize. This occurs around the 150-spin mark. The lines indicate significant volatility early on, but as the number of spins increases, the winnings stabilize, and the standard deviation lines flatten. - The lines do not converge. They remain parallel after stabilization, reflecting the risk and range of possible outcomes. This lack of convergence suggests that while the outcomes stabilize, there is a significant spread of possible results due to the nature of the Martingale strategy.

Additionally, we analyzed the median winnings to understand the distribution of outcomes.

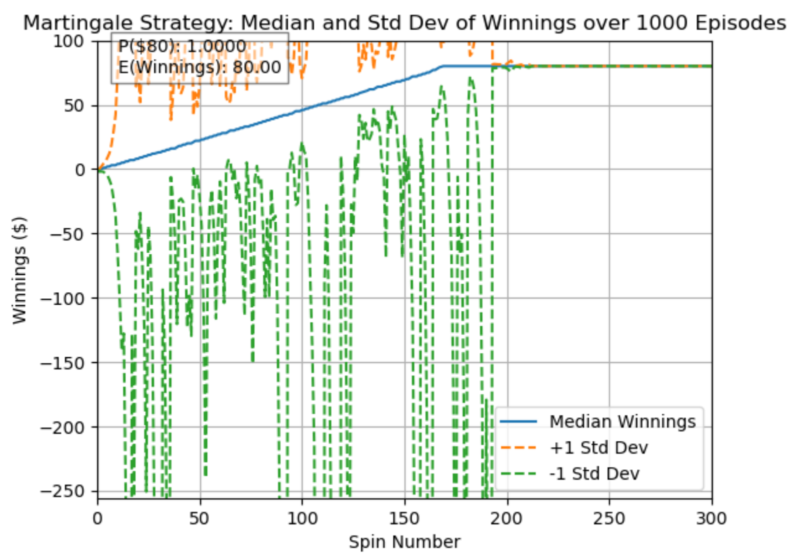

Figure 3—**Figure 3:** Median Winnings Across 1000 Episodes with Standard Deviation (Basic Martingale Strategy).

Median Analysis:—Figure 3 illustrates the median winnings. The median after 1000 spins was approximately $80.00, matching the mean. The standard deviation bands display a similar pattern, with the upper line stabilizing earlier. However, similar to the mean analysis, the lines do not converge, indicating that the range of outcomes remains wide due to the nature of the strategy.

2.2 Experiment 2: Martingale Strategy with Limited Bankroll

We repeated the experiments with a limited bankroll of $256 to simulate real-world conditions where resources are limited. The results provide a more realistic view of the strategy's performance.

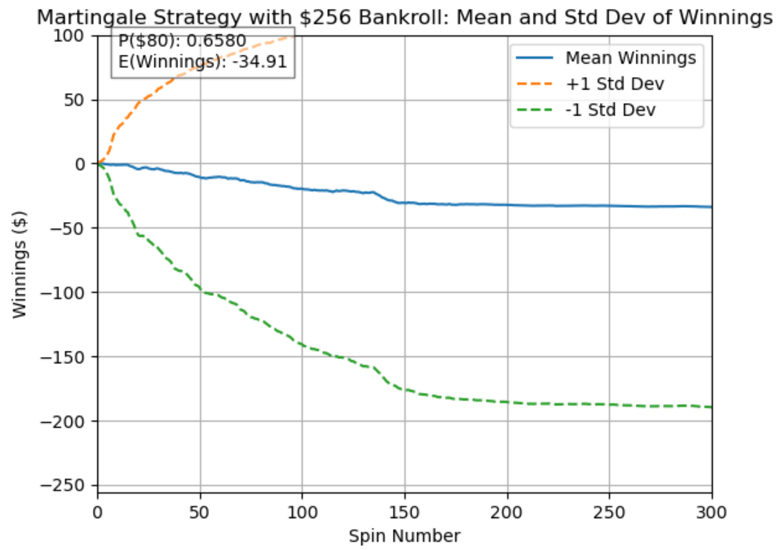

Figure 4—**Figure 4:** Mean Winnings Across 1000 Episodes with Limited Bankroll.

2.2.1 *Question 4: Estimated Probability of Winning $80 within 1000 Sequential Bets in Experiment 2*

Question: 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: The probability of winning $80 within 1000 sequential bets in Experiment 2 is **0.6580** (65.8%) according to the mean plot (Figure 4), and **0.6440** (64.4%) according to the median plot (Figure 5). These probabilities reflect the success rate of reaching $80 within the constraints of a $256 bankroll. Having a bankroll limit means the strategy could fail if it finishes the bankroll before recovering losses, and so the success rate drops to around 65-66%.

2.2.2 *Question 5: Estimated Expected Value of Winnings after 1000 Sequential Bets in Experiment 2*

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

Answer: The expected value of winnings after 1000 sequential bets in Experiment 2 is approximately **$-34.91** in the mean plot and **$-39.34** in the median plot. These negative expected values indicate that, on average, the strategy results in a loss when limited by a $256 bankroll. These outcome shows the inherent risk of the Martingale strategy, where losing streaks that exceed the bankroll lead to losses that cannot be recovered, resulting in a negative average outcome.

Standard Deviation Analysis:—Figure 4 demonstrates that with a limited bankroll, the mean winnings trend downward more sharply. The standard deviation lines show that the volatility remains high, and the lower standard deviation line continues to decline without stabilizing, indicating a high chance of great losses.

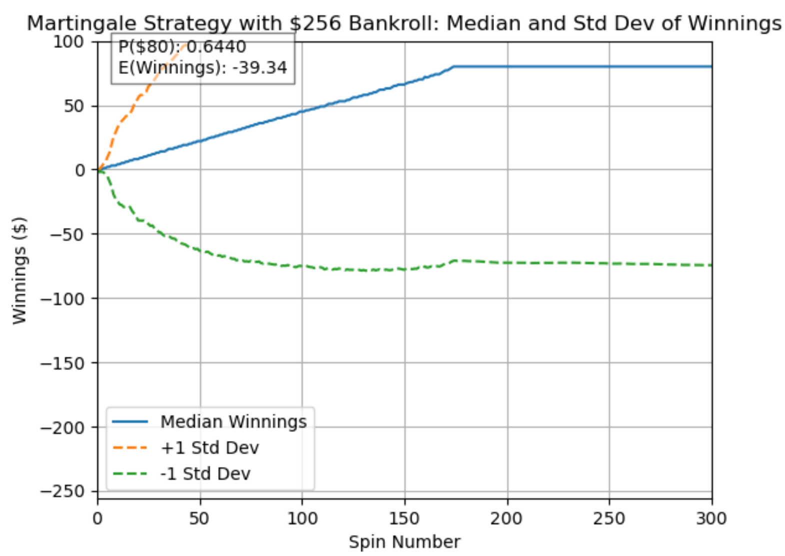

Figure 5—**Figure 5:** Median Winnings Across 1000 Episodes with Limited Bankroll.

2.2.3 *Question 6: Analysis of Standard Deviation Lines in Experiment 2*

Question: 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: - In Experiment 2, the standard deviation lines reach a maximum and minimum value, respectively, and then stabilize, as seen in Figure 4. However, they do not converge. - The lines remain separated by a consistent gap,which indicates that the range of outcomes continues to differ significantly due to the bankroll limit and its influence on the strategy's performance. The lack of convergence shows ongoing risk and variability in the strategy's outcomes, even after stabilization.

2.3 Benefits of Using Expected Values

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:** Expected values are important in understanding the performance of strategies like Martingale because they provide a comprehensive measure that accounts for the average outcome across multiple trials. The result of a single random episode could be an outlier.So instead, the expected value gives insight into the overall trend and risk associated with the strategy.

3 CONCLUSION

The Martingale strategy is theoretically sound, but it is fraught with risks in reality. Our experiments show that success is highly reliable on having unlimited resources and favorable short-term outcomes. In real life, the strategy is more likely to lead to financial losses, especially with a limited bankroll and so this is an impractical approach for real-world financial decisions.

4 REFERENCES

REFERENCES

[1] Grindu, Vlad (2024). "Roulette Odds Explained – House Edge and Payout Charts". In: *Techopedia*. URL: https://www.techopedia.com/gambling-guides/roulette-odds-probability#:~:text=9%E2%80%931%3D%208)-,Roulette%20Payouts%20Chart,-For%20a%20better.

[2] Hayes, Adam (2024). “Martingale System: What It Is and How It Works in Investing”. In: *Investopedia*. URL: https://www.investopedia.com/terms/m/martingalesystem.asp.

[3] Sachin, A (2024). “Martingale Systems and Why They Don’t Work in Stock Trading”. In: *Street Directory*. URL: https://www.streetdirectory.com/travel_guide/36622/investment/martingale_systems_and_why_they_dont_work_in_stock_trading.html#:~:text=The%20Martingale%20system%20is%20an,equal%20to%20his%20first%20bet..