Evaluating Blackjack Strategies Using Monte Carlo Simulation

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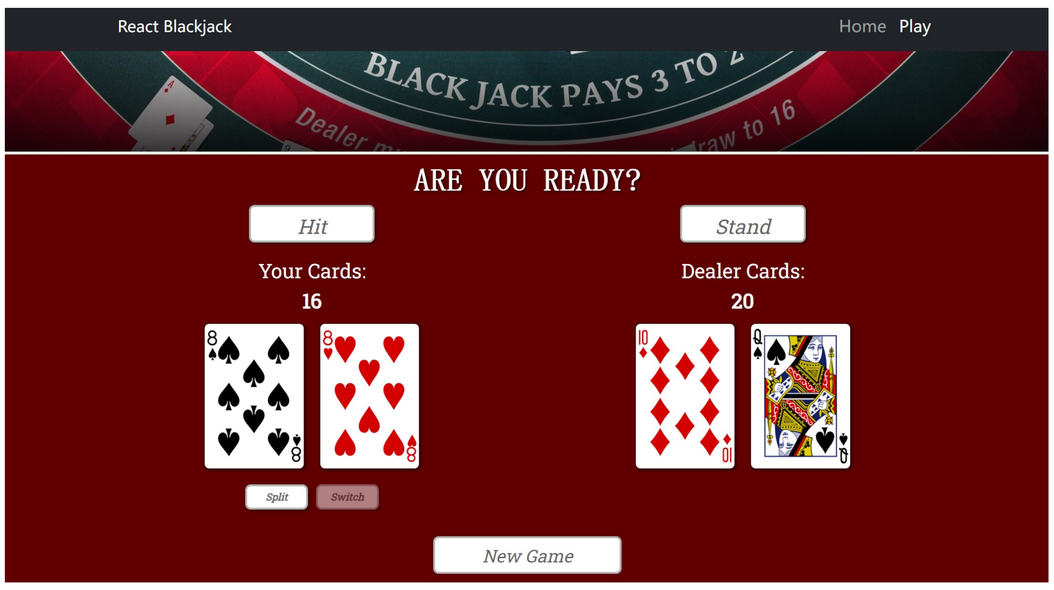
This is what my issue is...

Blackjack is a game of strategy and chance, where success depends on key decisions like hitting, standing, doubling down, and splitting. Mastering these strategies provides a significant advantage in beating the dealer.



This project uses Monte Carlo simulation to analyze and compare Blackjack strategies by modeling game mechanics such as deck management, hand evaluation, and player actions. The main goal is to evaluate the long-term effectiveness of these strategies through extensive simulations, providing insights into their impact on player performance and helping to identify the most consistently successful approaches.

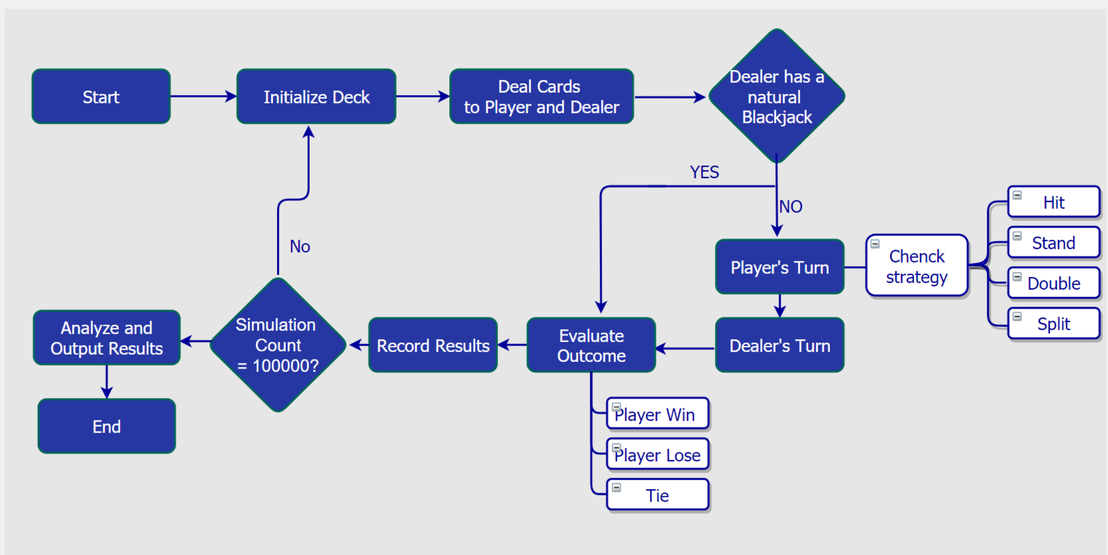
To investigate it, I did...

Monte Carlo Simulation

Monte Carlo methods rely on repeated random sampling to obtain numerical results. In the context:

- We simulate thousands of Blackjack hands for each strategy.
- Each hand is played out according to the strategy being tested.
- The results (wins, losses, pushes) are recorded.
- This process is repeated many times to build a statistical distribution of outcomes.

This is how it goes:



Strategies

Various Blackjack strategies implemented:

Strategy	Description
Simplest strategy	Hits if hand value is below 17; otherwise stands
Random strategy	Randomly chooses to hit or stand
Basic strategy	Classic strategy based on Blackjack strategy tables, considering both the player's hand and the dealer's visible card
Basic strategy (No Split)	A variation of the basic strategy that does not consider splitting pairs
Basic strategy (No Aces)	A variation of the basic strategy that ignores the special value of Aces
Basic strategy (No Splits or Aces)	A variation of the basic strategy that ignores both splitting pairs and the special value of Aces

Table 1. Description of Different Blackjack Strategies

I found out that...

The table below summarizes the mean profit and stake for each Blackjack strategy tested, highlighting the differences in performance across the strategies and providing a clear comparison.

Strategy	Mean Profit	Mean Stake
Simplest strategy	-142.4145	2500.0
Random strategy	-853.008875	2500.0
Basic strategy	-0.548625	2976.322
Basic strategy (No Split)	-20.688625	2788.31225
Basic strategy (No Aces)	-26.281875	2896.466
Basic strategy (No Splits or Aces)	-44.428875	2740.085

Table 2. Comparison of Mean Profit & Stake for Different Blackjack Strategies

The histograms below show the distribution of profits for each strategy.

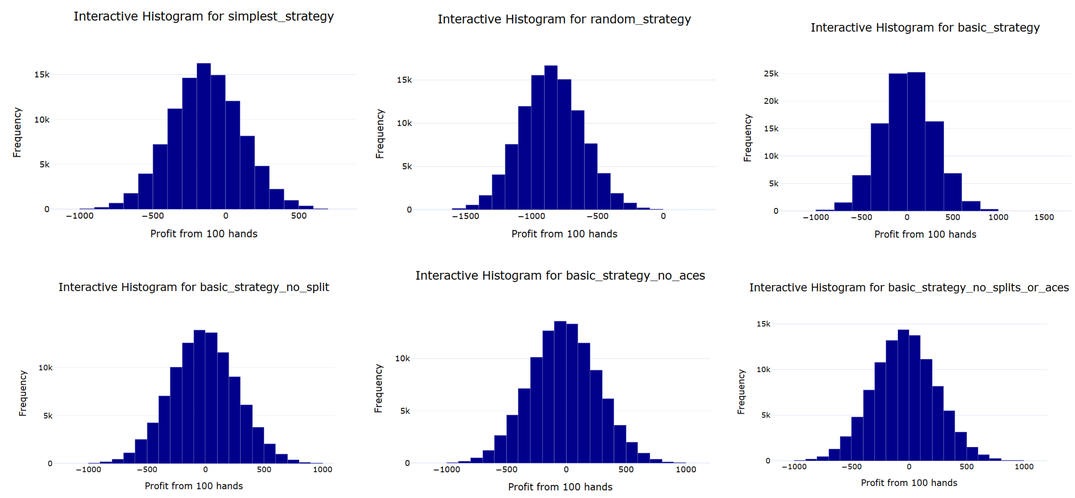


Table 3. Comparison of Interactive Histograms for Different Blackjack Strategies

My conclusion is...

- Basic Strategy is the Best: The basic strategy consistently gives the highest average profit and is the most reliable. It outperforms all other strategies, making it the best choice for long-term success.
- Random Strategy is the Worst: Making random decisions leads to the biggest losses, showing that having a strategy is crucial in Blackjack.
- Ignoring Splits and Aces Hurts Performance: The variations of the basic strategy that ignore splits, aces, or both don't perform as well as the full basic strategy, but they are still better than the simplest or random strategies.
- Basic Strategy is Less Risky: The profit distribution for the basic strategy is more concentrated, meaning it's less risky compared to others, especially the random strategy.

In the future, I will ...

- Implemente additional strategies: Explore and compare more advanced strategies, including card counting methods.
- Simulate more complex scenarios: Incorporate additional game rules, such as different deck counts, surrender options, and varying dealer rules.
- Optimize performance: Improve the efficiency of the simulation to handle even larger datasets and more complex strategy evaluations.
- Improve Visualization: Develop more detailed visualizations to better analyze the strategies' performance over time.

I took References from...

- Abdullah, M. (2020, October 1). Blackjack Simulator. Medium. https://medium.com/analytics-vidhya/blackjack-simulator-d89e763c9a84
- Mathur, S. (2019, March 21). The Statistics of Blackjack. https://towardsdatascience.com/the-statistics-of-blackjack-e3b5fc29e67d

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