Blackjack

Joshua Ortiga

Xin Li

Jonathan Le

December 19, 2022

1 Background

1.1 Blackjack Rules

The rules of Blackjack are simple. Every card in Blackjack (excluding Jokers) are weighed to be worth a certain amount of points. All cards from 2-10 are valued at their respective ranks. Face cards (Jack, Queen, and King) are valued at 10 points. Finally, Aces are valued at either 1 or 11 points, and can switch their values at any stage of the game.

The game starts with the dealer and the player drawing two cards, with the dealer only showing one of their cards. In Blackjack, you have the ability to either hit or stand. Hitting will draw you another card, while standing will end your turn, revealing the other dealer's card, and letting the dealer hit until they are at 17 points or higher.

The goal of the game is to get 21, or closer to 21 points than the dealer without exceeding 21 points. If you have more points than the dealer, you win the game. If the points are equal, you draw. and finally if you have less points than the dealer, and the dealer's points do not exceed 21, you lose (bust).

One final aspect of Blackjack to note is that in a real game, money and betting is involved. However, this research paper will not cover that aspect of the game. Therefore, surrendering, doubling down and splitting bets will not be considered for the scope in the research conducted.

1.2 Standard Optimal Strategy

The optimal strategy when playing a standard game of Blackjack is depicted in the figure below. Since betting money is outside the scope of our experiment, any time it is optimal to double down, we will consider it as as a hit instead.

The x-axes of the charts in the figure describes the dealer's known score. In Blackjack, only one of the dealer's initial cards is shown, this means that you can only know some of the dealer's score while it is your turn. The player must do their best to play their hand based on what they think the other dealer's card is.

The y-axes of the charts in the figure describes what cards the player has. This is also an important factor when the player decides their move because the player needs to play more conservatively if they are at high risk of busting (most notably, when the player has more than 11 points).

In the figure, there are two sections: *hard hands* and *soft hands*. The player is has a *soft hand* when they have an ace in their hand, and can safely hit without busting. This is because an Ace can be valued at 1 or 11 throughout the game, so the player's points can effectively "wrap around" back to a lower value if they exceed 21 points. This makes hitting far safer, which is why the player should be more willing to hit if they do have a *soft hand*.

In contrast, when a player has no Aces, they have a *hard hand*. The strategy is to play much more conservatively when you have a *hard hand*. This is because if the player goes over 21 points without drawing the Ace, then they bust and automatically lose the game.

1.3 Hypothetical Rule Changes

Since Blackjack has existed for a long time now, it is a solved game. However, the details of this paper will discuss a hypothetical rule change to the game. What if the game was played such that no face cards (Jacks, Queens, and Kings) were not in the decks? How would the META (most effective tactic available) of the game change?

1.4 Methodology

Since testing games of Blackjack manually would take a very long time, our group wrote some Python scripts to simulate game of Blackjack in order to gather data for our research. Xin Li wrote the original simulator as a summer project. Josh Ortiga forked it and modified it to be used to generate the necessary data to conduct our research.

In our Blackjack simulator repository, there are four important scripts used to gather our data. All of the scripts automate games of Blackjack and save the data and the graphs of the data to the *data* folder. If you are interested, we encourage that you play around with the parameters and generate some data yourself! For more details on how to use the scripts, consult the *readme* found in the Github repository.

1. *optimal_standard.py* - Simulates standard games of Blackjack and uses the optimal strategy in the figure above.

2. *unoptimal_nofaces.py* - Simulates games of Blackjack with the new rules (no face cards) using the same optimal strategy for the standard game of

Blackjack.

3. *optimal_nofaces.py* - Simulates games of Blackjack with our new optimal strategy given no face cards.

4. *calc_busts.py* - Simulates games of Blackjack with no face cards, and records the statistics of the dealer's face-up card and the frequency that the dealer busts.

2   Results

Lorem Ipsum

3   Summary

Lorem Ipsum

4   Works Cited

Blackjack Simulator
    Glossary of Game Theory
    Optimal Strategy Guide
    Optimal Strategy Chart