Project Report
Blackjack Card Counting
https://github.com/lexwraith/blackjacksim.git

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Part I
Introduction

Does counting cards give a player an advantage? The common consensus is a sound "yes", but what proof is there? The age-old anecdote of a famous card counter putting a casino out of business or scenes from the movie "Rain Man" featuring an autistic-savant come to mind, but who has actually confirmed any advantage to blackjack counting? What's to stop casinos from hosting fake sites claiming that counting does in fact work when the reality is it destroys the player bankroll using a fabricated promise?

The purpose of this paper is to answer the question, "Does counting give players an advantage in comparison to basic strategy in blackjack?" This is a simple yes or no question, and can be proven if, on average, a counting player makes a greater return on his initial bankroll than the non-counting player.

Part II
Hypothesis

The idea of counting is simple. When there are more cards with the value of ten or aces in the deck, the player has an advantage. The reasons are twofold:

1. The dealer has a higher chance of busting due to having to hit below a hard 17.

2. The player has a higher chance of blackjack.

As a consequence of said advantage, a player should bet more if the shoe is stacked in his or her favor. Of course, the average player who isn't counting would

not know if there are more tens and aces in the deck, but the advantage is not overwhelming due to shoes getting reset. Thus, the statement that this paper and experiment seeks to qualify as true or false is as follows:

A basic counting system in blackjack will yield a higher expectancy value per hand in the long run than no counting system.

Part III
Methodology

A list of constraints and rules to this paper:

1. This experiment uses basic blackjack rules with minor modifications.

   Dealer hits until hard 17.

   Players cannot surrender, split, or double.

   In any given simulation there is only one player and one dealer.

   Shoes reset randomly near the end of the shoe.

   Shoes consist of exactly 1 deck.

2. The counting system used will be a basic hi-lo counting system.

   Cards $\in \{2,3,4,5,6\}$ are valued as 1.

   Cards $\in \{10,J,Q,K,A\}$ are valued as -1.

3. Players are evaluated under uniform conditions.

   The player starts with \$1000 and bets either \$25 or \$100.

   The expected value will be determined as:

   $$(\frac{\$_{Ending} - \$_{Beginning}}{Hands\ Played})$$

4. All players play using a basic foundation strategy.

   Players will always hit under 12.

   If the dealer's card up is $\in \{7,8,9,10,J,Q,K,A\}$ the player will hit until hard 17.

   If the dealer's card up is $\in \{2,3,4,5,6\}$ the player will hit until hard 18.

5. Counting players have a few additions to basic strategy.

   Counting is defined as having a mental accumulator (the count) that adjusts with each seen card. At 0% accuracy, no changes are ever made to the

count, and at 100% accuracy, every card that has a count value adjusts the count. Hypothetically at 50%, only half the cards seen will change the count, and so on.

Players will use a true count system which is determined by this equation:

$$\frac{Count\ of\ Player}{Size\ of\ Shoe}$$

Where the size of the shoe is determined by the number of decks within the shoe.

Counting players will quadruple their bet to $100 if the true count of a shoe is greater than 5.

Counting players will hit more aggressively when at a hard 12 or hard 16 when the true count is below -10 and -15 respectively.

The independent variable of the experiment is how a player counted. Two assignments are tested:

1. Players played and counted with 100% accuracy.

2. Players played and did not count at all.

    An implication of this is that the player does not use progressive betting, i.e. the player never bets $100.

The dependent variable and variable of interest using a few calculations is the expected value per hand.

1. Each sample represents one player playing exactly 100 hands.

2. Each test is the average expected value of 100 samples.

3. Each experiment is run with a different setting for its independent variable and consists of 5000 tests. Thus, each experiment is the result of 50,000,000 hands played.

Part IV
Results

Table 1: 100% Accuracy vs Non-Counting using 1 Deck

Independent Variable	Expected Value Per Hand
100% Counting Accuracy	.3237%
Not Counting	.1823%

Table 2 (Auxiliary): 100/50/25% Accuracy using 1-5 Decks

	1	2	3	4	5
100%	.3237%	.2890%	.2489%	.2211%	.2096%
50%	.2979%	.2475%	.2190%	.1968%	.1889%
25%	.2669%	.2216%	.1940%	.1846%	.1864%

Part V
Analysis

Table 1 shows that there is roughly a doubling of return on investment per hand than not counting. Table 2 is an auxiliary table made out of curiousity: it shows that multiple decks and questionable counting accuracy scales off rather rapidly, especially with bad counting.

Part VI
Conclusion

It's very unlikely that the expected value per hand being roughly double of a normal strategy is a fluke. The reason why 5000 tests were used rather than 100 was that there was notable variance prior when using 100 tests. Thus we can say that it is extremey likely adopting a good counting strategy is likely to yield higher profit than not counting at all. This does not hold for questionable counting however, and it also doesn't hold when more than 1 deck is used. The advantages, as shown by the auxiliary table, fade rather quickly, especially if the player cannot pay attention and count. Because situations in the auxiliary table are more likely than finding a single deck blackjack booth and being able to count perfectly, it might not be wise to extrapolate this as blackjack being the ultimate money machine. It's likely that it is to the contrary as the auxiliary table was composed of 100 tests per value.

Part VII
Criticism

A list of problems with the experiment, and possibly and explanation of why things were done the way they were:

1. Multiple players: According to an article in Blackjack Insider, the only thing that changes when playing with up to six players is the number of hands per hour. http://www.deepnettech.com/article6.html. The feature is actually

implemented currently, but just unused.

2. Blackjack options: The reason surrender, double, and split were omitted was because of their utility to the core game, or really, lack thereof. Surrender is not offered very often, and only is allows when certain cards are showing by the dealer after the initial deal. Double and split are really just more hits, and really don't alter the core game. However, there is a chance that doubles can serve as a pathway to greater profit with utilized with a counting system, but that can be someone else's experiment.

3. Blackjack payout: Casinos have different rules to payout for blackjack, but 3:2 payout is very common. The counting system isn't reliant on getting blackjack however, and is more about winning hands in general.

4. Counting system: The reason hi-lo was used was because it is the most common and basic counting system there is. There are plenty of other systems such as Zen, and even other types of counts entirely as in how counting is done, but the role of this paper is to simply see whether or not counting provides a positive change to returns provided by playing blackjack.

5. Betting system: Usually, a player should play blackjack with an initial investment 100 times his or her big bet. In this simulation, the player only had 10 times, which means that many players lost all their money in the short run while it was possible for them to reap profits in the long run. This is arbitrary however, and is more realistic, as most people will not walk into a lower-end casino with $6000 just to play $15 blackjack.

6. "Basic" strategy: The basic strategy used is commonly passed out as cards to patrons at casinos. It bases the player decision on what the dealer's face up card is. A sample can be seen at: http://www.blackjackinfo.com/blackjack-rules.php.

7. Additional strategy: What is interesting about counting systems is there is no explicit way to act based off of the count. The true counts used in this simulation were determined simply because they seemed reasonable as thresholds to the shoe being stacked in a player's favor. Future experiments should definitely modify these thresholds for player action, as considering a shoe as advantageous at count = 5 is significantly different from count = 10.