

Pre-flop strategy in Texas Holdem Poker

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1 Introduction

In the game of Texas Hold'em poker, every player is given two cards from a deck of 52 cards. After every player has their cards, they can place a bet. The order of the bets starts at the player who is left of the dealer and goes through the circle until it reaches the dealer. Thus, the question can be asked: What is an intelligent strategy based on the pair of cards one is given?

2 Value of a hand

Before calculating the probability of a hand, one must understand what makes one hand of cards better than another. A standard deck has 52 cards in it. These cards are Ace, King, Jack, 10, 9, 8, 7, 6, 5, 4, 3, 2, and four suits: heart, spade, diamond, and clubs. In Texas Hold'em poker, the value of a card is based on how high it is in the ranking of the previously mentioned list, with Ace the best and two the worst; note that ace can act as the highest value and as one. A hand value is also based on what other three cards can work with them to make the most valuable set of five cards compared to another player.

3 Probability of hands

All the possible hands of Texas Hold'em poker can be found. The number of possible hands is

$$\binom{52}{2} = 1326 \quad (1)$$

We can introduce a set T with elements corresponding to each possible hand as follows: Let S, H, D, and C bet sets modeling the cards of each suit spades, hearts, diamonds, and clubs respectively with

$$S = \{A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2\} \quad (2)$$

$$H = \{A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2\} \quad (3)$$

$$D = \{A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2\} \quad (4)$$

$$C = \{A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2\} \quad (5)$$

All the cards in the deck are modeled by $T_0 = S \cup H \cup D \cup C$ and the set T is taken to be

$$T = \{A \in \wp(T_0) : \#A = 2\} \quad (6)$$

Thus, a probability measure can be created on the set T.

$$\pi(\{j, w\}) = 1/1326 \quad (7)$$

However, it is crucial to understand the odds of different types of hands because it is a significant factor used when ranking the hands against each other.

3.1 Pairs

A pair is a hand where the player has the same value twice, i.e. (Ace of Club, Ace of Spades). The odds of getting a pair can be found by looking at the number of different values of cards, which is thirteen, and the number of different suit combinations that can occur.

$$\frac{13 * \binom{4}{2}}{\binom{52}{2}} = .058 \quad (8)$$

3.2 Connectors

A connector is a hand that allows for straights to be created. A straight is when five cards are in ascending order i.e. (2,3,4,5,6). Thus, following the previous example, a connector can be (3,4) or (4,5). The odds of getting a connector can be found by (ADD this).

$$\frac{(43 - 8 + 484 - 44)}{\binom{52}{2}} = .3499 \quad (9)$$

3.3 Gappers

A gapper is a hand similar to a connector because it allows straights to be created. However, they connect longer distances, namely one, two, and three card gaps. For example, a two-gapper would be the cards of (3,6) for the straight of 2,_,4,5,_,.

3.3.1 One Gapper

A one gapper hand is a hand with a single card gap between the two cards, e.g., $\{3_h, 5_s\}$. A note of notation is the subscript of h,s,d, and c representing the different suits of hearts, spades, diamonds, and clubs. Twelve choices for the lower ranking card A,2,3,...,Q in a one gapper hand. Once the lower ranking card is chosen, the higher ranking card is determined by the number of suits for the low cards and then the number of suits minus the suit that has been used by the low card. This selection of suits can be thought of as the permutations of 4 choose 2.

$$\frac{12 * 4 * 3}{\binom{52}{2}} = 0.108 \quad (10)$$

3.3.2 Two Gapper

A two-gapper is consistent with a two card gap between the two cards in the hand e.g., $\{3_h, 6_s\}$. Eleven hands can be a two gapper chosen as the lower-ranking hand. After selecting the lower ranking hand, the higher ranking card is determined similar to a one gapper by find the permutations of the suits.

$$\frac{11 * 4 * 3}{\binom{52}{2}} = 0.099 \quad (11)$$

3.3.3 Three Gapper

A three-gapper is consistent with a three card gap between the two cards in the hand e.g., $\{3_h, 7_s\}$. Ten hands can be a three gapper chosen as the lower ranking hand. After selecting the lower ranking hand, the higher ranking card is determined similar to a one gapper by find the permutations of the suits.

$$\frac{10 * 4 * 3}{\binom{52}{2}} = 0.0904 \quad (12)$$

3.4 Suited

A suited hand holds two cards of the same suit (heart, spade, clubs, and diamonds). These hands allow for the creation of a flush and royal flush. A flush is five cards that are all of the same suit. We can calculate the number of suited hands(35) not already utilized in one of the following types and then multiply by the number of suits(4).

$$\frac{35 * 4}{\binom{52}{2}} = 0.105 \quad (13)$$

3.5 Suited Connectors

A suited connector or gappers can lead to a straight flush and royal flush.

$$\frac{13 * 4}{\binom{52}{2}} = 0.039 \quad (14)$$

3.6 Suited Gappers

3.6.1 Suited One Gappers

A suited one gapper hand is a hand with a single card gap between the two cards, e.g., $\{3_h, 5_h\}$. Twelve choices for the lower ranking card A,2,3,...,Q in a one gapper hand. Once the lower ranking card is chosen, the higher ranking card is determined, so only the suits need to be determined. If the suits are the same, then there are 4 choices for the suit (of both cards) for a total of

$$\frac{12 * 4}{\binom{52}{2}} = 0.036 \quad (15)$$

3.6.2 Suited Two Gappers

A suited two gapper hand is a hand with a two card gap between the two cards, e.g., $\{3_h, 6_h\}$. Eleven choices for the lower ranking card A,2,3,...,Q in a two gapper hand. Once the lower ranking card is chosen, the higher ranking card is determined, so only the suits need to be determined. If the suits are the same, then there are 4 choices for the suit (of both cards) for a total of

$$\frac{(11) * 4}{\binom{52}{2}} = 0.0331 \quad (16)$$

3.6.3 Suited Three Gappers

A suited three gapper hand is a hand with a three card gap between the two cards, e.g., $\{3_h, 7_h\}$. Ten choices for the lower ranking card A,2,3,...,Q in a three gapper hand. Once the lower ranking card is chosen, the higher ranking card is determined, so only the suits need to be determined. If the suits are the same, then there are 4 choices for the suit (of both cards) for a total of

$$\frac{(10) * 4}{\binom{52}{2}} = 0.0301 \quad (17)$$

4 Strategy

As can be seen from above, there are specific hands that have value in poker and have a better probability of leading to a successful round of Texas Hold'em. The hands above can be ranked based on how likely they can lead to a good outcome. Before looking at a good strategy, we can look at the number of hands that should not be considered by finding the sum of the hands subtracted from the number of hands.

$$\frac{1326 - ((6 * 13) + (43 - 8 + 484) + (12 * 4 * 3) + (11 * 4 * 3) + (10 * 4 * 3) + (35 * 4) + (12 * 4) + (11 * 4) + (10 * 4))}{\binom{52}{2}} = 0.039 \quad (18)$$

Thus, if one gets one of these 53 hands, they should consider folding, which is when a person places their hand back into the deck and decides not to play that round of the game.

4.0.1 High card

A high card is when your current hand comprises cards with a high value i.e., Ace through 10. The value of the high card could mean that your pair is a higher value than your opponent's hand.

4.0.2 Speculative hands v.s. valued hands

A speculative hand is a hand that has no value in the cards that it holds but has the opportunity to bring value later into the game. Thus, the hands of connectors, gappers, and suited cards are considered speculative hands. For valued hands, they are hands that have value from the draw, like the pair. As a result, a person can decide to play more aggressively when given a valued hand.

4.1 Charts

| | A | K | Q | J | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| A | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.039 |
| K | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.036 |
| Q | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0331 |
| J | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 |
| 10 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 |
| 9 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 | 0.105 |
| 8 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 | 0.105 |
| 7 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 | 0.105 |
| 6 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.039 | 0.039 | | 0.039 | 0.036 | 0.0331 | 0.0301 |
| 5 | 0.0301 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 | 0.0331 |
| 4 | 0.0331 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 | 0.036 |
| 3 | 0.036 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | | 0.039 |
| 2 | 0.039 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.0301 | 0.0331 | 0.036 | 0.039 | |

Figure 1: Odds of getting a suited hand

| | A | K | Q | J | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| A | | 0.3499 | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.3499 |
| K | 0.3499 | | 0.3499 | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.054 |
| Q | 0.054 | 0.3499 | | 0.3499 | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.049 |
| J | 0.049 | 0.054 | 0.3499 | | 0.3499 | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 |
| 10 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 |
| 9 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 |
| 8 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 | 0.1892 |
| 7 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.045 | 0.1892 | 0.1892 |
| 6 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.045 | 0.045 |
| 5 | 0.045 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.049 | 0.049 |
| 4 | 0.049 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.054 | 0.054 |
| 3 | 0.054 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | | 0.3499 |
| 2 | 0.3499 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.1892 | 0.045 | 0.049 | 0.054 | 0.3499 | |

Figure 2: Odds of getting a off-suited hand

The odds of getting a specific hand can be plotted in a graph. I will note the simplification that instead of creating the ten charts to represent each suit and combination of them, I have instead created an off-suited and suited graph. These graphs demonstrate the same patterns that would occur in the ten graphs. However, the charts can be simplified one more time. The Sklansky hand groups combine both the suited and offsuited charts together and rank the hands.

| | | start here if hole cards are Offsuit | | | | | | | | | | | | | |
|--|---|--------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | K | Q | J | T | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | |
| start here if hole cards are Same Suited | A | 1 | 1 | 2 | 2 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| | K | 2 | 1 | 2 | 3 | 4 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | |
| | Q | 3 | 4 | 1 | 3 | 4 | 5 | 7 | | | | | | | |
| | J | 4 | 5 | 5 | 1 | 3 | 4 | 6 | 8 | | | | | | |
| | T | 6 | 6 | 6 | 5 | 2 | 4 | 5 | 7 | | | | | | |
| | 9 | 8 | 8 | 8 | 7 | 7 | 3 | 4 | 5 | 8 | | | | | |
| | 8 | | | | 8 | 8 | 7 | 4 | 5 | 6 | 8 | | | | |
| | 7 | | | | | | | 8 | 5 | 5 | 6 | 8 | | | |
| | 6 | | | | | | | | | | 8 | 6 | 7 | 7 | |
| | 5 | | | | | | | | | | | 8 | 6 | 6 | 7 |
| 4 | | | | | | | | | | | | 8 | 7 | 7 | 8 |
| 3 | | | | | | | | | | | | | 7 | 8 | |
| 2 | | | | | | | | | | | | | | 7 | |

| Rank | Hole Cards | Playable Positions |
|------|---|----------------------|
| 1 | AA, KK, QQ, JJ; AKs | Early, Middle, Late |
| 2 | TT; AQs, AJs, KQs; AKo | Early, Middle, Late |
| 3 | 99; ATs, KJs, QJs, JTs ; AQo | Early, Middle, Late |
| 4 | 88; KTs, QTs, J9s, T9s, 98s; AJo, KQo | Early, Middle, Late |
| 5 | 77; A9s thru A2s, Q9s, T8s, 97s, 87s, 76s; KJo, QJo, JTo | Early*, Middle, Late |
| 6 | 66, 55; K9s, J8s, 86s, 75s, 54s; ATo, KTo, QTo | Middle**, Late |
| 7 | 44, 33, 22; K8s thru K2s, Q8s, T7s, 64s, 53s, 43s; J9o, T9o, 98o | Late*** |
| 8 | J7s, 96s, 85s, 74s, 42s, 32s; A9o, K9o, Q9o, J8o, T8o, 87o, 76o, 65o, 54o | |

* Playable in early position if game is loose/passive.
 ** Playable in middle position if game is loose/passive.
 *** Playable in late position if you are the first to bet.

Figure 3: Sklansky hand groups

4.1.1 Suited Strategy

Suited hands are incredibly speculative and, as a result, have risk early into the game. However, the possible rewards can outweigh this risk, as seen in suited high cards and connectors. However, if your connectors are not higher than the hand (8,7) suited or any other lower type of suited hand, it should only be played if the initial betting rounds are not aggressive. Because suited hands are speculative, you will gain enough knowledge to know if you should stay or leave when the first round of cards is placed on the table.

4.1.2 Off Suited Strategy

I begin by exploring the strategy of the value hands. The pair, for the most part, is an excellent hand. For high pairs(8 and above), a person should consider playing aggressively by betting high early on to push out speculative hands that could be a threat later in the game. For low pairs(7 and below), one could still play these hands but should be considered more speculative because they could turn into a three-of-a-kind and or a full house. For the speculative hands in the form of the connectors and gappers, if the hand does not have a high card present, then the hand should only truly be played when the table is not betting aggressively.