Analysis of Player Performance in Online Poker

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Abstract

As avid poker players, we sought out to investigate how a player's performance changes throughout a poker session. To do so, we collected and cleaned data from two online poker databases, both of which included players' hand history of online Texas hold 'em games. We conducted statistical hypothesis tests, analyzing the hypothesis that the win rate of players who had a negative cumulative net gain for the session is equivalent to that of players who had a positive cumulative net gain for a session. In order to verify this hypothesis, for each player in our database, we calculated the difference between two averaged win rates: one across all players with negative total gains and one across all players with positive total net gains. To reduce noise, we filtered out players who played fewer than 10 hands. We also took into consideration players' skill level. After running a z-test, and getting a p-value of: 7.1×10^{-8} for one dataset and 1.1×10^{-3} for the other data set, we rejected our null hypothesis. In conclusion, we determined that players in a losing session have a higher win rate than players in a winner session.

$$H_0 : P(\text{winning} \mid \text{cumulative net gain} < 0) = P(\text{winning} \mid \text{cumulative net gain} > 0)$$

Introduction

Poker is a common card game in which players wager over which "hand", a set of five playing cards, is best according to their rank. Texas hold 'em is if not the most popular variant of poker. To summarize, two unknown cards are dealt to each player, and five known "community cards" are dealt onto the table in stages - a series of three cards ("the flop"), an additional card ("the turn"), and the final card ("the river"). Betting rounds take place before the first and at every stage, where players have the betting options to check, call, raise, or fold. Of the five community cards and each player's own pair of cards, the single player who has the best hand and has not folded at the end of the betting round wins the round and all of the money bet.

We are seeking to understand whether a player is more likely to win a hand in a winning session (cumulative net gain is positive) or losing session (cumulative net gain is negative). To do so, we analyzed a player's win rate based on on their performance history on a given day. Thus, we came up with this hypothesis to test whether a player's win rate is higher during a losing session than during a winning session on a given day.

Methodology

We collected data of online Texas hold 'em games from Kaggle and Michael Maurer's IRC Poker Database. Both sources provide thorough logs of online games in text format. We parsed the text data into three tables: Games, Hands, and Actions. Using an SQLite database, we were able to efficiently store all the essential information in these hand logs; this schema enabled us to reconstruct all relevant information from joining these three tables.

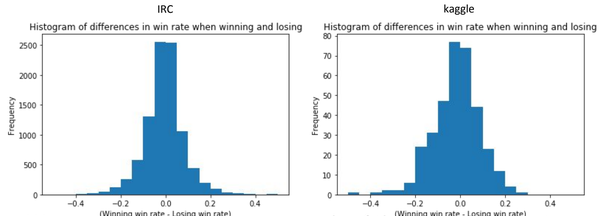
For the analysis, we first used SQL to query the database and loaded the relevant data into Pandas dataframes. With the goal of investigating player performance in a winning vs. losing session, we tested a few hypotheses. For each of these hypotheses, we extracted and manipulated the relevant data, plotted the data, and ran statistical tests using Statsmodel. One hypothesis compared players' win rates given that they won the previous hand to their win rates given that they lost the previous hand.

The hypothesis that yielded the most significant results compared players' win rates given that they are in the positive vs. negative on the session thus far. The null hypothesis was that being in the positive vs. negative has no effect on the probability of winning. To reduce noise, we filter out players that have played very few games. We ran a z-test to test whether, across all players, the difference between their winning session win rate and their losing session win rate was zero. Our analysis controls for variations in player skill because each player's winning session win rates is compared to their own losing session win rates.

Results

The first hypothesis test we conducted had insignificant results. We did not find evidence that players were more or less likely to win a hand given performance on the immediate previous hand, likely due to the fact that the variance was very high for both samples.

When testing the difference between players' winning session win rate and losing session win rate against a zero mean (this would mean that the players played equally well on average when winning and losing), however, we found that players on average win more after losing than winning. The average value for (winning win rate - losing win rate) is -5.0×10^{-3} (-0.50%) for the IRC dataset, with 9323 qualifying samples, and -1.8×10^{-2} (-1.8%) for the kaggle dataset, with 349 qualifying samples.



We ran two-sided z-tests on each of these samples to test their means against zero (the null hypothesis--that players play equally well when wissing and losing). The IRC dataset resulted in a p-value of 7.1×10^{-8}, while the kaggle dataset resulted in a p-value of 1.1×10^{-3}. Each of these values fall below the 0.05 threshold, therefore we consider these results significant and reject the null hypothesis.

Methodology and Results Visually

How it works

Each player is processed individually to produce their positive-negative winrate offset. Here we have a labeled example of how that process works.

1.

Each player's data is ordered chronilogically and divided by days. The dotted lines show breaks between days

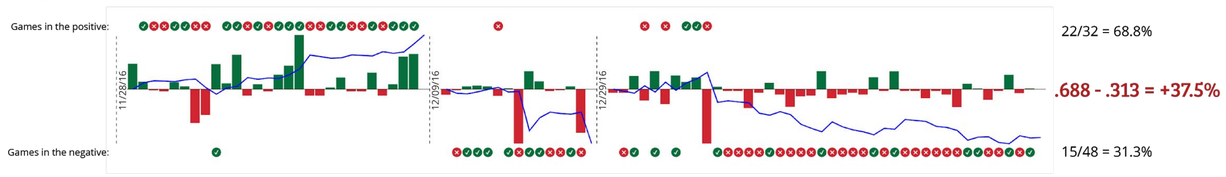
2.

Each game is represented by a bar on the graph below, with size being proportional to net gain. Red bars below the zero line are losses, and green bars are wins. We've ommitted games with zero net gain for clarity.

3.

Next, a running total of net gain is calculated for each day. This is represented the blue line. If the blue line is below the zero line, the player has lost money that day or is "in the negative." If it's above, they are "in the positive."

Real data:



4.

Now we tally each player's wins and losses in the positive and in the negative. Each circle with a "check" or "x" represents a win or a loss, respectively. If it's above the graph, it's a win or loss in the positive. If it's below, it's in the negative.

5.

These wins and losses are summed to get a win rate in the positive and a win rate in the negative. In this case, the player won 22 out of 32 games in the positive (68.8%) and won 15 out of 48 games in the negative (31.3%)

6.

Finally, we control for skill and eliminate noisy data. First, we exclude players who have played fewer than 50 total games, fewer than 10 games in the positive, or fewer than 10 games in the negative. To control for skill, we take the difference of each player's positive and negative win rates.

7.

All in all, this should result in a win rate difference of 0% if a player has equal chance of winning whether they are in the positive or negative. This player, however had a +37.5% winrate in the positive. Averaging all eligible players, the winrate diffential was -0.50% for the IRC dataset, and -1.7% for the kaggle dataset.

Conclusion

Claim: Players tend to improve their performance when in a losing session

This shows that players who are in a losing session become more thoughtful about their hands. The results could suggest that players in a poker round should be more aware of players who are net-negative in the session. Moreover, it could imply that the expected value of an arbitrary player's winnings of a poker session is not negative.

Additionally, the results can be used to determine if the average poker player, and more broadly the average person, is rational. If an event motivates someone to make better decisions, was that person initially rational? For instance, if an arbitrary player goes all-in preflop with low pocket pairs, having only called in a losing session, is the player rational? It appears that they are not rational, and are vulnerable to being exploited by those who are rational, especially in a game of poker.

To further examine these results, we could test how other factors affect win rate, such as position in a hand and betting patterns. Moreover, we could test how to take advantage of these results. For instance, should a player in a winning session play more conservatively based on our findings? These outcomes could even provide us with a profitable poker strategy.

References

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