Design an Innovative Poker AKQJ Game and Study Players' Psychological Characters

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Abstract

Poker is a very popular gambling game in casinos, but except professionals, most poker players lose money without applying probability statistics. This paper studies the poker probability by using a partial deck (a total 16 AKQJ cards with up to 6 players). The authors have used combination formula and derived general formulas of matching probability for each matching pattern. To simplify probability simulation, partial deck poker game was designed which can increase the matching probability significantly on some higher ranked patterns such as "Full House". With this creative AKQJ game, the winning patterns are down to "Four of a Kind", "Full House", "Three of a Kind", and "Two Pairs". If all 6 players are playing, this Poker AKQJ game can be very competitive since the basic Poker probability would be calculated to guide each poker player on their betting to avoid any risky move. To study the player's personality and psychology, each player has been assigned different playing characters based on the assigned degree of risk taking. Through this Poker AKQJ data simulation based on the worst-case probability, the poker players may avoid gambling disorder and lose a lot of money.

Keywords
Modeling, Statistics, JMP, Poker, Risk Management

1. Introduction

This introduction section would cover three different subjects: Poker Project Background, Gambling Disorder Psychology, and Innovative Poker AKQJ Game.

1.1 Partial Deck Poker Project Background

Most Poker players lost Money in Poker Gambling since they gamble blindly without applying the poker probability and assessing their risk on each play. Authors have utilized JAVA coding to simulate Poker Probability and study Sample Size effect on Statistics and decision making (Wang 2017, Chen 2018, Chen 2020). The project scope was for a learning purpose, not for gambling purpose. Authors used partial deck (J, Q, K, A) of 16 cards to simplify JAVA poker simulation. The full deck poker for 6 to 7 random cards is very popular in most Poker tournament (Billings 2002, Li 2013). Several research papers have demonstrated and simulated the poker probability by using Monte Carlo Simulation (Ulam 1949), Evolutionary Computing (H. Quek 2009), and Artificial Intelligence (Billings 1998), and there is also an US Patent (Ward 2004) studying the partial deck on Royal Flush probability. Nevertheless, the ranking of Partial Deck may be different from the Full Deck, and the Poker players will have to analyze the complex situations in real time quickly in order to have a reliable judgement. Using less partial deck could simplify the cards' situation and calculation of the winning probability.

1.2 Gambling Disorder Psychology

Gambling disorder, also known as compulsive gambling, pathological gambling, or gambling addiction, is the irresistible impulse to continue gambling. 3-4% of Americans have a gambling disorder. The causes of compulsive gambling are not established as it may be caused by a variety of reasons. Symptoms, however, include personal problems and problems with finances. There are many ways to stop gambling disorder, but they may be expensive and challenging. Gambling disorder may be put to an end by cognitive behavioral therapy. It focuses on the relation between thoughts, feelings, and actions. Support groups provide an opportunity for helping oneself. Many people with gambling disorder gamble to obtain great excitement. Calculating the probability might bring the excitement down and force the players to find an alternative that causes less problems.

1.3 Innovative Poker AKQJ Game

In this paper, the authors will study the Poker Probability by using only the 16-cards Partial Deck (AKQJ) and simulate the players' gambling characters up to 6 players demonstrated in Figure 1. Each player would receive two cards: one is disclosed and one is hidden. To simplify the game simulation, all four shared cards are disclosed and there is only one betting round in this paper. The algorithm developed in this paper can be easily extended to multiple betting rounds as in the formal Poker Tournament. Each poker hand is made up of a few betting rounds. The number of betting rounds depends on the poker variation (in Texas Hold'em there are four betting rounds, on Seven Card Stud there are five, and in Five Card Draw there are just two betting rounds).

Figure 1. 16-Card AKQJ Game Image

Due to the 16 cards limits with a much higher matching probabilities, the winning matching patterns are likely down to Four of a Kind, Full House and Three of a Kind. Section 2 would provide AKQJ game winning probability formula and algorithms. This paper would simulate the last betting round when all four shared cards are released, and each player has one hidden card. 10 out of 16 cards are revealed on the table. Therefore, this 16-cards AKQJ scenario is much simpler than the Full Deck or previous 24-cards Partial Deck to calculate each player's winning scenario in real game. The other objective is to study the players' gambling character and persona on the winning probability.

2. AKQJ Winning Probability

Based on previous 24-cards partial deck research study, the mathematical probability formula can be further modified in this section: Partial Deck Matching Probability, Odds Ratio of Partial Deck vs. Full Deck, and AKQJ Matching Probability.

2.1 Partial Deck Matching Probability

Table I has displayed the matching (m) probability formula of all potential partial deck (m=2~12) to full deck (m= 13). AKQJ game is when the number of cards=16 (m=4). Table 1 provided the most critical Poker mathematics of each matching pattern for the Partial Deck. The partial deck formula may not be applicable to all the matching patterns depending on the partial deck size m. Some matching patterns may require m is at least 5.

Table 1. Partial Deck Matching Probability

	4*m Partial Track		
	Trial	Event	Probability
Royal Straight	C(4m,5)	C(4,1)	C(4,1)/C(4m,5)
Straight Flush		C(4,1)*C(m-5,1)	C(4,1)*C(m-5,1)/C(4m,5)
Four of a Kind		C(m,1)*C(m-1,1)*C(4,1)	C(m,1)*C(m-1,1)*C(4,1)/C(4m,5)
Full House		C(m,1)*C(m-1,1)*C(4,3)* C(4,2)	C(m,1)*C(m-1,1)*C(4,3)* C(4,2)/C(4m,5)
Flush		C(4,1)*C(m,5)-C(4,1)*C(m-4,1)	[C(4,1)*C(m,5)-C(4,1)*C(m-4,1)]/C(4m,5)
Straight		C(m-4,1)* [C(4,1)^5-C(4,1)]	C(m-4,1)* [C(4,1)^5-C(4,1)]/C(4m,5)
Three of a Kind		C(m,1)* C(m-1,2)*C(4,3)*C(4,1)*C(4,1)	C(m,1)* C(m-1,2)*C(4,3)* C(4,1)*C(4,1)/C(4m,5)
Two Pair		C(m,2)*C(m-2,1)*C(4,2)*C(4,2)*C(4,1)	C(m,2)*C(m-2,1)* C(4,2)*C(4,2)*C(4,1)/C(4m,5)
One Pair		C(m,1)*C(m-1,3)*C(4,2)*C(4,1)*C(4,1)*C(4,1)	C(m,1)*C(m-1,3)*C(4,2)* C(4,1)*C(4,1)*C(4,1)/C(4m,5)
Nothing		[C(m,5)-(m-4)]*[C(4,1)^5-C(4,1)]	[C(m,5)-(m-4)]*[C(4,1)^5-C(4,1)]/C(4m,5)

2.2 AKQJ Matching Probability

In order to investigate and evaluate the matching probability of Partial Deck at different "m" size, the authors have compared the matching probability of "Flush", "Full House", and "Straight" with "m" number from 1 to 13 (4 cards to 52 cards) as shown in Table 2. When "m" is too small, some matching probabilities are not available to form these patterns. Also, the trend of the "m" size effect is quite different each other. For example, the "Flush" matching probability decreases when decreasing the "m" number while the "Full House" and "Straight" are opposite. This is expected as we need more cards available to pick five cards to form "Flush (which is the same type of cards) while for the "Full House," we want to reduce the variety of card numbers to form the "Full House". Based on the partial deck probability, we can adjust the odds of poker game by changing the "m" in partial deck (AKQJ game is when m=4 in Table 2).

Table 2. Partial Deck Poker Matching Probability

Trial			Flush				Full House				Straight		
Trial=C(4m,5)			Event=C(4,1)*C(m,5)-C(4,1)*C(m-4,1)			Matching Probability	Event=C(m,1)*C(m-1,1)*C(4,3)*C(4,2)			Matching Probability	Event=C(m-4,1)*[C(4,1)^5-C(4,1)]		Matching Probability
m	4m	Trial	C(m,5)	c(m-4,1)	Event	Event/Trial	C(m,1)	c(m-1,1)	Event	Event/Trial	C(m-4,1)	Event	Event/Trial
1	4	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
2	8	56	NA	NA	NA	NA	2	1	48	85.71%	NA	NA	NA
3	12	792	NA	NA	NA	NA	3	2	144	18.18%	NA	NA	NA
4	16	4368	NA	NA	NA	NA	4	3	288	6.59%	NA	NA	NA
5	20	15504	NA	NA	NA	NA	5	4	480	3.10%	1	1020	6.58%
6	24	42504	6	2	16	0.04%	6	5	720	1.69%	2	2040	4.80%
7	28	98280	21	3	72	0.07%	7	6	1008	1.03%	3	3060	3.11%
8	32	201376	56	4	208	0.10%	8	7	1344	0.67%	4	4080	2.03%
9	36	376992	126	5	484	0.13%	9	8	1728	0.46%	5	5100	1.35%
10	40	658008	252	6	984	0.15%	10	9	2160	0.33%	6	6120	0.93%
11	44	1086008	462	7	1820	0.17%	11	10	2640	0.24%	7	7140	0.66%
12	48	1712304	792	8	3136	0.18%	12	11	3168	0.19%	8	8160	0.48%
13	52	2598960	1287	9	5112	0.20%	13	12	3744	0.14%	9	9180	0.35%

Authors further plot the trending of matching probability vs. "m" size in Figure 2 to illustrate observations visually. There is ranking switch between "Flush" and "Full House" when "m" = 12. AKQJ game is when m=4 in Figure 2. At m=4, Full House Matching or better Matching Probability is close to 8% for each individual player. If we have 6 players playing in the Poker AKQJ game, there is about a 50% chance that the winner must get a big hand of at least Full House or Four of a Kind to bet more chips and increase the stakes.

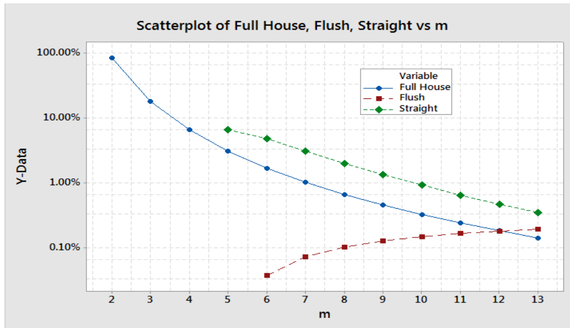

Figure 2. Eigenvector Loading Plot

3. Simulate AKQJ Poker Game

This section will develop probability algorithm to simulate players' gambling psychology: Poker Player Characteristics, Calculate Overall Winning Probability, Worst-Case Winning Probability, Sample Size and Power, and 6-Player AKQJ Data Collection Plan.

3.1 Poker Player Characteristics

The gambling characters are based on the level of risk taking. The 1st Player (A) is blindly gambling and will stay in the betting round no matter what cards he or she receives (0% winning Probability). The 6th Player (F) is very conservative, and he will stay in the betting round only when he has 100% confidence (100% winning probability). The other four Players (B-E) will stay when there is 20%, 40%, 60%, 80% winning probabilities. When calculating the winning Probability for any player, we will extend the previous 2-player algorithm to a 6-player algorithm that will be addressed in next section.

3.2 Calculate Overall Winning Probability

For calculating the winning probability of the Player A, two-player algorithm would be utilized to calculate the winning probability of Player A against each other players such as P(A vs. B), P(A vs. C)…., P(A vs. F). The overall winning probability of Player A is when Player A can win over all the other players. Therefore, the overall winning probability is P(A)= P(A vs. B)*P(A vs. C)*…*P(A vs. F). Same calculation would be applicable to the other players, but such calculation is impossible and not effective in the real time gambling. Authors played the AKQJ game and, in average, it takes more than 5 minutes to calculate the overall winning probability for any player. Unfortunately, most Poker Games only allow players one minute to determine the betting decision. We need to find a better alternative algorithm for the players to estimate their winning probability quickly and still precisely in the real Poker Game.

3.3 Simplified Worst-Case Winning Probability

We will use the Worst Scenario Case to simplify the winning probability algorithm. The worst case of Player A when against Player B is Player B has the best card (still available in the five hidden cards). Even though the best card is only at 1 out of five chance (20%). We will take this simple approach for each player to calculate their winning probability against the other players still on the table with their best card scenario (the worst case for this player). The overall P(A) would be calculated based on how many players that player A can win at the worst-case scenario as shown in Table 3.

Table 3. Worst-Case Winning Probability

Player A	Worst Scenario	Individual Winning%
B	Win	100%
C	Lose	0%
D	Win	100%
E	Win	100%
F	Lose	0%
Overall Winning %		60%

3.4 Design AKQJ Data Collection Template

The calculated sample size needed is 92 and each game would take 20 minutes roughly for each player to execute their psychology character role by calculating the worst-case winning probability. It will take over 30 hours to complete 92 data sets. Prior to collecting the data, a specially designed data collection template, Table 4, was made to collect the necessary data information such as all card distribution for shared and each player, calculating worst case winning probability for each player, making a decision of stay or fold, and chips lost or gained in each game for further data analysis. For each player to judge the winning probability based on the worst-case algorithm would probably take 10 seconds and would take less than 1 minute on time to decide the overall winning probability against the other five players. You can also smartly sit in the Player F position to allow you more time to do the calculation patiently.

Table 4. Poker AKQJ Game Data Collection Template

	Shared Cards				Player A (0%)		Player B (20%)	
	Card 1	Card 2	Card 3	Card 4	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution								
Worst Case Overall Winning Probability					No need to Calculate			
Stay or Fold in the Betting Round					Always Stay			
Results (win or lose chips)								

3.5 Card Shuffling Bias and Random Generation

Card shuffling randomness is very critical to the fairness of playing any poker game. Certain players may complain that they have a particular bad day if the cards shuffling is not random enough (Klarreich 2005, Bayer 1992). To avoid such shuffling bias, authors have first taken the standard card distribution sequence as shown in the Table 5. The card distribution sequence would follow the standard poker game.

Table 5. AKQJ Game Care Distributing Order

Shared Cards				Player A (0%)		Player B (20%)	
Card 1	Card 2	Card 3	Card 4	Open	Hidden	Open	Hidden
7	8	15	16	1	9	2	10
Player C (40%)		Player D (60%)		Player E (80%)		Player (100%)	
Open	Hidden	Open	Hidden	Open	Hidden	Open	Hidden
3	11	4	12	5	13	6	14

Then, a random number generator was utilized to determine the distribution order of the 16 A-K-Q-J cards as shown in Table 6.

Table 6. Random Card Generation

Card Type	Card Order	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10
S-A	1	S-K	D-K	D-Q	C-Q	H-K	C-J	D-J	C-Q	C-J	D-A
S-K	2	C-J	S-Q	C-J	S-K	D-K	H-Q	D-Q	S-Q	C-A	D-K
S-Q	3	S-A	C-A	D-K	H-Q	H-J	S-J	S-Q	D-Q	D-Q	H-J
S-J	4	C-K	D-A	S-J	S-J	S-Q	D-K	D-A	C-J	C-Q	C-J
H-A	5	S-Q	D-J	S-K	S-Q	H-Q	C-Q	H-J	H-K	H-A	S-J
H-K	6	D-A	H-A	H-K	C-K	D-J	H-J	H-A	S-J	S-K	S-K
H-Q	7	S-J	H-Q	D-J	H-J	H-A	D-A	C-Q	S-A	H-J	S-A
H-J	8	D-K	S-A	C-K	D-J	D-A	D-Q	C-K	H-Q	D-J	C-K
D-A	9	D-Q	H-J	H-A	S-A	D-Q	S-Q	D-K	D-A	C-K	D-Q
D-K	10	H-Q	C-Q	S-A	H-A	S-J	D-J	C-A	C-K	D-A	D-J
D-Q	11	C-Q	C-K	S-Q	C-J	C-K	S-K	S-A	H-J	H-K	H-K
D-J	12	H-J	S-K	C-A	C-A	C-Q	C-A	H-K	D-J	S-Q	C-Q
C-A	13	H-K	S-J	C-Q	D-A	C-A	C-K	H-Q	H-A	S-J	C-A
C-K	14	H-A	D-Q	H-Q	D-K	S-A	S-A	C-J	C-A	H-Q	H-Q
C-Q	15	D-J	H-K	D-A	H-K	S-K	H-A	S-K	D-K	S-A	H-A
C-J	16	C-A	C-J	H-J	D-Q	C-J	H-K	S-J	S-K	D-K	S-Q

3.6 First AKQJ Data Set and Analysis

Instead of completing 92 data sets, authors have decided to start the first run and results as shown in Table 7. The Player A (2-pairs) won the game even though Player B (Three of a Kind), Player D (Full House), and Player F (Full House) have higher ranks. This has demonstrated how the player characteristics would impact the Poker Game results. The above results may challenge the current Worst-Case algorithm (which may be too conservative on setting the personality character at higher confidence or winning probability level).

Table 7. The First AKQJ Run Result

1st Run	Shared Cards				Player A (0%)		Player B (20%)	
	Card 1	Card 2	Card 3	Card 4	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-J	D-K	D-J	C-A	S-K	D-Q	C-J	H-Q
Actrual Matching					2-Pairs		J-Three	
Worst Case Overall Winning Probability					No need to Calculate		10% Chance	
Stay or Fold in the Betting Round					Always Stay		Fold	
Results (win or lose chips)					5		-1	
1st Run	Player C (40%)		Player D (60%)		Player E (80%)		Player (100%)	
	Open	Hidden	Open	Hidden	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-A	C-Q	C-K	H-J	S-Q	H-K	D-A	H-A
Actual Matching	1-Pair		J-Full House		2-Pairs		A-Full House	
Worst Case Overall Winning Probability	0% Chance		50% Chance		0% Chance		80% Chance	
Stay or Fold in the Betting Round	Fold		Fold		Fold		Fold	
Results (win or lose chips)	-1		-1		-1		-1	

It may be more reasonable to lower the overall winning probability for the players B-F. Based on the Game 1 results, authors have also calculated the 30 worst case winning probability against the actual results, and only 21 out of 30 (70%) are consistent (worst case is reflecting the actual result). Therefore, it's necessary to lower the confidence players especially on the higher end (Players D, E, F). Otherwise, the high confidence required players may fold their cards most time and let the players with worse cards win the game like Player A in Game 1. Based on 70% consistency of the Worst-Case algorithm, the authors have decided to lower the character confidence level by 5%-20% across Players B-F as shown in Table 8.

Table 8. Revised First Run Result

1st Run	Shared Cards				Player A (0%)		Player B (15%)	
	Card 1	Card 2	Card 3	Card 4	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-J	D-K	D-J	C-A	S-K	D-Q	C-J	H-Q
Actrual Matching					2-Pairs		J-Three	
Worst Case Overall Winning Probability					No need to Calculate		10% Chance	
Stay or Fold in the Betting Round					Always Stay		Fold	
Results (win or lose chips)					-3		-1	
1st Run	Player C (30%)		Player D (45%)		Player E (60%)		Player (75%)	
	Open	Hidden	Open	Hidden	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-A	C-Q	C-K	H-J	S-Q	H-K	D-A	H-A
Actual Matching	1-Pair		J-Full House		2-Pairs		A-Full House	
Worst Case Overall Winning Probability	0% Chance		50% Chance		0% Chance		80% Chance	
Stay or Fold in the Betting Round	Fold		Stay		Fold		Stay	
Results (win or lose chips)	-1		-3		-1		8	

The new results are more reasonable. Player A should not win the game. Player D with a strong J-Full House should stay in the game. Player F won the game. This new released Players' Characters (Confidence Level) should reflect more to what the real Poker tournament is. Authors have decided to take these modified characters to complete the remaining games.

4. Results

In this section, authors have continued and completed the first Poker AKQJ random runs to validate the worse-case algorithm and investigate the gambling characters' impact on the AKQJ game results.

4.1 Summary of Poker AKQJ Card Patterns

Based on 5 runs data shown in Table 9, the worst-case consistency is about 67% to match the true situations. This result may indicate that there is a 33% chance players may be too conservative to bet their final round based on the worst-case scenario and lose their potential winning run. The most inconsistency is due to Player A who is blindly betting the final round no matter what cards in hands with only 30% consistency. By excluding Player A, the other players together have about 74% on average to match the true situation which is actually very close to the Player F confidence setting at 75%.

Table 9. Summary of AKQJ Card Patterns

		Actual Card Distribution					
Runs	Worst Case Consistency	1-Pair	2-Pairs	3-Kinds	Full House	4-Kinds	Winner (Should be)
1	70%	1	2	1	2	0	Full House
2	77%	0	4	2	0	0	3-Kinds
3	83%	0	4	0	2	0	Full House
4	57%	0	3	1	2	0	Full House
5	48%	0	4	1	1	0	Full House
	67%	3%	57%	17%	23%	0%	

The other interesting part is the matching pattern distribution. The small subset of Poker AKQJ 16-cards game is significantly different from the Full Deck 52-cards. For example, 2-pairs winning is higher than 1-pair, and Full House is higher than 3 Kinds since each player has a 23% chance to get Full House. Among 6 Players in Poker Game, the probability of at least one player has Full House= [1-0.77^6] = 79% which is very close to our 5-runs results at 80% (only the 2nd round winner not having the Full House). Therefore, this would be another helpful information for any player in the Poker AKQJ game that any player with their rank lower than Full House should not take any risk to bet big money in the final round. The other important observation is that the fifth round has significant lower consistency at 48% only. This 5th round may confuse most players in a real game, and the results may surprise players if following the worst-case algorithm.

4.2 Evaluate the Worst-Case Scenario

Table 10 has further evaluated the worst-case algorithm against the true scenario. Among five random runs, the average Worst-Case Best Winning % is around 76%, but only 50% for the 5th round (which is in line with the previous Worst-Case Consistency trend). The 5th round situation is unusual and make this round wide open to most players. By setting the gambling characters' confidence requirements, Players B-F all gave up, leaving Player A as the one staying in the game who won the game eventually. Among the total five rounds, only the 5th round result did not match the actual winner. This has indicated the players' character or personality may still impact the results based on the current worst-case scenario, and there is plenty of room for improving this Worst-Case algorithm.

Table 10. Evaluate Worst-Case Algorithm

	Worst-Case Results			
Runs	Best Card Winning%	Players Stay	W-C Winner	WC Matching Actual Winner
1	80%	3	Full House	Yes
2	80%	3	3-Kinds	Yes
3	90%	3	Full House	Yes
4	80%	3	Full House	Yes
5	**50%**	**1**	**2-Pairs**	**No**
	76%	**2.6**		**80%**

Though the Player A has only 2-Pairs behind two other players, Player E has a higher rank at 3 of a Kind and Player F has a Full House. If Player E can add one more rule based on Full House Chance at 23% chance in addition to the existing Worst-Case algorithm, Player E may stay in the game and win this 5th round as shown in Table 11.

Table 11. 5th Run Result

5th Run	Shared Cards				Player A (0%)		Player B (15%)	
	Card 1	Card 2	Card 3	Card 4	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-J	D-K	D-J	C-A	S-K	D-Q	C-J	H-Q
Actrual Matching					2-Pairs		2-Pairs	
Worst Case Overall Winning Probability					No need to Calculate		0% Chance	
Stay or Fold in the Betting Round					Always Stay		Fold	
Results (win or lose chips)					5		-1	
1st Run	Player C (30%)		Player D (45%)		Player E (60%)		Player (75%)	
	Open	Hidden	Open	Hidden	Open	Hidden	Open	Hidden
1st Game Cards' Distrbution	S-A	C-Q	C-K	H-J	S-Q	H-K	D-A	H-A
Actual Matching	2-Pairs		2-Pairs		A-3 Kind		A- Full House	
Worst Case Overall Winning Probability	0% Chance		0% Chance		0% Chance		50% Chance	
Stay or Fold in the Betting Round	Fold		Fold		Fold		Fold	
Results (win or lose chips)	-1		-1		-1		-1	

4.3 Which Player Has a Better Performance?

Each round result is also recorded in Table 12. Player F has the best overall performance. It's too early to decide which player character could win more games. Player A is too aggressive and has the most unique character by blindly staying in each game, losing most games as expected. By setting 75% as the Confidence level, Player F has the highest score and did not make any mistake staying in the betting round. However, Player F also missed the 5th round which he was supposed to win due to having only 50% confidence based on the current worst-case algorithm even with a Full House.

Table 12. Players' Win or Lose Summary

	A	B	C	D	E	F
1	-3	-1	-1	-3	-1	9
2	-3	9	-1	-1	-3	-1
3	-3	3	-1	3	-1	-1
4	-3	-1	-3	-1	-1	9
5	5	-1	-1	-1	-1	-1
Total	**-7**	**9**	**-7**	**-3**	**-7**	**15**

4.4 Future Work

Each Poker AKQJ run takes one author about 30 minutes to collect the raw data and summarize the results and pattern; thus, it is impossible to complete the 92 datasets manually. The authors are developing a Python code to automatically simulate these random AKQJ runs and summarize the results using programming. Also, as mentioned in this paper, there is still room for improving the Worst-Case algorithm by either optimizing the characters' confidence setting or adding additional rules like the Full House situation. The shuffling bias may be also addressed. This game can also be easily expanded from current one betting round to multiple betting rounds. The other opportunity is to consider the number of players still in the game as the game progresses, less and less players are still in the game which would impact the calculation of the worst-case scenario since less hidden cards may complicate the calculation and impact the character settings. 2-Players case may prefer more accurate calculation on the worst-case algorithm.

5. Conclusions

This innovative AKQJ Poker Game has significantly simplified the winning probability calculation. The worst-case algorithm has made it feasible that the Poker players could calculate their overall winning probability and make a rational betting decision based on their pre-set risk-taking character. The simplified AKQJ game has significantly minimized the players' emotional character and limit players' tricks to confuse the winning probability. The winner of each run becomes more random and less dependent on players' psychological characters while calculating the winning probability quickly in real poker game becomes more critical.

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