ACADEMY OF PROFESSIONAL DEVELOPMENT

Integrative Learning Student Artifact

Final Research Assignment: Poker and Game Theory Optimal

Abstract: Millions of people around the world play poker every year, with the invention of online poker, the popularity of the game has surged and so has the use of game theory optimal in poker. This paper compiles previously completed work in order to get a better understanding of what factors if any of game theory optimal has had on the game of poker and how people play the game. Through this paper, I examined the history of the game, game theory optimal and how game theory optimal had affected the game. From my research, I can conclude that the game theory optimal has changed the game and the way people play the game today. The Implications of these findings are discussed in the paper and how this information can be used to understand game theory optimal and how it can be applied to poker.

Final Research Assignment

Poker is a game that uses strategy, statistics, memory, psychology, and many more skills and abilities that are not solely specific to the game of poker but surely help you succeed. The smallest miscalculation of a range or misread of a bluff could cost you everything, and that is what makes poker so interesting. With the constant demand by players to gain an edge on their opponents the game of poker has become more challenging and the players have become more skilled than ever before. Throughout this paper, I will be looking at the history of the game of poker, how it has evolved over the years, what game theory optimal is, and how it can be applied to the game of poker today. Through compiling previously completed work, I will determine what effect if any the use of game theory optimal has had on the game of poker and how players use it to gain an advantage on the other players. As an economics major this topic of game theory optimal is very applicable to my future work. I will work from the knowledge I currently have of game theory optimal from previous mathematics and Economics courses while adding to my knowledge with information I gain from this research.

The first thing that my research looked at was how the game of poker is played. When looking at how to the game is played you will see that there are multiple different rounds throughout each hand. Each hand begins with two forced bets known as the “blind”. The small blind is put in each round by the person directly the left of the dealer and the big blind is put in

by the person to the left of the little blind (Billings et al., 2003). The dealer changes every round so this will also change who the blinds are. Poker consists of 4 rounds with each round being followed by a round of betting. After each round, each player at the table must decide if they would like to bet/raise, this would consist of raising the amount of money they have invested in the pot, The next choice would be to check/call this is when a player chooses to match the previous bet that had been made and lastly, a player could fold, when a player folds they give up on the hand and are no longer able to win the pot (Billings et al., 2003). The first-round is known as the pre-flop, each player at the table is dealt two cards face down. The next round is what is called the flop, the flop consists of 3 community cards that can be used by every player are dealt face up so that everyone can see. The third round is known as the turn card which is another community card. The last round is the river card, this is the last community card that is dealt face up. The goal of poker is to have a better hand than your opponent by making the best 5 card hand using your 2 pre-flop cards and the 5 community cards. (Billings et al., 2003)

Like most games, the game of poker that is currently played today comes from other games from the past. The games that closest resemble the current game of poker are games like "As Nas" a Persian card game or the Chinese domino card game that was played by 10th century Chinese emperors (History.com, 2013). As the game slowly evolved, we see other games such as Poque, a popular game from the 1700's that made its way to what is now the United States by French settlers (History.com, 2013). The card game spread across the country and slowly began to gain popularity. As the game grew in popularity more games were created. A card game called Texas holdem began to become the most played game. In 1970, Texas holdem was the game played at the world series of poker (History.com, 2013). As poker became more televised, the fan base grew addition of things such as hole cam enhanced the viewer's entertainment by allowing the viewer to see the cards of the players. Poker became even more popularized when it was brought to the big screen with films like the 1998 movie rounders that stared Matt Damon and even more currently films like Molly's Game or the casino royal film from the bond series. The game only continued to grow with the invention of online poker allowing players to play multiple games at once all around the world. Today it is estimated over 100 million people play poker around the world (History.com, 2013). As online poker became more available, players have more time to work on specific strategies and types of game play that was previously unavailable. With the expansion of online poker players are able to showcase their skills and abilities that might not of had opportunity to do so before. Annette Obrestad who made history as the youngest person to ever win a world series of poker bracelet is an avid online poker player. After Annette won, she was interviewed by Pokerlistings she was asked if online poker helped her learn the game faster, her response "Oh for sure, i've played thousands of tournaments online. Most professionals only play 60 or so live tournaments a year so I think I have an advantage there." Online poker has also given players an opportunity to display their skills, try different strategies and just gain more experience. Another player that showcased their ability on online poker was Chris Moneymaker. Chris in 2003, made history by being the first player to win the

world series of poker after qualifying on an online poker website. (Chris Moneymaker - How He Got Started and Where He's at Today 2019). With access to countless games at their fingertips, may players have started using Programs that allow a player to go back and see the best outcome and play that could have been used. These programs use a branch of mathematics that is known as game theory optimal, by using these programs players can deduce a strategy that can then be implemented into a live game whether it be online or in person. (*Best Poker Trainings Software - Cardplayer Lifestyle* 2020)

Game Theory Optimal (G.T.O.) is defined as "study of mathematical models of strategic interaction among rational decision makers" (Microsoft Academic). Mathematicians use game theory to predict or explain a certain behavior, but Game theory can also be used by economist while analyzing strategies, by business men in negotiations, and used by poker players who have applied it to the game of poker (Ross, 2019). Game theory optimal dates back to a 1944 when John von Neumann a Hungarian- American mathematician and his college Oskar Morgenstern who was an economist published their work titled *Theory of games and economic behavior* (Ross, 2019). The original creation of game theory was to be used in decision making in economics, but they and others found that it was also applicable to other aspects of the world. As more work was done on the topic of Game theory, a Mathematician named John Nash coined what is known as the Nash equilibrium. John Nash describes the equilibrium a stable situation where all participants are making the best choices they can, given the choice of the opponents (Ross, 2019). Nash also stated that for any games with a finite set of actions there must be at least one Nash equilibrium must exist in such a game" (Pedrycz, 2016)

The first example of G.T.O. "games" I will look at is the prisoner's dilemma, in this scenario two people are arrested for having possession of stolen goods, but the police that arrested them didn't have enough evidence of them committing the theft to convict the. In order to get a convection, the police need one person to confess on themselves or the other person that is being interrogated. What makes the decision difficult is that each person does not know what the other will choose. This game is an example if a game with imperfect information (Gallego).

		PRISONER 2	
		Confess	Lie
PRISONER 1	Confess	-8 , -8	0 , -10
	Lie	-10 , 0	-1 , -1

(Figure 1)

As we see above in figure 1 if both prisoners stay silent and don't confess, they would each only

get a single year in prison, if one prisoner confesses, and the other lie, the person that confesses goes free and the other serves 10 years in prison. Lastly, if both prisoners confess they will each serve eight years. When it comes to making the decision on whether to confess or lie, each prisoner must consider what the other will do because their outcome depends on the others decision. So, each prisoner must make their decision based what they think the other prisoner will do. In this example, prisoner one examines what choices prisoner 2 can make, if prisoner 2 confesses they will either get an eight-year prison sentence or he will go free. On the other hand, if he lies, he will either face a one-year sentence or a fill 10 years. It can be concluded that prisoner 2 will confess because that is the better choice for themselves, given this conclusion if prisoner 1 confess they will face an eight-year sentence, or he could lie but given prisoner 2's decision this would result in him receiving 10 years. With all this being said the Nash equilibrium in the prisoner's dilemma is for both to confess (Gallego).

Another version of a game that can easily be look at is known as the battle of the sexes. In this version of the G.T.O. game there is perfect information meaning both players have knowledgeable of each other's choices. In this game the two players have to decide what they are going to do on a specific night, Like the prisoner's dilemma each player has two choices, choice one is to go shopping while choice two is to go to a boxing match, but unlike prisoner's dilemma these two players only gain something if the two of them choose to do the same task. For this example, they will gain utility (Gallego).

		WOMAN	
		Boxing	Shopping
MAN	Boxing	2 , 1	0 , 0
	Shopping	0 , 0	1 , 2

(Figure 2)

As you can see in figure 2 there are choices that each player could choose that would give them no utility in return due to the fact they are not doing the same activities. For example, if the man goes to the boxing match and the women shopping, they both receive nothing. On the other hand, if they choose to both go to the boxing match the man receives 2 utility and the woman receives 1 and the inverse if they both go shopping the woman receives 2 and the man only receives one. So, in the battle of sexes there are two Nash equilibrium both can be seen in underlined red in figure 2. (Gallego) (Brams, 2020).

When playing poker there are multiple different types and styles of play. With some games having upwards of seven people playing at once you are bound to come across many of these different styles of play. The first style that is noticeable is how many hands a person

chooses to play, a loose player is someone plays a lot of hand while other players have a tight style, meaning they play very few hands. Another very noticeable style of play is how a player bets some play very aggressive meaning they bet a lot and while other players are passive and are more likely to call. (Panone). These 4 main types of players are loose-passive, loose-aggressive, tight-passive, and tight aggressive (Panone). When it comes to playing using G.T.O. it is crucial to use what is called mixed strategy. This is using different strategies across multiple hands in order to keep you opponent from exploiting you (Masterclass, 2020) This is due to the fact that G.T.O. play is more of a defensive strategy that is used to keep one from being exploited but does not focus on exploiting other players (8). With that being said G.T.O. is best used over multiple hands of poker rather than single hands. In order to best use G.T.O. you must narrow downs your opponent's range as much as possible in order to best understand their strategies (8).

With the development of the Nash equilibrium and using online computer software many people have attempted to solve games that apply. Many perfect information games have been solved by computers. The first being the computer program Chinook that won the first checkers world championship another was Deep Blue, the first computer software to defeat a person in checkers (Bowling et al., 2017). with the constant desire to solve these games the university of Alberta has developed two computer programs to play limit Texas holdem against each other. What the University of Alberta accomplished by teaching the two programs G.T.O. was that the two programs were unable to gain an advantage or an edge of more than one percent on their opponent (Bowling et al., 2017). Both computers were playing a using truly G.T.O. strategies and by doing so they never gave their opponent the ability to exploit them. With that being said if you were able to calculate the Nash equilibrium and range for each hand of limit Texas holdem you never allow the opponent to gain an edge on you. These two computers were only able to solve limit holdem but would only be applicable for no limit Texas holdem due to the fact that no limit Texas holdem does not follow the same rules as limit.

G.T.O. may not be able to completely solve no limit Texas holdem but it has completely changed the way people play the game today. While looking at how the style of play has evolved over the last 50 years I noticed that the amount of people playing using some amount of G.T.O. has significantly increased. Poker player and author of *Mathematics of Poker*, William Chen who is a quantitative analyst who has used his math ability to his advantage. Chen has is a two-time world series of poker bracelet winner has had great success in the poker world by using G.T.O. to develop game play that protects himself from being exploited. G.T.O. has also had an effect of the style of players we see today when poker was rising to its current popularity the number of players that would be described as exploitive was much higher than it is now. An exploitive player looks for a specific imbalance or flaw in some one else's play and attacks that players flaws in order to gain an advantage. The problem with this style is that the exploitive players leaves the opportunity to get exploited themselves. Using G.T.O. the objective is to become unexploitable. As I mentioned earlier in the paper G.T.O. is a strategy that is not necessarily about maximizing your winnings but rather the rational move that leaves you not as

vulnerable (Billings et al., 2003). In order to be effect G.T.O. must be played across multiple hands, if a player plays perfect G.T.O. across an unlimited amount of hands that player in theory would in the long run not lose money. It is important to look at how G.T.O. can be applied to the game of poker. Poker can be played in many different styles and ways some players are exploitive while other are not, some like to play every hand while others play very few. No matter how you play poker, it is crucial for long rate success to play with probabilities and range of hands. As discussed throughout the paper G.T.O. is not vital to play with but will help players in the long run. G.T.O. play can also be a great defensive strategy against a player who you are not familiar with by using G.T.O. you will not stray too far outside of your range and thus preventing you from exploitation.

In closing, this paper looked at the short but extremely rich history of the game known as Texas holdem. This paper took a look at how the game made its way to the United States, how to play, the people who have played and the different styles that people use at the table. With such a short history the game is only going to grow in popularity and in the public eye as poker is portrayed more in the spotlight due to its presence in many Hollywood movies. I also dove into the history of game theory optimal, how it can be applied to poker and multiple examples of game theory "games". Lastly, I examined how G.T.O. has changed the game of poker and how people play today. What I found from this examination was that G.T.O. has given poker players the ability to play poker while using an established playing strategy in order to not get exploited by your opponents and increase the amount of hands you win. With that being said most great poker player do not play strictly Game theory optimal, players stray away from G.T.O. in order to gain an edge or exploit their opponents, the key here is not to stray too far from G.T.O. so that your opponent can exploit you (Billings et al., 2003). In conclusion from my research I feel that G.T.O. has not only had a positive effect on the game of poker by making it more competitive but it has also had an effect on the style of play in poker today. To end, G.T.O has given the opportunity to plays to no longer play by simpling feeling out their opponents and looking for tells but rather using probability, range and pot odds to better determine the likelihood of winning the hand.

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