Are ChatGPT and GPT-4 Good Poker Players? - A Pre-Flop Analysis

Akshat Gupta
UC Berkeley
akshat.gupta@berkeley.edu

Abstract

Since the introduction of ChatGPT and GPT-4, these models have been tested across a large number of tasks. Their adeptness across domains is evident, but their aptitude in playing games and specifically their aptitude in the realm of poker has remained unexplored. Poker is a game that requires decision making under uncertainty and incomplete information. In this paper, we put ChatGPT and GPT-4 through the poker test and evaluate their poker skills. Our findings reveal that while both models display an advanced understanding of poker, encompassing concepts like the valuation of starting hands, playing positions and other intricacies of game theory optimal (GTO) poker, **both ChatGPT and GPT-4 are NOT game theory optimal poker players**.

Through a series of experiments, we first discover the characteristics of optimal prompts and model parameters for playing poker with these models. Our observations then unveil the distinct playing personas of the two models. We first conclude that GPT-4 is a more advanced poker player than ChatGPT. This exploration then sheds light on the divergent poker tactics of the two models: ChatGPT's conservativeness juxtaposed against GPT-4's aggression. In poker vernacular, when tasked to play GTO poker, **ChatGPT plays like a Nit**, which means that it has a propensity to only engage with premium hands and folds a majority of hands. When subjected to the same directive, **GPT-4 plays like a maniac**, showcasing a loose and aggressive style of play. Both strategies, although relatively advanced, are not game theory optimal.

1 Introduction

ChatGPT and GPT-4 are immensely powerful language models, capable of previously unimaginable tasks. These LLMs go beyond language understanding tasks and are able to do mathematics Frieder et al. [2023] and reasoning Liu et al. [2023], competitively passing bar exams for becoming a board certified lawyer Bommarito II and Katz [2022]Katz et al. [2023], being able to understand human emotions Elyoseph et al. [2023] etc. Playing games require a combination of many such skills, which makes it an interesting setting to test the capabilities of these models. While much attention has been given to analysing the capabilities of Large Language Models (LLMs) on different language understanding and reasoning tasks, evaluating their abilities in game playing in currently understudied. Poker is one such complex game that requires a combination of skills including mathematical analysis, reasoning, strategic decision making and understanding human behavior and human psychology. Game theory and exploitative decision making based on opponent behavior are at the heart of the game. In this paper, we put ChatGPT and GPT-4 to the test and evaluate their ability to play the game of poker.

Poker is a popular card game that is played in various forms throughout the world. The game consists of multiple rounds, where players receive private information in the form of their own cards, and

Figure 1: An example pre-flop setting.

public information is gradually revealed in the form of shared cards, known as the 'community cards'. Players make decisions based on their current hand strength, possible future outcomes, and inferred information about opponents' hands based on their actions and previous style of play. This makes poker a fascinating instance of *incomplete information game*. While some efforts towards evaluating LLMs in playing games have recently begun Tsai et al. [2023]Akata et al. [2023], it still remains a rather unexplored dimension along which LLMs are evaluated. To the best of our knowledge, this paper is the first instance of evaluating LLMs at playing incomplete information games. Also, even though Poker is an extremely technical game using game theory solvers to dictate decision making, it has been under studied in the machine learning community. Our paper to the best of our knowledge is first works in studying the use of language models for playing Poker.

The most popular variant of poker is called *Texas No-Limit Hold'em* (NLH) that epitomizes the challenge of decision-making under uncertainty and incomplete information. In this variant, each player is dealt two private cards, and five community cards are dealt (not all at once) face-up on the board visible to everyone. There are four different rounds of betting that happen in Texas NLH as explained below:

- **Pre-Flop** : This round of betting happens right after the players see their two private cards. Players have to choose from a few choices in poker including betting, folding, raising etc. The different kinds of decisions made in NLH poker are discussed later in the paper.

- **Post-Flop** : Once the pre-flop betting round finishes, three community cards are dealt face-up at the table visible to everyone. The event of dealing of the first three cards in NLH is called the *flop*. One round of betting happens right after the first three community cards are dealt, called the post-flop betting round.

- **Post-Turn** : After the post-flop betting round, a fourth community card is dealt, again face-up and visible to everyone, called the *turn* card. Another round of betting happens after the dealing of the turn card.

- **Post-River** : After post-turn betting round, the fifth and final community card is dealt, also face-up and visible to everyone. The final card is called the **river** card which is followed by the final round of betting.

In this paper, we study the pre-flop decisions made by ChatGPT and GPT-4 in a 9-player Texas No-limit Hold'em poker game, when the LLM's are the first to act in the game. Pre-flop betting is the simplest of the four betting rounds in poker. The three main factor determining the betting in this round are the private cards held by the player, the position at which the player is playing at, and previous pre-flop bets if any by other players. *Position* in poker refers to the order in which a player acts pre-flop. We go into more detail about positions in poker in a later section. Early action positions (where a player needs to act before other players) need to be played with more caution and players usually only play the best hands from early positions, whereas later positions can play a larger number of hands based on the actions of the previous players and their private cards.
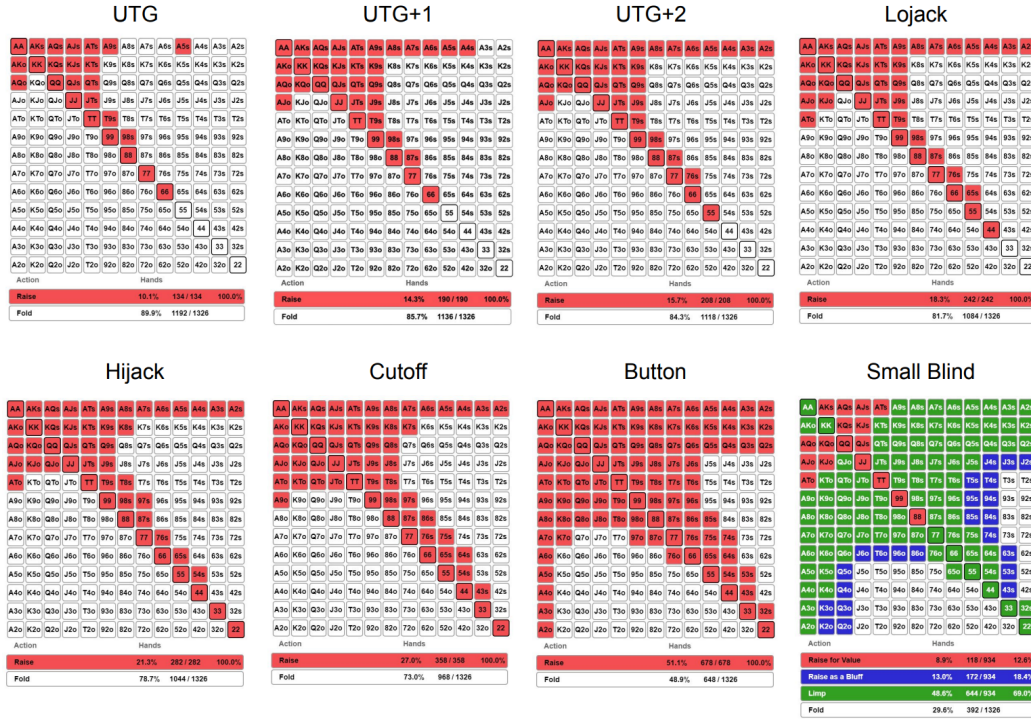
Raise First In (RFI)

Figure 2: GTO pre-flop strategy in Raise First In spots. The red color shows raised hand, green show limped hands, and white shows folded hands.

While LLMs like ChatGPT and GPT-4 were trained on a large amount of internet data, to the best of our knowledge, they were not trained to specifically play poker. The internet is full of information about poker, including multiple lessons and poker charts describing game theory optimal (GTO) poker, and a lot of discussions about hands and how to play them on online forums. Any knowledge that these models have about the game of poker would be implicitly learnt through these sources. With the vast amount of knowledge that these models have, its expected for these models to know about the game of poker; but being able to play the game optimally cannot be assumed. We evaluate the poker decisions made by ChatGPT and GPT-4 by comparing them to GTO poker decisions in the same situations.

This paper is written for both the AI community and the Poker community, with a focus on introducing advanced poker concepts to the AI community. Domain specific terminology is used from both domains, but this paper contains a more verbose introduction to poker. Even for people familiar with the game of poker, we highly recommend reading sections 2.1 and 2.2. These sections contain advanced poker concepts of *poker charts* and *game theory optimal poker* which form the basis of this paper and allows us to study decisions made by LLMs with some technical rigor.

2 The Pre-Flop Setting in No-Limit Hold'em Poker

In this paper, we ask ChatGPT and GPT-4 to make pre-flop decisions in a 9-player NLH poker game. Figure 1 shows the pre-flop setting in a 9-player Texas NLH game. The pre-flop round is the first betting round in the game which happens right after the private cards are dealt to the players. As part of standard poker rules, two players have to put a specific amount of money on the table without seeing their private cards. These players are called the *blinds*. The player called the *small blind* puts in half of the minimum bet that can be made in the game. The player called the *big blind* has to put an amount equal to the minimum bet that can be made in the game. The minimum bet in the game is a pre-decided quantity that is usually fixed for the duration of the entire game (considering

standard cash games). Coincidentally, the amount of the minimum bet is also called **big blind** (BB). For example, if the minimum amount you can bet at a table is 3$, then 1 BB = 3$. A common starting bet in poker is 3 BB, which in this example would be equal to 9$. To clarify for the readers, big blind is a term used both for a position in poker and the minimum amount that can be bet in a game, and is disambiguated by the context. We will be using the abbreviation *BB* to specifically refer to the amount of minimum bet and will never refer to the position by these abbreviations.

Since the small blind and big blind have to put in the chips without seeing their cards, the first person to act in the pre-flop scenario is the player after the big blind called the *under-the-gun* (UTG) player. The players next to act after the UTG player are called UTG+1 (pronounced as under-the-gun-plus-one) and UTG+2. The next positions are usually middle positions. In a 9 player scenario, the position to act after UTG+2 is called the *Lojack* (LJ), followed by Hijack (HJ), Cutoff (CO) and the Button (B). Position is a very important factor while making any decision in poker. These positions can be seen in figure 1.

In this paper, we study the first step in the pre-flop betting scenario called the **raise-first-in** (RFI). In this scenario, the player is the first to put chips in the pot. This can happen either if a player is first to act (UTG) or if all players before the current player have decided not to play (have folded). Thus, the players usually choose from one of the following basic actions in the RFI scenario:

- **Bet**: The act of placing a wager into the pot during a betting round. In poker, the term *bet* is specifically referred to the scenario when no previous player has wagered chips in the ongoing round, then the first player to wager chips is said to have *bet*. UTG player is the first to bet in the pre-flop round since the blinds do not place a voluntary bet.
- **Call**: The action of matching the bet made by a previous player is called a *call*. In the specific scenario of RFI, if a player matches the 1BB bet made by the big blind, then this calling action is referred to as a *limp*.
- **Raise**: Betting more chips than the bet made by a previous player called a *raise*. If a player raises, other players must either match the increased bet (call), raise it further, or fold.
- **Fold**: Choosing not to match a bet or a raise and therefore giving up any claim on the pot is called *folding*. A player who folds is out of action for the remainder of the hand.

In the RFI pre-flop setting, the only possible actions a player can take are Limp, Raise or Fold.

2.1 Poker Charts

Strategies in poker are represented using poker charts. Poker charts, also known as starting hand charts, are tools designed to guide players in their decision-making process, especially during the pre-flop stage of a NLH poker game. These charts provide a visual representation of the potential strength of each two-card starting hand, and often suggest an optimal course of action (such as fold, limp, or raise) depending on a player's position at the table. Position is crucial in poker as it determines the order of play, and having later position often provides a strategic advantage. The game-theory-optimal RFI pre-flop charts for different positions are shown in Figure 2. Note that there is a different decision matrix for every starting position, and in general, the earlier the position, the fewer hands are played. Poker chart to poker players are what periodic tables are to chemists. All poker players remember many such poker charts by heart to avoid needing computational solvers (which are never allowed in live games) and yet make game-theory optimal decisions.

These poker charts are arranged in a square of 13 by 13. This is a compressed representation of 1326 possible starting hands that a player can have (poker is played with a deck of 52 cards, with the cards divided into 4 suits of 13 cards each). Each starting hand can either be *suited*, which means that both cards belong to the same suit. For the purposes of a starting hand, Ace-King of Diamonds is equivalent to Ace-King of Hearts. The only relevant information here is that the cards have the same suit. Similarly, one combination of suits, example Spade-Hearts, is in no way different from another combination of suits like Club-Diamond. Hence, the only relevant information is that both cards have different suits. Therefore, apart from the numbers of the two cards, the only other relevant information that needs to be considered for making pre-flop decisions is whether the pair of cards are suited or unsuited. The suited cards form the upper diagonal matrix of the poker charts, depicted by 's', and the unsuited starting cards are denoted by 'o' in the lower diagonal matrix of the poker charts, with the diagonal elements containing two cards with the same number, called **pocket pairs**.

4

2.2 GTO Pre-flop Strategy

Poker charts shown in figure 2 contains game theory optimal RFI pre-flop for different positions. The RFI condition assumes that all players before the current player have folded or the current player is the first to act (UTG). Some very easy to observe patterns for GTO pre-flop play is that UTG player folds most hands. As can be seen in figure 2, UTG player folds approximately 90% of their hands, whereas a player on the button only folds 50% of their hands. This shows that one should only play a very restricted set of hands from early positions and can increase their range of cards from later positions. The second immediate observation is that GTO poker does not recommend that you limp (except at small blind position). That means that in general, the GTO strategy pre-flop is to either Raise, or fold. The GTO raise amount is usually considered to be 2.5 or 3 BB.

3 ChatGPT Playing Poker

We now move on to first have ChatGPT (gpt-3.5-turbo) play poker. We specifically analyse ChatGPT's decision making in the RFI pre-flop step. The first step in this process is to choose the right prompts to get ChatGPT to play poker. We experiment with different types of prompts. In the sections that follow, we go through the different prompts tried, our rationale for them and what we learnt about how to play poker with ChatGPT.

3.1 Basic System Prompt

After a lot of experimentation based on analysing model responses, we use the following system prompt to describe the RFI pre-flop setting to ChatGPT:

> *You are playing a 9 player Texas No-limit Holdem poker game. You will be provided with your position at the table and the hand you're holding. Please provide your pre-flop decision.*
>
> *Assume you are the first to act and everyone before you has folded, thus your decisions can be one of fold, raise or limp. If you are placing a bet, please specify your best size in terms of big blinds.*
>
> *Provide your decision without any explanation in the following format: DECISION(Raise, Fold, Limp), N BB (if placing a bet, replace N by bet amount)*

The above system prompt was carefully selected after trying many different prompts. The criteria for selecting the prompt was firstly, being able to appropriately describe the scenario of the game, and secondly, having ChatGPT generate output in the desired format. The first line in the prompt describes the game ChatGPT is playing, which is a 9-player Texas no-limit Holdem poker. ChatGPT is then provided with information about the RFI scenario, where it is asked to assume that everyone before it has folded and it is the first to act in the hand. To further aid ChatGPT in making decisions, we specify the options it has in such a scenario, which is either to fold, raise or limp. Finally, ChatGPT is asked to provide its decision in a specific format as described in the prompt.

3.1.1 User Prompts

The information about the cards and positions is provided as a user prompt. We experimented with two ways of providing the user prompt. In the first settings (called 'verbose'), we expand the name of cards and the *suit* information. In the second type of user prompt (called 'short'), we shorten the card names and the suit information to one letter. An example user prompt for both settings is shown below:

- Verbose : *UTG A,K suited*
- Short : *UTG AKs*

Our rationale for using the two types of user prompts was to describe the private cards as clearly as possible. The *verbose*-type user prompt describes the current hands more elaborately, and we expect the model to perform better with this user prompt. The *short*-type prompt on the other hand is a more

concise representation of the private card information, although it is the standard way of talking about hands in the poker community. All poker charts available online, including the one shown in figure 2, use this notation. The 's' stands for *suited* hands whereas the 'o' stands for *offsuit* hands.
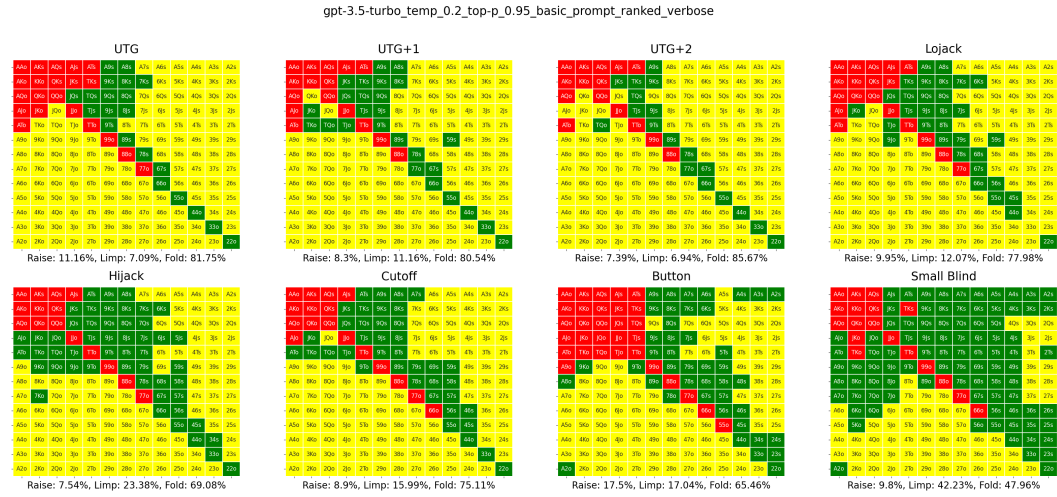

Figure 3: ChatGPT's pre-flop strategy in Raise First in spots. The red color hands show raised hands, green color shows limped hands and yellow shows folded hands. This decision matrix is for **verbose** user prompt.
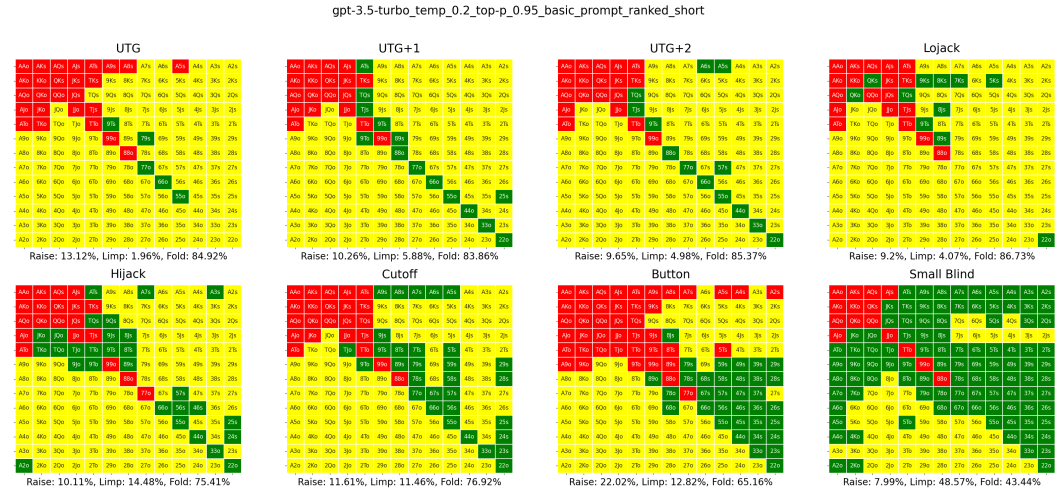

Figure 4: ChatGPT's pre-flop strategy in Raise First in spots. The red color hands show raised hands, green color shows limped hands and yellow shows folded hands. This decision matrix is for **short** user prompt.

3.1.2   Analysing ChatGPT Decision Matrix

Based on the above system prompt and two types of user prompts, we try to recreate the RFI pre-flop decision charts as shown in figure 2 for ChatGPT. The aim is to understand ChatGPT's decision making in this situation and consequently its adeptness in playing poker. With the given system and user prompts, we ask ChatGPT to make a decision of each hand combination on the pre-flop charts at every position. We perform these experiments for three values of temperature (0.2, 0.7, 1.0) and two values of top-p (0.95, 1), thus leading to 6 experiments for each of the two ways of prompting. We prompt the model 10 times for each hand, and choose the most common pre-flop decision made by the model to counteract errors due to sampling based generation. We find that temperature = 0.2 and
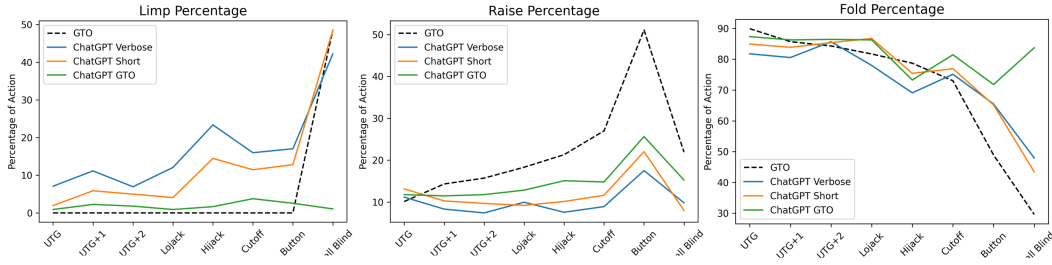
Figure 5: ChatGPT action percentage as a function of position. Action options that ChatGPT has are raise, fold and limp. The positions on the x-axis are ordered in order of action on the table.
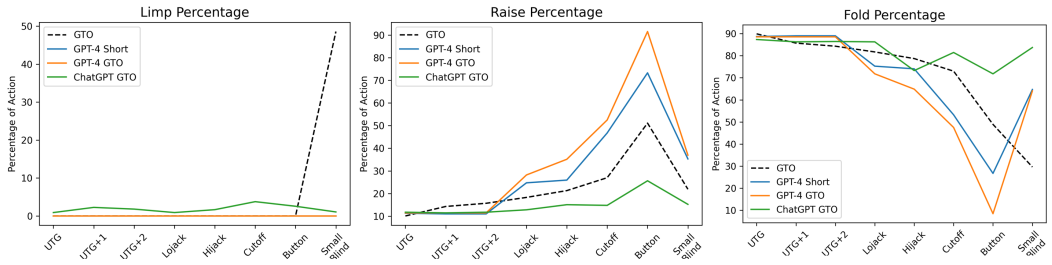

Figure 6: GPT-4 action percentage as a function of position. Action options that ChatGPT has are raise, fold and limp. The positions on the x-axis are ordered in order of action on the table.

top-p = 0.95 produces the most robust results which are closest to GTO results. In this section, we only show results for temperature = 0.2 and top-p = 0.95. The chosen values of temperature lead to generation of most probable answer, thus showing that most probable answer is better that sampling based generation for poker. The remaining decision matrices for all other temperature and top-p values will be presented in the appendix.

ChatGPT's pre-flop decision matrices are shown in figure 3, 4). Since this is our first look at ChatGPT playing poker, it is useful to highlight some non-trivial yet very fundamental observations about ChatGPT playing poker. We want to again remind the readers that ChatGPT is not trained to play poker, but just to predict the next word from a huge corpus of internet text.

- **Observation 1 - ChatGPT Understands Poker:** While ChatGPT's proficiency at poker is debatable, there is no doubt that ChatGPT understands poker at a fundamental level. An easy way to see this is to look at the Poker Charts produced by ChatGPT (figure 3, 4). At every position, ChatGPT always raises with pocket Aces (AA), which is the best starting hand in poker, and always folds 27 offsuit (27o), which is the worst starting hand in poker. It follows similar patterns of raising and folding with the few other top and worst starting hands in poker. This simple observation shows a very deep rooted understanding of poker, where it shows that ChatGPT not only understands the rules of poker, but also rankings of different hands, importance of having suited starting hands, pocket pairs, suited connectors etc. These are types of starting hands that are more likely to win than others, and ChatGPT is able to differentiate them with weaker hands.

- **Observation 2 - ChatGPT Understands Position in Poker:** While understanding of rules and relative winning potential of starting hands comes at early stages of playing, understanding the importance of position is a more advanced concept. As discussed earlier, the GTO way to play pre-flop is to play fewer hands from earlier positions, and to play a larger percentage of hands from later positions. We can clearly see this pattern being followed in the ChatGPT pre-flop charts, as show in figures 3, 4. We can also see this in figure 5, where the fold percentage decreases as ChatGPT plays from later positions.

- **Observation 3 - Generating most probable decisions is optimal for playing Poker with ChatGPT:** Increasing temperature, top-p and consequently increasing the likelihood of

7

generating different answers for the same question. While it might be better for some scenarios, it is very detrimental when making poker decisions. We find that sampling based generation can lead to very poor pre-flop decisions and thus we should stick to generating the most probable answer. Temperature = 0.2 and Top-p = 0.95 reduces the sampling probability significantly and creates a decision matrix closest to game theory optimal.

While ChatGPT does have an understanding of poker that seems more advanced than a beginner level understanding, it is still not game theory optimal (GTO). The simplest way to do this is to compare ChatGPT's decision matrix to the GTO poker charts shown in figure 2. The first thing to notice when comparing the plots is a lot of green color blocks in the ChatGPT decision matrix compared to GTO charts. Green color in pre-flop charts shows the action of limping, which means that ChatGPT limps a lot more than the GTO play.

- **Observation 4 - ChatGPT is a Limper:** A limper is a type of poker player that limps a large range of their hands pre-flop. Limping is not considered a winning strategy in poker as it signals a weak hands, reduces pot equity and gives opponents favorable pot odds to make a winning hand by allowing them to play for cheap. Limping is considered a sign of passive and timid player, or alternatively a recreational player or relatively newer poker player. This can also be seen in figure 5, where the limp percentage of ChatGPT for both *verbose*-type and *short*-type prompt are outlandishly higher than GTO optimal.

As we compare the two different prompting strategies, it is clear using the *short*-type user prompts perform better than the *verbose*-type prompts as it is more closer to GTO decision making. The *short*-type user prompts have fewer limps and more raises compared to the *verbose*-type prompts and these numbers of much closer to GTO pre-flop decisions. Although initially surprising, *short*-type user prompts would are the standard way of referring to hands in the poker community and thus it is quite likely that a larger portion of internet data about poker uses this terminology. Also, the approximate distribution of hands played by ChatGPT remains same with both prompts while the number of limps reduce significantly in the *short*-type user prompt, indicating that ChatGPT is trying to resonate with the user proficiency. If the user describes a hand in standard poker notation, they are more likely to be a more serious player, and thus provides them with close-to-GTO decisions. We complete this thought in the next section.

3.1.3 Evaluating Effect of Order of Cards

Another variable in choosing the correct prompt was the order in which the cards were presented to ChatGPT. One possible way to present starting hands was to always present the highest ranked of the two cards (Ace being the highest) first and the smaller ranked card second. Thus, if the private cards for a player are Ace and King, it will be written as *AK* in the *ranked* prompts and as *KA* in the *unranked* prompts. The results in figure 4 correspond to cards being presented in the ranked format.

The decision matrix for starting cards being presented using an *unranked* format is show in figure 7. With unranked prompts, we see the largest deviation from GTO pre-flop charts, with ChatGPT making extremely poor poker decisions. An example of such a decision is the type of cards ChatGPT raises from UTG, which is supposed to be the position where a player plays only the strongest hands. For example, ChatGPT raises UTG with Q-2-offsuit, which according GTO play should basically always be fold from most positions, let alone UTG. This shows that there is a *more* correct way to provide ChatGPT hand information which leads to more optimal decisions. This is likely because most of the pre-flop charts and internet text talking about GTO poker write about card combinations in this format. What is surprising is that ChatGPT isn't able to internally reconcile and disambiguate with the difference in representations of these hands.

- **Observation 5 - There is a *Correct* way to Ask ChatGPT to play Poker:** There is a right way and a wrong way to ask ChatGPT to make pre-flop decisions. The pre-flop cards should be provided in a *short*-type writing, like AKo or AKs rather than writing their more verbose forms. Similarly, writing the higher ranked card first is even more crucial to get more GTO-like decisions. For example, asking ChatGPT to predict A4s vs 4As will lead to completely different decision matrices.
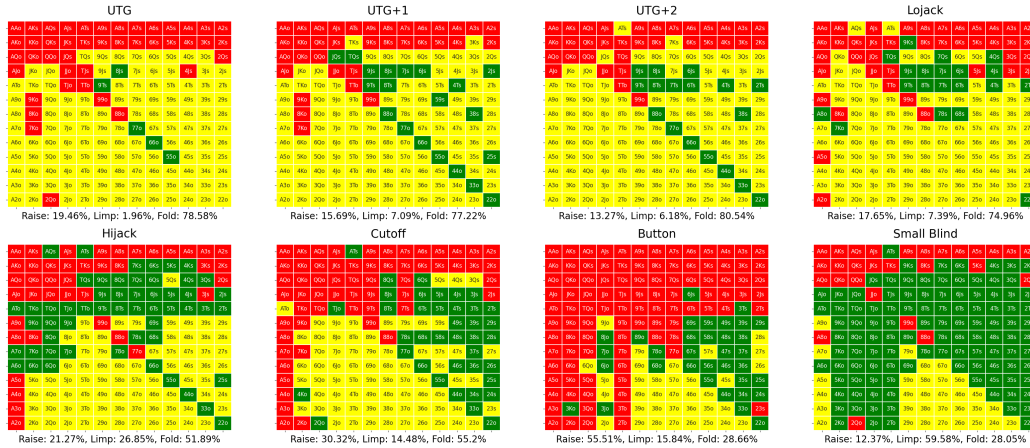
Figure 7: ChatGPT's pre-flop strategy in Raise First in spots. The red color hands show raised hands, green color shows limped hands and yellow shows folded hands. This decision matrix is for **short** user prompt, with the **unranked** order of card presentation.

3.2 GTO System Prompt

The above analysis shows ChatGPT has a deeper understanding of poker. If we look at the decision matrices of ChatGPT, we do find hints of a game theory optimal decision making. Since we're comparing ChatGPT's game with a GTO game, why not ask ChatGPT to play GTO poker. By doing this, we will also be able to find if ChatGPT knows how to play GTO poker. To do this, we change the previous system prompt to explicitly ask ChatGPT to make GTO decisions. To do this, we modify the system prompt as follows:

> *You are playing a 9 player Texas No-limit Holdem poker game. You will be provided with your position at the table and the hand you're holding. Please provide your pre-flop decision based on game theory optimal (GTO) poker.*
>
> *Assume you are the first to act and everyone before you has folded, thus your decisions can be one of fold, raise or limp. If you are placing a bet, please specify your best size in terms of big blinds.*
>
> *Provide your decision without any explanation in the following format: DECISION(Raise, Fold, Limp), N BB (if placing a bet, replace N by bet amount)*

The above prompt follows the same template as before with an additional line asking ChatGPT to make GTO decisions. We continue to use temperature = 0.2 and top-p = 0.95. We also use our learnings from the previous analysis, and use the 'correct' way to ask ChatGPT to play poker. That is, we provide hand information in a *short*-type user prompt where the hands presented in a ranked format.

3.2.1 ChatGPT GTO Decision Matrix Analysis

ChatGPT decision matrix when asked to make GTO pre-flop RFI decisions is show in Figure 8. One immediate thing to observe is that the number of limps goes down by a significant amount when ChatGPT is asked to make GTO decisions. This can also be seen in Figure 5, where the limp percentage of ChatGPT's GTO decisions is very close to zero. The number of hands ChatGPT raises with also increases, which is also seen in Figure 5.

- **Observation 6 - ChatGPT Understands GTO Poker, although its not GTO:** As we ask ChatGPT to make game theory optimal decisions, the kinds of decisions made by ChatGPT start to resemble GTO poker decisions a lot more. ChatGPT almost halves its limping range
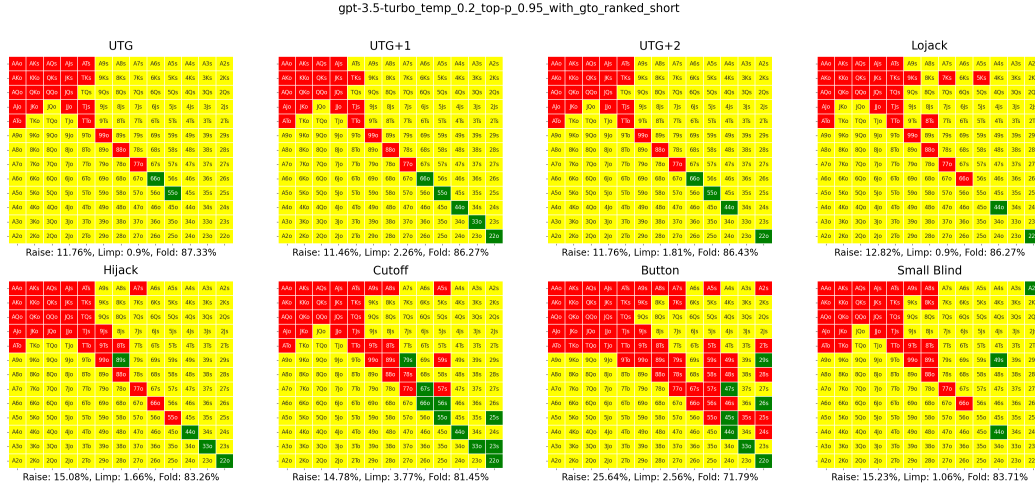
9

Figure 8: ChatGPT's pre-flop strategy in Raise-First-in using the **short** user prompt and **ranked** order of card presentation. Here, ChatGPT is specifically asked to play **GTO poker**.

and raises a lot more hands, thus becoming more aggressive player than when not prompted to make GTO decisions. Being aggressive is always more profitable in poker than limping passively, although ChatGPT still seems to have a few limps in its range. Additionally, ChatGPT raises with some weird hands, like K7s from the Lojack positions and plays and raises way fewer hands, especially from the button, thus deviating from GTO poker.

Although ChatGPT seems to understand what GTO poker is, it is not neccessarily GTO. It raises with much fewer hands than optimal, as shown in Figure 5, and also plays way fewer hands than optimal. ChatGPT also plays a significantly lower number of hands from the button, which is the one of the most profitable positions in poker, indicating that ChatGPT might be too tight in its approach.

- **Observation 7 - GTO ChatGPT is Possibly a Nit:** As we can see from figure 5, GTO ChatGPT only starts with the best hands and folds a lot more than optimal. Its raise percentages are way fewer than optimal, especially at the button. GTO ChatGPT's pre-flop play indicates that it might fall into a catgeory of player called *Nit*. *Nit* is a term used in poker terminology to describe players who are very tight/conservative. Being a *Nit* is not a profitable style of playing poker since this playing style can lead to missed opportunities, predictability, and vulnerability to aggressive opponents.

4   GPT-4 Playing Poker

Next we have GPT-4 play poker and analyse it's style of play. We use the two system prompts described in the above sections - basic prompt and GTO prompt. We also use the *short*-type user prompt to provide hand information in a ranked manner where the higher ranked card is provided first. We also use a temperature = 0.2 and top-p = 0.95. Because of the higher querying cost, we query GPT-4 five times for each hand and present the majority decision on the decision matrices.

The RFI pre-flop decision matrices of GPT-4 are shown in figures 9 and 10. Some of the basic observations for ChatGPT, including having a deep understanding of the game of poker and having more advanced understanding of poker concepts like position can be immediately seen from these poker charts. One striking observation in both basic and GTO prompts is that there are absolutely no limps in the pre-flop range of GPT-4. We also see that the decision charts of basic and GTO prompt are very similar except at later positions like the Button or Small Blind. This indicates that GPT-4 is naturally a more GTO player than ChatGPT, as it limps less, raises more and plays a larger number of hands compared to GTO ChatGPT without even being prompted to be game theory optimal.

- **Observation 8 - GPT-4 does NOT Limp at all:** The fact that GPT-4 has no limps in its entire range, for both the basic and GTO prompt shows that GPT-4 is a more advanced player
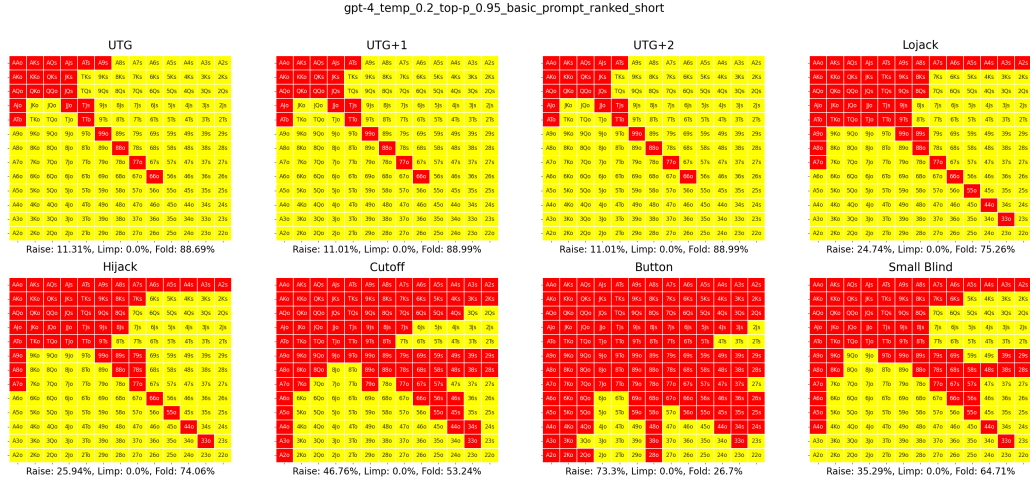
Figure 9: GPT-4's pre-flop strategy in Raise First in spots. This decision matrix is for **short** user prompt, with the **unranked** order of card presentation.
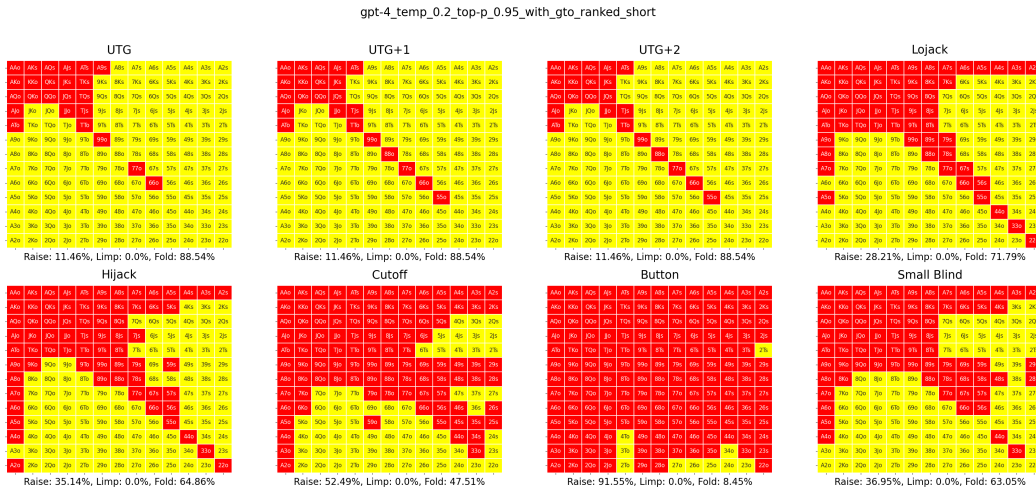
Figure 10: GPT-4's pre-flop strategy in Raise First in spots for **short** user prompt, with the **unranked** order of card presentation. Here, GPT-4 is specifically asked to play **GTO poker**

that ChatGPT. *Limping* is a strategy used by beginners which usually implies weakness. By eliminating limping, a player plays all hands in the same way, thus not giving away the strength of their hands. That's one of the reasons why limping is considered an absolute sin the professional poker circles.

- **Observation 9 - GPT-4 is more aggressive than ChatGPT:** The first reason for this observation is the fact that GPT-4 never limps. This itself makes it a more aggressive player as compared to ChatGPT. Additionally, as seen in Figure 6, GPT-4 even with the basic prompt raises way more hands than GTO ChatGPT. GPT-4 also plays a larger number of hands compared to GTO ChatGPT, and gets even more aggressive when asked to be GTO, as seen in Figure 6. Not limping, raising when being involved in the pot and playing a larger number of hands are signs of a more aggressive and possibly advanced player.

- **Observation 10 - GPT-4 is possibly a Maniac from Late Positions:** GPT-4 starts of playing close GTO from early positions, although from later positions, it becomes really loose and aggressive. Starting from the Lojack position, GPT-4 raises more hands than game theory optimal, ending up raising 90% of the hands from the Button when asked to be GTO. GPT-4's aggression is almost similar to a player type called *maniac* in poker. A *maniac* in

11

poker refers to a highly aggressive player who raises with a wide range of hands pre-flop, avoids limping, and exhibits unpredictable and unconventional play. While being aggressive in poker is generally profitable, being overly aggressive is usually not a profitable strategy because it can lead to high variance in returns, unpredictable play, and potential losses due to overly aggressive and non-strategic betting.

- **Observation 11 - GPT-4 still not GTO:** As seen from discussions above, although GPT-4 is a more advanced player when compared to ChatGPT, it is still not GTO. It plays way more hands than game theory optimal, raising all of them, especially from later positions.

5   Conclusion

Through our experiments, we find that both ChatGPT and GPT-4 have an understanding of the game of poker that is not just superficial. They don't just understand the rules of poker but also the intricacies of better and worse starting hands. Both models also understand the concept of position in poker and tend to play differently based on their position on the poker table. These observations are themselves show that both these models have an advanced understanding of the game of poker. This simple fact is a non-trivial outcome of the next token prediction objective of training these large language models.

While both these models have are not newbies at poker, they do have different tendencies when playing poker. ChatGPT naturally contains a lot of limps in its starting ranges, and when asked to become game theory optimal, it becomes a tight, conservative player, resembling a type of poker player called a *nit*. GPT-4 on the other hand has no limps in its range and is an aggressive player, closer to GTO than ChatGPT. While on early position GPT-4 behaves like a tight aggressive player, in later positions it becomes a more loose aggressive player. When asked to become GTO, it becomes even more aggressive, resembling a poker player type called **maniac**. Neither of these strategies are game theory optimal, although through initial analysis it does seem like GPT-4 is a more advanced player than ChatGPT.

It is interesting to see that these two models have exactly opposite tendencies which prevent them from being game theory optimal. ChatGPT tends plays a tight and conservative game, and limps some of its weaker hands. Thus, ChatGPT is not game theory optimal because it is less aggressive. GPT-4 on the other hand does not limp at all and raises all the hands it plays, yet it seems to be raising a lot more hands than necessary. Thus, GPT-4 is not game theory optimal because it is overly aggressive.

Both models also seem to have an understanding of what playing game theory optimal poker means, although both models have a different reaction when asked to play GTO. When asked to play GTO, ChatGPT removes a large number of limps and raises a larger portion of hands that it plays, thus becoming more aggressive. Additionally, ChatGPT also starts playing fewer number of hands, although its already playing fewer than optimal number of hands. Thus, for ChatGPT, playing GTO means to become tighter and more aggressive. GPT-4 is already an aggressive player and in order to become GTO, it neeeds to become tighter. Yet, when asked to play GTO, GPT-4 raises an even larger number of hands, mostly from the later positions. Thus for GPT-4, playing GTO means to be playing more aggressively, which is the opposite of what it needs to do. This almost points to the fact that these models are unaware of their own playing tendencies.

References

Elif Akata, Lion Schulz, Julian Coda-Forno, Seong Joon Oh, Matthias Bethge, and Eric Schulz. Playing repeated games with large language models. *arXiv preprint arXiv:2305.16867*, 2023.

Michael Bommarito II and Daniel Martin Katz. Gpt takes the bar exam. *arXiv preprint arXiv:2212.14402*, 2022.

Zohar Elyoseph, Dorit Hadar-Shoval, Kfir Asraf, and Maya Lvovsky. Chatgpt outperforms humans in emotional awareness evaluations. *Frontiers in Psychology*, 14:1199058, 2023.

Simon Frieder, Luca Pinchetti, Ryan-Rhys Griffiths, Tommaso Salvatori, Thomas Lukasiewicz, Philipp Christian Petersen, Alexis Chevalier, and Julius Berner. Mathematical capabilities of chatgpt. *arXiv preprint arXiv:2301.13867*, 2023.

Daniel Martin Katz, Michael James Bommarito, Shang Gao, and Pablo Arredondo. Gpt-4 passes the bar exam. *Available at SSRN 4389233*, 2023.

Hanmeng Liu, Ruoxi Ning, Zhiyang Teng, Jian Liu, Qiji Zhou, and Yue Zhang. Evaluating the logical reasoning ability of chatgpt and gpt-4. *arXiv preprint arXiv:2304.03439*, 2023.

Chen Feng Tsai, Xiaochen Zhou, Sierra S Liu, Jing Li, Mo Yu, and Hongyuan Mei. Can large language models play text games well? current state-of-the-art and open questions. *arXiv preprint arXiv:2304.02868*, 2023.