Chapter 6: Game Theory

Game theory is at once an essential and esoteric aspect of poker study. It is impossible to play at a high level without an intuitive understanding of the game theory concepts which are embedded in every poker decision. Yet most poker players have not explicitly studied game theory and have only a passing familiarity with its terminology and the details of its application. The purpose of this chapter is threefold: to provide a general introduction to game theory, with an emphasis on the concepts that are most useful to poker players, to discuss those concepts in the context of PLO, and to develop the understanding of those concepts through a series of concrete examples. The bible of poker game theory is The Mathematics of Poker, by Bill Chen and Jerrod Ankenmann. Every important idea in this chapter is covered more thoroughly and with greater sophistication by them, and I highly recommend that book to anyone with a serious interest in pursuing this part of poker learning. The intent here is merely to distill those concepts into a form which we will find useful through the pursuit of our theoretical framework.

Game theory is a branch of mathematics that deals with strategic decision-making. A **game**, broadly defined, consists of players, strategic options, and a set of payoffs/outcomes such that each player's strategic choices impact the outcomes for the other players. Many game theory problems are concerned with finding optimal strategies for individual players confined within a certain set of rules. One classic problem is the **Prisoner's Dilemma**, a contrived scenario whereby two Players, A and B, are each faced with a difficult decision after being arrested for a serious crime. The prisoners are isolated, given the opportunity to confess, and presented with the following set of outcomes, which are based for each on the combination of their own decision and the decision of their fellow prisoner. Each prisoner has the same two options, expressed in terms of their relationship to each other: Cooperate (that is, cooperate with their fellow prisoner/game player) or Defect (rat him out). If both cooperate, the police only have enough evidence to hold them for six months. If one defects and admits the full crime, the police offer him a walk, but his partner will get 10 years. If both defect, then each will receive 5 years.

Clearly, the best collective result is that both keep their mouths shut and serve six months, but each individual is making his decision on the basis of his own expected result. Careful examination of the terms reveals that regardless of what decision Player B makes, Player A is better off defecting and confessing to the crime. If Player B stays silent, A gets 6 months for doing the same and no sentence for defecting. If Player B defects, A gets 10 years for silence or 5 years for confessing. Because this game is **symmetric** (both players have the same strategic options and outcomes), the same is true for Player B. The outcome where both defect acts as a sort of magnet - the individual strategic thinking of the players draws the system into this particular state in which neither opponent should unilaterally change his strategy, because doing so opens him up to being **exploited** by a response from his opponent which leaves him worse off than before. Such a state is called a **Nash Equilibrium**, after economist and early game theorist John Nash.

The tension between individual and collective strategies inspires a quick detour before getting on with the main business. The **Tragedy of the Commons** is a name given to a phenomenon whereby what is best for the individual is not best for the collective. Sustainable resource problems, such as overfishing, are a main subset of such scenarios. A plainer example of a resource problem is of a crowd all craning over each other to see a speaker or some other spectacle. If one person gets a chair to stand on, he immediately benefits greatly relative to his fellow "players" (at the direct expense of some of those around him). But if everyone gets a chair, they are all back where they started, seeking a new way to find some small edge in sightline. The parallels to the evolution of poker strategy (along with accelerators of that evolution, such as training sites and books such as this one) are clear and mildly amusing.

Game Theory and Poker

So what does all this have to do with actually playing poker, and how do we want to incorporate and develop these basic definitions into our theoretical framework? Chapters 1-5 presented combinatorics, board texture categories, equity calculations, and expected value calculations. In a perfectly designed framework, game theory has two main functions. One, it tells us how to translate that data into a betting strategy that helps us maximize the equity we realize while finding ways to steal equity from our opponents.