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Game Theory in Blackjack

Source

Blackjack is a commonly played game in the casino and gambling communities, well known for its easy to learn rules and low house edge, making it ideal to play for a long time while minimizing potential losses. However, playing the game at a high level and learning what has been dubbed the "basic strategy" can take quite a while. There are a large number of possible hands that can be dealt to the dealer and to the player, each of which has a different optimal strategy (hit, stay, split, double down) to maximize the odds of winning the hand, and to maximize the payoff to the player, which is the net gain in earnings. When not following basic strategy, the advantage ends up being considerably in the house's favor, so following basic strategy is essential to minimize losses. However, it is possible to make a profit by playing blackjack over long periods of time by counting cards, a strategy which tips the odds in the favor of the player. Because of this, many casinos eject players who they believe to be counting cards as the strategy will always result in the house losing money, given the player counts correctly. It's disadvantageous for the player to be ejected, as they can no longer be profitable from playing the game, so the player would like to keep from being ejected. The opposite is true for the casino, but in order to determine whether or not the player is counting cards, the casino must implement some kind of surveillance system, which itself incurs a cost.

This leads to the discussion of an entirely new strategic game, where the players are the casino and the blackjack player, the set of actions for the player are either to count cards or follow the fixed "basic strategy", and the set of actions for the casino are to either carefully observe the player, or refrain from doing so. If the player decides to count cards, their payoff is o if they are observed counting cards, and a if they are not observed. If the player decides not to count cards, they receive a payoff of b regardless of whether or not they are observed. We assume that a > b > o, or that counting cards and not being caught makes the most money, while counting cards and being caught makes the least, with playing the game normally lying somewhere in the middle. Meanwhile, if the casino chooses to observe the player, it must pay a fixed cost F, and in any situation, the casino also suffers losses equal to the amount of the player's winnings. With these parameters, there are two interesting cases: one is when F >= a. In this case, there is a pure strategy equilibrium, which is for the player to count cards, and for the casino to ignore the player. This makes sense, since if the cost of observing the player is higher than the losses the casino incurs from the player counting cards, the casino should allow the card counting to continue to minimize its losses. When F < a, there is only a mixed strategy equilibrium solution, where the player chooses to count cards with probability q = F/a, and the casino chooses to observe the player with probability p = (a-b)/a. The article goes on to consider even more situations, taking into account variables such as the level of vigilance of the casino and the skill level of the player. If the casino is not very vigilant, the player will want to count cards more often since there is a lower chance for the player to be caught. Similarly, casinos shouldn't bother observing players who make mistakes when counting cards, regardless of whether or not they actually engage in card counting. These variables further change the mixed strategies for each of the players; it is very interesting to see how the player's optimal strategy changes dramatically based on the values of all the different parameters for the problem, and how a seemingly simple game can lead to a rather complex analysis.

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