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Independent Study & Mentorship

14 February 2025

Subject: An Introduction to Game Theory Part I: Strategic Games

MLA Citation:

An Introduction to Game Theory Part I: Strategic Games, gki.informatik.uni-freiburg.de/teaching/ws0607/advanced/recordings/aait-03-strategic-games.pdf . Accessed 11 Mar. 2025.

Assessment:

Bernhard Nebel’s "An Introduction to Game Theory: Strategic Games" outlines fundamental concepts in game theory, focusing on strategic games where players make simultaneous decisions. For this research assessment, I examined the basic principles of strategic decision-making, including dominated strategies, Nash equilibrium, and different game structures. Through this, I developed a stronger understanding of how rational decision-making is modeled mathematically and how strategic interactions can be analyzed using different solution concepts.

Nebel defines a strategic game as consisting of a finite set of players, each with a defined set of actions and a payoff function that assigns outcomes based on strategy choices. In these games, players seek to maximize their own payoffs, but their choices are interdependent (i.e. what one player does affects the outcomes for others). This reinforces the strategic nature of decision-making, where players must anticipate their opponents' moves to optimize their own results.

One of the key methods Nebel discusses is the elimination of strictly dominated strategies, or choices that always result in a worse outcome than another available strategy. If a strictly dominated strategy exists, rational players will never choose it, allowing it to be iteratively removed until only viable strategies remain. In some cases, this process converges to a single strategy profile, providing a clear solution to the game. However, in many games, strictly dominated strategies do not exist, requiring alternative solution concepts like Nash equilibrium.

Nash equilibrium is a state where no player can improve their payoff by unilaterally changing their strategy. Nebel illustrates this using classic games such as the Prisoner's Dilemma and Hawk-Dove, where strategic interactions lead to equilibrium states. Importantly, Nash equilibrium does not always produce the most optimal outcome for all players, but rather a state of strategic stability where deviation is not beneficial. Furthermore, some games have multiple Nash equilibria or even an infinite number of them, making equilibrium analysis more complex.

The document also explores zero-sum games, where one player's gain is another's loss, such as Matching Pennies. Unlike many other strategic games, these games may lack a pure strategy Nash equilibrium, requiring mixed strategies where players randomize their choices to avoid exploitation. This highlights the role of probability in strategic decision-making, reinforcing the idea that randomness can sometimes be the optimal approach in competitive scenarios.

Nebel's article enhanced my understanding of strategic interactions and solution concepts in game theory. The insights gained from this work will be crucial in developing my probability-based game, where players adapt their strategies based on observed outcomes. I predict that as players gain experience, they will adjust their tactics to eliminate suboptimal strategies and converge toward a stable equilibrium. In addition, the role of conditional probability will be central to my analysis. By examining repeated player interactions, I aim to identify emergent strategic patterns and assess how decision-making evolves over time. Ultimately, Nebel's work strengthens my approach to designing a game that captures the essence of strategic thinking and probability-driven behavior.