



## Introduction to Game Theory

**Game Theory**, the study of systems involving self-interested players. Examples like the grading game and the prisoner's dilemma illustrate how players' actions impact outcomes. The formal definition of a strategic form game is provided, along with key questions regarding optimal player strategies and predicting system outcomes.

Game theory is the study of games involving multiple self-interested agents. It explores how these players interact within a system to achieve various outcomes based on their actions.

-Understanding the concept of a game is essential, as it involves intelligent agents and their interactions within a system. This definition expands the common perception of games beyond mere competition.

-**The grading game** serves as a practical example of game theory, where students are the players, and their actions determine their grades. This illustrates the dynamics of decision-making within competitive environments.

-Each player in a game has an action set, which defines the possible choices they can make. In this context, the action set consists of the marks students can achieve in an exam.

- The outcome of a grading system is determined by the collective actions of all players involved. This interdependence highlights the importance of strategic decision-making among participants.

-Grading is based on relative performance, where the top percentages receive higher grades. This method emphasizes competition and influences how players approach their actions.

**The prisoners' dilemma** illustrates the strategic choices players face when confronted with potential consequences. Their decisions can significantly impact the outcome for both players involved.

-In the example, players can either confess or remain silent, affecting their jail terms. The uncertainty of the police's case adds complexity to their strategic decisions.

- Game theory highlights the interplay of players' decisions, where outcomes depend on the combined actions of each participant, not just individual choices. The prisoner's dilemma exemplifies this concept by illustrating the consequences of cooperation versus defection.

-The prisoner's dilemma showcases that rational player, aiming to minimize jail time, can make decisions that lead to worse outcomes for both. Cooperative behavior leads to reduced sentences for everyone involved.

In **congestion game** scenario, multiple commuters choose different paths to optimize travel time from a source to a destination. Their choices significantly impact the overall travel time experienced by all players.



-Game theory emphasizes the importance of understanding strategy sets, where players evaluate their available options. This evaluation is crucial for predicting outcomes in competitive situations.

- The traversal time of a path in a game is determined by the congestion on its edges, which is influenced by the number of players using those edges. Thus, the system's outcome is a reflection of all players' strategies and their interactions.

-Understanding how the number of players affects edge congestion can help in analyzing strategic decisions in games. Increased usage leads to longer traversal times for everyone involved.

-The independence of players in choosing paths contrasts with the interdependence of their actions, emphasizing the complexity of strategic interactions within the game framework.

-The formal definition of a game, particularly a strategic form game, includes players, their strategies, and outcomes, highlighting the structured nature of such interactions.

20:37 Game theory involves the analysis of players' strategies and their respective utility functions, which derive from the outcomes of their actions in a game context. Understanding these strategies and utilities is crucial for predicting players' decisions and game outcomes.

-Players' strategies can vary, and the utility function reflects the outcome derived from different actions within the game dynamics. This variability influences decision-making significantly.

-The prisoner's dilemma serves as a key example, showcasing how players' choices impact their utility and game outcomes. This example illustrates the complexity of predicting strategies.

-Two fundamental questions arise in game theory: how should players act given their interdependence, and can we predict the game's outcome based on their strategies? These questions guide the study of game theory.