

# Game Theory Through Examples Mathematical Association Of

Game Theory Through Examples Mathematical Association Of Game Theory Through Examples A Mathematical Association Guide

Game theory at its core is the study of mathematical models of strategic interaction among rational agents. It's a powerful tool applicable across diverse fields from economics and political science to biology and computer science. This guide explores game theory through illustrative examples, emphasizing the mathematical associations and providing a step-by-step understanding.

## I Understanding the Basics

### Key Concepts and Terminology

Before diving into examples, let's establish some fundamental concepts:

- Players:** The individuals or entities involved in the game.
- Strategies:** The possible actions each player can take.
- Payoffs:** The outcomes, often numerical, resulting from each combination of player strategies. These represent the utility or reward each player receives.
- Game Matrix or Payoff Matrix:** A table visualizing the payoffs for each possible strategy combination.
- Rationality:** The assumption that players aim to maximize their own payoffs.
- Information:** The knowledge players have about the game and other players' actions. Games can be simultaneous (players act at the same time without knowing the others' choice) or sequential (players take turns, aware of previous actions).

## II Types of Games Exploring Different Scenarios

Game theory encompasses various game types, each with unique characteristics and analytical approaches.

### A Simultaneous Games

These games involve players making decisions simultaneously without knowing the others' choice. The classic example is the Prisoners Dilemma.

**Example: The Prisoners Dilemma**

Two suspects are arrested and interrogated separately. Each can either cooperate (stay silent) or defect (betray the other). The payoff matrix is:

	Suspect B Cooperates	Suspect B Defects
Suspect A Cooperates	1, 1	1, 2
Suspect A Defects	2, 1	2, 2

The numbers represent years of prison sentence. A lower number is preferable. Notice that both defecting (2, 2) is worse for both than both cooperating (1, 1). However, rational self-interest leads both to defect, revealing the inherent conflict between individual rationality and collective good.

### B Sequential Games

In these games, players make decisions sequentially, with later players aware of previous actions. This often involves game trees which represent the sequence of choices and their outcomes.

**Example: The Centipede Game**

Two players alternately choose to cooperate (add a small amount to a pot) or defect (take the majority of the pot). The game continues until someone defects or a predefined limit is reached. This highlights the concept of backward induction, where players reason backward from the end of the game to determine their optimal strategies.

## III Nash Equilibrium Finding a Stable Solution

A crucial concept in game theory is the Nash Equilibrium. This is a state where no player can improve their payoff by unilaterally changing their strategy, given the other players' strategies.

### Finding the Nash Equilibrium

1. Identify all possible strategy combinations.
2. Analyze each player's payoff for each combination.
3. Check if any player can improve their payoff by switching strategies, given the other players' strategy. If not, you've found a Nash Equilibrium.

In the Prisoners Dilemma, Defect/Defect is the Nash Equilibrium, even though it's not the most desirable outcome for both players.

## IV Mixed Strategies Introducing Probability

Players don't always choose a single strategy; they can randomize their choices using



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