

Introduction to Game Theory

Introduction to Game Theory

Key concepts, definitions, and examples for a quick yet comprehensive overview.

1. What Is Game Theory?

- **Definition** – The mathematical study of strategic interaction among rational decision makers (players).
 - **Goal** – Predict outcomes when each participant's payoff depends on the choices of others.
 - **Fields of Application** – Economics, political science, biology, computer science, psychology, engineering, and everyday life (e.g., negotiations, auctions, sports).
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2. Basic Terminology

Term	Meaning
Player	An individual or entity that makes a decision.
Strategy	A complete plan of action covering every possible situation a player may face.
Pure Strategy	A deterministic choice (e.g., “cooperate” or “defect”).
Mixed Strategy	A probabilistic combination of pure strategies (e.g., 70% cooperate, 30% defect).
Payoff	Numerical reward (utility) a player receives from a particular outcome.
Game	The formal description of players, strategies, and payoffs.
Normal-Form (Strategic) Representation	Matrix/table showing payoffs for each strategy profile.
Extensive-Form Representation	Decision tree that captures the order of moves, chance events, and information sets.
Information Set	The set of decision nodes a player cannot distinguish between when making a move.
Dominant Strategy	A strategy that yields a higher payoff than any other, regardless of opponents' actions.

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Term	Meaning
Nash Equilibrium (NE)	A profile of strategies where no player can improve their payoff by unilaterally deviating.
Pareto Efficiency	An outcome where no player can be made better off without making another worse off.
Zero-Sum Game	One player's gain equals the other's loss; total payoff sums to zero.
Cooperative vs. Non-Cooperative	Cooperative: players can form binding agreements; Non-Cooperative: only self-enforcing strategies matter.

3. Classic Example: The Prisoner's Dilemma

	Partner Cooperates	Partner Defects
You Cooperate	(3, 3)	(0, 5)
You Defect	(5, 0)	(1, 1)

- **Dominant strategy:** Defect (higher payoff regardless of partner's move).
- **Nash equilibrium:** (Defect, Defect) ? (1, 1).
- **Pareto-optimal outcome:** (Cooperate, Cooperate) ? (3, 3) – better for both but not stable without enforcement.

4. Types of Games

Category	Description	Typical Example
Simultaneous-move	Players choose actions without knowing others' choices.	Prisoner's Dilemma, Rock-Paper-Scissors
Sequential-move	Players act one after another; later players observe earlier moves (or part of them).	Chess, Stackelberg competition
Static vs. Dynamic	Static: single-period interaction; Dynamic: multiple periods, possibly with discounting.	One-shot auction vs. repeated bidding
Complete vs. Incomplete Information	Complete: all payoff functions known; Incomplete: some private information (types).	Standard games vs. signaling games

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Category

Description

Typical Example

**Perfect vs. Imperfect