

Lecture 1

Basic concepts

Malcolm Keswell

28 July 2026

School of Economics

What is Game Theory?

Where does it fit?

- Economics
- Business
- Political science
- Psychology
- Biology
- Philosophy

Strategic interaction

- The theory of strategic interaction and action.
- Recognition and application of principles within real-life situations: the “how” and “why”.
- Everyday interactions in business, politics, diplomacy, war, and ordinary life.
- Games of strategy are already played in everyday life.
- Players include friends, parents, siblings, enemies, and lecturers.

Game theory applications

- Decisions about companies such as merger or takeover.
- Methods by which companies try to avoid mutually destructive price-wars.
- Ways in which companies can position themselves for possible changes in economic regimes.
- Ways in which companies should bid in tenders.
- Basic decisions on the pricing of products.
- Political elections.

History of game theory

- Invented in 1944 by John von Neumann and Oskar Morgenstern.
- Initially, it could only be applied to pure conflict situations where one agent's gain is exactly another's loss: a zero-sum game.
- But the work of other pioneers introduce non-zero sum games.
- John Nash, Reinhard Selten, Robert Aumann, John Harsanyi, and John Maynard Smith developed the field.

A typology of strategic games

Types of games and fundamental concepts

Classifying games

- Sequential vs simultaneous move games
- Fixed vs manipulatable rules
- One-shot vs repeated
- Conflict vs cooperation
- Cooperative vs non-cooperative game
- Information

Terminology and assumptions

- Equilibrium
- Evolutionary games
- Payoffs
- Strategies
- Rationality
- Common knowledge of rules

What is a game of strategy?

- Board games, card games, arcade/computer games, sports all have an element of luck as well as “strategy.”
- This course is not about these types of games.
- But on occasion, we will use card games and board games to frame real world scenarios.
- “Strategy” is separate from luck or chance.
- It is the mental skill or calculation needed to do well in a game.
- For example, in squash, physical skill is developed by practice, while mental skill is about shot selection and deception.

Game theory is strategic thinking

- You can think strategically about your interactions with others.
- But the other players are doing the same thinking at the same time as you.
- You must take into account their thinking, just as they are taking into account your thinking.
- Game Theory is the analysis or science of interactive decision-making.
- In *classical* game theory we assume **rational** decision making.
- Rationality in games means that players are perfect calculators and follow their **best response**.
- What is **optimal** depends on what others are doing.

What is a strategic game?

- For an interaction to be a strategic game, there needs to be mutual awareness of the cross-effect of actions.
- What one player does must affect the outcome for the other player, and what the other player does affects you.
- If you know this, you can react or take actions to prevent bad outcomes.
- You could also try to alter your opponent's future action to ensure that you receive a good outcome.
- But if you know this, so does your opponent, and they will be taking similar actions.

There is strategic interaction between players.

Classifying games

Conflict or cooperation

- Games that have a winner and a loser are called **zero-sum** games.
- It occurs when players' interests are in conflict.
- But it need not be zero: there could be a positive amount that players are in conflict over, called a **constant-sum** game.
- Most economic or social games are not zero-sum; it is not simply win or lose.
- For instance: a joint business venture: combine skills and experience.

One-shot games

- Have no repercussions on other games.
- Have no repercussions with other players who could learn about your typical actions of play.
- Interactions tend to be ruthless.
- Players do not know about each other, including strengths or weaknesses.
- Secrecy and surprise is important.

Repeated games

- What comes to mind when you think of a repeated interaction?
- In repeated games with ongoing relationships, there is an opportunity to build reputations.
- Reputations may be for fairness, toughness, honesty, reliability, and so on.
- Players get to know opponents better, and vice versa.
- Players can better exploit mutually beneficial prospects, for example by arranging to divide profits over time.

Types of information

- External uncertainty
 - Uncertainty about external circumstances
 - for example weather or an unanticipated shock.
- Strategic uncertainty
 - Uncertainty about what kind of moves one's opponent has made in the past or is currently making.
 - If the game does not have external or strategic uncertainty, the game is one of perfect information.
 - Otherwise, the game has imperfect information.
 - When one player knows more than another, the game has incomplete or asymmetric information.

Types of information

- The key thing about information is being selective about releasing it.
- Sometimes, revealing superior information about yourself is beneficial, for example letting your opponent know that you have the upper hand.
- But will your opponent believe you? You have an incentive to exaggerate or lie, and your opponent knows this.
- The more informed player can send **signals**: actions that serve as credible proof of information.
- The less informed player can use **screening** devices to induce credible revelation of information.

Cooperative vs non-cooperative games

- Many strategic interactions include a cooperative component, so players may have an incentive to get together and reach an agreement.
- But this creates an incentive to cheat.
- Does one player get a better outcome by going against the agreement?
- If both players know this, why stick to the agreement at all?
- **Cooperative games:** joint-action agreements are enforceable.
- **Non-cooperative games:** games in which enforcement is not possible.
- Cooperative games do not necessarily produce cooperative outcomes.
- Non-cooperative games do not necessarily produce non-cooperative outcomes.
- Non-cooperative games can result in mutual gain, especially in repeated games.

Terminology and assumptions

Strategies

- Strategies are the choices available to players.
- A strategy is a complete plan of action that tells a player what actions to take in response to every possible action by an opponent.
- A strategy that always selects an action with certainty is called a pure strategy.
- In a sequential move game, your strategy is the action taken on that single occasion.
- In a simultaneous move game, you do not know what the other player is going to do, so you need a complete plan of action.

Example

If he plays A, then I will play X. But if he plays B, then I will play Y.

Payoffs

- Most games require calculations and comparisons of gains and losses, costs and benefits.
- We use payoffs to give players a numerical scale with which to compare outcomes.
- The number associated with each outcome is the player's payoff for that outcome.
- Higher values indicate higher payoffs.
- Payoffs can take the form of monetary income, profit, or ratings.
- The payoff scale depends on what the analyst wants to represent.

Outcome	Payoff
Sleep	4
Eat cake	2
Play PS	1
Drink wine	3

Outcome	Payoff
Sleep	R80
Eat cake	R40
Play PS	R10
Drink wine	R60

Representing simultaneous move gamea

		Player 2	
		ℓ	r
Player 1	L	4, 4	2, 5
	R	5, 2	3, 3

Game A

		Player 2	
		ℓ	r
Player 1	L	1, 1	-5, -5
	R	-5, -5	1, 1

Game B

		Player 2	
		ℓ	r
Player 1	L	4, 4	0, -3
	R	-3, 0	2, 2

Game C

Rationality

- Most of Game Theory includes the assumption of rational behaviour.
- Players are perfect calculators and follow their best strategy.
- Each player has complete knowledge of their own interests and how to achieve them.
- Rationality does not include factors like value systems or morals.
- Rationality involves recognising that when other players make a choice, they calculate consequences using their own value system.
- You cannot assume that your opponent would act as you would in the same situation.

Common knowledge of rules

- We assume that, at some level, players have a common understanding of the rules of the game.

The rules consist of

1. List of players.
 2. Strategies available to each player.
 3. All possible outcomes.
 4. Payoffs of each player or all possible combinations of strategies pursued by all players.
 5. The assumption that each player is a rational maximiser.
- In Game Theory, we cannot analyse what we cannot see, so the information given by the rules is known to all players.

Equilibrium

- When players interact, they generally reach some sort of equilibrium.
- This is when each player is using the strategy that is the best response to the strategies of the other players.
- It refers to a vector of strategies, one for each player, in which no player has an incentive to switch to an alternative strategy.
- Equilibria are not necessarily situations in which players do well, but strategy choices should converge towards equilibria as players learn.
- Reaching an equilibrium could come about after trial-and-error or even after some non-equilibrium outcomes.