Lecture 1 - Introduction

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1 Definition

- Game theory aims to help us understand situations in which individuals interact.
- The essentials elements of a game are players, actions, payoffs, and information
- Such elements are known as the rules of the game; The modeller's objective is to describe a situation following these rules to explain what will happen in that situation

1 Definition

- Players are the individuals who make decisions. Each player's goal is to maximize her utility by choice of actions

- When making their decisions
  - players assume that other players with whom they interact with also develop strategies and anticipate them - correctly or not - when deciding
  - make decisions by taking into account the fact that other players will react to their choice
- Consequently,
  - The payoff of each player not only depends on her own decisions (i.e., actions) but also on that of the other players.
  - The choice of players depends on the way they anticipate the other players'choice
  - Anticipation patterns are linked to information and rationality

1 Definition

- Optimal choice, players.multiplicity and suitable anticipation make these relationships quite complex to analyze: we here talk about strategic interactions
- GT can be seen as the analysis of individuals' decision-making who behave in strategic interactions
- Note: The analysis is likely to be conducted from a rational viewpoint
- One can easily imagine that strategic interactions lead to complex analysis even when the number of players is limited

2 Differences between decision theory and game theory

The characteristic of the uncertainty matters !

- In a decision setting, the uncertainty is **exogenous** and refers to random shocks of nature, and individuals have exogenous beliefs regarding them that can be translated into probabilities.

- In a game, the uncertainty is **endogenous** and it is called strategic uncertainty.

3. Methodology

- Game theory consists of a collection of models (or games).
- A model can be seen as an abstraction used to understand observations, experiences and to analyze how strategic interactions work.
- A model derives power from its simplicity and shortcuts
- however, a model is not likely to help the understanding of a phenomenon if its assumptions do not cope with the "true" conditions and constraints at stake
- it has therefore to integrate the features of a situation that appear to be relevant

3. Methodology

- To describe a situation of strategic interactions, we have to identify 5 elements:
  1. number of players (or individuals who make strategic decisions)
  2. the role of nature(or randomness, luck)
  3. the rules of the game, i.e., (i) who play when ?, (ii) what information do players have when making their decisions? (iii) What can individuals do when it is the time to make their decision?
  4. outcomes: for each set of possible actions of individuals and nature, what is the outcome of the game?
  5. preference functions or utilities, i.e., what are the individuals' preferences over possible outcomes?

4. Differences between cooperative and non-cooperative game theory

4.1 Non-cooperative game theory

- This does not mean that individuals do not seek to cooperate.
- individuals make decisions following their personal interest.
- Individual **commitments are not enforceable**
- focus on individual's behavior: What are the decisions an individual should make? In a given setting, which type of decisions is more likely to be chosen by rational individuals ?
- The solutions are called the **game equilibrium**.
- Examples: Cournot game, Bertrand game, Stackelberg game in IO

4.2 Cooperative game theory

- agreements are fully enforceable and are irrevocable
- Cooperation is exogeneous and is imposed by the rules of the game
- Cooperation can be seen as a propriety of the game
- ffocus on groups of individuals called **coalition**: What are the coalitions that can be constituted? How, within each coalition, the outcome of the cooperation has to be shared?
- The solution is called the **game solution**.
- Examples: Cartel / coalition

5. Application 1. The penalty-kick game

- Let assume two players, namely player A and player B (shooter and goal-keeper)
- Consider the rules of the game as follows: each player has to choose between left and right
- Define the outcomes/payoffs as such: if both players make the same choice, player A gives \$1 to player B otherwise, player B gives \$1 to player A
- Economic application: incumbent vs. newcomer firms

5. Application 2. The date game

- Assume two players, namely player M and player F
- Consider the rules of the game:
  - player M and player F are not at the same location and cannot communicate
  - each player knows she has to meet the other one but they both have forgotten where
  - they only remember that meeting place is “Duomo” or “Repubblica”
  - each player has to decide where to go and can make only one choice
  - if they meet each other, they have lunch together; otherwise they have lunch alone
- Outcomes are defined as follows:
  - if both players have lunch together, they both have high level for utility (normalized to 1 for illustration purposes)
  - otherwise, they have both low level for utility (normalized to 0 for illustration purposes)

Key results

- The essential elements of a game are players, actions, payoffs and information
- The combination of the strategies chosen by each player defines an equilibrium
- The ability of individuals to align their interests defines cooperative games or non-cooperative games

6. Formal definitions

- **Players**: Players are the individuals who make decisions. Each player's goal is to maximize her utility by choice of actions.
- **Nature**: Nature is a pseudo-player who makes random actions at specified points in the game with specified probabilities.

6. Formal definitions

- **Action**: An action (or move) by player i , denoted a_i , is a choice she can make.
  - Player i's action set, denoted $A_i = \{a_i\}$, is the entire set of actions available to him
  - An action profile is a list $a = \{a_i\}$ $(i = 1, ..., n)$ of one action for each of the n players in the game

- **Payoff**: By player i's payoff $\pi_i(s1, ..., sn)$, we mean either:
  - The utility player i receives after all players and Nature have picked their strategies and the game has been played out; or
  - The expected utility she receives as a function of the strategies chosen by herself and the other players.