Introduction to Game Theory

and Mechanism Design

Objectives of the course

Engineering approach to Economic Theory

Typical Engineering approach ◀ Analysis
Synthesis

Examples:

- Circuit - analyze with different resistors, capacitances, find out voltage, current
  - synthesize a circuit with desired voltage, current
  Algorithms - analyze to find complexities, then design according to a desired complexity

In Game Theory, the setup is:

Multiple agents with possibly conflicting objectives - GAME
Given a game - find most probable outcomes on responses of the agents/players: Game Theory.
- Analysis part, predictive approach

Given a “reasonable” outcome - find/build the game that yields that as a probable outcome: Mechanism Design
- Synthesis part, prescriptive approach.

Example of Game Theory: Neighboring Kingdom’s Dilemma

Kingdoms A and B have limited options to invest wealth

1. Agriculture: save people from starvation

2. Warfare: ransack other kingdom and have their wealth

Outcome is dependent on the joint action of both.
E.g., if A chooses Agri and B chooses War, then B gets all the agricultural produce of A since A has not developed techniques to protect itself.
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<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td>A</td>
<td>5,5</td>
<td>0,6</td>
</tr>
<tr>
<td>B</td>
<td>6,0</td>
<td>1,1</td>
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Question: What is a "reasonable" outcome of the above game?

Little more formally,

A game is a formal representation of the strategic interaction between multiple agents called players.

The choices available to the players are called actions.

The mapping from the state of the game → set of actions

Depending on the context, games can be represented in many ways:

Normal form, Extensive form, Repeated, Stochastic, …
Game theory is the formal study of strategic interaction between players that are rational and intelligent.

A player is rational if she picks actions to achieve her most desired outcome, e.g., maximize her payoff.

A player is intelligent if she knows the rules of the game perfectly and picks action considering that there are other rational and intelligent players in the game.

Intelligence implies that the player has sufficient computational ability to find the “optimal” action against other players.

Objectives of game theory:

provide predictions of an outcome