Game Theory

Basic Framework

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Rational Decision-Making

- What is the objective?
- What are the courses of actions available?
- What are the constraints on the actions considered?
- Out of all possible actions, which course of action best meets the objective?

Complications

- Uncertainty about the environment
- Interactions

Decision Theory: Decision-making in a fixed environment

- Environment known with certainty
- Environment known with uncertainty
  - Available information translates into a probability distribution
    - Objective beliefs
    - Subjective beliefs

Game Theory

- Games: Interactions between mutually aware players.
- Strategic Games: When each participant is significant in the interaction because
  - Each player is large or
  - Commitments or private information narrow down the scope of the relationship to a point where each is an important player within the relationship

Game Classification

- Timing of the Moves
- Nature of Conflict
- Repeated Interaction
- Informational Condition
- Flexibility of Rules
- Enforceability of Cooperative Agreements
### 1. Timing of the Moves

- **Sequential Move:** If I do this, how will my opponent react?
- **Simultaneous Move:** What is my opponent going to do right now?
- **Issues**
  - First-Mover Advantage
  - Second-Mover Advantage
  - Commitment vs Flexibility

### 2. Nature of the Conflict

- **Zero-Sum Game:** One player’s gain is the other’s loss
- **Constant-Sum Game:** Dividing up the pie
- **Non-Zero Sum Game:** Conflict vs Cooperation (most business situations)

### 3. Repeated Interaction

- **One-Shot Game**
- **Repeated Game:** Game with on-going relationships (with the same or different partners)
  - reputation
  - information acquisition
  - punishment
  - integrity

### 4. Informational Condition

- **Asymmetric Information**
  - The players’ attempt to infer, conceal, or sometime convey the information becomes an important part of the game and the strategies.
  - Reveal the good and conceal the bad.
  - Signaling: Convince the less-informed parties by actions that are credible proof of the information.
  - Screening: The less-informed party’s strategy designed to induce the credible revelation of information by the more-informed party.

### 5. Flexibility of the Rules

- **Pre-Game:** Making rules of the game
- **Multi-Period Games:**
  - Changing Rules
  - Acting within the Chosen Rules
  - Pre-emptive actions change the rules of the subsequent games permanently.

### 6. Enforceability of the Cooperative Agreements

- **Cooperative Game:** Enforceability (through external forces)
- **Non-Cooperative Game:** Sustainability (through internal incentive mechanism)
- **Business Games:** Non-cooperative games
  - No external enforcement of joint-action agreement
  - Must be sustainable from within
Structure of the Game

• A game is defined by:
  – Strategies available to all the players
  – Their information
  – Their objectives

1. Strategies

• Complete Plan of Action
  – One-Shot Simultaneous Move Game
  – Sequential Move Game
  – Repeated Game
• A computer program for actions in all possible contingencies
• Tactics vs Strategies?

2. Payoffs

• Numbers associated with each possible outcome
  – The payoffs for one player capture everything in the outcomes of the game that he cares about.
  – Does not necessarily imply selfishness.
  – Use expected payoffs (probability-weighted payoffs), if facing random prospects.

3. Rationality

• Players: Perfect calculators and consistent pursuer of their best strategies
  – Each has a consistent set of rankings (values, payoffs) over all the logically possible outcomes.
  – Each calculates the strategy that leads to the outcome of the highest rank.
• Heterogeneous Value Systems
• Heterogeneous Choices

• Incomplete and asymmetric information
  – Not knowing the other players’ value systems
• Rationality Unrealistic?
  – Incomplete knowledge of their own preferences
  – Limited computational ability
• Rationality: Good approximation when the game is repeated among the same players.

4. Common Knowledge of the Rules

• Rules of the game:
  – The list of players
  – The strategies available to each player
  – The payoffs of each player for all possible combinations of strategies pursued by all the players.
  – The assumption that each player is a rational maximizer.
• The rules must be common knowledge
  – Each player must know these rules (this is not enough)
  – Each must know that the other knows these rules
  – Each must know that the other knows that he knows these rules
  – Each must know that the other knows that he knows that the other knows these rules
  – ......etc., etc., etc.
  – Ad infinitum.

• Example: King and the Red Hats.

• Why do we need common knowledge?
  – analytical necessity for deriving the likely outcome of a game

Equilibrium

• What is likely to happen when rational players’ strategies interact in a well-defined game?
• (Nash) Equilibrium: A set of strategies, one for each player, with the property that each player’s strategy is the best response to those strategies of the other players.