ECE 457A - Tutorial 6

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Nelder-Mead Algorithm

- **Python**
  - `scipy.optimize.minimize(fun, x0, method='Nelder-Mead')`
- **MATLAB**
  - `fminsearch(fun, x0, options)`

Game Theory

- A theoretical framework designed to conceptualize social scenarios involving rival participants
- Empirical situations may be delineated, and their results forecasted

Game Theory

- **Different Types of Games**
  - Cooperative vs. Non-Cooperative Games
  - Zero-Sum vs. Non-Zero-Sum Games
  - Simultaneous Move vs. Sequential Move Games
  - One-Shot vs. Repeated Games
  - Symmetric vs. Asymmetric Games

- **Different Types of Games**
  - **Cooperative vs. Non-Cooperative Games**
    - Cooperative Game: A game in which participants can negotiate binding contracts that allow them to plan joint strategies
    - Non-Cooperative Game: A game in which negotiation and enforcement of binding contracts are not possible
  - **Nash Equilibrium**
    - A game theory concept that determines the optimal solution in a non-cooperative game.
    - The Nash equilibrium states that the optimal strategy for a player is to keep their initial strategy, assuming the other players also keep their strategies unchanged.
    - A game may include multiple Nash equilibria or none.

Game Theory

- **Different Types of Games**
  - **Zero-Sum vs. Non-Zero-Sum Games**
    - Zero-Sum Game: A game that always produces a net gain of zero, with one party winning and the other party losing
    - Non-Zero-Sum Game: A game that produces a net positive or net loss

- **Different Types of Games**
  - **Simultaneous Move vs. Sequential Move Games**
    - Simultaneous (Concurrent or Static) Move Game: A type of game that involves players engaging in the game simultaneously without knowledge of each other's moves or actions, and the players lack substantial information about their opponents' performance and select their strategies independently, irrespective of the opponent's choices
    - Sequential (Dynamic) Move Game: A type of game in which each player moves before others can choose their actions, and the players are aware of the moves made by their opponents and base their decisions on that information for subsequent moves

- **Different Types of Games**
  - **One-Shot vs. Repeated Games**
    - One-Shot Game: A game that is played only once
    - Repeated Game: A game in which actions are taken and payoffs received over and over again

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- **Different Types of Games**
  - **Symmetric vs. Asymmetric Games**
    - Symmetric Game: A game wherein all players are on an equal footing, and the same rules apply to all
    - Asymmetric Game: A game wherein different roles and goals get assigned to every player

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Game Theory - Examples

- **Nash Equilibrium**
  - Imagine a game between Tom and Sam.
  - Both players can choose strategy A to receive \$1, or strategy B to lose \$1.
  - The scenario when both players choose strategy A and receive a payoff of \$1 is a Nash equilibrium.

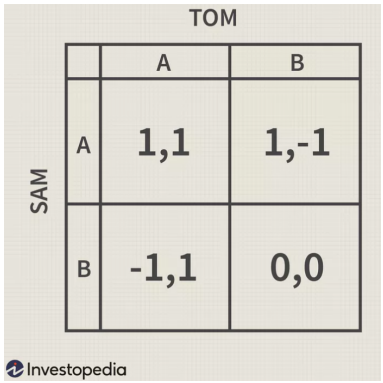

Figure: Nash Equilibrium (Julie Bang / Investopedia)

Game Theory - Examples

- **Zero-Sum Games (Matching Pennies)**
  - Two players, A and B, place a penny on the table simultaneously.
  - If both pennies are heads or tails, Player A wins and keeps Player B's penny; if they do not match, then Player B wins and keeps Player A's penny.
  - It is a zero-sum game because one player's gain is the other's loss.

A / B	Heads	Tails
Heads	(a) +1, -1	(b) -1, +1
Tails	(c) -1, +1	(d) +1, -1

Investopedia

Figure: Matching Pennies (Image by Julie Bang ©Investopedia 2020)

Game Theory - Examples

- **Simultaneous Move Games**
  - Rock-paper-scissors is an example of a simultaneous game because both players act at the same time.
- **Sequential Move Games**
  - Games such as chess, infinite chess, backgammon, tic-tac-toe, and Go are examples of sequential games.

Game Theory - Examples

- **One-Shot Games**
  - Prisoner's Dilemma is an example of a One-Shot game because a single round of decisions determines the outcome.
- **Repeated Games**
  - Iterated Prisoner's Dilemma is a repeated version of the Prisoner's Dilemma where the two suspects face the same dilemma in multiple rounds, making choices over and over.

Game Theory - Examples

- **Symmetric Games**
  - Two-player zero-sum games are symmetric because both players have identical sets of strategies, and the payoff matrix is the same for both players (e.g., Matching Pennies).
  - Games like "Divide the Cake" or "Cutting the Pizza" can be symmetric when both players have the same preferences and aim to divide a resource fairly.
- **Asymmetric Games**
  - Asymmetric Prisoner's Dilemma is an asymmetric game where the two suspects may have different stakes or preferences, leading to asymmetry in payoffs. For example, one player faces a much harsher punishment if both players defect.

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