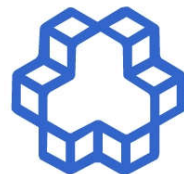


نظریه بازیها Game Theory

ارائه کننده: امیرحسین نیکوفرد
مهندسی برق و کامپیوتر دانشگاه خواجه نصیر



دانشگاه صنعتی خواجه نصیرالدین طوسی

About the course



- Lectures:
 - Saturday and Monday 9:00-10:30
- Office hours:
 - Sunday 14-16
- Grading
 - Homework and Mini Project 20 %
 - Final exam 45%
 - Project (10% bonus) 35%-45%

Reference



There are many interesting books on game theory.

We will be using the following two:

- ❑ Basar, T., Olsder, G. J., Dynamic non-cooperative game theory, Second Edition, SIAM, 1999.
- ❑ Hespanha, Joao P, An introductory course in non-cooperative game theory, 2011.

Extra Material

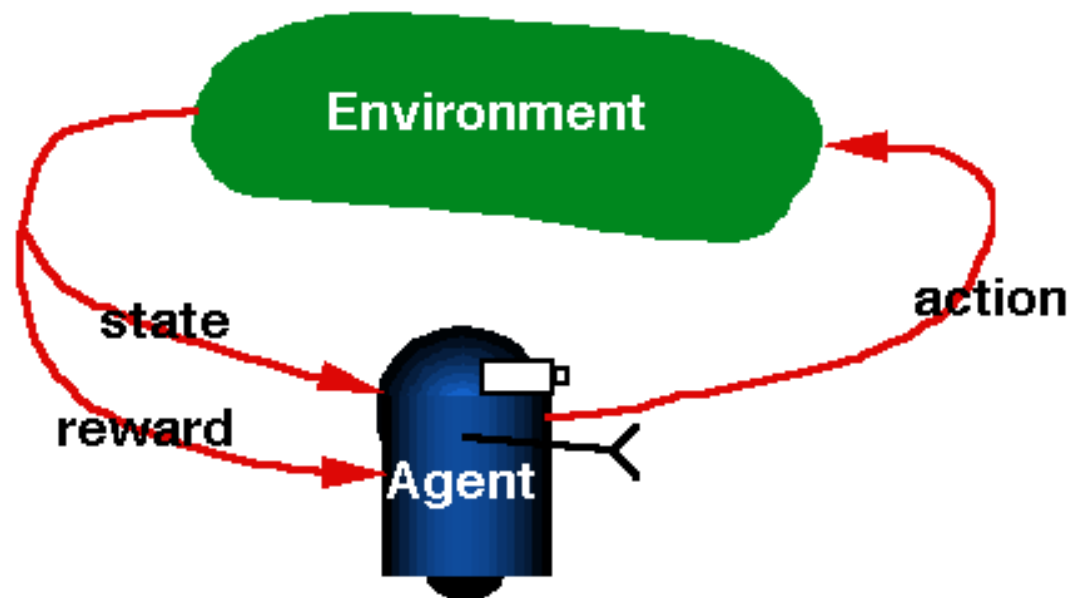
- ❑ D. P. Bertsekas ,Dynamic Programming- Deterministic and Stochastic Models, Prentice-Hall, Inc., 1987.
- ❑ Fudenberg D., Birole J., Game Theory , MIT Press, Cambridge, Massachusetts, 1991.

Introduction



Game Theory: mathematical tools to study situations involving both conflict and cooperation (multi-person decision problems)

- Used in economics, political science, biology to understand competition and co operation among agents.
- role of treatment/punishments in long term relations.



Introduction



Mechanism Design (MD): “Inverse Game Theory”:

Design of a game (or incentives) to achieve an objective (eg. system-wide goal or designer’s selfish objective)

- Optimization theory extended for systems in which there are independent agents not under direct control, and must be “coerced” through the use of incentives.
- In Economics, MD is all about designing the right incentives

Engineering Application



- Recent interest in networked-systems (communication and transportation networks, electricity markets).
 - Large-scale networks emerged from interconnections of smaller networks and their operation relies on various degrees of competition and cooperation.
 - Online advertising on the Internet: Sponsored search auctions.
 - Distributed control of competing heterogeneous users.
 - Information evolution and belief propagation in social networks.
 - Problem of Exploitation of Learning

What is Game Theory ?



1. The **players** are the agents that make decisions (At least 2 Players)
2. The **actions** available to each player at each decision point
3. The **information structure** specifies what each player knows before making each decision
4. The **objective** specifies the **payoffs** of each in the game

Example (Rock-Paper-Scissors):



- A game is specified by: **players** (1...N), **actions**, and **(expected) payoff matrices** (functions of joint actions)

| | | A's action | | | B's action | | | | |
|------------|----------|------------|----------|----------|------------|----------|----------|----|----|
| | | <i>R</i> | <i>P</i> | <i>S</i> | <i>R</i> | <i>P</i> | <i>S</i> | | |
| A's action | <i>R</i> | 0 | -1 | +1 | B's action | <i>R</i> | 0 | +1 | -1 |
| | <i>P</i> | +1 | 0 | -1 | | <i>P</i> | -1 | 0 | +1 |
| | <i>S</i> | -1 | +1 | 0 | | <i>S</i> | +1 | -1 | 0 |

- If payoff matrices are identical, A and B are **cooperative**, else **non-cooperative** (**zero-sum** = purely competitive)



Rationality

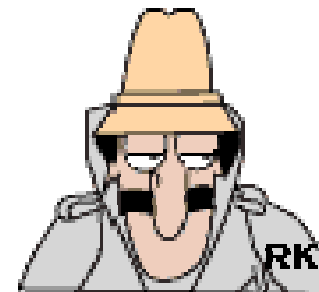


Assumptions:

- ❖ humans are rational beings
- ❖ humans always seek the best alternative in a set of possible choices

Why assume rationality?

- narrow down the range of possibilities
- predictability



What Game Theory is Not!



- ❑ Real-life games are enormously complex and difficult to model.
 - ❑ Aim: Model important features of actual game in hope that we can gain some insight.
- ❑ Real-life players are not always rational!
- ❑ Game theory does not always give unique way to play game.

History:



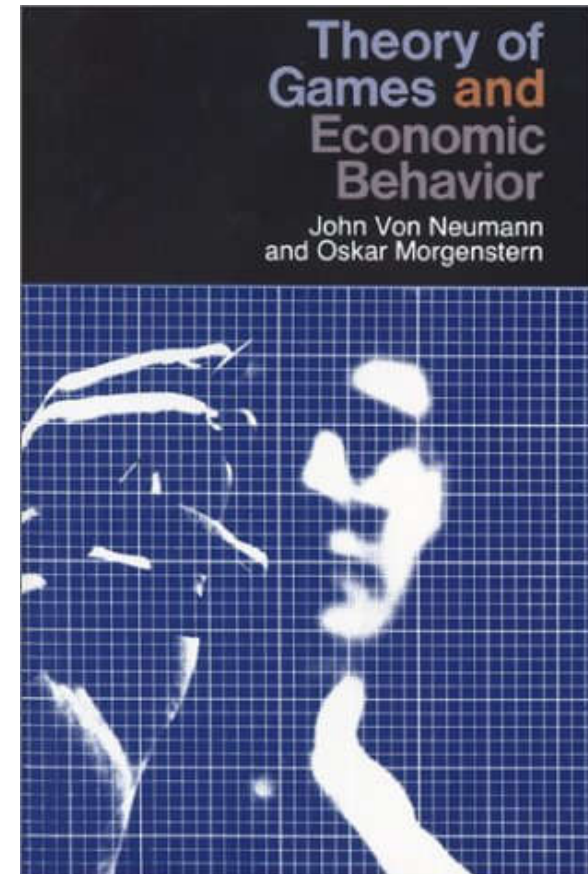
- Human conflict and interactions
 - mathematicians as **Christiaan Huygens** (1629-1695) and **Gottfried W. Leibniz** (1646-1716)
- Researches on the Mathematical Principles of the Theory of Wealth
 - **Antoine Augustin Cournot** (1801-1877) in 1838
- The first general mathematical theorem in game theory
 - **Ernst Zermelo** (1871-1956) in 1912
- The notion of a **mixed**, or **randomized**, strategy
 - **Emile Borel** (1871-1956) around 1920.



History:



- Optimal mixed strategies and an expected value for the Zero-sum game (minimax theorem) .
- **John von Neumann** in 1928
- Theory of Games and Economic Behavior, with **Oskar Morgenstern** in 1944, establishing game theory as a field.



History:



John Nash (1928-2015)

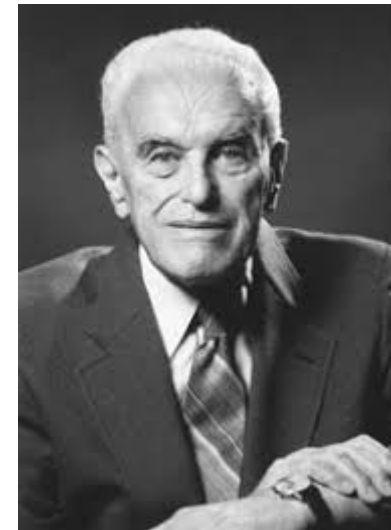
- Received his Ph.D. from Princeton University with a 28-page thesis on his 22-nd birthday.
Invented the notion of Nash equilibrium.
- The existence of equilibrium outcomes in mixed strategies for multi-person games, in 1951.
- Wrote a seminal paper on bargain theory.



History:



- Nobel prize in Economic Sciences 1994 awarded to **Nash, Harsanyi** (Bayesian games) **and Selten** (subgame perfect equilibrium)
- 2005, **Auman** and **Schelling** got the Nobel prize for having enhanced our understanding of cooperation and conflict through game theory
- 2007 **Leonid Hurwicz, Eric Maskin and Roger Myerson** won Nobel Prize for having laid the foundations of mechanism design theory.



Real-Life vs. Game Theory games



- World of Warcraft
- Buying a house
- Salary negotiations
- World Series of Poker
- Competitive pricing:
 - Airline fare wars
- OPEC production cuts
- Rock-Paper-Scissors
- Prisoners' Dilemma

Project

