
Game Theory (CS4187)

Lectures 26

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Mechanism Design

- Today we are starting **Module 4. Not part of Minor 2.**
- Module 4 is about **Mechanism Design.**
- Mechanism design deals with the question: How can a “game designer” **design the rules of the game** such that **players behave according to how the game designer want them to behave.**
 - In most cases that we will see in this course, “how the game designer want players to behave” depends on what the objective function of the game designer is.
 - **Rules of the game designer decides the utility function** of the players which in turn decides how players will behave.
- Mechanism design can be interpreted as “inverse game theory”.
 - In many ways it is the **engineering** side of game theory because we are **designing** the game.

Examples of Mechanism Design

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Example 1 (Sponsored Search Auctions)

- Multi-good auctions: Goods are the advertisement slots (three in this example).
- Goodness of each good: Here it is the **click-through-rate** associated with the advertisement slot.
 - Higher the advertisement slot in the search page, the more is the click-through rate.
- Bidders bid for an advertisement slot.
 - Bid is a scalar; bidders are not bidding for different advertisement slots.
 - Bidders have **private valuation (Bayesian games)** about the monetary value associated with a user landing on their page.

Examples of Mechanism Design

Example 2 (Peer Review to get Departmental Funding)

- N candidates each with their own project proposal.
- There are competing for $M < N$ funding opportunities inside the department.
- The candidates review each other (peer review) and give a score out of 1 to 10 (10 being the best).
- Candidates can their own friend circle which is their **private information**.
- How should the peer review committee design the rules of the game so as to ensure truthful review? **What would these rules consist off?**

Examples of Mechanism Design

Example 3 (Strategic Voting)

➤ True preference ordering:

$S1: b > a > c$

$S2: b > a > c$

$S3: a > c > b$

$S4: c > a > b$


a : Arcade, b : Basketball, c : Car ride.

- Assume the first three voters are non-strategic voters (they vote their true preference order), the 4th one is strategic voter.
- The 4th voter knows that if it reveals its true order, then definitely option b will be selected which is its least favourite. If it chooses $a > c > b$ instead (which is false), it has 50% chance of being chosen. a is the 2nd favourite of $S4$. 5

Few Qualities of a Good Mechanism

apartments in Kompally


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Example 1 (Sponsored Search Auctions)

- Assume there is only one slot (one good) and multiple candidates who wants to advertise are bidding.
- We use **second-price sealed bid auction** (also called **Vickrey auction**).

Few Qualities of a Good Mechanism

Vickrey Auction

b_1, b_2, \dots, b_N

Player i : V_i, b_i

↳ Bidding $b_i = V_i$ is the dominant strategy;
i.e. no matter what b_{-i} are, Player i 's
utility is maximized by bidding V_i .

Few Qualities of a Good Mechanism

Vickrey Auction

> b_1, b_2, \dots, b_N

Player i : V_i, b_i

> $B_i = \max_{j \neq i} b_j$

$b_i < B_i$ (Losing)

• Utility = 0

$b_i \geq B_i$ (Winning)

$V_i < B_i$

Utility
= $V_i - B_i$

$V_i \geq B_i$

Utility
= $V_i - B_i$

$b_j < V_i$

Few Qualities of a Good Mechanism

- Dominant strategy incentive compatibility. → *truth revealing*
 - Bidding the true valuation is the dominant strategy not matter what the other players are bidding.
- Ex-post efficiency.
 - Game designer would achieve the same result is it knows the private information.
- Computationally efficient.

$$\begin{aligned} \max \quad & \sum_{i \in N} V_i x_i \\ \text{Sub. to:} \quad & x_i \in \{0, 1\} \quad \forall i \in N \end{aligned}$$

Private info.



Thank You!