
Game Theory (CS4187)

Lectures 26

Date: 21/10/2024

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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

apartments in Kompally

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Flats for Sale in Kompally Hyderabad
315 - Flats for Sale in Kompally Hyderabad | **Apartments in Kompally** for Sale
Without Brokerage · 3 BHK Flat In Cascade Greens For Sale In Kompally · 2 BHK Flat ...

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), a has 50% chance of being chosen.
 a is the 2nd favourite of S4. 5

Few Qualities of a Good Mechanism

The screenshot shows a Google search results page for the query "apartments in Kompally". The results are as follows:

- Hivision Residency in Kompally - Spacious 2 & 3 BHK...**
Claim Free Interiors Worth ₹5 Lakhs With Your New Home Purchase at Hivision Heights!
Apartment building · Hyderabad · Open · Closes 6 pm
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2 BHK Flats in Kompally · Flats for Sale in Kompally... · 3 BHK Flats in Kompally
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Flats for Sale in Kompally Hyderabad
315 - Flats for Sale in Kompally Hyderabad | Apartments in Kompally for Sale Without Brokerage · 3 BHK Flat In Cascade Greens For Sale In Kompally · 2 BHK Flat ...

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

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

$b_i < B_i$ (Loosing) $b_i \geq B_i$ (Winning)

o Utility = 0

$v_i < B_i$	$v_i \geq B_i$
Utility $= v_i - B_i$	Utility $= v_i - B_i$ $b_i < v_i$

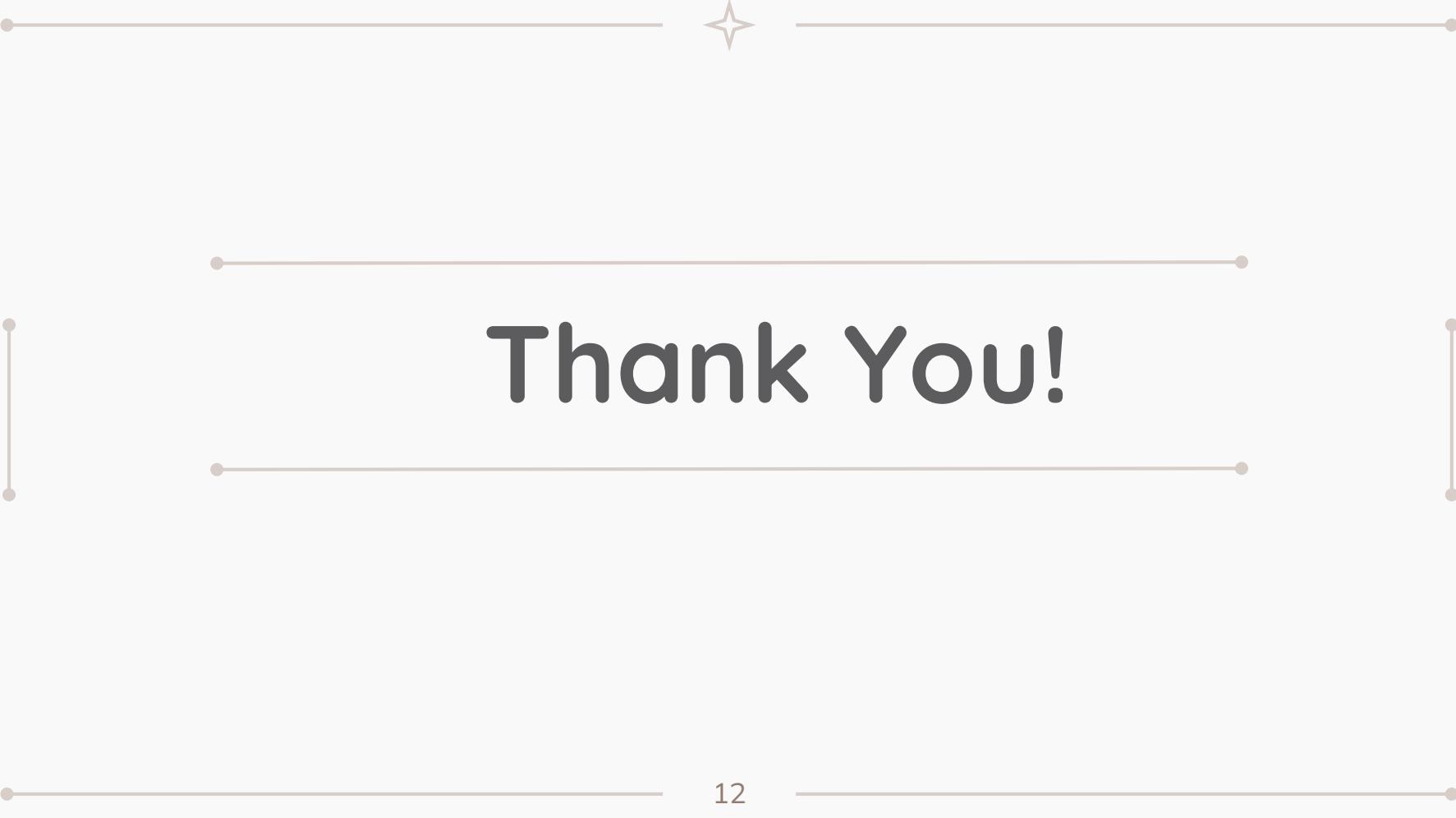
Few Qualities of a Good Mechanism

- 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 if it knows the private information.
- Computationally efficient.

$$\max \sum_{i \in N} v_i x_i$$

Sub. to:
 $x_i \in [0, 1] \forall i \in N$

Private info.



Thank You!