Theory of Online Markets and Platforms

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Bellagio Convening on Human+AI Markets

Outline

- Overview of Existing Online Markets
- Canonical Market Model
- Signaling / Information Design
- Mechanism Design
- Discovery
- Miscellaneous

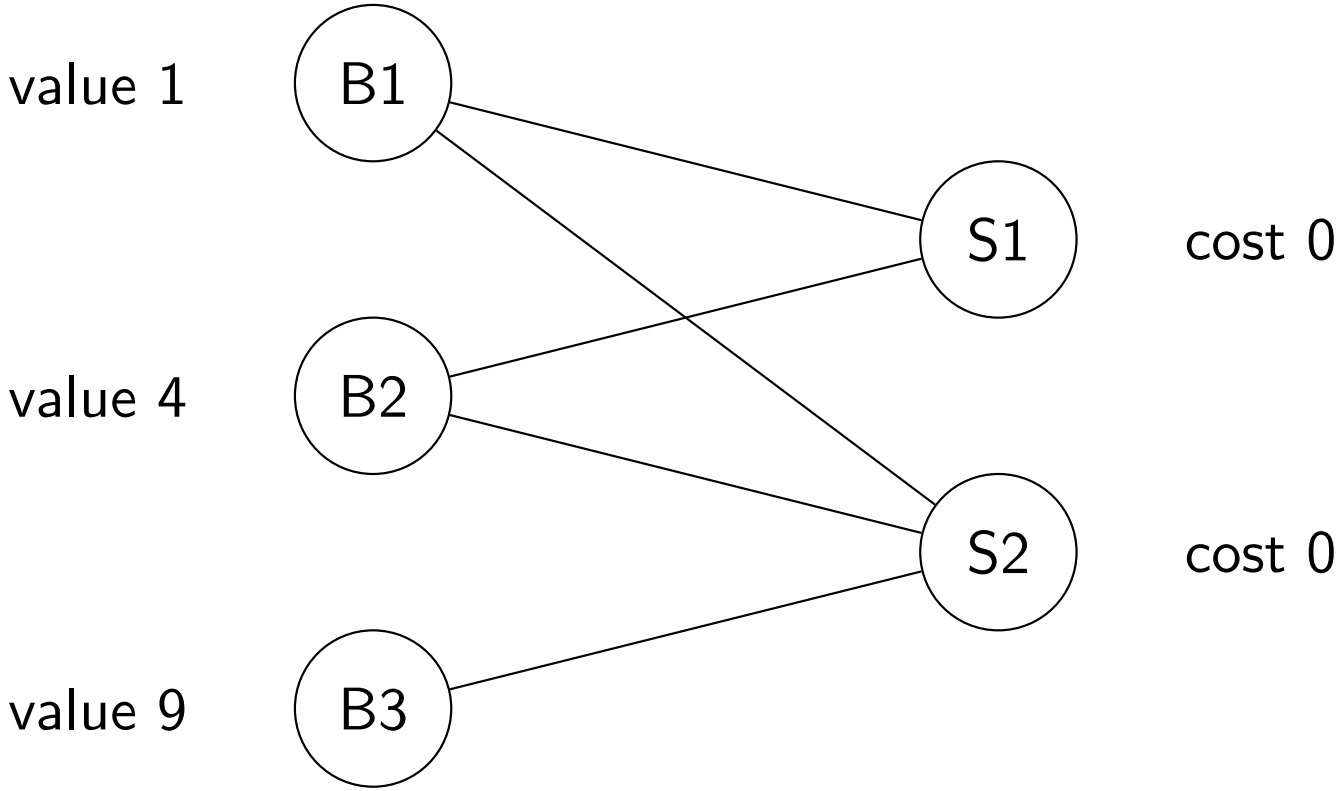
Overview of Existing Online Markets

- Amazon (market equilibria/algorithmic collusion)
- Google (auctions)
- Uber/Lyft (online matching)
- eBay (reputation)
- Netflix (recommendations)
- Spotify (data markets, supply chains)
- Upwork (signaling)
- Yelp (online learning)

Canonical Market Model

- Buyers: values
- Sellers: costs
- Outcomes: allocation and prices
- Goals: welfare, revenue, etc.

Example



- Allocation (maximizes total welfare): $\{(B2, S1), (B3, S2)\}$
- Prices (satisfy individual rationality): $0 \leq p_{21} \leq 4$; $0 \leq p_{32} \leq 9$

Signaling / Information Design: seller advantage

Bayesian priors:

- values/costs drawn from publicly known distribution
- instantiation known only to sellers

Game Time! Markets for lemons.

- There are 18 sellers, each selling a lemon or a peach.
- Sellers: cost of selling a lemon is 3, cost of selling a peach is 8
- Buyers: value of buying a lemon is 4, value of buying a peach is 10
- Bayesian prior: half of us produce lemons, others peaches

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- Sellers, write your price on your paper, hold it up!
- Buyer, go shopping!

Mitigation

Costly signaling

- Sellers can go to marketing school and receive a diploma
- It takes more costly effort for lemon sellers to go to marketing school
- Can be equilibrium where only peach sellers go to marketing school

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Information design

- Sellers can commit to "experiment" (e.g., certification by a platform)
- Platform can improve sales by labeling some lemons as peaches
- In example, label a random 1/3 of lemons as peaches

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Game Time! Pandora's box.

- There are 3 boxes, each of which either contains a prize or not
- The prize in box 1 has value 2 with probability 1/2, costs 1 to open
- The prize in box 2 has value 4 with probability 1/2, costs 1 to open
- The prize in box 3 has value 8 with probability 1/4, costs 2 to open

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Weizman index policy

- When values are independent, optimal search policy is an index rule
- For binomial case above, index is "value − (cost/probability)"

Mechanism Design: buyer advantage

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Game Time! Selling ice cream

- Ilan is offering a scope of ice cream
  (Ilan will buy ice cream for someone in this room)

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Game Time! Selling ice cream

- Ilan is offering a scope of ice cream
  (Ilan will buy ice cream for someone in this room)
- Ilan is going to use a first-price auction to sell it
- Write your name and bid on your paper, hand it in
- Highest bidder wins, pays the price

Auction Design

Auction formats

- First-price auction: Highest bidder wins, pays bid
- Descending auction: Price drops, bidders can clinch at current price
- Second-price auction: Highest bidder wins, pays second-highest bid
- Generalized second-price auction: Advertisers ranked in order of bid, pay bid of advertiser they beat
- Ascending auction: Price raises, bidders can clinch if only they remain
- Vickrey auction: Winners pay "externality" imposed on losers

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Auction properties

- Revelation principle
- Truthfulness as dominant strategy
- Welfare optimization (also implementation theory)
- Revenue equivalence

Belief Elicitation

Prediction games

- "Buyer" has beliefs about state of world
- "Seller" wants to elicit them

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- Write your answer and your prediction of what others will say.

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Mechanisms:

- Proper scoring rules: pay agents based on prediction and outcome
- Peer elicitation: pay agents if their answer is correlated with their peers
- Bayesian truth serum: pay agents for answers that are more common than predicted

Discovery

- Online learning: repeatedly explore a fixed set of options to find one with highest mean reward (e.g., ice cream shops in Bellagio)
- Social learning: a sequence of buyers repeatedly make choices with knowledge of the choices (and sometimes outcomes) of previous buyers to maximize reward

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Game Time! Information cascades

- I have a deck of 20 cards, 10 red and 10 blue
- I will leave the room, flip a coin, remove half of one color at random
- I will then show you in sequence a random card and ask you to guess what the majority color is in the deck

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Incentivized exploration

- buyers sequentially choose options (ice cream shop), report quality
- make incentive compatible recommendations based on reports that induces sufficient exploration to enable learning

Miscellaneous

- Pricing (oligopolies, price discrimination)
- Investment (Shapley value, contract design)