IIT KHARAGPUR

NPTEL ONLINE CERTIFICATION COURSES

NPTEL

E-BUSINESS

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Week 12: Lecture1

ECONOMIC CONSIDERAIONS IN AUCTION

We are going to learn

- Auction design problem
- Efficiency and optimality considerations
- Example of auction mechanism design

Auction Design Problem

- Deals with economic considerations
- Designing auctions rules with some desirable property to satisfy the auctioneers need
  - Modeling preference, behavior and information available to the agents
  - Designing mechanisms in which the agent strategies result in the outcomes with the desirable properties.

Modeling bidders valuation of a product

- Private value model
  - Each participant has a potentially different value for good in the question
  - Symmetric (or asymmetric)
    - All the bidders draw their values from a common distribution
- Common value model
  - The good in the question has the same value for all the participants
- Interdependent Value Models
  - Each bidder has only an estimate regarding the value.
  - This estimate may change after getting the price signal from others.

Auction mechanism design goals

- Pareto efficiency
  - Design an auction that results in a Pareto efficient outcome
  - The item under consideration goes to the person who needs it most (He may not pay the highest amount)
  - After trade should not be possible
- Profit maximization
  - Design an auction that yields the highest expected profit to the seller
  - The item should go to the person who pays the highest amount.

Efficiency Vs. optimality

- Optimal auctions are designed to maximize the expected revenue of the seller by using a set of tools including posing a reserve price or charging an entry fee, whereas the objective of efficient auctions is to maximize the social welfare, the sum of the players' surplus.

- Efficient design aims to maximize the system welfare, whereas the optimal design aims to maximize the seller's individual revenue.

Efficiency Vs. optimality

- Since optimality and efficiency usually cannot be achieved simultaneously, the auction designers have to make the choice before he states the rules of the auction.

- A financial self-interested agent may prefer the optimal auctions, while a public agent like the government may prefer the efficient auctions to gain more social welfare. Nevertheless, all agents need to balance optimality and efficiency to make the auctions practical.

Efficiency Vs. optimality

- Three popular mechanisms: First price, second price and English Auction
- Efficiency
  - All the major action formats are efficient assuming the bidder is truthful
- Optimality
  - First price auction and English auctions are optimal.
  - Second price auction becomes optimal if an appropriate reserve price is set.

Modeling the basic auction mechanisms

- Auction as a (Bayesian) game
  - Bidders are the players
  - The problem is to find the equilibrium
- The formulation help finding the efficient allocation
- Assumptions of the basic model
  - n bidders
  - Bidder's values are independent and identical random variables (symmetric, independent bidders)
  - Bidders are risk neutral
  - They show no collusion or predatory behavior
- Under this assumption all the basic auction formats are efficient and generate same revenue
  - Revenue equivalence theorem

Example: Bidding Strategy in second price auction

- In a second price under independent private value setting and with risk neutral bidders, bidding truthfully is a dominant strategy
- The item under consideration goes to the bidder who values it most.
- The value is measured in terms of price. So the item must go to the bidder with highest valuation for the product.
- Considering the bid as a proxy for the valuation, the item may go to the highest bidder. But, what is the guarantee that the all the bidders bid truthfully?

Example: Bidding Strategy in second price auction

- A case of two bidders
  - Let the valuations are v_1, and v_2
  - Let the bids are b_1 and b_2
  - Expected payoff of 1st bidder is prob$[b_1 \geq b_2][v_1 - b_2]$

If $v_1 > b_2$ then in order to win the bidder 1 will make b_1 as high as possible. This happens when he sets $b_1 = v_1$

If $v_1 < b_2$ then in order to avoid winning the bidder 1 will make b_1 as low as possible. This is possible only if he sets $b_1 = v_1$

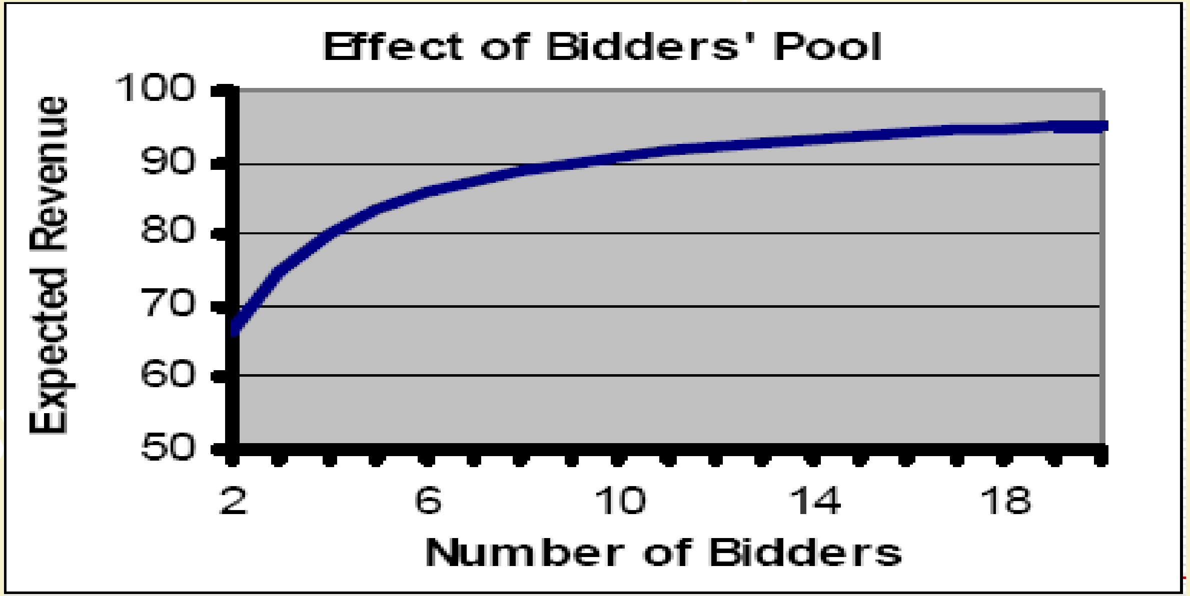
- Incentive compatible direct mechanism

Optimal Mechanisms

- Increasing the expected revenue
- Two ways
  - Increasing the number of bidders
  - Setting up a reserve price

More Bidders = higher Expected Payoff

For n bidders with IPV and V~U(50,100):



Reserve Prices

- A minimum price, *r*, below which the seller does not sell the item
  - "Excludes" some bidders with $v < r$
- Proper reserve price increases revenue

Relaxing the basic assumptions

- Risk aversion
  - Worried about not winning
  - Bids higher
  - Prefers English auction
- Asymmetric valuations
  - Strong Vs. Weak bidder
- Reputation effect
  - Aggressive

Interdependencies

- Interdependent values -a bidder's valuation is affected by knowing the valuation of other bidders
  - Each bidder has only a partial information about the value of the item being sold in the form of a signal, which is a random variable
- Pure common value – item has the same value for all bidders. Each bidder has only an (unbiased) estimate/signal of the value prior to the auction

Revenue under interdependencies

- English auction and second price auctions are no longer equivalent
- English auctions are likely to yield more revenue than both 1st and 2nd price auctions.
- More information flow is likely to increase the value of the object. Therefore, releasing all the information about the item being sold the auctioneer may yield more profit.

Winner’s Curse

- The winner curse takes place when winner pays too much, due to their failure to anticipate and correct their bidding strategy
- The winner is the bidder with highest price signal.
- Winning means that everybody else had a lower estimate
- To correct winner’s curse bidders have to “shave” their bids further

Week 12: Lecture2

WINNER DETERMINATION PROBLEM

We are going to learn

- Winner determination problem under various auction setting.

A simple winner determination problem

What kind of auction?

- single-item
- single-unit
- single winner
- forward auction
- price only bids

How do we solve it?

- A simple sorting problem !!

$$\max \sum_i p_i x_i$$

$$s.t \sum_i x_i \leq 1$$

$$x_i \in \{0,1\}$$

Where p_i is the price of item i, x_i is a binary variable indicating selling decision on item i

Winner determination problem in complex auction formats

- Multi unit auctions
  - Forward auction
  - Reverse Auction
  - Constraint types
    - Divisible bid
    - Indivisible bid
    - Price Schedule
- Multi-item auctions
  - Forward auction
  - Reverse Auction
  - Constraints types
    - Number of winning suppliers
    - Budget limit on trades
    - Market share constraints
    - Representation constraints
    - Volume discounts
- Multi Attribute auctions
  - Reverse auction
  - Constraint types
    - Single sourcing
    - Multiple sourcing
- Double auctions and exchanges
  - Trading securities and financial instruments
  - Continuous double auction
    - Clears continuously
  - Clearinghouse auction
    - Periodic clearing
  - Constraint types
    - Aggregation
    - Divisibility
    - Homogeneous / heterogeneous items

Multi unit auctions

- Forward auction
  - Maximization of selling price
- Reverse Auction
  - Minimization of procurement cost
- Bid types
  - Divisible bid
  - Indivisible bid
  - Price Schedule

Multiunit auction with divisible bids

Bidder (i)	Bid (p_i, q_i)		
1	(20, 30)	3	Total quantity sold
2	(30, 30)	1	Total quantity sold
3	(15, 60)	4	(Only 20 units are sold)
4	(10, 30)		
5	(25, 20)	2	Total quantity sold

Total Quantity to Sell =100
Total Quantity Sold =100
Total Revenue=30*30+25*20+20*30+15*20

$$\max \sum_i p_i x_i$$
s.t
$$\sum_i x_i \le Q$$
$$x_i \le q_i \quad \forall i$$
$$x_i \ge 0$$

Where
i **The buyer** i
p_i **is unit price**
q_i **is the quantity**
Q **is the total demand,**
x_i **is the decision variable**

- Each bid is represented as a price quantity pair (p_i, q_i)
- Again a simple sorting problem
- Last chosen bid gets partial allocation!!

Multiunit auction with indivisible bids

Bidder (i)	Bid (p_i, q_i)	
1	(20, 30)	selected
2	(30, 30)	selected
3	(15, 60)	
4	(10, 30)	
5	(25, 20)	selected

Total Quantity to Sell =100
Total Quantity Sold =80
Total Revenue=30*30+25*20+20*30

$$\max \sum_i p_i q_i x_i$$

$$s.t$$
$$\sum_i q_i x_i \leq Q$$
$$x_i \in \{0,1\} \quad \forall i$$

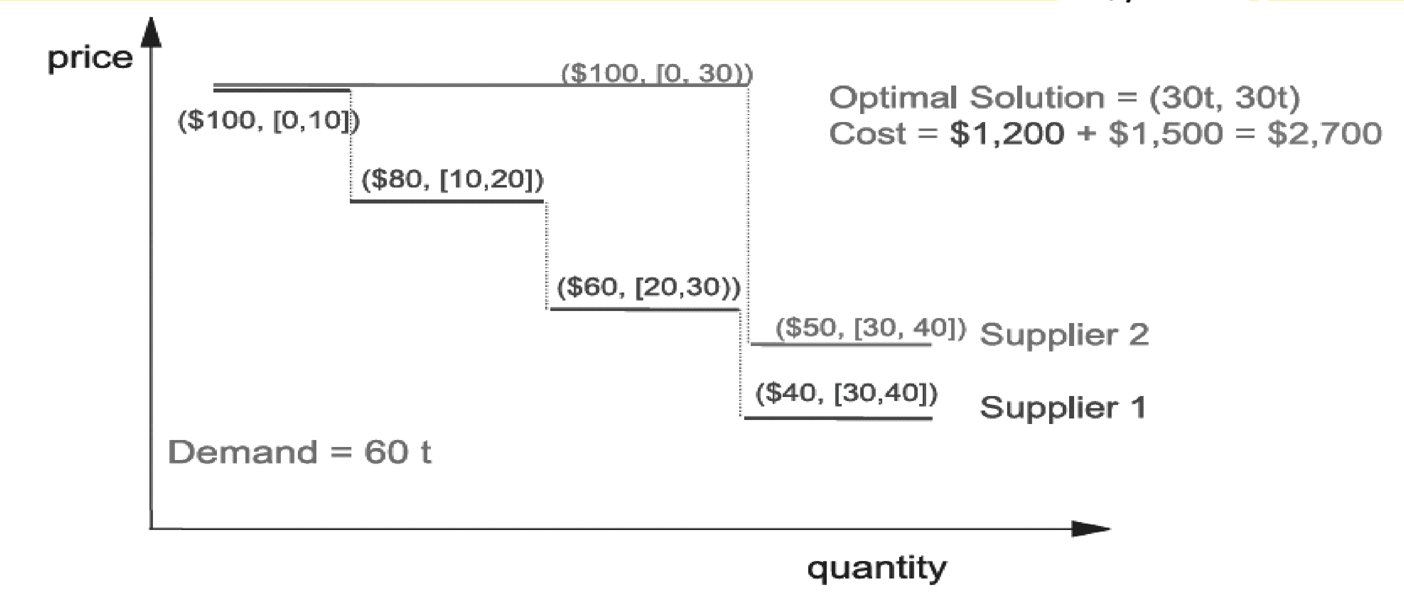
Where
i **The buyer i**
p_i **is unit price**
q_i **is the quantity**
Q **is the total demand,**
x_i **is the decision variable**

- Each bid is represented as a price quantity pair ($p_{i,}$ q_i)
- A knapsack problem!!
- Can be solved by Branch and Bound Algorithm?
- A greedy algorithm does exist

Multiunit reverse auction with price schedule for volume discount bids

- Price schedule for i^{th} seller is represented as $\{(p_{i1}, [\underline{q}_{i1}, \overline{q}_{i1}]), \ldots (p_{iM_i}, [\underline{q}_{iM_i}, \overline{q}_{iM_i}])\}$

p_{ij} is the per unit price for the quantities in the interval $[\underline{q}_{ij}, \overline{q}_{ij}]$



A multiple choice knapsack problem

Multi –item forward auctions

Set of items to be sold = {A, B, C, D, E}
Two bidders submit the bundled bids

Bundles of Bidder 1	Bundles of Bidder 2
[100, {A,C,D}]	[50, {E}]
[150, {A,B,C}]	[200, {C, E}]
[50, {A,B}]	[75, {D, E}]
[75, {B,C}]	

$$\max_{x_i(S)} \sum_{S \in B_i} \sum_i x_i(S) p_i(S)$$

$$\text{s.t.} \quad \sum_{S \in B_i} x_i(S) \leq 1, \qquad \forall i$$

Only one bundle from each buyer

$$\sum_{S \in B_i, S \ni j} \sum_i x_i(S) \leq 1, \qquad \forall j$$

$$x_i(S) \in 0, 1, \qquad \forall i, S$$

Each item *j* is considered only once

$\mathcal{G} = (1, \ldots, N)$ set of items to be sold

$S \subseteq \mathcal{G}$

$B_i \subseteq 2^{\mathcal{G}}$ the bid set from bidder *i*

p_i (*S*) Price offered by bidder *i* for bundle *S*

Multi –item forward auctions: **A set packing problem**

- **Given:** A set of subsets *S = S_1, ..., S_m* of the universal set *U*
- **Problem:** What is the largest number of mutually disjoint subsets from *S*?

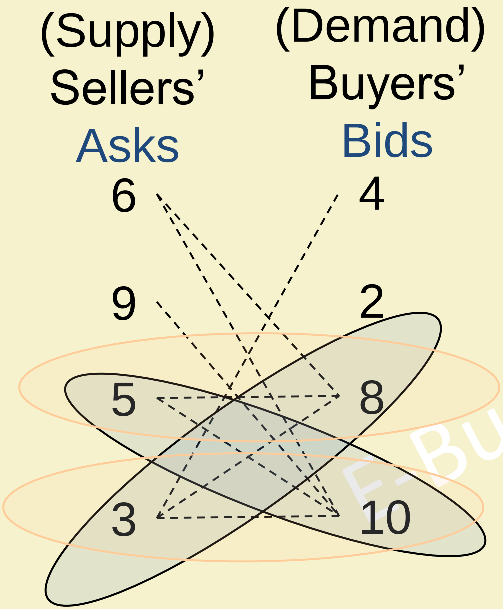
Adding Business rules as side Constraints further increases the complexity

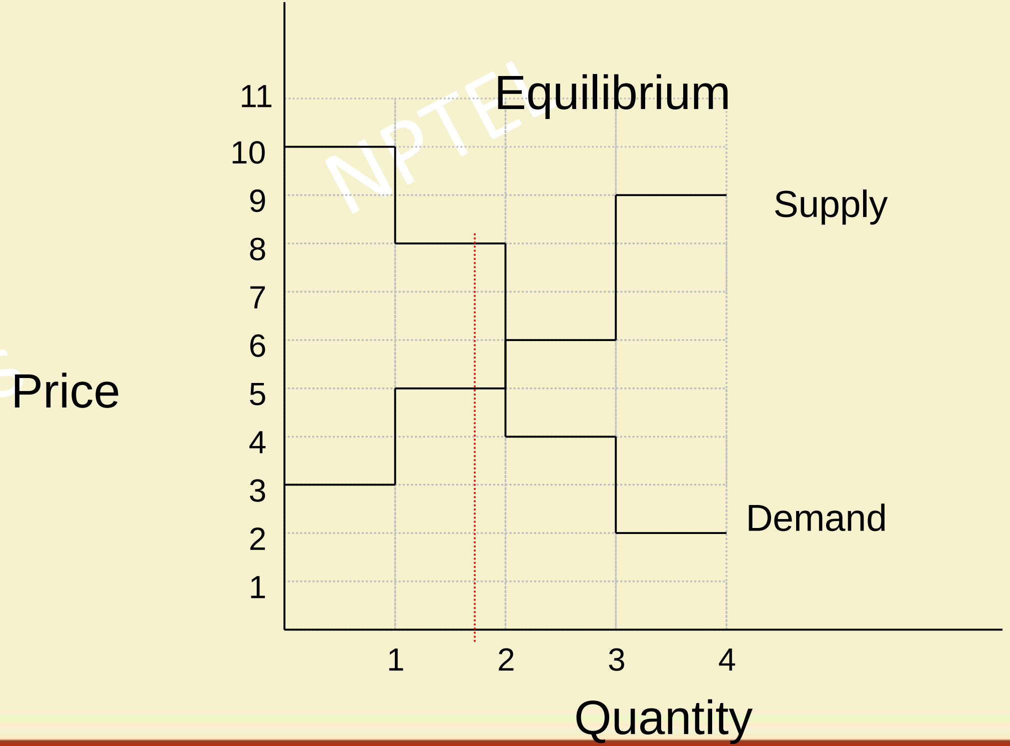
- Number of Winning Suppliers
  - Multi sourcing
- Budget Limits on Trades
  - How much I can spend
- Markets hare Constraints
  - How much business to allocate to each winner
- Reservation Prices
  - What is the minimum price below which the seller will not sell the product, i.e. minimum bid price

Double Auctions

- A multiple buyer and multiple seller auction
- Used in financial institutions for over a hundred years
  - Ex. New York stock exchange
- Two types
  - Continuous double auction, which clears continuously
  - Clearinghouse or *call* auction, which clears periodically

Determining the equilibrium point in double auction





Winner determination problem in double auction

- The problem is to maximize market surplus. Where surplus is defined as the difference between the *bids* and *asks*
- In the last example where 4 sellers try to sell a single unit of some homogeneous good, and 4 buyers bid to buy a single unit each, the winner determination problem can be formulated as

$$\max \sum_{i=1}^{4} \sum_{j=1}^{4} (p_j - p_i) x_{ij}$$

$$s.t$$

$$\sum_{j=1}^{4} x_{ij} \leq 1 \qquad \forall i$$

$$x_{ij} \in \{0,1\} \qquad \forall i, j$$

Other Considerations During Double auction problem formulation

- Aggregation
  - Role of market maker in disassembling and reassembling bundles of items
  - Consideration of either buy side items or sell side items or both
- Divisibility
  - Ability to satisfy a fraction of agent's bids and asks
- Homogeneous/Heterogeneous goods

Week 12: Lecture 3

ONLINE AUCTION ISSUES

We are going to learn

- Issues related to online auctions
- Online auction example

Classification of Online Auction Types

SELLERS \ BUYERS	ONE	MANY
ONE	Bilateral negotiations	Web-based sales auctions C2C and B2C
MANY	Web-based procurement (Reverse) auctions C2B and B2B	Web-based exchanges

Online design issues

- Choice of appropriate mechanism
  - Currently the English auction is the dominant mechanism on the Internet.
  - Second price which is not well adopted in traditional auctions has become an important option.
- Bid constraint
  - Minimum bid
    - Reserve price
  - Maximum bid
    - Buy-now price
- Auction Duration
  - Ending rules
- Multi-unit auctions and handling complex auction formats
  - Quick response time
  - Appropriate algorithms

Integrating Online Auctions into a Firm's Business Model

- B2C surplus auctions
  - A firm may use auctions to dispose of surplus inventory
- B2C Auctions as a Regular Sales Channel
- B2B surplus auctions
- B2B procurement auctions
- Use of auction intermediaries

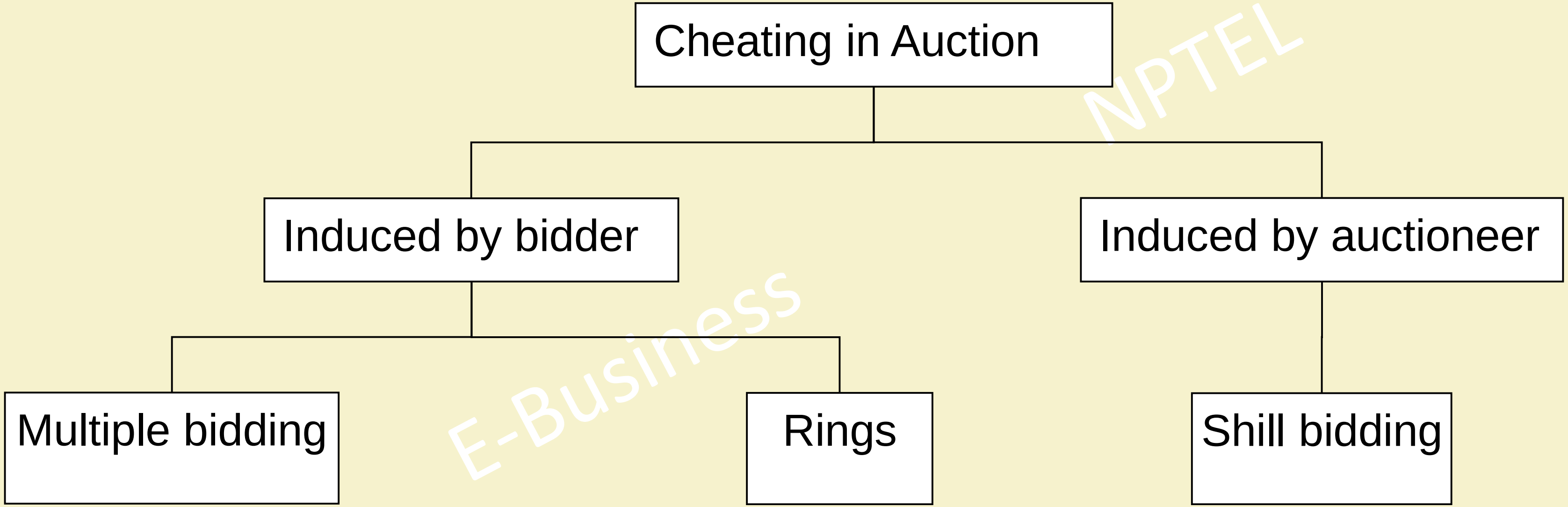
Fraud in online auctions

- Auction frauds constitute the largest part of all Internet frauds (60 %) (Internet Fraud Complaint Center (IFCC))
- Auction frauds is of six categories
  - Non-delivery of goods
  - misrepresentation of the items
  - Triangulation
    - The perpetrator buys items from an online merchant using stolen credit card number and then sells them to unsuspecting buyers.
  - Fee stacking
    - Fee stacking occurs when a seller keeps adding hidden charges
  - Selling of black-market goods
    - Illegally copied software packages, audio CDs, movie CDs and games
    - Improper packaging and does not offer any form of warrantee or instruction manual that may have come along with the original goods.
  - Multiple bidding and Shill bidding (Cheating)

Cheating

- Cheating unlike other fraud categories leaves *no direct evidence* of its occurrence
- Some of the reasons that encourage cheating over the Internet
  - Cheap pseudonyms
  - Greater information asymmetry
  - Lack of personal contact
  - The tolerance of bidders

Types of Cheating



Cheating in electronic auction

Auction at e-Bay

- All eBay auctions use a ascending-bid format which is a hybrid of English and Second price auction. with the important distinction that there is a fixed end time set by the seller.

Models:

- Standard Auction
- Reserve Price Auction
- Buy It Now Price
- Dutch Auction
  - Not synonymous with traditional Dutch auction
  - Multi-unit auction with volume discount

The Proxy Bidding and Bid Increment

- The proxy mechanism allows a bidder to submit a maximum bid (i.e., maximum willingness to pay) with a guarantee that eBay will raise the bidder's active offer automatically until the bidder's maximum bid value is reached.
- The bid placed by the proxy system is referred as the bidder's proxy bid.
- In a reserve price auction, the seller's reserve price is treated like any other bid; if the buyer's offer meets or exceeds the reserve (secret) bid set by the seller, the buyer's bid would be raised to that price immediately.
- EBay enforces a minimum bid increment that, along with the current ask price, determines a lower bound on bids the server will accept.
- The bid increment table specified by eBay defines a schedule in which the minimum increments increases with the current ask price.

Auction at e-Bay

Data available to a bidder

- Item description
- Number of bids
- ID of all the bidders
- Time of their bid and the bid amount
- Time remaining until the end of the auction,
- Whether or not the reserve price has been met,
- The current ask price (list price).
  - The list price is the second highest price plus a small increment as specified in the bid increment table of eBay.

Auction at e-Bay

Bidding Strategies

- Single bid engagement
  - Evaluator
  - Late bidder
  - Sniper
- Multiple bid engagement.
  - Skeptic
  - Unmasking

Auction at e-Bay

End of Week 12