# Lecture 15 Auctions



# Administration

- Review:
  - PA6 due on Monday
  - PA7 goes out on Monday
  - I still have a bunch of graded midterms



### **Auctions**

- The Web often has:
  - Lots of participants
  - With no central control
  - Who need to find a price
- Auctions are the central method
- Ebay, Google ads best known. Also:
  - Pricing grid computing resources
  - Pricing bandwidth
  - Others



### Auctions

- Auctions can appear to be a fact of life, but there are lots of different kinds of auctions, which favor different outcomes
- Sometimes called mechanism design, creating an auction system can be highly mathematical
- Agents in an auction have different motives & strategies
- Tightly-related to game theory



# The Players

- There's a seller, and a set of bidders
- There's also a thing to sell
- Assume that **bidders** each know their valuation of the thing
  - A bidder will pay the valuation if necessary
  - Would like to pay less, if possible
  - Is this realistic?
- Seller does not know the buyers' valuations of the thing
- **Bidders** do not know each others' valuations
- Despite being self-interested and private, players must somehow find a price



# Many kinds of auctions

- Ascending bid, or "English" auction
  - Price goes up, until one bidder left
  - This is the kind of art auction that James Bond attends in movies; best-known type
- Descending bid, or "Dutch" auction
  - Price goes down, until someone bites
  - Used in Dutch flower auctions



### More auctions

- First price sealed bid auction
  - Winner pays his bid
  - Examples to come
- Second price sealed bid auction
  - Winner pays the 2nd place bid
  - Used by Ebay
  - Sometimes called a Vickrey auction



# First-price, sealed-bid

Vahed bids \$2



Mike bids \$1

Vahed wins! Pays \$2.00



# Second-price, sealed-bid



Vahed bids \$2



Mike bids \$1

Vahed wins again! This time he pays \$1.00, not \$2.00



### **Analysis**

- Think about who wins, and how much the winner pays
- Ascending bid auction
  - What is the bidder's likely strategy?
  - Bidder stays in until price reaches bidder's value
  - Who wins? What does the winner pay?
- Sealed-bid second-price auction
  - What is the bidder's likely strategy?
  - For moment, assume bidder bids true value
  - Who wins? What does the winner pay?
- In both cases, winner is the bidder with highest value, pays 2nd-highest value



# Second-Price Analysis

- Bidding true value is always best
- v<sub>i</sub> = i's value for the object
  b<sub>i</sub> = i's bid for the object
- Payoff to bidder is:
  - $v_i$  max( $b_i$ ) if  $b_i$  > max( $b_i$ )
  - 0 otherwise
- If b<sub>i</sub> > v<sub>i</sub>, bidder would pay more than he values it (with negative payoff)
- If b<sub>i</sub> < v<sub>i</sub>, bidder may fail to obtain object (with zero payoff)
- Thus, best strategy is b<sub>i</sub>=v<sub>i</sub>



# Second-Price Analysis

- In second-price auction, your bid does not directly impact what price you pay
- It determines whether to get to pay or not

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# First-Price Analysis

- What is the bidder's likely strategy?
  - Because the bid determines the price, bidding the true value may lead to overpayment
    - Bidders tend to underbid in a first-price auction

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### Pay-Per-Click Auctions

- Consider the auction for ads that Overture used to run.
  - Overture was the first company to do text search ads. Even before Google! It was bought by Yahoo in 2003.

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# **Overture PPC Auctions**

- Bidders can purchase "keywords"
  - Whenever a search user types keyword, then ads are displayed in descending order of bid. The high-bidder has "won" the auction.
  - If the user clicks on the ad, then highbidder pays the search engine the bid price
  - User can click on many, or no, ads
  - How should we determine bid price?
    - Overture: First-price sealed bid auction

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### Overture in Action!

- Three parties bid on the best, most profitable keyword out there:
  - "eecs485"







\$1

\$2

\$3



#### Overture in Action!



- VP Cheney is pos #1
  - He bids \$3, pays \$3



- Vahed is pos #2
  - He bids \$2, pays \$2



- Mike is pos #3
  - He bids \$1, pays \$1
- What should Cheney do?



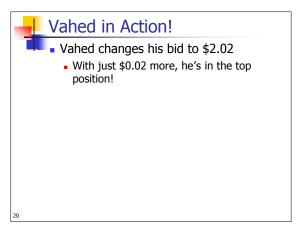
# Cheney in Action!

- Cheney changes his bid to \$2.01
  - He's going to save \$0.99 with every click!

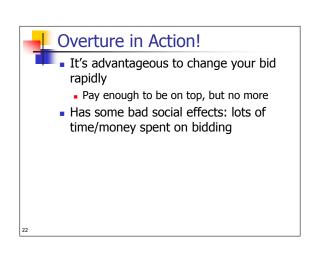
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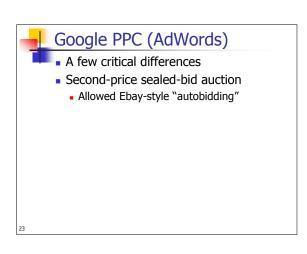
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# Google in Action!

- Unlike Overture, Google auction prices are kept secret. You don't know what other people bid.
  - But you can guess. What if Cheney changes his bid to \$2.75?

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### Google in Action!



- Vahed is pos #1
  - He bids \$3.00, but pays \$2.76



- VP Cheney is pos #2
  - He bids \$2.75, pays \$1.01



- Mike is pos #3
  - He bids \$1, pays minimum
- Vahed pays more; no change



# Google PPC (AdWords)

- More differences:
  - Displayed ads ranked by combination of bid amount and ad-quality
  - How do PPC motives differ from Ebay's?
  - Click-through rates are highly dependent on the ad text
  - Google was originally the "cheap competitor" to Overture, then overtook

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### Other issues in auctions

- I lied, slightly. Google AdWords is not exactly a Vickrey auction
  - Standard 2nd-price auctions sell one item
  - Google sells multiple items
  - It's a "Generalized Second Price" auction
  - Lacks some properties of Vickrey
- What if you want two items in successive items, but if you can't get them both, want nothing?
- What if you can collude with other bidders?
  - See spectrum bids