Auctions

Part III: Dynamics — Episode 8

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Paying Per Click

- Ads in Google's sponsored links are based on a cost-per-click model
  - Advertisers only pay when a user actually clicks on the ad
- The amount that advertisers are willing to pay per click is often surprisingly high
  - To occupy the most prominent spot for "calligraphy pens" costs about $1.70 per click
  - For some queries, the cost per click can be stratospheric — $50 or more for a query on "mortgage refinancing"!

But how does a search engine set the prices per click for different queries? — it would be difficult to set these prices with so many keywords!

Required reading: “Networks, Crowds, and Markets,” Chapter 9.1 — 9.5

Let’s first focus on a few simple types of auctions, and see how they promote different kinds of behaviour among bidders

Simple auctions

- Consider the case of a **seller** auctioning off one item to a set of buyers
- Assumption: a bidder has an **intrinsic value** for the item being auctioned
  - She is willing to purchase the item for a price up to this value, but no higher
  - Also called the bidder's **true value** for this item

Four main types of auctions

- **Ascending-bid** auctions (**English** auctions)
  - Carried out interactively in real-time
  - The seller gradually raise the price
  - Bidders drop out until one bidder remains — the winner at this final price

Four main types of auctions

- **Descending-bid** auctions (**Dutch** auctions)
  - Carried out interactively in real-time
  - Seller gradually lowers the price from some high initial value
    - until the first moment when some bidder accepts and pays the current price

Four main types of auctions

- **First-price sealed-bid** auctions
  - Bidders submit simultaneously “sealed bids” to the seller
  - The highest bidder wins the object and pays the value of her bid

Four main types of auctions

- **Second-price sealed-bid** auctions (Vickrey auctions)
  - Bidders submit simultaneous sealed bids to the sellers
  - The **highest bidder** wins the object and pays the value of the second-highest bid
  - William Vickrey, who proposed this type of auctions, were the first to analyze auctions with game theory (1961)

When are auctions appropriate?

- Auctions are generally used by sellers in situations where they do not have a good estimate of the buyers' true values for an item, and where buyers do not know each other's values
  - If the intrinsic value of the buyer is known, there's no need for auctions
  - The seller (or the buyer) simply commit to a fixed price that is just below the intrinsic value of the buyer (or just above that of the seller)

The goal of auctions

- The goal of auctions is to elicit bids from buyers that reveal these values
  - Assuming that the buyers have **independent**, **private**, **true** values for the item

Descending-Bid and First-Price Auctions

- In a descending-bid auction —
  - As the seller lowers the price from its high initial starting point, no bidder says anything until finally someone actually accepts the bid and pays the current price
  - Bidders learn nothing while the auction is running, other than the fact that no one has accepted the current price yet
  - For each bidder i, there's a first price b_i at which she would be willing to break the silence and accept the item at price b_i
- It is equivalent to a **sealed-bid first-price auction**: this price b_i plays the role of bidder i's bid
  - The item goes to the bidder with the highest bid value, and this bidder pays the value of her bid in exchange for the item

Ascending-Bid and Second-Price Auctions

- In an ascending-bid auction —
  - Bidders gradually drop out as the seller steadily raises the price
  - The winner of the auction is the last bidder remaining, and she pays the price at which the second-to-last bidder drops out
  - For a bidder, it doesn't make sense to stay after the price exceeds her true (intrinsic and private) value
  - Or to leave before the current price reaches her true value
- A bidder stays in an ascending-bid auction up to the exact moment when the current price reaches her true value
  - The item goes to the highest bidder at a price equal to the second-highest bid
  - This is precisely the rule used in **sealed-bid second-price** auctions

Second-Price Auctions

- **Main result**: With independent, private values, bidding your true value is a **dominant strategy** in a second-price sealed-bid auction
  - That is, the best choice of bid is exactly what the object is worth to you
- To show this, we need to formulate the second-price auction as a **game**
  - Bidders correspond to players
  - Let v_i be bidder i's true value for the object
  - Bidder i's strategy is an amount b_i to bid as a function of her true value v_i

Truthful bidding in second-price auctions

- The payoff to bidder i with value v_i and bid b_i is defined as follows:

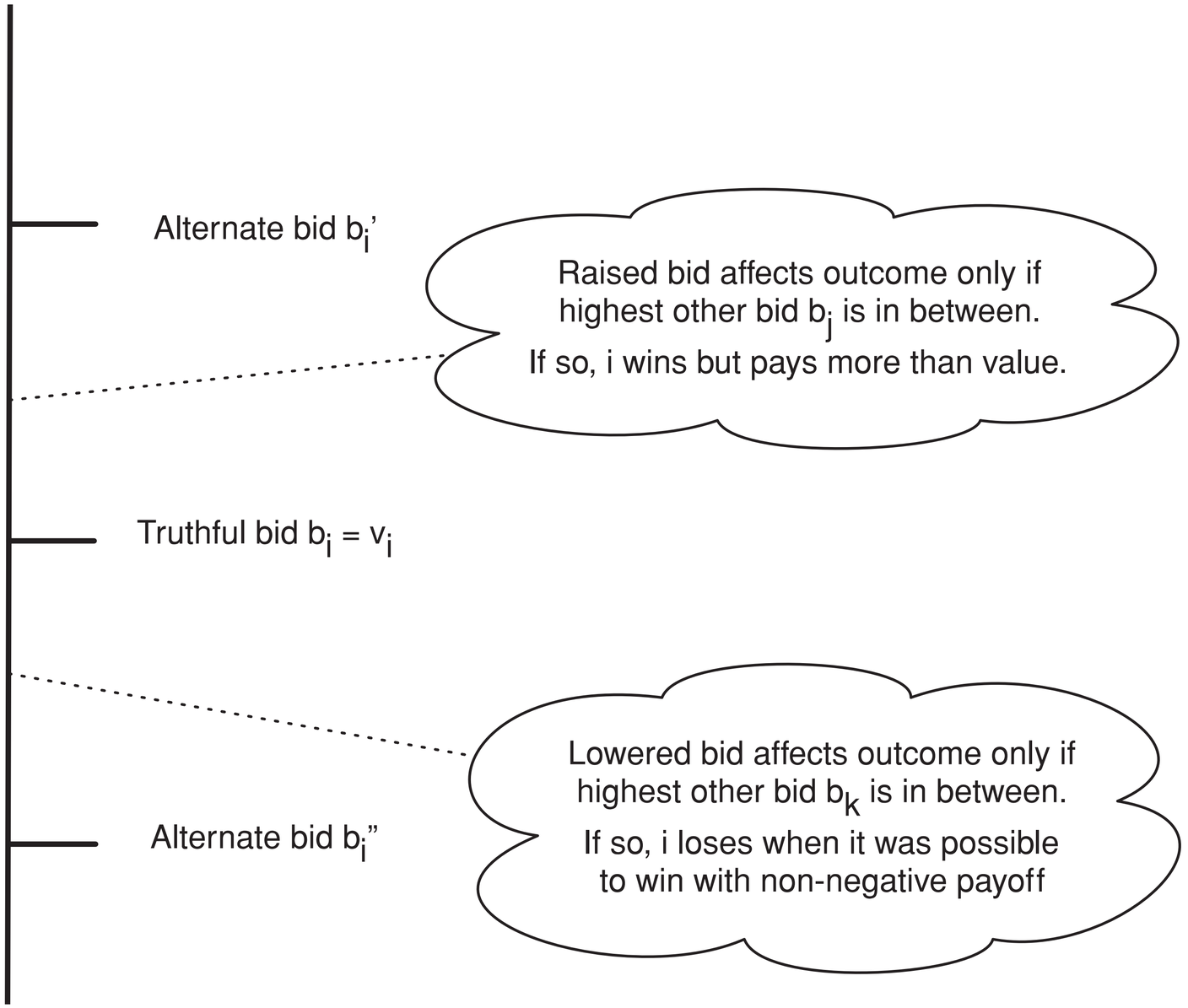
> If b_i is not the winning bid, then the payoff to i is 0. If b_i is the winning bid, and some other b_j is the second-place bid, then the payoff to i is $v_i - b_j$.

- Claim: In a sealed-bid second-price auction, it is a dominant strategy for each bidder i to choose a bid $b_i = v_i$.

Proving the claim

- We need to show that if bidder i bids $b_i = v_i$, then no deviation from this bid would improve her payoff, regardless of which strategy everyone else is using
- Two cases to consider: deviations in which i raises her bid, and deviations in which i lowers her bid
- In both cases, the value of i's bid only affects whether i wins or loses, but it never affects how much i pays in the event that she wins
  - which is determined entirely by the other bids

Deviating by raising or lowering her bid



First-price auctions

- The payoff to bidder i with value v_i and bid b_i is defined as follows:

> If b_i is not the winning bid, then the payoff to i is 0. If b_i is the winning bid, then the payoff to i is $v_i - b_i$.

- Bidding your true value is no longer a dominant strategy!
  - A payoff of 0 if you lose (as usual), and a payoff of 0 if you win, too
- The optimal way to bid is to "shade" your bid slightly downward, in order to get a positive payoff if you win
  - If it's too close to the true value, your payoff won't be large if you win
  - If it's too far below, you reduce the chance of winning

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