

Lecture 4: Sponsored Search Auctions: k-item auction, prominence, pay-per-click

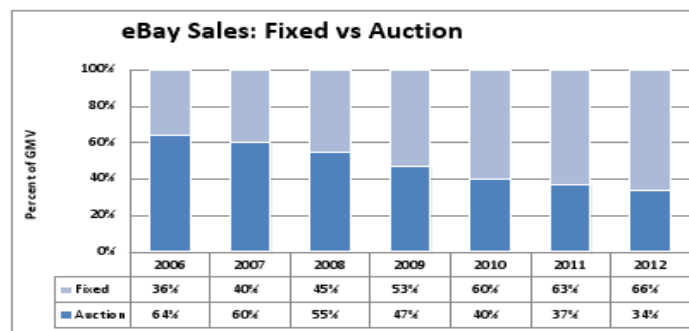
eBay: The rise of fixed price (Drop in fraction of revenue from auctions for eBay)

Courtesy: Sarah Boisseree

Sarah Boisseree
MS&E 233

Year	Auction	Fixed
2006	64%	36%
2007	60%	40%
2008	55%	45%
2009	47%	53%
2010	40%	60%
2011	37%	63%
2012	34%	66%

*All data comes from the annual reports (10-k) for eBay found on the SEC website
**Percentage of Gross Merchandise Volume (GMV) used in comparisons



Likely cause: Sellers know buyer value better and switch to auctions.

Other possible causes:

- Buyers are less patient and most auctions don't result in sales.
- Sellers who were merchants on Amazon joined eBay and they were accustomed to fixed price sales.
- ...

Identifying causality is hard :)

See for example: [Simpson's Paradox](#)

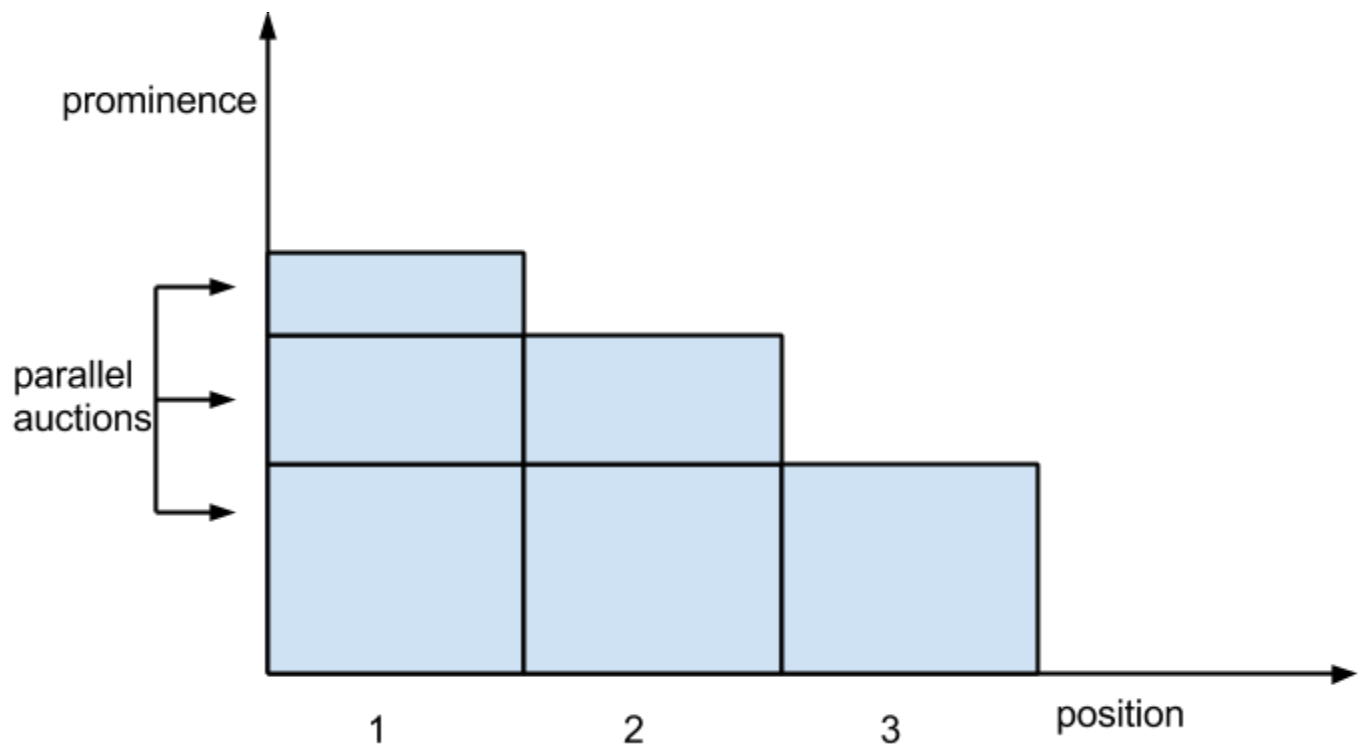
Back to Sponsored Search...

First-Cut: Efficient auction for k identical items

- For a given query, first identify all eligible advertisers and their bids per impression
- Run efficient, multi-item auction with as many items as positions on sale.
- Notice that this is a k+1st price auction. (Must have bid independent threshold, must allocate to top k bidders.)
 - Notice that the auction of running a second price auction for each item in succession, removing the winner at each step is not incentive compatible
 - E.g. items positions, and 5 bidders with values 10, 9, 8, 7, 6. Highest bidder pays 9, though it would still have won if it dropped its bid to 7.5, in which case it would only pay 7.

Second Cut: Deal with varying prominence

- Problem: different positions have different amounts of prominence to search users
 - see ads for query ['camera'](#) on Bing



- Thus, from an advertiser's perspective, these auctions sell 'views' and not impressions
 - So the bids are for a view.
- As we will see, this is mathematically equivalent to many simultaneous k+1st price

auctions; of course what runs is just one auction

- Define position prominence q_j as the probability of user noticing position j .
 - Higher slots are more prominent: $q_j > q_{j+1}$
 - From the picture, there is an auction of j identical items with weight $q_j - q_{j+1}$ for every $j \in 1 \dots \#positions$
 - Putting auctions together: Rank bidders in decreasing sequence of bid per view (b_j). Allocate according to rank: i th highest bidder pays: $\sum_{j>i} (q_{j-1} - q_j) b_j$;
assume that $q_j = 0$ for positions which don't exist

Pay-per click advertising

- Naive sales pitch: "You only have to pay if you get a click"
- Practical truth: How can advertiser estimate value per view?
 - Easier for search engine to [predict click-through-rate](#) than for the advertiser to do so.
 - Probability c_i that user viewing the ad will click on it. Notice that we did not say 'probability that a shown ad will get a click'; this difference is necessary because of the prominence issue discussed earlier.
 - This is a function of the query and the advertiser
 - Possible for advertiser to identify value for a click. Impossible for search engine because it does not know what clicks lead to sales.
 - This results in concise communication from the advertiser to the search engine. Imagine communicating a bid per query type!
 - Results in lower risk for the advertiser: Suppose that advertiser bids 0.5\$ per impression/view, knowing that it has a value of 5\$ for each click, and presuming that it has a click-through-rate of 0.1. Suppose its actual click-through rate is lower, it risks losing money.
- Therefore, inventory is impressions, but we should sell clicks
 - Given a bid per click, we can multiply it by the predicted click-through rate, and derive a bid per view.
 - Then, we run the per-view auction from the previous section.
 - When charging, divide per-view price by *predicted* click-through-rate (c_i)
- Example: Consider a second price auction for a single position: Rank bidders by $b_i c_i$, Give item to highest ranked bidder; charge $b_2 c_2 / c_1$ per click. Notice that this price is less than b_1 for the click. So there is no risk for the advertiser.
- Notice, poor click-through rate implies costlier clicks. Therefore, incentive to improve click-through rate
- In summary: For a given query, first identify all eligible advertisers and their bids per click, and their predicted click-through rates, **compute** bids per-view, then run auction as

above. When charging, divide per-view price by *predicted* click-through-rate (c_i)

User Happiness

- Search Engine Competition
 - Users want good search, will tend to use one search engine
 - Advertisers need eyeballs, can advertise on multiple search engines
 - Consequence: Search engines compete for users, and not advertisers (unless budget constrained)
 - Ads on search need to be non-annoying and useful. Important to not [blind](#) users to ads.
 - Contrast with pop-ups, spam email, banner ads

End of lecture