

Application domain: Internet advertising

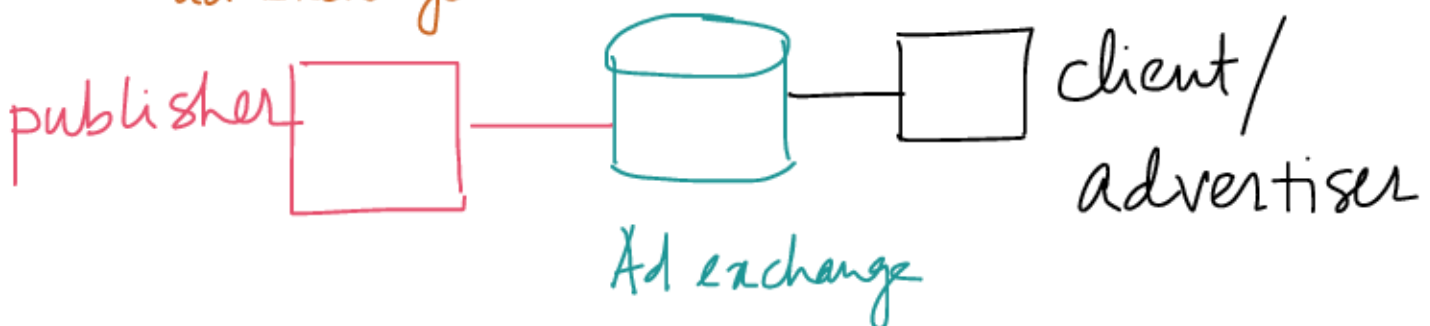
The success of internet advertising

- ① **User data**: advertiser can gather a lot of data of the user to design targeted products.
- ② **Measurable actions**: can classify buyers into categories and measure the interest and take appropriate actions
- ③ **Low latency**: real time bidding, automated bidding, decisions on the fly possible.

Types of ads on the internet

- ① **Sponsored search ad**: advertisers bid on the keywords entered by the users during search.
- ② **Contextual ads**: depending on the content of the page, post or email message
- ③ **Display ads**: traditional modes of advertising, e.g., banner ads in newspapers.

Ads are complex - modern internet advertising is handled via
ad exchanges



Small businesses can customize their ads via exchanges.

Position Auctions : auctions to sell multiple ad positions on a page.

Let $N = \{1, 2, \dots, n\}$: set of advertisers

$M = \{1, 2, \dots, m\}$: set of slots

assume : $m \geq n$ - every ad is shown

1 : best position, m : worst position.

Evolution of position auctions

- ① Early position auctions ordered the ads via bid-per-impression
 - just for showing the ad.
 - newspaper ads e.g.
 - all risk on the advertiser
- ② Bids on clicks - pay-per-click model
 - risk is shared by the publisher
 - ranked by bid-per-click
 - shown ads are not clicked, publisher earns nothing
- ③ Today's approach : rank advertisers based on the product of probability of click and bid value.
 - probability of click is called click through rate (CTR)
 - rank by expected revenue

Advertiser value

Assumptions: ① clicks generate value to the advertisers

② all clicks are valued equally - no matter what position the ad is displayed. The position only affects the chance of getting the click.

these assumptions help decouple the value effect and position effect

Agent i 's expected value when her ad is shown at position

$$j \in M : v_{ij} = \underset{\substack{\uparrow \\ \text{click through rate}}}{CTR_{ij}} \cdot v_i \quad \leftarrow \text{value of a click}$$

$CTR_{ij} \in [0, 1]$: probability of getting a click on i 's ad at j .

quality component e_i position component p_j

$$CTR_{ij} = e_i \cdot p_j \quad ; \text{ user effect, position effect}$$

hence the expected value : $v_{ij} = p_j (e_i v_i)$

position effect is assumed to be decreasing with position

$$p_1 = 1, p_j > p_{j+1} \quad ; j = 1, \dots, m-1.$$

v_i is the only private information of the advertiser.

p_j and e_i are measurable

search engines estimate the e_i : say \hat{e}_i

bidders bid b_i , ads are ranked in decreasing order of $\hat{e}_i b_i$