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# Setting Allocations and Prices in Auctions

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## Setting Allocations and Prices in Auctions

### ABSTRACT

This disclosure describes techniques to rank advertisers in an auction, such as an auction for advertisements delivered over the Internet. Advertisers that participate in the auction are classified into two types. The first type includes advertisers that make use of remarketing lists, or other valuable information. The second type includes advertisers that do not use remarketing lists. Bids from advertisers of the first type are adjusted to a virtual bid prior to conducting the ad auction. Bidders are ranked on the basis of their bids. Prices that the winning bidders pay, e.g., price per click, are adjusted by a scaling factor. Incorporating such techniques in ad auctions can enable greater revenue for advertising networks and content owners.

### KEYWORDS

- bid adjustment
- remarketing list
- search ads
- ad auctions
- revenue optimization

### BACKGROUND

Delivery of advertisements over the Internet is important to advertisers, content owners, and online advertising networks. For example, advertisers can reach audiences that are likely to be interested in their product by placing advertisements in relevant contexts, such as alongside search results, on certain websites, during a related video etc. Content owners and advertising networks derive revenue by displaying advertisements.

Online advertising networks use auctions e.g., real-time auctions, to select the advertisements to show in different contexts. For example, an advertising network may choose a subset of advertisers for a given context, e.g., advertisers that express interest in advertising on a web page that includes search results for a particular search phrase. Multiple advertisers place bids on the search phrase. The advertising network conducts an auction to

determine the advertisers whose advertisements are then shown on the results page for the search.

Remarketing lists identify users that are known to have previously expressed interest in an advertiser's product or business. For example, remarketing lists can identify users that previously visited the advertiser's site, opened a mobile application for the advertiser, or otherwise engaged in online behavior specified by the advertiser. Such users often represent a valuable opportunity to an advertiser. The advertiser therefore may have a greater willingness to pay to display its advertisement to such users and accordingly, raise its bid in the auction. Other advertisers that participate in the auction may not recognize such an opportunity.

In auctions such as generalized second price auctions, each bidder pays a price that is equal to the bid of the next highest bidder. When certain advertisers have a big advantage over other advertisers in the auction (e.g., access to information such as remarketing lists, targeting data, etc.) that other advertisers lack, such advertisers can win the auction and pay a lower price than their willingness to pay. This results in a loss of revenue for the advertising network and/ or content owners.

## DESCRIPTION

This disclosure describes techniques to conduct ad auctions that can enable advertising networks and content owners to derive higher revenue from advertisers that have access to information such as remarketing lists. The advertising network that conducts the ad auction distinguishes between the advertisers, e.g., based on whether they can access to remarketing lists, or other information related to the value of an advertisement.

### Delivery of online advertisements

Fig. 1 shows an example web page that includes advertisements. The web page includes a search box 110, where a user can enter a search query. For example, the user has entered the query "candy shop" in the search box shown in Fig. 1. In response to the user query, a search engine delivers search results, such as results 130 as shown in Fig. 1. Further, the search engine delivers advertisements 120a-n. As shown Fig. 1, the advertisements are positioned in the search results page one below the other. Different values may be assigned to the different advertisement positions. For example, position 120a may be valued higher than

position 120b, based on a higher likelihood that the user will see or click on an advertisement shown in position 120a.

While Fig. 1 shows a search results page, with “search ads,” other types of advertisements can be shown in different types of web pages. For example, “display ads” may be shown on web pages alongside page content e.g., in a section of the page, as an overlay on the page, before page load, etc. In another example, advertisements may be shown before, after, or during a video that a user views. In another example, advertisements may also be shown as part of a mobile application, such as a smartphone app, a tablet app, an app for wearable devices, etc.

In some or all of these contexts, one or more advertisements may be shown, e.g., at different positions. When the advertisements are displayed as part of web page or other content, position may refer to a location of the advertisement with reference to a display screen. In another example, video advertisements may be shown, e.g., at different times, or in different sequence order. In this example, position may refer to the sequence order or the time at which the advertisement is shown. Ad auctions may be conducted to select advertisements to be displayed at each of the positions.

### Ranking advertisers and determination of prices

Fig. 2 shows an example method 200 to conduct ad auctions in a context where certain bidders have access to information such as one or more remarketing lists, while other bidders do not have such access. The ad auction can be carried out automatically e.g., by code that implements method 200. The code that implements the ad auction can be incorporated in hardware (e.g., FPGA, ASIC, etc.), software, or a combination of hardware and software. In operation, advertiser data such as bids and whether an advertiser has access to remarketing lists, is accessed. For example, such data may be available through a database maintained by the advertising network.

In one example, method 200 can be implemented as a sequence of steps as described below. Numbers in parentheses denotes the corresponding block in Fig. 2.

1. Classify (210) the advertiser according to whether the advertiser is making use of remarketing lists (or has access to other valuable information) in this particular auction or the advertiser is not making use of such a list.

2. Determine whether the advertiser is making use of remarketing lists (220). If the advertiser is making use of remarketing lists, calculate a virtual bid (230) for this advertiser based on the advertiser's raw bid and a scaling factor  $\alpha$ . The calculation of the scaling factor  $\alpha$  is described in detail in the next section.
3. If the advertiser is not making use of remarketing lists, use the raw bid for this advertiser (240). Repeat steps 1-3 for all advertisers that have placed bids in this auction (250).
4. Choose the allocation of ads in the auction by ranking the advertisements (260) on the basis of virtual bids (if an advertiser is making use of remarketing lists) or raw bids (if an advertiser is making use of remarketing lists) by placing the advertiser with the  $j$ -th highest such bid in the  $j$ -th position available.
5. Calculate prices for the advertisers depending on whether the advertiser made use of remarketing lists in this auction (270). If the advertiser made use of such lists, determine whether the next advertiser is using remarketing lists (280).
  - a. If the next advertiser (e.g., the advertiser directly below the current advertiser, in terms of position of the advertisement as described above) is making use of remarketing lists, charge the current advertiser a price per click equal to the raw bid of the next advertiser (282).
  - b. If the next advertiser is not making use of remarketing lists, charge the current advertiser a price per click that is greater than the raw bid of the next advertiser by an amount reflected by the scaling factor  $\alpha$  (284).
6. Calculate prices for the advertisers that did not make use of remarketing lists. Determine whether the next advertiser is using remarketing lists (290).
  - a. If the next advertiser is not making use of remarketing lists, charge the current advertiser a price per click equal to the raw bid of the next advertiser (292).
  - b. If the next advertiser is making use of remarketing lists, charge the current advertiser a price per click that is lower than the raw bid of the advertiser directly below by an amount reflected by the scaling factor  $\alpha$  (294).

Steps 5-6 of method 200 are repeated until prices are determined for as many advertisers as there are positions available for advertising, or until there are no more advertisers. The next section describes an example technique to calculate the scaling factor  $\alpha$ .

### Determination of scaling factor

In adjusting the bids of advertisers that make use of remarketing lists, a scaling factor is used. The scaling factor ( $\alpha$ ) is used in ranking and pricing advertisements in the auction. There are two overall steps involved in determination of the scaling factor.

First the size of the optimal scaling factor is determined. Next, the scaling factor is used in ranking and pricing advertisements in the auction. In some examples, the calculation of the scaling factor  $\alpha$  may depend on the usage of the scaling factor. A first example of usage is when the scaling factor is used in the short-run, e.g., before advertisers have a chance to change their bidding strategies in response to the changed incentives of the mechanism. A second example of usage is when the scaling factor is used in the long-run, e.g., after advertisers have a chance to modify their bidding strategies. Regardless of whether the scaling factor is used in the short run or the long run, the overall procedure for calculating the optimal value of  $\alpha$  is as follows:

1. Consider a range of different values of  $\alpha$  between 0 and 1, e.g., every value of  $\alpha$  between 0 and 1 that is an integral multiple of 0.001.
2. Identify ad auctions that took place in a particular time interval, e.g., auctions that took place within the past week. For each of these auctions:
3. Define  $b_j$  as the value of the  $j$ -th highest bid (e.g., in expected cost per thousand impressions of the advertisement) that was placed in the auction, define  $x_j$  as the value of the position normalizer for position  $j$ , and define  $s$  as the number of positions that were available for advertisements in the auction.
4. Determine whether any advertisers amongst the top  $s+1$  bidders in this auction made use of remarketing lists. If no such advertisers made use of remarketing lists for search ads, do not use data from this auction. If at least one such advertiser made use of remarketing lists, define  $i$  to be the highest position where the advertiser made use of remarketing lists.
5. For each bidder in the auction, estimate the value the bidder has for an advertising opportunity by using the bids that the various advertisers placed in the auction, the position normalizers in the auction, and the number of positions that were available for advertisements in the auction.

6. For the advertiser that was identified in Step 4, calculate both the bid that this advertiser would make if the scaling parameter  $\alpha$  were used and the position that this advertiser would be placed in after the advertiser adjusts the bid.
7. By making use of all the terms identified in Steps 3-5 as well as the predictions of how advertiser bids will change in Step 6, calculate how much revenue would change in each of the auctions considered in Step 2 as a result of using a scaling parameter  $\alpha$  for each of the scaling parameters  $\alpha$  considered in Step 1.
8. By making use of all the terms identified in Steps 3-5 as well as the predictions of how advertiser bids will change in Step 6, calculate how much economic efficiency would change in each of the auctions considered in Step 2 as a result of using a scaling parameter  $\alpha$  for each of the scaling parameters  $\alpha$  considered in Step 1.
9. For each of the various values of  $\alpha$  considered in Step 1, calculate the total revenue change that would result by using that particular value of  $\alpha$  by summing the revenue changes calculated for each individual auction in Step 7. Define  $R(\alpha)$  as the total revenue change that would result from using a particular value of  $\alpha$ .
10. For each of the various values of  $\alpha$  considered in Step 1, calculate the total efficiency change that would result by using that particular value of  $\alpha$  by summing the efficiency changes that were calculated for each individual auction in Step 8. Define  $E(\alpha)$  to be the total efficiency change that would result from using a particular value of  $\alpha$ .
11. Select the parameter  $\alpha$  that results in the highest possible weighted average of efficiency and revenue. In particular, to maximize a weighted average of efficiency and revenue that places weight  $\lambda$  on efficiency and weight  $1-\lambda$  on revenue, choose the value of  $\alpha$  that results in the largest value of  $\lambda E(\alpha) + (1-\lambda)R(\alpha)$  amongst the values of  $\alpha$  considered in Step 1.

The overall procedure to calculate the optimal value of  $\alpha$  may be identical regardless of whether the value is being calculated for optimal value for the short run before advertisers have a chance to modify their bidding strategies or the long run after advertisers have a chance to modify their bidding strategies in response to the changed incentives of the mechanism. However, in different implementations, details of the calculations may differ depending on whether the short run or the long run is being considered. For example, steps 6-7 of the above procedure may be performed differently depending on whether the calculation is for the optimal  $\alpha$  for the short run or the long run.

After computing both what the optimal parameter  $\alpha$  would be in the short run before advertisers have a chance to modify their bidding strategies as well as what this optimal parameter would be in the long run after advertisers have a chance to modify their bidding strategies, a decision is made regarding the use of this information to choose the value of the parameter  $\alpha$  in running the ad auction. In some implementations, the value of these estimated parameters that is closest to zero may be chosen. However, other approaches could be employed such as choosing a weighted average of these two optimal parameters depending on the relative importance of the short run vs. the long run.

This disclosure describes techniques to re-rank advertisers in an auction. For example, in an auction for multiple positions on a web page, there may be two types of bidders. A first type may be advertisers that make use of remarketing lists, or other valuable information. A second type may be advertisers that do not use remarketing lists. Per the techniques of this disclosure, bids from advertisers of the first type are adjusted to a virtual bid, prior to conducting the ad auction. For example, bids are adjusted by scaling down the advertiser's bid by a factor. Bids from advertisers of the second type are not adjusted. Bidders are ranked on the basis of their bids. Prices that the winning bidders pay, e.g., price per click, are adjusted by the scaling factor.

The described techniques have several advantages. For example, higher prices may be charged to advertisers who make use of a remarketing list (or other valuable information) for search ads than they would be charged in standard auctions in which these advertisers may pay much lower prices than they would be willing to pay, given their bids. The techniques can adjust prices and re-rank advertisements in the auction in such a way that advertisers will not have to pay a higher price per click than the amount they value these clicks in the auction. The techniques can provide ranking and pricing that can maximize a weighted average of economic efficiency and revenue.



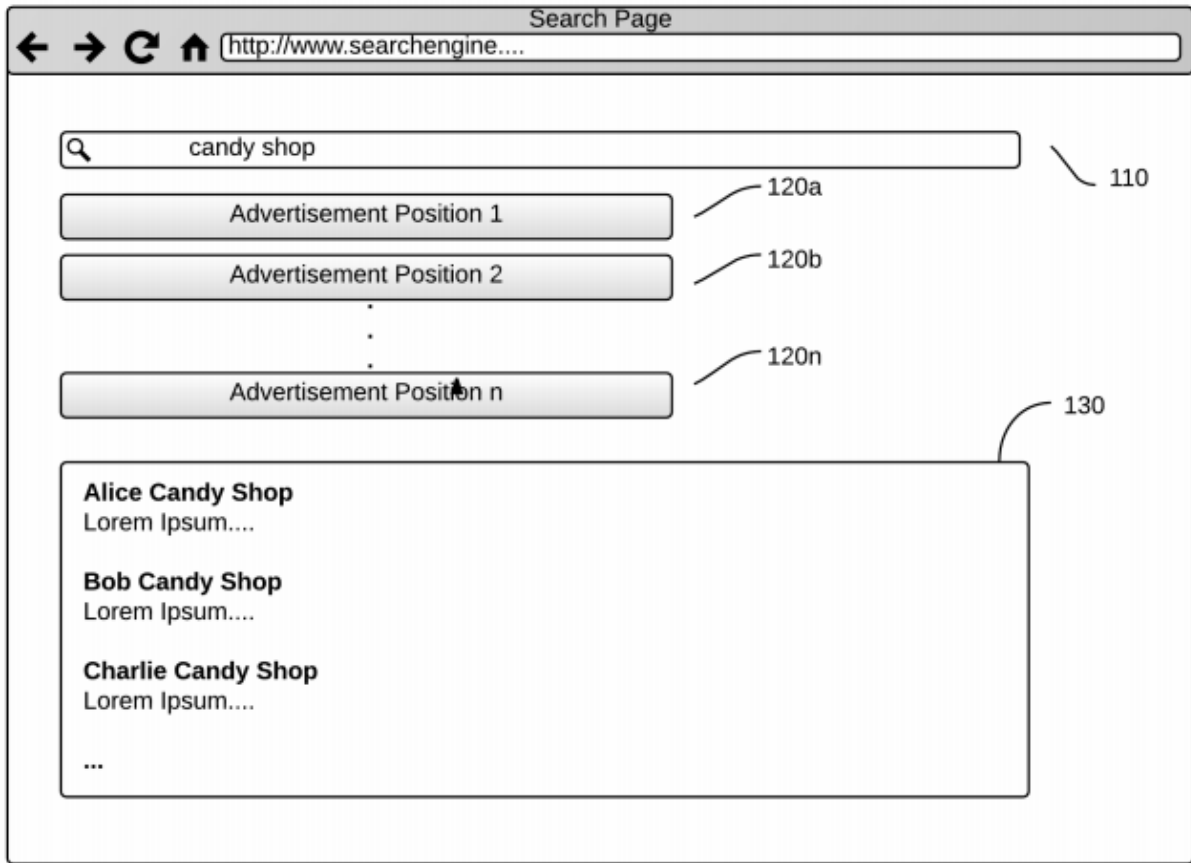


Fig. 1

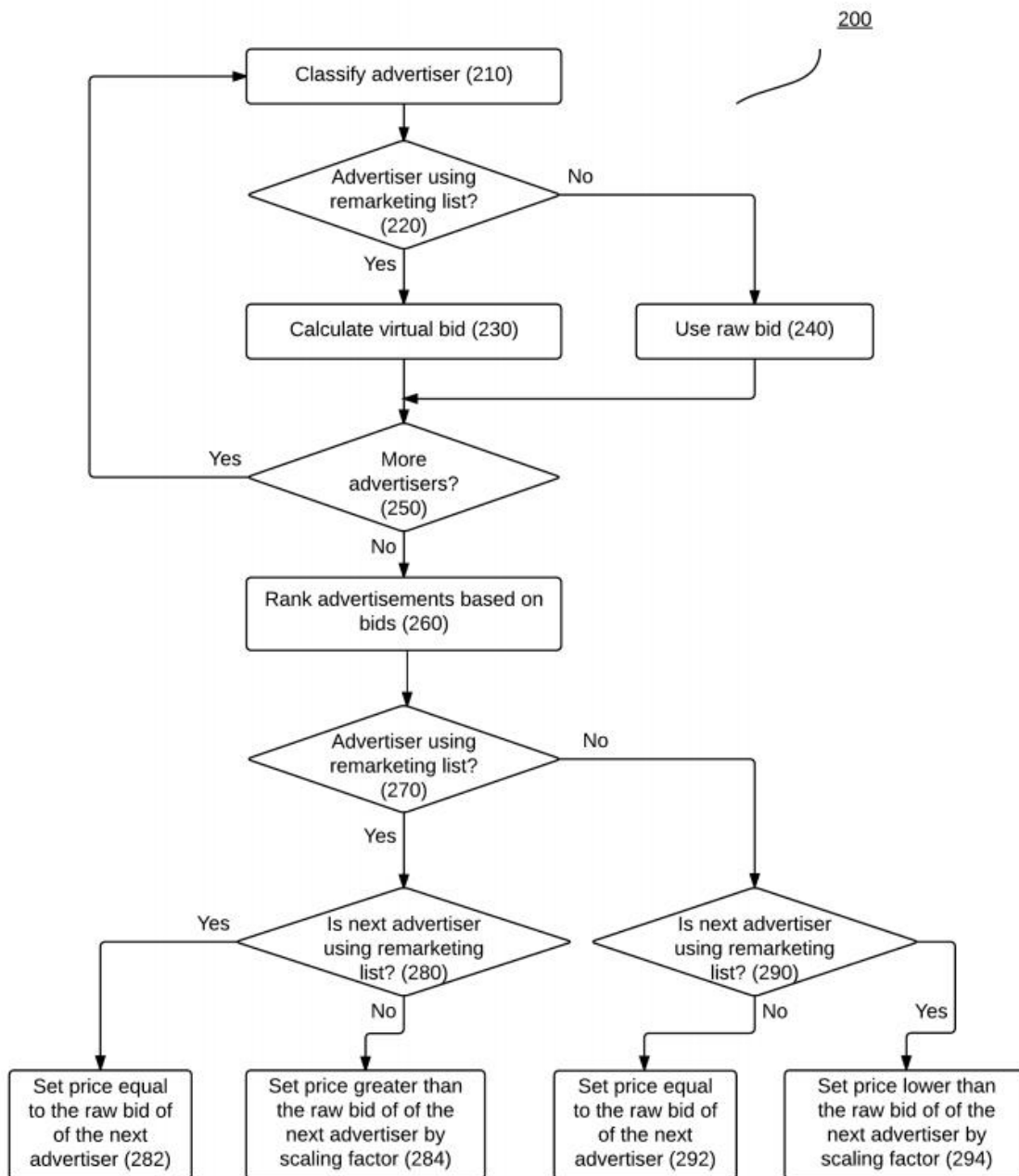


Fig. 2