Optimal Bidding in Multi-Item Multi-Slot Sponsored Search Auctions

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With the growing popularity of search engines among consumers, advertising on search engines has also grown considerably. We study optimal bidding strategies for advertisers in sponsored search auctions. In general, these auctions are run as variants of second-price auctions but have been shown to be incentive incompatible. Thus, advertisers have to be strategic about bidding. Uncertainty in the decision-making environment, budget constraints and the presence of a large portfolio of keywords makes the bid optimization problem non-trivial. In addition, there keywords are not independent. In this paper, we formulate and solve the advertiser's decision problem. We propose two bidding policies in our paper. The first policy ignores the interaction between keywords and is referred to as the "myopic" policy in this paper. We extend this bidding policy to incorporate interaction between keywords, and refer to this policy as the "forward-looking" policy since it entails decision making over several time horizons. Depending on the advertiser's intent, level of sophistication and nature of the products being advertised, the advertiser might choose the myopic or the forward-looking policy. This paper makes three main contributions. The first contribution is towards improving managerial practice. Advertisers spend billions of dollars on sponsored search. The techniques described in the paper can help increase the Return on Investment (RoI) for advertisers and SEM firms, as demonstrated in our field implementation. The second key contribution is that our approach represents a significant step forward for the academic literature on bidding in multi-slot auctions. All the papers to date have studied the problem either in a deterministic setting or in a single-slot setting and have relied on heuristic solution techniques due to the complexity of the optimization problem. In contrast, we compute optimal bids in the more realistic stochastic multi-slot setting. The third contribution of this paper is that it is the first paper on bidding in sponsored search to incorporate the interdependence between keywords into a multi-period bidding problem. The interdependence in keyword performance, commonly referred to as spillovers, is a well-documented feature of sponsored search (Rutz and Bucklin, 2011) but has not been considered in the bidding literature. The interactions between keywords are modeled in the form of positive spillovers from generic keywords into branded keywords. The spillovers are estimated using a dynamic linear model framework. An approximate dynamic program is formulated to solve the advertiser's bidding problem. To validate our approaches, we estimate the parameters of the models using data from an advertiser's sponsored search campaign and use the bids proposed by the models in a field experiment. The "myopic" policy outperforms the advertiser's policy by 75.38% and the "forward looking" policy improves the ROI by another 7.87%. The results of the field implementation show that the proposed bidding techniques are very effective in practice.

Categories and Subject Descriptors: K.6.0 [MANAGEMENT OF COMPUTING AND INFORMATION SYSTEMS]: Economics

General Terms: Economics, Measurement, Algorithms

Additional Key Words and Phrases: Sponsored search, search engine marketing, bid optimization, stochastic optimization, stochastic modeling, dynamic programming


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EC’12, June 4–8, 2012, Valencia, Spain.
ACM 978-1-4503-1415-2/12/06.