

Upcoming Operations Research Ph.D. Final Oral Exam

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Price Trajectory Algorithm for Solving Iterative Auction Problems

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Abstract:

A variety of auctions exist in the literature such as the English auction, the Dutch auction, and the Vickrey auction. The underlying problem in an auction is to find the winners and the corresponding payments. Proxy bidding has proven useful in solving auction problems in many real-world auction formats, most notably eBay. Proxy bidding has been proposed for several iterative combinatorial auctions, such as the Ascending Package auction, the Ascending kBundle auction, and the iBundle auction.

In this dissertation, a new type of iterative auction called the Simple Combinatorial Proxy auction is proposed. The winners of the new auction are the same as that of the Ascending kBundle auction.

Simulating the incremental bidding decisions of the agents is a popular method to solve proxy-enabled version of the auction problems. This approach has some disadvantages. First, the outcome depends upon implementation details. Second, the accuracy of the outcome relies on the bid increment. Third, the running time is sensitive to the magnitude of values, the ordering of agents, and the tie-breaking rules.

In this dissertation, a new approach called the Price Trajectory Algorithm is presented to solve iterative combinatorial auctions with proxy bidding. This approach computes the agents' allocation of their attention across the bundles only at "inflection points" -- the points at which agents change their behavior. Inflections are caused by one the following reasons: (1) an introduction of a new bundle into an agent's demand set, (2) a change in the set of current competitive allocations, or (3) a withdrawal of an agent from the set of active agents. The proposed algorithm tracks the behavior of agents and the competitive allocations of items to establish a connection between the demand set and competitive allocations. With the allocation of agents' attention, one can compute the slopes of price curves to get the bundle prices and speed up the computation by jumping from one inflection point to another.

The price trajectory algorithm can solve the Simple Combinatorial Proxy Auction and the Ascending Package Auction. It has several advantages over alternatives: (1) it computes exact solutions; (2) the solutions are independent of the bid increment or tie-breaking rules; and (3) the solutions are invariant to the magnitude of the bids.

It is shown that this solution is same as the solution from simulation. For the security consideration, a cryptographic protocol is presented for the price trajectory algorithm. It guarantees that only the auctioneer obtains the correct and necessary information from the agents and there is no leak of private information between agents. The detection of fraud by the auctioneer is also discussed.