Abstract

ITERATIVE COMBINATORIAL AUCTIONS:
ACHIEVING ECONOMIC AND COMPUTATIONAL EFFICIENCY
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A fundamental problem in building open distributed systems is to design mechanisms that compute optimal system-wide solutions despite the self-interest of individual users and computational agents. Classic game-theoretic solutions are often prohibitively expensive computationally. For example, the Generalized Vickrey Auction (GVA) is an efficient and strategy-proof solution to the combinatorial allocation problem (CAP), in which agents demand bundles of items, but every agent must reveal its value for all possible bundles and the auctioneer must solve a sequence of NP-hard optimization problems to compute the outcome.

I propose *i*Bundle, an *iterative* combinatorial auction in which agents can bid for combinations of items and adjust their bids in response to bids from other agents. *i*Bundle computes the efficient allocation in the CAP when agents follow myopic best-response bidding strategies, bidding for the bundle(s) that maximize their surplus taking the current prices as fixed. *i*Bundle solves problems without complete information revelation from agents and terminates in competitive equilibrium. Moreover, an agent can follow a myopic best-response strategy with approximate values on bundles, for example with lower- and upper- bounds.

My approach to iterative mechanism design decomposes the problem into two parts. First, I use linear programming theory to develop an efficient iterative auction under the assumption that agents will follow a myopic best-response bidding strategy. Second, I extend the approach to also compute Vickrey payments at the end of the auction. This

makes myopic best-response a sequentially-rational strategy for agents in equilibrium, inheriting many of the useful game-theoretic properties of the GVA.

*i*Bundle implements a primal-dual algorithm, CombAuction, for the CAP, computing a feasible primal (the provisional allocation) and a feasible dual (the ask prices) that satisfy complementary slackness conditions. An extended auction, *i*Bundle Extend&Adjust, interprets a primal-dual algorithm, VickAuction, as an iterative auction. VickAuction computes the efficient allocation and Vickrey payments with only best-response information from agents. Experimental results demonstrate that *i*Bundle Extend&Adjust, which keeps *i*Bundle open for a second phase before adjusting prices towards Vickrey payments, computes Vickrey payments across a suite of problems.