Joint Optimization of Virtual Capacities and Bid-Prices for Revenue Management

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Abstract

We consider a network revenue management problem where the physical capacity at the perish time of the asset is uncertain while the firm processes requests and/or not all the accepted requests show-up at the service delivery time. For both cases, the controller sets a virtual capacity and a bid-price for each of the resources at the beginning of the finite horizon, and collects revenues by accepting or rejecting requests for products using a standard bid-price policy; i.e., a reservation is accepted as long as there is enough virtual capacity available and the collected revenue exceeds the sum of the bid-prices of the resources defining the product. At the end of the horizon, the effective capacities and demands are realized. If there is not enough room and part of the accepted requests cannot be accommodated, the controller incurs a penalty cost for each bumped reservation. The firm's objective is to maximize the total cumulative adjusted revenue (sales revenue minus penalty cost) obtained by the end of the horizon.

We present a continuous capacity formulation for this problem which allows for the partial acceptance of requests. The model admits a simple calculation of the sample path gradient of the adjusted revenue function. This gradient is then used to construct a stochastic steepest ascent algorithm. We show that the algorithm converges (w.p.1) to a stationary point of the expected adjusted revenue function under some mild conditions. Then, through an exhaustive numerical study, we show that our controls are computed within an order of magnitude faster computational times than other recent proposals and deliver revenues that are comparable or higher than the ones obtained from those benchmarks.

Key words: stochastic gradient, simulation-based optimization, bid-prices, network capacity control, overbooking.

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