New Approaches for Integrating Revenue and Supply Chain Management

by

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Abstract

In the first part of the thesis, we describe a general framework called online customer selection that describes natural settings where suppliers must actively select which customer requests to serve. Unlike traditional revenue management models that have sunk costs, we assume there are supply chain costs that depend on the demand being served. Specifically, customers arrive in an online manner, each with a set of requirements and associated revenue, and are either accepted or rejected upon arrival. Rejected customers incur a lost-sales cost, while accepted customers are satisfied with minimum possible production cost. The goal of the supplier is to minimize the total cost of lost sales and production. We provide algorithms with strong performance guarantees that are based on new variants of repeated optimization as well as concepts from mechanism design. Specifically, we show that the cost of our algorithms are within a small factor of the optimal offline cost for any demand sequence, and we show nearly matching lower bounds on these factors.

In the second part of the thesis, we propose the use of opaque products in a retail setting. A product is said to be opaque when the customer only knows what they have purchased after the transaction is complete. Opaque products have been used in the hotel and airline industry where customers purchase rooms or airfare without a priori knowledge of the brand name. In this work, we propose the use of opaque product selling in the retail industry, where there are nonperishable goods and supply chain costs. We show that a small amount of opaque selling can achieve significant ordering and holding costs savings for the supply chain. We also describe a generalization of opaque selling that provides a natural tradeoff between customer choice and supply chain performance. Moreover, we describe settings when a stationary opaque selling strategy can outperform an optimal dynamic pricing strategy, which is often difficult to compute and susceptible to strategic customers.

In the third part of the talk, we focus on a variant of the joint replenishment problem, which arises in the previous two parts as well as in many applications in inventory management, logistics, and maintenance scheduling. In this problem, there are multiple item types that each has a given time-dependent sequence of demands.
that need to satisfied. In order to satisfy demand, orders of the item types must be placed in advance of the due dates for each demand. Every time an order of item types is placed, there is an associated fixed setup cost depending on the subset of item types ordered. In addition, there is a cost to hold inventory for demand that has yet to be served. The overall goal is to minimize the total fixed ordering costs plus inventory holding costs. In this work, the fixed cost of an order, also known as a joint setup cost, is a nondecreasing, submodular function over the item types. For this general problem, we show that a greedy approach provides an approximation guarantee that is logarithmic in the number of demands. Then we consider three special and practical case of submodular functions which we call the laminar, tree, and cardinality cases, and provide constant factor approximation algorithms for these cases.

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