

DISSERTATION DEFENSE

Models and Methods for Omni-channel Fulfillment

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Omni-channel retailing, the combination of online and traditional store channels, has led to the use of traditional stores as fulfillment centers for online orders. A key aspect of omni-channel fulfillment problems is the tradeoff between cancellations of accepted online orders and profits: a riskier fulfillment policy may result in more online sales but also more cancelled orders.

In this dissertation, I will describe two approaches to the fulfillment problem cast generally as a stochastic optimization problem of setting inventory thresholds above which the online channel stays open.

In the more traditional approach, we build a stochastic model of the process leading to order cancellations for a single item so that retailers may find inventory and fulfillment policies that effectively use this information along with shipping costs between various locations. We describe iterative algorithms based on Infinitesimal Perturbation Analysis (IPA) that converge to optimal and locally optimal policies within certain flexible policy classes for the multiple-location version of this model, and show their empirical performance on simulated data based on real data from a high-end North American retailer.

In a more modern approach, we apply techniques from machine learning and discrete optimization to find fulfillment policies that perform well empirically at maximizing revenues subject to a constraint on cancellations across a large portfolio of items. Using the real data mentioned earlier, we build estimators that predict the cancellation probability and other features of incoming online orders. We formulate and solve an optimization problem based on these estimates to get a fulfillment policy in a separate second step. Then we investigate a joint estimation and optimization model based on a neural network to find both the generative parameters for our estimates as well as the policy that maximizes revenue while limiting cancellations. We show how both the separate and joint estimation and optimization models can be used to account for data truncation. The joint methods typically identify policies that more closely track target cancel rates than the separate estimation and optimization methods. For the

joint method, we also custom built a neural network layer to efficiently solve the knapsack optimization problem central to our model and demonstrate substantial empirical improvement in running time and scalability over existing methods.