The Traveling Purchaser Problem with time-dependent quantities

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Abstract

The Traveling Purchaser Problem (TPP) looks for a tour visiting a subset of markets to satisfy a positive discrete demand for some products at minimum traveling and purchasing costs. The problem is known to be NP-hard in the strong sense, and finds application in different real contexts. Frequently, as a static problem, the TPP lacks of realism: different purchasers may compete for the same resources, and the products quantity supplied in the markets may reduce during the day. We study a variant of the TPP where product quantities in the markets are time-varying by a constant positive consumption rate. The problem is analyzed in a single-day horizon, with fixed product prices and daily stock replenishment. Although in real contexts the product consumptions can be dealt with stochastic processes, we consider a deterministic linear decrease of the quantities over time. We show that such an approximation can safely represents a conservative estimation to the real consumption when the selected line slope is chosen steep enough. We propose a compact formulation for the problem, and strengthen it with connectivity constraints. A new branching strategy and a primal heuristic, enforcing the bounding operations, have been embedded into a branch-and-cut framework. The branching rule exploits a simple valid inequality and the presence of necessary markets. The resulting method outperforms CPLEX 12.6 when used to solve the proposed model. Algorithms have been compared on standard TSPLIB instances modified to include products and quantities decreasing at different rates of consumption.

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