The multi-product multi-depot vehicle routing problem with inventory restrictions

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Abstract

In reality, the optimal distribution of different goods from potentially multiple depots to customers depends on the inventory levels in the depots. Customers can only be served if sufficient inventory of the demanded product is available. When a depot runs out of stock, delivery might have to be organized by another depot, and, thus, routing decisions have to be adapted. Likewise, not every product might be stored in every depot, due to inventory policies or facility constraints.
There seems to exist no model that captures this interaction between inventory and routing aspects at the supplier accurately, even though vertical supply chain integration is a major trend in logistics. We aim at filling this gap by introducing the multi-product multi-depot vehicle routing problem with inventory constraints (MPMDVRP).

The problem is defined as follows: given several depots with defined stock levels for several products, find the lowest-cost routes such that the known demands of a set of customers is satisfied and the capacity and inventory constraints of vehicles and depots are not violated. This problem has not been described in the literature before, but it is closely related to the multi-depot vehicle routing problem and the inventory routing problem.
We study the complexity of the MPMDVRP and develop a heuristic based on variable neighborhood search with specifically designed operators. With this algorithm, we investigate the effect of different inventory policies on the optimal routing, and derive guidelines to utilize the potential of integrated inventory and routing decisions in modern logistic systems.

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