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1 Introduction

In this work, we study a multi-commodity transportation planning problem (MCTPP) which occurs in short and local fresh food supply chain. The problem contains 3 sets of stakeholders : the suppliers, the logistics providers managing the supply chain, the customers. The MCTPP can be defined based on a directed graph $\mathcal{G} = (\mathcal{V}, \mathcal{A})$, in which $\mathcal{V} = \mathcal{V}_S \bigcup \mathcal{V}_D \bigcup \mathcal{V}_C$ is the set of vertices, $\mathcal{A} = \{(i,j)|i,j \in \mathcal{V}\}$ is the set of arcs. More precisely, $\mathcal{V}_C$ represents the set of customers, $\mathcal{V}_D$ is the set of depots and $\mathcal{V}_S$ represents the set of suppliers. Suppliers provide a set of commodities $\mathcal{M}$, which can be moved to the depots. The depots deliver the commodities to the customers. A cost c_{ij} is associated with each arc $(i,j) \in \mathcal{A}$ and represents the non-negative cost of traversing arc (i,j). In the MCTPP, the decision maker is the logistic provider who manages the depots, decides where to buy and how to distribute the commodities. Inventory at the depots is not considered. Depots allow for consolidation of commodities that arrive from supplier before delivery to customers. A sketch of the MCTPP is depicted in Figure 1.

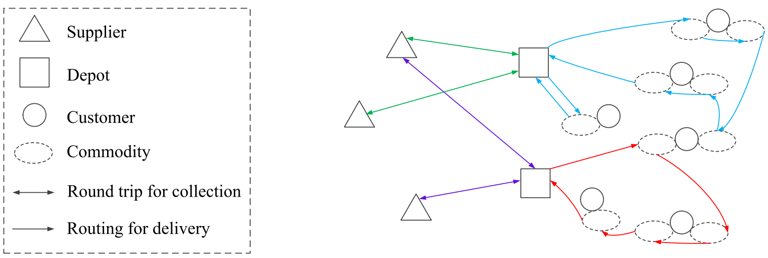

FIG. 1 – An instance with feasible solution of the MCTPP.

The MCTPP aims at optimizing the collection and delivery operations, which can be decomposed in two sub-problems $\mathcal{SP}1$ and $\mathcal{SP}2$. $\mathcal{SP}1$ considers collection operations while $\mathcal{SP}2$ considers delivery operations.

$\mathcal{SP}1$ is a problem in which a set of commodities have to be transported from the suppliers to the depots. Each supplier can provide a limited quantity of several commodities. A quantity of each commodity has to be brought to depots (in order to satisfy customer demands in problem $\mathcal{SP}2$). Transport is performed by a fleet of homogeneous trucks with a limited capacity. These trucks are flexible and can transport any subset of commodities. Trucks only perform round trips between depots and suppliers. It is possible to perform more than one trip between one depot and one supplier. Each trip between a depot and a supplier has a fixed cost independent of the quantity transported. The problem $\mathcal{SP}1$ is to decide which depots are in use and which quantities to transport between suppliers and depots. The objective is to minimize the total travelling cost : the sum of the fixed cost of the trips.

$\mathcal{SP}2$ is the multi-depot case of the C-SDVRP [1]. The C-SDVRP is a problem where customers require multiple commodities and considers only one depot with sufficient quantity for each commodity to satisfy all the customers' demand. All commodities can be mixed in a vehicle as long as the vehicle capacity is respected. Multiple visits to a customer are allowed in order to decrease transportation costs. But a single commodity has to be delivered at once for the convenience of customers. The objective is to minimize the total traveling cost. $\mathcal{SP}2$ extends the C-SDVRP by considering multiple depots, each with an available quantity of each commodity. Each vehicle starts its trip from a depot and ends it at the same depot.

In order to solve the MCTPP, this work considers two cascade resolution approaches : first $\mathcal{SP}1$ then $\mathcal{SP}2$ or first $\mathcal{SP}2$ then $\mathcal{SP}1$. In both cases, the problem solved first determines the quantity of each commodity that has to be present at each depot. The second solved problem takes this information and deals with delivery or collection accordingly.

2 Solution method

Solving method of $\mathcal{SP}2$: we adapt the adaptive large neighborhood search (ALNS) that we previously proposed in [2] to deal with multiple depots. We first assign commodities to depots by solving a generalized assignment problem (GAP), then a split algorithm [3] is applied for each depot to get a feasible solution. Moreover, the local search operators and the repair heuristics have been updated to the multi-depot case, by considering moves between depots and available quantities at depots.

Solving method of $\mathcal{SP}1$: we propose two mixed integer linear programming (MILP) in order to solve $\mathcal{SP}1$.

- When $\mathcal{SP}2$ has been solved first, the exact quantity of each commodity needed at each depot to deliver customers is known. Hence constraints are added in $\mathcal{SP}1$ in order to ensure that the supply quantity is greater than the required quantity at each depot.
- When $\mathcal{SP}1$ is solved first, the exact quantities to bring to each depot is not known, but we need to ensure that $\mathcal{SP}2$ will have a feasible solution (each commodity of each customer is delivered by only one vehicle). Hence we add variables and constraints in $\mathcal{SP}1$ to ensure a feasible assignment of customers' commodities to the depots.

Sequential solving of MCTPP : when $\mathcal{SP}2$ is solved first, we consider two cases : (1) $\mathcal{SP}2$ with infinite capacities at the depots ; (2) $\mathcal{SP}2$ with finite capacities at the depots : given a commodity the finite capacity at each depot is set as the total demand for this commodity divided by the number of depots, plus the maximum customer demand for this commodity. When $\mathcal{SP}1$ is solved first, we also consider two cases : (3) after solving $\mathcal{SP}1$, $\mathcal{SP}2$ is solved directly from the solution of $\mathcal{SP}1$; (4) after solving $\mathcal{SP}1$, we increase the quantity supplied to the depots by using the remaining capacity of the trucks without increasing cost (since it is a fixed cost). This leads to more flexibility when solving $\mathcal{SP}2$.

3 Conclusions and perspectives

We generate sets of instances based on the instances in [1]. We test and compare the four approaches mentioned above. Results will be presented at the conference.

Références

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