The truck-and-freighter routing problem

ORO - Optimization in Trabnsportation and Logistics
project at home

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FL ▶*Problelm introduction to be rewritten*◀

The truck-and-freighter routing problem consists in delivering goods starting from a principal distribution center to the multiple customers in a city. Within the city, there are 2 different areas. One is called vehicle-size regulated area and the other is called non-vehicle-size regulated area. To serve both areas, 2 different transports vehicles are available; a small truck (freighter) which will be able to reach both areas due to its size and lower CO_2 emission, and a big truck which will serve only non-vehicle-size regulated area. In terms of capacity, a big truck will contain a significantly bigger capacity than the smaller truck. When a small truck has no loading goods, they will meet up the closest meeting point which will be located at a customer point which is located in the non-vehicle-size regulated area, furthermore; the small truck will be loaded again to continue delivering to the rest of the customers. The goal is strategically find the best routes, which includes also meeting points. At the end, all customers need to be reached by the optimal route minimizing the total distance covered and the transportation cost.

When both vehicles have completely covered all customers, they will need to meet again at a certain meeting point, finally; the big truck will carry the small one inside it, and come back to the main distribution center.

1 Problem description

In the truck-and-freighter routing problem (TFRP), we consider a distribution centre (DC) which takes index 0. J denotes the set of customers and $J^S \subset J$ is the subset of customers that can be served only by a feighter. We denote by P the set of parking nodes where coupling, decoupling and tranfers can occur between the freighter and the truck. The costs for both of vehicles are defined as C_{ij}^B, for a big truck, and C_{ij}^S, for a small truck. q_j represents the demand of each customer j. The capacities for each big and small trucks are defined as Q_B and Q_S.

This problem is illustrated on Figure 1.

1.1 Assumptions

Following conditions are assumed,

1. A small truck is considered as the only truck which can reach to customers in the vehicle-regulated area. The customers in non-vehicle-regulated area can be served by both big and small trucks.

2. To each of the trucks, one driver will be assigned.

3. Both big and small trucks must depart from depot and return to it at the same time.

4. All different routes must be considered as a non-directed graph. Meaning that there is no restriction on the direction the truck might take.
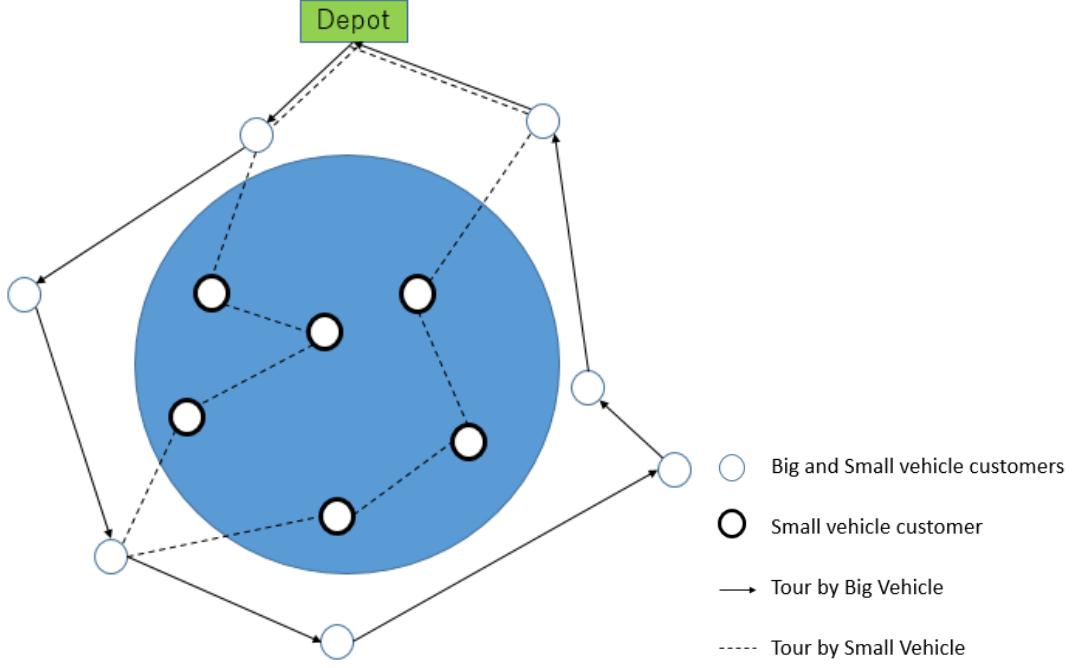
Figure 1: Problem Structure and Tour Types in the problem

5. All customer j must be visited at least once.

6. Time window at each customer j is not considered.

2 Modeling the TFRP

FL ▶*The most important part below*◀

2.1 Sets and data

Sets:

- $J = \{1, ..., n\}$: set of customers.

- vertex 0 and $n+1$ model the depot.

- $J_S \subset J$: nodes which can be served by the small truck only

- $J_B \subset J$: nodes which can be served by the large truck only

- P: set of transfer nodes

- $V = \{0; n+1\} \cup J \cup P$

Data:

- c_{ij}^B: cost of going from node $i \in V$ to node $j \in V$ with the big truck

- c_{ij}^S: cost of going from node $i \in V$ to node $j \in V$ with the small truck alone

- q_j demand of customer $j \in J$

- Q^B, Q^S respective capacities of big and small trucks

- t_{ij}: time of traveling from node $i \in V$ to node $j \in V$

- s_j: duration of service at customer $j \in J$

- $[a_j, b_j]$: customer $j \in J$ time window

2.2 Model

Decision variables

- ....

$$min \; z =$$

such that:

$$\sum_{i \in J} X_{ijkl} \qquad\qquad \forall j, kl \in \dots \qquad\qquad (1)$$

$$(2)$$

2.3 Comments

The objective function states that ...

Constraints (1) state that ...

3 Valid inequalities

4 Experimentations