A Cluster-First Route-Second approach for the Shared Customer Collaboration Vehicle Routing Problem

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Introduction

The current business environment is involved in globalized commerce and requires higher levels of response time, at the lowest logistic costs, by the firms and the supply chain. Thus, new trends have appeared for the management of the supply chain. In that sense, to increase the level of customer service and decrease logistics cost, strategic alliances or partnerships among companies are essentials. One strategy that had been an interest point of academy and industry in the last decade is cooperation and coordination, which according to the level of the supply chain allow joint work between companies in order to achieve a common goal [1].

Horizontal Cooperation (HC) allows companies at the same level of the supply chain to identify and exploit situations of mutual benefit through joint work. This has been taken as an important principle in order to consider joint route planning, purchasing groups and manufacturing consolidation centers [2,3]. To deal with this situation, a new variant of the vehicle routing problem (VRP) is introduced by [4], named Shared Customer Collaboration Routing Problem (SCC-VRP). This problem considers horizontal cooperation at the distribution level, to optimize the potential benefits derived from such alliances between companies.

In this paper we developed a Cluster-first Route-second approach for the SCC-VRP. The cluster part assigns the demand of customers to the vehicle fleet able to serve such demand, while the routing part determines for each vehicle the order in which its assigned customers are visited.

Problem description

The Shared Customer Collaboration Vehicle Routing Problem (SCC-VRP) was introduced by [4] in order to consider collaborative scenarios in Horizontal Cooperation strategy within the framework of last mile deliveries. Multiple carriers working in the same area and with some common customers join their operations (vehicle fleets capacities) to serve those customers, at minimal cost, within routes including their own customers. The joint route planning in SCC-VRP considers simultaneously three scenarios for the customers: 1. Not shared Customers, for whom demand is served by their corresponding carrier, 2. Shared customers for whom demand is not shared, i.e., these customers are
visited by several carriers but each of these carriers serves its corresponding demand, and 3. Shared customers whose demand belong to one carrier and is served by other one, whereby, in the route planning of some carriers would be visits to customers of other ones and will lack own customers, that are served by other carriers. The first scenario generalizes the classical Multi Depot Vehicle Routing Problem (MDVRP) for all customers not shared, and the second and third scenarios are related with Split Delivery Vehicle Routing Problem (SDVRP) for the shared customers, but considering that the demand would be completely transferred between carriers, not partially split. The aim of the problem is to minimize the total costs of the whole set of routes.

**Solution approach**

On the best of our knowledge this problem has been solved through exact approaches, nevertheless this methods are very time consuming and this why our approach is based on a route-first cluster-second (CFRS) heuristic, due to its computational efficiency [5]. An exact method based on an assignment problem is developed to create clusters for each vehicle fleet of each carrier, the model allows exchanging demands corresponding to the same customer and/or just transfer its complete request to a carrier involved at the shared costumer, i.e., the demand is not split. Vehicle capacity constraints are considered at this first step. The Concorde TSP Solver [6] is then used to determine the route of each vehicle, according to the clusters defined in the first part.

The solution approaches was compared with results of Fernández et al. [4] in Table 1. The work of Fernández et al. consider two formulation, Vehicle Formulation (VF) and Load Formulation (LF), which has an average computational time of 7200 and 3900 seconds respectively, and a maximum running time limited to 7200 seconds per instance. For each instance is calculated the gap between the results of [4] and this work.

<table>
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<th>Instance</th>
<th>VF Obj*</th>
<th>T(s)*</th>
<th>LF Obj</th>
<th>% GAP</th>
<th>LF Obj</th>
<th>% GAP</th>
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**TAB. 1 – Computational results (* represent our results).**

**References**


