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An Intelligent K-Means Algorithm for Location-Allocation and Vehicle Routing Problem

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Abstract

Capacitated location-allocation routing problem is about delivering the goods from depot centers to customers. The aims of this problem is to determine the optimum number of depots at the strategic decision level to place factories and allocate customers to these depots, while establishing tour of the vehicle between depots and customers must be built at the tactical or operational levels to supply customers. In recent years several researchers have focused on Location Routing Problem (LRP). We consider in this paper location-allocation routing problem. Our objective is to minimize the routing and location-allocation costs which are main contribution in supply chain costs. Location and routing decisions are interdependent and studies have shown that the overall system cost may be excessive if they are tackled separately. These problems are NP-hard and the combination of them is NP-hard too and solving this problem in medium and large size problem is difficult. In this study, we want to use the business intelligence methods for simplifying the LRP and to solve this problem in large size with exact algorithm. We propose an Intelligent K-means Algorithm (IKMS) for clustering the customer nodes. Then we locate the depots with other k-means algorithm. Finally we allocate these customers to depots. After these steps, we solve the Traveling Salesman Problem (TSP) for each cluster independently, and determine the tour of each vehicle. We will show that our algorithm presents good solutions.

Keywords:

Capacitated location allocation routing problem, Intelligent K-means algorithm, clustering, ANOVA test.

1 Introduction

In recent years by considering the speed of growing customer tendency to reduce waiting time to reach their request, many managers focused on decisions about location of distribution centers and vehicle routing. The LRP purpose is to determine the location of depot from where vehicles start their tours and return to it after serving the customer's requests. By solving the location problem the appropriate location for depots are attained and by solving the routing problem the best routes for vehicles are determined.

Various versions of LRP have been studied during the last years. However, the classical versions are still interesting and deserve a particular attention [1]. The LRP can be defined as a combination of two NP-hard and difficult problems of facility location problem (FLP) and vehicle routing problem (VRP). Since both problems belong to the class of NP-hard problem, the LRP is also an NP-hard problem [1]. H. Mint made an attempt to solve the simultaneous delivery and pickup problem confronting an actual library distribution system. Their solution approach has a three-phase sequential procedure which was analogous to a "cluster-first rout-second" method [2].

Due to the complexity of the problem, only very small LRP instances can be solved exactly by linear programming solvers, and relaxing the existing integer linear models yield weak lower bounds. Therefore, heuristics are required to obtain appropriate solutions in acceptable running time on the large instances [1]. One technique for solving this problem is clustering. Cluster analysis studies the division of entities (as objects or individuals) in groups based on their characteristics. Dantzig and Ramser were of the first ones highlighted the identification of clusters in the multiple travelling salesman problem (MTSP) [1].

Glicksman and Penn (2008) study the group location-routing problem, in which depots and vehicles have no capacities and the customers are partitioned into groups. One has to simultaneously select a subset of depots to be opened and a collection of tours that covers all customer groups in order to minimize the costs of the tours and the fixed costs of opened depots. Each customer group has its own demand and vehicles are capacitated. A heuristic is developed for solving the problem [3]. Harks, Konig, and Matuschke [4] study several location-routing problems (LRP with uncapacitated depots, LRP with cross-docking and prize-collecting LRP), they combined algorithms and lower bounds for different relaxations of the original problems.

The k-location-routing problem, in which at most k uncapacitated depots without fixed costs can be opened in a metric space, is addressed by Carnes and Shmoys [5], who develop a primal-dual scheme and apply lagrangian relaxation to