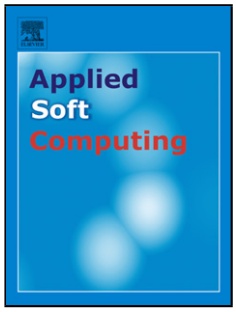

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Two effective simulated annealing algorithms for the location-routing problem

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Abstract

Two heuristics based on the simulated annealing method are presented for solving the capacitated version of the Location-Routing Problem. The first heuristic has four components, which are: generate an initial solution from using a greedy procedure based on allocating customers to the closest facilities; apply four neighborhood operators based on swap and insertion moves; perturb the best solution by solving 0-1 knapsack problems and, then, improve the resultant solution with the Lin-Kernighan heuristic; and, diversify the solution into closing and opening different facilities. The second heuristic is a simplified version of the first one in which the third component is disregarded because it may be time-consuming. Computational experiments conducted on three sets of benchmark instances show that the two heuristics are very competitive and have outperformed other methods published in the literature. They presented an overall average gap of 0.17% and 0.13%, respectively, and improved previous solutions within a reasonable computing time for nine large instances.

Keywords: Location-Routing Problem, Simulated Annealing, Neighborhood Operators, Diversification.

1. Introduction

Logistic companies wish to reduce the overall cost of locating facilities, as well as delivering goods using optimization techniques based on exact and heuristic algorithms. Instead of solving problems independently and combining their solutions, it is naturally better for such companies to consider problems in an integrated way because decisions can be taken simultaneously benefiting the overall cost minimization. In this sense, the Location-Routing Problem (LRP) emerges as integrating interrelated decisions of the facility location problem and the vehicle routing problem [1]. As researched by Drexl and Schneider [2], real world applications of the LRP appear in delivery of goods [3], distribution of military equipment [4], collection and transportation of residues [5], perishable food delivery [6], among others, which in turn justify efficient methods to solve it.

The LRP is a combination of two NP-hard combinatorial optimization problems [7]. In the facility location problem it is necessary to define, at a minimum cost, where to open facilities (depots, factories, warehouses, etc.) for serving customers' demands, while in the vehicle routing problem it is necessary to determine routes of an overall minimum cost, which depart from a single

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