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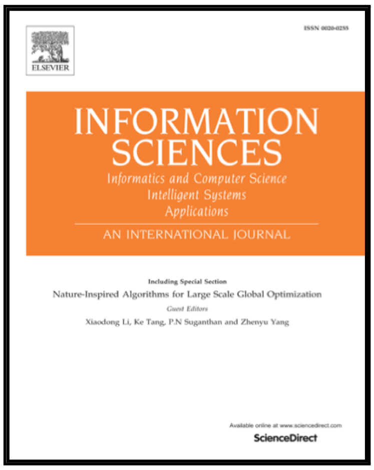

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Multi-Vehicle Selective Pickup and Delivery Using Metaheuristic Algorithms

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Abstract

The pickup and delivery problem (PDP) addresses real-world problems in logistics and transportation, and establishes a critical class of vehicle routing problems. This study presents a novel variant of the PDP, called the multi-vehicle selective pickup and delivery problem (MVSPDP), and designs three metaheuristic algorithms for this problem. The MVSPDP aims to find the minimum-cost routes for a fleet of vehicles collecting and supplying commodities, subject to the constraints on vehicle capacity and travel distance. The problem formulation features relaxing the requirement of visiting all pickup nodes and enabling multiple vehicles for achieving transportation efficiency. To solve the MVSPDP, we propose three metaheuristic algorithms: tabu search (TS), genetic algorithm (GA), and scatter search (SS). A fixed-length representation is presented to indicate the varying number of vehicles used and the selection of pickup nodes. Furthermore, we devise four operators for TS, GA, and SS to handle the selection of pickup nodes, number of vehicles used, and their routes. The experimental results indicate that the three metaheuristic algorithms can effectively solve the MVSPDP. In particular, TS outperforms GA and SS in solution quality and convergence speed. In addition, the problem formulation produces substantially lower transportation costs than the PDP does, thus validating the utility of the MVSPDP.

Keywords: Selective Pickup and Delivery Problem, Multiple Vehicles, Tabu Search, Genetic Algorithm, Scatter Search.

1. Introduction

The pickup and delivery problem (PDP) belongs to a critical class of vehicle routing problems and arises in several real-world logistic problems, such as the delivery of packages and letters. In the PDP, customers are classified into pickup nodes and delivery nodes, which represent customers providing and demanding commodities, respectively. The PDP is used to find the shortest route that satisfies the requests of customers. Comprehensive surveys of the PDP are presented in [7, 50, 51, 61]. Parragh et al. [50, 51] divided PDP scenarios into transportation between the depot and customers as well as conveyance among customers. The first type involves commodities picked from and delivered to the depot. This one-to-many-to-one (1-M-1) PDP is applicable to reverse logistics in simultaneously managing product distribution from the storehouse and material collection for remanufacture [33, 34, 55, 56]. The second type implements the one-to-one (1-1) PDP structure, through which commodities are transferred between paired pickup and delivery nodes (e.g., dial-a-ride system [18] and message transmission in mobile networks [64]). This type can also be applied in many-to-many (M-M) transportation to supply a set of delivery nodes with commodities collected from numerous pickup nodes [1, 8, 9, 24, 37].

In most PDPs, equal amounts of total supply and total demand are assumed, which implicitly imposes a constraint on visiting all customers [7]. Ting and Liao [61] recently proposed the selective pickup and

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