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Variable neighborhood descent for solving the vehicle routing problem with time windows

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Abstract

This paper is concerned with designing an integrated transportation solver for the Vehicle Routing Problem with Time Windows (VRPTW). The VRPTW is one of the most tackled transportation problems in real-world situations. It consists in determining the minimum cost distance routes for a number of homogeneous vehicles stationed at a depot, that have a task of delivering goods to a number of customers within a specified time windows. As the VRPTW is known to be NP-hard combinatorial problem, it is hard to be solve in a reasonable computational time. Therefore, numerous metaheuristics-based approaches have been developed for finding near-optimal solution for VRPTW. To cope with the VRPTW, a VND approach is proposed. In order to demonstrate the performance of the approach in term of solution quality, we apply it on benchmark instances. The VND provided better results, in terms of solution quality, than existing approaches results.

Keywords: Combinatorial optimization, Transportation, VRPTW, VND.

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1 Introduction

The transport activity is one of the most important activities in logistics. A better organization of this activity mainly vehicle routing presents an economic challenge [6]. Because of this economic importance and priority, researches have paid great interest to the vehicle routing problem (VRP). The are many variations of VRP, such as the Capacitated Vehicle Routing Problem (CVRP), Vehicle Routing Problem with Pickup and Delivery (VRPPD), Dynamic Vehicle Routing Problem (DVRP) and the Vehicle Routing Problem with Time Windows (VRPTW).
There are many impressive researches for solving the VRPTW in the literature. There are two major categories for the approaches, namely exact methods and approximate methods. Since the MDVRP is $\mathcal{NP}-hard$ [12], the literature on exact approaches is sparse [3] and [6]. Most authors have focused on the development of approximate methods to find near-optimal solutions quickly. Example of approximate approaches include Ant colony optimization [2], genetic algorithm [3] and [14], tabu search [8] and [11], and Variable neighborhood search [4], [5] and [11]. A recent survey paper [10], [1] and [13] summarizes resolution approaches for solving the VRPTW.
In this paper we apply the VND approach for solving the VRPTW. The VND approach has shown remarkable success in solving the VRPTW and is one of the most preferred approaches for this problem. The remainder of the paper is organized as follows. Section 2 provides a description of the resolution methodology. Section 3 describes the computational results. And in the final section, we close with some concluding remarks.

2 VND approach for solving the VRPTW

The Variable Neighborhood Descent (VND) was proposed by Hansen and Mladenović (2003) [7]. VND is a relatively young metaheuristic concept that has successfully been applied to several combinatorial optimization problems. It performs as follows:
Let $N_1, ..., N_n$ be the set of predefined neighborhood structures, and $N_k(s)$ be the set of solutions using the k^{th} neighborhood of s. The local optimum s' of f regarding to $N_k(s)$, is a feasible solution, where no solution $s \in N_k(s')$ such that $f(s) < f(s')$. The VND is a metaheuristic that switches between neighborhoods $N_1, ..., N_n$ according to a predefined order.
Starting with the first neighborhood N_1, VND performs a local search until no further improvements are available. Then, from local optimum, it continues