Study on Dynamic Vehicle Routing Problem with Time Windows

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Abstract

In the context of information technology, efficient and reliable logistics are a key factor for the economic success of online shops, This necessarily requires an effective way to plan goods delivery to improve efficient and speed, the most important and widely studied combinatorial optimization problems, which continue to draw attention from researchers is the vehicle routing problem, which can optimize the logistics network system if a good algorithm can be raised. This paper made a literature review of DVRPTW , Hope to offer a little help for a better solution to DVRPTW.

Keywords

information technology; goods delivery; distribution planning; VRP;.

1. Introduction

In recent years, with the arrival of network era and the development of e-commerce, the market competition of product become increasingly fierce, the enterprise scientific and technological potential is also limited. The traditional ways by reducing material consumption to obtain "first source of profits" and by saving labor gets "second source of profits " has been far from satisfying the needs of enterprise development, companies began to look away from the production areas to the circulation, the development of the logistics industry has become the companies' " third source of profits", which to a large extent, affect the quality of service. In the context of information technology, efficient and reliable logistics are a key factor for the economic success of online shops, and shipping costs are one of the biggest concerns for online customers[1]， This necessarily requires goods delivery to improve efficient and speed. This means that modern logistics enterprises need accurate and quick to send the goods to the customer to meet their service requirements. Therefore, efficient and flexible distribution planning plays a vital role in promoting enterprise competitive power.

Logistics network optimization is an important part in logistics system, the major part is collection and loading of goods and the process of delivery, as the last mile is currently regarded as one of the most expensive, least efficient and most polluting sections of the entire supply chain [2]. Increasing customer requirements exacerbate flexibility of delivery. So the most important and widely studied combinatorial optimization problems, which continue to draw attention from researchers is the vehicle routing problem. The Vehicle Routing Problem (VRP) aims to find the optimal set of routes for a fleet of vehicles to serve customers under specific constraints. In its basic form, the VRP involves a single depot as the start and end points of the routes. Each customer is associated with a location and a demand quantity. Each vehicle serves the customers along the designated route, and the total demand cannot exceed the maximum capacity [3]. Based on the basic vehicle routing problem (VRP), it has extended and changed for a number of different types in academic research and practical application, including vehicle routing problems with time windows， VRPTW [4],Vehicle Routing Problem with Time Deadlines VRPDT[5],fleet size and mix vehicle routing problems， FSVRP[6],vehicle routing problems with multiple use of vehicle， VRPM[7],vehicle routing problems with backhauls, VRPB[8], vehicle routing problem with stochastic demand, VRPSD[9].Early scholars mainly studies static unconstrained VRP[10,11], but the problem is very much prone to the criticism that has no flexibility. In addition, it does not take into account of vehicle capacity constraints and distribution center constraints; it is difficult to apply in practice to address the issues of mismanagement and waste of resources. Therefore, scholars began to study the dynamics of the more constrained VRP[12,13], and consider the broader implementation in real-life situations. In this article the dynamic VRP with time windows (DVRPTW), in which the delivery of goods to each customer should be occurred in the interval [ai,bi]; where, ai and bi are the earliest and the latest allowable times that the service should be taken place. In general, solution approaches for DVRPTW can be divided into two main classes: those applied to dynamic and deterministic routing problems without any stochastic information, and those applied to dynamic and stochastic routing problems, in which additional stochastic information regarding the new requests is known.[14] Given the fact that in the real-world application tackled in this paper, the information is dynamically given by a company, we will focus on the first class of dynamic problems.

2. Literature review

VRP was formulated mathematically by Dantzig and Ramser[15]. Due to its inherent complexities and usefulness in real life is rich in different solution approaches. Some other papers that also make use of time slices and solve static VRPs are due to Rizzoli et al.[16,17]. The dynamic (real-time) vehicle routing problem with time windows (DVRPTW) in particular is still even harder to solve than the static problem since customer requests are generated or do occur dynamically mainly during the execution of the problem-solving procedure[18]. Ali Gul Qureshi[19] presents a micro simulation-based evaluation of an exact solution approach for the soft time windows variant of the Vehicle Routing Problem (VRP) that also considers penalties on the late arrival. But exact algorithms only solve small size instances, for example, Dell'Amico et al. [20] only found the optimum solution for instances up to 40 customers by a proposed exact algorithm based on branch-and-price approach. Due to the difficulty for solving DVRPTWs to optimality, heuristics and meta-heuristics constitute an increasingly active research area in the literature. Gendreau et al. [21] described a DVRPTW motivated by a courier service application. The customers appear in real-time and must be served within a given soft time window. The TS method used in their work was originally designed for the static version of this problem and was therefore modified in order to deal with a dynamic version. Ghannadpour, Noori, Tavakkoli-Moghaddam, and Ghoseiri[22] tackle a DVRPTW, in which the time windows are considered as fuzzy. Moreover, they use a homogeneous fleet of vehicles and multiple objective functions. A solving strategy based on the genetic algorithm (GA) and three basic modules are proposed, in which the state of the system including information of vehicles and customers is checked in a management module each time. Barkaoui et al.[23] presents a novel algorithm introducing a new strategy to integrate anticipated future visit requests during plan generation, aimed at explicitly improving customer satisfaction. An evaluation of the proposed strategy is performed using a hybrid genetic algorithm previously designed for DVRPTW that they modified to capture customer satisfaction over multiple visits. Lorini et al. [24] studied developments in mobile communication technologies, which are a strong motivation for the study of dynamic vehicle routing and scheduling problems. They developed a problem-solving approach for a VRP with dynamic requests and dynamic travel times and extended to account for more sophisticated communication means between the drivers and the central dispatch office. They focused on the second class of the Solomon's VRPTW benchmark problem instances[25] and the results demonstrated the benefits of this extension. Chevrier et al. [26] proposed a hybrid evolutionary approach for multi objective dial-a-ride problem where, three objectives of minimizing the number of vehicles used, minimizing the journey durations and minimizing the delays are optimized. In their work, the comparison of three state-of-the-art evolutionary algorithms: the Non-dominated Sorting Genetic Algorithm II(NSGA-II), the Strength Pareto Evolutionary Algorithm 2 (SPEA-2)and the Indicator Based Evolutionary Algorithm (IBEA) are done. Hansen[27] and Jesica de Armas[28] have proposed a meta-heuristic procedure based on Variable Neighborhood Search to solve DVRPTW by considering a fixed heterogeneous fleet of vehicles and several real-world constraints/attributes. Xu, Wang, and Yang [29]also takes into account the same problem with urgent requests, but uses a VNS as solving algorithm. In addition to the above several methods, other reviews of exact and approximate methods for DVRPTW can be found in[30].

Throughout the literature survey, several literature papers have proved the effectiveness of developing algorithms to solve DVRPTWs, but none of them has tackled a Dynamic Rich Vehicle Routing Problem.

3. Problem description

The classical VRPTW usually has a homogeneous fleet of vehicles with limited capacity to severe the static customer or fixed workload. Each customer has a specified time require that the task must be completed at the time windows. And the objective is to minimize the number of operating vehicle and minimize the total traveled distance, at the same time meeting the customers' satisfaction to improve the service quality. In this paper, we want to introduce a new DVRPTW; we studied the variant static of workload problem, in which the number of customers and their requests are dynamically changed during the construction of the solution, which is more consistent with the actual situation.

In our work of DVRPTW, the main data of customers and the request time are known in advance, but as in the real situation there always has new business added in or some customer change their service time during the task being execution, that makes the partial route construction an evolutionary process, interleaving plan construction and plan execution. When a new routing line is generated the vehicle must apply it, time window constraints of each customer must be obeyed as the first criteria, if a vehicle arrives at a destination too early it must wait before carrying out its service, furthermore, if it shows up too late, a penalty cost is imposed for lateness. But we also should know that if it cost too much to meet the satisfaction of a certain customer, it may violate the objective of function that to minimum the total cost, so the node may be abandoned.

4. Conclusion

This effort toward solving DVRPTW with multiple customer visits, aims at meeting customer satisfaction in a dynamic environment., we need to consider all aspects of the goal, such as the shortest total time, the highest customer satisfaction in the real problem.which should be studied from multiple perspectives and multi-objective aspects in the future.

Taking into account the overall benefits of the logistics business, we need to consider the inventory and management of distribution center. Therefore, considering the location,inventory and distribution of the distribution center together to draw the lowest total cost of the program, is the focus of future research, which have more practical significance.

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