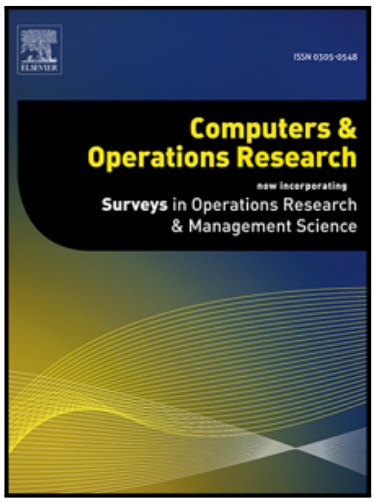

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A Simulation Based Restricted Dynamic Programming Approach for the Green Time Dependent Vehicle Routing Problem

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Abstract

This paper addresses a green Time Dependent Capacitated Vehicle Routing Problem that accounts for transportation emissions. The problem has been formulated and solved using Dynamic Programming approach. The applicability of Dynamic Programming in large sized problems is, however, limited due to exponential memory and computation time requirements. Therefore, we propose a generic heuristic approach, Simulation Based Restricted Dynamic Programming, based on weighted random sampling, the classical Restricted Dynamic Programming heuristic and simulation for the model to solve large sized instances. These decision support tools can be used to aid logistics decision-making processes in urban distribution planning. The added values of the proposed model and the heuristic have been shown based on a real life urban distribution planning problem between a pharmaceutical warehouse and a set of pharmacies, and ten relatively larger instances. The results of the numerical experiments show that the Simulation Based Restricted Dynamic Programming heuristic can provide promising results within relatively short computation times compared to the classical Restricted Dynamic Programming for the Green Time Dependent Capacitated Vehicle Routing Problem. The Simulation Based Restricted Dynamic Programming algorithm yields 2.3% lower costs within 93.1% shorter computation times on average, compared to the classical Restricted Dynamic Programming. Moreover, the analyses on the effect of traffic congestion in our base case reveal that 2.3% benefit on total emissions and 0.9% benefit on total routing cost could be obtained if vehicles start delivery after heavy congested period is passed.

Keywords: Time dependent capacitated vehicle routing problem, Heuristics, Restricted Dynamic Programming, Sustainability

1. Introduction

Vehicle Routing Problems (VRPs) in general deal with the distribution of goods from a central depot to a set of customers by means of a fleet of vehicles. Capacitated Vehicle Routing Problem (CVRP) is one of the main variants of Vehicle Routing Problem (VRP), which comprises m homogeneous capacitated vehicles dispatched from a single depot to serve a set of customers with known locations and demands. Each vehicle route must end at the starting point, central depot, without exceeding the capacity of the vehicle at any point and each customer must be visited exactly once. The basic CVRP assumes that travel times between locations are constant. However, real-world vehicle routing applications require tools that are able to take into account the effects of traffic density on travel speed which is dependent on location and time of the day. This need leads to the incorporation of time dependent travel times into the CVRP that forms the Time Dependent Capacitated Vehicle Routing Problem (TDCVRP). Traditional objective for the TDCVRP is to

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