Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 125 (2014) 262 – 274

Procedia Social and Behavioral Sciences

The 8th International Conference on City Logistics

Hierarchical Traffic Network For Heuristic Approximation Method Of Vehicle Routing Problems

Mariko Okude[a]*, Eiichi Taniguchi[b]

[a]*Hitachi Research Laboratory, Hitachi, Ltd.,1-1 Omika-cho 7-chome, Hitachi-shi Ibaraki 319-1292, Japan*
[b]*Department of Urban Management, Kyoto University, Nishikyo-ku, Kyoto 615-8530, Japan*

Abstract

In actual society, accurate delivery planning that can deal with both large scale customers and dynamically fluctuating traffic conditions are expected. Therefore, such delivery planning needs a high performance calculation method for approximate solutions that calculates many approximate solutions to deal with various delivery conditions in a short time. For this reason, we propose an approximate solution calculation method for vehicle routing problems (VRPs) that obtains a better solution in a shorter time. The proposed method generates an approximate solution by using a hierarchical traffic network composed on the basis of a vehicle's behavior, which is the frequency of using roads. We confirmed that the calculation time of the proposed method depends on the constitution rule of the hierarchical network. In this paper, we describe the composition of a hierarchical network that moves closer to the best approximate solution in a short time.

Keywords: Vehicle routing problem; approximation method; tabu search; traffic network

1. Introduction

Vehicle routing problems (VRPs) are optimization problems that occur in the final phase of the supply chain, which is a series of product supply flows. The approach to obtaining the best approximate solution is very

* Corresponding author. Tel.: +81 294 52 5111; fax: +81 294 52 7616.
E-mail address: mariko.okude.uh@hitachi.com

doi:10.1016/j.sbspro.2014.01.1472

important not only to environmental conservation and energy-saving, but to efficiency in logistics activity. VRPs are defined as problems that involve optimizing the distribution of goods from depots to a given set of customers with a known demand by using a given number of vehicles of fixed capacity. Fig. 1 shows the basic concept of VRPs. Many types of problems used to develop the constraints of this problem have been treated. The representative problems are as follows.

- Capacitated vehicle routing problem (CVRP)
  Problem that involves the constraint of the load capacity on each vehicle. This problem is a basic VRP.
- Multi depot vehicle routing problem (MDVRP)
  Problem of optimizing the delivery routes of vehicles from multiple depots.
- Dynamic vehicle routing problem (DVRP)
  Problem of considering the dynamic changes (change in customer demand, addition of new customers, etc.) of delivery conditions.
- Time-dependent vehicle routing problem (TDVRP)
  Problem that involves the fluctuation of travel time under the influence of traffic congestion.
- Vehicle routing problem with time windows (VRPTW)
  Problem of preventing visits except to those within the time frame requested by each customer.

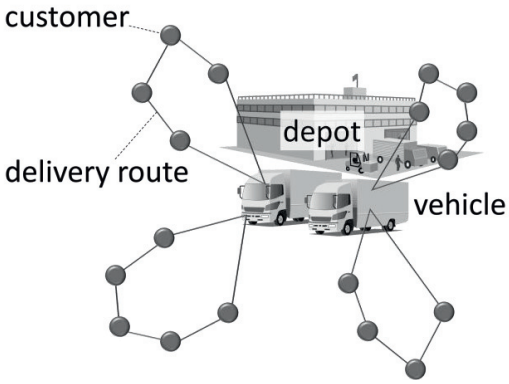

Fig. 1. Basic concept of VRPs.

In society, delivery routes for which the traffic conditions are not considered during the planning phase cause various societal problems such as delays in delivery time, overtime work for delivery workers, an increase in CO_2 emissions, or noise in urban areas. To combat worsening traffic congestion problems in urban areas, various problems as well as time constraints such as VRPTW or TDVRP have been studied. High-performance approximate solution methods that have the ability to change delivery planning in a short time are required in addition to methods that get a more accurate approximate solution that considers the fluctuation of travel time. Our method in this paper treats CVRP, which is the simplest VRP for developing a high-speed approximate solution method for tracking of the fluctuations.

There are two kinds of methods for solving VRPs. One is the approximate solution method for calculating a solution, and the other is the exact solution method that always calculates the optimum solution in a basic form. The approximate solution method is used for general problems of large-scale distributions, whereas the exact solution method is effective for time windows and definitive problems such as small scale distributions. When the number of customers develops into a large-scale VRP, it is difficult to find the optimum solution from among a combination of a huge number of candidate solutions. For large-scale problems such as practical problems, rather than taking the time of investigation into the optimum solution, the approximate solution method is used to find the best solution closest to the optimal solution.