A Metaheuristic Method for the Multi Trip Vehicle Routing Problem

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Mots-clés : *multi trip vehicle routing problem, memetic algorithm, city logistics.*

1 Introduction

In recent years the number of passengers and freight vehicles increased in urban areas causing traffic congestion and increasing air and noise pollution. Municipalities understood the need to take in consideration environmental issues to improve the quality of live in cities. Laws have been introduced to avoid big trucks in city centers, to limit the number of trips of the same vehicle and to encourage the use of environmental friendly carriers. Moreover, platforms for the collection of goods are built outside the city.

The need of an efficient distribution system that takes into account distribution cost, but at the same time considers environmental aspects aims the concept of city logistics [3]. In this context MODUM project (founded by Agence Nationale de la Recherche) seeks for the development of an efficient system of mutualized distribution. Carriers allowed to enter city centers (*van*s in the following) are parked at platforms located around the beltway where trucks arrive and are unloaded. Then, goods are distributed to final customers by vans.

Vans could be vehicle with limited capacity, due to laws restriction imposed and the narrowness of streets that characterize historical parts of downtowns. Then, it seems normal to allow vans accomplish several trips during the working day. The multi trip vehicle routing problem (MTVRP) arises in this context.

In the MTVRP, a fleet of identical vehicles with limited capacity is based at the depot. A set of customer demands have to be fulfilled during the working day. The MTVRP calls for the determination of a set of routes and an assignment of each route to a vehicle, such that the total routing cost is minimized, each customer is visited by exactly one route, the demand of the customer in the same route does not exceed the vehicle capacity. The total duration of the routes assigned to the same vehicle could exceed the working day time, but overtime is penalized [2].

A memetic algorithm (MA) is proposed to face the problem. Starting from an initial population, new individuals (or chromosomes) are produced using the classical order crossover. Each individual is simply a sequence S without trip delimiters of the n customers that have to be served. An adaptation of the Split procedure proposed in [1] is used to divide S in several trips and to assign those trips to vehicles in order to obtain a MTVRP solution.

The proposed procedure works on an auxiliary acyclic graph G with $n + 1$ nodes, where node 0 is the depot and node i represents customer S_i (the client in ith position in S). Each arc in G connecting node i with j, $i < j$, represents a trip serving customer from S_{i+1} to S_j. A path from the depot to the last node in G determines the routes that compose a solution. Different solutions could be associated with the same path regarding the way they are assigned to vehicles.

Several solutions are constructed in parallel with a label-based method. A label is associated with each partial solution and dominated labels are discarded in order to contain the computational time.

During the search phase vehicle load capacity could be violated, but it is penalized with a penalty factor λ that changes dynamically.

In order to compete with other metaheuristic methods, as tabu search or simulated annealing, local search (LS) is used as mutation (or education) operator. It is applied to children with a fixed probability in order to improve their quality.

Computational tests are conducted on benchmark instances proposed in [2]. Results show the efficiency of the proposed method compared with others found in literature. A solution without overtime is found on 90 instances out of 104, and in 13 cases the optimum value is found. On two instances a new best known solution is found.

2 Conclusions et perspectives

MTVRP approximately describes the final step of a mutualized distribution system where merchandise is distributed from a depot to final customers by vehicle that are allowed to perform several trips. In the future we will consider new aspects and features of a real distribution system and we will add those peculiarities to the problem we have faced. The aim is to find new methodologies and solutions that could be used to efficiently manage the distribution of goods in large cities.

Références

[1] C. Prins. A simple and effective evolutionary algorithm for the vehicle routing problem. In *Computers & Operations Research*, 31(12) :1985–2002, 2004.

[2] É.D. Taillard, G. Laporte, M. Gendreau. Vehicle Routing with multiple use of vehicles. In *Journal of Operational Research Society*, 47 :1065–1070, 1996.

[3] E. Taniguchi, R. Thompson, and T. Yamada. Emerging Techniques for Enhancing the Practical Application of City Logistics Models. In *City Logistic VII* Maillorca 7th - 9th June 2011:1–21, 2011.