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A Hybrid Genetic Method for the Multi Trip Vehicle Routing Problem with Time Windows and Release Dates

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1 Introduction

The MODUM¹ project studies a distribution system based on city distribution centers (CDI) located around a city. It is presented in Figure 1. Trucks with merchandise that has to be sent to customers arrive from “main road axis” called *Doors* (unfilled circles, thick arrows). Then, they stop at CDI, where goods are unloaded. CDIs are located around the city center. Environmentally-friendly vehicles (called *vans* in the following) are used to accomplish final deliveries to customer locations (filled spots). Delivery trips (thin arrows) start from one CDI, visit assigned customers and end at one of the CDIs. Moreover, trips can end at parking points (triangles). The possibility of leaving vans at parking points will not be developed in this paper.

CDIs are connected with a *shuttle*. The shuttle circularly goes from one CDI to another CDI (dashed arrows), displacing merchandise. This allows to locate merchandise already in the CDI to a more convenient place for the final delivery. Moreover, carriers can deliver merchandise to the CDI they prefer. The shuttle service is carried out with a regular frequency during the working day.

Outbound flows, starting with a pick-up at customer location, are considered as well into the system. However, deliveries and picks-up are treated separately and cannot be accomplished in the same trip.

Vans have to drive into city centers through small roads, respecting size and weight limitations. They normally have a limited capacity and if they are electrical vehicles, their autonomy is limited as well. It is natural to allow vans to accomplish several trips during the working day. Moreover, with each client, is associated a time window (TW) during which service should be accomplished. Release dates on goods are taken into account. They represent the arrival of merchandise to the CDI.

The location of doors and CDIs, the frequency of the shuttle, the fleet sizing are determined at the strategical level. In this work, it is assumed they are known quantities, since we focus

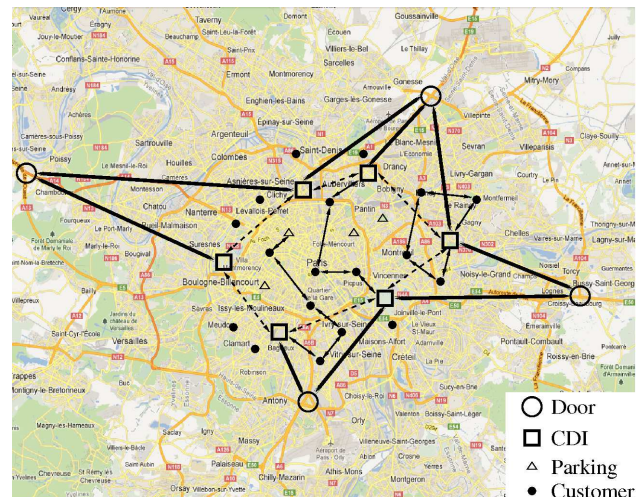


FIG. 1 – MODUM project scheme

1. <http://www-lipn.univ-paris13.fr/modum>

on the operational level and in particular on the optimization of the last-mile delivery between CDI and customers. Also, for this presentation, we consider a simplified version of the routing problem.

We consider only one CDI (the depot) where the fleet is located. Trips start and end at the depot. Parkings are not taken into account at this level. The problem that arises is called the Multi Trip Vehicle Routing Problem (MTVRP) with Time Windows and Release Dates (MTVRPTWR). The MTVRP was introduced in [2]. MTVRP with TW has been studied as well [1]. To the best of author's knowledge this is the first time that MTVRPTWR is addressed.

The MTVRPTWR can be defined as follows. A fleet of vans with the same capacity is located at the depot. A set of customers has to be served. With each customer is associated a demand and a time window. Vans incur in a traveling time when driving from the depot to each customer and from one customer to another. Moreover, a release date represents the moment of availability of merchandise at the depot. A time horizon T_H represents the working day during. Overtime is not allowed.

The MTVRPTWR calls for the determination of a set of routes and an assignment of each route to a vehicle, such that the total travel time is minimized and the following conditions are satisfied : *a*) each route starts and ends at the depot, *b*) each customer is visited by exactly one route during the time window, *c*) if r is the greatest release date associated with the demands loaded in a van, it cannot leave the depot before r , *d*) the sum of the demands of the customers in any route does not exceed the capacity of the vans, *e*) the total duration of the routes assigned to the same vehicle does not exceed the time horizon T_H .

A memetic algorithm for the MTVRPTWR is developed. It makes use of an adaptation of the Split procedure proposed in [3] to obtain a MTVRPTWR solution from *giant tours*. A giant tour is a sequence of the clients to be served.

The algorithm is tested on a benchmark set of instances.

2 Perspectives

The algorithm will be extended to the multi-depot case. Parkings and the shuttle will be considered. It will be embedded in a simulator and used to evaluate the whole MODUM system. The simulator will be developed to manage the dynamic arrival of merchandise to the CDIs. A static version of the algorithm will be used to obtain the starting routing plan to perform the day after. Demands that could not be served the day before and all the already known new requests are considered by the static algorithm. A dynamic version of the algorithm is used to manage new requests and re-optimize the routing plan.

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