Communication Title: **A three-phase heuristic for a capacitated Vehicle Routing Problem with pickups, time windows and packing constraints**

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Abstract:
Retailers are offering increasingly widespread e-commerce services and the number of boxes sent via a service carrier is dramatically growing. Therefore, efficient loading of the boxes during transportation is crucial in the development of the routes and this arrangement must be optimised simultaneously with the visit of the customers during their period of availability, i.e. their time window.

Since the collection and delivery points can be geographically spread, carriers perform the process over two days: on the first day, they collect the boxes and on the second day, they deliver them. The return to the depot between the two days allows them to separate the pickup operations from the delivery operations. In this work, we focus only on the collection of boxes since it has received less attention in the literature compared to delivery while it is subject to more uncertainty as additional pickup requests may pop up, or the number of boxes to collect can change during the day. Furthermore, the collection process, in which the vehicle is initially empty, is much more able to react to these types of disruptions on-the-fly. The collection problem gives rise to a Three-Dimensional Capacitated Vehicle Routing Problem with Time Windows (3L-CVRPTW).

In order to deal with real-life problems, we conduct a survey among Belgian transportation service providers with a consulting group. They expect to be able to provide routes with respective schedule and loading plan while minimising transportation distances and not exceeding their own vehicle fleet. The schedule must respect the time windows and a maximum working duration, whereas the loading plan must be valid at each customer location and satisfy some constraints (namely, geometric, vertical stability, orientation, and multi-load constraints).

Considering the complexity of the integration of the routing and packing problems, off-the-shelf solvers are unable to quickly generate solutions. Therefore, we are currently developing a three-phase heuristic to provide a good solution in a short time. The first step consists in building an initial solution via the savings heuristic of Clarke and Wright. The second step is a route elimination procedure in order to reduce the number of routes if it exceeds the fleet size. In the last step, we try to improve the solution via a General Variable Neighbourhood Search. The neighbourhoods are based on typical routing operators such as relocate or swap in inter and intra routes, and the crossover.

We tested our heuristic on 600 instances from the literature. Based on our first experiments, we observed an average improvement of 5% of the initial solution, whatever the number of customers in the solution, whereas the computation time decreases with the number of customers. Our next step is to tune the heuristic and then compare it to existing algorithms to check the effectiveness of our method.

Keywords: loading, routing, time windows, GVNS