Multi-Trip Vehicle Routing Problem with Time Windows and Heterogeneous Fleet

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This paper introduces a metaheuristic approach to solve a variation of the well-known vehicle routing problem *VRP*. The aim here is to present a solution to the *Multi-trip Vehicle Routing Problem with Time Windows and Heterogeneous Fleet*. In this problem, named *MTVRPTWHF*, each customer defines the delivery time or time windows within which vehicles are allowed to arrive. The problem also considers an heterogeneous fleet in which both capacity and cost differs from one vehicle to another. A vehicle can be assigned to more than one route and the total time needed to complete these routes must not exceed a defined time horizon constraint.
Since the *VRP* is a *NP-Hard* problem then the *MTVRPTWHF* is also *NP-Hard*. Thus, and in order to efficiently solve the problem in terms of computational cost, we have developed a metaheuristic algorithm to solve it. The first part of the algorithm concerns the creation of an initial solution to start from based on *Solomon* insertion heuristic and the second part improves the obtained solution by applying a *Local Search* approach based on *Simulated Annealing*, methodology inspired in the process of annealing in metallurgy which is often used in combinatorial optimization problems. The algorithm showed to be very effective in finding high-quality solutions in terms of execution time and functional values.
A set of benchmark instances for the problem were taken and adapted from instances originally defined for a particular vehicle routing problem named *VRPHF (Vehicle Routing Problem with Heterogeneous Fleet)* defined by *Golden et Al.* and *Taillard* in which neither time windows nor time horizon constraints were present. Instances involving 50, 75 and 100 customers were selected to test the algorithm. These instances were adapted to our problem by adding time windows and time horizon constraints. We have taken the results obtained by *Gendreau* and *Tarantilis* over the *Golden et Al.* and *Taillard* instances as reference values and we have compared our results with these using the *GAP* measure. The algorithm achieved good results which are summarized at the end of this paper.