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Optimizing Constrained Shortest Path for a Vehicle Routing Problem

The Vehicle Routing Problem we consider is classically constrained by the capacities of the vehicles and by the time windows of the customers. Moreover, we dispose of an heterogeneous fleet : several types of vehicles with different capacities, different speeds and different costs (fixed, time and distance) can be used. But, the main particularity of our application consists in considering the whole route time in the cost computation. More precisely, if a vehicle arrives at a customer before the beginning of its time window, the corresponding waiting time is taken into account.

For such an application, we have first defined a set of reduction rules, that allow to reduce the number of edges between customers. And second some of these rules also discretize each customer's time window into a set of intervals. For a customer i, each interval is defined by a period of time (included in the time window) where the set of partial paths arriving to i remains unchanged and where the cost of each of these partial paths remains constant. First, this discretization allows a reduction of the time windows: in the first (resp. last) interval, all the times except the last (resp. first) one can be suppressed. But, this discretization is particularly interesting for the methods where the different possible arriving times have to be considered.

The interest of such reduction rules will be illustrated on a constraint shortest path algorithm used in a column generation based exact method.