Abstract

The Vehicle Routing Problem with Intermediate Replenishment Facilities (VRPIRF) is a tactical routing problem that arises when each vehicle can perform not one but a sequence of service trips, called a rotation, before going back to the central depot and recharge at replenishment facilities in between two trips. Vehicles are homogeneous and can perform neither trips exceeding their capacity, nor rotations exceeding a given shift length. The aim is to find a least cost set of rotations that visits each one of a set of client exactly once, the cost of a route being the sum of the costs of the visited arcs.

We propose a Set-Partitioning-like MILP model with route variables for the VRPIRF which makes use of replenishment arcs and arrival times.
The former allow to represent a rotation as an elementary closed path with both its endpoints on the depot. The latter allow to keep track of the time spent on any partial path from the depot to a customer and are therefore used to impose the shift duration constraint.

Based on such MILP formulation we design a Branch&Price algorithm, in which the Pricing Problem is an Elementary Shortest Path Problem with Resource Constraints (ESPPRC) solved by means of a DP algorithm. The algorithm is enhanced with ng-paths and a q-paths-based completion bound method to accelerate the convergence of the Column Generation performed at each node of the Branch&Bound tree.