A Branch & Cut algorithm for the Multi-trip Vehicle Routing Problem with Time Windows

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Abstract

The Multi-trip Vehicle Routing Problem with Time Windows (MTVRPTW) generalizes the well-known Capacitated Vehicle Routing Problem (CVRP) in that vehicles can perform more than one trip within a maximum shift length but must comply customer time windows. The MTVRPTW has recently got the attention of scholars due to its applications to city logistics. A Branch & Price approach is proposed in [1], while [2] tackles a variant with limited trip duration.

We propose a three-index MILP formulation for the MTVRPTW that makes use of base and replenishment arcs. The former model the direct connection between two nodes, while the latter imply a reload operation in between two clients. Base and replenishment arc variables are vehicle-indexed. Replenishment arcs allow to represent a journey as an elementary path and thus to ensure connectivity by separating SECs on a transformation of the graph. Further sets of two-indexed variables allow to impose time windows, shift length, and service-dependent loading time constraints.

The use of classical capacity constraints to enforce the load limit on vehicles leads to a Branch & Cut algorithm. Capacity constraints are then strengthened after branching decisions to exploit some properties of the vehicle index.

Preliminary tests have been conducted, with promising results.

F.Hernandez, D.Feillet, R.Giroudeau, O.Naud, "Branch-and-price algorithms for the solution of the multi-trip vehicle routing problem with time windows." EJOR, 249(2):551-559, 2016.

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