
A branch-price-and-cut algorithm for the mixed capacitated general routing problem with time windows

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Abstract

We introduce the Mixed Capacitated General Routing Problem with Time Windows (MCGRPTW). This problem is defined over a mixed graph, for which some nodes, arcs and edges have strictly positive demand and must be serviced through a fleet of homogeneous capacitated vehicles. The aim is to find a set of least-cost vehicle routes that satisfy this requirement, while respecting pre-specified time windows, and without exceeding the vehicle capacity. The MCGRPTW generalizes the Capacitated Arc Routing Problem with Time Windows (CARPTW) and many other routing problems. Its main application can be found within urban waste collection, where garbage quantities are collected along the streets, but specific locations (e.g., industrial and commercial sites) need to be considered as single points due to the large amount of garbage. In this context, time windows represent common constraints in real-world cases. The transformation of routing problems in equivalent ones defines a solution approach quite often used in the scientific literature. We transform the MCGRPTW into an equivalent node routing problem over a directed graph and solve it through a branch-price-and-cut algorithm. Branch-price-and-cut is a variant of branch-and-bound, with bounds obtained by solving linear programs and performing column and cut generation; branching decisions are taken to derive integer solutions. We demonstrate the effectiveness of the solution approach through an extensive computational study, where both CARPTW and MCGRPTW instances are solved.

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