The Capacitated Arc Routing Problem with Zigzag Options

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The Capacitated Arc Routing Problem with Zigzag options (CARP-Z) arises in a variety of applications related to postal services, trash collection and snow plowing, in which some streets require service along both sides of the street. Let $G = (V, E)$ be a connected graph with node set V and edge set E. Let $E_S \subset E$ be a subset of edges which should be serviced exactly once (single edges) and represent the streets requiring service by a normal traversal. Another subset of edges $E_D \subset E$ must be serviced twice (double edges) and represents streets which must be serviced on both sides, either by two separate traversals in opposite directions, or by a single *zigzagging* traversal. The objective of CARP-Z is to find a set of vehicle routes with minimum cost, such that each route starts and ends at the depot, each required single edge is serviced by a single normal traversal, and each required double edge is serviced by two normal traversals or a zigzag pass, and the total demand of all edges serviced by any vehicle does not exceed its capacity.

The CARP-Z is NP-hard as a natural generalization of the CARP. To this date, few works have been dedicated to it. In this presentation, we propose a hybrid metaheuristic and an exact branch-cut-and-price (BCP) algorithm for solving this problem. Our metaheuristic is an extension of the unified hybrid generic search (UHGS) applied to the CARP and its variants with *mode choices* by [1]. It relies on two additional modes to represent zigzag services and relies on a tailored dynamic programming auxiliary subproblem to evaluate the associated costs. The BCP generates non-elementary routes using a specialized pricing algorithm and improves the solutions by separating some families of cuts adapted from the literature. Our experiments on benchmark instances for this problem demonstrate the good performance of both algorithms, and highlight interesting paths for future research.

References

[1] T. Vidal, "Node, edge, arc routing and turn penalties: Multiple problems - one neighborhood extension", *Operations Research* 65(4): 992-1010, 2017.