Integer Programming Formulations for the k Edge-Connected 3-Hop-Constrained Network Design Problem

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Abstract: In this paper, we study the k edge-connected L-hop-constrained network design problem. Given a weighted graph $G = (V, E)$, a set D of pairs of nodes and two integers $L \geq 2$ and $k \geq 2$, the problem consists in finding a minimum weight subgraph of G containing at least k edge-disjoint paths of length at most L between all the pairs $\{s, t\}$ of D. This problem has been studied in some special cases, in particular when $L = 2, 3$ and $k = 2$. Here we introduce new integer programming formulations using transformations of G into directed graphs when $L = 2, 3$ and $k \geq 2$. We also discuss the polytopes associated with these different formulations. In particular, we introduce new classes of valid inequalities and study conditions under which these inequalities define facets. Using these results, we devise Branch-and-Cut and Branch-and-Cut-and-Price algorithms for the problem. We present computational results and compare the different formulations.

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