A formulation and an exact algorithm for the Disaster-Recovery Graphical Traveling Salesman Problem

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The Graphical Traveling Salesman Problem is a version of the well-known Traveling Salesman Problem in which the graph is not assumed to be complete and, therefore, each vertex can be traversed more than once. In this work we consider the possibility of reducing the cost of the edges by paying a certain price.

Consider an undirected graph $G = (V, E)$. For each edge $e \in E$, there are K possible upgrade levels, each one having an associated cost c_e^k and price α_e^k, with $c_e^1 \geq c_e^2 \geq \ldots \geq c_e^K$ and $\alpha_e^1 \leq \alpha_e^2 \leq \ldots \leq \alpha_e^K$. The Disaster-Recovery Graphical Traveling Salesman Problem (DR-GTSP) consists of finding the optimal route traversing all the vertices in V and the optimal upgrade level for each edge so that the total price paid for the upgrade does not exceed a certain budget P and the total cost of the route is minimized.

This problem could have applications in the delivery of aid in case of natural disasters, after which roads may be damaged or even cut off. In such situations, a set of limited resources (money, workers, materials,…) could be employed to improve the road network with the goal of designing a route that visits a set of locations (populations that need to be reached by the aid) in the shortest possible time.

Here we propose a formulation for the DR-GTSP, several valid inequalities that strengthen this formulation, and a branch-and-cut algorithm. Some preliminary computational results obtained with this exact algorithm on a set of randomly generated instances will be presented.