Multi-vehicle prize collecting arc routing for connectivity problem

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Abstract

After a natural disaster roads can be damaged or blocked by debris, while bridges and viaducts may collapse. This commonly observed hazard causes some road sections to be closed and may even disconnect the road network. For effective disaster response, roads should be cleared or repaired to provide accessibility and relief services to the affected people in shortest time. We study an arc routing problem that aims to regain the connectivity of the road network components by clearing a subset of the blocked roads. In this problem, we maximize the total prize gained by reconnecting disconnected network components within a specified time limit. These prizes are determined based on the population of the components. The solution should determine the coordinated routes of each work troop starting at a depot node such that none of the closed roads can be traversed unless their unblocking/clearing procedure is finished. The coordination of the routes is required to prevent traversing blocked edges before their opening procedure is done. We develop an exact Mixed Integer Program (MIP) and a matheuristic method. The matheuristic solves single vehicle problems sequentially with updated prizes. To obtain an upper bound, we first relax the timing elements in the exact formulation and then solve its relaxed MIP, which decomposes into single vehicle problems, by Lagrangian Relaxation. We show the effectiveness of the proposed methods computationally on both random Euclidean and Istanbul road network data generated with respect to predicted earthquake scenarios.

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