Metaheuristics for the Multi-objective and Periodic Node, Edge, Arc Routing Problem considering Costs and Route Inconsistency

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Security problems can have many different facets – cash in transit operations (e.g. collecting or delivering cash), guard duties (e.g. personal protection, patrolling areas, custody of buildings), or military operations (e.g. movement of troops, patrolling territory) – for which the considered aspects are usually the costs and security of a solution.

This research focusses on a multi-objective and periodic node, edge, arc routing problem (MO-P-NEARP). This covers a mix of patrolling streets with intermittent stationary guard duties. The two objectives that we study are costs and route inconsistency. Route inconsistency measures how often arcs or edges are used within given periods (not counting service), and whether the sequences, in which the services take place, have similar subsequences.

In an earlier attempt the MO-P-NEARP has been converted to a VRP-like problem. For the latter three different multi-objective framework – multi-directional local search (MDLS), ϵ-constraint heuristic (ϵ-CH), and ϵ-box-splitting heuristic (ϵ-BSH) – have been used sharing an underlying adaptive large neighborhood search (ALNS).

The ALNS has been tested for the single-objective version with respect to costs on several benchmark sets (BHW, CBMix, DI-NEARP, MGGDB) and delivered results close to the best published ones. For the multi-objective frameworks MDLS, ϵ-CH, and ϵ-BSH have been compared on the MGGDB instances. Furthermore, they have been tested on real world instances based on Vienna.

The second attempt does not convert the MO-P-NEARP as above and instead uses the original graph network in the hope of possibly exploiting sparsity and being able to find more diversified solutions regarding inconsistency. For this attempt the multi-objective frameworks and the underlying local search from the earlier are adapted to the new solution structure.