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PHD THESIS

Secure vehicle routing: models and algorithms to increase security and reduce costs in the cash-in-transit sector

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This work covers routing problems dealing with security issues while transporting cash and valuables. The physical transportation of cash plays a vital role in our daily lives. In 2012, worldwide cash transactions were estimated at $11.6 trillion. Unsurprisingly, due to the nature of the transported goods, carriers are constantly exposed to serious security threats such as robberies.

This thesis focus on the development of some routing models which directly and indirectly handle the risk of being robbed in order to support decision makers when planning safe and cost effective vehicle routes. The proposed models and the related optimization techniques find their natural applicability in the cash-in-transit sector, even though they might be easily extended to other domains such as the transportation of dangerous goods and/or the design of patrol routes for security agents.

More specifically, three variants of the well-known vehicle routing problem are described, where a risk constraint limits the risk exposure of each vehicle. In addition, a multi-objective decision model, where both risk and travel costs need to be minimized, is developed to support the decision process. Finally, a model that extends the traditional vehicle routing problem and generalizes the well-known peripatetic routing problem is presented to indirectly increase security by enhancing route unpredictability.

Several effective algorithms based on metaheuristics are developed to solve these challenging optimization problems. These approaches belong to the general iterative local search and grasp metaheuristic frameworks, producing near-optimal solutions in limited computation time. A transparent design phase is reported and extensive test are performed to statistically validate and evaluate the impact on solutions of every heuristic component.