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# The vehicle routing problem with locker boxes

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## Abstract

Direct-to-consumer deliveries show an ongoing increase due to the fact that people prefer to order online nowadays. This trend comes along with new challenges, as for example the problem of delivery failures that occur when customers are not at home at the time of a delivery. Additional delivery attempts or dropping the parcels at any arbitrary station causes inefficiencies and inconveniences for both the logistics provider and the customer.

To deal with these changes, it is necessary to consider innovative aspects when designing an efficient logistics systems. In this work, we introduce so called locker boxes to the network, which leads to the vehicle routing problem with locker boxes (VRPLB). We assume that locations and configuration of the locker box stations are already decided. Locker box stations are constrained by capacity. The access to the boxes is not restricted to any opening hours, whereas a delivery to a customer's private address can only happen within a certain time frame. We consider the number of successful home deliveries as a measure for customer satisfaction and will present two variants for taking this into account in the model.

We use randomly generated instances for computational experiments. Both models are implemented as mixed integer programs and small instances are solved with Gurobi. A set covering method is used to solve larger instances heuristically. Adaptive Large Neighbourhood Search (ALNS) serves as a metaheuristic approach. Finally, we combine ALNS with set covering, yielding a hybrid ALNS for the VRPLB.

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