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Title
Efficient Move Evaluations for Time-Dependent Vehicle Routing Problems with Route Duration Constraints

Abstract
We consider the Vehicle Routing Problem with Time Windows, time-dependent travel times and in which route duration is constrained and/or minimized. This problem arises in many real-world transportation applications, for instance when modeling road traffic congestion and driver shifts with maximum allowed working time. To obtain high quality solutions for instances of 1000+ requests, (meta-) heuristics are needed, which typically rely on some form of Neighborhood Search. In such algorithms, it is crucial to quickly check feasibility and exact objective change of local improvement moves. Although constant time checks based on preprocessing are known for both the time-dependent VRPTW, and the VRPTW with duration constraints, the combination of the two is significantly harder, leading to quadratic time complexity in the number of requests. We show how preprocessing can be used to decrease the move evaluation complexity from quadratic to linear time. Furthermore, we introduce a new data structure that reduces computation times further by maintaining linear time move evaluation complexity even when the neighborhood is searched in non-lexicographic order. Our numerical experiments illustrate the trade-off between computation time and memory usage among the different methods. On 1000 customer instances, our methods are able to speed-up a construction heuristic by up to 8.89 times and an exchange neighborhood improvement heuristic by up to 3.94 times, without requiring excessive amounts of memory.

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