Enhanced Multi-Directional Local Search for the Bi-Objective Heterogeneous Vehicle Routing Problem with Multiple Driving Ranges

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Abstract

The transportation sector accounts for a significant amount of greenhouse gas emissions. To mitigate this problem, electric vehicles have been widely recommended as green vehicles with lower emissions. However, the driving range of electric vehicles is limited due to their battery capacity. In this paper, a bi-objective mixed-integer linear programming model is proposed to minimise total costs (fixed plus variable) as well as CO2 emissions caused by the vehicles used in the fleet for a Heterogeneous Vehicle Routing Problem with Multiple Loading Capacities and Driving Ranges (HeVRPMD). To solve the proposed model, an enhanced variant of Multi-Directional Local Search (EMDLS) is developed to approximate the Pareto frontier. The proposed method employs a Large Neighbourhood Search (LNS) framework to find efficient solutions and update the approximated Pareto frontier at each iteration. The LNS algorithm makes use of three routing-oriented destroy operators and a construction heuristic based on a multi-round approach. The performance of EMDLS is compared to MDLS, an Improved MDLS (IMDLS), non-dominated sorting genetic algorithm II (NSGAII), non-dominated sorting genetic algorithm III (NSGAIII), and the weighting and epsilon-constraint methods. Extensive experiments have been conducted using a set of instances generated from the Capacitated Vehicle Routing Problem benchmark tests in the literature. In addition, real data is utilised to estimate fixed and variable costs, CO2 emissions, capacity, and the driving range of each type of vehicle. The results show the effectiveness of the proposed method to find high-quality non-dominated solutions.

Keywords: Routing, Multi, objective, Multi, directional Local Search, Electric Vehicles, Multiple Driving Ranges

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