Electric Vehicle Routing Problem with Time Windows and Stochastic Waiting Times at Recharging Stations

Merve Keskin[*†1], Gilbert Laporte[2], and Bülent Çatay[3]

[1]Warwick Business School – The University of Warwick Coventry CV4 7AL, UK, United Kingdom
[2]HEC Montréal – 3000 chemin de la Cote-Sainte-Catherine, Montreal H3T 2A7, Canada
[3]Sabanci University – Faculty of Engineering and Natural Sciences, Istanbul, Turkey

Abstract

The Electric Vehicle Routing Problem with Time Windows (EVRPTW) and Stochastic Waiting Times at Recharging Stations is an extension of the EVRPTW where the EVs may wait in the queue before the recharging service starts due to limited number of available chargers at the recharging stations. Since the customers and the depot have time windows, long waiting times at the stations in addition to the recharging times may cause disruptions in logistics operations. In this study, stations are equipped with single chargers and partial recharging is allowed. We use an queuing system to model the waiting times. We model this problem as a two-stage stochastic program with recourse using scenarios and propose a simheuristic method to solve it effectively. The proposed method is based on Adaptive Large Neighborhood Search and uses well-known mechanisms from the literature with adaptations for the problem as well as a new adaptive mechanism developed for the problem. To calculate the probabilities and the expected costs, simulation is used. We perform an experimental study using both small and large instances from the literature to investigate the performance of the proposed method and the influence of the stochastic waiting times at stations on routing decisions and costs. The results show that the simheuristic provides good solutions in both quality and computational time, and the uncertainty in waiting times may have significant impact on route plans.

Keywords: electric vehicle routing problem, simheuristics, adaptive large neighborhood search

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[*]Speaker
[†]Corresponding author: Merve.Keskin@wbs.ac.uk