A Learning Large Neighborhood Search for the Dynamic Electric Autonomous Dial-A-Ride Problem

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In the dynamic electric Autonomous Dial-a-Ride Problem (e-ADARP) a fleet of electric autonomous vehicles (e-AVs) provide on-demand door-to-door transport to on-line requests. The problem maximizes the number of served demand and minimizes a cost function composed of the total operational cost and user inconvenience. Differently from conventional vehicles, e-AVs operate non-stop and offer more flexibility to modify their plans in real-time. Given that e-AVs are electric, the planning process needs to continuously re-optimize the vehicle battery levels, decisions regarding detours to charge stations, recharge times, together with the classic dial-a-ride features.

In this work, we propose a two-phase heuristic approach to solve the dynamic e-ADARP. The first phase consists of an insertion heuristic that efficiently modifies both vehicle routes and schedules with the arrival of new transportation requests. The second phase introduces a new Learning Large Neighborhood Search algorithm to re-optimize the vehicle plans through intra- or inter-route customer exchanges. We formulate the choice of the operator by a classification problem, where the operator represents a class and selected characteristics of the problem instances or solutions represent the features. Numerical results are produced from an event-based simulation based on existing benchmark instances and real-world data from ride-hailing services.