

Hybrid Genetic Algorithm for the Hybrid Electric Vehicle Routing Problem with Mode Selection

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Hybrid electric vehicles (HEVs) are becoming increasingly popular due to stringent carbon emission regulations. However, their limited battery capacity necessitates stopping at recharging stations during transport. This study introduces the Hybrid Electric Vehicle Routing Problem (HEVRP) with mode selection, incorporating recharging or refilling at power or gasoline stations. The modes include battery-based mode (primarily operated by the Electric Engines), gasoline-based mode (primarily operated by the Internal Combustion Engines (ICE)), balance mode (operated by both of the above methods in balance), and only gasoline mode (only operated by the ICE). Efficient route planning is crucial for minimizing energy consumption and maximizing fuel efficiency through optimal mode selection according to road conditions. We propose a Hybrid Genetic Algorithm (HGA) to address the HEVRP with mode selection. The HGA combines Local Search (LS) techniques with Genetic Algorithm (GA) techniques, formulated as a mixed integer linear programming model. Using Solomon's benchmark data, categorized into small (5, 8, 10 customers), medium (15, 20, 25 customers), and large-scale (between 30-100 customers) datasets, we conducted numerical experiments. The results demonstrate that the proposed HGA outperforms the traditional GA method in efficiency and effectiveness, not only for small-scale scenarios (for HGA average value is 84.14 and time is 33.46s, for GA average value is 95.48 and time is 99.79s) but also produces better results for medium (for HGA average value is 155.19 and time is 364.46s, for GA average value is 184.42 and time is 702.19s) and large-scale (for HGA average value is 570.33 and time is 2292.43s, for GA average value is 679.25 and time is 2593.48s) situations. This research contributes to sustainable transportation by enhancing HEV efficiency through advanced route planning. Our findings highlight the positive impact of integrating GA and LS algorithms, offering a robust solution to the HEVRP with mode selection.

Keyword: Hybrid Vehicle; Vehicle Routing Problem; Mode Selection; Hybrid Genetic Algorithm