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SECOND PRIZE

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Optimising Mixed-Fleet Multi-Terminal Electric Bus Schedules with Cutting-Edge Metaheuristics

Transportation is a vital sector responsible for a substantial portion of CO2 emissions, comprising 25% of the total emissions. To combat this environmental challenge and mitigate greenhouse gas emissions, the electrification of transportation has emerged as a pivotal strategy. Within this paradigm, public transport stands out as a promising domain for the adoption of electric vehicles (EVs). Particularly, the electrification of buses in urban areas presents a significant opportunity to curb emissions. However, this transition also brings forth unique challenges, notably the Multi-Terminal Mixed-Fleet Electric Bus Scheduling Problem.

This research aims to address this challenge by exploring various heuristics and metaheuristics tailored to handle the scalability issues inherent in urban-scale instances. The study introduces two Chain-Trip Builder (CTB) heuristics to generate initial feasible solutions, complemented by two metaheuristics: Simulated Annealing and Genetic Algorithm. The former focuses on refining initial solutions through local search techniques, while the latter optimises the mixing of bus fleets, thereby improving overall operational efficiency.

Evaluation of these methodologies was conducted using real-world data from the shuttle network of Luxembourg City, encompassing up to 1084 trips, 11 terminals, and full-day service operations. The findings reveal substantial reductions in operating costs, such as cost per mileage and charging costs, as well as decreased overheads like fleet size. Moreover, the study underscores the importance of an optimal balance in the composition of bus fleets, challenging previous assumptions favouring full-electric fleets. This comprehensive investigation offers valuable insights into efficient electric bus scheduling within urban environments, contributing significantly to the broader objective of achieving sustainable transportation systems.