Technical University of Munich
TUM School of Engineering and Design
Chair of Automotive Technology

Master Thesis / Semester Thesis / IDP

Reinforcement Learning based Charging Strategy for Battery Electric Trucks with Charging Point Reservations

Motivation:

Commercial vehicles are significant contributors to greenhouse gas emissions within European road transport. Transitioning to battery-electric commercial vehicles offers one of the most effective pathways to achieving meaningful and sustainable emission reductions. This transformation aligns with the European Commission's ambitious goal to cut CO_2 emissions from heavy-duty vehicles by 90% by 2040. Additionally, the increasing number of companies requiring environmentally responsible supply chains reinforce the urgency of this shift. Especially long-haul electric trucks will have high demands on the public charging infrastructure and its availability. As charging stops on the route will be inevitable, precise scheduling and reliability in operation are of high interest for the freight forwarders. To meet those requirements, smart route planning and charge stop integration including reservation of charge points are promising ideas.

Thesis topic:

To enable smooth and reliable on-route charging for electric trucks, freight forwarders must efficiently plan routes and charging stops for battery electric trucks (BET). Ideally, this occurs through an adaptive process that accounts for all charging infrastructure constraints.

The objective of this thesis is to develop a reinforcement learning (RL) approach for the operational planning of a single BET, explicitly considering a given charging infrastructure and the possibility of reserving charging points. This approach utilizes an agent-based simulation framework as the learning environment to derive an optimal policy for where, how much, and how long to charge along a fixed route. The RL agent will learn to navigate real-world constraints, such as regulatory driver rest requirements, nonlinear charging characteristics, and vehicle-specific operational flexibilities. A particular focus lies in integrating charging point reservations into the learning process to ensure more reliable and efficient BET operations. Finally, the performance of the developed RL approach will be evaluated within the simulation framework and compared to other trucks and planning methods.

Work packages:

1. Literature review on BET operations, charging reservation methods, and RL in logistics
2. Analysis and selection of a suitable RL algorithm and definition of the state, action, and reward space
3. Conceptualization of the RL-based operational strategy, including the integration of reservations
4. Implementation and training of the RL agent within the existing agent-based simulation framework
5. Fine-tuning and validation of the learned policy
6. Evaluation and benchmarking of the RL strategy against conventional planning methods within the simulation environment

Requirements:

- Passion for e-mobility and energy-transition technologies
- Good programming skills in Python, Basics in Git
- Initial experience with Reinforcement Learning
- Independent and strategic way of working
- Enjoy working in a team
- Very good German or English language skills

I look forward to receiving your application with a CV, current overview of grades (+ any other documents) and a brief motivation. I'm happy to discuss the topic with you in detail in a personal meeting. **The thesis can be written either in German or English.**

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Start date:
From now on

Workplace:
FTM, Garching Forschungszentrum. The thesis can be done on site or remotely.