Dresden University of Technology

CHAIR OF RAILWAY OPERATIONS

Topic Description - Master / Diploma thesis

Reinforcement Learning for Large-Scale Train Timetable Rescheduling Problems

Problem description

Train Timetable Rescheduling (TTR) is a key component of Railway Traffic Management, ensuring the safe and efficient operation of railway systems when unexpected events occur. These events may include infrastructure failures, rolling stock breakdowns, or other operational irregularities that require adjustments to the planned timetable. In these situations, train schedules must be adjusted in real time to produce a conflict-free timetable while minimizing deviations from the original schedule.

Although many optimization methods have been developed for TTR, finding high-quality solutions within the strict time constraints of real-time railway operations remains a significant challenge due to the problem's computational complexity. Reinforcement Learning (RL), a branch of Machine Learning, has recently emerged as a promising approach for sequential decision-making problems. Several studies have demonstrated its potential for train timetable rescheduling. This thesis aims to investigate and develop RL-based methods for large-scale train timetable rescheduling using the open-source ***DISPLIB*** benchmark library, which provides standardized railway dispatching instances and serves as a common platform for developing and comparing train timetable rescheduling methods. The work will involve a literature review, the development of an RL-based framework for train timetable rescheduling using DISPLIB, and a comprehensive experimental evaluation against existing approaches. Furthermore, there is a possibility to build on the existing models developed at the chair.

Assignment

- Review the state of the art in reinforcement learning for train timetable rescheduling.
- Become familiar with the open-source DISPLIB benchmark library.
- Design and implement a reinforcement learning framework for train timetable rescheduling.
- Evaluate the proposed approach on benchmark instances and compare its performance with existing methods.
- Document the methodology, results, and conclusions in a master's thesis.

Background

The student should have a solid background in transportation science, preferably in railway operations and scheduling. Basic knowledge of machine learning, particularly reinforcement learning, is desirable. Experience with Python programming and machine learning frameworks such as PyTorch is an advantage. This topic is suitable as a master's thesis or Diploma thesis project.

Reference

Berto, Federico, et al. "Rl4co: an extensive reinforcement learning for combinatorial optimization benchmark." *Proceedings of the 31st ACM SIGKDD Conference on Knowledge Discovery and Data Mining V. 2*. 2025. https://doi.org/10.1145/3711896.3737433

Kloster, Oddvar, et al. "DISPLIB: a library of train dispatching problems." *arXiv preprint arXiv:2509.12254* (2025). https://doi.org/10.48550/arXiv.2509.12254

Fouladi, Ashkan, et al. Real-time microscopic train rescheduling using graph neural network based reinforcement learning. http://dx.doi.org/10.2139/ssrn.6604465

Contact

Prof. Dr. Nikola Bešinović	|	nikola.besinovic@tu-dresden.de	| POT 108
M.Sc. Ashkan Fouladi	|	ashkan.fouladi@tu-dresden.de	| POT 111