TECHNISCHE UNIVERSITÄT DRESDEN

PROFESSUR FÜR BETRIEB VON BAHNSYSTEMEN

"Friedrich List" Faculty of Transport and Traffic Sciences
Chair of Railway Operations

Thesis project: Automatic selection of problem reduction algorithms for train rescheduling

Description

Real-time train rescheduling requires frequent and fast adjustments of train timetables impacted by unforeseen disruptions or disturbances. Solving such problems is computationally challenging, especially in large and complex station and/or network areas with dense traffic.

Recent research proposes a data-driven problem reduction framework for train rescheduling that leverages supervised Machine Learning (ML) to predict a subset of the solution space. These so-called *Scopers* learn from pre-solved problem instances and act as pre-processors, aiming to significantly reduce problem complexity before running an optimization solver.

Initial experiments suggest that the performance of different Scopers—such as Logistic Regression (LR), Random Forest (RF), or Deep Neural Networks (DNN)—varies across individual instances. For example, while a DNN-based Scoper may outperform an RF-based Scoper on one instance (e.g., depending on the type or location of a disruption), the opposite may occur on another.

This thesis project proposes the development of an automatic *Scoper Selector* that learns to select which Scoper is best suited for a given problem instance. By selecting the most promising algorithm dynamically, the project aims to combine the strengths of multiple pre-trained Scopers and thereby to further improve the computational efficiency of train rescheduling.

Assignment

- Review existing literature on problem reduction, ML-integrated optimization approaches, and/or algorithm selection techniques
- Generate a suitable database for model training and validation
- Train suitable classifiers for Scoper selection
- Identify key features that promote individual Scoper performance
- Evaluate predictive performance and discuss implications for the extension of the existing data-driven problem reduction framework
- Write a report/thesis.

Background

This thesis project offers the opportunity to gain experience in data science and optimization, while addressing practically relevant challenges in railway traffic management. A solid background in transportation science, Machine Learning, or Operations Research is recommended. Programming skills (e.g., Python/R) and familiarity with algorithm selection techniques are advantageous but can also be developed during the project. The student may use and build upon available resources at the Chair (i.e. models and algorithms). This topic is suitable for a diploma thesis, MSc thesis, or student research project (Studienarbeit).

References

Nygren, E., Eichenberger, C., & Frejinger, E. (2023). Scope Restriction for Scalable Real-Time Railway Rescheduling: An Exploratory Study. arXiv preprint arXiv:2305.03574.

Rashedi, N., Sankey, N., Vaze, V., & Wei, K. (2025). A machine learning approach for solution space reduction in aircraft disruption recovery. European Journal of Operational Research, 323(1), 297-308.

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