TECHNISCHE UNIVERSITÄT DRESDEN

PROFESSUR FÜR BETRIEB VON BAHNSYSTEMEN

Fakultät Verkehrswissenschaften
Chair of Railway Operations | Chair of Big Data Analytics in Transportation

Thesis project: Rail Rescheduling Using End-to-End Learning

Description

Rail rescheduling is essential for maintaining efficient operations, particularly when disruptions occur due to delays or unforeseen events. Traditional rescheduling approaches often require manual adjustments, which can be slow and inefficient. This thesis proposes to investigate the use of machine learning (ML) techniques, specifically neural networks (NNs), to automate and optimize rail rescheduling. The focus will be on applying end-to-end learning, where a neural network is trained to directly map raw input data (such as train schedules, delays, and infrastructure constraints) to optimized rescheduled outputs without the need for manual intervention at intermediate steps. End-to-end learning allows the model to learn from historical data (or optimization models) and improve its rescheduling decisions autonomously, enhancing both efficiency and adaptability.

End-to-end learning refers to a machine learning approach where a model learns to map raw input data directly to the desired output through a single, unified process, without requiring intermediate features to be engineered by humans. In the context of rail rescheduling, this would mean inputting raw train schedule and delay data into a neural network, which would then output optimized rescheduled timetables. This contrasts with traditional methods that often rely on manually defined features and heuristics.

Assignment

- Analyze current approaches for machine learning approaches for rail rescheduling
- Collect and process relevant traffic data
- Propose KPIs, including the speed of rescheduling and system-wide impacts
- Design and implement a neural network model capable of performing end-to-end rail rescheduling
- Test your new approach on real-world instances and determine its advantages for railway operators
- Write a report/thesis

Background

The student should have a strong background in transportation science, preferably rail operations and scheduling. A solid understanding of neural networks, deep learning techniques, and/or optimization problems is welcome. Familiarity with or willingness to learn programming languages such as Python, as well as ML frameworks like TensorFlow,PyTorch or similar, is recommended to implement and test the proposed models. The research topic can be suitable as MSc thesis project or a diploma.

References

Bengio, Y., Lodi, A., & Prouvost, A. (2021). Machine learning for combinatorial optimization: a methodological tour d'horizon. European Journal of Operational Research, 290(2), 405-421.

Kotary, J., Fioretto, F., Van Hentenryck, P., & Wilder, B. (2021). End-to-end constrained optimization learning: A survey. arXiv preprint arXiv:2103.16378.

Tang, R., De Donato, L., Besinović, N., Flammini, F., Goverde, R. M., Lin, Z., Liu, R., Tang, T., Vittorini, V. & Wang, Z. (2022). A literature review of Artificial Intelligence applications in railway systems. Transportation Research Part C: Emerging Technologies, 140, 103679.

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