TECHNISCHE UNIVERSITÄT DRESDEN

Fakultät Verkehrswissenschaften „Friedrich List“
Institute of Railway Systems and Public Transport, Chair of Railway Operations

Optimizing Urban Rail Transit Efficiency. A Comprehensive Timetabling Approach with Cross-line Services

Problem description

Urbanization and population growth have spurred the expansion of rail transit systems to meet the increasing demand for efficient and sustainable transportation. Currently, the urban rail transit system's organizational structure predominantly follows a single-line independent operation mode. This necessitates passengers to undertake multiple transfers between different lines to reach their destination, inevitably elongating their travel time. Additionally, the consequence could be even high train operation cost. In contrast, the cross-line operations, defining operations that cross over multiple lines, offers a more direct and efficient approach to meeting passenger demands. The aim of this research is to develop an optimized train timetabling approach for cross-line operations in urban rail transit systems. By strategically planning and implementing cross lines, we seek to minimize travel time for passengers, reduce operational costs, and enhance the overall efficiency of the urban rail transit network. Through a comprehensive analysis of factors such as demand patterns, network topology, and operational constraints, our goal is to propose a robust and adaptable timetabling framework that can be applied across diverse urban environments.

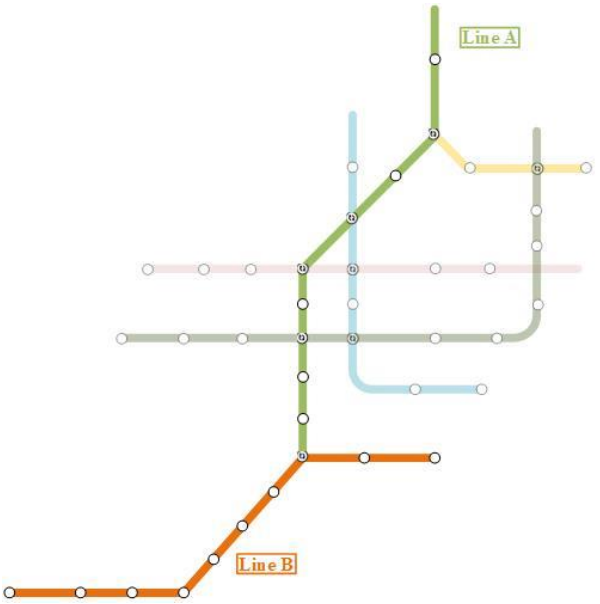

Figure 1: Cross-line operation of urban rail transit. In the network, lines A and B are operated with single-line services, and additional cross-line services could operate over both existing lines A and B (partly or fully).

Assignment

- Literature review: Collect and analyse exiting literature on timetabling for metro networks, and railway service network design
- Mathematical Model Construction: Construct a model that considers both train timetabling and rolling stock circulation within the framework of through operation. The model should emphasize efficiency, minimizing travel time, and reducing operational costs.
- Comparison of Timetabling Strategies: Compare the effectiveness of periodic and non-periodic timetables in urban rail transit. Analyze how each approach impacts passenger travel time, system reliability, and operational efficiency.
- Numerical Experiments: Set up and conduct numerical experiments to validate the efficacy of the proposed model. Use real-world data or realistic scenarios to simulate the urban rail transit environment. Adjust parameters as necessary and analyze the outcomes.
- Write a report

Background

The student will develop and implement a mathematical model using Python (or similar language) with the Gurobi/CPLEX (or similar) optimization solver. Proficiency in programming and prior experience with optimization modelling are an advantage. The topic can be used for a research project (Studienarbeit), a diploma thesis, or an MSc thesis.

References

Wang Y., Liao Z., Tang. T, et al. (2017). Train scheduling and circulation planning in urban rail transit lines. *Control Engineering Practice*, 61: 112-23.
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Cadarso L., Marín Á. (2012). Integration of timetable planning and rolling stock in rapid transit networks. *Annals of operations research*, 199: 113-35.

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