

### MIP-Based Optimization of Transfer Stations in Multi-Modal Transport Networks (topic introduction) *Kaarle Mäkelä* 24.04.2024

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Työn saa tallentaa ja julkistaa Aalto-yliopiston avoimilla verkkosivuilla. Muilta osin kaikki oikeudet pidätetään.





# **Public Transportion Network**

- Public transportation networks (PTNs) are graphs where the nodes represent traffic junctions, and the edges represent routes between the junctions.
- Often PTNs are weighted graphs, where the weights may represent many things (operation costs, travel time, etc.)
- PTNs are accompanied by OD-matrices, which contain information about the number of passengers traveling from one node to another.





## **Multi-Modal Transport Networks**

- PTNs that contain multiple modes of transportation (walking, bicycle, bus, tram, etc.)
- Possible to transfer between modes of transportation







## **The Problem**

- Given a multi-modal PTN and a maximum number of transfer stations B, What is the optimal set of transfer stations that minimize the travel time of all passengers?
  - $\circ$  If B=1, do we select node 5 or node 6 as the transfer station?







# **Objectives**

- Formulate the problem as a (mixed)-integer programming problem.
  - How are the constraints modeled?
  - How is passenger routing modeled?
  - Decision variables?
- Implement the model and compute Pareto front.







### Scope

- Each edge has a set travel time for each modality.
- The OD-matrices of the modalities are well-known.
- Transfers can only occur within shared stops.
- Timetables will not be considered.
- Line plans will not be considered.





## Implementation

- Model will be implemented in Python.
- LinTim software toolbox for public transportation planning and optimization. Contains algorithms for the various steps of public transportation planning.
- The implementation will be done inside the LinTimenvironment.





### Schedule

- Start working on MIP-formulation 3/2025
- Topic introduction 4/2025
- Working on implementation and writing 4-5/2025
- Thesis ready 6/2025





#### **Materials**

- LinTim documentation: https://lintim.net/
- Heinrich, I., Herrala, O., Schiewe, P. and Terho, T., 2023. Using Light Spanning Graphs for Passenger Assignment in Public Transport. In: C. Ahnert, H. N. Psaraftis and P. Sanders, eds. 2023. ATMOS 2023: 23rd Symposium on Algorithmic Approaches for Transportation Modelling, Optimization, and Systems. Dagstuhl, Germany: Schloss Dagstuhl–Leibniz-Zentrum für Informatik, pp.1–17. Available at: https://drops.dagstuhl.de/opus/volltexte/2023/19036/ [Accessed 17 Apr. 2025].



