Institute of Automotive Technology
TUM School of Engineering and Design
Technical University of Munich

#SMARTMOBILITY

Bachelor-/Semester-/Master-Thesis/IDP

TransitNet2Tensor: A Practical Pipeline for Turning GTFS Bus Networks Into Grid-Based Tensors and Reconstructing Them

Public transport data is usually published as GTFS feeds containing stops, routes, and trip shapes. Modern spatial ML and GeoAI models, however, typically work with fixed-size raster grids rather than irregular graphs. This thesis develops an end-to-end pipeline that takes a real bus network and:

1. Converts it into a simple, compact 4-layer grid representation (stop density, line intensity, direction encoded as sin/cos), and 2. Reconstructs a meaningful network back from that grid using classical algorithms or ML models, like encoder-decoder Networks.

The core idea is to build something concrete and usable: a tool that can rasterize a full city's bus network into images, and then recover stops, corridors, and connections from those images with measurable fidelity. Students will work with real GTFS data from multiple cities and build a clean, reproducible pipeline that can serve as a baseline for future GeoAI research.

Work Packages

- Study how GTFS data describes bus networks and how raster grids are typically used in spatial ML.
- Define a clear 4-layer tensor format (gridsize, spatial extent, flow definition, normalization).
- Implement a deterministic rasterization pipeline (stops, line geometry, and directional encoding).
- Implement at least one reconstruction pipeline: thresholding + skeletonization + junction detection + stop snapping + corridor extraction.
- Optionally implement a second reconstruction method (e.g. streamline tracing or a light UNet that predicts node/edge likelihoods).
- Evaluate reconstruction accuracy (stop recovery, corridor similarity, connectivity, robustness) across cities and resolutions.
- Deliver a reusable codebase and documented examples for future students and researchers.

Prerequisites

- Programming experience in Python
- Ability to work independently and structure your work clearly

Variations of the topic and additional research questions proposed on your own initiative are always welcome. If you are interested, please send an email including your CV, transcript, and a short explanation of why you are particularly well-suited for this topic.

The write-up should document the individual work steps in a clear and structured manner. The candidate commits to completing the project independently and to properly citing all scientific resources and tools used. The submitted work will remain with the department/chair as part of the examination records.

Prof. Dr.-Ing. M. Lienkamp

Supervisor: Till Zacher, M.Sc.

Issued: _____

Due: _____