Technische Universität München
Chair of Transportation Systems Engineering

Master Thesis Topic

Advanced Calibration Methods for Agent-Based Transport Simulation (MATSim) with Application to the Munich MATSim Model

Background

Agent-based transport simulation platforms such as **MATSim** are increasingly used for high-resolution modeling of travel behavior and network dynamics. However, the credibility and policy relevance of such models depend crucially on robust calibration techniques. Traditional calibration methods, often manual or entropy-based, are time-consuming and prone to subjectivity. Emerging studies emphasize the need for more efficient, data-driven, and automated calibration routines, especially in large-scale and multimodal contexts.

Recent literature highlights diverse **calibration strategies**: from Cadyts-based Bayesian optimization that adjusts plan utilities using observed link counts (Zhuge et al., 2021), to surrogate modeling approaches that replace computationally intensive simulations with machine-learning approximators (El Megzari et al., 2025). In scenarios such as Open Berlin, Rakow et al. (2025) show how automatic ASC calibration using log-difference adjustments can dramatically improve mode-share convergence, replacing legacy manual efforts.

For MATSim applications in cities like Munich, rich sources of **calibration data**, such as BASt traffic counts, MiD survey data, can support the design of calibration routines. Leveraging these resources, this thesis aims to develop and evaluate a suite of calibration workflows for MATSim.

Methodology

The prospective student will pursue the following key steps:

1. **Literature Review**
   Conduct a comprehensive review of calibration techniques in agent-based models, with special emphasis on: Traditional methods (entropy and optimization-based), Bayesian methods and surrogate modeling methods. Other potential methodologies should also be surveyed, e.g. cross-disciplinary insights where ABM calibration is relevant. Various strategies for faster calibration and simulation should also be studied.

2. **Development of Calibration Routines**
   - Survey potential calibration datasets and preprocess.
   - Implement alternative approaches to calibrate mode-related utility parameters
   - Define and test multiple calibration objectives: E.g. mode share, link volume, departure time distribution.
   - Improve efficiency of calibration and simulation procedures.

3. **Application and Evaluation**
   - Test calibration routines on a smaller dataset and evaluate speed, calibration error (e.g., MSE, MAPE), and computational efficiency.

- Evaluate results on larger dataset.

Results

1. A classification of calibration methods suited to large-scale MATSim applications
2. Implementation of novel calibration routines with different methodologies and corresponding benchmarked performance metrics
3. A calibrated and validated MATSim Munich Model, showing improved realism in mode choice and routing

Application Instructions

The ideal applicant should have prior experience in programming (preferably in Python and Java), optimization techniques, and agent-based transport modeling, particularly with MATSim. Interested candidates are invited to apply by sending a recent transcript and indicating their preferred starting date via email to Shahriar Iqbal Zame (shahriar.zame@tum.de) and Filippos Adamidis (filippos.adamidis@tum.de). Early expressions of interest are encouraged.

Preliminary work

1. Zhuge, C., Bithell, M., Shao, C. et al. An improvement in MATSim computing time for large-scale travel behaviour microsimulation. Transportation 48, 193–214 (2021). https://doi.org/10.1007/s11116-019-10048-0
2. El Megzari, I., Ciari, F., & Frayret, J.-M. (2025). Dynamic Calibration of a Carsharing System in Multiagent Transport Simulation. Transportation Research Record: Journal of the Transportation Research Board, 2679(1), 1832–1846. https://doi.org/10.1177/03611981241257513
3. Rakow, C., Kreuschner, M., & Nagel, K. (2025). Advancing the MATSim Open Berlin Scenario: Improvements in transport scenario generation and calibration methods. Transportation Research Procedia, 86, 732–739. https://doi.org/10.1016/j.trpro.2025.04.091
4. Patwary, A. U. Z., Huang, W., & Lo, H. K. (2021). Metamodel-based calibration of large-scale multimodal microscopic traffic simulation. Transportation Research Part C: Emerging Technologies, 124, 102859. https://doi.org/10.1016/j.trc.2020.102859