Chair of Traffic Engineering and Control
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Coordinate-based Lane-Specific Detector Map Matching in SUMO

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Motivation / Background

- The ‘MCube DatSim 2.0’ project aims at developing a **data-driven multimodal demand and network generation framework** for microscopic traffic simulations, using the city of Munich as a case study - the goal is the development of a ‘Digital Mobility Twin’ for ex-ante evaluations of the impact of mobility interventions on urban air quality
- **Generation of MIV-Demand** based on induction-loop data and SUMO dfrouter, which requires the correct placement of detectors on lanes in the whole network
- **Required Accuracy:** lane-specific map matching of detectors is currently not accurate enough to generate realistic demand

Previous Work & Own Contribution:

Common Practices:

- Division of map matching techniques: probabilistic, topological, and geometric [1]
- Mostly used for lane-specific map matching of detectors: perpendicular projection of static points to segments / curves
- Limitations & Risks: Accuracy of detector locations and density of the network heavily affect the accuracy of the matching process [2]

Existing Implementation in SUMO:

- mapDetectors.py [3]

Iteratively find the closest lanes (Incremental increase of radius with factor 10) → Match to the closest possible lane depending on the allowed vehicle class → Position detector aligned with the lane to minimize deviation from the true position

- Issues: Topology & Directionality Problems when coordinates and network differ significantly

Own Contribution:

- Implementation of a topology-aware matching process
- Improved positioning on lanes
- Implementation of logical checks
- Addition of a logging file to comprehend the process

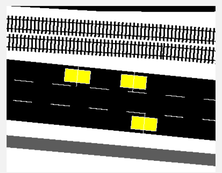
Code and Network published on GitHub

GitHub

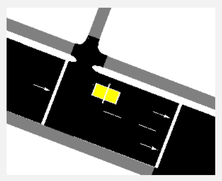
Edge-Cases

Real Detector Locations (QGIS) | Incorrectly Mapped Detectors (SUMO)

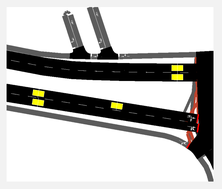
- The “closest lane” assignment is incorrect, which can lead to inconsistencies, e. g., the number of matched lanes not corresponding to the actual number of available lanes



- Detectors are shifted to one direction, leading to being matched to only one lane



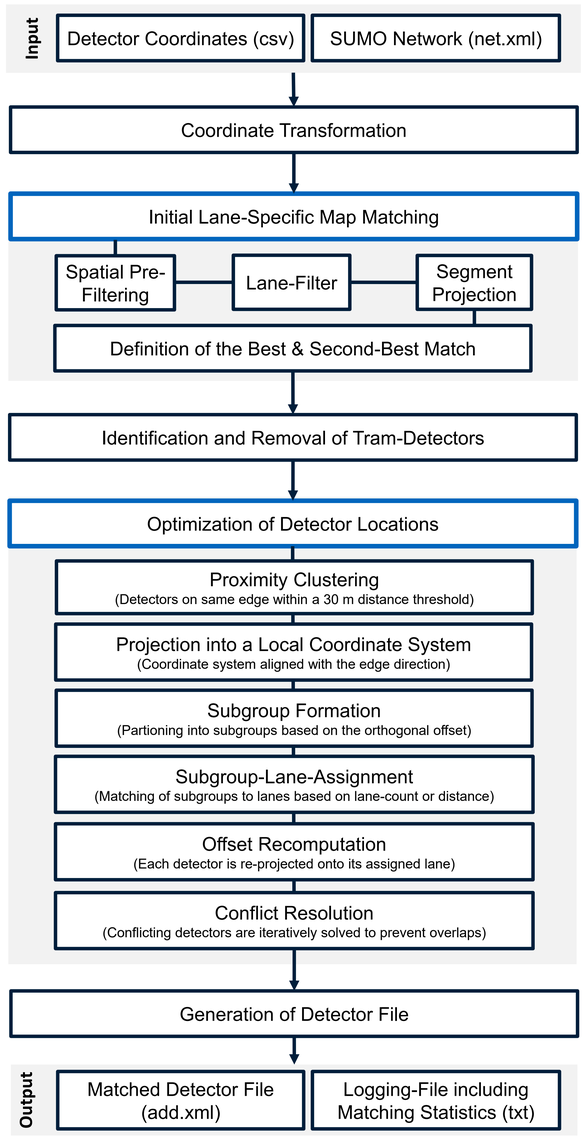
- By not knowing detector types, detectors may be assigned to lanes that are not permitted for the corresponding vehicle classes



Solutions:

- Orthogonal distance between detectors must be maintained
- Longitudinal distance between detectors must be maintained
- Detectors are not allowed to be in the same position on an identical lane
- Detectors are only allowed at specific lanes, e.g., car detectors are not allowed on *rail*-, *subway*-, *tram-lanes*, etc.

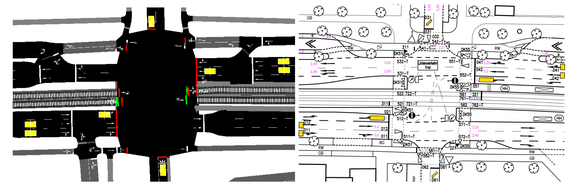
Methodology / Algorithm



Application and Validation

Intersection 1:

Intersection 2:



Limitations

- Detector-Data: shifted detectors / assignment to vehicle types
- Accuracy of the network (number of lanes, position of lanes)
- Optimization on the edge level with the assumption that the edge is matched correctly in the initial map matching

Future Work

- Implementation of directionality to prevent mismatching regarding directions
- Implementation of re-matching across multiple edges
- Addition of a filter based on detector types

References

[1] Quddus et al. 2007, Current map-matching algorithms for transport applications: State-of-the art and future research directions, Transportation Research Part C, doi:10.1016/j.trc.2007.05.002

[2] Brakatsoulas et al. 2005, On Map-Matching Vehicle Tracking Data, Proceedings of the 31st VLDB Conference, Trondheim, Norway

[3] Eclipse SUMO 2026, mapDetectors.py, GitHub, https://github.com/eclipse-sumo/sumo/blob/main/tools/detector/mapDetectors.py

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