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Simulation-Based Analysis of Traffic Closures

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Abstract
Traffic closures influence not only the affected road segment, but also the wider traffic conditions in the surrounding network. This work presents an end-to-end pipeline for building and using a macroscopic traffic model of Brno from open data. The workflow covers network preparation, zoning, supernetwork-based handling of external demand, demand construction, assignment, calibration, and an interactive scenario viewer for closure analysis. The result is a reproducible open-source system that supports map-based exploration of full closures and lane-reduction scenarios together with direct delta visualization in the user interface.

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1. Introduction

Traffic closures caused by road works, accidents, or planned events can significantly affect traffic in a city. Their impact is usually not limited to the closed road itself. A restriction on one segment may redirect vehicles to parallel corridors, overload nearby intersections, and worsen traffic conditions in more distant areas. For this reason, planners need tools that make it possible to simulate such situations before changes are introduced in practice.

This work focuses on simulation-based analysis of traffic closures in Brno. The goal is to create a complete open-source workflow that starts with raw input data and ends with an interactive application for scenario testing. The solution is built on top of the AequilibraE framework [1] and uses open datasets such as OpenStreetMap [2] and Czech census-based transport data [3]. The overall approach follows the principles of macroscopic transport modeling [4, 5], but emphasizes a practical implementation based entirely on open tools and open data. Although the workflow is demonstrated on Brno, its structure is transferable to other cities with comparable input data.

2. Pipeline

Pipeline consists of connected steps that transform source data into a simulation-ready project and, in the final stage, into an interactive scenario tool. In the first phase, the road network is built from OpenStreetMap [2] and normalized into an AequilibraE project [1]. This step includes graph import, filtering, and attribute preparation for later assignment.

The second phase extends the urban model with zoning and a supernetwork representation. Traffic analysis zones are created for the study area, external gateway zones are added, and centroid connectors are built to connect zones to the assignment network. A larger-scale supernetwork is then used to model interactions between the city and the surrounding national road system.

The third phase prepares travel demand and produces origin-destination matrices. The fourth phase performs traffic assignment, calibration, and validation against reference traffic counts. The final phase serves the results through an application that supports both baseline exploration and What-If closure scenarios.

3. Network

The network layer represents the road structure used for traffic assignment. It is derived from raw OpenStreetMap road data [2] and then filtered into a clean assignment network for Brno and its surrounding area. This transformation reduces the original map graph to the subset of links that are relevant for road traffic simulation while preserving the connectivity required for realistic route choice.

The poster contrasts the raw OSM graph with the filtered assignment network. The raw graph contains all mapped road detail and is therefore not suitable for direct use in assignment. The filtered version removes irrelevant or unusable elements and produces a more compact structure that is appropriate for macroscopic simulation. This prepared network then serves as the basis for demand loading, calibration, and scenario testing. The assignment itself follows the common principles of macroscopic road network modeling [4, 5].

4. Zoning

A traffic model requires not only the road network itself, but also a spatial division into zones from which trips originate and where they end. For this reason, the study area is partitioned into internal traffic analysis zones and complemented by external gateway zones. Internal zones represent areas within Brno and its surroundings, while gateway zones represent traffic entering or leaving the study area.

The zoning layer shown on the poster combines these internal and gateway zones together with centroid connectors. The connectors provide the interface between zone centroids and the physical road network, which allows origin-destination demand matrices to be loaded onto the network during assignment. This step links abstract travel demand with concrete network paths.

5. Supernetwork

A city-scale assignment network alone is not sufficient when a substantial part of traffic comes from outside the modeled urban area. To address this, the workflow introduces a supernetwork built on a larger Czech road graph derived from OpenStreetMap [2]. This broader graph is used to classify external flows and relate them to gateway zones around Brno.

The poster shows both the national-scale supernetwork and a detailed study window around Brno. This structure makes it possible to represent through-traffic and other external movements more realistically than if the model were limited only to the city network. As a result, closure scenarios inside Brno can reflect not only local redistribution, but also changes in how external traffic passes through the region.

6. Demand, Assignment, and Fit

Once the network and zoning are prepared, travel demand is built and assigned to the network. The demand stage produces origin-destination matrices that capture movement between internal zones as well as interactions with external gateways. These matrices are based on available census-derived transport data, especially SLDB 2021 [3].

The assignment and fit stage combines simulation with calibration and validation. Traffic is assigned to the network, the resulting link volumes are compared with reference observations, and the model is iteratively refined. This ensures that the baseline state shown to the user is reasonably aligned with measured traffic conditions. The practical assignment workflow is implemented in AequilibraE [1] and follows standard transport modeling principles [4, 5].

7. User Interface

A key outcome of this work is the interactive user interface shown on the poster. It provides direct access to the modeled network through a map-based environment in which users can inspect the baseline state and define scenario interventions. The interface supports both full road closures and lane-reduction scenarios.

The baseline view visualizes traffic conditions by using color coding and line-width scaling. Scenario views display modified states together with delta maps that highlight where traffic increases or decreases relative to the baseline. By connecting simulation outputs with an accessible visual interface, the system turns a transport model into a practical decision-support tool.

8. Conclusion

This work presents a practical pipeline for simulation-based analysis of traffic closures in Brno. The workflow starts with open road and transport data, builds an assignment network with zoning and supernetwork support, generates demand, calibrates the model, and exposes the results through an interactive web interface.

The resulting system enables rapid What-If analysis of closures and lane restrictions and helps reveal their wider network effects through direct comparison with the baseline state. At the same time, the overall workflow is sufficiently general to be adapted to other cities that provide similar open transport and road network data.

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