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Traffic assignment for an integrated land use and transportation model in a large metropolitan area: case study of Munich

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EXTENDED ABSTRACT

This work presents the use of MATSim for the network traffic assignment within the framework of an integrated land-use and transportation modelling suite. Both private car and public transportation trips are considered. The implementation of MATSim in the greater metropolitan area of Munich is described, including data collection and model setup. In particular, the presentation explores scaling factors that balance MATSim runtimes with reasonable model results. Different sizes of random sub-samples of trips were simulated and compared with the total sample of trips in terms of travel times and vehicle counts, in order to determine the minimum number of trips that needs to be simulated and scaled to obtain reliable results.

The integration of land-use and transportation models links short term decision of individuals (trips) with their long term choices, such as dwelling and job allocation, car ownership, getting married or having a child. Accordingly, each type of decision interacts with the other defining a complex loop between transportation and land-use. There are very few examples of integrated land-use and transportation, but only a few of them are fully operational (Ziemke et al, 2016; Hurtubia et al, 2015). One of the most promising approaches is based on microscopic (multi-agent) simulation. It means that the behavior of every agent belonging to a synthetic population is simulated individually, both regarding transportation and land-use decisions. According to this, the short-term behavior of individuals (i.e. congestion on the way to work) may be easily linked with their long-term behavior (i.e. moving to a location closer to workplace), facilitating the integration. However, one of the challenges of multi-agent models is their complexity and long runtime, especially when carrying out the traffic assignment for a large metropolitan area.

To overcome this shortcoming, we are developing the microscopic integration of the land-use model SILO (Simple Integrated Land Use Orchestrator), the travel demand model MITO (Microscopic Travel Demand Model Orchestrator) and the traffic assignment model MATSim (Horni et al, 2016). The travel demand inputs to MATSim are generated by MITO and SILO. Firstly, the land use model SILO produces and updates the synthetic population for the area. Then, the travel demand model MITO generates and distributes all trips made by the synthetic persons and households. These trips are assigned to the network using MATSim, either for private transport and transit. The estimated individual travel times that outputs MATSim are later used as an input for further runs of SILO.

This modelling suite is implemented for the greater metropolitan area of Munich (Germany). The study area includes those municipalities where at least 25 % of commuters work in one of the five core cities in the area: Munich, Augsburg, Ingolstadt, Rosenheim and Landshut. As a result, the study area has a population of 4.3 million with 1.7 million workers that live in 444 municipalities.

With respect of private vehicles traffic, the road network was obtained from Open Street Maps. Given the large extension of the road network (0.5 million links) and the number of agents (1.7 million home-based trips to work, half of them by car), runtimes were over 8 hours to simulate one-day traffic. Therefore, we analyzed the impact of sub-sampling the population on link traffic counts, individual travel times and expected levels of service and delays. With this purpose, different scaling factors decreasing from 100 % to 1 % were simulated. As the number of trips is reduced by a scaling factor, the capacity of the transport network needs to be reduced proportionally. Moreover, two different levels of detail of the network were obtained: the finer includes all the links (0.5 million) and the coarser excludes residential roads (0.2 million). The results were compared systematically, to provide the minimum number of trips at the appropriate network level of detail that result in reliable estimations of travel time and congestion. This comparison was carried out by the values of the re-scaled link traffic counts, and by the travel times from every origin to every destination.

With respect of public transport, transit supply was modeled to assign transit trips, as well as to provide travel times by transit among the study are analysis zones. The entire transit system was modeled from a combination of Open Street Maps data (stop locations and lines), google Directions API data (travel time between stops for local trains, tramway and subways) and MATSim travel time data on the road network (travel times between bus stops). Transit frequencies, vehicles sizes and schedules were derived heuristically.

In addition to setting up the model for the great metropolitan area of Munich and comparing it with previous attempts (Kickhöfer, 2016), this presentation provides recommendations to determine the minimum scaling factor for private car trips required to obtain reliable estimations, the appropriate level of detail of the road network and a procedure to generate public transport supply based exclusively on open data, and in absence of publicly available standardized schedule data. Lastly, general guidelines for data exchange (either trips or travel times) between different models were defined. The potential interactions with the components of the integrated land-use and transportation modelling suite SILO-MITO-MATSim are analyzed as well.

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