Cutting it Down - From Nationwide Models to Local DRT-Studies

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In modern transport planning, it is of great importance to have a quick, reliable and – most of all – accurate way to simulate hypothetical scenarios with custom infrastructure or policy changes like speed reductions or new pricing schemes. MATSim models, constructed and used by Senozon and many other commercial and academic institutions, provide a very good solution for this problem. However, building a model from scratch each time for new customers with new areas they want to study requires great effort and time. This is why we opted for yearly releases of models that cover the entirety of a country. For this we use country-wide input data such as federal census data, workplace statistics, and activity patterns derived from the Senozon Mobility Pattern Recognition (MPR)[1].

For local transport studies, however, it is unfeasible to simulate the whole model for only a minor change in one particular region. We therefore cut out partial models that only cover the area of interest (study area) and parts of the surroundings (model area) which improves simulation times compared to the runtime of the entire country model. The biggest challenge in this approach is the fact that some agents will not stay in one region – they might start their day in the study area but might have travelled to the far end of the nation by the end of the day. These agents still are relevant for the accurate depiction of traffic flows and movement patterns within the study area, but in order to simulate them with full mode choice enabled, the infrastructure required for all plausible alternative routes needs to be retained for all allowed modes, i.e. typically car, public transit, bicycle and walk. The imposed overhead and thus increased computation time increases the costs associated with one single MATSim run and may also be a deal-breaker for some customers.

For some time, we used an approach in which we would dismiss the agents that move away the farthest to cut down on the necessary infrastructure that we need to deliver. While this has the upside of having all agents sensitive to infrastructure changes, the downside is that it still either requires extensive infrastructure outside the study area or cuts away a significant amount of the mobile population and therefore traffic (see figure 1). Furthermore, traffic outside the study area is missing. This influences the decisions of agents leaving the area.

We therefore developed a new method to cut out regional models with an “infrastructure-first” approach. We make sure that the infrastructure outside the desired model area is kept to a minimum by cutting as close to the model border as possible and adding virtual “border” facilities to every point at which an agent could enter or leave the model area by car, foot, public transit or any other transport mode the model supports. We then split agents leaving the model area into single trip agents (“STAs”), keeping only the trips that are at least partial inside the model area. In the case of incoming or outgoing trips, we relocate the trip start or end to the new border facility the agent passes by when crossing the border. The activity time of the border

[1] https://senozon.com/wp-content/uploads/Whitepaper_MPR_Senozon_DE-3.pdf

activity is set to the expected time at which the agent would cross the border in the full model. These agents serve as a kind of background traffic and should not perform mode choice during the simulation runs of the study. However, they can modify their routes. Agents with all trips inside the model area ("ATAs", all trip agents) are kept unaltered and remain full feasible for studies. Figure 2 also shows an example of a scenario cut out with this method. With this new approach we were able to cut down computation time significantly while retaining the full 100pct sample of the population of the area of interest.

Using this method requires the choice of a suitable model area buffer around the study area: Too big and the file sizes and runtimes become too large for customers to handle; too small and too many agents will be transformed into STAs which are insensitive to any policy that might trigger a mode or time choice. The specific shape of the model area is also relevant, making sure not to accidentally cut out a relevant bypass or similar heavily used infrastructure. Following these criteria , our local models usually feature a close fit to local transport surveys without or with only minimal additional calibration required. For instance, the Kombinom2[2] research project made use of several such local models, e.g. for the Hildesheim area in Germany, which showed differences for car and walk mode share compared to official local data of around 1% each and a mobility rate that also only was 1% off.

The fact that the model works with 100% of the population is especially relevant for scenarios using DRT. Scaled up models using 10% or even 25% of the population show a very different DRT usage and pooling rate due to the very individual and granular nature of ride pooling. That differs from other KPIs found in classical mobility models like congestion patterns or noise emissions which work reasonably well on upscaled models.

Apart from research projects, a submodel is currently used for studies by Berlin's largest transit authority BVG. The 100% submodel of the Berlin Metropolitan area includes all its approximately 5 million domestic agents and additional special-interest demand – mainly tourists derived from the regular zone-based transport model of BVG. To ensure the model is easy to set up even for the more inexperienced users and configuration errors are kept to a minimum, we developed a setup in which only the minimal required configuration parameters need to be adjusted. In the case of a DRT focused scenario, those parameters entail e.g. service area, fleet size, number of virtual stops, and pricing. The scenarios run in a reasonable time even for large fleet pools and allow for different configurations almost each day.

[2] https://bmdv.bund.de/SharedDocs/DE/Artikel/DG/mfund-projekte/kombinom-2.html

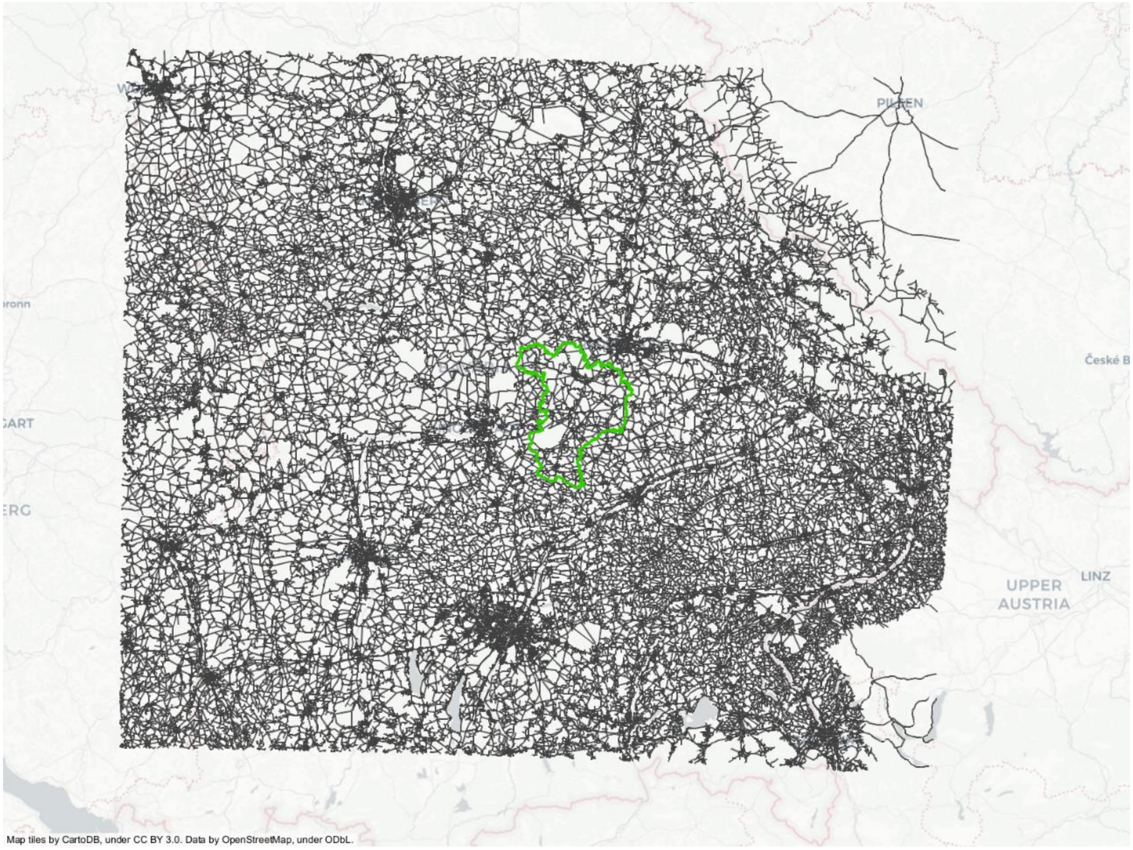

Figure 1: The car network required to cover 98% percent of the population interacting with the study area (green)

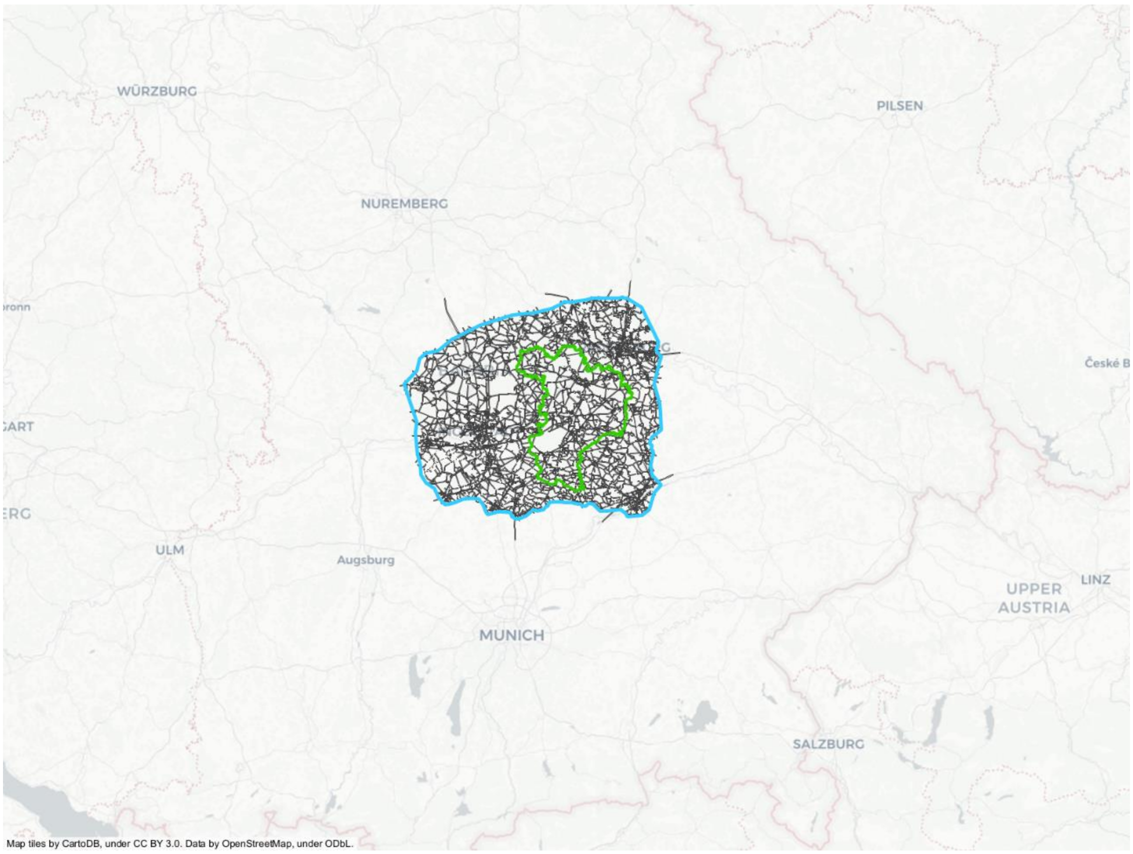

Figure 2: The car network required for a model with roughly 50% single trip agents, of which 97% never interact with the study area (green) but only perform activities near the custom model border (blue).