Developing an Agent-based Model for the Ruhr Region

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1. Introduction

The Regionalverband Ruhr (RVR) and the Technische Universität Berlin have collaborated over the past several years to develop and improve an agent-based transport simulation model for the metropole ruhr region. We will describe the scenario building process, the question of validation, and end with an outlook on further work we would like to collaborate on.

2. Methodology

The *transport demand* is derived from a national transport model from the Senozon AG Neumann and Balmer (2020). The demand generation for the commercial transport sector will be presented in detail in a separate talk by Ewert et al. (2025). For the *transport supply* the street network is derived from OSM OpenStreetMap (accessed 2021-07-09). Additional information on the bike infrastructure has been provided by the RVR. The public transport (pt) supply is derived from GTFS data. The pt costs are distance-based, depending on the zone an agent travels within. There are three distinct pricing schemes:

1. The VRR tariff level A is used within the association area.[1]
2. The eezyVRR fare is charged outside the association area up to the state borders of North Rhine-Westphalia.[2]
3. In the rest of Germany, the German tariff is used.[3]

Car cost are derived from Martins-Turner et al. (2024). The speed factor in urban areas is set to 0.75, similar to Rakow and Nagel (2024). The transport mode bike is simulated on the network utilizing the bicycle module, developed by Ziemke et al. (2018, 2017). Income-dependent scoring is activated, resulting in a discrepancy in the perception of monetary cost among agents Kickhöfer et al.

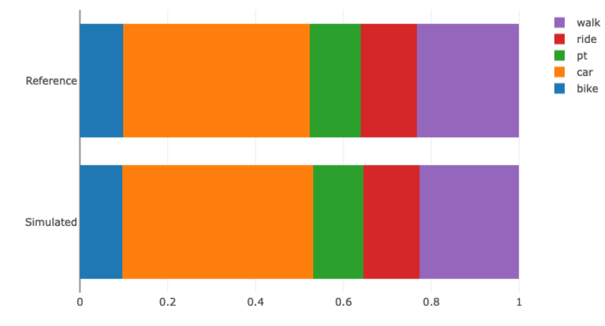

Figure 1: Modal Split

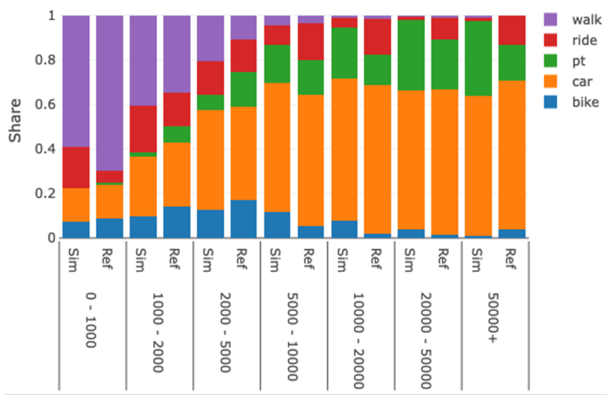

Figure 2: Modal Distance Distribution

(2011). Parking search times are accounted for by constant additional access and egress times. Parking costs are also included.

3. Preliminary Results

The model is calibrated to match the modal split and the modal distance distribution given in the "Mobilität in Deutschland" infas et al. (2019).

In order to evaluate the model, illustrative simulation runs are conducted. Initially, 21 pt lines are deleted from the transit schedule. The hypotheses are that a slight decrease in the share of pt in the modal split to the transport mode car and bike in the area of the missing lines

[1] `https://www.vrr.de/de/tickets-tarife/tarifgebiete-regionen-preisstufen/`

[2] `https://eezy.nrw`

[3] `https://deutschlandtarifverbund.de/tarifbedingungen/`

can be observed, and that a higher capacity utilization of the pt lines that run on the same route as the missing lines is expected. The simulation results, when viewed in the context of the entire scenario, indicate that while a 0.2 % decrease is observed, this is not significant. In order to examine small-scale effects in the vicinity of the missing lines, an analysis is conducted of the passenger numbers of line 169, which runs between Essen-Margarethenhöhe and Velbert-ZOB. It is notable that between Essen-Werden and Velbert-ZOB, the line runs parallel to the SB19 line, although the latter does not serve all stops. In the simulation run, the SB19 line is removed from the timetable. In accordance with predictions, routes from the base run are shifted to the alternatives, for example to the parallel line 169. The overall view of the line reveals an increase in daily passenger numbers from 10,824 to 12,111, which corresponds to an increase of 11.9 %. The increase in passenger numbers is 12.2 % in the direction of Velbert-ZOB and 11.5 % in the direction of Essen-Margarethenhöhe. A more pronounced illustration of the effects is evident in the cross-section of the city border between Essen and Velbert, as depicted in the passenger numbers. The increase at this particular point is 46.7 % (from 3036 to 4455 passengers).

As a second illustrative example we increase the cost for the transport mode car, by 50 % using the daily monetary constant. Shifts from the mode car to other modes of transport are expected. More precise, in the lower distance classes (up to 5,000m), shifts to cycling and walking and, to a lesser extent, to pt. In the medium distance classes (between 5,000 and 10,000m), pt and cycling should increase and in the higher distance classes (from 10,000m) mainly pt. In addition, travel times should increase, as it can be assumed that the time required per trip by other means of transport is higher. As expected, there is a shift from the car to other modes of transportation. The modal split for the car decreases by 2.93 %. The modal distance distribution shows that the share of the transport mode car is decreasing, particularly up to trips with a length of 10,000 meters. However, for longer trips, the decrease is small and, accordingly, pt cannot benefit from this, as was formulated in the expectations. In particular, the share of cycling and walking in the low and medium distance classes is increasing. Pedestrian traffic even shows an increase beyond the low-distance classes (up to 2000 meters), which is not necessarily in line with expectations.

4. Discussion and Conclusion

Apart from the obvious computational challenges associated with such a large scenario, there are notable areas that have the potential for further development:

1. Establish a consistent work flow to simulate policy cases. In particular, correctly modifying the pt schedule remains a challenge.
2. Update the population to define a future scenario to account for changes in land use and potential demographic changes.

To further test and validate the model, we plan to apply the recommendation provided by the FGSV Verlag GmbH.

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