# Applying Geovisualisation to Validate and Communicate Simulation Results of an Activity-based Travel Demand Model

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Short paper

## Abstract

Despite the immanently strong spatial relation of transport demand models – both with respect to the input data, as well as the simulation results – graphical, map-orientated visualisation with a focus on time-space-related phenomena is rarely applied for the purpose of validation, analysis, and communication of model data. At the same time, the visualisation of time-space related data is a prominent field of research in geography and geomatics, resulting in a wide range of examples for good representation. We present current work aiming at bridging this gap for the case of an activity-based travel demand model.

## 1 Motivation and Background

Transport models are important, well-established tools in traffic-related planning and decision-making processes. They allow for the analysis of the current traffic situation, the forecast of the future development of transport demand, or the scenario-based investigation of various potential development paths. As mathematical models, they have high requirements with respect to the scope and level of detail of the input data, simultaneously producing vast amounts of intermediate and final output data. The nature and extent of this data has become even more diverse, as aggregate, flow orientated modelling approaches, often referred to as macroscopic 4-step models, which have been dominating the operational use for a long time, are gradually superseded by microscopic demand and traffic flow models (MCNALLY & RINDT 2012). Microscopic or activity-based demand models stress the idea that transport is derived from individuals participating in activities, thus modelling and maintaining information of the daily activity pattern of each individual within the analysis region.

Not only validation, "the assessment of behavioural or representational accuracy" (BALCI 2010, 1), both with respect to input as well as output data, but also the analysis and communication of the results produced is no trivial task, being further complicated by the general complexity of these models. In this context, it seems surprising that graphical visualisation of the handled data is a rarely used means of visual support. Validation and communication of simulation results occurs primarily by means of statistical tables and simple graphs, or the provision of key indicators describing the development of transport demand (e.g. average number of trips or distance travelled) (e.g. BOWMAN et al. 2006, PENDYALA et al. 2005). While maps of the flow volumes resulting from traffic assignment is the most

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common visualisation, so-called spider transport network diagrams are more rarely used (SAMMER et al. 2010:83). Only recently, there has been increasing work on map-based and often animated visualisations of model results. While a considerable amount of these animations are primarily intended as eye-catchers, others are used as a method of stressing time-relevance for the subject observed, such as emission distribution (e.g. MILLER 2010), or utilisation of activity locations (e.g. EHLERT 2014). Nonetheless, exploitation of the advantage of having trip-chain-based individual travel patterns is rarely seen in visualisation, an example being the work presented by EHLERT (2014) on empowering a well-established macroscopic transport model to visualize individual trip chains in 2D.

At the same time, developing adequate forms of visualising time-space-orientated mobility data has been a field of research in geography and geomatics for quite some time (see e.g. LENNTORP 1976), and has still received significant attention in recent years (e.g. KRAAK 2003). Popular representations comprise a. o. chronomaps, activity density patterns, space-time aquariums, space-time-trajectories, as well as various forms of animations (e.g. SPIEKERMANN & WEGENER 1993, KWAN 2000, KLEIN 2013). Nevertheless, most of the representations proposed are both especially suited and rarely used for the analysis of data that either serves as input for or stems from activity based microscopic demand models.

## 2 Integrating Visualisation in a Transport Model Tool Chain

This paper presents our current status of work aiming at bridging this gap between geovisualisation techniques for time-space data on the one hand, and their current application in transport model data presentation on the other. It reports on recent enhancements of automated visualisation tools developed for TAPAS (Travel-Activity-Pattern Simulation), an activity-based microscopic demand model developed at the DLR Institute of Transport Research (CYGANSKI & JUSTEN 2007). Within a TAPAS-simulation run, daily mobility patterns are calculated for each individual of the synthetic population in the study area. The sum of these daily activity plans results in the overall picture of the traffic demand in a study area (see figure 1). As a result of a simulation run, individual trajectories with specific locations and modes for each trip, information on departure, arrival, and activity duration time, trip purpose, and socio-demographic characteristics of the person and the associated household are all stored as input data for further usage in a PostgreSQL/PostGIS database.

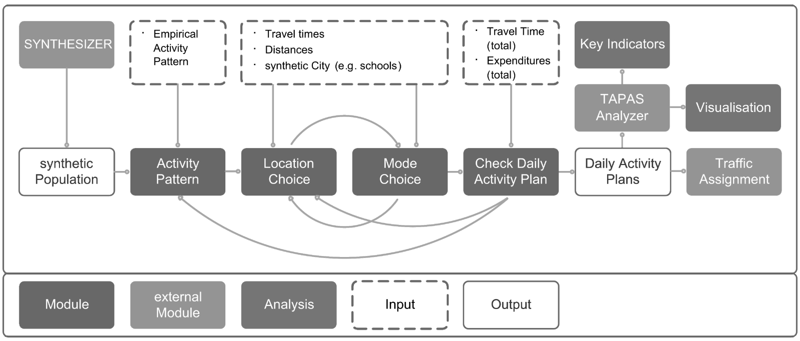


**Fig. 1:** Simulation flow of the transport demand model

The TAPAS-Analyser provided methods for standard output processing such as the generation of key indicators, simple graphics of descriptive statistics, as well as visual representation of traffic assignment results, for some time. However, specific extensions for the automated generation of the maps and animations were only recently developed. Here, three visualisations are presented, which were first implemented within a master's thesis (TESKE 2014) and are currently under further development:

- time-space-trajectories for one or more individuals in 3D (see figure 2 left),
- animated map, referred to as the "Pulse of the City" because of the flashing of locations when an activity starts (see figure 2 center)
- traffic flows between analysis zones (see figure 2 right).

Additionally, thematic background layers on various regional scales are generated.

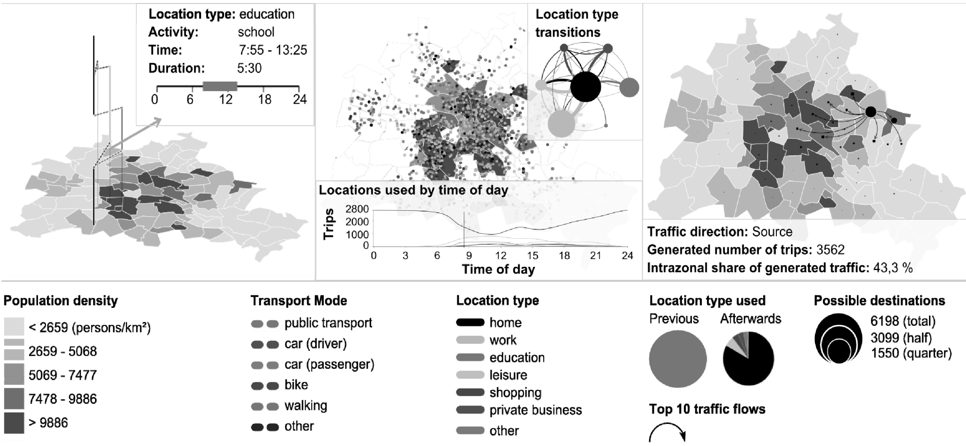


**Fig. 2:** (1) Joint visualisation of time-space-trajectories of two household members (left), (2) Animated map showing the "Pulse of the City", with corresponding diurnal curve and network diagram displaying transitions between location types (center), (3) Visualisation of location type specific traffic flows between analysis zones, accounting for activity-chain-based additional information, in this example restricted to trips starting at educational locations (right)

The different visualisations are generated as interactive scalable vector graphics (SVG), enabling support for panning, tilting, and zooming of the map, as well as the export of the generated SVGs for further usage. Special selection and filtering provisions allow both for general usage by interested laymen, as well provision of special details for model validation. Technical implementation is based primarily on JSON and the D3.js JavaScript library.

# 3 Conclusion and Outlook

This contribution reported on recent work aiming at seamlessly integrating a visualisation tool into an existing transport demand model tool chain. The presented implementation allows for automated map generation, either for all or specific extracts of simulation runs, significantly easing the communication of results both for scientific as well as educational purposes. Upcoming work will address computational issues with large samples and put a stronger focus on the validation of input and output data. The current status of work clearly indicates the potential that the well-established research field of visualisation techniques for time-space-related data in geography and geomatics offers transport modelers, seeking to enhance the communication of their model data. This is particularly true for microscopic demand models with their detailed individual and trip-chain-based information.

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