Mobility Transition Simulation

Simulating the mobility system for decision support

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In Short

- Empirically founded large-scale agent-based models help analyse and discuss societal challenges
- The Mobility Transition Model (MoTMo) simulates mobility demand in Germany at high resolution
- An extended and improved version shall be used in Decision Theatres; its analysis and calibration requires HPC.

***Figure 2:** The Decision Theatre. IT-supported discussion of societal challenges with scientists and stakeholders.*

Synthetic populations and agent-based models represent complex social systems for simulating, analysing, and discussing potential future evolutions in view of societal challenges such as climate change, financial crises or pandemics. Persons, households, firms, political or administrative organizations, etc. are the elements of such systems; they act and interact, often based on incomplete information, within a social network embedded in a common environment (geographical conditions, infrastructure, resources, etc. as well as norms, rules, and narratives). Agent-based models depict these elements on the computer, whereby the synthetic population ensures that the virtual agents match statistical distributions of the thus represented real-world population. Large-scale simulations of repeated interactions of the many agents then provide an overview over potential evolutions of the system.

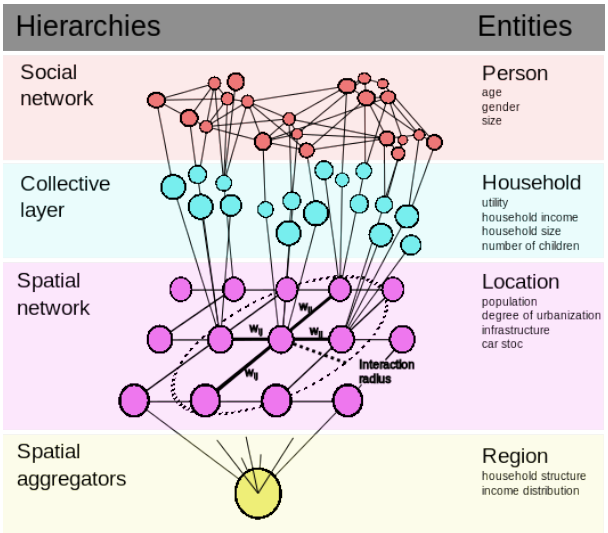

***Figure 1:** Basic structure of the Mobility Transition Model*

The Mobility Transition Model (MoTMo) is such an agent-based model. It has been developed by the Global Climate Forum to provide projections of a mobility transition in Germany, in particular, to investigate potential shifts to new technologies, such as electric vehicles (EVs), and new behaviours, such as car sharing. It is based on a high-resolution synthetic population of persons and households in Germany. These agents can choose between five mobility types (conventional "brown" car, electric "green" car, public transport, car sharing, and non-motorised mobility) and do so based on general factors (e.g., the price of a technology), local conditions (e.g., the availability of charging stations for electric vehicles) as well as on experience and information they gather from others. Thus, the model helps analyse private mobility demand taking into account both behaviour and technical change.

In view of a sustainable mobility transition, MoTMo helps explore different options or assumptions – from subsidies and other policy measures, via several investment strategies, to alternative expectations on exogenous developments like the evolution of battery prices for EVs or of the carbon intensity of the German electricity mix – and their consequences, such as emissions from mobility or the utility people gain from their mobility choices.

MoTMo-simulation results have been visualised in first “Decision Theatre” (DT) events to support discussions on sustainable mobility between scientists, stakeholders, and citizens. Participants can experiment with the model by creating scenarios to explore potential effects of, e.g., a CO2 price on fuel or accelerated charging infrastructure deployment for electric vehicles. Simulation results relating to these scenarios are interactively visualised on large screens surrounding the group.[1]

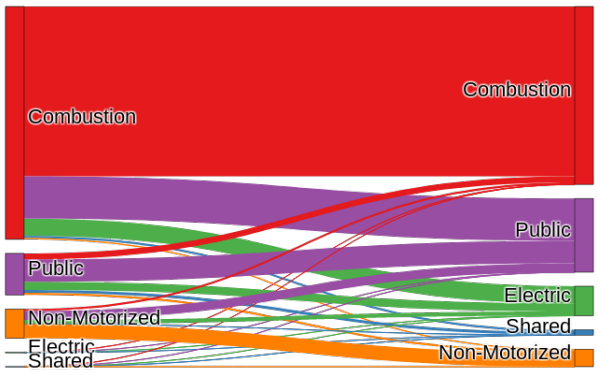

Figure 3: *Example: Switching of selected mobility types by agents over the period from 2017 to 2035, resulting from MoTMo for a specific set of policy measures and assumptions*

Due to the use of a spatially distributed synthetic population, participants can identify with agents in the model. The agent-based model structure is also rather easy to communicate: assumptions about agents and their actions have to be carefully explained, but knowledge on mathematical modelling is not required from participants. Since assumptions on people and their behaviour are not generally defined and agreed upon (as they are, e.g., for some physical systems) the discussions can also help modellers obtain feedback for improving model assumptions as well as addressing the most relevant questions. Thus, the Decision Theatre can also become a research tool for co-creation of knowledge on societal challenges in an iterative modelling and dialogue process between scientists and stakeholders [2].

Figure 4: *The Decision Theatre as a research tool for co-creation of knowledge on societal challenges*

Simulating the behaviour of up to 70 million agents is a computing and memory intensive task, even for a single simulation. For analysing the outcome of a model like MoTMo, however, it is necessary to run ensembles of up to 5.000 simulations. Without the support from High Performance Computing it would not be possible to develop a model at the high resolution that is able to capture early innovation effects and allows a detailed spatial as well as social zoom to scrutinize, e.g., cities, or specific household types and income groups.

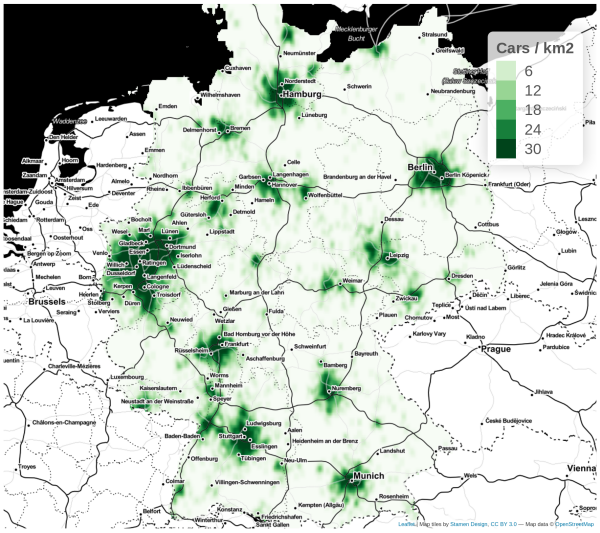

Figure 5: *Example: Estimated number of electric vehicles per km^2 in the year 2035, resulting for a specific scenario*

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https://globalclimateforum.org/portfolio-item/dtnamo/

More Information

[1] https://www.kopernikus-projekte.de/aktuelles?news=Decision_Theater_zur_nachhaltigen_Mobilitaet&utm_source=hootsuite

[2] Jahel Mielke and Andreas Geiges. Model-stakeholder interactions for a sustainable mobility transition (2018). Available at SSRN: https://ssrn.com/abstract=3245159

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