Using AGADE Traffic to Analyse Purpose-driven Travel Behaviour

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Abstract. AGADE Traffic is an agent-based traffic simulator that can be used to analyse purpose-driven travel behaviour of individuals that leads to the emergence of systemic patterns in mobility. The simulator uses semantic technology to model knowledge of individuals and thus is able to capture individual preferences and personal objectives as determining factors of travel decisions. This creates a deeper understanding of the individuals and allows for new analysis options. Using an example, we give an overview of analysis instruments implemented in our simulator that are particularly suitable to examine results of individual-based simulations.

Keywords: Traffic Simulation, Behaviour Analysis, Agent Systems.

1 Introduction

Current state of road traffic is a system in overload mode that requires a fundamental change in the concepts of everyday mobility. Frequent traffic jams and the perpetual lack of parking space are obvious consequences of this situation. Private companies and public institutions are already working intensely on solutions that exploit contemporary technological innovation [4]. Measures in complex public systems are threatened by rebound effects [1], e.g. car sharing services at first sight encourage people to abandon their private vehicles thus freeing up space in urban areas. However, if they apply to the wrong audiences effects may even end up worsening the traffic situation. It has been observed that car sharing services were accepted as an alternative to *public transport*, which in consequence has increased the number of people travelling in individual vehicles [5]. In order to prevent counterproductive effects from happening, traffic planners need more elaborate tools for working out new ideas on mobility. Computer-based simulations can be applied to predict and investigate effects of planned measures in complex traffic systems. More specifically, agent-based simulation models that focus on simulating individuals and their purpose-driven travel behaviour are particularly suitable for analysing causal changes that have led to the emergence of new systemic patterns.

2 Main purpose

AGADE Traffic is an agent-based traffic simulator that places modelling of individuals at the center of attention. The simulator focuses on individuals pursuing personal objectives which determines purpose of their trips. Travel purpose plays a crucial role in the perception of personal preferences and thus has an effect on individual travel behaviour. For example, *time/punctuality* has a different value when commuting to work as compared to a social visit. Hence, travel behaviour is specific to the context of travel which is why in AGADE Traffic agents are modelled to have knowledge not only about traffic but also about the simulated domain (see [7]). The application of semantic methods creates flexibility in modelling of agent knowledge which allows simulation and analysis of a wide range of scenarios that cover more than just transport related research questions. In [2], we have demonstrated effectiveness and efficiency of this approach. By adding more details to the modelling of individuals, simulation results can produce more insight about the individuals and their decision-making processes. AGADE Traffic implements a series of analysis instruments that can be used to examine this type of individual-based simulation models.

3 Demonstration

During our research activities we have dealt with environmental impact caused by urban mobility. Private shopping is a travel purpose that accounts for a significant share of urban mobility (see [6] Table 3.2) which is why we have chosen a scenario that simulates mobility of individuals during their grocery shopping. Our scenario is situated in the area around the German city of Wetzlar. Given that Wetzlar has circa 50.000 inhabitants and assuming that one person shops for one household and 20% of the household shop during the simulated time interval, simulation has been performed for a set of 2130 agents. During the simulation, agents are assigned a list of food items to be procured. Agents are then required to make decisions about *selection of supermarkets* as well as *mode of travel*. Modelled supermarkets not only differ in product supply, but also their stock may vary in price tendency, product quality and sustainability. Consequently, in some cases agents will not purchase all items on the grocery list at a selected grocery store, which requires them to visit subsequent target locations. Details of simulation data as well as source code of the simulation are available at GitHub.[3] Based on research activities around this scenario, we have implemented a series of analysis instruments that can also be used for other simulation scenarios.

Simulation results include *routing information* that describe where the agents have travelled. This is visualised with a heat map that colour-codes traffic load on road sections (see [3] Figure 1). Details on global system behaviour such as temporal distribution of traveller volume, visited target locations as well as selected modes of travel are visualised using appropriate charts. When comparing

[3] see https://github.com/kite-cloud/agade-traffic

results of two simulations with identical agent populations, AGADE Traffic allows side-by-side visualisation of simulation results. Using provided filter options it is possible to examine specific groups of agents that are particularly relevant for the analysis. This helps to identify systemic changes and to pinpoint areas that require more in-depth analysis (see Figure 1). For example, identifying a significant shift in modal choices when looking at the relevant pie charts leads to questions on the extent of how this shift affects environmental impact of road traffic on the global system. Explanation for this lies in the comparison of calculated performance indicators. Environmental impact is measured by the indicators *global travel distance* which is the sum of the overall distances travelled by the set of all agents, and *combustion distance* that only considers modes of travel that produce exhaust gases.

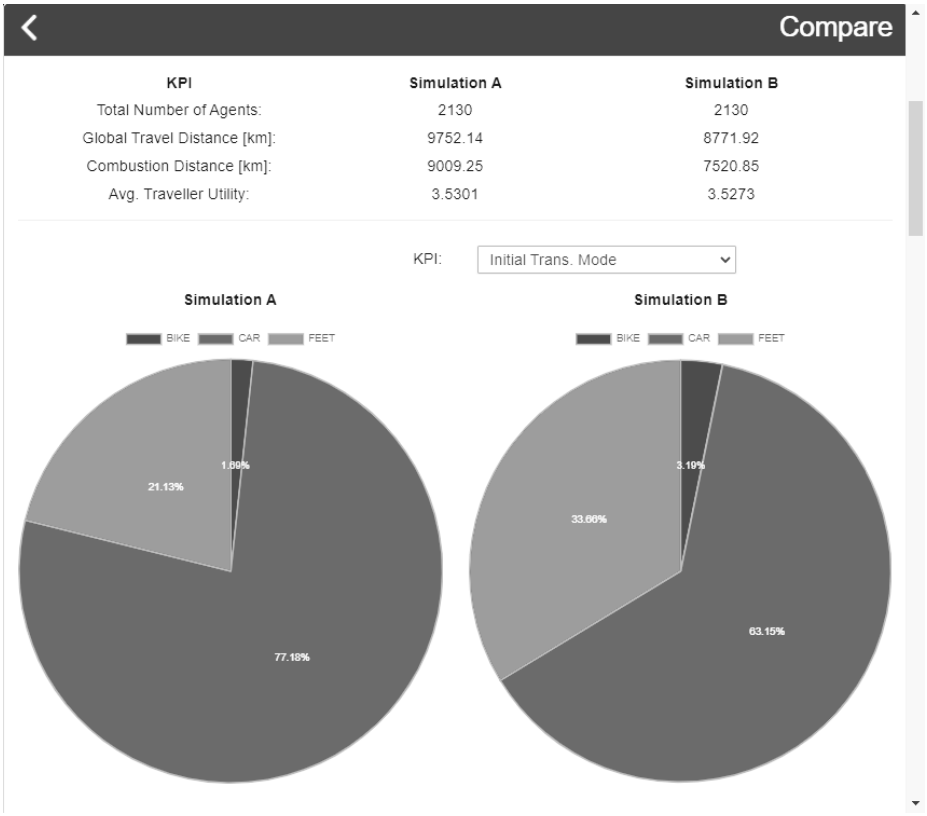

Fig. 1. Side-by-side visualisation of simulation results.

Meanwhile, another question arises as to what causal chains have led to this type of behavioural changes. This is where the strength of AGADE Traffic becomes apparent. The detailed modelling of individuals makes it possible to ex-

plain behavioural changes by evaluating their individual preferences. Currently, we are able to output and compare preference values, hence it is possible to identify trends regarding change of attitude that ultimately lead to change in decision-making. As our simulator makes use of semantic technology to compute preferences, we are also able to produce a detailed protocol of firing and non firing rules that can later be used to explain how preferences of an individual were determined. We are working on visualisation options that improve knowledge extraction from this protocol in order to enhance analysis capabilities of AGADE Traffic simulator.

4 Conclusion

AGADE Traffic is an agent-based traffic simulator that uses semantic technology to model individuals and their purpose-driven travel behaviour. The simulator implements a series of analysis instruments allowing for side-by-side comparison of simulation results. Information on global system behaviour is measured by performance indicators and visualised using appropriate charts. Going one step further, the AGADE Traffic approach aims at explaining behavioural changes of the system by evaluating individual traveller preferences, currently allowing to identify trends regarding change of attitude that ultimately lead to change in decision-making.

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