– Extended Abstract –

Activity scheduling in a miscroscopic integrated land-use transport modeling framework

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1 Introduction

It is well-known that land-use and transport are strongly interrelated. Land use determines where activities take place. The demand for transport is derived from people's wish to participate in activities that take place in different locations. At the same time, the performance of the transport system determines how well activities can be reached and, therefore, influences land-use development. This interrelationship between land use and transport has been widely recognized and is known as the *land-use transport interaction cycle*.[4] Starting with Hansen [2], a considerable amount of cross-disciplinary research has been undertaken to understand and analyze this relationship, which has established a long-standing tradition of *integrated land-use and transport (ILUT) models*.[4, 5]

To the authors' knowledge, however, all existing integrated land-use transport models have an aggregate perspective of analysis as they use aggregate travel time and cost matrices to transfer information from the transport side of the model to the land-use side. This aggregate perspective is associated with an array of shortcomings, especially as lifestyles and patterns of mobility and time use become more and more diversified. Different people will, for instance, take travel time into account in a different way. While for a worker with traditional nine-to-five office hours, morning and afternoon travel peaks are likely decisive in choosing a residential location, this parameter will be of less influence for somebody who works on flexible work hours and even more so for teleworkers.

The goal of this research is to take advantage of recent advances in microsimulation models and create a new fully microscopic integrated land-use transport modeling framework that is fit to address aforementioned research and policy analysis questions in a more behaviorally sound and individualized way than existing ILUT models.

2 Methodology

Over the last decades, microsimulation models have advanced significantly. As such, there are now operational microscopic models for land-use development, transport simulation, and activity choice and scheduling.

In this research, SILO (www.silo.zone) is used to model the land-use development of the Belgian region of Flanders. SILO consists of the three main modules of (1) *household relocation*, (2) *demography*, and (3) *real estate development*. It simulates the development of land use and demographics of the study region on a year-by-year basis.

The output of each SILO simulation year (i.e. the predicted demography given as an updated synthetic population and land use of that year) constitutes the basic inputs to derive a demand for transport of that point in time. Together with information on transport supply, e.g. transport networks, a transport simulation of that point in time can be performed in the agent-based transport simulation framework MATSim (www.matsim.org, [3]). In MATSim, each synthetic person (*agent*) has one or more *plans* that they carry out during the simulated day. In doing so, the agents compete for network resources. By being able to mutate their activity-travel plan(s) (e.g. by choosing different routes) in a given iteration, a realistic representation of real-world traffic of the study region emerges.

In a previous study [6], a basic integration of SILO and MATSim has already been successfully established. Results have been shown for the Washington-Baltimore metropolitan area in the USA. The approach was simplistic in that travel plans of each agent only contained the commutes from home to work and back. By this, it was shown that the approach is capable to model the morning travel peak realistically.

In order to to be able to take into account the full interrelationship between travel and land use, the present work extends the previous research by integrating the activity choice and scheduling model FEATHERS.[1] The synthetic population of a given simulation year with respective locations and demographics constitutes the foundation on which FEATHERS predicts activity-travel patterns for each member of the synthetic population based on Monte-Carlo simulation, where each agent takes successive decisions based on 26 decision trees. The study region of Flanders was chosen because a readily applicable FEATHERS model was already in place.[1]

3 Preliminary Results

A major hurdle in the process of integrating the three microscopic models was the fact that FEATHERS is written in C++, while SILO and MATSim are written in Java. This has been solved by wrapping FEATHERS into a WINE-based environment that can be called out of the MATSim Java code. As such, new activity-travel plans for each agent can be created when another component of the modeling frameworks requires this (e.g when an agent has relocated their home according to the land-use model).

Next to the integration of SILO and MATSim from previous work [6], is was shown that MATSim and FEATHERS communicate in a stable fashion and that decision taken by agents in either model can be forwarded to the other model and interpreted and processed in it. Ongoing work is related to the design of the specific dependencies between agent's choices in either model. Initial case studies for the region of Flanders which will serve to illustrate the usefulness of the integrated model are being prepared.

References

[1] T. Bellemans, B. Kochan, D. Janssens, G. Wets, T. Arentze, and H. Timmermans. Implementation framework and development trajectory of FEATHERS activity-based simulation platform. *Transportation Research Record*, 2175(1):111–119, 2010.

[2] W. Hansen. How accessibility shapes land use. *Journal of the American Planning Association*, 25(2):73–76, 1959.

[3] A. Horni, K. W. Axhausen, and K. Nagel, editors. *The Multi-Agent Transport Simulation MATSim*. Ubiquity Press, in preparation. See `http://matsim.org/the-book`.

[4] M. Wegener. Operational urban models: State of the art. *Journal of the American Planning Association*, 60(2):17–29, 1994.

[5] M. Wegener. Overview of land-use transport models. In K. Hensher, D.A.; Button, editor, *Transport Geography and Spatial Systems*, number 5 in Handbook in Transport, pages 127–146. Pergamon/Elsevier Science, 2004.

[6] D. Ziemke, K. Nagel, and R. Moeckel. Towards an agent-based, integrated land-use transport modeling system. *Procedia Computer Science*, 83:958–963, 2016.