Simulating the Influence of Social Contacts Spatial Distribution on Travel Behavior

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1 Introduction

In developped countries, a continuous increase of the share of trips which are performed for leisure purposes could be observed in the last dozens of years (Schlich et al., 2004; Axhausen, 2005). Stauffacher et al. (2005) — who analyzed the motives behind leisure activities using the results 12 weeks leisure travel diary survey — found social contact to be the most important. In addition, respondents travelled with social contacts for more than 70% of leisure activities.

Previous studies have been conducted with the idea that an important factor in leisure trip destination choice, or activity duration choice, is the ability to meet social contacts. Examples of empirical work include Carrasco and Habib (2009), Habib and Carrasco (2011) or Moore et al. (2013). All those studies show a significant influence of social contacts on the spatial and temporal distribution of activities. In addition, the influence of the social nature of human beings was shown to generate paradoxical effects. For instance, Harvey and Taylor (2000) show that persons working from home tend to travel *further* for leisure purpose, in order to fulfill their need for social contact, that they cannot fulfill at their workplace. A model ignoring such effects might thus substantially underestimate the traveled distances for such individuals.

Another field of empirical research studies the spatial characteristics of social networks. For instance, Carrasco et al. (2008) studied the relationship between individual's socioeconomic characteristics and the spatial distribution of their social contacts; Kowald (2013), used the technique of *snowball sampling*, where random individuals are asked to list social contacts, that are in turn contacted and asked the same set of questions, to collect data that was used by Arentze et al. (2012) to estimate a model capable of synthetizing social networks with realistic geographical and topological properties. This kind of model is essential if one wants to include social network interactions in microsimulation model.

This integration of social networks in multiagent simulation frameworks has already been attempted by other authors. Due to their disaggregated description of the world, such models are particularly well suited to the representation of complex social topologies. Han et al. (2011), Hackney (2009), Ronald et al. (2012), Ma et al. (2011, 2012) or Frei and Axhausen (2011) present agent based systems which do integrate social networks or joint decision mechanism, that are not yet integrated into any operational mobility simulation platform.

Those remarks point the need to represent social contacts in microsimulation, to actually represent the influence of social contacts, and of their geographical distribution, on travel behavior. This paper presents a model to represent *joint decisions*, that is a prerequisite for testing such effects. The variability of the results under different social network characteristics is then explored, for a scenario in the Zurich area.

2 Model and Simulation Framework

A simulation framework was developed for the simulation of joint decisions for mobility behavior forecasting.

Game theory, as a theoretical framework to represent competition, has been used in many forms in transportation research since the seminal work of Wardrop (1952). A way to extend this view is to consider an equilibrium at the *day level*: individuals try to get the most from their full day, given the behavior of others.

A solution concept for the "daily planning game", including the possibility of binding agreements, was developed, inspired by the classical house allocation game (Schummer and Vohra, 2007): the *Absence of Improving Coalition* concept. Given an allocation of daily plans to individuals, an improving coalition is a set of social contacts that could *all* be better off by *simultaneously* changing their daily plan. One can think of a group of friends switching from individual dinners at home to a joint dinner in a restaurant.

A co-evolutionary algorithm is implemented to search for a solution, by modifying the process of the MATSim software, that can be seen as an emulation of a learning process (Nagel and Marchal, 2006). Co-evolutionary algorithms are particularly well suited for this kind of problems (Ficici, 2004; Popovici et al., 2012).

3 Results

This section presents results for runs with two distinct social networks, for simulations in the Zurich Area.

Table 1 presents statistics of the synthetic social networks, compared with the statistics from the snowball sample from Kowald (2013). The social networks were generated using the model from Arentze et al. (2013), estimated on this same dataset.

Fig. 1 presents the traveled distribution per mode. The realism of the social network improves a lot the realism of the traveled distances for joint travel, in particular for the “driver” mode: drivers perform much less detours when social contacts are properly located. In addition, it

Table 1: Characteristics of the Synthetic Social Networks

			Homophily (%)		
Social Network	Clustering	Avg. Degree	Age	Gender	Distance (km)
Snowball	0.206	22	46.3	61.7	26.6
Long	0.190	22	30.7	56.5	49.1
Long (ZH)	0.187	20.6	29.4	55.7	17.8
Short	0.150	21.7	45.2	66.0	18.8
Short (ZH)	0.225	20.6	45.4	66.2	7.3

makes the traveled distances for bike and walk shorter, improving their fit of the observed data, by adding more joint trip opportunities for trips too short for public transport, but too long for walk or bike.

Figure 1: Travel Distance Distribution per Mode

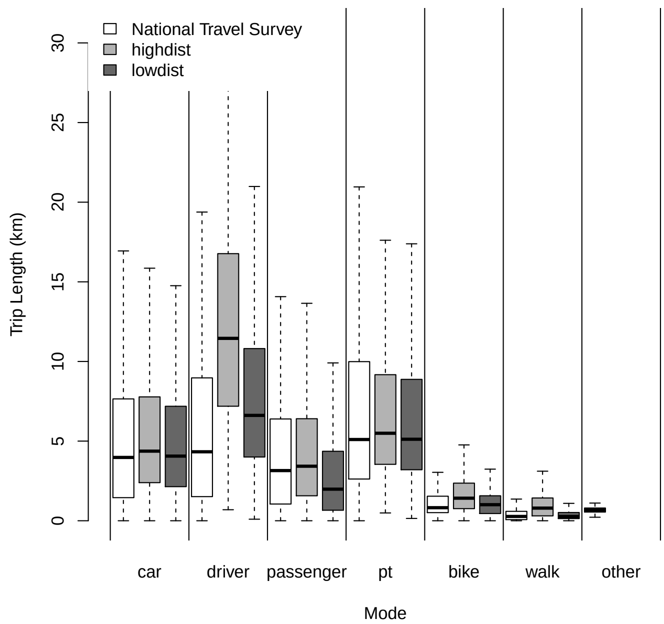
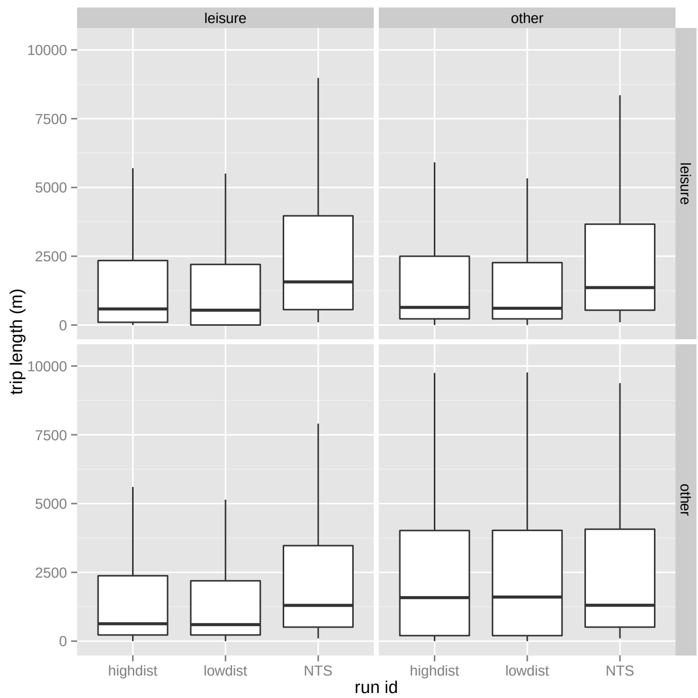


Fig. 2 shows the distance distribution per Origin/Destination activity type pair. The geography of the social network has here only a minimal influence on the travelled distance distribution.

Figure 2: Travel Distance Distribution per Purpose



4 Conclusion

The geography of social contacts is assumed to be an important factor influencing daily mobility, as previous studies showed that leisure activities are mainly performed for social purposes. However, current forecasting tools fail to represent this kind of phenomenon.

Representing the influence of the spatial distribution of social contacts on the characteristics of travel requires representing how individuals agree on a joint outcome.

This paper presented an algorithm to simulate this kind of decisions, based on an equilibrium formulation allowing coordination, that is solved through a *co-evolutionnary algorithm*.

Testing the algorithm with two social networks, with realistic and too long ego-alter home-home distances. There is an important effect of the realism of the social network on the realism of traveled distances as a car passenger. However, the willingness to perform joint activities does not seem to improve the travelled distances to leisure the way it was expected.

It is hypothesized that the remaining problems come from an inaccurate *population synthesis*, that includes also the allocation of activity chains to agents. Solving this problem is the most important of the next steps. A new survey, as well as the use of phone call data, is envisionned to develop a method to co-generate activity chains for social contacts.

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