Activities are generated due to “physiological, psychological and economical needs” (Wen and Koppelman, 2000), and can be categorised as subsistence (work-related), maintenance (keeping the household running), and leisure. Participation in, and scheduling of, social and leisure activities is not as easily predicted as more regular, formal activities such as work. Social and leisure activities are the reported purpose for a large number of trips, ranging from 25 to 40% for various countries (Axhausen, 2006) and therefore insights in the processes by which these are generated and scheduled are potentially important for travel demand management.

The consensus so far is that social activities are driven by the members of one’s social network, in particular “determining trip destination, frequency, mode and scheduling” of leisure and “personal” activities (Hackney and Axhausen, 2006). Buliung and Kanaroglou (2007) state that some researchers are already looking beyond households to the influence of social networks. This means that current methods of modelling decision processes in an individual manner will need to be revised to take into account that many decisions are made jointly. In some cases, joint activity decision making within households has been investigated, however existing models do not capture the actual mechanisms behind the decision making. Moreover, these models focus on interactions within households and have not considered personal social networks at large.

This paper demonstrates how agent interaction theory can be used to model collaborative decision processes for scheduling joint (social) activities. This research was undertaken as part of a larger project to develop an agent-based simulation model to investigate the effects of social processes on activity and travel behaviour. As well as the dynamics of the social network, we are interested in the activity/travel generation that emerges from that network, focussing on predicting the participants in, frequencies of, and locations of social activities.

Agent-based modelling is frequently used for applications where representations of the behaviour and intentions of, and interactions between, heterogeneous individuals are required. Both Bonabeau (2002) and Macal and North (2006) present lists of system attributes that are ideal for selecting agent-based modelling for that system, including amongst others: agents have dynamic relationships with other agents; relationships form and dissolve; agents have a spatial component
to their behaviours and interactions; and the topology of the interactions is heterogeneous and complex. Therefore, agent-based modelling appears to be appropriate for our model, due to the complex relationships and interactions between individuals and the individuals’ situatedness in an urban environment.

Interactions between agents are an important component of agent-based applications. The individuals in our model each have an agenda, and interact and negotiate with others to schedule social activities, in particular negotiating about the nature of the activity, participants, time, and location. The different interactions we describe permit a more decentralised and collaborative approach to joint activity scheduling, that is better aligned with both the principles of agent-based modelling and decision making in reality than determining schedules individually.

Agent interactions have several components: the negotiation set (the possible proposals), a protocol, strategies, and a rule to determine that the interaction is complete (Wooldridge, 2002).

For the negotiation set, we have developed a list of activity patterns, including the activity purpose and location, as well as an indication of which acquaintances are likely to be involved and when (e.g., interacting socially with work colleagues is likely to be during the week, whereas visiting family is mostly a weekend activity).

The protocols we use are based on those developed by Wainer et al. (2007) for agreeing on a meeting time. As these protocols are concerned with only one issue (time), elements from multi-issue negotiation need to be incorporated. Although it has been shown that proposing complete deals at each step is computationally more complex (as opposed to making decisions on each issue individually), it is Pareto optimal (Fatima et al., 2006).

Our model has two protocols for different activities. The first is used for activities that have a set time and place, and is known as the invite protocol. This protocol is used when the host of the activity simply requires a yes/no answer from the recipients. This could be used for, e.g., a birthday party invitation or an invite to attend a concert.

The second case (negotiation) is more complex, as the location, time, duration, people involved (“with whom”), and the type of activity itself need to be agreed on. In this case, the interaction consists of two phases. The protocol is identical for both phases, however the values of the items under consideration are different. In the first phase, the host contacts one or more people with a proposal for an activity. The recipients evaluate the suggestions and possibly make their own suggestions, until all are agreed on the location (home, restaurant, museum, etc.), day/time (weekday/weekend, morning, afternoon, evening), and duration (a few hours, half day, full day) or some
decide to drop out of the negotiation. In phase two, the agreements from the first phase are used to determine the precise location, day and time, as well as the individual’s travel requirements for the activity.

The agents’ decisions and strategies are determined by utility functions. A prototype of the interaction has been developed in Python, in order to experiment with parameters and choice sets.

This paper describes joint decision processes for scheduling social activities with many participants, within a larger model of travel behaviour. We also discuss how this model fits in with the agent-based modelling paradigm. Our use of interaction theory and processes is a novel way of realistically modelling social interactions involved in scheduling activities. We show that the protocols satisfy some basic properties, including termination, safety (e.g., all messages are handled, the protocol is unambiguous), and liveness, and are computationally efficient. These protocols could be incorporated into more-encompassing agent-based activity scheduling process models, where joint activities are modelled. Future work includes more empirical experimentation and implementation in full-scale activity-based models.

References


