Abstract

Accommodating Household Interactions in Daily Activity Scheduling Models: Cairo a Case Study

世帯構成員の相互作用を考慮した日常的な活動スケジュール形成モデルに関する研究：カイロを事例として.

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One of the important aspects of daily activity generation and scheduling that requires consistency concerns the coordination and synchronization of activity-travel patterns of individuals belonging to the same household. Several types of household interactions could be observed within the context of short-term activity-travel scheduling. Household members allocate tasks among one another, make trade-offs between solo and joint activity participation, and often facilitate activity participation for household with restricted mobility. Also, household members allocate and/or share limited resources (i.e. common household vehicle, computer) among one another.

There has been an increasing realization that such household interdependencies have to be accommodated explicitly within comprehensive activity-based models. Regardless of the importance of this type of consistency, modeling household-level decision-making is not a well-developed field,

especially in terms of modeling inter-personal task allocation, and inter-personal collaboration in joint activities.

Given this state of the art, this PhD thesis sets out to explore the possibilities of developing a comprehensive model that is able to represent household interaction mechanism in the process of daily activity scheduling.

The fundamental principal underlying the suggested approach is that observed household interactions in daily activity scheduling stems from a Negotiation Process in which household member's: share information, evaluate the information from their local prospective, and jointly come to a decision.

The following research questions were formulated to guide this research:

➢ How can household interactions in daily activity scheduling be conceptualized, taking into account variability in behavior and different decision styles?

➢ How can this conceptual framework be represented in terms of a mathematical model?

➢ Knowing that any model household interactions behavior would necessarily be complex, how can the parameters of the model be estimated?

➢ What is the best way of measuring the nature of household interactions of activity-travel patterns, taking into account the embedded attributes of activities?

This thesis reports the analyses that were conducted to provide an answer to these research questions and the results that were obtained.

The motivation of this study stems from current travel behavior and the associated intra-household interactions in Cairo, as a study area. Undertaking joint travel with household and/or non-household members constitutes approximately 41.3% of all trips (total 21 million. trips around 9 million. are joint trips). Further, the empirical results from the recent two-day activity-travel diary survey indicate that across all non-mandatory activity types, more than two-thirds of all episodes

are joint episodes, while less than one third is solo episodes (65% of all non-mandatory activity episodes in weekday are joint episodes, while joint non-mandatory activity episodes in weekend day constitute 75% of all episodes). This reflects a greater degree of inter-personal and intra-personal interactions patterns and task allocation particularly for Cairo people. Therefore, developing a daily activity and travel schedule model that explicitly accommodate household interactions for Cairo is necessary.

In order to achieve the main goal of the research, four major research steps are being set up. First, a comprehensive analyzes and modeling of the intra-personal and inter-personal interactions in daily activity and travel patterns of individuals in Cairo were carried out. This step has thought to provide more insights into household interactions in daily activity and travel of individuals in Cairo, Egypt. Further, the analysis take account of other factors known to affect the intra and inter-personal dependences associated with daily activity and travel patterns. Second this study proposes a negotiation mechanism of household interactions in daily activity planning. Defining the household negotiation problem in daily activity planning and scheduling, the protocol that the household could use in their negotiation, the strategies that they use while negotiating and the utility that individual use to evaluate offers and counter offers.

Third, the study presents a behavior agent architecture that is used to reproduce the daily activity scheduling behavior of individuals as well as the household. The model designed as a multi-agent simulation system with a negotiation kernel agent. The kernel agent is developed as an evolutionary system that is proved to be able to model the negotiation between two household heads in their activity planning process. This is demonstrated by computational simulations to analyze various situations of negotiation that are difficult to approach mathematically, and proved the feasibility and ability of the suggested evolutionary system. Furthermore, the proposed evolutionary system relaxed the perfect rationality assumption that has been under criticism by researchers. The

agents in these simulations are not assumed to be completely rational, but rather they learn by doing, and adjust their negotiation strategies based on feedback from interactions with each other. Evolutionary algorithms (EAs) are used in this thesis to govern the adaptive behavior of the agents in the computational experiments. EAs are increasingly being used to model societies of learning computational agents and humans, especially within the field of agent-based computational economics. As shown in this thesis, EAs can be used effectively for negotiation learning.

Finally, as a fourth step, a new internet based household weekly activity scheduling survey (IDASHA), has been developed to addresses the problem of collecting data on the underlying household activity scheduling process. IDASHA goes beyond previous methodologies by providing a means to observe the planning and scheduling process as it occurs in reality in the household over a multi-day period. The survey has spanned the period between March to April, 2009 In Cairo, Egypt. A total sample consisting of 45 households has been obtained. The IDASHA dataset is utilized to verify the model of household activity scheduling.

In the overall, this research was envisioned as a very important step in the development of an operational, activity-based, travel-demand forecasting system that comprehensively accommodates various intra-personal and inter-personal linkages in daily activity-travel choices.