Simulating Shop-Around Behavior

Toshiyuki Kaneda, Nagoya Institute of Technology, Japan
Takumi Yoshida, Bureau of Housing and Planning, Nagoya City Office, Japan

ABSTRACT

Shop-around spatial behaviors of downtown visitors are characterized as MultiPurpose-MultiStop (MPMS). However, the authors’ investigations have revealed visitors frequently switch planned actions and generate improvised actions. By using an agent-based approach, especially with a medium-size specimen, simulating such spatial behaviors opens a rich vein of research, not only into such practical aspects as downtown revitalization but also several theoretical aspects. Based on data analysis, the authors have newly devised Agent Simulation of Shop-Around (ASSA). ASSA is a kind of activity-based model and each agent makes and remakes their schedule to visit shops based on time constraints and shop preferences, chooses alternative venues to visit when they fail in an errand, and makes impulse stops at shops and detour actions when time allows. A series of such activities carried out on one day will affect the next downtown visit schedule and so on. This paper refers to existing researches and briefly explains the features of ASSA, especially focusing on decomposition of the shop-around behaviors and the system components. The latest pilot ASSA ver.3 attempts a dynamic simulation of naturalistic and intelligent shopper behaviors. The authors then discuss the verifications by illustrating simulated performances in an actual shopping mall.

Keywords: Agent-Based Modeling, Bounded Rationality, Dynamic Scheduling, Improvised Action, Learning and Adaptation, Planned Action, Shop-Around Behavior

INTRODUCTION

The shop-around behavior model is also known as the MultiPurpose-MultiStop (MPMS) model and since the 1980s it has been developed and studied in such fields as geography and urban planning, not only for its practical application, e.g., downtown revitalization and town center management, but also for its theoretical interest in the field of spatial analysis (Kelly, 1981). By the 1990s, the application of the logit model that combines data-fitting and approximate utility-maximization, helped establish the 'Markov-chain type’ models that make up transition probability OD-matrices. A typical microsimulation is Linked Logit and Poisson Model (LLPM), with a Poisson assumption on visitor arrival times. However, in the era of agent modeling, limitations pointed out concerning the Markov property, which ignores the personal history of downtown visitors, led to new approaches being explored.

The Logit model can be interpreted as used in an approximate estimation of the random utility, thus LLPM is considered to be a rational
model. In other hands, the agent model would be considered as a bounded rational model, so there are at least two types of bounded rational models. One type is a rule-based approach that employs heuristics, which can be interpreted as an expression of ‘procedural rationality,’ as referred to by H. A. Simon. Implementation technologies such as the production system in knowledge engineering and advanced researches had already been made into this approach.

The other type is the assumption-relaxation approach, which relaxes the assumption of perfect rationality with perfect information by adopting the concepts of satisficing or the constraint satisfaction principle. This approach is also based on the ‘satisficing principle’ of mathematical models proposed by Simon and followers (e.g., Rubinstein, 1998).

In agent modeling research the daily activity-travel model has taken the lead in such fields as transportation planning (Table 1). Albatross (Arentze et al., 2001) is formulated as a rule-based system that guarantees data-fitting by employing a data-mining tool to generate heuristic rules (binary tree). Aurora (Arentze, Pelizaro, & Timmermans, 2005) is formulated as a utility-based theoretical model that generates a schedule by combining each activity (errand) that has non-linear S-shape utility and employing genetic algorithms; in addition, in response to an unexpected event such as congestion, the model carries out re-scheduling.

However, when the shop-around behavior model is compared to the daily activity-travel model that has the same MPMS structure, its characteristics can be found in human like planned actions and the improvised actions that down town visitors display; therefore, as a theme for research, the shop-around behavior model faces a higher degree of difficulty. There are few existing studies except Kurose, Bogers, and Timmermans (2001).

Our survey results show visitors frequently switch planned actions and engage in improvised actions. Based on data analysis, we have newly devised Agent Simulation of Shop-Around (ASSA) (Kaneda & Yoshida, 2008; Yoshida & Kaneda, 2012; Yoshida, 2010).

ASSA is a kind of activity-based model and deals with agent spatial behaviors on shop-around trips in downtown areas. In ASSA, each agent makes and remakes their schedule to visit shops based on time constraints and shop preferences, chooses alternative venues to visit when they fail in an errand, and makes impulse stops at shops and detour actions when time allows. A chain of such activities on one day affects their plan for the next visit and so on. In this context, our agent is “naturalistic and wise”; in short, their behavior is boundedly rational in the short term, but, by devising and implementing planning (dynamic scheduling/re-scheduling), and learning and adaptation functions, it is intellectual in the long term. In this paper, firstly we refer to existing researches and briefly explain the features of ASSA, especially focusing on decomposition of the shop-around behaviors and the system components. The current pilot version ASSA ver.3 attempts a dynamic simulation of naturalistic and intelligent shopper behaviors. Then, we discuss its verifications by illustrating the simulated performances in an actual shopping mall case.

AGENT SIMULATION OF SHOP AROUND (ASSA)—ITS CONCEPT AND STRUCTURE

Decomposition of Visitor’s Shop-Around Behavior

The first feature of the downtown visitor’s behavior modeled is the function of time allocation or scheduling of visits to shops under a limited time allowance (time budget). Implementing the scheduling function in itself was an antithesis of the Markov model, even if it does emphasize time constraint, and was an application of the intelligent planning function in the agent. Shop-around spatial behavior, as referred to here, has been explained in cognitive science (Hayes-Roths & Hayes-Roths, 1979).

The second feature modelled was dynamic updates as part of the agent’s behavior, including mainly re-scheduling. This also relates to intellectual functions like adaptation and learning.
A Collaborative Multi-Agent Framework for Internet-Based Teleoperation Systems
[www.igi-global.com/article/a-collaborative-multi-agent-framework-for-internet-based-teleoperation-systems/87165?camid=4v1a](www.igi-global.com/article/a-collaborative-multi-agent-framework-for-internet-based-teleoperation-systems/87165?camid=4v1a)

A Multi-Agent Simulation of Collaborative Air Traffic Flow Management
[www.igi-global.com/chapter/multi-agent-simulation-collaborative-air/26948?camid=4v1a](www.igi-global.com/chapter/multi-agent-simulation-collaborative-air/26948?camid=4v1a)