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SYSTEMATIC ANALYSIS OF MICRO DYNAMICS IN AGENT BASED SIMULATION

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ABSTRACT

Micro dynamics analysis in agent-based simulation plays an important role when the simulation is used for decision making in social systems. Since the analysis has been carried out through trial and error of analysts, its quality highly depends their skills and it is impossible to find out all significant relationships between macro phenomena and agent behavior. This paper proposes a novel analysis methodology not dependent on individual skills in order to investigate agent behavior systematically. By the methodology, analysts can generate meaningful hypotheses to explain a target macro phenomenon based on the agent behavior. We verified the effectiveness of our proposed methodology with the simulation of checkout area in a supermarket and showed that the method can generate hypotheses including the findings that were obtained by a specialist in agent-based simulation.

1 INTRODUCTION

Agent-based simulation can explain why social phenomena arose in terms of individual behavior and their social interactions. Micro dynamics analysis is an effective method to explain a social phenomenon in detail from a micro viewpoint by observing dynamical changes of agents' behavior (Ohori and Takahashi 2012). Results with micro dynamics analysis play an important role in decision making in a complex social system since they help promote communication between stakeholders (Ohori et al. 2014). In conventional studies, the micro dynamics analysis has been carried out through trial and error of analysts. There are two problems in the way: 1) quality of results highly depends on the skill of analysts; 2) it is impossible to find out all the relationships between macro phenomena and individual behaviors. In recent years, there are a few attempts to systematically perform micro dynamics analysis (Tanaka et al. 2017). However they cannot completely identify important relationships between variables of an agent model and the target macro phenomenon. The purpose of this study is to establish a systematic way to find a comprehensive explanation about how agents' behavior cause notable macro phenomena. This paper proposes a novel methodology to generate significant hypotheses about the explanation. The methodology makes following contributions: 1) analysts can discover new findings that experts in simulation target do not recognize in a short time without overlooking from big simulation data; 2) variation in analysis results depending on individual skills in agent-based simulation can be suppressed.

2 METHODOLOGY

The overview of the proposed method is shown in Figure 1. Our approach is to find agent clusters which can sort out target agents with high accuracy. First, the simulation outputs agent logs and aggregated data as performance measures of the system. Then, the target agents are selected by analysts based on their target macro phenomena. For example, if the target phenomena is a congestion in a specific area, target agents should be the agents caught in the congestion (agents stay in the area for a long time). The agent

clusters are generated from log data of simulations. In general, the simulations output log data of agents' behavior in many aspects such as physical position, state transition and history of their internal variables. Our methodology generates different agent clusters for each aspect. Then, it calculates accuracy for each combination of agent clusters to tell the target agents from the other agents. The combinations of high accuracy are hypotheses to explain the target agents, i.e., characteristics of the agent clusters in the combination can explain which type of agents or behavior are related to the target macro phenomena.

Figure 1: Overview of the proposed method

3 CASE STUDY

We tested the proposed methodology with the simulation of checkout area in a supermarket (Yamane et al. 2012). Figure 2 shows the screen shot of the simulation. Agents in the simulation come to the checkout area from one of the entrances with goods to buy, select a counter, go into a queue, check out and exit. The simulation outputs *(x, y)* coordinates and lengths of queues when an agent selects a counter and time from enter to exit. The objective of analysis is to explain how agents take longer time for the checkout process, so we selected agents which take more than 700 seconds as target agents (about 3.4% of all agents). We used K-means as clustering method and k = 5 for *x* coordinate, *y* coordinate and lengths of queues so 15 agent clusters are generated. For each combinations of these clusters, we calculated F-measure as the accuracy measures. The results included the findings that were obtained by a specialist in agent-based simulation. For example, one of the results shows that the agents come from the left side of the area and select a counter on the left side when all of the counters have long queues take longer time.

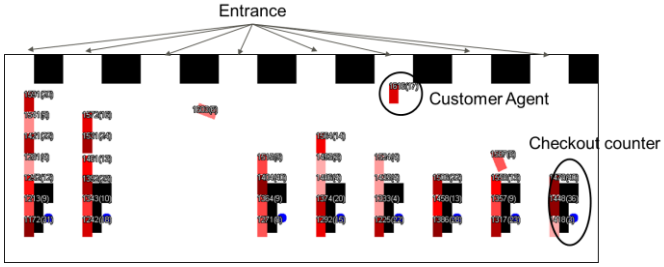

Figure 2: Screen shot of the simulation

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