Participatory Simulation for Games with a Purpose – a Case Study

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Shortl Paper
Corresponding Author:
martin.imkeller@gmx.de
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Martin Imkeller[1], Michaela Sonnleitner[1], Jana Gassner, Yannick Nies, Lisa Bauer, Sarah Baumann, Lena Grami, Anna Naegele and Christian Neuwirth

Department of Geography, Ludwig-Maximilians-University Munich, Germany

[1]These authors contributed equally to this project and should be considered co-first authors

Abstract

This article demonstrates the use of participatory simulation (PS) techniques in the context of gaming and behavioural analysis. Typically, PS tools are conceptualized for educational purposes. We extend this traditional framework by developing a multiplayer game with the purpose of investigating behavioural effects of leadership in collective mobility decisions. The game was implemented with the NetLogo extension HubNet. Each participant in the game controlled one agent. The game's goal was to reach predefined destinations via fixed routes and to obtain the maximum score. To reach destinations, players had the choice between the transport modes of bus and car. They obtained points (two points for bus, one for car) for the selection of the mode that was chosen by the minority of participants. Furthermore, a proportion of the players were given allegedly true information about the mobility choice of participants who had real-life leadership positions. The game's outcomes do not reveal substantial influences of leadership on individual mobility decisions. Personal choices depend, rather, on the assessment of other players' behaviour and of local traffic conditions. The study also exposes an important limitation of HubNet that lies in the visualization of information on the HubNet interface.

Keywords:

agent-based modelling, games with a purpose, HubNet, collective mobility decisions, leadership

1 Introduction

This paper presents an innovative approach for the use of participatory simulation (PS) to investigate the influence of leadership on mobility-related choices. PS (as pioneered by Wilensky & Stroup, 1999b) is a form of agent-based simulation in which multiple human participants control individual agents. So far, PS has been used as a tool for education (e.g. Yin et al., 2013; Klopfer, 2008; Aldinger et al., 2005; Wilensky & Stroup, 1999a, 1999b, 1999c), but rarely for behavioural studies (e.g. MaharaJ et al., 2011). Nonetheless, the existing server–client architecture seems to be applicable in a broader context. A possible application is the analysis of human decisions using "purpose games" (LaFourcade et al., 2015; Von Ahn & Dabbish, 2008).

We present a mobility game which is intended to investigate effects of leadership on the decisions of game participants. Earlier studies revealed various factors influencing individual decision-making:

- Hansmann (2012), Chialdini & Goldstein (2004), Asch (1951) and Sherif (1935) described the adjustment of individual decisions in reaction to others' behaviour;
- the Theory of Planned Behaviour assumes that individual choices are highly dependent on personal preferences (Ajzen, 1991) as well as on specific conditions (e.g. the consumption of alcohol at an event, or local traffic features) acting upon the individual (Hansmann, 2012);
- in the field of Game Theory, Simon (1959) discovered that people typically retain successful choices, whereas failure tends to trigger a rethinking of choices.

Gaming results are compared to these study outcomes in a final discussion section. In addition to behavioural analyses, the capabilities and potentials of PS and HubNet for purpose games are outlined in the discussion. Below, the methods used for these investigations are described in detail. This is followed by an exposition of the results and their discussion.

2 Methodology

The game described here was implemented using the NetLogo HubNet extension. As realistic gaming environments engage the interest of participants (Leoneti, 2016; Maharaj et al., 2011), the game was designed as a skill game with five different scenarios (Table 1). Each scenario corresponds to one round and is based on a realistic real-world event. In every scenario, players were asked to choose between two modes of transport (bus or car) for their trip to a predefined destination. Only those participants who arrived in time received points.

Table 1: Description of routing scenarios

Scenario	Description
1: Football match	You got tickets for the football match Germany against England at Allianz Arena. Starting point: Lindwurmstr. 211.
2: Open Air Concert	Your favourite band is playing at a charity event at Königsplatz. Starting point: Dirschauer Str. 6.
3: Oktoberfest	Your employer invites you and your colleagues to the Oktoberfest. Starting point: Fraasstr. 1.
4: Crashed Ice	The yearly Red Bull Ice Cross event is taking place at Olympiapark. Starting point: Helene-Wessel-Bogen 26.

5: Flea market	The first flea market of the year, where you would like to meet up with friends, is taking place at Riem Trabrennbahn. Starting point: Würmtalstr. 51.

The success of players was evaluated by simple majority arithmetic. Those participants who opted for the mode of transport chosen by the majority did not arrive in time because of overcrowding or congestion. In contrast, players who chose the minority traffic mode won. If they were successful (in arriving in time), participants who chose the car received one point, whereas players who chose the bus were awarded two points. This difference in scoring was introduced to make choices for participants more complex and to reward bus-users for choosing the environmentally friendly mode of transport. For each player, the goal of the game was to reach a maximum score.

Players in the mobility game were unaware of the decisions of the others. Four players were given allegedly true information about the mobility decisions of three selected leaders. These leaders were participants with a high reputation within a university. The other participants were staff members or students at the same university. The assumption was that leaders influence the decision of staff members and students.

At the beginning, all participants were familiarized with the game's goal and with the HubNet interface. Prior to each round, participants were given information about the corresponding scenario (Figure 1).

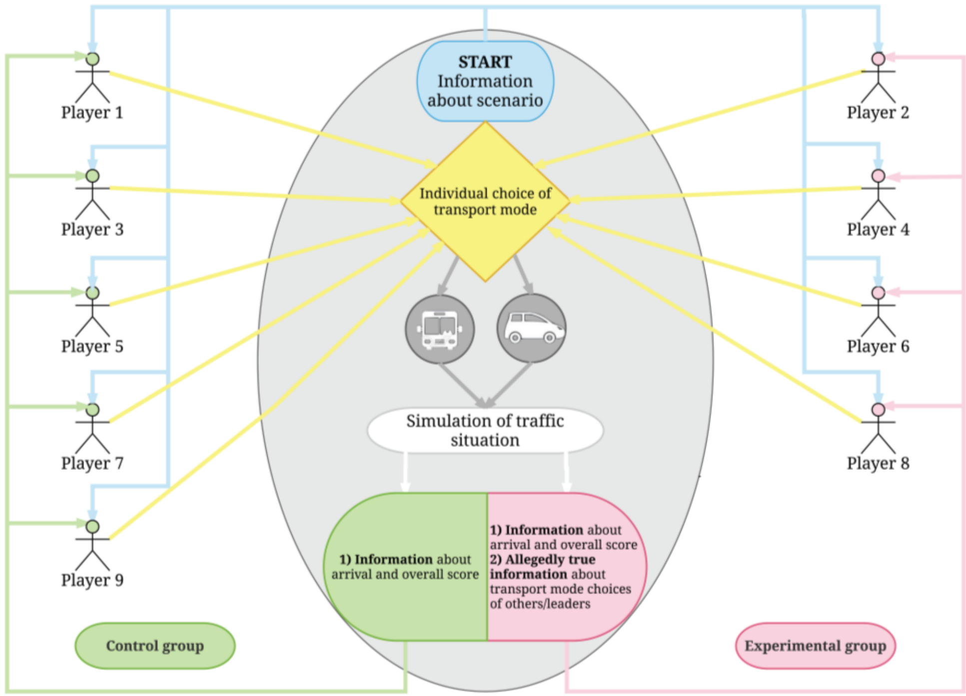

Figure 1: Use case diagram of game settings

In scenarios 2 to 5, messages about the allegedly true choices of leaders were displayed on the information monitors of four players. All participants were informed via the monitor as to whether they had arrived at the destination in time or not. An additional monitor showed the player's score throughout the game (Figure 2).

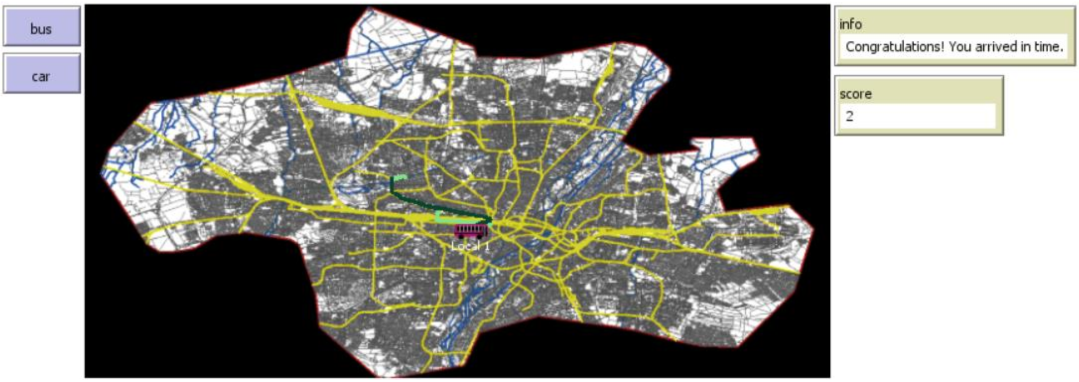

Figure 2: HubNet user interface with information on timely arrival and current score

Participants' choices and scores were captured in an output text file. To verify different influences on individual decisions, all players were asked before starting the simulation to fill in a general questionnaire about their professional status, gender, age and place of residence. Furthermore, they had to write down the reasons for their choices after each scenario, in order to make decisions governed by leadership effects explicit.

3 Results

Those participants who obtained alleged information about the choice of car as mode of transport by leaders (scenarios 2 – 5) did not choose the car more often than players who did not get this information. The car was chosen as the mode of transport in 43.8% of the selection options with information about leadership decisions; 44.8% of the choices without such information were made in favour of the car.

The simulation results show decision patterns that are not related to leaders' decisions (Table 2). Some users changed their mode of transport from round to round (e.g. players 3 and 6). Others kept the same mode of transport: player 5 chose the bus in each scenario. These two decision patterns did not lead to high scores.

In contrast, players 8 and 9 were fairly successful thanks to changing their mode of transport just once during the game. Player 9 was the overall winner of the game with a total score of 5, obtained by selecting the same transport modes as the minority chose in four out of five scenarios (car in scenarios 1 – 3, bus in scenario 5). Player 9 received no information about leaders' decisions and was a student.

Table 2: Choice of mode of transport, score per player, and scenario with and without information about leaders' decisions

Player	Chosen mode of transport	Scenario 1, score	Scenario 2, score	Scenario 3, score	Scenario 4, score	Scenario 5, score	Total score
1	Bus	0			0		2
	Car		1	1		0	
2	Bus	0	0	0			1
	Car				1	0	
3	Bus		0		0		2
	Car	1		1		0	
4	Bus	0		0			2
	Car		1		1	0	
5	Bus	0	0	0	0	2	2
	Car						
6	Bus		0		0		2
	Car	1		1		0	
7	Bus	0	0	0			1
	Car				1	0	
8	Bus		0	0	0	2	3
	Car	1					
9	Bus				0	2	5
	Car	1	1	1			

	With information about the decisions of leaders
	Without information about the decisions of leaders

The reasons for participants' decisions were associated with the assessment of others' behaviour and with specific factors related to the scenarios (Table 3). Player 3, who changed the mode of transport from round to round, mentioned a mix of local conditions and the assessment of others' behaviour as reasons for their choices. Player 6, who had a similar choice pattern, named local factors (e.g. traffic conditions) as reasons for the switch between modes of transport.

Changes of mode of transport because of prior success or failure with one mode were mentioned seven times by participants. However, this choice pattern could not be observed in the majority of the decisions made by players. Throughout the game, participants changed their mode of transport ten times after having failed to obtain scores. In twelve cases, players continued to use a transportation mode although they had experienced failure with the same mode in the previous round.

Player 5, who chose the bus as the mode of transport throughout the whole game, mentioned local conditions and the high reward for bus users as reasons for his choices. In the following scenarios, he stayed with the bus, assuming that the others would change their mode of transport. Player 8, who except for scenario 1 chose the bus, gave the reasons for his choices as environmental considerations (included under 'attitude towards means of transport' in Table 3) and the assessment of the behaviour of others. Player 9, the most successful in the game, cited a mix of local conditions and the assessment of others' behaviour as reasons for his/her decisions. In summary, of the 53 decision statements, 32 choices are justified by strategic thinking, whereas 21 statements refer to real-life habits (Table 3).

Table 3: Frequency of reasons mentioned

Reasons provided	Frequency of mention
Sum of Reasons associated with strategic thinking	**32**
Assessment of the behaviour of others	23
Success or failure with prior choice	7
Decision for bus due to high reward	2
Sum of reasons associated with real life habits	**21**
Local conditions	14
Use of bus because of the intended consumption of alcohol	4
Attitude towards means of transport	3
Number of reasons overall	**53**

4 Discussion and Outlook

The results of this purpose game follow well-known behavioural mechanisms. First, individuals adjust their decisions in reaction to the actions of others (Hansmann, 2012; Chialdini & Goldstein, 2004; Asch, 1951; Sherif, 1935). In the case described here, the reasons for their choices given most often by participants are associated with the assessment of the behaviour of others. Second, according to the theory of planned behaviour, individual choices are highly dependent on personal preferences (Ajzen, 1991). Such preferences were mentioned 21 times. In contrast, Simon's (1959) observation of players' decisions being dependent on the frequency of success could not be confirmed in this game. The majority of players did not change their mode of transport subsequent to bad experiences in terms of scoring.
Furthermore, the influence of leadership on decision-making processes (as demonstrated by McHugh et al., 2016; Marchiondo et al., 2014; Cianci et al., 2013) was not be observed in this experiment. This is explained partially by limitations associated with the HubNet interface design. The import of customized graphics is constrained by the software: information about leader choices can only be displayed on monitors separate from the actual simulation monitor and may be overlooked by participants.

Moreover, information about the different scenarios cannot be provided in HubNet. Improvements in this context have been realized by external extensions with formats such as Flash animations (MaharaJ et al., 2011). Another constraint concerns the amount of data which can be transferred between server and clients. Due to the dynamic data exchange during runtime, performance is significantly reduced compared to traditional applications of NetLogo. Likewise, the upload of different layers reduces performance.

In addition to constraints related to input / output operations, the number of players is limited in HubNet. According to WILENSKY (2016), the tool has not been sufficiently tested with more than 25 participants involved in a simulation. In the case study presented here, the number of players was constrained mainly by the availability of workstations. Due to the small number of participants, results are interpreted as an experience report. Future studies may build on this experience to conduct further experiments in a participatory simulation environment.

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