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Agent Based Modelling of Urban Systems

First International Workshop, ABMUS 2016
Held in Conjunction with AAMAS
Singapore, Singapore, May 10, 2016
Revised, Selected, and Invited Papers

Springer

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Preface

The first international ABMUS (Agent Based Modelling of Urban Systems) workshop was held at the AAMAS (Autonomous Agents and Multi Agent Systems) conference in 2016, as a way of bringing together a group of researchers working in this growing area. The workshop had 16 paper submissions, with authors of 14 of these attending the workshop. Eight of the revised papers along with three invited papers appear in this collection. The workshop attracted about 25–30 participants and was run as four discussion sessions. The four broad topics were:

- Systems and frameworks
- Realistic vs. stylized environment/infrastructure
- Activities and behaviors
- Software support

These topics were selected based on important recurring aspects where it was deemed that discussion would be valuable. Three to five authors were assigned to each session and were asked to summarize their paper in no more than three to five minutes, with ten minutes dedicated to responding to specific questions on the discussion topic. Authors were expected to draw on their experience generally, as well as on the specific paper submitted. This was followed by approximately an hour of discussion by all participants.

The specific questions discussed in each session were as follows:

1. Systems and frameworks
   - What other platforms do you have experience of?
   - Why did you choose this platform?
   - What things did you find particularly useful with this platform?
   - Did this platform have some weaknesses with respect to your application?
   - How would you like to see this platform develop?
2. Realistic vs. stylized environment/infrastructure
   - What aspects of the environment did you need to model?
   - Was your modelling realistic or stylized (e.g., grid-based physical environment is stylized, road network is realistic)?
   - Did you use actual data for your simulation?
   - Was your agent population built using any actual data? If so what?
   - How much of the work in building the simulation was related to obtaining and incorporating data or realistic environment aspects?
   - What advantages do you think there are in using realistic vs. stylized representations?

3. Activities and behaviors
   - What agent activities or behaviors have you represented?
   - Are these activities/behaviors determined in advance, or do they depend on what happens in the simulation? Describe how they are determined.
   - How do the agent activities/behavior affect the environment in ways that affect other agents?
   - Do you have different "types" of agents, and if so what are they?
   - To what extent do agents of the same type end up behaving quite differently to each other, due to the simulation?
4. Software support — what general purpose support tools or additions or plug-ins beyond platforms, as discussed in session 1, will be useful in moving forward the field of ABMs for urban simulation?
   - How does your work support software re-use, or the ability of groups to leverage each other's work?
   - What software development principles are important if as a community we are to move this field forward?
   - What are some key components or support tools that could really make a difference for this field?

Participants were extremely engaged in discussion and the workshop was highly interactive. A couple of important themes that emerged were the need for greater sharing, re-use, and modularity in the software developed, as well as the importance of infrastructure supporting integration of complementary models within a domain. A noticeable trend was also the importance of detailed microsimulation data obtained from a variety of sources. In many cases far more effort was focused on this aspect of modelling the system than on agent behaviors. It would seem that for urban simulations to be trusted, this level of specific detail is important.

The papers collected here cover a range of topics relevant to modelling of urban systems.

Four papers are related to specific aspects of urban systems modelling: the paper by Stefano Picascia and Neil Yorke-Smith – "Towards an Agent-Based Simulation of Housing in Urban Beirut" – deals with patterns of degeneration and regeneration of housing stock in Beirut, in the presence of massive refugee migration, while the paper by Patrick Taillandier, Arnaud Banos, Alexis Drogoul, Benoit Gaudou, Nicolas Marilleau, and Chi Quang Truong – "Simulating Urban Growth with Raster and Vector Models: A Case Study for the City of Can Tho, Vietnam" – deals with representation of geographic space for applications studying urban growth. The paper by Nidhi Parikh, Madhav Marathe, and Samarth Swarup – "Integrating Behavior and Microsimulation Models" – is in the application domain of disaster management in an urban setting, with a focus primarily on integrating reasoned behaviors within the ABM using semi-Markov decision processes for each agent. This paper epitomizes the growing need to model more complex human decision-making than is often used in ABMs. The invited paper by Pascal Perez, Arnaud Banos, and Chris Pettit – "Agent-Based Modelling for Urban Planning: Current Limitrations and Future Trends" – outlines some challenges for the area of agent-based modelling for urban planning. A major focus is the need for

modular systems comprising models of different aspects. This was also a conclusion of the workshop discussion. They also argue for the importance of theory-based models and models developed via participatory processes.

Four papers deal with aspects of traffic simulation: "Software Architecture for a Transparent and Versatile Traffic Simulator" by Michael Zilske and Kai Nagel describes a plug-in to MATSim to support integration of new components, while the one by Haitam Laarabi and Raffaele Bruno – "A Generic Software Framework for Carsharing Modelling Based on a Large Scale Multi-Agent Traffic Simulation Platform" – uses that framework, and describes an adaptation or extension of MATSim to support applications studying car sharing. "Mapping Bicycling Patterns with an Agent-Based Model, Census and Crowdsourced Data" by Simone Leao and Chris Pettit is an introductory exploration that is part of a longer-term study on bicycle transportation. The invited paper in this section – "Transportation in Agent-Based Modelling" – by Sarah Wise, Andrew Crooks and Michael Batty argues that transportation modelling is a critical aspect of urban systems modelling, even when it is not the main focus. The authors present different levels of complexity at which the transportation systems can be modelled and argue that it is important to ensure that the transportation model is at the appropriate level of granularity for the main focus of the urban system model. They also argue that direct agent–agent communication and interaction are important elements of ABM of urban systems and should, in fact, be part of the ABM specification for urban systems. They specifically look at the importance of transportation models in the different application areas of crime, disease spread, and land use.

The three remaining papers deal with some specific applications. The paper by Luca Crociani, Gregor Lämmel, and Giuseppe Vizzari – "Simulation Aided Crowd Management: A Multi-scale Model for an Urban Case Study" – also actually uses MATSim, although their focus is on pedestrian rather than vehicle movement, in an application exploring crowd management during a large event. "A National Heat Demand Model for Germany" by Esteban Munoz provides a detailed estimation of heat demand for the whole of Germany. This paper is an example of the use of detailed microsimulation data and infrastructure playing a more important role than agent behaviors. The invited paper from the Architecture and Town Planning Faculty at Technion in Israel, "How Smart Is the Smart City? Assessing the Impact of ICT on Cities" by Michal Gath Morad, Davide Schaumann, Einat Zinger, Pnina O. Plaut, and Yehuda E. Kalay, provides an interesting perspective on the important but unknown effects, side effects and after effects of incorporating ICT into "smart cities." Agent-based simulation can provide one of the tools to allow city planners to further explore these issues.

Other papers not included here covered an additional paper on pedestrian agents in an urban space, water and sanitation, public transport, microcars, and microsimulation as an approach distinct from ABM.

The paper by Patrick Taillandier, Arnaud Banos, Alexis Drogoul, Benoit Gaudou, Nicolas Marilleau, and Chi Quang Truong has been previously published in the AAMAS collection of the most innovative papers from the 2016 workshops [1], but is republished here with the permission of Springer. The paper by Luca Crociani, Gregor Lämmel, and Giuseppe Vizzari is a substantially extended version of the paper in the AAMAS collection of best papers from the 2016 workshops [2].

Overall, this collection provides a snapshot of some of the work in this growing area of agent-based urban simulation.

November 2016

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