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SI: AGENT-DIRECTED SIMULATION

Guest Editorial
Introduction to the special issue on agent-directed simulation

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1 Agent-directed simulation

Agent-directed simulation (ADS) integrates the technologies of modeling and simulation, and agent systems; and consists of three distinct, yet related areas that can be grouped under two categories as follows:

- Simulation for Agents (*agent simulation*): simulation of agent systems in engineering, human and social dynamics, military applications etc.

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- Agents for Simulation (which has two aspects): *agent-supported simulation* that deals with the use of agents as a support facility to enable computer assistance in problem solving or enhancing cognitive capabilities; and *agent-based simulation* that focuses on the use of agents for the generation of model behavior in a simulation study.

From one hand, ADS allows us to use agents to develop domain-specific simulation; from the other hand, it supports the use of agent technology to develop simulation techniques and toolkits that are subsequently applied, either with or without agents. The real world problems are complex and there is no single agent-based abstraction that can solve every problem. The integration of simulation and agent technology can help us better understand complex real world problems and improve our capability in developing autonomic simulation systems with robust decision making in real-time for these problems.

2 ADS symposium at SpringSim

The Agent-Directed Simulation symposium is an annual conference as part of the Spring Simulation Multiconference (SpringSim) sponsored by the Society for Modeling and Simulation International. As the premier platform to the synergy of simulation and agent technologies, ADS attracts enthusiastic responses every year, and has an impressive Program Committee (http://www.scs.org/springsim/2011?q=node/205).

The symposium of 2011 attracted 27 paper submissions from 14 countries. Every paper was reviewed by three referees, and in the end 17 papers (63%) were accepted for presentation at the conference. It comprised a full two-day of exciting scientific discussion in the 2011 SpringSim multiconference in Boston, April 4–5, 2011. Each paper was allowed 30 minutes for presentation and discussion.

3 CMOT special issue

The success of the symposium led the organizers to pursue a further selection and propose to edit this special issue of *Computational and Mathematical Organization Theory*. A further round of call for paper was sent to all accepted papers. Authors were asked to significantly expand and improve their ADS paper in order to make a submission to the special issue. All submissions were reviewed by three referees. Finally we accepted three for this issue, together with three invited papers (the invited papers were also reviewed by three referees). The six papers investigate four different research domains in agent-directed simulation: Simulation in Health Sciences, Verification to Agent-based Models, Social Simulation, and Simulation in Military domain. We believe that this special issue provides the most recent developments in these selected topics and will be an important source of information for researchers in the area of agent-directed simulation.

The first paper is “A proposal for augmenting biological model construction with a semi-intelligent computational modeling assistant” by Scott Christley and Gary An. This paper proposes an operational agent model to composite dynamic knowledge

in bio-medical domain by using modeling and simulation ontologies. The intelligent agent can automate the generation of simulations of dynamic biomedical phenomenon to replace the current linear bottleneck approaches for testing causality of discovered correlations (a parallel process). It proposes an extension to the current static biomedical ontologies, the use of simulation ontologies, and AI planning to compose biomedical simulations.

The second paper is "Verifying Agent-Based Models with Steady-State Analysis" by James Gentile, Gregory Davis, and Samuel Rund. This paper addresses an important question of agent-based simulation—how to verify if the simulation results accurately manifest the conceptual model it is based on? The paper shows that it is possible to perform formal steady-state analysis on some agent-based models. As an example of these methods, an ecological model which simulates reproductive dynamics of mosquitoes is implemented and tested against hypothesized outputs for age structure, biomass and periodicity.

The next three papers fall into the category of social simulation. The paper "How Behaviors Spread in Dynamic Social Networks?", by Yu Wu and Yu Zhang, studies network dynamics if agents can freely change their connections based on their individual interests in social networks. Because Yu Zhang is a co-organizer of the symposium, this paper was subject to special treatment: another co-organizer ensured that she was not involved in either of the revision processes. The paper proposes a new social norm rule called Highest Weighted Neighborhood (HWN) that agents can dynamically choose their neighbors to maximize its own utility through all previous interactions between the agents and these neighbors. The HWN rule allows agents to keep their rationality, while many existing rules only allow agents to connect to a random new agent. The paper proves that in the 2-action pure coordination games, the network stabilizes in a clustering state and all relationships in the network are rewarded the optimal payoff. This theoretic work can enable further study on network stability in network evolvement.

The paper "Asset Pricing under Ambiguous Information: An Empirical Game-Theoretic Analysis", by Ben-Alexander Cassell and Michael Wellman, exploits the capability of agent-based models to investigate a recent model proposed by Epstein and Schneider in the finance literature, and its ability to explain the classic equity premium puzzle in risky asset pricing. The paper employs an empirical game-theoretic approach to derive stable market compositions among the set of candidates. For a broad range of market configurations, the paper finds a significant equity premium only when agent pricing reflects risk aversion, and that ambiguity aversion contributes negligibly to this premium. These findings underscore the need to verify that results from abstract representative-agent models are supportable in a higher-fidelity model where heterogeneity and strategic interactions are taken into account.

The paper "Agent-Based Modeling and Simulation of Community Collective Efficacy", by Minghao Wang and Xiaolin Hu, introduce a multi-agent system to simulate collective behavior raised from individuals in a community. The model is based on the theory of self-efficacy and planned behavior and shows how collective behavior is generated when individuals in the same community interact with each other and vice versa how generative behavior affects individual's decision. The model is applied to social ecology systems to study the spatial patterns of collective efficacy emerging at the community level.

The last paper "Modelling Medieval Military Logistics: An Agent-based Simulation of a Byzantine Army on the March", by Philip Murgatroyd, Bart Craenen, Georgios Theodoropoulos, Vincent Gaffney and John Haldon, proposes an agent simulation model designed to investigate historical military events where typically the historical sources are scarce on detail. The goal is to find new evidence to supplement existing historical analysis. The proposed model integrates agent design and AI A* search algorithm for route finding. The fine part of agent design includes both agent and environment design and the interaction between agents and the environment and the communication interaction between each agent. This designed model can be applied to many suitable domains in military topics.

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Yu Zhang received her Ph.D. in Computer Science at Texas A&M University. She is Associate Professor in the Department of Computer Science at Trinity University and Director of the Laboratory for Distributed Intelligent Agent Systems. Dr. Zhang's research falls within Agent-Based Modeling and Simulation. Her research is currently supported by three NSF grants. She is the editor-in-chief of The International Journal of Agent Technologies and Systems and an associate editor of The Transaction of Simulation, and in program committee for over 10 conferences and technical groups, such as Autonomous Agents and Multi-Agent Systems. She has regularly reviewed proposals for federal agencies. She is Program Co-Chair of Agent Directed Simulation of SCS SpringSim 2010. She is in the organizing committee of IEEE SMC 2009 and SCS SpringSim 2009. She is Program Chair of IEEE Women In Engineering Central Texas Chapter (CTC), Program Chair of IEEE SMC Society CTC, and Vice Chair of IEEE Computer Society CTC.

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Tuncer Ören is a professor emeritus of computer science at the School of Electrical Engineering and Computer Science of the University of Ottawa, Canada. He has been involved with simulation since 1965. Dr. Ören's Ph.D. is in Systems Engineering from the University of Arizona, Tucson, AZ. His basic education is from Galatasaray Lisesi, a high school founded in his native Istanbul in 1481 and in Mechanical Engineering at the Technical University of Istanbul. His research interests include advanced methodologies for modeling and simulation; agent-directed simulation; agents for cognitive and emotive simulations especially for conflict management training (including representations of human personality, understanding, misunderstanding, emotions, anger triggers and anger mechanisms); reliability, QA, failure avoidance, ethics; as well as body of knowledge and terminology of simulation. He has over 450 publications (over 110 in the 2000s)—some translated in Chinese, German and Turkish. He has contributed to over 400 conferences and seminars held in over 30 countries. During his career he has delivered nearly 200 invited talks/presentations and in the 2000s alone, he has contributed to over 150 events. Dr. Ören has been recognized, by IBM Canada, as a pioneer of computing in Canada where he has been also the Founding Chair of the Executive Committee of the Chairmen of the Canadian Computer Science Departments. He received "Information Age Award" from the Turkish Ministry of Culture and plaques and certificates of appreciation from organizations including ACM, AECL, AFCEA, NATO, and Turkish General Staff. In 2011, he

is inducted to “SCS Modeling and Simulation Hall of Fame”. Dr. Ören had received the “Distinguished Service Award” in 2006 and “Distinguished Professional Award” in 2003 from the same learned society where he is also a distinguished lecturer.

Greg Madey received the Ph.D. and M.S. degrees in operations research from Case Western Reserve University and the M.S. and B.S. degrees in mathematics from Cleveland State University. He worked in industry for several firms, including Goodyear Aerospace, Gould Oceans Systems (now part of Northrup-Grumman), and Loral (now part of Lockheed Martin). He is currently a faculty member in the Department of Computer Science and Engineering at the University of Notre Dame. His research includes topics in agent-based modeling and simulation, emergency management modeling and simulation, web-services and service oriented architectures, bioinformatics, web portals for scientific collaboration, open source software, and cyberinfrastructure. He has published in various journals including, Communications of the ACM, IEEE Transactions on Engineering Management, IEEE Computing in Science & Engineering, The Journal of Systems & Software, BMC Bioinformatics, Computational & Mathematical Organization Theory, Nucleic Acids Research, Decision Sciences, The European Journal of OR, Omega, Expert Systems with Applications, and Expert Systems. He is a member of the ACM, AIS, IEEE Computer Society, Informs, and the Society for Computer Simulation.

Maarten Sierhuis is manager of the Knowledge, Language and Interaction area at the Palo Alto Research Center. Before that he was senior scientist at NASA Ames Research Center (ARC) and adjunct professor at Carnegie Mellon Universityâs Silicon Valley campus. He is co-principal investigator of the Brahms agent-oriented language and simulation environment, in the Work Systems Design & Evaluation group in the Collaborative and Assistant Systems area within the Intelligent Systems Division at NASA ARC. He holds a PhD in social science informatics from the University of Amsterdam, in which he developed a theory for modeling and simulating work practice using Brahms. Prior to joining NASA, Sierhuis was a member of technical staff at NYNEX Science & Technology (1990–1997); earlier he was at IBM in New York and Sema Group in The Netherlands (1986–1990). He has presented invited lectures on Brahms, has published widely in this area and holds two software patents involving work practice simulation and hypertext databases.