AISB Journal **1**(1), © 2001
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Editorial: Special Issue on Agent Technology

Eduardo Alonso[⋆], Simon Colton[†], Daniel Kudenko[⋆⋆],
Luc Moreau[‡], Michael Schroeder[⋆] and Kostas Stathis[⋆]

[⋆] Department of Computing, City University, London,
Northampton Square, London, EC1V OHB, UK.
eduardo@soi.city.ac.uk ; msch@soi.city.ac.uk ; kostas@soi.city.ac.uk

[†] Division of Informatics, University of Edinburgh,
80 South Bridge, Edinburgh, EH1 1HN, UK.
simonco@dai.ed.ac.uk

[⋆⋆] Department of Computer Science, University of York,
Heslington, York, YO10 5DD, UK.
kudenko@cs.york.ac.uk

[‡] Department of Electronics and Computer Science,
University of Southampton, Southampton, SO17 1BJ, UK.
L.Moreau@ecs.soton.ac.uk

1 Introduction

For the last two decades, agent-based technology has been applied to building intelligent systems. The ability of agents to make their own decisions and adapt to and learn from their environment is a very powerful tool for implementing intelligent systems of general competence. In addition, the study of multi-agent systems — collections of specialised agents working in parallel — has helped us to solve complex problems not previously solved using a centralised approach. Moreover, agent-based simulators have been used to better understand cooperation and competition in society. It is therefore not surprising that agent-based systems have been successful in many varied domains, including E-commerce, online learning, medicine, entertainment, human-computer interaction, business management, traffic control and conflict simulation.

Because agent technology is such a key area of Artificial Intelligence, and as Britain is strongly represented in this area, the Society for the Study of Artificial Intelligence and the Simulation of Behaviour decided to make agent technology the theme of their 2001 convention (AISB'01), held in York. Five invited talks in the plenary sessions at AISB'01 were on agent-based topics. Nick Jennings discussed "Automated Haggling: Building Artificial Negotiators", Lyndon Lee described the "Multi-Agent Research at British Telecom", Andrew Jones spoke "On the Concept of Trust", Christoph Benzmüller presented "An Agent Based Approach to Reasoning" and Jim Doran described "Agents and Ecosystem Management: from the Fraser River to Boolean Networks".

Furthermore, the convention included symposia on (a) Software Mobility and Adaptive Behaviour, (b) Information Agents for E-commerce, and (c) Adaptive Agents and Multi-Agent Systems. We invited certain authors from these symposia to submit extended papers to this special issue, so that we could present a broad cross-section of cutting edge agent technology in one volume. In the three sections below, we briefly describe the three subdomains of agent technology represented here, and the specific work from the authors with papers in this volume.

2 Adaptive Agents and Multi-Agent Systems

In recent years, intelligent agents and multi-agent systems have become a highly active area of AI research. Intelligent Agents have been developed and applied successfully in many domains, such as E-commerce, human-computer interaction, entertainment, process management and traffic control. When designing agent systems, it is impossible to foresee all the potential situations an agent may encounter and specify an agent behaviour optimally in advance. Agents therefore have to learn from and adapt to their environment. This task is even more complex when nature is not the only source of uncertainty, and the agent is situated in an environment that contains other agents with potentially different capabilities, goals, and beliefs. Multi-Agent Learning, i.e., the ability of the agents to learn how to cooperate and compete, becomes crucial in such domains.

Even though Machine Learning (ML) has been studied extensively in the past, ML research has been mostly independent of agent research and only in recent years has it received more attention in connection with Agents and Multi-Agent Systems. This is in some ways surprising, because the ability to learn and adapt is one of (if not the) most important feature of intelligence and autonomy. Nowadays, the integration of ML technology into agent systems has become a major challenge.

Research in Machine Learning for agents and multi-agent systems is still in the beginning stages, and many issues are still unresolved. Amongst these issues are the question of the source and the proper selection of training data (e.g., the credit assignment problem), how to achieve coordinated and specialized behaviour in a team of learning agents, the timeliness of learning problems, and many more (see, for example, (Sen and Weiss, 1999) and (Kazakov and Kudenko, 2001) for overviews). While reinforcement learning has become the predominant learning technique for agents, very recently the focus is shifting towards hybrid solutions that incorporate other ML approaches. We expect to see this trend gaining momentum in the near future.

The Symposium on Adaptive Agents and Multi-Agent Systems at AISB'01 was a pioneering experience, as no symposium on learning agents had been organized previously in the UK. With the symposium, we intended to increase awareness and interest in adaptive agent research in the European AI community, and encourage further research and collaboration between Machine Learning experts and Agent Systems experts. Last but not least, we intended to give a representative overview of current research in the area of adaptive agents in Europe and worldwide. For this Special Issue, we have chosen three papers from our symposium. Firstly, Frances M. T. Brazier and Niek. J. E. Wijngaards introduce automated servicing as a way of designing adaptable agents, an idea that does not draw on the classical view of machine learning, but sees adaptation as an externally driven process. Secondly, Pedro Rafael Graça and Graça Gaspar propose an agent-architecture to deal with real-time (group communication) problems where it is important both to react to constant changes in the environment and to learn to recognize the generic tendencies in the sequence of those changes. Finally, Chia-Hsuan Yeh and Shu-Heng Chen's paper presents an economic simulation based on an artificial stock market. Their simulation is used to study how economic heterogeneity improves market efficiency.

3 Information Agents for Electronic Commerce

Internet connectivity is creating an information-centric society where millions of people access large amounts of information stored in distinct and possibly heterogeneous data sources, on a daily basis. Frequently, pieces of information from different sources can be

combined to create new and often more meaningful information. As a way of automating this process, a research strategy is currently being devoted to the development of information agents (Klusch, 1999), software components that can act on behalf of individual users to manage intelligently the information one typically finds in distributed networks like the Internet.

However, as the complexity of creating new information increases (finding the right pieces to produce a new one can be quite time consuming), the concept of information is slowly transforming itself from a freely accessible entity to that of a product with a price. This transformation has opened up new markets where information is traded electronically much the same way a physical product is (Cohen and Stathis, 2001). However, the importance of information markets is that physical products are not excluded, in that these too can be represented as pieces of information.

The symposium on Information Agents for Electronic Commerce at AISB'01 presented current research on a wide range of issues, in particular, where activities for trading information in an electronic market could take place between people, organizations or both (Dignum and Sierra, 2001). The papers selected for this special issue address the three particular aspects of service composition, user-agent interaction, and specification of agent behaviour using computational logic and constraints.

In "Towards Agent-Based Service Composition Through Negotiation in Multiple Auctions", Chris Preist, Andrew Byde, Claudio Bartolini and Giacomo Piccinelli go beyond the use of auctions for basic services and investigate how to compose services and in particular how to use auctions to negotiate about such composed services. In "Designing Agents for a Virtual Marketplace", Kaveh Kamyab, Frank Guerin, Petar Goulev and Ebrahim Mamdani design an adaptive virtual sales assistant, which builds on a Belief Desires and Intentions (BDI) architecture and fuzzy rules to engage in interaction with the user. Finally, in "BDI Agents and Constraint Logic", Stuart Chalmers and Peter M. D. Gray declarative specify an electronic commerce application where the internal architecture of the agents is based on the BDI model too, but in this case, using constraints as the main representation and implementation formalism.

4 Software Mobility and Adaptive Agents

Mobile agents have emerged as a paradigm for structuring distributed applications. A mobile agent is a program, which can, at runtime, make autonomous decisions about the locations where it will continue its execution (Lange and Ishima, 1998). Other methods for providing software mobility have been proposed, including evolutionary and self-organising systems, ants, mobile agents, mobile code and active networks.

Software mobility can bring robustness, performance, scalability or expressiveness to systems. It has been used successfully in different application domains, including network management, Internet resource discovery, electronic market places and interaction with mobile users. The topic of mobility is the object of active research, and many varied aspects are under investigation, such as communications between mobile entities, languages to express mobility and their typing, management of resources and security infrastructure for mobile code. The development of a theoretical framework able to describe and reason about systems with mobility has also received much attention. In particular, the Ambient calculus (Cardelli and Gordon, 1998) introduces the idea of a location delimited by boundaries and operations to move across such boundaries.

For this Special Issue, we have chosen two papers from the symposium on Software Mobility and Adaptive Behaviour. First, Lidia Yamamoto and Guy Leduc present a re-

flector service to maintain application level-connectivity in the presence of network-level multicast failures; this service relies on mobile code and makes use of migration to adapt its behaviour to the network configuration. Second, Julian Padget presents a specification of electronic institutions in process algebras extended with locations; he examines some key aspects of a prototypical E-institution using the Seal and type-safe Ambient calculi in order to compare their properties.

Acknowledgments

We wish to thank everyone involved in the organisation of the AISB'01 convention, including the conference office staff, the technical support and secretarial staff, and the helpdeskers, without whom the conference would have collapsed. In particular, we would like to thank the programme committee members for the three AISB'01 symposia represented here, for their help in attracting, selecting and reviewing papers, not just for the symposia, but also for this volume: Jean-Pierre Briot, Mark D'Inverno, Michael Fisher, Christophe Giraud-Carrier, Lyndon Lee, Michael Luck, Scott Moss, Joerg Mueller, Simon Parsons, Jeremy Pitt, Chris Preist, Omer Rana, Marek Sergot, Carles Sierra, Francesca Toni, Jan Vitek, Gerd Wagner, Ian Wakeman and Mike Wooldridge.

Special thanks to Enric Plaza for giving an invited talk at the symposium on Adaptive Agents and Multi-Agent Systems, and the AgentLinkII network for funding his visit. We wish to praise Geraint Wiggins for his inspiration in getting the AISB Journal off the ground. Not only did he suggest the split from the AISBQ and that the first issue be on agents, but, as chair of SSAISB, he has also been involved with every detail in both the research and administrative aspects of creating this new journal.

References

Cardelli, L. and Gordon, A. (1998). Mobile Ambients. In Nivat, M., editor, *Foundations of Software Science and Computational Structures, Lecture Notes in Computer Science*, volume 1378, pages 140–155. Springer-Verlag.

Cohen, M. and Stathis, K. (2001). Strategic change stemming from E-commerce: implications of multi-agent systems on the supply chain. *Journal of Strategic Change*, 10:139–149.

Dignum, F. and Sierra, C. (2001). *Agent Mediated Electronic Commerce. The European AgentLink Perspective. Lecture Notes in Computer Science*, volume 1993. Springer-Verlag.

Kazakov, D. and Kudenko, D. (2001). Machine learning and inductive logic programming for multi-agent systems. In Luck, M., Marik, V., Stepankova, O., and Trappl, R., editors, *Multi-Agent Systems and Applications*. Springer-Verlag.

Klusch, M. (1999). *Intelligent Information Agents - Agent-Based Information Discovery and Management on the Internet*. Springer-Verlag.

Lange, D. and Ishima, M. (1998). *Programming and Deploying Java Mobile Agents with Aglets*. Addison-Wesley.

Sen, S. and Weiss, G. (1999). Learning in multi-agent systems. In Weiss, G., editor, *Multi-Agent Systems*. MIT Press.