Preface

The ESAW'00 workshop on Engineering Societies in the Agents' World was held on 21 August 2000 in conjunction with the 14th European Conference on Artificial Intelligence in Berlin at Humboldt University.

The recent research and technology advances in the area of Distributed Artificial Intelligence (DAI) are paving the way towards building new worlds. In the near future, multitudes of autonomous software agents are expected to be deployed in our networks and on the Web, to pursue goals on our behalf by communicating, synchronising, and either cooperating or competing with each other. These multi-agent systems (MAS) can no longer be conceived as static – multi-component – software architecture. Instead, due to the autonomous behaviour of agents and to the richness and dynamics of their interaction patterns, MAS can be better conceived in terms of *artificial societies* of individuals, living in and possibly roaming across a specific – often distributed – environment, and interacting according to patterns resembling those of human societies or complex eco-systems.

Given the above scenario, MAS are far beyond the boundaries of DAI, and researches in the area of MAS should necessarily gather contributions from many different and heterogeneous areas such as Distributed Systems, Social and Cognitive Sciences, Mobile Computing, and so on. In addition, although applications and systems built as societies of autonomous and intelligent agents promise to provide computer scientists and engineers with the expressive and computational power to tackle levels of complexity never reached before, specific abstraction, methodologies, and tools are required to enable an engineered approach to the construction of such systems. We feel an urgent need not only for theoretical foundations making MAS conceptual setting clear, but also for specific methodologies driving the design of agent societies, for specific technologies and processes driving their development, and for powerful and manageable infrastructures making agent societies a viable approach to embed intelligence into applications.

The above considerations motivated the organisation of the ESAW'00 workshop, devoted to discuss technologies, methodologies, and models for the engineering of complex applications based on societies of agents, and aimed at bringing together people and contributions from both within and outside the field of DAI by promoting cross-fertilisation. By focusing on the social aspects of MAS, ESAW'00 concentrated on the space of agent interaction, rather than on specific intra-agent issues, and on the technology and methodology issues rather than on the pure theoretical aspects.

In particular, the workshop aimed to address the following issues:

- coordination models and technologies for engineering agent societies
- analysis, design, development, and verification of agent societies
- engineering social intelligence and emergent behaviours in MAS

- application experiences in building agent societies
- centralised vs. decentralised social control
- interaction/coordination patterns in agent societies
- security and mobility issues in agent societies
- enabling infrastructures for agent societies
- methodologies, tools, and artifacts for engineering agent societies
- design vs. self-organisation

In response to the ESAW'00 call for papers, we received twenty papers, which were peer-reviewed for scope and quality. The ten best submitted papers were accepted for presentation and discussed at the workshop. After a further phase of review and expansion, also meant to incorporate the results of the workshop discussion, the selected papers were included in the present volume.

The quality of presentations at ESAW'00 was high, and triggered a highly interesting discussion amongst the 25 participants of the workshop – which we would sincerely like to thank for their active participation and the level of their contributions to the debate.

The central question of the discussion was what of the agent societies is to be modelled, and how should they be engineered. Around this very general question, several specific issues were discussed related to:

- engineering of emergent behaviours in agent societies
- models and roles of the environment
- modelling and engineering methodologies and standards

Concerning the behaviour of the society, emergence seemed to be a central issue, and all the participants agreed that a theory of emergence may be needed for the engineering of complex agent systems.

Opposed to common assumptions in software engineering, any equilibria of the agent system are explicitly not accepted, and changing roles is common. This behaviour seemed to be outside the scope of prescriptive modelling, and caused rather by some sort of "indirect programming". Engineering the self-evolution of an agent system and enabling adaptation, e.g., by selection, learning, negotiating, or intervention of the environment, was considered a central challenge. To do so, some structured agent-behavioural language was considered necessary in order to change parameters that affect the emergent behaviour. Platforms for the development of agent systems thus need to offer evaluation methods.

Since the study of emergent behaviours has to focus also on the environment in which agents live, other than on agents themselves and their interaction, the importance of identifying or modelling the agents' environment led to another major thread of discussion. Agent-based models should provide a view of MAS as something more than distributed systems, and also supply suitable abstractions to capture the environment in which they are situated.

In several cases, the environment in which a MAS is immersed should be considered as active. First, unforeseen interactions with the environment have to be expected, given that several real-world systems and applications exist in

dynamic and unpredictable environments. Second, open agent systems intrinsically deal with environments that entities can enter and leave at any time: this suggests that an active environment could be naturally exploited to model an open system. Finally, it may sometimes be necessary to embed specific interaction laws within the environment: this raises the issue of the models and enabling technologies allowing such laws to be represented and enforced.

Due to its active nature, the environment might be modelled as an agent, or as a set of agents. However, that may turn out to be the wrong abstraction level for several kinds of applications, and in particular for those that require an explicit modelling and engineering of agent-to-environment interactions, distinct from agent-to-agent interactions. There, it seems mandatory for an engineered approach to agent societies to adopt the environment itself as a primary abstraction in the design and development of agent societies.

Yet another issue discussed was that of modelling and design methodologies. While standard methodologies like UML could be adapted to model agent societies, it was unclear whether the current state of the UML technology is enough to capture all fundamental notions, and to express them at the most suitable level of abstraction. In this context, it was also stated that misusing abstractions as provided by standard methodologies can point to defects or a lack of expressiveness in these abstractions.

To integrate a different modelling perspective, one may consider layers of abstractions and use different models of roles and societies at various levels. Then, each of these levels could be engineered individually, as in the case, for instance, of reliable message passing. In that case, a lower level could be devoted to engineer a reliable message-exchange scheme between two agents, whereas an upper level could be devoted to engineer complex interaction protocols, based on the reliability provided by the lower level.

Finally, a brainstorm session collected requirements on modelling tools and infrastructures to support the insights from the discussion.

ESAW'00 was our first attempt to put researchers from different areas together to discuss the multi-faceted issues that emerge in the engineering of complex systems as societies of agents. Given the level of the contributions, we are confident that this volume will be useful to the agent community, by providing many original and heterogeneous views on such an interdisciplinary topic as well as several attempts to put everything together. It is our hope that ESAW'00 will be only the first event of a series, meant to provide the agent community with a forum where novel ideas and results can be shared by crossing the boundaries of the many research and application areas that meet in the agent field.

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