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Engineering Environment-Mediated Multi-Agent Systems

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Preface

Software intensive systems are increasingly expected to deal with changing user needs and dynamic operating conditions at run time. Examples are the need for life reconfigurations, management of resource variability, and dealing with particular failure modes. Endowing systems with these kinds of capabilities poses severe challenges to software engineers and necessitates the development of new techniques, practices, and tools that build upon sound engineering principles. The field of multi-agent systems focuses on the foundations and engineering of systems that consists of a network of autonomous entities (agents) that interact to achieve the system goals. One line of research in multi-agent systems, inspired by biological, physical and other naturally occurring systems, concerns multi-agent systems in which agents share information and coordinate their behavior through a shared medium called an agent environment. Typical examples are gradient fields and digital pheromones that guide agents in their local context and as such facilitate the coordination of a community of agents. Since environment-mediation in multi-agent systems has shown to result in manageable solutions with very adaptable qualities, it is a promising paradigm to deal with the increasing complexity and dynamism of distributed applications.

Control in environment-mediated multi-agent systems is decentralized, i.e., none of the components has full access or control over the system. Self-organization is an approach to engineer decentralized, distributed and resource-limited systems that are capable of dynamically adapting to changing conditions and requirements without external intervention. This useful system property is often reflected in functions such as self-configuration, self-optimization, and self-healing. Engineering approaches to self-organizing systems often rely on global functionality to emerge from local and autonomous decisions of individual agents that communicate through a shared agent environment. When designing a system that is based only on local interactions in the environment and the emergent properties resulting from these interactions, it is a difficult research problem on the one hand to obtain the required global behavior of the system and on the other hand to avoid undesired global properties.

A particular issue in the design of self-organizing systems is determining the suitable complexity of the individual agents required to achieve the desired emergent functions. Typically, agents in self-organizing systems are less complex in their sensing, reasoning, and acting capabilities than agents in traditional multi-agent systems that follow a deliberate organizing approach. But, depending on the application domain, the functional requirements, and the sheer number of agents available in a particular setting, individual agent complexity may vary. As agent complexity increases, self-organization may become harder to achieve and to prove. EEMMAS addresses the approach of environment mediation among self-organizing agents that off-loads some of the agent complexity into the processes

of the dynamic agent environment. Off-loading agent complexity into the agent environment simplifies agent design, implementation, and evaluation and thus increases the likelihood of a successful application development.

The papers in this volume include both selected and thoroughly revised papers from EEMMAS 2007 and invited papers. The papers show how the agent environment provides a design element that allows multi-agent system engineers to manage complexity at different stages of the development life cycle. We hope that the papers of this volume stimulate further research in environment-mediated multi-agent systems.

March 2008

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