ON APPLICATIONS AND ENVIRONMENTS FOR MULTI-AGENT SYSTEMS

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Abstract

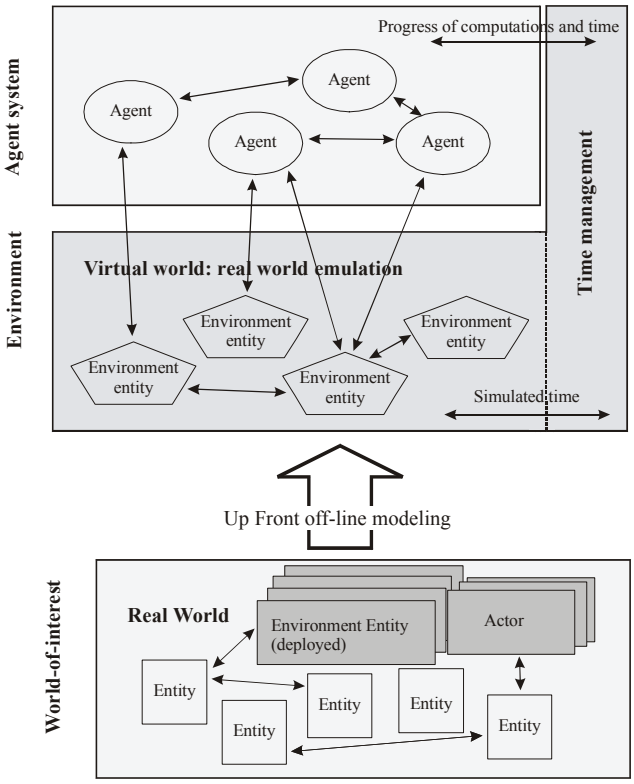
This paper addresses MAS environments from an application perspective. It presents a structured view on environment-centric MAS applications. This comprises three base configurations, which MAS applications may apply directly or combine into a composite configuration. For each configuration, the paper presents key issues, requirements and opportunities (e.g. time management issues, real-world augmentation opportunities and state snapshot requirements). Thus, the paper delineates what environment technology may implement to serve MAS applications. Sample applications illustrate the configurations. Electronic institutions provide an example of an environment technology, already achieving some maturity. This paper is a preview of a more extensive paper (Autonomous Agents and Multi-Agent Systems (2007) 14:61–85, DOI 10.1007/s10458-006-9002-5).

1 Simulation Applications

In simulation applications, agents interact with the environment, which models entities in the world-of-interest. There is **no run-time connection** from the real world to these models in the environment.

In this area, repositories of reusable **emulation models can capture important domain knowledge** and improve the overall quality of the models employed in MAS. The fact that these **emulation models correspond to parts of the real world** facilitates integration and reusability significantly. To this end, emulation model developers must avoid relying on a specific context and only reflect the corresponding part of the world-of-interest.

Specific for the simulation context is the need for **time management functions**. Some of these functions are the subject of ongoing research. In contrast, the ability to slow down agent computations when the emulation requires more than real-time, or the ability to emulate in real-time while agents are deliberating in combination with the speed-up of discrete-event simulation when agents are idling, are relatively simple time management functions. Nonetheless, such functionality is absent in existing simulation software and cannot be added later. Environment technology has the opportunity to provide suitable support at the core of its implementations.

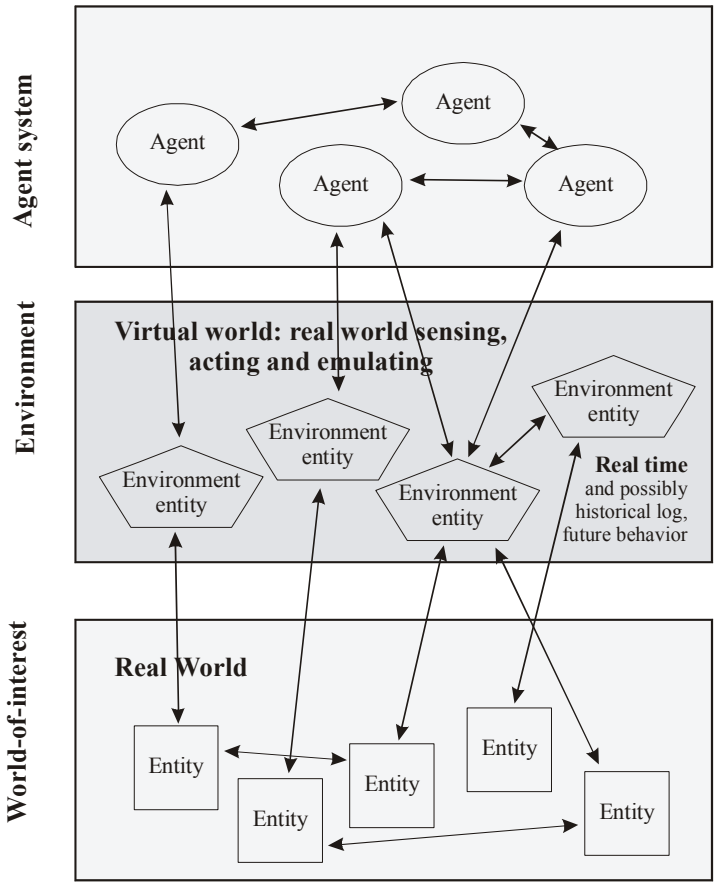


2 Real-world Interaction

A second configuration targets applications rooted in the physical world. Agents handle **all** decision-making aspects; the environment reflects the remaining entities in the world-of-interest. There is a **run-time connection** between the environment and the real world. **The agents only interact with the real world through the environment as an intermediary.**

In this configuration, **the environment provides important augmentations of the real world**. It provides enhanced access to the real world (sensor data processing, virtual sensors and actuators), on-line auto-updated documentation (specs, maps), and information processing infrastructures (stig-mergy). In additon, the environ-ment regulates the usage of and access to real-world entities. Moreover, it extends the real-world by its past (log or trace) and its future (what-if models, possibly reflecting intentions and commitments).

This functionality typically is reusable and modular. Indeed, many of the environment entities can be developed based on self-knowledge (of the corresponding real-world entity) only. Hence, such augmented environment entities can be constructed to be reusable wherever and whenever an instance of the correspond-ing real-world entity exists. And, much of the functionality is application-independent.



3 Other configurations

In a third configuration, the environment augments **adaptive structured information systems**. These augmentations extend the information system, monitor the information system and add information processing structures. Furthermore, the environment captures the behavior of the agents themselves, allowing the agents to benefit from past experience of the agent community. Moreover, the environment may provide links between information structures.

Composite configurations reveal how base configurations must anticipate integration requirements. The functionality identified in the composite configuration includes access to the 'system state' in base configurations. Time and time management services are also important.

Finally, the paper addresses software support. **Electronic Institutions** are discussed as an example of relevant technology.

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