Chapter 5
The Jadex Project: Simulation

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Abstract. Simulation is on the one hand an important application area for multi-agent systems, but on the other hand also a useful tool for building agent applications. This chapter investigates constructs and techniques that foster both usages of simulation in the context of agent technology. The vision for integrating simulation support consists in establishing simulation transparency, i.e. it should be ensured that applications can be built to a large extent without simulation specific parts. First, approaches for dealing with time in simulated and non-simulated agent execution are discussed. Afterwards the role of virtual environments in agent applications is tackled. Both technical topics are illustrated using concrete applications that further represent the different usages of simulation.

1 Introduction

The combination of agents and simulation forms a mutual benefit. Multi-agent-based simulation (MABS) is an approach, that uses the concept of an agent for supporting social simulation. Agents are well suited for e.g. representing realistic human behavior in simulation models, such as pedestrian traffic in a to be constructed train station. Therefore, agents are an accepted technology in the area of simulation. Viewed from the opposite direction, simulation is also a useful technology for supporting the construction of agent applications. In many agent applications, the interaction between the agents is considered to be an important part of the computational algorithm, e.g. in negotiations or decentralized coordination. Building such agent applications often requires fine tuning of parameters and making sure that the application produces suitable results, which can both be achieved by simulating the application behavior for testing and evaluation purposes.

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This is one of two chapters describing practical applications built with the Jadex agent framework. This chapter describes techniques and constructs of Jadex, that particularly focus on supporting simulation while establishing simulation transparency to a large extent. Simulation transparency means that the functional code of an application must not contain any simulation specific aspects. In this way an easy transition between simulations and applications can be achieved, e.g. code from an upstream simulation can be directly used to implement an application. It has to be noted that the environment and its connection to the application cannot be made transparent as in many cases a virtual one needs to be replaced by a real one.

Each section starts with a short historical background about why a certain topic was considered important for Jadex, followed by a more general motivation about the relevance of the concept itself. A related work section is presented for each concept, trying to give an overview of the field with pointers to other relevant works in the area. Afterwards the approach as implemented in Jadex is covered in detail and further illustrated by example applications that have been built. Each section closes with a short summary.

In this chapter, the following topics are tackled. The simulation of agent systems for supporting analysis and testing of applications is examined in Section 2. A useful supplement for simulation, but also a relevant topic in itself is the concept of virtual environments as described in Section 3. Finally, in Section 4 a conclusion and critical reflection on the described topics is given.

2 Simulation Clocks

One important aspect of simulation is how time passes during simulation runs. E.g. event-driven simulation allows executing scenarios “as fast as possible”, because computation only happens for the relevant time points. Using timed execution, simulation helps comprehending system activities and interrelationships from a global perspective and in a timely condensed fashion. Analysis of system behavior can be done in different ways. On the one hand hypotheses about the system behavior can be tested using simulation experiments and on the other hand conclusions can be drawn from experimentation under different setups e.g. comparing alternative strategies. Finally, verification of system behavior is related to hypotheses testing but more concerned with ensuring that the simulation model complies in its behavior to some system design specification.

Yet, the connection between simulation and application construction is often not well established. In many cases simulation is considered on its own as technique for experimentation. If a simulation is part of a real world application development project, in many cases simulation is used to analyze and verify the expected real world system behavior. Hence, the simulation