Organizational Metamodel for Large-Scale Multi-Agent Systems

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Abstract The main objective of this research is to ease organizational design of large-scale multi-agent systems (LSMAS) development. Methods including ontology engineering, metamodeling and code generation are proposed to achieve the set goal. The resulting modeling tool is expected to aid in development of LSMAS for numerous application domains.

1 Introduction

The function of an organization is to overcome various limitations of individual agents [6], and utilize agent cooperation and diversity in order to achieve organizational goals. Therefore, organizational modeling of large-scale multi-agent systems (LSMAS) that comprise software agents (as characterized by [3, p. 34]), is a problem worth researching. Proposing an upgrade of recent research on LSMAS organization, the planned research and the proposed organizational metamodel are based on the seven perspectives of organizational modeling [4]: organizational structure, organizational culture, strategy, processes, individual agents, organizational dynamics, as well as context and inter-organizational aspects.

2 Research Proposal

The planned research will build upon already established results presented in [1, 4, 6], based on three identified objectives:

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– O1: To define a comprehensive ontology that will combine concepts of organizational modeling and concepts of large-scale multi-agent systems.
– O2: To create an extensive organizational metamodel based on the developed ontology.
– O3: To develop a modeling tool to generate a basis (i.e. skeleton) of a large-scale multi-agent system, consistent with the defined principles of organizational modeling.

Several research questions have been identified, based on the proposed objectives:

– RQ1: Which organizational concepts are meaningful and suitable for organizational modeling of the large-scale multi-agent systems domain? Which of those should be included in the ontology or the metamodel being developed?
– RQ2: What real-life large-scale multi-agent system scenarios shall be targeted using the developed modeling tool?
– RQ3: How do large-scale multi-agent systems modeled according to various organizational models contained in the defined metamodel perform compared to each other and to real-life agents?

The stated driving elements of this research will serve as evaluation basis for the identified research hypothesis expressed as follows:

*Research hypothesis (**H1**): Based on the holistic organization ontology, it is possible to build a metamodel to be used for modeling complex large-scale multi-agent systems.*

It is assumed that an organizational metamodel can be built based on the developed holistic organization ontology. The presented hypothesis H1 will be evaluated using test-bed scenarios that will be developed within a massively multiplayer online role-playing game (MMORPG) as a suitable example of LSMAS application domain.

2.1 Preliminary Research

Preliminary research has been conducted within the ModelMMORPG[1] project: performance of real-life agents has been measured, a work in progress autonomous agent is being developed, and an ontology of organizational terms is being defined. Furthermore, initial multi-agent modeling methods for multiplayer on-line games (MMOGs) have been identified.

[1] Large-scale Multi-Agent Modelling of Massively Multi-player On-line Role-Playing Games, for more information visit ai.foi.hr/modelmmorpg

2.2 Future Research Plans

Focused on answering the identified research questions, the following stages are planned:

1. The comprehensive LSMAS organizational modeling ontology will be defined (building on [5]) using an ontology engineering methodology (e.g. METHONTOLOGY).
2. An extensive organizational metamodel for LSMAS will be constructed.
3. A modeling tool for generating LSMAS skeleton will be developed based on the metamodel.
4. The implemented modeling tool will be put to use on a number of test-bed scenarios to be identified, possibly including the Internet of Everything (IoE), smart cities, and especially MMOGs.

2.3 Methodology

Proposed methodology for achieving the set research goals depends heavily on ontology engineering, since the proposed organizational metamodel will be based on the ontology being developed. One of the considered ontology engineering methodologies is METHONTOLOGY [2].

The metamodeling process based on the developed ontology will yield an organizational metamodel. Symbols of the metamodel should be suitable for use with a modeling tool, yet descriptive enough for organizational models of LSMAS. Similar modeling languages will be considered in the process, and the defined metamodel may be compared for disadvantages and advantages to a popular modeling language (e.g. UML). Once developed, the metamodel will be tested using test-bed scenarios.

3 Reflections

Having performed analysis of related LSMAS research, the author is not aware of an attempt to build a comprehensive ontology that combines concepts of organizational modeling and concepts of LSMAS in the way proposed in this research. The most distinguishable novelty of the proposed holistic ontology lies in its comprehensiveness, since it comprises several perspectives of organizational modeling, as opposed to classically observed organizational structure perspective only.

Interdisciplinary nature of the subject area is most enticing, since it encompasses both a social (organization theory) and computer science (ontology engineering, metamodeling, software development) approach. It is hoped that the results of the proposed research will provide us with new and unseen possibilities of software engineering of LSMAS, especially in the areas of the IoE, smart cities and MMOGs.

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