

# Multi-Agent Abstractions and Organizations and the i\* framework

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**Abstract.** i\* is one of the more promising goal-oriented modeling framework to capture and model multi agent systems (MAS) requirements. Moreover, i\* has been incorporated as the foundation for one of the more important AOSE methodologies, that is, Tropos. Our research interests related with i\* cover two mainly directions. The first, is to compare i\* with other methods, techniques and notations for capturing and modeling MAS abstractions. The second is related to the computational organization theory to model the organizational perspective of the MAS. Specifically, we are analyzing the critical issue of coping with adaptive changes of MAS organizations whenever circumstances claim for changes in the very MAS structure. Then, we are surveying different relevant AOSE methodologies, Tropos (and therefore i\*) among others, to discuss their suitability in dealing with adaptation in MAS organizations.

## 1 Introduction

A great deal of efforts in the Agent-Oriented Software Engineering (AOSE) area focuses on the definition of methodologies to guide the process of engineering complex software systems based on the multi agent systems (MAS) paradigm. AOSE methodologies, as they have been proposed so far, mainly try to suggest a clean and disciplined approach to analyze, design and develop MASs, using specific methods and techniques.

Those efforts have to consider the relevance of requirements engineering for agent based systems. Like any paradigm, Agents-Oriented introduces different abstractions which have to be captured in the modeling of the problem and solution domains. However, several of the AOSE methodologies do not (or partially) cover the requirements elicitation phase [Cernuzzi, et al. 2005].

Different aspects have been considered to capture and model requirements for design and development of MAS: organizational, behavioral, domain, and goals model. The two mainly approaches consider the actors (or scenario-based) perspective (i.e. CREWS, AUML) and the goal-based perspectives (GBRAM, KAOS, i\*). Then, it may be useful to analyze the benefits and limitations of such approaches for the AOSE methodologies.

Moreover, among the abstractions characterizing MAS, the organizational perspective covers a special role. In effect, the general behavior of the MAS strongly

depends on the interaction among the different agents composing the global organization. This introduces the need to capture and model at least the social structure (including its topology), the static and dynamics relationships among agents and the rules and norms governing the global behavior.

In MAS organizations the types of interactions among component vary a lot, and may change during the time, depending on the goal of the system and the objective of each agent. In effect, MAS, as well as the great majority of modern software systems, are likely to be subject to a large number of adaptive changes during their lifecycle. Since, some changes may affect the very structure of the MAS, an AOSE methodology should not only facilitate the effective development of a MAS answering to specific requirements, but should also facilitate engineers and developers work whenever adaptive structural changes in the overall organization of a MAS are required.

Therefore, it may be interesting to analyze how AOSE methodologies (Tropos among them) with their corresponding processes, models and notations, facilitate designers to cope with adaptive changes that may have a global impact on the overall design of a MAS.

## **2 Objectives of the research**

Our research interests related with i\* cover two mainly directions each one with its specific objectives. The first, is to compare i\* with other methods, techniques and notations for capturing and modeling MAS abstractions. The goal of such comparison is to eventually suggest relevant methods and notations to extend the existing AOSE methodologies which do not cover the requirement elicitation phase in their process.

The second direction is related to the critical issue of coping with adaptive changes of MAS organizations whenever circumstances claim for changes in the very MAS structure. Then, we are surveying different relevant AOSE methodologies to discuss their suitability in dealing with adaptation in MAS organizations. Among others, we are analyzing the Tropos methodology and consequently the i\* framework, for modeling the organizational perspective considering the adaptive changes.

## **3 Scientific contributions**

Considering the critical issue of capturing and modeling requirements for agent based systems, we think that some kind of analysis (evaluation) of methods, techniques and notation for capturing MAS requirements may improve the reliability of their adoption in the AOSE methodologies and, more generally, in the design and development of agent based systems. Therefore, we have already presented a first comparison among three different methods, namely RETO, Agentis, and GBRAM [Rodriguez et al 2008] and we are planning to extend such comparison to different approaches like i\*.

On the other hand, the issue of continuous design change/adaptation in MAS organizations has been the subject of several studies. However, the specific problem

of how to properly analyze, design, and develop a MAS so as to make it ready to adaptation is definitely under-studied [Cernuzzi and Zambonelli 2006].

Some recently proposed AOSE methodologies explicitly face the problem of structuring the organization of the MAS introducing some degree of modularity separation of concerns that make them more suitable for adaptive change. Among others, an interesting approach is offered by Tropos.

The Tropos framework aims at building agent-oriented software that operates within a dynamic environment. A curious thing is the Greek etymology of the word which means “easily changeable/adaptable”. Tropos is mainly requirement-driven, adopting the i\* organizational modeling framework, and views the information systems as social structures that is a collection of social actors, human or software, which act as agents, positions, or roles and have social dependencies among them. To capture the organizational perspective, Tropos includes actors diagrams for describing the network of social dependency relationships among actors (modeling an agent, a role or a set of roles), and rationale diagrams for analyzing and trying to fulfill the specified goals of the actors. Also in the architectural design phase, more systems actors are introduced and goals and tasks assigned to the systems are deeper specified in term of sub-goals and sub-tasks. As presented in [Cernuzzi and Zambonelli 2006], this clear focus of Tropos on the definition of the organizational structure is a key requirement for promoting adaptive organizational changes.

## **4 Conclusions**

The results of comparative analysis of requirement engineering frameworks for MAS introduce the opportunity of improving those AOSE methodologies which do not (or partially) cover the requirement elicitation process. In this direction, we are proposing such improvement for the Gaia methodology.

On the other hand, as presented in [Cernuzzi and Zambonelli 2006] several AOSE methodologies offer relevant insights to deal with the adaptive changes in MAS organizations. However, most of the AOSE methodologies are concerned with the analysis and design processes only [Cernuzzi et al. 2005]; few are trying to cover the development and deployment of the system; less yet are concerned with the maintenance stage of the system. Thus, even when a methodology is more suitable for a design-for-change perspective, a specific attention to the maintenance process and the definition of proper guidelines for change and adaptation are lacking, which is a great limitation for modern methodologies.

As a final point, it is also worth outlining that the dynamism of modern scenarios and need of nearly continuous adaptive changes claim for evolutionary process models and, more specifically, agile extreme process models. However, current agile and extreme software process models focus on small- to medium-size projects, and are not yet ready to tackle the complexity of developing large-scale adaptive MAS.

## **5 Ongoing and future work**

In the requirement elicitation direction we have already presented a first comparison among three different methods, namely RETO, Agentis, and GBRAM [Rodriguez et al. 2008]. We are planning to extend such comparison including i\*.

Moreover, being the organizational modeling a central point for the current AOSE methodologies, we are analyzing how AOSE methodologies facilitate designers to cope with adaptive changes that may have a global impact on the overall design of a system (i.e., on the overall architecture/organization of MAS). For this purpose, different aspects may have relevant impact. The application of principles like modularity and separation of concerns, the adopted process of the methodology, the explicit modeling of relevant abstractions for organizations (i.e. organizational structure and control regime), among other factors, may help designers to choose a different organization whenever circumstances claim for changes. Therefore, in this on-going work we are surveying some relevant AOSE methodologies (Gaia, Tropos, Ingenias and Passi) to discuss their suitability in dealing with adaptation in MAS organizations.

## **References**

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