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Towards a Model of Multi-Agent Systems' Organization

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1   Introduction

With the growing interest in Multi-Agent Systems (MAS), the need of useful tools to design such systems is an important concern of research. As initiated in the ASIC model [1] and developed in [2], modeling a complex and decentralized system using MAS technics can be viewed through four main axes : agents, interactions, organizations and the environment in which agents interact.

In this context, we are interested in modeling the organization of a MAS. For us, the organization axe deals with the structure of the agents in the system, along different schemes (hierarchy, team, group...), in order to control their processing.

In our opinion, this structure is related to the definition of responsibilities regarding the execution of missions among agents. Considering the MAS research scenario, two main approaches can be found : a pre-defined one and an emergent one. In the pre-defined approach, this structure constrains the functionning of the agents (i.e. it is a design constraint) whereas in the emergent approach, this structure is the result of the functionning of the agents.

In this paper, we are mainly concerned with the first approach. We present an organizational model whose core notions are organisational *roles* and *links*. This model is currently used for the specification of a groupware application using a MAS approach.

2   Modeling the Organizational Structure

Organization is a field of interest in different domains : ethology, biology, economics, sociology ... In MAS, an organization is often expressed as a set of roles and links between them. What these roles and links are depends on the authors [3, 4]. Schematically, the organization enables to express *who* does *what*, *when* one does it and often *how* one does it.

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Our model of a MAS organization [5] is decomposed into an organizational structure (OS) and an organizational entity (OE) :

- The OS is defined as a graph of organizational *roles* and organizational *links* between them ;

- The OE is a set of agents of the system, structured according to an OS : agents are associated to roles and connected according to the corresponding links, i.e, it is a kind of instantiation of an OS.

2.1 Roles

A role is a coherent collection of *missions*. A mission is defined by a quadruple of four sets : *goals, plans, actions* and *resources*. Each set can be eventually empty. The goal set defines the goals to achieve for the defined mission. The plan set defines the plans to follow, the action set, the actions to execute, and the resource set, the resources to be used.

The combination of these four sets, allows us to define and constrain a mission with more flexibility. For example, a mission defined with only goals, allows the agent that fulfills this mission to define its own plans, using any actions and resources. In this sense, it is less constrained than an agent that has to fulfill a mission with specified plans, actions and/or resources to use.

2.2 Organizational Links

An organizational link is a directed arc between two roles. It can be an *authority* link, a *communication* link or an *acquaintance* link. This link is labelled by a possibly empty subset of missions of the source role and subset of missions of the target role. Through these links, agents playing the source role of the link, may respectively control, communicate or represent the agents playing the target role, in the context of the missions qualifying the link.

The roles and the set of three links, authority, communication and acquaintance, can be viewed as a superposition of three graphs respectively the control graph, the communication graph and the acquaintance graph.

The control graph represents control paths among roles in the organization. It defines the degree of control/influence that agents playing the source role may carry on agents playing the target roles.

The communication graph represents the path of allowed information transit in the organization. The aim of the graph is to better represent the organization data flow.

The acquaintance links allow the agents to have knowledge and maintain a representation of other agents. These knowledges and representations can concern the dependence relations between these agents, the skills of these agents, the degree of preference, etc., and it can help an agent to choose an interlocutor for a particular cooperation.

3 Conclusion

In this paper, we have presented a first step towards modeling the organization in a MAS. We have proposed a structure of agents in a system according to OS,

which is composed of roles and links. The use of this model is currently applied on a groupware application.

This is a first attempt to validate our model that enables us to envisage different perspectives of development. First, we have to enrich the formalization of the roles and links especially to ensure a well defined semantics on these concepts (deontic logic should be a good candidate). In parallel, we have started to study the validation of these organizational structures in terms of coherence : is such an authority link justified beetween these roles [6] in face of existing dependence relation [7]. Besides the definition of a MAS organization, we have then to start to design agents that are themselves able to design and settle such organizational structures dynamically in an emergent approach.

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