ABSTRACT

Organization concepts and models are increasingly being adopted for the design and specification of multi-agent systems. Agent organizations can be seen as mechanisms of social order, created to achieve common goals for more or less autonomous agents. In order to develop a theory on the relationship between organizational structures, organizational actions, and actions of agents performing roles in the organization, we need a theoretical framework to describe and reason about organizations. The formal model presented in this chapter is sufficiently generic to enable the comparison of different existing organizational approaches to Multi-Agent Systems (MAS), while having enough descriptive power to describe realistic organizations.

INTRODUCTION

Organizing is important in distributed computational systems, just as it is important in human systems. Researchers, within both the computer science and the organization theory fields, agree that many concepts and ideas can be shared between the two disciplines to better understand human organizations and to design more efficient and flexible distributed systems (So and Durfee; 1998; Cohen, 1986; Fox, 1981). However, due to its nature, organizational theory research tends to be not very formal from a computational perspective, which makes it difficult when moving from its use as a concept or paradigm towards using social and organizational concepts for the formalization of social concepts in Multi-Agent Systems (MAS).
Given such different views, the difficulty of comparing, analyzing and choosing a given approach becomes clear. Even if our aim is not to solve this problem, in this chapter we present initial steps towards the specification of a formal model for the study of agent organizations. The motivations for this model are twofold. On the one hand, the need for a formal representation of organizations, with their environment, objectives and agents in a way that enables to analyze their partial contributions to the performance of the organization in a changing environment. On the other hand, such a model must be realistic enough to incorporate the more ‘pragmatic’ considerations faced by real organizations. Most existing formal models lack this realism, e.g. either by ignoring temporal issues, or by taking a very restrictive view on the controllability of agents, or by assuming complete control and knowledge within the system (cf. Wooldridge, van der Hoek, 2005; Santos et al, 1997). Formal models for organizations that are able to deal with realistic situations, must thus meet at least the following requirements (Dignum, Tick, 2007):

1. represent notions of ability and activity of agents, without requiring knowledge about the specific actions available to a specific agent
2. accept limitedness of agent capability
3. represent the ability and activity of a group of agents
4. deal with temporal issues, in special the fact that activity takes time
5. represent the concept of responsibility for the achievement of a given state of affairs
6. represent organizational (global) goals and its link to agents’ activity, by relating activity and organizational structure

All of the above requirements are related to the more structural properties of an organization and will be met with the theory developed in this chapter. Furthermore, the following requirements are needed to enable complete representation and analysis of organization:

7. deal with resource limitedness and the dependency of activity on resources (e.g. costs)
8. represent organizational dynamics (evolution of organization over time, changes on agent population)
9. represent organizations in terms of organizational roles or positions
10. relate roles and agents (role enacting agents)
11. deal with normative issues (representation of boundaries for action and the violation thereof)

These requirements are related to the more operational aspects of an organization. E.g. the notion that agent activity has a cost (that is, choosing one or the other course of action is not only dependent on agent capabilities but also the costs of the action must compare positively to its benefits) is related to actual performance of an agent within the organizational structure (Dastani et al., 2003, Grossi et al, 2007a, Vazquez-Salceda et al., 2005). Due to space limitations we will not deal with these requirements in this chapter. Some related research on the analysis of organizational structures is presented in Chapter VIII, “Structural Aspects of Organization” by Grossi and F. Dignum.

This chapter is organized as follows. In section 2 we discuss related work and motivate the need for the formal language. In section 3 we define ability and activity of agents and groups. Section 4 presents the formal model for organization including structural and interaction properties. The use of our language for the modeling of organizations is exemplified in section 5. Finally, section 6 presents our conclusions and directions for future work.
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