Formalizing Organizational Constraints
A Semantic Approach

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1   Extended Abstract

This is an extended abstract of [11]. An important line of research in the multi-agent systems (MAS) field that has received increasing attention in the last years, is to assign an organization to the MAS with the aim of organizing and regulating it. Assigning an organization to a MAS can be done by developing an *organizational specification* in an organizational modeling or programming language (see, e.g., [3, 1, 6, 2, 4]). An organizational specification abstracts from the individual agents that will eventually play the roles in the organization. It may define the structure of the agent organization in terms of roles and the relations between roles, and specify the norms (e.g., obligations and prohibitions) that are to be followed by the agents of the MAS. Organizing a MAS should make the agents more effective in attaining their purpose, or prevent certain undesired behavior from occurring. An organizational specification achieves this by imposing *organizational constraints* on the behavior of agents that function in the organization.

Agents that operate in such an organized MAS are expected to take these organizational constraints into account when deciding what to do. For example, if an agent plays a role, this typically comes with obligations that are to be adhered to. Agents should be aware of this and take this into account when deciding on action, if they are to operate effectively and flexibly in the organization. Agents that are capable of such organizational reasoning and decision making are called *organization-aware agents* [10, 9]. Organization-aware agents should be contrasted with agents that have been designed to function in a particular organization and that do not reason about the organizational specification. For such agents, it will be more difficult to adapt their behavior to changes in the organizational specification. That is, an important advantage of organization-aware agents is added flexibility due to the fact that they are able to understand the organizational specification.

Our research objective is the development of languages and techniques for organization-aware agents. An essential step towards this is specifying clearly what an organization expects from agents, i.e., what the organizational constraints are. Ambiguity or unclear specifications of such constraints may at best result in innocent misbehavior on the part of the agents but at its worst may result in a dysfunctioning organization. Moreover, without a precise specification of organizational constraints it is not clear what to aim for when developing (languages and techniques for) organization-aware agents.

In [11], we investigate organizational constraints in the context of the well-known MOISE$^+$ organizational modeling language [8, 7, 6]. MOISE$^+$ does not come with a comprehensive formalization of all organizational constraints. Nevertheless, some aspects are formalized in [7], and [5] formalize some constraints by expressing them in a normative programming language with formal semantics. Our approach to making organizational constraints precise is to define a formal semantic framework for MOISE$^+$ MAS and an accompanying linear temporal logic (LTL) to express its properties. We discuss which constraints MOISE$^+$ imposes on agents, and analyze them by making them precise in LTL. We use LTL rather than a deontic logic since it allows to characterize properties of the traces that are produced by executing a MAS, which is precisely what we need for expressing hard and soft constraints. We show that multiple interpretations of

constraints are sometimes possible, and explore the space of possibilities by formalizing different variants in LTL and investigating their properties. These analyses demonstrate the need for a rigorous specification of organizational constraints, and provide the foundations for the development of organization-aware agents that function in a MOISE$^+$ MAS.

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