Using Agent-based Organisational Models for Crisis Management*

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Abstract

Simulations of crisis scenarios have the potential to increase insight in the organisational structures needed as crises escalate. Multi-agent system (MAS) models allow for cost-effective simulations of changing organisational structures, enabling analysis of the implications for enactment during crisis escalation with respect to roles and communication structures. This paper presents an organisation-based model for crisis management that supports simulation of the dynamics of crisis management.

1 Introduction

Crisis management is a challenge, especially when crises escalate. The numbers of organisations involved increases, communication lines change, roles change. Simulations provide a means to study the consequences of escalation of crises with respect to structures involved. As a crisis escalates, organisational structures are systematically updated to reflect the changes in the nature of the crisis and the number of parties involved. In the real world, simulations are enacted using active personnel. However, such simulations are expensive, both in terms of the cost of execution and the cost of the time required for the emergency service personnel involved. Computer models of escalation of crisis, provides a more cost effective means to study the potential of different organisational structures in very many different scenarios.

The research presented in this paper is part of the ALIVE project. ALIVE aims to apply organisational theory to the design and implementation of software systems. The main focus of the project is to create complex systems based on the composition of (existing) services, through the addition of levels of abstraction. The advantage of added levels of abstraction to the design process of systems is two-fold: 1) it is often more intuitive to think in organisational structures and interactions while designing complex interactions for services, and the addition of the layers of abstraction allows for a gradual (fluent) transition from the system as foreseen to the actual implementation; 2) when changes happen in the environment (for example, specific services become unavailable) the added levels of abstraction act as an explicit representation of the conceptual steps made at design, thus giving additional information on why certain interactions are as they are, that enables the system to dynamically cope with the changes.

2 Crisis Management Organisations

The domain of crisis management, in particular the study of crisis response scenarios, is an active area of research in the field of Multi-Agent Systems [4]. In this domain agents, roles and groups can be clearly identified, the interaction patterns between (groups of) agents can be coordinated, and the interaction between

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(groups of) agents with their changing environment can be modelled. Most current systems provide coordination and planning capabilities for teams of agents, often assuming the emergence of group behaviour. Formalised organisation processes defined by governments and aid agencies define a strict frame for action. Organisations have been defined as instruments of purpose [2], that is, organisations have objectives to be realised. Objectives of an organisation are achieved through coordinated actions of agents efficiently, requiring distribution and coordination of activities such that 'the right agent is doing the right thing' [1]. Formal processes and requirements are the basis for the modelling of a MAS that regulates the activities of the different agents. This approach can be seen to be a form of adjustable autonomy. A formal organisational model determines the range of autonomy of the participating agents, that in fact is adjustable [5].

The results of the ALIVE process can be used to implement agents representing personnel involved in crisis management as well as the underlying crisis management scenario. The instructions are interpreted by the personnel agents, and are executed. Landmark patterns determine sequence of actions that actor agents will order other agents to perform. For example, if a landmark pattern determines that all people must be evacuated before the fire can be extinguished, the fire service agent will wait for this condition to exist before putting out the fire. These patterns are utilised to simulate different strategies to achieve a set of goals.

This methodology supports rapid development of new scenarios while maximising the reuse of existing agents. Scenarios depend on a set of predefined agent types and a set of landmarks. The coordinator interprets these landmarks. Work is ongoing towards developing a complete set of agents that will allow the representation of more complex scenarios. This also involves the creation of a set of additional agent types to represent all of the actors involved in such scenarios.

3 Conclusions

This paper describes how organisational models can be used to simulate crisis management organisations. The organisational models allow the scenarios to be defined in a structured way. These scenario structures are then taken and implemented in the AgentScape system [3]. Organisation modelling provides the ability to determine where the relationships between stakeholders exist and how these relationships influence the results of a crisis. The organisation model presented in this paper enables the explicit representation of both structural and strategic concerns and their adaptation to changes in the environment.

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