I-Rescue: A Coalition-Based Approach to Support Disaster Relief Operations

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Abstract

I-Rescue is a framework/system that supports the establishment of coalitions during disaster relief operations. Based on the roles that joint agents are playing, they are organised into a hierarchical structure composed by the strategic, tactical and operational levels. Each level provides specific handles so that agents can manage shared models specified via a general-purpose constraint-based representation. Via shared models, agents in multiple levels will be able to share knowledge and integrate different capabilities during the planning and execution stages of operations.

1 Introduction

The amount and diversity of agents involved in disaster relief operations suggest the use of a command and control structure that provides mechanisms to coordinate the efforts of these agents. A way to deal with this scenario is to consider every agent as a member of a coalition, which supports the integration of agents' capabilities [Allsopp *et al.*, 2002] and the interaction among them.

I-Rescue (http://i-rescue.org) is a framework/system to support the establishment of coalitions, during disaster relief operations, that use the I-X approach [Tate *et al.*, 2002] as form of integration. Via specific issue and constraint handles, agents can create and modify representational models that are shared with others agents so that knowledge can be discerned by a whole (or a specified part of a) coalition.

I-Rescue provides a hierarchical structure of command and control composed at three levels (strategic, tactical and operational), which enable the development of coordination tasks in a complementary way. Consequently users on each level carry out different tasks and decision processes, and the specification of handlers to support their activities is been based on particular requirements of each level.

The remainder of this document is structured as follows: section 2 summarises the I-X shared model ideas. Section 3 presents the I-Rescue structure and the features of its decision levels. Section 4 describes the representational models that can be handled by the agents. Section 5 discusses some conclusion and future works, while the last part lists some references.

2 Shared Models

The I-Rescue approach involves the use of shared models for task-directed communication between agents who are jointly exploring a range of options for the synthesis of a product. Each product, described in XML, is represented as a set of constraints on the space of all possible products of a domain using the <I-N-C-A> ontology [Tate, 2000], a general-purpose constraint-based representation. This representation is intended to support a number of different uses:

- For automatic and mixed-initiative generation and manipulation of processes (e.g. plans);
- As a common basis for human and system communication about processes;
- As a target for principled and reliable acquisition of plans, process models and processes product information;
- For formal reasoning about individual and collaborative processes.

An important role of ontology is to support knowledge sharing activities [Gruber, 1995]. Using <I-N-C-A> as common ontology in a coalition, the models generated can be shared, analysed and modified by any joint agent.

3 I-Rescue Structure

The I-Rescue system performs planning and decision processes at three different levels: strategic, tactical and operational (Figure 1). In each level there is a specific kind of agent (called *I-Rescue*, *I-Help* and *I-Aid* respectively) that interacts with users in a mixed initiative style. This approach results in several advantages: intensifies the user control and involvement, permits user interaction during whole decision process so that they are able to understand why ways were chosen or avoided, and removes the premise of complete and bug-free knowledge.

According to the level that agents are operating in the structure (Figure 1), they will have specific features and requirements. *I-Rescue agent* supports users that are developing strategies in a high-level of granularity ("what-to-do decisions"). It deals with diversified and non-technical information and the issues are sometimes accomplished in the long term. Basically the whole setting is affected by its decisions.

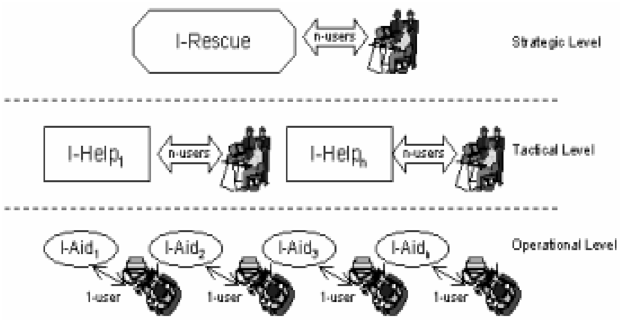

Figure 1 – Hierarchical structure of the I-Rescue system

I-Help agents usually account for refining the decisions generated by the strategic level, deciding who will carry out the tasks ("who-will-do decisions") via processes as resource scheduling and load balancing. Thus information is more specialised and limited groups of agents will be affected by their resolutions.

I-Aid agents support the users that, in fact, accomplish the tasks. For this reason, their level of knowledge is well specialised in the domain that they are operating in and their decisions are on sets of atomic actions.

These and others features show a dissimilarity between the hierarchical levels that influences the specification of the handlers, which are been adapted in accordance with the users' tasks into each level.

4 Representational Models

Agents are able to handle representational models of (strategic, tactical or operational) plans, ongoing execution, relationships and environment.

The development of a *plan model* can be carried out via delegation, SOP (Standard Operation Procedures) and intelligent planning processes. Via delegation users choose sub-tasks and agents to accomplish these tasks. SOPs are sequences of pre-defined tasks that are based on standard experiences as best practice [MPAT, 2002] [US Joint Pub, 1998]. Planning provides handlers to manipulate a set of constraints such as time, priority and sequence.

The ongoing *execution model* describes the current status of activities and it is manipulated via agents' reports. This model supports, mainly, the processes of plans' failure predictions. The *relationship model* shows the position of each agent into the coalition and the restrictions policies on kinds of interaction that one agent can have with other. The *environment model* provides ways for sharing information about scenarios and their objects. Users can update these models in accordance with their perceptions.

Handlers for representational models are specified as plug-ins and they can be extended via an open plug-in interface according to possible new requirements.

5 Conclusions and Directions

The coalition metaphor is a natural way of putting together different agents that have objectives in common during disaster relief operations. In scenarios like that, agents will perform in distinct levels, dealing with different information and carrying out complementary tasks. So, a better understanding of these levels and their relations can improve the mechanisms of interaction among agents and system.

This work is considering this fact to specify customised agents that provide mechanisms more limited to the users' roles. Together with the representational models summarised here we are currently formalising the use of I-Rescue as a hierarchical mixed-initiative planning system and considering a future integration with emerging technologies (Wireless communication, Personal Digital Assistants, Global Positioning System, etc.) that turn it into practical application.

References

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