Using *Jason* and MOISE$^+$ to Develop a Team of Cowboys

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1 Introduction

This paper gives an overview of a multi-agent system forming a team of “cowboys” to compete in the Multi-Agent Programming Contest 2008 (the ‘Cows and Herders’ scenario). In the two previous contests, we tested and improved *Jason* [2], an agent platform based on an extension of an agent-oriented programming language called AgentSpeak(L) [5]. The language is inspired by the BDI architecture, thus based on notions such as goals, plans, beliefs, intentions, etc. The participation in previous contests also increased our experience both in using BDI concepts as well as in programming agents with *Jason* specifically. In the 2006 contest, the focus was on the definition of agent’s plans [1], leading to rather reactive agents. In the 2007 contest, the focus was on (declarative) goals [3], leading to more pro-active, goal-directed agents.

For the 2008 contest, we were motivated to continue improving the multi-agent programming abstractions, now towards social or organisational agents, using the concepts such as roles and groups. The system is therefore developed in two dimensions: agents (using declarative goals) and organisation (using groups, roles, and shared goals). Among several organisational models available, we will use the MOISE$^+$ model because it is well integrated with *Jason* [4]. Our objective in participating in this contest was thus twofold: (i) to continue to test and improve *Jason* and its integration with MOISE$^+$; (ii) evaluate the use of organisational constructs in the development of the team.

2 System Analysis and Design

It is clear, from the description of the scenario, the importance of cowboys working as a coordinated team. It would be very difficult for a cowboy alone to herd a group of cows. We therefore adopted a strategy strongly tied to the notion of group of agents where issues such as spatial formation, membership, and coordination would be emphasised.

The organisational structure of the team is specified in Fig. 1 using the MOISE$^+$ notation. Our team has two types of subgroups: one to explore the environment searching for cows (the exploration group) and another one that leads the herd towards the corral (the herding group). The team always has three instances of the exploration group, each one responsible for some part of the scenario. The agents enter and leave these groups as the result of their decision to start or stop searching cows. The herding groups are dynamically created as the agents decide to herd a cluster of cows. The number of those
groups and the agents that belong to them depend on the size and location of found clusters of cows. The following roles can be played by agents in the respective groups:

- **explorer**: explores the environment until it detects a cow;
- **scouter**: follows the explorer;
- **herder**: herds the cows detected by explorers until they reach the corral;
- **herdboy**: helps the herder to lead cows to the corral.

The roles leader and cowboy are abstract and used to specify common properties of their sub-roles. For example, leaders have authority over others cowboys.

The general dynamics of the agents playing the above roles is described with the help of the following scenario. (1-start) At the beginning of the simulation, three exploration groups are created with two agents in each group, on playing the explorer and the other the scouter role. Agents split themselves up so as to cover as wide a range as possible, without necessarily keeping each other in sight. (2-herd) As soon as an agent perceives cows, it informs the members of its exploration group. The explorer of the group creates a new herding group and then changes its role to herder. The scouter also changes its role to herdboy in the new group. After the new group is created, a cluster of cows is assigned to it based on the cows already seen by the agents. The leader then defines the group formation so that the cows are led to the corral. (3-merge) If two herding groups are too near, they are ‘merged’: one group remains and the other is removed from the organisation. All agents of the removed group change their roles to herdboy in the remaining group. (4-dissolve) Once the corral is reached and the cluster is empty, the herding group is dissolved and the agents create exploration groups returning to the first step (1-start). Table 1 briefly presents the goals that agents are obligated to achieve when playing each of the roles. An agent that adopts the role scouter, for instance, is obligated to achieve the goals share_seen_cows and follow_leader.

Although we have some global constraints over the agents’ behaviour (based on the roles they are playing), they are autonomous to decide how to achieve the goals assigned to them. While coordination and team work are managed by the MOISE+ tools, the autonomy and pro-activeness are facilitated by the BDI architecture of our agents implemented in Jason. Regarding communication (required, for example, for the share_seen_cows goal), we use speech-act based communication available in Jason.