Universitat Rovira i Virgili

Introduction to MultiAgent Systems

Final Report

Report of the Practical Work

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Introduction

Goal

In this report we present the final approach of the Multi-agent system implemented for solving the practical work of IMAS.

Description

In this report we will discuss:

- The implemented solution main characteristics: architecture and communication protocols.
- The main differences from Activity 1 and 2 versus the final implementation, giving again a reasoned explanation.
- The results and statistics obtained with our MAS system on the "settings for evaluation" provided.
- Improvements than we consider relevant to be implemented to improve the system performance and statistics results.
- Finally, we will present our conclusions on the practical work and the implemented solution.

Multi-agent System Architecture

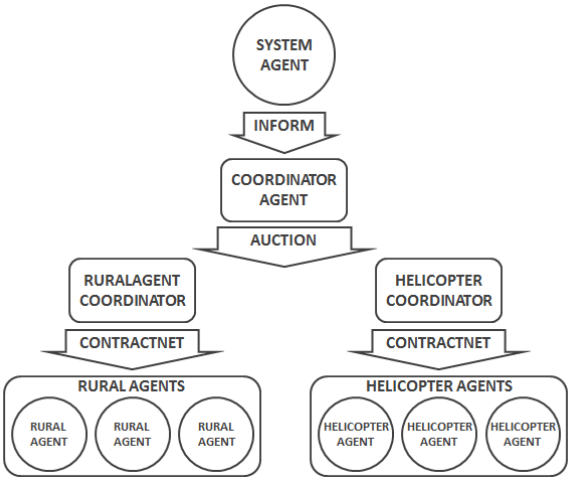

Figure 1: Architecture and protocols implemented.

In figure 1 we can see how the agents of our system communicate. The information flow would be:

1. The System-Agent changes the environment: adding new elements to be taken into account(avalanches) and new injured people to be rescued.
2. The System-Agent sends a model of the environment to the Coordinator-Agent.
3. The Coordinator-Agent identifies the non-assigned tasks to be distributed and performs an auction of one of them among the Helicopter-Coordinator and the Rural-Agent-Coordinator.
4. The Rural and Helicopter Coordinator-Agents in order to give a bid for a task, they propagate the task to the Helicopter and Rural Agents, using the ContractNet communication protocol.
5. Each single Rural and Helicopter Agent will evaluate how "interested" are they to perform the published task. And return an effort cost than it involves them to perform it.
6. The Helicopter and Rural Coordinator-Agents evaluate all the retrieved costs and use them for answering how interested are they to accept the task, by bidding to the auction than the Coordinator-Agent announced.
7. The Coordinator-Agent selects who wins the auction from the retrieved bids and informs two the Helicopter an Rural Coordinator-Agents of the auction result.
8. The Helicopter and Rural Coordinator-Agents inform to the Helicopter and Rural Agents about the ContractNet result, according to the auction result.
9. If there are more non-assigned tasks to be distributed with the auction process then it continues from step 3. Otherwise, the distribution of the tasks is finished.
10. They will be communicated again in relation to the distributed tasks informing from the resulting states from performing them.
11. When a task is finished the final result is stored for the MAS system statistics. Otherwise, when it fails to be accomplished the Coordinator-Agents adds it to the non-assigned tasks re-distributes it.

Modifications from the previous Activities

As it can be seen in section , there are no modifications within respect to previous proposal in Activity 2. From this, we can deduce than the MAS system described in our Activity 2, is a correct approach for this practicum. Since, as has shown, our proposal was feasible to implement and able to solve correctly the practicum requirements.

Although we have not changed our description of the MAS system, we may explain some unseen features and decisions than we have taken since the last delivery.

- Helicopter restriction: we decided to restrict one helicopter to only be able to land and take off from one single hospital. This decision was taken to reinforce the ability of helicopters to pic up more than one injured person per travel. Due, since if we divided the map in two parts, this advantage could be lost in many cases.

Statistics

Settings file

In this section we will discuss the characteristics of the configuration used for testing our MAS system. The results are presented in the Results section .

		Settings Attributes										
		AD	HC	P/H	RC	LIP %	SIP %	SF	# SS	# He	# R	# Ho	# MH
Configurations	First call	5	20	2	1	90	10	20	600	2	8	2	8
	Default	5	20	2	1	90	10	20	600	2	7	2	7

Table 1: Settings configurations used for testing our MAS system.

LEGEND:
AD: Avalanche Duration; **HC:** Helicopter Cost; **P/H:** Helicopter Capacity; **RC:** Rural Cost; **LIP %:** Light Injured People probability; **SIP %:** Severely Injured People probability; **SF:** Steps to Freeze; **# SS:** number of Simulation Steps; **# He:** number of Helicopter-Agents; **# R:** number of Rural-Agents; **# Ho:** number of Hospitals; **# MH:** number of Mountain-Huts.

In table 1 we can see the details of the settings used for testing our MAS system. As we can observe, both settings are very similar. The 'First call' settings has one more Rural-Agent and one more Mountain-Hut, but, besides this differences all other attributes have the same values.

From this we can deduce than the critical difference will be the Map shape and the elements distribution among it.

Results

Here we discuss the obtained results running our MAS system on the settings defined in section .

Configurations	Statistics results							
	TC	C/P %	# DP	# RP	RP %	FVAvg	HoRP %	MhRP %
First call	5	1	0	5	1	5.18	0	1
Default	2	1	0	2	1	6.29	0	1

Table 2: Statistics results obtained from the configurations presented in section .

LEGEND:
TC: Total Cost; **C/P:** Ratio of cost per person; **DP:** Died people; **RP:** Rescued people; **RRP %:** Ratio of rescued people; **FVA:** Average of steps for first visit; **HoRP %:** People ratio brought to hospitals; **MhRp %:** People ratio brought to mountain huts; **# He:** number of Helicopter-Agents; **# R:** number of Rural-Agents; **# Ho:** number of Hospitals; **# MH:** number of Mountain-Huts.

Further extensions

Due our time limited resources we have not been able to explore further interesting configurations of communication protocols and architectures than could probably lead us to better results. Some of the implementations than we were not able to perform were:

- Changing the default basic architecture of the described MAS system: Is completely hierarchical, but having a hybrid architecture, perhaps, allowing the rural agents to perform coalitions and distribute tasks among themselves, it could significantly improve the statistics of our system.
- Give to agents some learning capabilities in order to adapt to different map shapes and weather conditions (if variable).

Conclusions

In this section we will discuss our conclusions on the IMAS practical work.

- As we can observe from the results of our MAS system, the initial performance is very good, also the cost ratio maintains low, but when the resources start to be occupied and avalanches increase the Rural-Agents average time for rescuing, we start to get worse results. But, still we think than we obtain good results from what we expected initially.
- From this work we have seen that many real problems where different independent actors take different roles, could be emulated with agents and have an human like outcome.
- Although that, implementing agent based systems, actually, is not very exploited, which explains the lack of technologies and support software for doing it. Agents are still the state of the art for many problems in AI. Since they can reproduce social behaviour better than other technologies.

References

[1] Wooldridge, M. (2009). An introduction to multiagent systems. John Wiley & Sons.

[2] Khan Majid Ali ,Boloni Ladislau (2007). Coalition Formation and Teamwork in Embodied Agents. University of Central Florida

[3] Durfee, E. H., & Lesser, V. R. (1991). Partial global planning: A coordination framework for distributed hypothesis formation. Systems, Man and Cybernetics, IEEE Transactions on, 21(5), 1167-1183.

[4] Antonio Moreno, Agent communication, *Introduction to Multi-Agent Systems Notes (2015)*

[5] Antonio Moreno, Cooperation in MAS (I): emergent cooperation, PGP, GPGP, *Introduction to Multi-Agent Systems Notes (2015)*

[6] Antonio Moreno, Cooperation in MAS (II): Coalition formation, Contract Net, *Introduction to Multi-Agent Systems Notes (2015)*

[7] Antonio Moreno, Cooperation in MAS (III): Negotiation via auctions, *Introduction to Multi-Agent Systems Notes (2015)*

[8] Antonio Moreno, Cooperation in MAS (IV): Voting, *Introduction to Multi-Agent Systems Notes (2015)*

[9] Antonio Moreno, Cooperation in MAS (V): implicit methods, *Introduction to Multi-Agent Systems Notes (2015)*