CBR-Oriented Heterogeneous Agents in PolyteCS03 Rescue Simulation Team

M. Ebrahim. Shiri, Pooyan Fazli, Alireza Davoodi, Farzad Kohantorabi

Faculty of Math. and Computer Science
Department of Computer Science

Amirkabir Univ. of Technology (Tehran Polytechnic), 424, Hafez Ave., Tehran 15914, Iran

http://www.aut.ac.ir/polytecs
{shiri, pooyanfazli, alirezadavoodi@aut.ac.ir, torabi@safineh.net}

Abstract: This paper is to describe the main features of the PolyteCS03 rescue simulation team. PolyteCS03 is the result of the 2-year-research in Robotic Simulation Research Lab at Amirkabir Univ. of Technology (AUT). Our main goal in this project is to develop a multi-agent system based on fast and improved methods of learning and deciding in cooperative planning.

Keywords: Case Based Reasoning, Reinforcement-Learning, BeleifUCB, BeliefPCB, DesireUCB, DesirePCB, IntentionUCB, IntentionPCB, Graph with Classified Concepts and Relations

1 Introduction

PolyteCS03 team members have worked on soccer simulation league for almost two years [1]. Now we want to use this 2 years of experience in other MAS system in rescue simulation league. Rescue simulation is an effective environment to achieve variety of experiences in field of artificial intelligence and multi-agent systems [2]. The main interest behind the PolyteCS03's effort in rescue simulation domain is to develop and apply decision and learning techniques in multi-agent systems. Especially we are interested in *Case-Based Reasoning (CBR)* [3,4], which is a recent approach to problem solving that has got a lot of attention over the last few years .

In section 2 we will describe the communication protocol and the world model of the agents. In section 3 agents' decision and learning mechanism is described. In section 4 we will discuss PolyteCS03 agent architecture. In section 5 we will introduce a particular knowledge representation formalism called *Graph with Classified Concepts and Relations (GCR)* and finally to put all together, conclusion and future works.

2 World Model and Communication

One of the most power full aspects of the robocup rescue simulation is the intercommunication between agents in its cyberspace. PolyteCS03 has put a great effort on developing a communication system between its agents and center agents. Using this facility, agents can act as effectively as they do in a real world case. We have developed a dynamic task assignment system, which is done completely by sending messages back and forth to centers (Fire Station, Police Office, etc.). Each platoon agent reports the problems in its world model to the appropriate center and the center sets up and updates a global world model based on these messages to establish teams of agents dynamically to solve problems in the disaster space and sends mission messages back to platoon agents.

In addition, different centers are also sending their global world's information to each other to keep their selves updated of the disaster space. They also communicate to ask for urgent helps under special circumstances, which can be determined by applying dynamic policies.

3 CBR-Oriented Heterogeneous Agents in PolyteCS03 Rescue Simulation Team

Global decision about the strategy of each team (Police force, Fire Brigades, Ambulance Team) is determined by centers. Team strategy includes distributing agents to different positions of city considering the priorities, which differs according to the type of problem. (For example blocked roads with higher potential of being passed take higher priority and fires in more saturated portions of the city take higher priority). This determination scheme is done by Case-Based Reasoning techniques [5]. Each center is equipped with a *Universal Case Base (UCB)*, which with the help of the global world model made by the communications with agents and other centers is used to determine global strategy of its team in the city. In addition, each rescue agent includes a *Primary Case Base (PCB)*, which is used simultaneously with the global strategy determined by the center and current agent's position and state to select the best action.

We have recently used *reinforcement-learning* methods in addition to Case-Based Reasoning techniques to revise the cases. For this purpose, we consider states that receive negative or nonnegative reinforcement according to current action.

4 Agent Architecture

The PolyteCS03's agent is based on BDI architecture. Belief layer describes the knowledge of the agent including the center and other agents' messages and understanding of the system environment, such as different strategies. Desire layer is connected to belief layer to have the world model. This layer includes a part of UCB (or PCB) named *DesireUCB* (or *DesirePCB*) to select the proper desire out of all possible choices. Intention layer also includes a part of UCB (or PCB) named *IntentionUCB* (or *IntentionPCB*). This layer based on proper desire selected in desire layer and *IntentionUCB* (or *IntentionPCB*) executes the reasoning process and determines the plan to reach the aim.

5 GCR Representation in Case Based Structure Agents

Representing different situations of disaster space in a case is the most important part of our agent. In fact the representation problem in PolyteCS03 is the problem of decision what to store in a case, finding an appropriate structure for describing case contents, and deciding how the case memory should be organized and indexed for effective retrieval and reuse.

For this purpose, we introduce a particular knowledge representation formalism called *Graph with Classified Concepts and Relations (GCR)*, which is an extended model of the conceptual graphs [6] to represent the cases and their solutions.

In [7] we discussed some interesting capabilities of the GCR. We argued that it makes possible to express the relations between the solutions and cases, to express the modifications that are necessary to adopt the previous case to the current situation and goals.

Further, our memory architecture is also structured using this formalism, i.e. within this memory organization, the categories are inter-linked via GCR, which contains the features and intermediate states. (e.g. similar cases).

The memory organization is thus embedded in a network structure of *categories, cases,* and *index pointers.* Each case is associated with a category and each index value (indices) points to a single case or the associated category. At least one of the cases in a category is representative (we refer to them as *typical* cases).

Finding a case that matches the current situation is done however by combining the input features of case into a pointer to the case (or category that shares most of the features). If these features match with the description of its typical cases then these cases are returned, else the indices under that category are then traversed in order to find the case that contains most of the additional features.

Storing a new case is performed in the same way, with the additional process of dynamically creating new node containing the description of the case and jointing it to the category using the GCR formalism. The referent part of the established relation will then represent the similarity between the typical case and the stored one. The new case is stored thus, by searching for a matching case, and by establishing the appropriate feature connection. If the feature of the new case matches the feature of an existing one, the new case may not be retained.

Because rescue simulation is a dynamic real-time environment, the privilege of this method is that the agent in restricted time can fast retrieve the best case or cases to find the best solution for decided situation.

6 Conclusion

Communication between agents plays an important role in our team. Also we could develop a memory architecture (GCR) for fast and improved deciding and learning. Case-Based Reasoning techniques manages the decision making process of our agents.

At the end, PolyteCS03 members would like to thank YabAI members for making available YabAPI source code.

References

1. M. Ebrahim. Shiri, Pooyan Fazli, Alireza Davoodi, M. Moin Ayazifar, Vahid Hashemi and Sara Ramezani. PolyteCS Team Description For RoboCup2002 .
2. Peter Stone, Manuela Veloso, Multiagent Systems: A Survey From Machine Learning Perspective. Autonomous Robots, Volume 8, Number 3, July 2000.
3. Alireza Davoodi. Case-Based Reasoning and Applications. Fourth Student Conference of Computer Society of Iran, Isfahan, Iran, Pages 377-389, 2002.
4. M. Lenz, A. Hubner, and M. Kunze. Textual CBR. In M. Lenz, H.-D. Burkhard,B. Bartsch-Sporl, and S. Web editors, Case-Based Reasoning Technology –From Foundations to Applications. LNAI 1400, Berlin, 1998. Springer Verleg
5. Pooyan Fazli, Alireza Davoodi. CBR-Oriented Heterogeneous Agents in Soccer Simulation Domain. Fourth Student Conference of Computer Society of Iran, Isfahan, Iran, Pages 33-39, 2002
6. Sowa, J.F. Principles of Semantic Network: Exploration in the Representation of Knowledge. Morgan Kaufmann Publisher Inc., San Mateo CA, 1991.
7. M. E. Shiri, Graph-Structured Representation for Case-Based Systems. First International Conference on Graphs, and Computational Algorithms, Tehran, Iran, 2000.