Retrospective Analysis of RoboCup Rescue Simulation Agent Teams

(Extended Abstract)

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ABSTRACT

We introduce the Score Vector, a new evaluation scheme for the agent teams participating in RoboCup Rescue Simulation Competitions. It is a vector of parameters which monitor the game and provide analysis of the game at a microscopic level, and we show its robustness by thorough testing in various scenarios. We further explore the possibility of designing new scenarios to aptly challenge the teams.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent systems; D.2.8 [**Metrics**]: Performance measures

Keywords

RoboCup Rescue Simulation, Mechanism Design

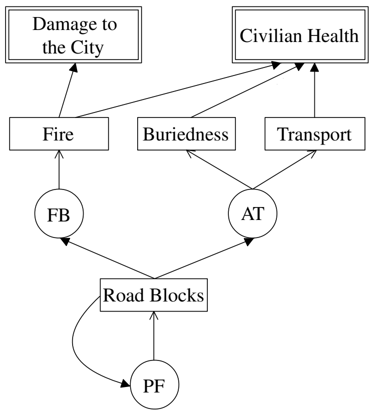

Figure 1: Score Dependancies

1. INTRODUCTION

Natural calamities such as earthquakes and floods cause massive damage to a city with certain temporary and permanent effects like infrastructural damage and loss of civilian life respectively. Effective planning and execution by the search and rescue teams, with minimal response time is cruicial.

Computer aided simulations of such scenarios help governments and other organizations gain experience in disaster mitigation and management[1]. The RoboCup Rescue Simulator is one such generic urban disaster simulation environment executed on a network of computers. It further helps researchers focus on multiple issues in multi-agent systems such as heterogeneous agent coordination and cooperation, and decentralized decision making use of incomplete information.

The RoboCup Rescue Simulation Competition (RCRSC) [3] is held anually as part of the RoboCup, the twelfth instance of which was conducted in Suzho, China in 2008. Agent teams from around the world compete against each other every year. The scoring policy used in the current RoboCup Rescue Simulator though, fails to showcase an agent team's performance during a game. Live monitoring of a game to select the winner is required. It is an interesting challenge for researchers in multi-agent systems and mechanism design to come up with an unbiased evaluation rule, with no weak points to exploit, that assesses how well the agent teams perform.

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1.1 Contributions to the Paper

The evaluation rule underwent a minor change in the year 2002 [2]. In this paper, we give a new scoring methodology that captures numerous inter-related aspects such as progress of civilian state of health, rescue operations, et cetera. for evaluating a team. We argue that without taking these inter-related aspects into consideration, as in the current scoring method, the scoring is rendered poorly as it cannot capture the true picture of the state of the teams' performance. These aspects can help the organizers of the competition set new challenges and shape the existing ones into a rigid form. The participants can make use of the same to investigate and rectify any defects present in their algorithms.

2. SCORE VECTOR

Figure 1 shows the dependencies among the factors that affect the score of any RCRSC. **Damage to the City** and **Civilian Health** at the top are the two most important factors as mentioned in the Section 2. However, **Damage**

Table 1: Factors influencing the performance of a rescue team and the type of influence on the score

No	Factor	Inf	Obj
A	Agent State:		
	A.1. Dead (0<=HP<=10)	Neg	Min
	A.2. Critical (11<=HP<=40)	Neg	Min
	A.3. Average (41<=HP<=70)	Pos	Max
	A.4. Healthy (71<=HP<=100)	Pos	Max
B	Time spent by a rescue agent travelling	Neg	Min
C	Average number of messages passed	Neg	Opt
D	Ratio of civilians in refuge	Pos	Max
E	Ratio of civilians rescued	Pos	Max
F	Percentage of building area destroyed	Neg	Min
G	Ratio of fires extinguished	Pos	Max
H	Average time taken to		
	H.1. Rescue a civilian	Neg	Min
	H.2. Extinguish a fire	Neg	Min
	H.3. Transport a civilian to a refuge	Neg	Min

to the City is caused by ***Fire*** which is taken care of by the fire brigade (FB). There are two issues for FB, namely ***Road Blocks*** and limited capacity to carry water. ***Road Blocks*** are cleared by the police force (PF) and lack of coordination between FB and PF results in FB travelling longer distances than required to extinguish fires and refill tanks. This results in a wastage of time and fuel, and additional damage to city. A similar argument can be put forth in the case of the ambulance team (AT). **Civilian Health** is affected by ***Fire***, ***Buriedness of Civilian*** and ***Transport of Civilian to Refuge***. AT's job is to rescue civilians from the debris and transport them to the refuge which can get delayed due to the presence of ***Road Blocks***.

With so many factors influencing the game, it is not correct to decide the winner with just a number. A vector defined by these factors gives an insight to a team's strategy and the confidence to decide the winner. Factors we considered to evaluate the teams for the competition are given in Table 1.

We ran the finalists of the competition 500 times on different maps to compare the results of the Score Vector with those of the current score policy. Detailed design and analysis of the Score Vector can be found at [5].

2.1 Research Challenges for Agent Teams

With the Score Vector new scenarios can be modelled to target specific weaknesses in teams. Similar to limited water storage for fire brigades, every agent should have a limited fuel tank. The team must then try to work very carefully because a lot of time is wasted in the process of going to and fro fuel stations and refuelling the vehicles. This calls for selective road block clearances by police force agents. Ambulance team agents can create pseudo refuge points in the city with the help of which they can save time and fuel by dropping off civilians to be picked up by another ambulance agent passing by. The team can be asked to design coalitions consisting of fire brigades, ambulance teams and police forces to rescue as many civilians as possible along with extinguishing fires quickly. Each coalition could concentrate on some part of the map with idle coalitions moving around to help others. These coalitions can also evolve over time by splitting and merging.

No agent team can do better than the rest with respect to every parameter of the Score Vector. For example, an agent can choose to either explore the city looking for civilians in distress, or finish its work thereby increasing its utility. The Score Vector provides a substantial challenge to agent teams to develop the right set of strategies that can satisfy all its parameters in a balanced fashion. Finally an optimally functioning RCRSC Agent Team can be built.

2.2 On Importance of Score Vector

Unlike a regular scalar quantity currently used, the Score Vector provides multiple prespectives on behaviour and performance of agent teams. In fact, contradictory and seemingly impossible tasks which require agent teams to make tradeoffs will be measured by the Score Vector. It is truly a challenge for an agent team to use a single strategy or approach to optimize the parameters of Score Vector. The agent competition can be designed such that agent teams cannot predict which parameters are important and need to be considered. Further, the parameters themselves can be weighed to rank the teams based on the difficulty levels of different performance aspects of the agent teams. With the Score Vector, teams can identify which aspects of their strategy are good and which are not. This gives them a better way to analyze and compare their performances with others during a game as well as after the game.

3. CONCLUSION

RCRSC has been in existence for several years now. Since 2002, the scoring rule has been a scalar quantity with the agent teams concentrating only on one or two aspects to win the competition. An agent team to win needs to do many things well. The different perspectives of various parameters and their dependencies (see Figure 1) have not been explicitly brought out by the current scoring scheme. In this paper, we designed a Score Vector that brings out various parameters that measure the agent team's performance. Our experimentation by running the 2008 RCRSC's finalists one hundred times on five maps helped us gain a deeper understanding of the Score Vector and make it as a viable approach to evaluate teams in future. Agent performance across all parameters throughout the 300 cycles of rescue effort can be treated as a time series and evaluated to rank the teams. Our on-going effort is along these lines.

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4. REFERENCES

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