Robocup 2017
Rescue Simulation League Team Description
Allameh Tabatabaei (Iran)

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Abstract

This document describes the main feature of algorithms and contribution of Allameh Tabatabaei 2017 that is going to take participate in the Robocup 2017. As this is first time of participation, all of the following implementation and methods have been re-designed based on "Icarus" source code which has been placed 5th in Iran Open 2016.

In this competition, we have used the Pizza clustering algorithm for police agents. Furthermore, we decided to provide a specific clustering method for fire brigades. In addition, we implemented some solutions to improve the cooperation between police forces and fire brigades. Eventually, the ambulance team clustering follows the base k-means clustering method.

Each agent type will have its own target allocating solution. We believe these solutions could be very effective on the performance of each agent.

1 Introduction

Natural disasters are one of the most catastrophic accidents which lead people to die and causes enormous financial loss every year. As the humanity knows, these casualties can be reduced with a practical disaster management. The main purpose of RoboCup Rescue Simulation (RCRS) competitions is to prepare, develop and implement various algorithms and methods for real-world situations in addition to improving programmers' skills and challenging them.

In order to achieve these goals, a large urban disaster is simulated that simulates agents' actions in this situation. Rescue Simulation Competitions took place in 2001 after a massive earthquake in Kobe, Japan in order to reduce infecting damage in future earthquakes. This simulation matches real world limits and problems as accurately as possible.

Rescue simulation agents include ambulance team agent, police force agent and firefighter. The main task of the police force is opening the closed roads, the main duty of the ambulance team is saving lives and fire extinguishing is the main duty of the firefighters. In addition, all the agents are responsible for facilitating the other team's tasks.

Allameh Tabatabaei is a multi-agent rescue team developed at the Computer Department of Allameh Tabatabaei High School. This year, the primary focus of our team was to implement previously developed algorithms in last year's team (Icarus, a C++ Soshiant based team) in ADF framework, Especially the target allocations algorithms and clustering methods.

2 Modules

The clustering and target allocator modules were subject to changes and a new helper module known as Estimated Data was added to the code which allows the agents to provision the state of the map and helps their target selection abilities. Since the primary focus of the team was on target selection and not the way the agents approach their target, the path planning module was almost left intact as it is in ADF framework.

2.1 Clustering

New Clustering algorithms allow agents to leverage different clustering methods based on the situation and the task given to them which increase the effective operational range of the agents, the improved target allocation and a better agent performance in overall.

Clustering for each agent type is done through the default K-Means algorithm, independent of other agents. This algorithm is well-known of its easy implementation and high-speed performance. The main purpose of K-Means is to define a centroid point which has the minimum distance from its neighbor objects.

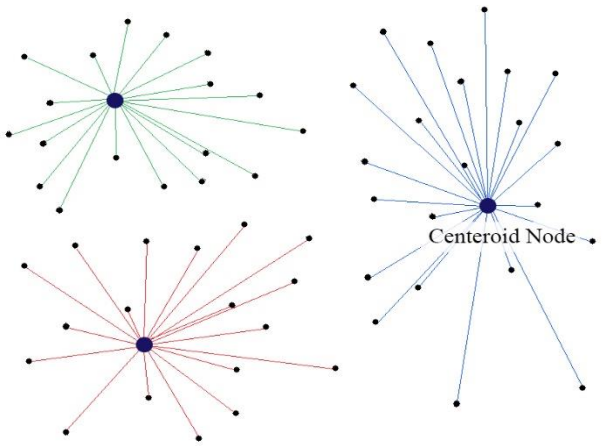

Fig 1. *K-Means operation.*

On the other hand, there are some problems with this strategy like its hypersensitivity to the initial value and getting caught in the trap of local optimum. Because of that, we tried to develop and implement Canopy clustering method to compensate the wasted time and to have a better performance on agents.

In the Iran Open 2017 competition, we used Canopy clustering method. Beforehand, we had concluded that it is a better option to choose rather than K-Means, but contrary to our anticipations, this method did not help us as we expected. Our main focus during implementing canopy clustering was to have the minimum elapsed time. But the main structure of this algorithm did not let us perform our desirable subdividing methods to cluster the entire map. Because of that, we decided to provide our individual clustering idea.

Since we decided to design an entire new clustering method, simultaneously we needed to focus on that extraordinary cooperation between fire brigades and police forces. Some points in the map play a critical role during the simulation. In the case of fire brigades, there are few buildings which are usually large and have many other buildings nearby. As an obvious thing, their ignition will cause neighbors to fire and we decided to use these building as our cluster centers. Among other vital points, we tried to choose gas stations as cluster centers as well. Entities which will be included in these clusters' area are buildings which their status is changing at the moment. By "changes in status" we mean changes in temperature and burn rate.

Moreover, we implemented a number of additional solutions to improve the cooperation between fire brigades and police forces as before. For example, to decide which buildings could be involved in a cluster area, the conditions of nearby police forces will be placed under scrutiny and based on this investigation, the agent will decide if that building could be chosen or not.

This idea is in its earliest days and there is no doubt that we will promote this idea to more advanced stages.

The police forces use Pizza slicing method to do the clustering. This idea for police forces strategy was to clear all of the roads which lead to a refugee. Basically, Pizza slicing shape structure helps us to achieve the most of the critical roads in a cluster. We believe this method could be one of the best ways to apply to the police forces clustering so far because of its shape structure and its similarity to police forces methods which we have provided.
Eventually, as we mentioned before, if any fire brigade wants to examine any building, it will investigate that building's nearby police forces and their conditions. Obviously, these solutions which have been implemented in these agents' orders could extremely improve the cooperation between fire brigades and police forces.

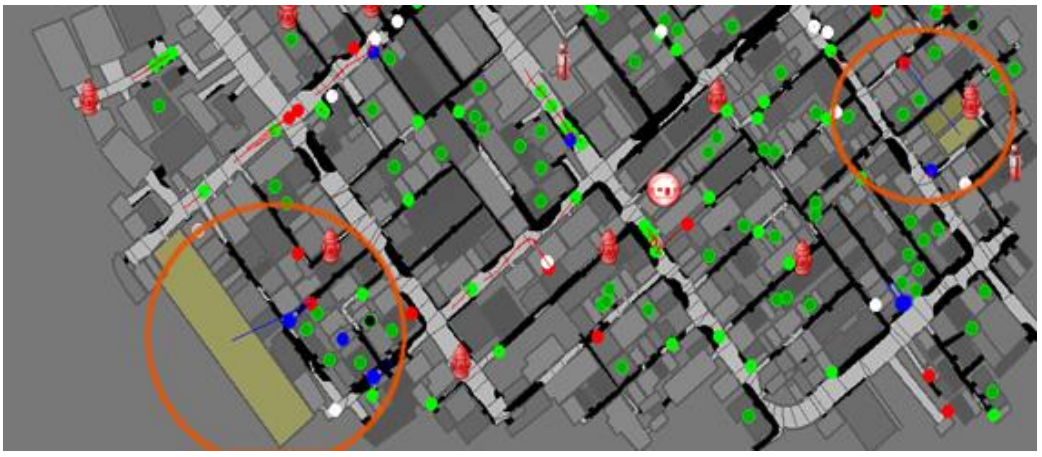

Fig 2. *This picture shows fire brigades and police force agents cooperation.*

2.2 Estimated Data

There are situations in which there is a need to forecast and know about the future state of the map and simulation, there is also a need for these kinds of forecasts in different target selectors of the agents to let them select a target with the highest priority and take a more effective decision. To fulfill these requirements a new module named “Estimated Data” was developed.

Estimated data is a new module introduced to the ADF framework. This module acts as a helper for other modules which adds the capability to forecast state of the map and simulation. It could be very useful for estimating the probability of buildings ignition and help the fire brigades to forecast the fire buildings and take actions even before the actual fire.

Since the performance and accuracy of this method have both great importance, we designed a new formula to fulfill both requirements. This solution calculates a more accurate information about the buildings which have a higher probability of ignition.

$$P = \frac{W \times T}{\log D \times \log S}$$

(P = probability of ignition, W = wind velocity, T = temperature of the fires source building, D = distance between source building and destination building, S = size)

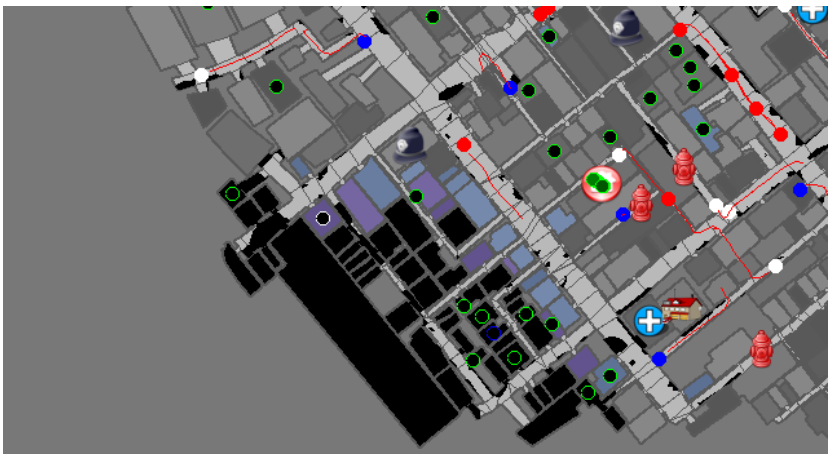

Fig 3. *The effect of estimated on fire brigades' target selection by preventing the spread of fire.*

2.3 Target Allocators

Target selection is one of the most critical parts of the decision-making process of an agent. Because of this high importance, the main effort of our team was put on related modules of target selection.

Since each agent has its own special task and operational sector, it needs its own special target selection algorithms. These algorithms can be mainly divided into three sub-categories based on the agent type that uses them.

2.3.1 Police Force

The police forces use Pizza slicing method to let them decide which target is most suited to be cleaned. The slicing of the map depends on the size of the map and based on the distance of targets.

The primary task of a police force agent is to clear the blockades with the highest priority and then patrol and search the map. In patrolling phase, the agent moves between refugees in an iterative mode to make sure that the important roads leading to refugees are always clear and the entrance of all refugees are open.

The police force has a priority list which consists of blocked refugees, roads, civilians and agents. This priority list is sorted based on a dynamic valuing system in which the blocked refugees have higher priority compared to other roads and blocked civilians have higher priority compared to agents. This system has various factors like the candidate distance to the agent, the HP and buried coefficient of the humans.

The valuing formula for human allocating is as follows:

$$T = \frac{\log H}{(P!)\,B}$$

(T = target value, H = human health point, P = path planning array length,
B = buried coefficient)

With using this formula, each entity which could be known as the main target will achieve a value and eventually, the best entity will be selected as a target based on its value.
Note that this valuing system has also been developed in a way to improve the cooperation between police forces and fire brigades.

2.3.2 Fire Brigade

The fire brigade agents use our specific clustering method to let them decide which building is most suited to be extinguished. In our tests, although we changed our clustering method, this formula continued to show its great performance. Part of this was due to the solutions we provided for the development of cooperation between fire brigades and police forces.

The target selection formula for fire brigades is as follows:

$$\text{Civilian in the building} \Rightarrow 5\times10^3 - \left[T + S + (\frac{D}{4}) \right]$$

$$\text{Agent in the building} \Rightarrow 3\times10^3 - \left[T + S + (\frac{D}{4}) \right]$$

$$\text{No human in the building} \Rightarrow 10^3 - \left[T + S + (\frac{D}{4}) \right]$$

(T = temperature of the building, D = distance between agent and destination building, S = size of destination building.)

According to this formula, there are some constants multiplied by the main parameters. These constants have been used to implement a useful primacy which could lead us to select the best building. As the same process with police forces, each fire brigade will investigate if there is any human in the building or not. Then based on the formula, the best target (building) will be selected as a target.

Fig 4. *This picture demonstrates the optimized valuing system, fire brigades extinguish a building which is not too big and not too small*

2.3.3 Ambulance Team

Based on our research, any improvements on ambulance team's civilian selection strategy can significantly improve the overall score. The ambulance team's duty is to save or revive damaged civilians and transport them to the nearest refugee. But in some situations, there are multiple civilians on the agent's eyesight and eventually, some disorder will happen to the agent's task list. In these cases, we need an algorithm to allow the ambulance team to select the best target to be rescued.

This creative algorithm has made on the basis of the civilians HP, each civilian's damage, distance from each civilian and the exact position of a civilian. The formula of ambulance team which has been used in this algorithm is as follows:

$$T = \frac{\log\left(\frac{H^8}{D+1}\right)}{S(B+1)}$$

(T = target value, H = civilian's health point, D = civilian's damage, B = civilian's buried coefficient, S = distance between ambulance agent and civilian)

Unfortunately, we did not have enough time to bring the formula to the desirable we had. Please note that this formula is just a preliminary equation, and we will definitely try to develop it in the future.

3 Conclusion

It is known to all that the best way to gain the highest score in these competitions is, the way of producing the target selection methods. As the target selection is extremely needed to be dynamic, so it will be requiring a dynamic valuing system. To achieve this purpose, this valuing system needs to be run on a dynamic map (not a static one), So we produced multi-clustering for each agent to achieve this goal.

References

[1] https://mahout.apache.org/users/clustering/canopy-clustering.html
[2] ESKILAS Team Description IranOpen 2012
[3] Hadi, A. Taheri, P. Foroutannezhad, A: Soshiant Team Description Paper IranOpen 2014
[4] Keshvary, D. Ebadian, S. Saleh. ESKILAS Team Description Paper IranOpen 2013
[5] Mahdi Eshraghi, Ali Seraj. Icarus Team Description Paper IranOpen 2016
[6] P. Gohardani, S. Rostami, S. Mehrabi, P. Ardestani, M. Taherian. MRL Team Description Paper Robocup 2015
[7] http://www.hungarianalgorithm.com/examplehungarianalgorithm.php
[8] https://en.wikipedia.org/wiki/K-means_clustering