RoboCup 2016
Technical Challenge Team Description Paper
GUC ArtSapience (Egypt)

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Abstract

This paper describes the contribution of the GUC_ArtSapience team in the Technical Challenge competition in RoboCup 2016. The coming sections present the different approaches that are adopted by the team in this year. The Technical Challenge competition is a new competition introduced for the first time this year using a new Agent Development Framework (ADF). The ADF provides a structured simulator where we added our K-means ++ clustering, our path planning and target selector techniques.

1 Introduction

Rescue planning and optimization is one of the emerging fields in Artificial Intelligence and Multi-Agent Systems. The Agent Development Framework (ADF) provides an interesting test bench for many algorithms and techniques in this field. It is built on top of the Rescue Simulator by providing new structured modules such as *Clustering*, *PathPlanning* and *TargetSelector* modules.

In the ADF, agents are extended from the RMAS agents. However, they have more attributes that makes it easier to implement different algorithms ,for example, the scenario information, and the pre-computed data are such an add-on. Moreover, agents have two different handlers that should be implemented; the tactic aspect of the agent, and the control one.

Figure 1 shows the difference in the phases of the simulation between the ADK and the Rescue Agent Simulator (RAS). The main difference is adding a pre-computation phase "preparation" phase where the agents act with limited knowledge since their computed data is not performed yet.

The paper is divided as follows, section 2 describes our clustering technique. In section 3, the path planning approach is explained. Section 4 is the Target Selector description and finally section 5 is the conclusion.

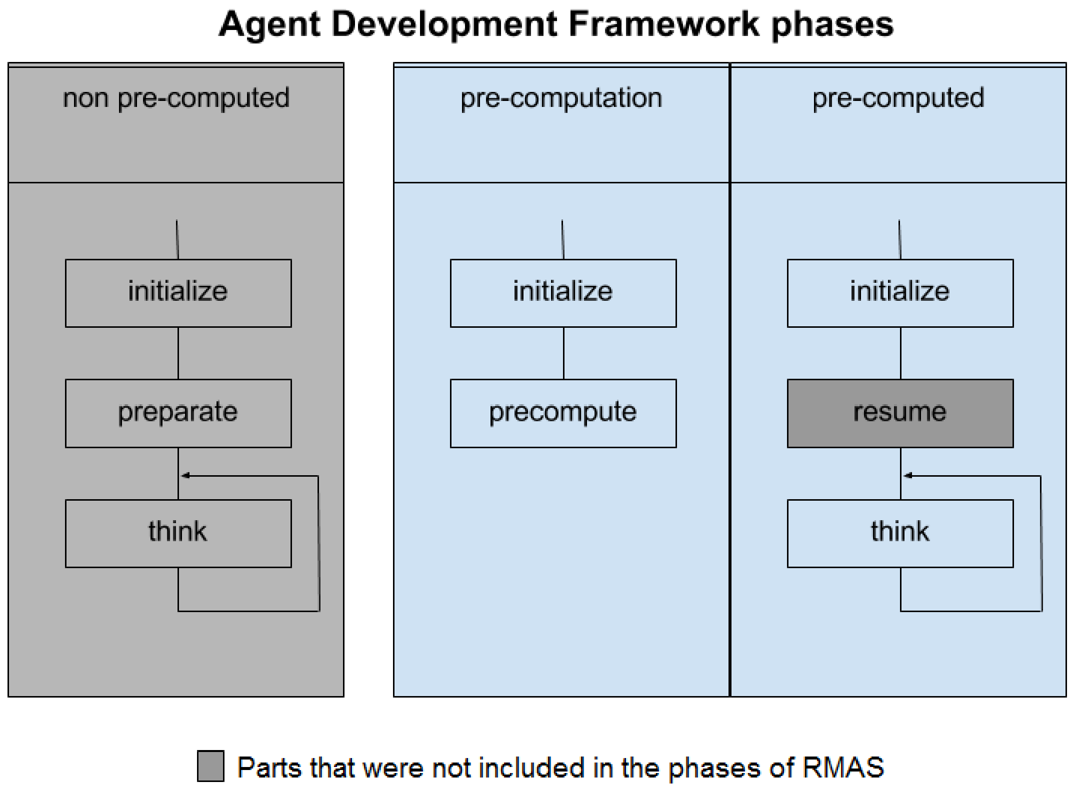

Figure 1: ADK Simulation phases compared to RAS

2 Clustering

In our clustering module, K-means++ is used to calculate the initial cluster centroids which are selected from a uniform Gaussian distribution over the buildings/roads in the map. Instead of having a one-to-one mapping relation between clusters and agents where each agent was assigned exactly one cluster [3]. A many-to-many relation is implemented where an agent could be assigned to many clusters, and each cluster could have more than one agent assigned to it based on the agents proximity to the clusters as well as the priority of the cluster itself. The priority of a cluster depends on the total areas of the buildings in the cluster and the importance of those buildings. The percentage of the cluster priority is multiplied by the total number of agents in order to decide the number of the agents that will be assigned to each cluster. Since the relation between the clusters and the agents is a many to many relationship, the percentage could be greater than or equal to 1.

3 Path Planning

The implemented searching algorithm for the agents is *Dijkstra*. It finds the shortest path between two nodes in the graph. Instead of repeating the computations each time step, a different approach is to compute the paths between each two nodes on the world model graph in the pre-computation phase, which would be used as a look-up table for the agents. This table is updated regularly with the roads status whether cleared or blocked. The agent then can look up the path it is willing to take and check if it is clear. If so, it traverses the path directly without any further computations during the simulation, otherwise the agent computes a different path and add it to the look up table an alternative path.

4 Target Selector

The Target Selector differs according to the type of agent in action. Each type of agent is discussed separately in the following sections.

4.1 Fire Brigade Agents

The adopted approach for the fire brigades is based on the old implementations of our team in the RAS [3]. The target selector of the fires used by the fire brigade agents gives the highest priority to the warm buildings. This allows the agents to contain the fire region from the outer bounds in order to control the fire region and prevent its spreading. Warm buildings in the same region are then prioritized according to their size. Large buildings have higher priority as they have a higher effect on their neighboring buildings.

Moreover, the target selector of fires, also gives high priority to gas stations rather than any other type of building. Another metric that is used in prioritization is the location of the fire and in which cluster does it belong, whether it's in the agent assigned cluster or in a near cluster or a far one. The nearer the fire is, the higher priority it will have for a certain agent.

4.2 Ambulance Team Agents

The Ambulance team agents aim to rescue the highest number of civilians possible. Ambulance agents are assigned to clusters then each agent prioritizes the civilians in its cluster. We use our trained Linear regression [2] learning model from RAS to predict the estimated time of death of civilians. The training model uses data which is collected by running different maps and scenarios. Given the training data-set, the relation between the input pairs (HP, Damage, burridness) and the output (ETD) is obtained first by training the data-set and then using the output learning model for future predictions. The *ETD* is the output variable in the model often referred to as the target. In case the civilian is alive and healthy till the end of the simulation, then the output is *none*. The ETD still has a large number of possibilities, this is the main reason for choosing linear regression. Applying the classifier on the previously obtained training data-set generated the following model [1]:

$$ETD = -0.009 * hp - 0.9197 * damage + 0.2056 * burridness + 328.291 \quad (1)$$

4.3 Police Agents

The Police agents are distributed across the map, whereby, each agent is assigned a certain cluster consisting of a set of roads and buildings. Each agent is mainly concerned with clearing blockades in its cluster so as to facilitate the movement of other agents, fire brigades and ambulance agents, to their respective targets. Such a process requires prioritizing the tasks received by the police agent, based on the severity of each task. So the target selector of the blockades will have the highest priority to clearing blockades on paths leading to buildings which have been reported on fire in order to facilitate the movement of fire brigades, so that the fire could be contained before spreading. Also the cluster of the police agent is a metric in the target selection, blockades in the agent's cluster will have higher priority rather than other blockades. In other words, in the case of absence of any high priority tasks in its cluster, the agent would undertake any fire report in the two clusters in its immediate proximity. This is due to urgency of fire, and the need for rapid extinguishing. Another metric is position of the blockade to be cleared, for example, if it is on a path that leads to agents jammed in the blockades, and hence, incapable of fulfilling their tasks. Another prioritization is for clearing the blockades on paths leading to refuges, satisfying the needs of fire brigades for water, and that of civilians for shelter or paths leading to civilians which were reported buried.

Another target selector for police agents is which places to go and investigate its state, and reporting that state to other agents via communication channels.

5 Conclusion

In this paper, we explained our attempts to use the new ADK and build our own clustering, path planning and target selector modules. The used approaches included K-means++ for clustering and pre-computed Dijkstra searching algorithm for path finding. In addition, a description of how our agents prioritize their targets has been given for each of the three types of agents. We're still exploring more techniques to improve our algorithms and the agents' performance.

References

[1] Kevin P Murphy. *Machine learning: a probabilistic perspective.* MIT press, 2012.

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[3] Mina Sedra Ahmed Jihad Salman ElDash Maggie Moheb Mohab Ghanim Fadwa Sakr Ahmed Abouraya Dina Helal Sameh Metias, Mahmoud Walid and Slim Abdennadher. Rescue simulation league team description guc artsapience. Robocup, 2015.