# A Group Forming Algorithm and Clustering Algorithm based Learning for Rescue Agents

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**Abstract.** We implemented cooperation model (that the agent get his act together with other agents) and a group forming algorithm for our rescue agents. And we adopted idea that some adjacent burning buildings are recognized a cluster. Therefore, our rescue agents can behave efficiently.

## 1 Introduction

In rescue simulations we can test the following conditions, which have yet to be discussed, such as:

1. The difficulty of the problems keeps changing.
2. The agents must solve the problem under conditions of urgency.
3. Problems occur simultaneously.
4. Problems which an agent cannot solve by itself occur, and
5. The number of agents that are needed to solve a problem is not decided.

In order to solve the problem that includes the above noted problems, we implemented a group-forming algorithm to our rescue agents.

We think of adjacent burning buildings as a "cluster". But, this idea called "clustering" needs many times. Then, we implemented a clustering algorithm based learning to our rescue agents.
Through following sections, we explain the following two points.

1. A cooperative agent approach by using a group forming approach.
2. A clustering approach based learning for burning building.

## 2 A cooperative agent model by using a group-forming algorithm

NITRescue04 agents form a group according to the difficulty of a problem, and can solve the problem without wasting resources that the agent cannot solve by itself. The group consists of a leader agent and some member agents. Every agent may become a leader agent if the agent found a problem which the agent cannot solve by itself. If an agent becomes the leader agent, the agent can form a group and manage the group. The member agents form the group according to the group-forming request from the leader agent.

The state diagram of our agent's behavior is shown in Fig. 1. An agent repeats the following flow: (1) an agent selects a task and (2) the agent solves the task. If the agent selects a task that the agent cannot solve by itself, the agent tries to form a group to solve it cooperatively.

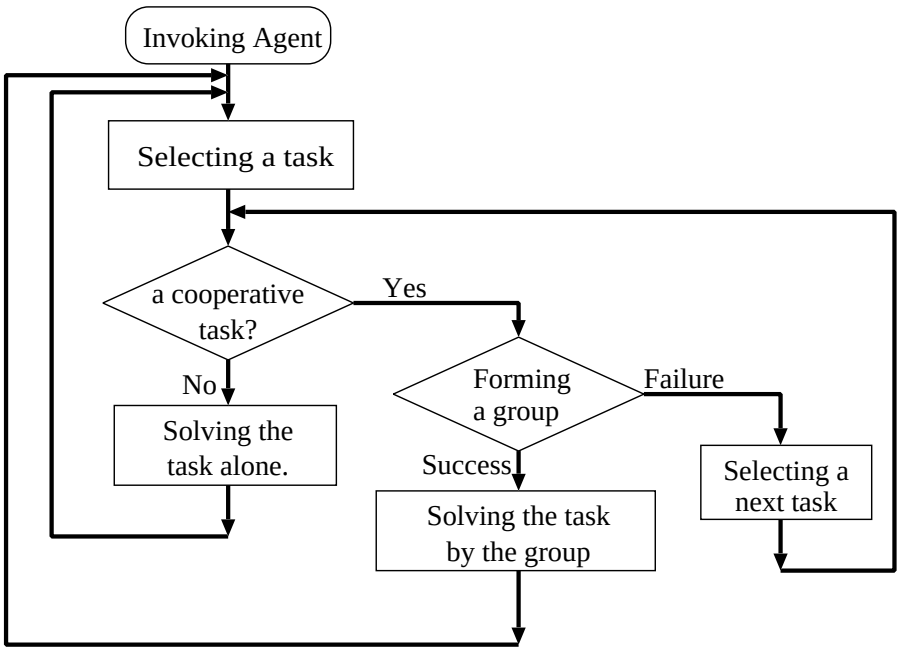


**Fig. 1.** State diagram of agent's behavior

The group-forming routine of our algorithm consists of four steps: (1) sending a group-forming request, (2) sending a response of participation, (3) sending a group-forming success message, and (4) solving a cooperative task by a group. Details follow.

**Step 1:** An agent sends a group-forming request to other agents. This request includes the priority of the selected task. This agent becomes the leader

agent.

**Step 2:** When an agent receives the group-forming request, the agent checks both the id of the leader agent and the priority of the task, and then decides whether the agent participates in the group. If the agent participates in the group, the agent sends a response of participation to the leader agent. This agent, which participates in the group, is a member agent.
In this step, a leader agent can also receive a group-forming request. If the request is for the same cooperative task, the leader agent checks the ids of the agents and the priorities of the tasks which are included in the requests. Based on the received agent's id and task's priority, the leader agent decides whether the agent becomes a member agent.

**Step 3:** The leader agent checks whether the cooperative task can be solved by the group which consists of the leader and member agents when the leader agent receives a response. If the task can be solved by the group, the leader agent sends a group-forming success message to the member agents. If not, the leader agent sends a group-forming failure message.

**Step 4:** When a member agent receives the group-forming success message, the member agent selects the task included in the group-forming request, and the agent cooperatively participates and solves the task with the other agents of the group.

After the leader agent and member agents have formed a group, these agents communicate with each other to solve the task efficiently.

Through solving the task cooperatively, some tasks have solved. But others become more complicated before. In the case, the agents dissolve or leave the group. The condition for a member agent to dissolve the group has to be basically the same as the condition for the leader agent to dissolve it. If not, nobody could dissolve the group if the leader agent became unable to perform. Thus, our agents can keep solving the task, since member agents can also check the state of the cooperative task.

The agent may leave the group if the agent detects that the agent cannot cooperate with other member agents to solve the task. When an agent leaves the group, the agent has to send a dissolve message to the other member agents.

## 3 A Clustering Algorithm for Burning Buildings based Learning

3. A Clustering Algorithm for Burning Buildings based Learning

We consider that clustering for burning buildings is effective. However, clustering needs many times. So, It is too late to finish decision making within limited times.

Then, We designed clustering algorithm based learning. This algorithm is the method for decreasing times of calculation by reducing the number of the

elements for clustering. This method consists of two phases, learningphase and classified phase. In the learning phase, agents learn how to pick out only the elements located border of the cluster("outline elements"). In the classified phase, the agents execute clustering the elements picked out by the learning phase. Each algorithm is below.

- The Learning Phase
  1. Decide state of an element using information of neighborhood.(Fig.2)
  2. Judge whether it is the "outline elements" using it's state.(Fig.3)
  3. Give the reward if the judgement is correct.(Fig.4)
- The Classified Phase
  1. Pick out the set of the "outline elements" out of the set of all elements using result of learning.(Fig.5)
  2. Execute clustering the set of the "outline elements". (Fig.6)
  3. Assign remained elements to that cluster. (Fig.7)

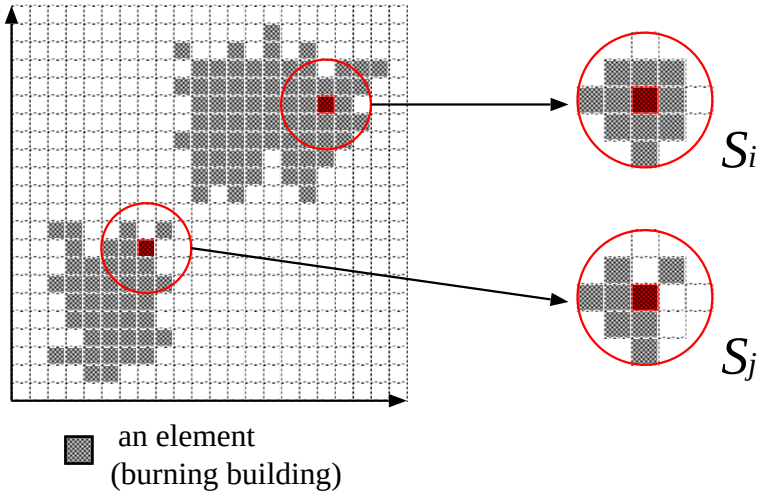


**Fig. 2.** Learning Phase (Step1)

By using this algorithm, our fire brigade agents can do the clustering of adjacent burning building in a short times. In addition, the "outline elements" is the building located border of the big fire, so they can find easily holded line of the big fire.

## 4 Conclusion

We implemented above concepts for our rescue agents. our agent can behave efficiently by introducing these concepts. It is the future work that we consider the efficient extinguishing order for burning buildings.

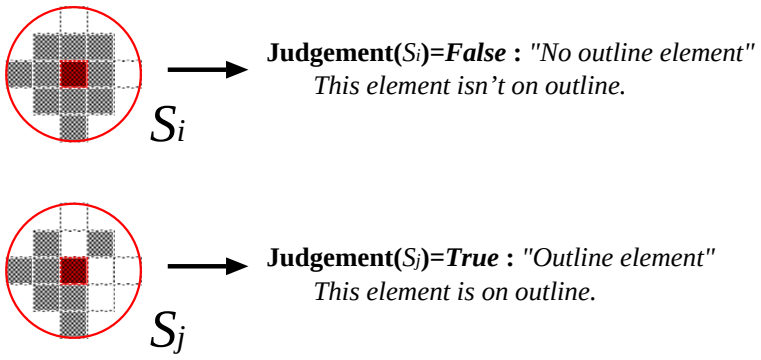


**Fig. 3.** Learning Phase (Step2)

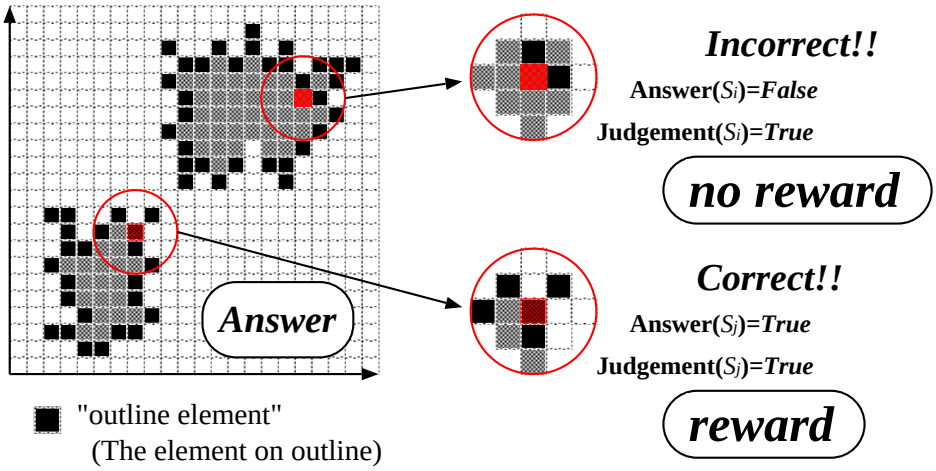


**Fig. 4.** Learning Phase (Step3)

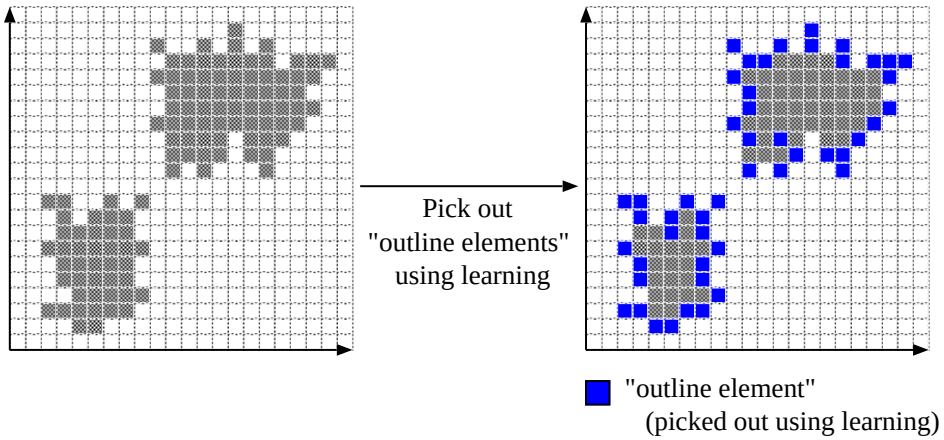


**Fig. 5.** Classified Phase (Step1)

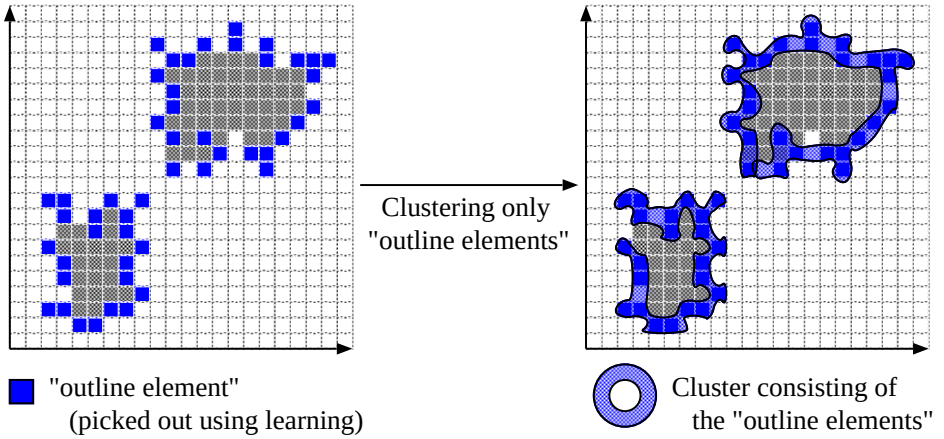


**Fig. 6.** Classified Phase (Step2)

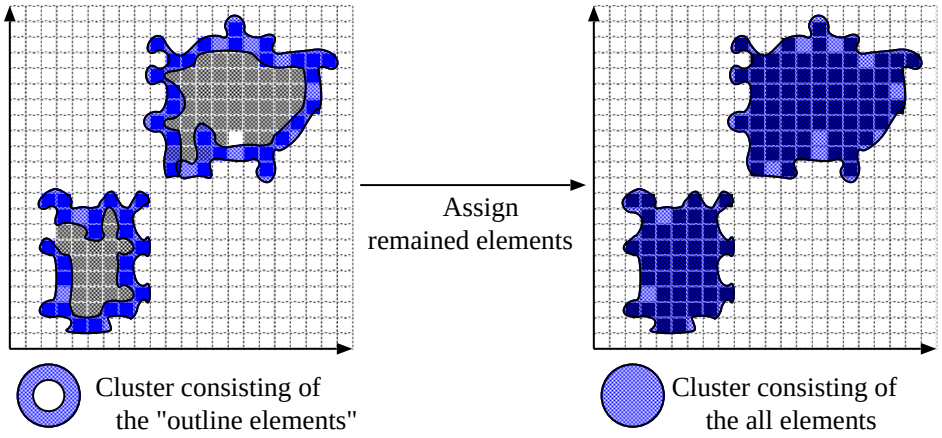


**Fig. 7.** Classified Phase (Step3)

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