Vol-2, Issue-1 PP. 154-159 ISSN: 2394-5788

GLOBAL JOURNAL OF ADVANCED RESEARCH
(Scholarly Peer Review Publishing System)

Ant Clustering Algorithm In Cooperation Of Agents

Alireza rezaee
Assistant professor of Department of Mechatronic Engineering,
Faculty of New science and technologies,
University of Tehran,
P.O.Box 143951374, Tehran,
IRAN

Abstract
In a dynamic environment that different agent are present, a crucial problem is to find agents with similar skills efficiently in order to perform a certain task that can not be done by single agents or even a small group of agents. This can be done via global communication, but in case where only local communication are possible, the problem changes into finding clusters of homo-skill agent via local communication and limited sense potency .T he study of ant colonies behavior and their self-organizing capabilities is of interest to solve current problem, it provides models of distributed adaptive organization, which are useful to solve difficult optimization, classification, and distributed control problems, among others. In this paper, we propose an ant clustering algorithm (AC) and Ant Sleeping Model (ASM) applied to discover groups of homo-skill agents in order to solve one problem in cooperation of agents. An Example paradigm is presented to demonstrate the implementation and its results are shown.

Keywords*:* Ant colony,sleeping model,dynamic environment, agents.

1. INTRODUCTION

Cooperation is perhaps the paradigm example of social activity in both real and artificial social systems; it is certainly the best studied process in multi-agent systems research. Cooperation in human societies is an intricate and subtle activity. However, some progress has been made on understanding the types of situation in which cooperation can arise, and how it can proceed [1].

One of the problems that can arise in cooperation is how agents can find peer agents with similar capabilities in order to perform tasks that can not be done by a single agent or a small group of agents. One can find rather simple solutions when agents' capabilities are not dynamically changing and when agents are able to communicate globally. But in lack of these conditions, it becomes a crucial problem in order

In current paper, problem of finding homo-skill agents is represented with respect to ant social behavior as adaptive distributes organization and more specifically using Ant Sleeping Model (ASM) and Ant Clustering Algorithm (AC). Ant

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sleeping model and ant clustering algorithms have been applied successfully to data mining problems to find clusters of data as in [2]. In their work, Artificial Ants Clustering Algorithm and ASM are presented to resolve the clustering problem in data mining by simulating the behaviors of gregarious ant colonies. In the ASM mode, each data is represented by an agent. The agents' environment is a two-dimensional grid. In AC, the agents can be formed into high-quality clusters by making simple move according to little local neighborhood information and the parameters are selected and adjusted adaptively. Experimental results on standard clustering benchmarks demonstrate the ASM and A4C are more direct, easy to implement, and more efficient than previous methods.

In Next section we will briefly describe ASM and AC biological grounding, in section II the algorithm is described and in section III experiment results are presented.

2. ANT SLEEPING MODEL

The social insects' behaviors such as reproducing, food hunting, nest building, garbage cleaning, and territory guarding show that gregarious social insects such as ants and bees have high swarm intelligence [1,2]. Many optimization algorithms have been designed to simulate such swarm intelligence and these algorithms have been successfully applied to the areas of function optimization [2], combinational optimization [1,3], network routing [4] and other scientific fields. Among the social insects' many behaviors, the most widely recognized is the ants' ability to work as a group in order to finish a task that cannot be finished by a single ant. Also seen in human society, this ability of ants is a result of cooperative effects. The cooperative effect refers to the phenomenon that the effect of two or more individuals or parts coordinating is higher than the total of the individual effects.

Due to the need for security, the ants are constantly choosing more comfortable and secure environment to sleep in. This makes ants to group with those that have similar physiques. Even within an ant group, they like to have familiar fellows in the neighborhood. This is the inspiration for us to establish the artificial ants sleeping model (ASM). In ASM, the agent represents the ant, and his purpose is to search for a comfortable position for sleeping in his surrounding environment. His behavior is simple and repetitive: when he doesn't find a suitable position to have a rest, he will actively move around to search for it and stop until he finds one; when he is not satisfied with his current position, he becomes active again.

Cellular Automata (CA) [5], which is firstly proposed by J.von Neumann, is a discrete solution method of partial differential equations. It is a very effective tool to simulate complex phenomenon by using only a few rules and simple operations. The concept of artificial ants was proposed in CA previously. Some researchers have achieved promising results in data mining by using the artificial ant colony. Deneubourg et al [6] are the first scientists to perform research in this field. They proposed a Basic Model (BM) to explain the ants' behaviors of piling corpses.

Inspired by the behavior of ants, we borrow the principle of CA in artificial life and propose an Ants Sleeping Model (ASM) to explain the ants' behaviors of searching for secure habitat.

3. DESCRIPTION OF ALGORITHM

G represents a two-dimensional array of all positions, G(x, y) = i, if there is an agent labeled i at position (x, y), otherwise G(x, y) = 0. Any agent has a number of properties indicated by its data object. s_x and s_y are agent's vision limits in

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horizontal and vertical direction, $N(agent_i)$ is used to denote 's neighbor whose size is $(2s_x+1)\times(2s_y+1)$. $L(agent_i)$ is used to denote a set of empty positions in $N(agent_i)$.

$d(agent_i, agent_j)$ is determined by the distance between $agent_i$ and $agent_j$, representing the variance between

them . Normally, Euclidean is taken as distance. $f(agent_i)$ represents the current fitness of $agent_i$, α represents the average distance between and other agents, and is used to determine when should leave from other agents. They are defined as following:

$$f(agent_i) = \frac{1}{(2s_x+1)\times(2s_y+1)} \sum_{agent_j \in N(agent_i)} \frac{\alpha_i^2}{\alpha_i^2 + d(agent_i, agent_j)} \quad (1)$$

$$\alpha_i = \frac{1}{n-1}\sum_{j=1}^{n} d(agent_i, agent_j) \quad (2)$$

$$p_a(agent_i) = \cos^{\lambda}(\pi f(agent_i)) \quad (3)$$

In the above, λ is a parameter, and can be called agents' activated pressure. Function represents the probability of the activation of by surroundings. In each loop, after the agent moves to a new position, it will recalculate its current fitness f and probability p so as to decide whether it needs to continue moving. If the current p is small, the agent has a lower probability of continuing moving and higher probability of taking a rest at its current position. Otherwise the agent will stay in active state and continue moving. The agent's fitness is related to its heterogeneity with other agents in its neighborhood. The agents influence the fitness of its neighborhood during the movements. With increasing number of iterations, such movements gradually increase, eventually, making similar agents gathered within a small area and different types of agents located in separated areas. Thus, the corresponding data items are clustered.

It can be easily seen that in ASM the local effect can expand to the whole living environment of the agents and cause some global effects. Using only local information, the agents can update information and send it through the grid to other agents. The agents dynamically form into clusters through the cooperative effect. The algorithm is as following:

Algorithm AC

1. initialized the parameters
2. for each agent ***do***
    3. place agent at randomly selected site on grid
4. end for
5. while (not termination)
    6. for each agent ***do***
        7. compute agent's fitness and activate probability
        8. $r \leftarrow random[0,1]$
    9. if $r \le p_a$ ***then***
    10. activate agent and move to random selected neighbor's site not occupied by other agents
    11. else
    12. stay at current site and sleep
    13. end if

Vol-2, Issue-1 PP. 154-159 ISSN: 2394-5788

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14. end for
15. adaptively update parameters
16. end while
17 output location of agents

4. IMPLEMENTATION AND EXPERIMENT RESULTS

The algorithm is implemented in C# language using .Net framework to monitor behaviors of agents as ants that mimic sleeping behavior of real ants. For purpose of testing, 400 agents were put randomly at a grid of size 100*100. Their skills as numeric values were a distribution as following data sets: set 1 as $(\mu = 2, \sigma = 1)$, set 2 as $(\mu = 15, \sigma = 1)$, set 3 as $(\mu = 20, \sigma = 1)$ and set 4 as $(\mu = 10, \sigma = 1)$. Their vision limit was set to 1 (representing 1 cell in grid), and their activation pressure was calculated dynamically during running. The run lasted about 1000 clock ticks and agents were clustered into 4 separate clusters. The results are shown as in figure.1, 2 and 3.

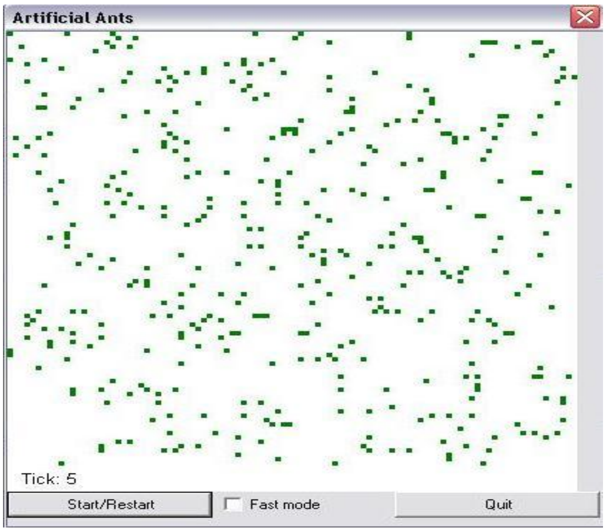

Fig. 1.Tick 0, 400 Agents put randomly at grid

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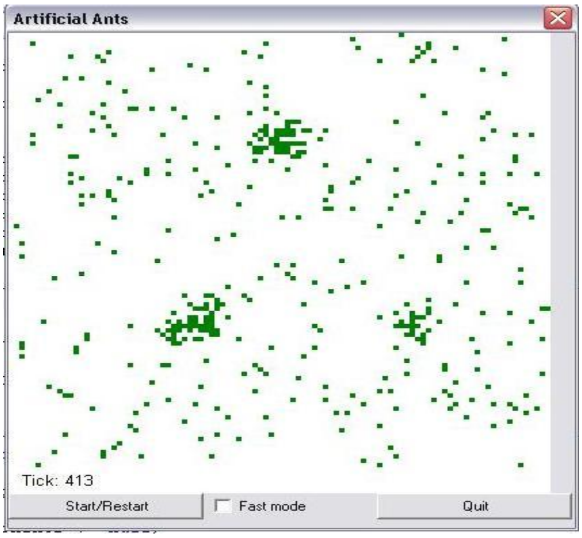

Fig. 2. Tick 400, clusters appearing

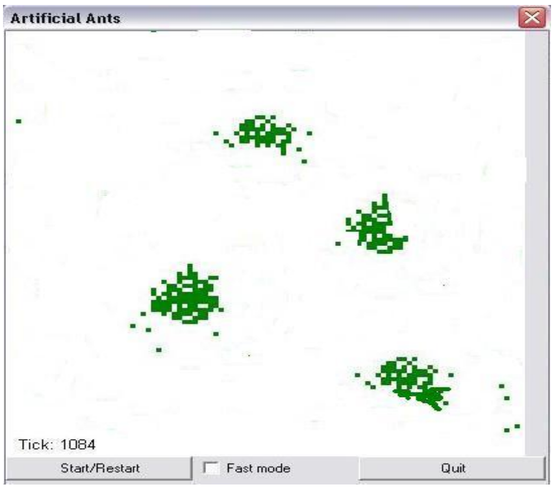

Fig. 3. Tick 1000, Clustered agents

The results show that after 1000 clock ticks, the agents were clustered into groups with the highest degree of similarity in their skills. Our results showed that this task can be done in a reasonable time compared to similar algorithms such as LF and others. However some techniques can be used to increase quality of clustering (the error rate was about 17 in 400).

5. CONCLUSION

An ant sleeping model along ant clustering method is used to identify peer agents with similar skills in order to cooperate in a dynamic environment where large number of agents is required to finish a required task as soon as possible. The results show that it can be done in a reasonable time using these two algorithms along with modification applied to them.

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