The Locality of Information Gathering in Multiagent System

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Introduction

Multiagent systems are controlled in a distributed manner, because the agents have more autonomous behaviors. So it is considered more difficult to capture and predicate global behaviors of such systems. We pay attention to the relationship between characteristics of each agent and the global structure in such a system.

One of the characteristics that has a close relationship with the global structure could be the way the agents get information for decision making. With regard to this problem, Huberman gives significant suggestion(Huberman & Hogg 1988). But his study and all the other researchers do not explicitly take 'distributedness' into account.

In this research, we focus on the locality of information gathering of each agent so that we can deal with 'distributedness' explicitly. As a means of analysis, we employ a computer simulation of quasi-ecosystem(Takashina, T & Watanabe, S 1995).

The locality and the sensor output entropy of agents

We aim at formalization of a multiagent system to capture the locality of information gathering. We deal with a system $\mathbf{A}$ which consists of agents $\mathbf{a}_i, i \in \{1, ..., n\}$ in a space $\mathbf{X}$. The architecture of an agent consists of a sensor, a decision maker and an effector.

The degree of locality is defined by $l(\mathbf{X}, N) = \frac{\|\mathbf{X}\|}{\|N\|}$, where N is the area from which an agent gets information. $l(\mathbf{X}, N)$ takes the value of $[1, \infty)$.

To quantify the complexity of actual sensor output, we define the entropy of sensor output. Let a set of actual sensor output value be $\{V_i | i \in \{1, ..., m\}\}$ and the probability distribution be $P_s(V_i)$. **Entropy of sensor output** is $H_{sensor} = -\sum_{i=1}^{m} P_s(V_i) \log P_s(V_i)$.

Experiment

We constructed the model of quasi-ecosystem as an adaptive ecosystem. There are two kinds of agents in the world. The role of an agent is fixed for each kind, but the action rules change through natural selection.

In this system, the plant, the herbivore and the carnivore live on two dimensional grid field (120 x 120). There is interaction between the three, such as the herbivore eats plant and the carnivore eats the herbivore.

The degree of locality in this system is $l(\mathbf{X}, N) = l'(R) = \frac{120 \times 120}{(2R+1)^2 - 1}$, where R is the range of perception.

Table 1 shows the result which is obtained by simulation with changing R_h, the range of perception of herbivore and fixing other parameters. It is considered that when the entropy of sensor output is high, which means the sensor is working well, the behavior of each agent has improved incrementally and the global behavior of the system becomes brisk and stable.

Table 1: Experimental Result

	$l(R)$	H_{sensor}		Quality index dynamics
		μ	σ	
8	49.8	0.82	0.34	raise to not so high
10	32.7	1.14	0.07	raise to not so high
12	23.1	1.24	0.03	raise incrementally
14	17.1	1.10	0.13	raise to high
16	13.2	0.69	0.16	low quality index

Conclusion

Our experiments imply that the entropy of sensor output, which reflects the locality of information gathering, is one good index for knowing the qualitative property of the system.

In order to confirm this result, experiments using the models which use other learning methods should be done. If the results are confirmed, it will be useful in methodology of multiagent system design.

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References

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