Acquiring Co-evolution Mechanisms in Organizational-Learning Oriented Classifier System

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ABSTRACT: Organizational-learning oriented Classifier System (OCS) is an extension of Learning Classifier Systems (LCSs) to multiagent environments with introducing the concepts of organizational learning (OL) in organization and management sciences. In this paper, to apply OCS to Computational Organization Studies, we develop a novel agent-based social simulation system. The simulater is applied to "Ecological Marketing", which reveals interesting agent behaviors on the domain.

1. INTRODUCTION

Organizational-learning oriented Classifier System (OCS) is an extension of Learning Classifier Systems (LCSs) which was studied in Genetics-Based Machine Learning (GBML) literature. The architecture of OCS is extended to multiagent environments with introducing the concepts of organizational learning (OL) in organization and management sciences (Kim 1993). OCS employs learning mechanisms of both individual/organizational levels and knowledge-lean/data-driven types. In such environments, agents should cooperatively learn each other and solve a given problem (Takadama 1999). In OCS, each component or software agent learns its own appropriate problem solving functions through local interactions among its neighbors, and forms the organizational structure to complete given tasks without explicit control mechanisms. OCS has shown the performance to solve complex multiagent learning problems and have been applied to practical knowledge systems. We believe that OCS is also useful for Computational Organization Studies.

In this paper, we utilize the OCS architecture to develop a novel agent-based social simulation system. The system is characterized by the agents that (1) solve multi-objective problems, (2) pursue different goals, (3) form classes to behave and/or learn and (4) live in multiple environments. We report four organizational learning techniques, "Copy of other's actions", "Copy of other's rules" and "Modification of actions", that accelerate the evolution of intra-class agents, and "Intervention to other's actions" that accelerates co-evolution between different kinds of agents. We implement the system applied to "Ecological Marketing", in which agents are divided to the two classes: producers and consumers. The two classes of agents co-evolve their know ledge to adapt the competing environments with multiple objectives.

2. ARCHITECTURE OF OCS

The proposed system architecture extended from conventional Learning Classifier System (LCS) (Goldberg 1989) with organizational learning methods. The system

solves a given problem with multi-agents' organizational learning where the problem cannot solve by the sum of individual learning of each agent. The basic idea of the proposed system comes from Organizational-learning oriented Classifier System (OCS), however, the proposed system is extended from the original OSC so that we deal with the agents with the characteristics described above. We will omit the detailed descriptions about the system common with the original OCS (refer to Takadama 1999), and only describe the differences.

(1) Coping with multi-objective problems

First, we have changed the form of the classifiers, which are stored within "Individual Knowledge" module, in order to cope with multi-objective problems dealt with the agent. Each classifier individually holds strengths for each objective. Each of the strength values means the adaptation score towards the corresponding objective. The score is calculated by a method described later. Individual knowledge will be iteratively improved by reinforcement learning.

(2) Extension for multiclass agents

Each agent class has each different viewpoint to interpret the status of the environment, different objectives to act, or different actions. To attain this, we design "Effector" and "Detector" for each individual class. By this way, we extend OCS to multi-class agent system without changing the internal architecture of OCS-agent.

(3) Evaluating agents' actions

We describe a way to evaluate agents' actions under the requirements from multiple environments and the aims to meet their actions to the multiple objectives. An agent in a same agent class has the same objectives for its actions. These objectives are implicit requirements from the environments that it lives.

(4) Methods for organizational learning

We prepare the two organizational learning methods for agents in a same class.

- Copying action parts of a classifier

When agent's actions result in bad statuses, the "action part" of classifiers is substituted by the other actions, which have followed good results.

- Copying Classifiers or Rules

While an agent succeeded in its actions, the agent offers classifier sets that made the success to a shared place. When applying GA operations, all agents adopt those classifiers as the elitist ones.

3. Ecological Marketing Simulator

Ecological Marketing is one of general marketing methods that approache consumers with a supplier or its product keen on corresponding ecological problems. We have modeled Ecological Marketing very simple, and simulated it in order to validate the effectiveness of the architecture discussed so far. The objective of Eco-marketing Simulator is to find out the stable conditions both supplier and consumer classes of agents live by co-evolving their knowledge each other.

Co-evolution is the evolution between different kinds of living things with their interactive affections. In a framework of our study, the co-evolution is an evolutional

learning between the supplier agent class and the consumer agent class by cooperative learning, which means to get benefit each other by cooperating toward their common objectives to correspond to ecology, and competitive learning, which means to conflict of interests between makers to earn money and consumers to buy cheaper product. We simulate Ecological Marketing with supplier agents and consumer agents, both of which are implemented by the classifier system mechanisms.

One of the simulation results are shown in Figure 2, in which both the two classes agents co-evolve their positions to keep both the eco-marketing environment and their own two different objectives.

4. Conclusion

This paper has proposed a new architecture to simulate the ordinal agents that may have multi-objectives, varieties in characteristics, multi-class, and/or multiple environments. We develop it with learning classifier systems and validate the effect of the organizational learning methods. As a result, our methods "Copy of Actions", "Copy of Rules" and "Modification of Actions" lead the multiagents' organizational learning about their suitable actions for their multi-objectives.

References

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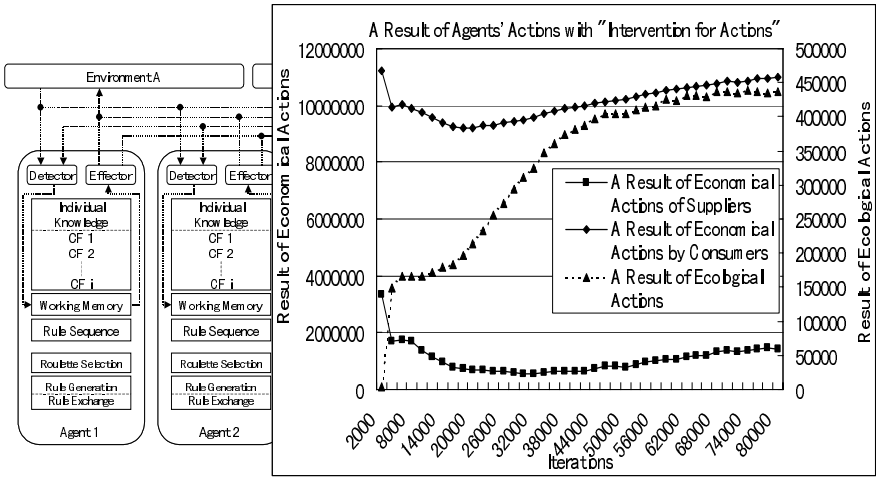

Figure 1 Architecture of OCS

Figure 2 Simulation of Coevolving Agents