Collaborative Learning Agents with Structural Classifier Systems

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Abstract

We propose a new learning agent architecture for collaborative learning. To learn any complicated task in multi-agent environment, simple reinforcement architectures have limitations on learning. Therefore, we propose splitting learning mechanism into three separate layers to learn required behavior, which are respectively organized by the Classifier Systems [Holland 86]. It can learn to communicate with other agents, to make plans, and to select actions based on the plans and other agents' behavior. We show that these agents can select cooperative actions as a collaborative group.

1 AGENT ARCHITECTURE

We introduced two ideas to our architecture as important components to realize collaborative learning. First idea is hierarchical learning that consists of abstract level and concrete level learning of planning to make agents learn long series of actions. Next idea is communication learning that makes agents learn communication partners to act rationally using information about other agents' plan.

From these ideas, we built a structural architecture, which has three leaning parts, respectively called the goal, action, and communication layer. It also has a place for exchanging information among layers, called the social model. The social model has all output of these layers and other agents' information through communication. Figure 1 shows the conceptual model of our agent architecture including flow of information among layers.

The goal and action layers conduct hierarchical learning. The goal layer learns to make sub-goal plans, which we must make by hand presently, for a global goal of a task. The action layer decides actual actions to achieve sub-goals. The communication layer learns to select a communication partner to get information, needed by the goal layer. Information of other agents gathered through communication is stored in social model.

Because of splitting layers, the reward system must have propagation mechanism of reward among layers. The Profit Sharing method is used for reward propagation. All reward given from environment is distributed to the sequence of activated rules of goal layer. The reward of action and communication layer is propagated from goal layer when each layer satisfied goal layer's requirements.

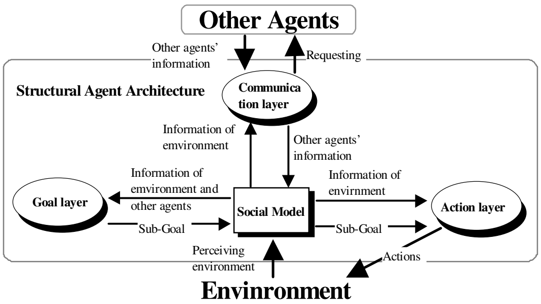

Figure 1: information flow inside the agent

2 EXPERIMANTS AND RESULTS

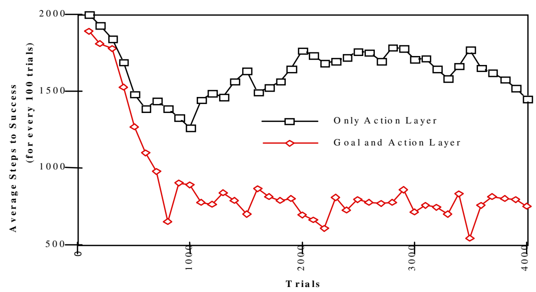

Figure 2: a result (non-layered vs. two-layered agent)

Figure 2 shows one of experimental results, the difference of learning efficiency between structured and non-structured agent. From this graph, we can see that structural architecture achieves high and stable learning performance.

In conclusion, we think it was proved that our structural learning mechanism including communication has ability to learn complicated tasks in multi-agent environment.

References

J.H. Holland, K.J. Holyoak, R.E. Nisbett, and P.R. Thagard (1986). *Induction*, MIT Press.