Self-Organizing On-line Learning Fuzzy Inference Model

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1. Introduction

Fuzzy inference models can conduct advanced inference like humans and are applied to many intelligent systems. In this paper, we propose an on-line learning fuzzy inference model. The proposed model executes a self-organizing learning with input/output (I/O) data of the model and their evaluations obtained by trial-and-error of a task. Therefore the model can adapt to environmental changes. We confirm performance of the model using a mobile robot task simulation.

2. Previous works

Most of the conventional learning models of fuzzy inference are supervised learning models[1, 2, 3]. Hence the models require teacher signals to learn. However, it is difficult to determine teacher signals under an environment with changing. SOR Network[4] can learn without teacher signals using a self-organizing approach. The model requires an I/O data and the one-to-one corresponding evaluation with I/O data, which is obtained by a trial-and-error, at each learning.

A robot navigation task[5] aims at moving of a mobile robot from start to goal without any collisions with a wall. The robot is controlled by repeating the inference, and only one evaluation is given after the task. Therefore, learning data obtained by one trial of a task are a series of I/O data and only one evaluation shared among the series; note that there is not a one-to-one correspondence between I/O data and an evaluation. SOR Network can not handle such a task.

3. The Proposed Model

The proposed model learns using a self-organizing approach, and can perform on-line learning with only one evaluation shared with several I/O data in a trial.

Fig.1(a) is the structure of the model. The model consists of a fuzzy inference unit and a buffer. The fuzzy inference unit has some fuzzy rules described in if-then form. This unit infers an action from input data and puts out it. I/O data of the fuzzy inference are stored in the buffer during a trial, and are exploited in learning mode with the evaluation value (Fig.1(b)). Evaluation value E is fed to the model at the end of every task trial. E has positive value when a task succeeded. When a task failed, E has negative value.

In learning mode, I/O relationships that are profitable for the task achievement are learned with data stored in the buffer and an evaluation value. Such a self-organizing learning is executed after each end of a trial. Hence, it is expected that the achievement rate increases with repetition of the task, and that the model adapts to change of environment.

The model exploits both of data in case of success and failure for learning. All of the I/O data with negative evaluation value is not necessarily an improper relationship, and all of the I/O data with positive evaluation value is not necessarily proper. Therefore, there is the possibility that inference becomes unstable by learning. To avoid this problem, the model selects data to exploit for learning automatically by using the membership function. It is expected to make the inference stable by this select function.

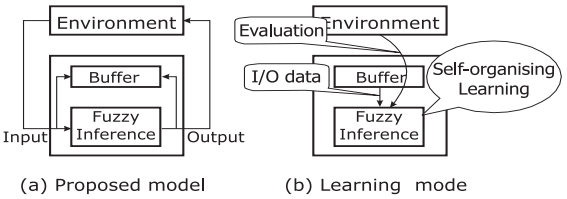

Figure 1: Proposed model(a) and Learning mode(b).

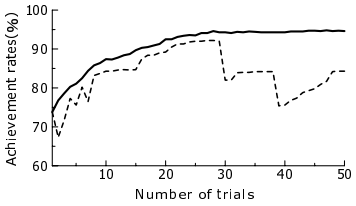

Figure 2: Change of achievement rates.

4. Experimental Results and Discussion

We confirm performance of the model using the mobile robot task simulation[5]. Fig.2 is the result of the experiment, and indicates the relation between the number of trials and average achievement rates. A solid line indicates the case where the model used the select function for learning, and broken line indicates the case where the model did not use the select function. The achievement rate increases with the number of trials using the select function.

5. Conclusion

In this paper, we proposed an on-line learning fuzzy inference model. The proposed model executes a self-organizing on-line learning with data obtained by trial-and-error of a task. The model learns with an evaluation shared with several I/O data in a trial. Therefore, the model can adapt to environmental changes. We confirmed performance of the model using the mobile robot task simulation.

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