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Improvement of Learning Efficiency by Sleeping Neural Network

Tatsuya IDE Chihiro IKUTA
Yoko UWATE Yoshifumi NISHIO
(Tokushima University)

1. Introduction

In general, humans have been sleeping during one third of life. The working of human's brain is fallen when human does not have sleeping. Thus, it is important to sleep for correct working of brain [1]. We consider that it can say also to neural networks.

In this study, we propose a Multi-Layer Perceptron with Sleeping State (SSMLP). This network has a stress value which is increased by working of neuron. If the stress value transcend to a limit, SSMLP becomes sleeping state. We expect to obtain a good performance by repeating working and sleeping states. We confirm that SSMLP has better performance than the conventional MLP by learning a sinusoidal function.

2. Experiment method

We consider the MLP composed of three layers (connected 3-5-1). The updating rule of neuron is given by Eq. (1). We use sigmoidal function for output function as Eq. (2)

$$x_i(t+1) = f\left(\sum_{j=1}^{n} w_{ij}(t)x_j(t) - \theta_i(t)\right), \quad (1)$$

$$f(a) = \frac{1}{1+e^{-a}}, \quad (2)$$

where x: input or output, w: weight parameter, θ: threshold.

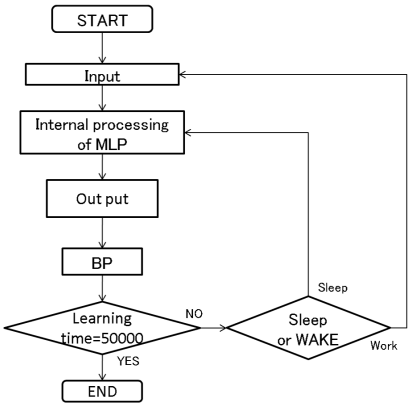

Figure 1: Flow chart of SSMLP.

We show the flow chart of SSMLP in Fig. 1. SSMLP is learned by Back Propagation [2] in the same way as the conventional method. However, SSMLP has a sleeping states. SSMLP charges with stress value during the working states. If the stress value transcend to a limit, SSMLP becomes the sleeping state. SSMLP cuts off the input layer and every target point becomes 0.5 during the sleeping states. After the sleeping states, SSMLP returns to the working state and the input layer is reconnected.

3. Simulation result

We compared learning performance of SSMLP and the conventional MLP by learning a sinusoidal function. The ratio of work and sleep is set as 2:1 to imitate the human. The update is repeated 50000 times.

Figure 2 is a typical result. We can see that learning curve of SSMLP is very oscillating by the sleeping states. However, SSMLP obtained the smallest error locally.

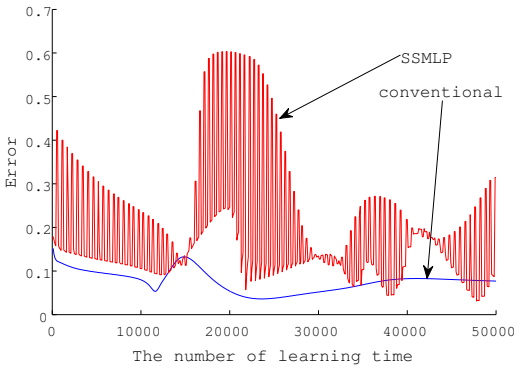

Figure 2: Learning curve of each MLP.

Table 1: Performance of each MLP.

	Avg. Err.	Min. Err.
SSMLP	0.040431	0.01971
conventional	0.087858	0.03598

Table 1 shows the average and the minimum errors of ten trials. SSMLP's performance is better than the conventional MLP's. We consider that SSMLP could escape out from the local minimum by the sleep states.

4. Conclusions

In this study, we have proposed MLP with sleeping state. This network was inspired from human's sleep. SSMLP has a sleeping state and normal learning. In the sleeping state, SSMLP cuts off the input layer. We confirmed that SSMLP gains better performance than the conventional MLP for learning a sinusoidal function.

References

[1] K. A. Paller and J. L. Voss, "Reactivation and Consolidation of Memory During Sleep," Learn and Memory, vol. 11, pp. 664-670, 2004.
[2] D. E. Rumelhart, G. E. Hinton and R. J. Williams, "Learning Representations by Back-Propagating Errors," Nature, vol. 323, pp. 533-536, 1986.