17 - 21 Durability of Affordable Neural Network for Neuronal Death

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1. Introduction

In this study, we investigate the durability of the affordable neural network when some of the neurons in the hidden layer are damaged, after the learning process.

2. Damages Neurons of Affordable NN

In Refs. [1], we have proposed a network with affordable neurons in the hidden layer of the feedforward neural network structure for efficient BP learning. We introduced the affordable neurons to reflect important properties of the brain.

We assume that some neurons in the hidden layer are damaged by some causes after the BP learning. The connections to the output layer of the damaged neurons are cut as shown in Fig. 1. Namely, the damaged neurons do not operate. In this situation, we investigate the performance of the network when the learning data are inputted to the network.

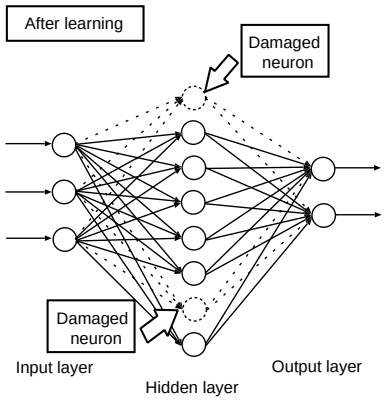

Figure 1: Damaging neurons.

3. Simulated Results

We consider the feedforward neural network for the task to produce output x^2 for input x, as one learning example. We investigate the total error between the output and the desired target when some neurons are damaged after learning. We define "Average Error E_{ave}" by the following equation.

$$E_{ave} = \frac{1}{P}\sum_{p=1}^{P}\left\{\frac{1}{2}(t_{pi} - o_{pi})^2)\right\}. \quad (1)$$

In this study, we prepare 9 neurons in the hidden layer of the network and the number of the affordable neurons is set to 1 to 3. For comparison, we investigate the performance of the conventional neural network without any affordable neurons.

3.1. Effect of Damaged Neurons

The simulation result is shown in Fig. 2. The E_{ave} of both the affordable neural network and the conventional neural network becomes worse by increasing the number of the damaged neurons. By comparison of two networks, the affordable neural networks gain better performance than the conventional neural network when some neurons are damaged. From these results, we confirmed that the affordable neural networks can operate well even if some neurons are damaged.

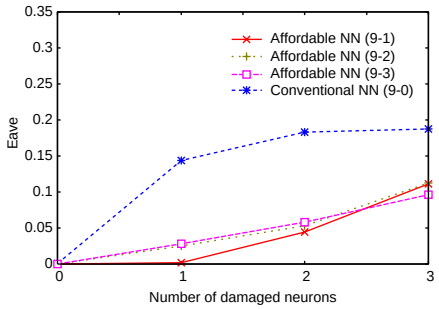

Figure 2: E_{ave} when some neurons are damaged.

3.2. Position of Damaging Neurons

Next, we investigate the relationship between performance and position of the damaging neurons. The simulated results when the damaged neurons is only one are shown in Fig. 3. From this figure, the conventional neural network is not good. And the performance of the conventional neural network does not depend on the position of the damaged neurons. On the other hand, the affordable neural network is almost very small when any neuron in the hidden layer is damaged.

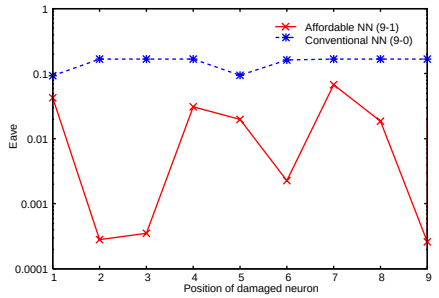

Figure 3: E_{ave} and position of damaged neurons.

4. Conclusions

In this study, we confirmed that the affordable neural network keeps its good performance. It is obvious that the affordable neurons exert an important influence on durability of the network.

Reference

[1] Y. Uwate and Y. Nishio, "Back Propagation Learning of Neural Networks with Chaotically-Selected Affordable Neurons," *ISCAS'05*, pp. 1481-1484, May, 2005.