Learning Ability of Evolving Affordable Neural Networks with Genetic Algorithm for Back Propagation Learning

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1. Introduction

In our previous research, we have proposed a new network structure with affordable neurons in hidden layer of the feedforward neural network. We named this proposed network "Affordable Neural Network" [1]. We consider that the operation of the affordable neural network is especially effective on evolution of neural network in brain.

In this study, we investigate the performance of the affordable neural network when the hidden layer is evolved using GA. By computer simulations, we consider that the affordable neurons exert an important influence on evolution process in the hidden layer of the network.

2. Evolving Affordable Neural Network

We have proposed the network structure with affordable neurons in the hidden layer of the feedforward neural network for more efficient BP learning [1]. We introduced the affordable neurons to reflect a function of the brain. The extra neurons in the hidden layer are prepared in advance. During the BP learning, all of the neurons in the hidden layer are not used at every updating. Namely, some of the neurons are selected for the learning and the rest of the neurons are deactivated.

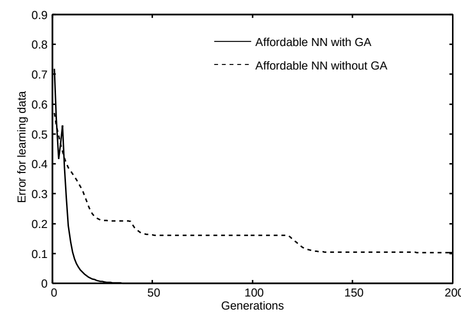
Correspondence between GA and hidden layer is shown in Tab. 1.

Tab. 1: Correspondence relationship GA and hidden layer of neural network.

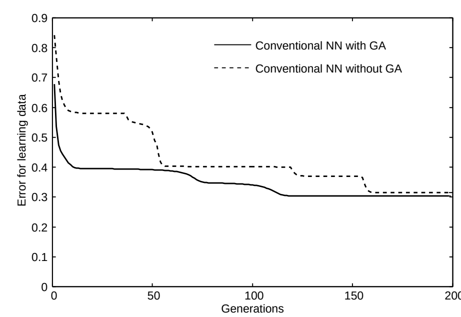
GA	hidden layer of neural network
individual	network structure of hidden layer
population	population of networks
chromosome	weights of neurons in hidden layer
fitness	error for learning data

4. Simulated Results

In this study, we use the batch BP learning algorithm. We consider the feedfoward neural network producing the same chaotic time series as the inputted chaotic time series generated by a skew tent map as one learning example. The learning time of one generation is set to 10 and the generation number is set to 100. Hence, the network with GA learn the learning data 1000 times. For comparison, we investigate the performance of the network without GA. We prepare 20 neurons in the hidden layer and the number of the affordable neurons is set to 6. Furthermore, we investigate the performance of conventional network without affordable neurons to make clear the learning ability of the affordable neural network. Figure 1 shows the simulation result for the case that mutation probability is set to 0.01. From this figure, the error of the affordable neural network with GA converges to the optimal solution by increasing the number of generations. However, the network without GA can not escape from local minima. We can see that the network with the affordable neurons gains good performance by applying GA as shown in Fig. 1(a). On the other hand, the network without the affordable neurons does not work well by applying GA as shown in Fig. 1(b). From these results, we confirm that the affordable neurons exert an important influence on evolution process in the hidden layer of the network.



(a) Affordable neural network.



(b) Conventional neural network.

Fig. 1: Error between output of neural network and teach data.

5. Conclusions

In this study, we investigated the performance of affordable neural network when the hidden layer is evolved using GA. We applied this affordable neural network with GA to learning chaotic time series generated by skew tent map. By computer simulation, we confirmed that the affordable neurons exert an important influence on evolution process in the hidden layer of the network.

References

[1] Y. Uwate and Y. Nishio, "Back Propagation Learning of Neural Networks with Chaotically-Selected Affordable Neurons," *IEEE International Symposium on Circuits and Systems (ISCAS'05), pp. 1481-1484, May 2005.*