15-1

Neural Network Having Artificial Neurotransmitter

Kazuki NAGAO[1] **Shinsaburo KITTAKA**[1] **Yoko UWATE**[1] **Yoshifumi NISHIO**[1]
([1] Tokushima University)

1. Introduction

Neural Network (NN) and Deep Learning are made to imitate the human nervous system. There are the following three substances constituting the human neural circuit. First, there are many nerve cells (neuron) in the human brain, and information is passed on next neurons through the connection, and we can judge things. Second, synapse connects to neurons and becomes junction for communicating information. Third, neurotransmitter is substances generated from synapse. It excites and suppresses neurons. It has a role to promote learning. Now, neuron and synapse are used in NN and Deep Learning. However, neurotransmitter is not used in NN and Deep Learning.

In this study, we propose new systems of feed forward Neural Network (FFNN) having artificial neurotransmitter. We use characteristic of acetylcholine among neurotransmitter. Acetylcholine has been reported to be related to diseases and memory. We use this system and improve learning accuracy more than basic system.

2. Proposed method

We used artificial characteristics of acetylcholine for the middle layer of FFNN. Proposed system that is used in this study is shown in Fig. 1.

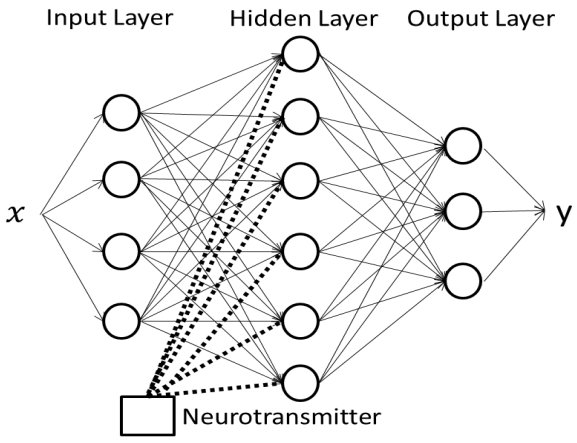
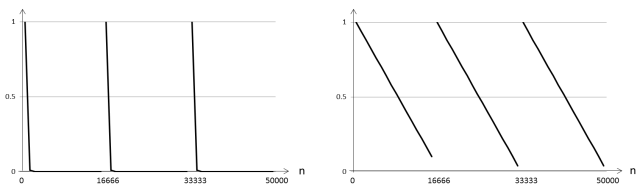


Figure 1: Schematic diagram of new system about FFNN.



(a) pattern1. (b) pattern2.

Figure 2: Two patterns which artificial characteristics of acetylcholine.

Characteristics of acetylcholine are not fully understood yet. We use two reported characteristics of acetylcholine in this study. First, the amount of acetylcholine secretion varies in a daily life. Second, the amount of secretion recovers by having breakfast, lunch and dinner. For using these characteristics, we made two patterns which artificial characteristics of acetylcholine (Fig. 2). Pattern 1 shows that the amount of secretion decreases curvilinearly at each learnning loop. Pattern 2 shows that the amount of secretion decreases linearly at each learnning loop.

$$h_{ij}(t+1) = f\left\{\sum w_{ij}(t)x(t) - \theta\ (t)\right\} \tag{1}$$

Equation (1) shows the propagating equation of the conventional neuron system at hidden layer. It does not have the acetylcholine's system. x is input data. w is connection weight. θ is threshold. h is output value.

$$h_{ij}(t+1) = f\left\{\sum w_{ij}(t)(x(t)+\chi) - \theta\ (t)\right\} \tag{2}$$

Equation (2) shows the propagating equation of the neuron having the acetylcholine's system at hidden layer.

And Eqs. (1) and (2) using sigmoid function Eq. (3) for activation function.

$$f(a) = \frac{1}{1+e^{-a}} \tag{3}$$

3. Simulation result

We define as the learning loops = 50000. We use Iris data set and define as the number of learning data sets = 150. The number of neurons in each layer is 4, 10 and 3.

Table 1 shows error rate for conventional system and proposed systems.

Table 1: Error rate.

	error
basic	0.05139
pattern1	0.00023
pattern2	0.00023

From Table 1, the learning accuracy is improved in proposed systems over conventional system. Error rate of pattern 1 and 2 are same.

4. Conclusion

We can approach human neural circuits more than conventional FFNN system by the proposed method. And we can improve learning accuracy. We understand that it is good to use artificial characteristics of acetylcholine for FFNN.

In the future, we will discover new patterns about characteristics of acetylcholine. And we further deeply examine how to use acetylcholine in NN.