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Feed-forward Neural Netwoks with Changing Sigmoid Functions

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1. Introduction

A neural networks is widely used in verious of area, such as recognize written characters and recognize voice. The neural networks need learning to do these things. So changing learning method to improve quality of the neural networks makes various of areahigh accuracy. Here, we attention feed-forward neural networks. Feed-forward neural network's learning method is back-propagation. We changed sigmoid functions and improve quality of back-propagation.

2. Proposed method

In this study, we focus on influence of feed-forward neural networks with changing sigmoid functions. The sigmoid functions is used in the output of each neuron and calculation in back-propagation. We change the parameter "k" in sigmoid functions. The parameter "k" in sigmoid functions shows below.

$$f(x) = \frac{1}{1 + exp(-kx)} \tag{1}$$

The glaphs of sigmoid functions and its differential form are shown in Figs 1 and 2.

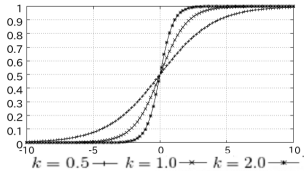

Figure 1: sigmoid functions

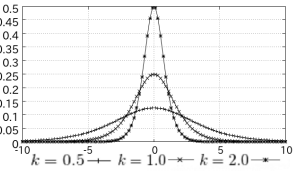

Figure 2: differential sigmoid functions

As these glaphs, the gradient of the sigmoid functions is steep pitch with increasing the parameter "k", and the maximum value of differential sigmoid functions is high with increasing the parameter "k". Moreover, we change the parameter "k" at every iteration.

3. Simulation results

In this simulation, we divide iris plants into 3 types. There are total of 150 data entries. The data records 4 attributes and 3 classifications. The 4 attributes are sepal length, sepal width, petal length and petal width. The 3 types of iris flower are Iris Setosa, Iris Versicolor and Iris Virginica.

First, we decide the learning rate (a) has smallest inaccuracy. Table 1 shows the score of inaccuracy's average with changing a .

Table 1: The inaccuracy with changing a

a	0.1	0.2	0.3	0.4	0.5
ave	0.0513	0.0303	0.0392	0.0426	0.0841
a	0.6	0.7	0.8	0.9	1.0
ave	0.0941	0.0978	0.1107	0.1204	0.1017

The learning late has smallest inaccuracy is 0.2. So we improve back-propagation with learning rate = 0.2. The simulation results of our proposed method are shown in Fig 3 and 4. Here, we decrease the parameter "k" by 0.001 at every iteration.

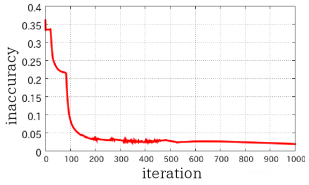

Figure 3: successful learning

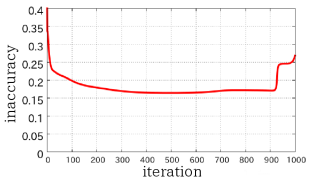

Figure 4: failure learning

Fig 3 shows the pattern of success. It's better than usual method. However, our learning method has the pattern of failure like Fig 4. The pattern of failure can not show when we do not decrease the parameter "k". So we decrease the parameter "k" by 0.001 at every iteration since 300 times. Fig 5 shows the simulation result of our new learning method. And Table 2 is the score of inaccuracy.

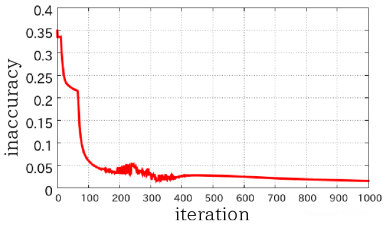

Figure 5: Propsed method's learning

Table 2: The inaccuracy with our new method

k	0.6-0.53	0.7-0.63	0.8-0.73	0.9-0.83	1.0-0.93
ave	0.0614	0.0274	0.0350	0.0162	0.0206
k	1.1-1.03	1.2-1.13	1.3-1.23	1.4-1.33	1.5-1.43
ave	0.0178	0.0295	0.0984	0.3232	0.2719

This result has smaller inaccuracy than usual method at the parameter k = 0.7-0.63, 0.9-0.83, 1.0-0.93 and 1.1-1.03.

4. Conclusions

As the simulation results, we improve back-propagation with changing the parameter "k" in sigmoid functions. The proposed method is decreasing the parameter "k" by 0.001 at every iteration since 300 times. This learning method's inaccuracy is smaller than usual method. In future work, we validate another data. And search other pattern of changing the parameter "k".