Improvement of Learning Accuracy and Reduction of Learning Loops by Using Noise in Deep Learning

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I. Introduction

In this study, We propose a noisy back propagation of deep learning. Weights of neurons are optimized using a noise in the back propagation. The purposes of this study are to improve learning accuracy and to reduce learning loops. We compare the proposed system with the conventional system using two data sets.

II. System model

Figure 1 shows a schematic drawing of deep learning consisting of two intermediate layers. Equations (1), (2) and (3) show forward propagation, back propagation and weight adjustment in Fig. 1, respectively. We use Gaussian distribution (0, 0.01) for noise and add the noise to the back propagation. In addition, the putting place of noise is changed.

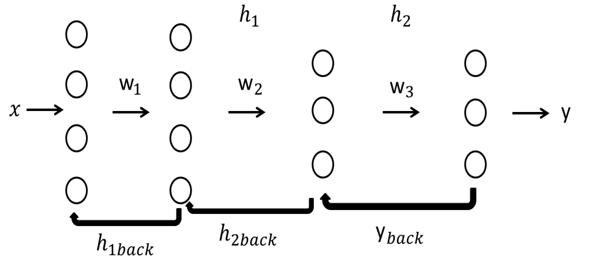

Fig. 1. Schematic drawing of deep learning consisting of two intermediate layers.

$$\begin{cases} h_1 = \dfrac{1}{1+e^{(-\sum(\mathrm{w}_1 x))}} \\ h_2 = \dfrac{1}{1+e^{(-\sum(\mathrm{w}_2 h_1))}} \\ x = \dfrac{1}{1+e^{(-\sum(\mathrm{w}_3 h_2))}} \end{cases} \tag{1}$$

$$\begin{cases} \mathrm{y}_{back} = (\mathrm{y}-t\mathrm{y})(1-\mathrm{y})\mathrm{y} \\ h_{2back} = \sum \mathrm{w}_3 \mathrm{y}_{back}(1-h_2)h_2 \\ h_{1back} = \sum \mathrm{w}_2 h_{2back}(1-h_1)h_1 \end{cases} \tag{2}$$

$$\begin{cases} \mathrm{w}_1^{(\mathrm{l}+1)} = \mathrm{w}_1^{\mathrm{l}} - \varepsilon x h_{1back} \\ \mathrm{w}_2^{(\mathrm{l}+1)} = \mathrm{w}_2^{\mathrm{l}} - \varepsilon h_1 h_{2back} \\ \mathrm{w}_3^{(\mathrm{l}+1)} = \mathrm{w}_3^{\mathrm{l}} - \varepsilon h_2 \mathrm{y}_{back} \end{cases} \tag{3}$$

(A) Iris data set [1]

We use a model with two intermediate layers. Simulations are carried out for 7 noise input patterns and the conventional no noise case.

(B) Cars data set [1]

We use a model with three intermediate layers. Simulations are carried out for 14 noise input patterns and the conventional no noise case.

III. Simulation results

Figures 2 and 3 show the change of the learning accuracy and learning loops of the conventional system and the proposed system with the noise to h_{1back} and y_{back}.

(A) Iris data set

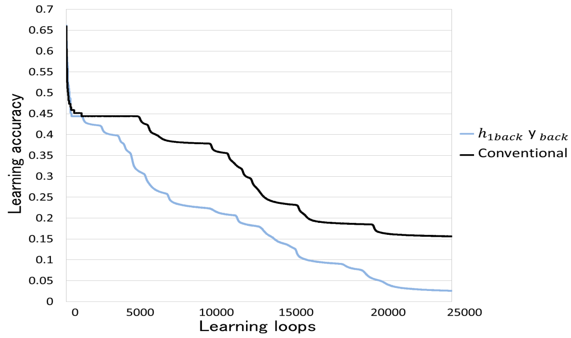

Fig. 2. Simulation results for Iris data set.

(B) Cars data set

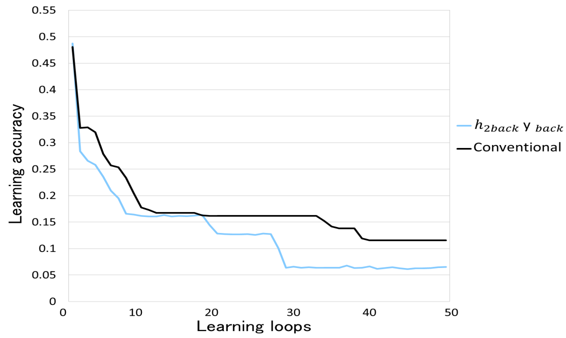

Fig. 3. Simulation results for Cars data set.

We improve learning accuracy and reduce learning loops by using noise for the back propagation. From the tendency of research results of two data sets, We found that results are improved by using noise for y_{back} of back propagation. Because, y_{back} of back propagation is compared with input and output data. Hence, it is properly carried out weight adjustment.

IV. Conclusions

In this study, We proposed a technique of deep learning using noise for the back propagation. In the proposed technique, We chose Gaussian distribution (0, 0.01) for noise. We confirmed that this technique was effective in simulations with two data sets.

References

[1] A. Asuncion and D. Newman (2007), "Machine Learning Repository," https://archive.ics.uci.edu/ml/about.html