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Introduction of Fast Neural Network Algorithm and Artificial Neural Network-Driven Fuzzy Reasoning into Seismology

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Neural network (NN) and fuzzy theory have been begun to apply to seismology¹⁾²⁾³⁾. However, when these technologies are applied to seismology, there are two problems: (1) NN needs much training time, because seismology uses large number of physical signal. (2) fuzzy reasoning has only heuristic method for decision of membership function (MF), and has no adaptive function. I propose two solutions of them and hope these technologies are applied to seismology.

Fast NN Learning Algorithm⁴⁾

We've formulated backpropagation algorithm (BP) using non-linear optimization methods. The problems of ordinal BP are: (1) there is no way to decide a learning rate ϵ , (2) it uses the steepest descent (SD) method that is the best locally but is not good globally. Our algorithm can decide optimum ϵ dynamically using Davies-Swann-Campey (DSC) search and decide a learning conjugate gradient (CG) direction using Fletcher-Reeves (FR) method. When we define E as error at output layer, w as weight vector, g as SD gradient, and p as CG direction, the weight modification of the n -th iteration is formulated as following:

$$\begin{aligned}\Delta w_n &= -\epsilon_n p_n \\ p_n &= g_n + \beta_n p_{n-1} \\ \beta_n &= \frac{\|g_n\|^2}{\|g_{n-1}\|^2} \\ g_n &= \frac{\partial E_n}{\partial w_n}\end{aligned}$$

Furthermore, we've proposed three improvements for DSC search, one improvement for FR method, and one criteria for finding bad learning situation.

These techniques are evaluated by exclusive-OR problem. I tried this evaluation two thousand times and got expected convergence time. When convergence condition is $E < 10^{-5}$, our algorithm has taken quarter the convergence time less than ordinary one.

NN-Driven Fuzzy Reasoning⁵⁾

In fuzzy theory, the fuzzy number is essential concept and is defined by MF. Therefore any application of fuzzy theory treat MF. Unfortunately there was no way to decide it. Moreover, it is impossible to adapt the variant environment of fuzzy theory application. Even if we decide MF

with much trial and error, it becomes to be useless if the environment is varied.

The solution of these problems is to find automatical and adaptive decision method of MF. We propose NN-driven fuzzy reasoning that decides MF automatically using the learning function and non-linearity of NN. Hereafter it is no need to depend on heuristics. This proposed method can also modify MF dynamically according to the dynamical environment using its learning function.

I show you one example of proposed method that is applied to the estimation problem. The task is estimation of pollutional index (COD: Chemical Oxygen Demand) in Osaka gulf from five parameters (water temperature, water transparency, DO density, salt density, and filtered COD density). The estimated result is shown in Fig.1. First thirty two data are used in training, and the other twelve data are used as evaluation.

The NN-driven fuzzy reasoning has obtained satisfactory estimation. This result makes us believe that the proposed method is applicable to the seismological estimation.

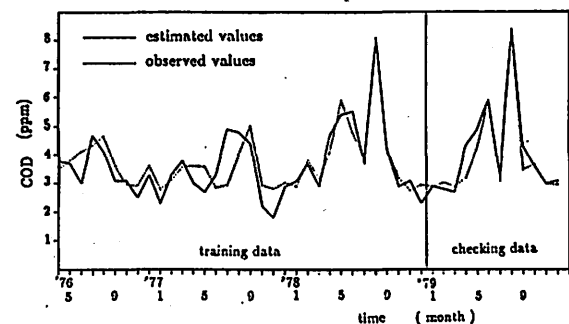


Fig.1 estimation of COD density

References

- 1) H.Yokoyama, "Application of Neural Network for Seismic Wave Processing - recognition of seismic wave -", meeting of Seismological Soc. of JPN, pl07, Sep. 1988 (Japanese)
- 2) Y.Lihua et al., "Fuzzy Cluster Analysis on Composite Fault Plane Solutions of Small Earthquake", Intern. Worksh. on Fuzzy Sys. Applicat., pp181-182, Aug., 1988
- 3) J.Yamin et al., "The Application of Fuzzy Comprehensive Evaluation to Earthquake Prediction", Intern. Worksh. on Fuzzy Sys. Applicat., pp183-184, Aug., 1988
- 4) H.Takagi et al., "Fast Learning Algorithm for Artificial Neural Network using Non-Linear Optimization Method", spring meeting of EIC, Mar. 1989 (Japanese)
- 5) H.Takagi et al., "Artificial Neural Network-Driven Fuzzy Reasoning", Intern. Worksh. on Fuzzy Sys. Applicat., pp183-184, Aug., 1988