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Neuro-Genetic Learning to the algal dynamics: a preliminary experiment for the new technique to the ecological modelling

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1. Introduction

Ecological Modelling is a comprehensive area in the dynamic ecosystem study. It is strongly necessary to utilize adequate methodology against the uncertainty and complexity of the ecosystems. The Artificial Neural Network (ANN) is a representative model for those circumstances and achieved the best performance (Recknagel, 1997; Jeong et al., 2001). Modellers selecting the data-mining approaches, however, occasionally confront the difficulty in deciding subordinate aspects of the model architectures. Modeller's experiences do important role for the determination of those collateral status (see Jeong et al., 2001), which usually costs much time. Neuro-Genetic Learning (NGL) was suggested as a good solution for the problem (Vonk et al., 1997). In this study, the prediction of monthly phytoplankton dynamics in a river system was conducted with NGL approach as a preliminary experiment.

2. Materials and Methods

The NGL progressed the step of determining ANN structure automatically. NGL is the combination of computational algorithm between ANN and Genetic Algorithm (GA). (Fig. 1). GA tries to find the best solution from the solution space. The NGL put the Multilayer Perceptron (MLP) structures as solution candidates. The genetical training searched the feasible network architecture from the solution space.

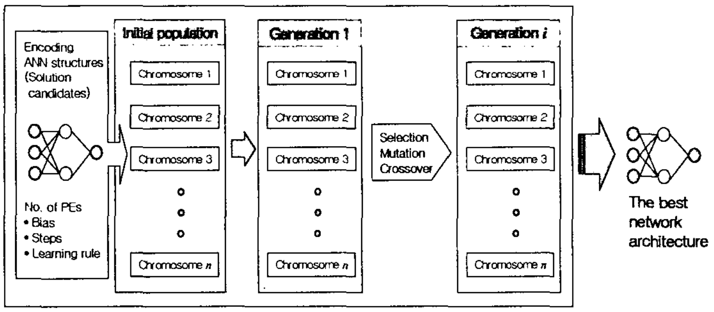

Fig. 1. A comprehensive diagram of the NGL used in this study.

NGL determined the number of Peceptron Elements (PEs), bias, the step size, and learning rule of the composed MLP. After the decision of the structure, the network was trained by the training dataset (four years: 1995-1998, monthly averaged) and the performance was tested on the independent 1994's chl. *a* concentration.

3. Results and Discussion

NGL determined the number of nodes (20 PEs) in the hidden layer and others after 50 chromosomes (500 epochs per each) for 100 generations (Final Fitness, 3.7×10^{-6}). When the fixed MLP was trained with four years data for 1000 epochs, the training error (mean squared error) was 3.7×10^{-4}. Fig. 2 depicted the result of prediction. Overall timing as well as magnitude of the prediction well matched to the observed data. The estrangement in summer was due to the amount of dataset used in training. Data-mining approaches generally requires large amount of dataset (Recknagel 1997). However, with small dataset, the NGL-MLP produced reasonable time-series prediction.

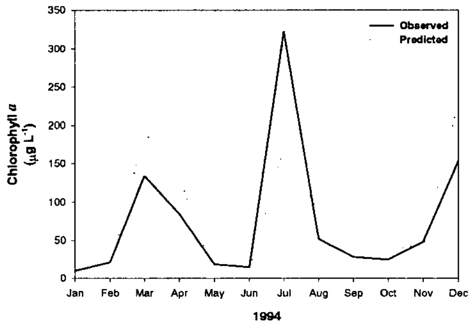

Fig. 2. The result of prediction of algal dynamics in 1994 with using NGL-MLP model.

Usually MLP was used for the time-series modelling in freshwater systems (Recknagel, 1997). Jeong et al. (2001) adapted Recurrent Neural Network with time-lagged data input to reflect the dynamic nature of ecosystem. Even though their results showed the good performance, much efforts were required for finding the appropriate structures. NGL successfully automated the creation of network architecture. This experiment showed the possibility of NGL to the time-series ecological modelling.

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