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Adaptation of Momentum Factor and Steepness Parameter in Backpropagation Algorithm Using Fixed Structure Learning Automata

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Backpropagation (BP) algorithm is a systematic method for training multi-layer neural networks, which, despite many successful applications, also has many drawbacks. For complex problems, backpropagation may require a long time to train the networks and it is possible that no training occurs at all. Long training time can be the result of non-optimal parameters. It is not easy to choose an appropriate value for the parameters of a particular problem and the parameters are usually determined by trial and error. If the parameters are not chosen appropriately, slow convergence, paralysis and continuous instability can result [1-4]. Moreover, the best values for the parameters at the beginning of training may not be good enough later. In this paper, a technique has been incorporated into BP algorithm for adaptation of steepness parameter and momentum factor in order to achieve a higher rate of convergence. Through interconnection of Fixed Structure Learning Automata (FSLA) to the feedforward neural networks, learning automata scheme is applied in order to adjust these parameters based on the observation of random response of neural networks. The main motivation in using learning automata as an adaptation algorithm is in its capability of global optimization when dealing with multi-modal surfaces. The feasibility of the proposed method is shown through simulations on three learning problems: exclusive-or, encoding problem and digit recognition. These problems are chosen because they have different error surfaces and collectively present an environment that is suitable to determine the effect of the proposed method. The simulation results show that the adaptation of these parameters using this method increases not only the convergence rate of learning but also the likelihood of escaping the local minima. Computer simulations provided in this paper indicate that at least a magnitude of savings in running time can be achieved when FSLA is used for the adaptation of momentum factor and steepness parameters. Furthermore, simulations demonstrate that the FSLA approach performs much better than the Variable Structure Learning Automata (VSLA) approach reported in [1,2].

TRODUCTION

or backpropagation training algorithm (BP), an ative gradient descent algorithm, is a simple way to in multi-layer feedforward neural networks [5]. The kpropagation algorithm is based on the gradient cent rule:

$$\Delta w_{jk}(n) = -\alpha \frac{\partial E}{\partial w_{jk}} + \mu \Delta w_{jk}(n-1), \qquad (1)$$

where w_{jk} is the weight on the connection outgoing from unit j and entering unit k, α, μ and n are learning rate, momentum factor and time index, respectively. In the BP framework, α and μ are constant and E is defined as:

$$E(n) = \frac{1}{2} \sum_{p=1}^{\neq\text{patterns}} \sum_{j=1}^{\text{outputs}} (T_{p,j} - O_{p,j})^2, \qquad (2)$$

where $T_{p,j}$ and $O_{p,j}$ are desired and actual outputs for pattern p at output node j and the index p varies on the training set. In the BP algorithm framework, each computational unit computes the same activation function. The computation of sensitivity for each neuron requires the derivative of activation function, therefore, this

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