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A SINGLE PARAMETER DYNAMIC SEARCHING ALGORITHM FOR MULTI-LAYER NEURAL NETWORKS (PART I)

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Abstract. *This paper proposes for multi-layer neural networks a learning algorithm which dynamically records the information of every sample as it goes through every neuron by means of several arrays, the information can be called by programs at any moment. For each searching process, only one parameter of the neural networks is allowed to change. The parameters of three-layer neural networks are classified into four categories. For each type, according to the characteristics of multi-layer neural networks, the expressions of error function and its first-order and second-order derivative are deduced in this algorithm. The Newton iteration method is applied to the proposed algorithm so as to speed up the convergence rate. The proposed algorithm adjusts the data in the arrays synchronously as long as changes occur in the parameters of the neural networks.*
Keywords: Multi-layer neural networks, Training algorithm, Coordinate rotation method SPDS algorithm

1. **Introduction.** Multi-layer neural networks is an important model for neural networks, which is extensively applied in such fields as pattern recognition, automatic control, data processing, etc. At present, the widely-used learning algorithm of multi-layer neural networks is the back propagation algorithm which is called B-P algorithm. It is based on the error back propagation brought forward by Rumelhart in 1986, each searching process is along the negative gradient direction. Computational experiences reveal that the convergence rate of B-P algorithm is slower in general and it becomes more apparent when the scale of the problem is sizeable. When taking the training issue of multi-layer neural networks as a numerical optimization problem, the existing unconstrained optimization method provides several training algorithms which have a higher convergence rate. These algorithms include conjugate gradient method and quasi-Newton method, which use the information of first-order derivative to improve the convergence rate. The main reason underlies that the slow convergence rate of B-P algorithm and its modified forms are the extreme computation complexity of error function. The conjugate gradient method and quasi-Newton method both avoid direct usage of Hessian matrix, yet the quasi-Newton method uses the information of first-order derivative by approaching the inverse of Hessian matrix. Generally speaking, the quasi-Newton method is fit for the training of small-scale neural networks, whereas the conjugate gradient method can be applied to the training involving large-scale neural networks.

This paper proposes an algorithm for training multi-layer neural networks which is different from the principle of B-P algorithm and other present algorithms. The algorithm proposed adopts a single variable rotation searching strategy, that is, to allow only one parameter of the neural networks to change to carry out one-dimension searching process.