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MULTI-LAYER NEURAL NETWORK LEARNING ALGORITHM BASED ON RANDOM PATTERN SEARCH METHOD

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Abstract. *A Random pattern search method (RPS) for learning multi-layer artificial neural network is proposed. As a derivative-free direct search algorithm, the proposed learning model provides a very simple and effective means of searching the minima of an objective function directly without any knowledge of its derivatives. Furthermore, by incorporating a random mechanism, it also has some chance of escaping from local minima by permitting temporary error increases during learning. Thus the network may eventually reach the global minimum state or its best approximation with higher probability. We test this algorithm on several benchmark problems, such as exclusive-or (XOR), parity, alphabetic character learning, function approximation problems and a real world classification task. Simulation results show that the systems can be trained efficiently by our method for all problems.*
Keywords: Multi-layer neural network, Pattern search, Random, Learning

1. **Introduction.** Multi-layer feed-forward neural networks (MFNNs) are the most popular class of artificial neural networks (ANNs) which have been widely applied to pattern recognition, signal processing, time series prediction, non-linear control, identification problems and so on [1]. The class of networks consists of multiple layers of computational units interconnected in a feed-forward way. Each neural in one layer has directed connections to the neurons of the subsequent layer. The training of them [2] can be viewed as the optimization of a criterion function from a set of input-output pairs with respect to a set of parameters-the weights and thresholds [3]. In other words, it is a kind of multidimensional minimization of the error measure function. Minimizing the multi-layer neural network error measure function in realistic problems is a difficult task since many layers, the multitude of training patterns and the variety of categories cast a very complex landscape with wide plateaus and narrow valleys [4].

Recently, several gradient descent based algorithms [2,5,6] and global optimization techniques (such as genetic algorithm [7] and simulated annealing [8-11]) have been present to train the multi-layer feed-forward neural networks. Although global optimization techniques provide an alternative method to problems that are difficult to solve with traditional optimization algorithms, they suffer from poor convergence properties and difficulties to reach high quality solutions when the structure of neural networks becomes complex and there are large training samples [12]. Furthermore, as a first-order gradient based non-linear optimization method, the back-propagation (BP) algorithm is most widely used and an effective algorithm for training multi-layer feed-forward neural networks [2]. It iteratively adjusts the network parameters (all weights and thresholds) to minimize the error measure function using a gradient descent technique. Most recently,