Chapter 70
Improving Performance of Higher Order Neural Network using Artificial Chemical Reaction Optimization:
A Case Study on Stock Market Forecasting

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ABSTRACT

Multilayer neural networks are commonly and frequently used technique for mapping complex nonlinear input-output relationship. However, they add more computational cost due to structural complexity in architecture. This chapter presents different functional link networks (FLN), a class of higher order neural network (HONN). FLNs are capable to handle linearly non-separable classes by increasing the dimensionality of the input space by using nonlinear combinations of input signals. Usually such network is trained with gradient descent based back propagation technique, but it suffers from many drawbacks. To overcome the drawback, here a natural chemical reaction inspired metaheuristic technique called as artificial chemical reaction optimization (ACRO) is used to train the network. As a case study, forecasting of the stock index prices of different stock markets such as BSE, NASDAQ, TAIEX, and FTSE are considered here to compare and analyze the performance gain over the traditional techniques.

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INTRODUCTION

Artificial Neural Networks (ANN) are found to be good universal approximator which can approximate any continuous function to desired accuracy. It also allows the adaptive adjustment to the model and nonlinear description of the problems. Some earlier use of ANN for the financial forecasting purpose can be found in the research work carried out by Refenes et al. (1994), Schoeneburg (1990), Yoon et al. (1994), Yoon and Swales (1991), Choi et al. (1995), Gately (1996), and Drossu and Obradovic (1996). The ANNs have recently been applied to many areas such as data mining, stock market analysis, medical and many other fields. Gradient based methods are one of the most widely used error minimization methods used to train back propagation networks. Back propagation algorithm is a classical domain dependent technique for supervised training. It works by measuring the output error calculating the gradient of this error, and adjusting the ANN weights and biases in the descending gradient direction. Back propagation is the most commonly used and the simplest feed forward algorithm used for classification. Back propagation based ANNs are very popular methods to predict stock market with better calculation, spreading abilities and stronger nonlinear mapping ability.

It is observed that Multilayer Perceptron (MLP) has been adopted as the most frequently used ANN by the researchers for the task of forecasting. An MLP contains one or more hidden layer, and each layer can contain more than one neurons. The input pattern is applied to the input layer of the network and it propagates the signals through the network from one layer to other till it reaches the output layer. During the forward phase, the synaptic weights of the networks are fixed. In the backward phase, the weights are adjusted in accordance with the error correction rule popularly called as back propagation learning rule. Some forecasting applications of MLP are financial time series forecasting by Yu and Wang (2009), market trend analysis by Aiken and Bsat (1999), macroeconomic data forecasting by Aminian et al. (2006), stock exchange movement by Mohamed and Mostafa (2010), railway traffic forecasting by Zhuo et al. (2007), airline passenger traffic forecasting by Nam and Yi (1997), maritime traffic forecasting by Mohamed and Mostafa (2004), electric load forecasting by Darbellay and Slama (2000) and air pollution forecasting by Videnova et al. (2006). Though MLP is the most widely and frequently used technique, but it suffers from slow and non convergence. Calderon and Cheh (2002) argued that the standard MLP network is subject to problems of local minima. Again there is no formal guideline how to develop a network for the MLP technique as suggested in the work carried out by Swicegood and Clark (2001). It is suggested that to overcome the local minima problem, more number of nodes may be added to the hidden layers. But multiple hidden layers with large number of neurons in each layer make the network computationally inefficient. Finding an optimal structure of the network of MLP technique leads to a combinatorial problem. Defining a feasible architecture and parameters for MLP is very often a matter of trial and error which is also computationally very expensive. From the study of the existing literature on stock market index forecasting, it is observed that improved forecasting accuracy and adopting models with less computational complexities are important areas of present day research in the stock market. The research work by (Patra et al. 2009a), Kim et al.(2006), (Majhi et al., 2009a) proposed a trigonometric functional link network (FLN) using least mean squared (LMS) and recursive least square (RLS) to forecast both short and long term forecasting. The work concludes that FLN based stock market prediction model is an effective approach both computationally as well as performance wise to foresee the market levels both in short and medium terms future. There have been several applications of FLN including pattern classification and recognition by Mishra and Dehuri (2007), Mishra et al. (2008), (Dehuri and Cho, 2010a), (Dehuri and Cho, 2010b), (Majhi et al. 2009b), system identification and