Chapter V
Foreign Exchange Rate Forecasting Using Higher Order Flexible Neural Tree

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ABSTRACT

Forecasting exchange rates is an important financial problem that is receiving increasing attention especially because of its difficulty and practical applications. In this chapter, we apply Higher Order Flexible Neural Trees (HOFNTs), which are capable of designing flexible Artificial Neural Network (ANN) architectures automatically, to forecast the foreign exchange rates. To demonstrate the efficiency of HOFNTs, we consider three different datasets in our forecast performance analysis. The data sets used are daily foreign exchange rates obtained from the Pacific Exchange Rate Service. The data comprises of the US dollar exchange rate against Euro, Great Britain Pound (GBP) and Japanese Yen (JPY). Under the HOFNT framework, we consider the Gene Expression Programming (GEP) approach and the Grammar Guided Genetic Programming (GGGP) approach to evolve the structure of HOFNT. The particle swarm optimization algorithm is employed to optimize the free parameters of the two different HOFNT models. This chapter briefly explains how the two different learning paradigms could be formulated using various methods and then investigates whether they can provide a reliable forecast model for foreign exchange rates. Simulation results showed the effectiveness of the proposed methods.

INTRODUCTION

Foreign exchange rates are amongst the most important economic indices in the international monetary markets. Since 1973, with the abandonment of fixed foreign exchange rates and the implementations of the floating exchange rates system by industrialized countries, researchers have been striving for an explanation of the movement of exchange rates (J. T. Yao & C. L. Tan, 2000). Exchange rates are affected by many highly correlated factors. These factors could be economic, political and even psychological. The interaction of these factors is very complex. Therefore, forecasting changes of foreign exchange rates is generally very difficult. In the past decades, various kinds of forecasting methods have been developed by many researchers and experts. Technical and fundamental analysis are the basic and major forecasting methodologies popular use in financial forecasting. Like many other economic time series, a foreign exchange rate has its own trend, cycle, season, and irregularity. Thus to identify, model, extrapolate and recombine these patterns and to realize foreign *exchange rate forecasting* is a major challenge. Thus much research effort has been devoted to exploring the nonlinearity of exchange rate data and to developing specific nonlinear models to improve *exchange rate forecasting* including the autoregressive random variance (ARV) model, auto regressive conditional heteroscedasticity (ARCH), self-exciting threshold autoregressive models, There has been growing interest in the adoption of *neural networks* (Zhang, G.P., Berardi, V.L, 2001), fuzzy inference systems and statistical approaches for *exchange rate forecasting*, such as the traditional multi-layer feed-forward network (MLFN) model, the adaptive smoothing *neural network* (ASNN) model (Yu, L., Wang, S. & Lai, K.K., 2000), etc..

The major problems in designing an artificial *neural network* (ANN) for a given problem are how to design a satisfactory ANN architecture and which kind of learning algorithms can be effectively used for training the ANN. Weights and biases of ANNs can be learned by many methods, i.e. the back-propagation algorithm (Rumelhart, D.E. et al., 1986), genetic algorithm (D. Whitley et al., 1990; G. F. Miller et al., 1989); evolutionary programming (D. B. et al., 1990; N. Saravanan et al., 1995; J. R. McDonnell et al., 1994), random search algorithm (J. Hu, et al., 1998) and so on. Usually, a *neural network's* performance is highly dependent on its structure. The interaction allowed between the various nodes of the network is specified using the structure only. There may different ANN structures with different performance for a given problem, and therefore it is possible to introduce different ways to define the structure corresponding to the problem. Depending on the problem, it may be appropriate to have more than one hidden layer, feed-forward or feedback connections, and different activation functions for different units, or in some cases, direct connections between the input and output layer. In the past decades, there has been increasing interest in optimizing ANN architecture and parameters simultaneously.

There have been a number of attempts in automatically designing ANN architectures. The early methods of architecture learning include constructive and pruning algorithms (S. E. Fahlman et al., 1990; J. P. Nadal, 1989; R. Setiono et al., 1995). The main problem with these methods is that the topological subsets rather than the complete class of ANN's architecture are searched in the search space by structural hill climbing methods (J. Angeline et al., 1994). Recently, a tendency for optimizing architecture and weights of ANNs by evolutionary algorithm has become an active research area. Xin Yao, et al. (Yao X. et al., 1997, 1999), proposed a new evolutionary system called EPNet for evolving the architecture and weights of ANNs simultaneously. EPNet is a kind of hybrid technique. Here architectures are modified by mutation operators that add or delete nodes/connections. Weights are trained by

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