IDEA GROUP PUBLISHING **ITB13011**

701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com

This paper appears in the publication, *Artificial Neural Networks in Finance and Manufacturing*
edited by Joarder Kamruzzaman, Rezaul Begg, and Ruhul Sarker© 2006, Idea Group Inc.

Chapter VI

Hierarchical Neural Networks for Modelling Adaptive Financial Systems

Masoud Mohammadian, University of Canberra, Australia

Mark Kingham, University of Canberra, Australia

Abstract

In this chapter, an intelligent hierarchical neural network system for prediction and modelling of interest rates in Australia is developed. A hierarchical neural network system is developed to model and predict 3 months' (quarterly) interest-rate fluctuations. The system is further trained to model and predict interest rates for 6-month and 1-year periods. The proposed system is developed with first four and then five hierarchical neural networks to model and predict interest rates. Conclusions on the accuracy of prediction using hierarchical neural networks are also reported.

Introduction

The prediction of uncertain dynamic systems, which are subject to external disturbances, uncertainty, and sheer complexity, is of considerable interest. Conventional modelling and prediction methods involve the construction of mathematical models describing the dynamic systems to be controlled and the application of analytical techniques to the model to derive prediction and control laws (Caudell, Xiao, & Healy, 2003; Kosko, 1992; Medsker, 1995; Rakovic, 1977; Vidyasagar, 1978; Wang, Devabhaktuni, & Zhang, 1998; Zadeh, 1965, 1973, 1994;). These models work well provided the system does meet the requirements and assumptions of synthesis techniques. However, due to uncertainty or sheer complexity of the actual dynamic system, it is very difficult to ensure that the mathematical model does not break down.

Neural network technology is an active research area (Chester, 1993; Grossberg, 1988; Kosko, 1992). It has been found useful when the process is either difficult to predict or difficult to model by conventional methods. Neural network modelling has numerous practical applications in control, prediction, and inference.

Time series are a special form of data where past values in the series may influence future values, depending on the presence of underlying deterministic forces. These are trend cycles and nonstationary behaviour in the time-series data are used in predictive models. Predictive models attempt to recognise patterns and nonlinear relationships in the time-series data. Due to the nature of data in time series, linear models are found to be inaccurate and there has been a great interest in nonlinear modelling techniques.

Recently, techniques from artificial-intelligence fields such as neural networks (NNs), fuzzy logic (FL), and genetic algorithms (GA) have been successfully used in the place of the complex mathematical systems for forecasting of time series (Azoff, 1994; Bauer, 1994; Cox, 1993, 1994; Davis, 1991; Gallant, 1993; Goldberg, 1989; Karr, 1991; Lee, 1990; Lee & Takagi, 1993; Mamdani, 1993; Michalewicz, 1992; Ruelle, 1989; Schaffer, 1994). These new techniques are capable of responding quickly and efficiently to the uncertainty and ambiguity of the system.

Neural networks (Azzof, 1994; Chester, 1993; Gallant, 1993; Hung, 1993; Karr, 1994; Knigham, 1996; Kingham, & Mohammadian, 1996; Welstead, 1994; Zuruda, 1994;) can be trained in an adaptive manner to map past and future values of a time series and thereby extract hidden structure and relationships governing the data (Lapedes, & Farber, 1987).

Investors and governments alike are interested in the ability to predict future interest-rate fluctuations from current economic data. Investors are trying to maximise their gains on the capital markets, while government departments need to know the current position of the economy and where it is likely to be in the near future for the well being of a country's people (Madden, 1995).

In the next section, the development of a hierarchical neural network system is considered. This section also describes the financial data that can be used to predict the fluctuations of interest rates in Australia. The application of hierarchical neural network systems for the prediction of quarterly interest rates in Australia is then considered.

Comparison of the results from single neural networks and the proposed hierarchical-neural network-system is made. The long-term prediction of interest rates by increasing