Chapter XXII
Trigonometric Polynomial Higher Order Neural Network Group Models and Weighted Kernel Models for Financial Data Simulation and Prediction

Lei Zhang
University of Technology, Australia

Simeon J. Simoff
University of Western Sydney, Australia

Jing Chun Zhang
IBM, Australia

ABSTRACT

This chapter introduces trigonometric polynomial higher order neural network models. In the area of financial data simulation and prediction, there is no single neural network model that could handle the wide variety of data and perform well in the real world. A way of solving this difficulty is to develop a number of new models, with different algorithms. A wider variety of models would give financial operators more chances to find a suitable model when they process their data. That was the major motivation for this chapter. The theoretical principles of these improved models are presented and demonstrated and experiments are conducted by using real-life financial data.

INTRODUCTION

Financial operators have nowadays access to an extremely large amount of data, quantitative and qualitative, real-time or historical, and use this information to support their investment decision-making process.

Quantitative data, such as historical price database or real-time price information is largely processed by computer programs. However, there are only few programs based on artificial intelligence techniques for financial analysis intended for the end user. Financial operators have only a limited choice of models for the data.

Until now, in the area of financial data simulation and prediction, there is no single neural network model that could handle the wide variety of data and perform well in the real world.

A way of solving this difficulty is to develop a number of new models, with different algorithms. A wider variety of models would give financial operators more chances to find a suitable model when they process their data. That was the major motivation for this chapter.

The degree of accuracy is the most important characteristic of a simulation and prediction model. A way to increase the degree of accuracy of a model is provided in this chapter. Group theory with trigonometric polynomial higher order neural network models and weighted kernel models are used in this chapter to improve accuracy.

In the artificial intelligence area, the traditional way of operating is the Questions and Answers (Q&A) method. The neural network model looks like a 'black box' for the financial operators. Within the Q&A method, financial operators do not need to know much about the underlying model without outside intervention, given the relevant training data. This kind of process is called 'model-free inference'. For situations where it is too difficult or time consuming to derive an accurate mathematical representation for the physical model, such a system would be ideal in practice.

The difficulty is due to the dual nature of the estimation of error in a problem. An incorrect model that has insufficient or inappropriate representational ability will have a high bias. On the other hand, a model able to be truly bias free must have a high variance to ensure its encoding flexibility, and hence will require a prohibitively large training set to provide a good approximation.

The dilemma is that, the more representational power a neural network model is given, the more difficult it is for it to learn concepts correctly. Each neural network model has an inherent underlying process that is used to construct its internal model and, as a consequence, any solution that is found will be naturally biased by the representational power of the learning system. Such bias includes the architecture type, connection topology and perhaps the input and output representations. Consequently the estimation of these parameters relies on the prior knowledge or biases of the researcher about the problem, annihilating the original goal of bias free learning.

To achieve low variance while simultaneously estimating a large variety of parameters requires an impractical number of training examples.

One possible solution to this problem is to develop a new model that is visible to the operator. The proposed program in this chapter will allow the operator to watch every aspect of the model during the training process.

BACKGROUND

The basic ideas behind Artificial Neural Networks (ANNs) are not new. McCulloch & Pitts developed their simplified single neuron model over 50 years ago. Widrow developed his 'ADALINE' and Posenblatt the 'PERCEPTRON' during the 1960's. Multi-layer feed-forward networks (Multi-Layer Perceptrons or MLPs) and the back-propagation algorithm were developed during the late 1970's, and Hopfield devised his recurrent (feed back) network during the early 1980's. The develop-