

Chapter 31

A Neuro–Fuzzy Expert System Trained by Particle Swarm Optimization for Stock Price Prediction

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ABSTRACT

In today's competitive markets, prediction of financial variables has become a critical issue. Especially in stock market analysis where a wrong prediction may result in a big loss in terms of time and money, having a robust prediction is a crucial issue. To model the chaotic, noisy, and evolving behavior of stock market data, new powerful methods should be developed. Soft Computing methods have shown a great confidence in such environments where there are many uncertain factors. Also it has been observed through many experiments that the hybridization of different soft computing techniques such as fuzzy logic, neural networks, and meta-heuristics usually results in better results than simply using one method. This chapter presents an adaptive neuro-fuzzy inference system (ANFIS), trained by the particle swarm optimization (PSO) algorithm for stock price prediction. Instead of previous works that have emphasized on gradient base or least square (LS) methods for training the neural network, four different strategies of PSO are implemented: gbest, lbest-a, lbest-b, and Euclidean. In the proposed fuzzy rule based system some technical and fundamental indexes are applied as input variables. In order to generate membership functions (MFs), a robust noise rejection clustering algorithm is developed. The proposed neuro-fuzzy model is applied for an automotive part-making manufactory in an Asia stock market. The results show the superiority of the proposed model in comparison with the available models in terms of error minimization, robustness, and flexibility.

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INTRODUCTION

In today's competitive markets, prediction of financial variables has become a critical issue. Especially in stock market analysis where a wrong prediction may result in a big loss in terms of time and money having a robust prediction is a crucial thing. For predicting stocks' return/price and making buy/sell decisions in stock market people generally use two types of analysis including security analysis and portfolio analysis (selection). The security analysis itself can be divided into two categories as technical analysis and fundamental analysis.

In technical analysis, all the information about the stocks is hidden in the prices and trading volumes. Thus, an investment policy based on technical analysis is a policy for predicting future stock prices by studying the historical prices and volumes' data. On the other hand, fundamental analysis lies in information about macroeconomic variables, company's performance and related industries in order to predict the future stock price direction. Finally, portfolio selection is concerned with selecting a combination of securities among portfolios containing large numbers of securities to reach the investment goal (Li & Xu, 2009).

Recent advances in soft computing offer many tools and techniques for forecasting noisy environments like stock markets and capturing the nonlinear behavior of these environments (Atsalakis & Valavanis, 2008). Also, artificial neural networks (ANNs) have been used for this purpose for a long time (Kim & Han, 1998; Aiken & Bsat, 1999; Chi, Chen, and Cheng, 1999; Lee, 2001; Wah & Qian, 2002). However these models have their own limitations due to the noise and complex dimensionality of stock price data. Besides, the size of data set and the input variables may also interfere with each other. Therefore, the result of these models and methods may not be very persuasive.

Fuzzy system modeling is a powerful tool for stock market analysis. Wang (2002) presents

a data mart to reduce the size of stock data by combining fuzzification techniques with the grey theory to develop a fuzzy grey prediction as one of predicting functions to predict the possible answers immediately. Fazel Zarandi et al. (2009) proposed an interval type-2 fuzzy rule based system for stock price prediction. Their proposed type-2 fuzzy model applies both the technical and fundamental indexes as the input variables. In this work an indirect approach is used to fuzzy system modeling by implementing the modified cluster validity index for determining the number of rules in fuzzy clustering. Jilani and Burney (2008) presented a simple time-variant fuzzy time series forecasting method. They have proposed a fuzzy metric to use the frequency-density-based partitioning. The proposed fuzzy metric also uses a trend predictor to calculate the forecast. Chang and Liu (2008) introduced a fuzzy system based on Takagi-Sugeno-Kang (TSK) for prediction of stock price. Chu et al. (2009) presents a new time-series model for stock index forecasting using dual factors to improve the forecasting accuracy of fuzzy time-series models.

At the computational level, a fuzzy system can be observed as a layered structure (network) similar to artificial neural networks of the Radial Basis Function (RBF) type (Jang & Sun, 1993). For parameters optimization in a fuzzy system, gradient-descent training algorithms can be employed. Hence, this approach is usually referred to as neuro-fuzzy modeling (Brown & Harris, 1994; Jang, 1993).

In recent years, neuro-fuzzy systems have frequently been used for stock price prediction. These approaches are to use quantitative inputs like technical indices and qualitative factors such as political effects. Kuo, Chen, and Hwang (2001) fuzzy neural network trained with a genetic algorithm to measure the qualitative effects on stock price. They applied their system to the Taiwan stock market. Aiken and Bsat (1999) used a Fuzzy Neural Network (FNN) trained by a genetic algorithm (GA) to forecast three-month US

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