Chapter 8
Development and Performance Analysis of Fireworks Algorithm-Trained Artificial Neural Network (FWANN): A Case Study on Financial Time Series Forecasting

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AbStract

Financial time series are highly nonlinear and their movement is quite unpredictable. Artificial neural networks (ANN) have ample applications in financial forecasting. Performance of ANN models mainly depends upon its training. Though gradient descent-based methods are common for ANN training, they have several limitations. Fireworks algorithm (FWA) is a recently developed metaheuristic inspired from the phenomenon of fireworks explosion at night, which poses characteristics such as faster convergence, parallelism, and finding the global optima. This chapter intends to develop a hybrid model comprising FWA and ANN (FWANN) used to forecast closing prices series, exchange series, and crude oil prices time series. The appropriateness of FWANN is compared with models such as PSO-based ANN, GA-based ANN, DE-based ANN, and MLP model trained similarly. Four performance metrics, MAPE, NMSE, ARV, and R2, are considered as the barometer for evaluation. Performance analysis is carried out to show the suitability and superiority of FWANN.

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INTRODUCTION

The process of predicting the future data based on current and past data of a financial time series is known as financial time series forecasting. Financial time series are highly nonlinear and their movement is quite unpredictable due to economical, political, natural, and global phenomena. Accurate forecasting model design is the keen objective of researchers, financial experts, and speculators. Several conventional as well as advanced computing-based forecasting models have been developed and applied to financial domain. In early days a quite good number of mathematical as well as statistical models are suggested to model the financial time series (Contreras, Espinola, Nogales, & Conejo, 2003; Leigh, Hightower, & Modani, 2005; Swider & Weber, 2007; Kung & Yu, 2008). These models are based on the assumption of the linearity of current and previous variables and are not efficient in handling highly non-linear time series data.

With the exponential growth in computing technologies, the process of financial forecasting becomes faster and more powerful. The advancement in the electronic communication and popularity of internet technologies made the access of financial data easy. Conventional computing, i.e. hard computing requires a lot of computation time and precisely stated analytic model. However, soft computing is tolerant of imprecision, partial truth, uncertainty and approximation. It mimics the human brain as it represents ideas that seem to emulate intelligence to solve commercial problems. In soft computing the tolerance for uncertainty and imprecision is exploited to achieve tractability, lower computation cost, robustness, high machine Intelligence quotient and economy of computation. Soft computing techniques are better suited to deal with the uncertainty and irregularity involved in financial time series. Hence, they are widely used for analyzing and forecasting the financial data. They can be broadly categories as: Artificial Neural Network, Evolutionary Algorithms, and Fuzzy Logic System.

Artificial Neural Network (ANN) has the analogy with the thinking capacity of human brain and thus mimicking it. Introduction about ANN can be found in (Haykin, 2010; Kecman, 2006; Rajasekaran & Pai, 2007; Aliev, Fazlollahi & Aliev, 2004). The ANN can imitate the process of human behavior and solve nonlinear problems, which have made it popular and are widely used in calculating and predicting complicated systems. ANNs are found to be good universal approximator which can approximate any continuous function to desired accuracy. These are considered to be an effective modeling procedure for mapping input-output containing both regularities and exceptions as the case of financial time series. These advantages of ANN attract researchers to forecast financial time series with ANN based models. Dealing with uncertainty and nonlinearity associated with financial time series with ANN based forecasting method primarily involves recognition of patterns in the data and using such patterns to predict future event.

The adjustment of neuron weight and bias of ANN is the key factor of ANN training and is a crucial task. The performance of ANN based models are solely depends upon the adjustment of weight and bias vectors. To circumvent the limitations of gradient descent-based ANN training, large number of nature and bio-inspired optimization techniques are proposed and applied (N. Shadbolt). Evolutionary computing techniques are based on the behavior of nature. Normally these algorithms are motivated by biological evolution and termed as evolutionary algorithms of metaheuristic. The ideas of imitating concepts from nature have great potential in developing algorithms to solve engineering problems. In recent past, applications of these techniques have achieved popularity in wide area of engineering, computer science, medicine, economics, finance, social networks and so on. Their performance depends upon several algorithm specific control parameters and there is no single technique performing well on