Forecasting financial time series using a low complexity recurrent neural network and evolutionary learning approach

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Abstract The paper presents a low complexity recurrent Functional Link Artificial Neural Network for predicting the financial time series data like the stock market indices over a time frame varying from 1 day ahead to 1 month ahead. Although different types of basis functions have been used for low complexity neural networks earlier for stock market prediction, a comparative study is needed to choose the optimal combinations of these for a reasonably accurate forecast. Further several evolutionary learning methods like the Particle Swarm Optimization (PSO) and modified version of its new variant (HMRPSO), and the Differential Evolution (DE) are adopted here to find the optimal weights for the recurrent computationally efficient functional link neural network (RCEFLANN) using a combination of linear and hyperbolic tangent basis functions. The performance of the recurrent computationally efficient FLANN model is compared with that of low complexity neural networks using the Trigonometric, Chebyshev, Laguerre, Legendre, and tangent hyperbolic basis functions in predicting stock prices of Bombay Stock Exchange data and Standard & Poor’s 500 data sets using different evolutionary methods and has been presented in this paper and the results clearly reveal that the recurrent FLANN model trained with the DE outperforms all other FLANN models similarly trained.

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1. Introduction

Financial time series data are more complicated than other statistical data due to the long term trends, cyclical variations, seasonal variations and irregular movements. Predicting such highly fluctuating and irregular data is usually subject to large errors. So developing more realistic models for predicting financial time series data to extract meaningful statistics from it, more effectively and accurately is a great interest of research.
in financial data mining. The traditional statistical models used for financial forecasting were simple, but suffered from several shortcomings due to the nonlinearity of data. Hence researchers have developed more efficient and accurate soft computing methods like Artificial Neural Network (ANN); Fuzzy Information Systems (FIS), Support Vector Machine (SVM), Rough Set theory etc. for financial forecasting. Various ANN based methods like Multi Layer Perception (MLP) Network, Radial Basis Function Neural Network (RBFNN), Wavelet Neural Network (WNN), Local Linear Wavelet Neural Network (LLWNN), Recurrent Neural Network (RNN) and Functional Link Artificial Neural Network (FLANN) are extensively used for stock market prediction due to their inherent capabilities to identify complex nonlinear relationship present in the time series data based on historical data and to approximate any nonlinear function to a high degree of accuracy. The MLP structure is evaluated as per MLP. But it possesses a higher rate of convergence and lesser computational cost than those of a MLP structure. A wider architecture of various FLANN models have been discussed. Comparing the performance of different FLANN models for predicting stock prices of Bombay Stock Exchange data and Standard & Poor’s 500 data set, it has been tried to find out the best FLANN among them. The rest of the paper is organized as follows. In Sections 2 and 3, the detailed architecture of various FLANN models and various evolutionary learning algorithms for training has been described. The simulation study for demonstrating the prediction performance of different FLANNs has been carried out in Section 4. This section also provides a comparative result of training and testing of different FLANNs using PSO, HMRPSO, and DE (Mohapatra et al., 2012; Qin et al., 2008; Wang et al., 2011) based learning for predicting financial time series data. Finally conclusions are drawn in Section 5.

2. Architecture of low complexity neural network models

The FLANN originally proposed by Pao in 1992 is a single layer single neuron architecture, having two components: Functional expansion component and Learning component. The functional block helps to introduce nonlinearity by expanding the input space to a higher dimensional space through a basis function without using any hidden layers like MLP structure. The mathematical expression and computational calculation of a FLANN structure is same as MLP. But it possesses a higher rate of convergence and lesser computational cost than those of a MLP structure. A wider architecture of various FLANN models and various evolutionary learning algorithms for training has been described. Comparing the performance of different FLANN models for predicting stock prices of Bombay Stock Exchange data and Standard & Poor’s 500 data set, it has been tried to find out the best FLANN among them. The rest of the paper is organized as follows. In Sections 2 and 3, the detailed architecture of various FLANN models and various evolutionary learning algorithms for training has been described. The simulation study for demonstrating the prediction performance of different FLANNs has been carried out in Section 4. This section also provides a comparative result of training and testing of different FLANNs using PSO, HMRPSO, and DE (Mohapatra et al., 2012; Qin et al., 2008; Wang et al., 2011) based learning for predicting financial time series data. Finally conclusions are drawn in Section 5.
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