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Foreign Currency Exchange Rates Prediction using CGP and Recurrent Neural Network

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Abstract

Feedback in Neuro-Evolution is explored and evaluated for its application in devising prediction models for foreign currency exchange rates. A novel approach to foreign currency exchange rates forecasting based on Recurrent Neuro-Evolution is introduced. Cartesian Genetic Programming (CGP) is the algorithm deployed for the forecasting model. Recurrent Cartesian Genetic Programming evolved Artificial Neural Network (RCGPANN) is demonstrated to produce computationally efficient and accurate model for forex prediction with an accuracy of as high as **98.872 %** for a period of 1000 days. The approach utilizes the trends that are being followed in historical data to predict five currency rates against Australian dollar. The model is evaluated using statistical metrics and compared. The computational method outperforms the other methods particularly due to its capability to select the best possible feature in real time and the flexibility that the system provides in feature selection, connectivity pattern and network.

Keywords: Foreign exchange rate forecasting; Neural Networks; Cartesian Genetic Programming; Neuro-evolution; Recurrent Networks; Time Series Prediction

1. Introduction

The data associated with financial time series is noisy, unstable and fluctuating. The non-linear and

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volatile nature of foreign exchange data cannot be efficiently predicted by current statistical models used for forecasting of stock exchange rates (Philip et al., 2011). Artificial neural networks (ANNs) are used to solve countless real-world problems, with financial time series forecasting being one of the most challenging amongst them. The performance of time series forecasting model however is limited by its low accuracy for forecasting longer periods of time. This work presents a Neuro-evolutionary algorithm based on Cartesian Genetic Programming evolved Artificial Neural Network (CGPANN).

This paper depicts a novel computational method of input selection for stock market forecasting using neural networks. Such an approach, where the algorithm selects the desired number of nodes that gives the best possible output and an optimal network, has not been proposed up till now. The method involves extracting the best possible feature of input variables of neural networks and that of stock market time series. The system provides flexibility in real-time feature selection, network architecture and connectivity pattern for prediction. Feature selection results in the removal of irrelevant features. Selection of the connectivity pattern involves deciding whether to use a recurrent connection or a feed-forward connection. Hence the system could be used as a recurrent neural network as well as a feed-forward network.

2. Literature review

Forecasting research literature is rich in terms of the published work in recent times owing to the development of information technology. The experimental results show that as opposed to the statistical models such as ARIMA (Autoregressive integrated moving average), neural network models produce better results, demonstrating their suitability for forecasting the foreign exchange rates. (Kadilar & Adla, 2009) explored both ARIMA time series model neural networks for Turkish TL/US dollar exchange rate series. The results show that the ANN method has a far better accuracy compared to the ARIMA time series model, proving the superiority of ANNs over statistical model. (Kamruzzaman et al., 2010) explored three different Artificial Neural Network (ANN) based forecasting models: Standard Back propagation (SBP), Scaled Conjugate Gradient (SCG) and Back propagation with Bayesian Regularization (BPR) to predict six different currencies against Australian dollar and evaluated their performance in terms of prediction accuracy. (Naeini et al., 2010) focused on the use of a feed forward multilayer Perceptron (MLP) to use the historic records regarding the stock share in order to predict a company's stock value and compared it with Elman Recurrent Network and Regression Model. Results indicate that MLP has lower MSE, MAPE, and MAE values in comparison with Elman and linear regression whereas the Elman recurrent neural network outperforms the multilayer Perceptron in predicting the direction of changes. Time series forecasting carried out by (Kryuchin et al., 2011) uses two ANN techniques, Multilayer Perceptron (MLP) and Volterra. According to (Philip et al., 2011), Hidden Markov Models are unstable for trading tool on foreign exchange data, the reason being that the results are dependent on too many factors. Although the Multilayer Perceptron (MLP) neural network is used widely in forecasting systems, it has the drawback of being time consuming and not being able to restore the memory of past events (Wei & Cheng, 2012). To improve the past forecasting models, (Wei & Cheng, 2012) suggests a hybrid forecasting model that refines past models and optimizes the Elman Recurrent Neural Network (Elman NN) for predicting the Taiwan stock price trends. The proposed model outperforms the other listed models due to nonlinear prediction capabilities, faster convergence, and accurate mapping ability.

3. Recurrent Cartesian Genetic Programming evolved Artificial Neural Network (RCGPANN)

The research solution discussed here for the purpose of foreign currency exchange forecasting has been implemented for recurrent CGPANN or RCGPANN, which is different from other classes of CGPANN due