An improved shuffled frog leaping algorithm based evolutionary framework for currency exchange rate prediction

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HIGHLIGHTS

- An evolutionary framework using an improved shuffled frog leaping (ISFL) algorithm is proposed for prediction of currency exchange rate.
- The ISFL algorithm is applied as a learning algorithm to estimate the unknown parameters of a computationally efficient functional link artificial neural network (CEFLANN).
- The model is validated over three currency exchange data sets such as USD/CAD, USD/CHF and USD/JPY.
- The model performance is also compared with two other evolutionary models such as SFL-CEFLANN and PSO-CEFLANN.

ARTICLE INFO

Article history:
Received 30 January 2017
Received in revised form 19 April 2017
Available online 15 June 2017

Keywords:
Neural network
Evolutionary technique
Shuffled frog leaping algorithm
FOREX prediction

ABSTRACT

Forecasting purchasing power of one currency with respect to another currency is always an interesting topic in the field of financial time series prediction. Despite the existence of several traditional and computational models for currency exchange rate forecasting, there is always a need for developing simpler and more efficient model, which will produce better prediction capability. In this paper, an evolutionary framework is proposed by using an improved shuffled frog leaping (ISFL) algorithm with a computationally efficient functional link artificial neural network (CEFLANN) for prediction of currency exchange rate. The model is validated by observing the monthly prediction measures obtained for three currency exchange data sets such as USD/CAD, USD/CHF, and USD/JPY accumulated within same period of time. The model performance is also compared with two other evolutionary learning techniques such as Shuffled frog leaping algorithm and Particle Swarm optimization algorithm. Practical analysis of results suggest that, the proposed model developed using the ISFL algorithm with CEFLANN network is a promising predictor model for currency exchange rate prediction compared to other models included in the study.

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1. Introduction

Purchasing power of one currency with respect to another one i.e. (FOREX), eminently prevails the trading of different currencies. Accurate and unbiased prediction of these exchange rates ultimately influences the international transactions and the global monetary market. But being time series, these data are highly unstable and fluctuating in nature. Several external
factors, such as many highly interrelated economic, political, social and even if the psychological behaviors of the individual traders and investors greatly influences the exchange rate of currencies. Hence developing more automated approaches to foresight the exceptionally nonlinear and non-stationary foreign exchange rates more effectively and accurately is of leading emphasis in financial institutions as well as companies with exposure to foreign currencies. The successful currency exchange rate prediction will help in financial benefits and to facilitate strategic financial planning.

Several contributions including time series models, computational intelligence based models and hybrid models are available in literature for efficient prediction of currency exchange rate. Most of the suggested statistical time series models are based on the assumption that the data are correlated and linear in nature. However, in reality foreign exchange rates seldom satisfy such assumptions. As a consequence, the statistical models are not able to grab the inherent nonlinear and dynamic behavior of exchange rates time series data more precisely with satisfaction. To cope with limitations of time series models and to meet the increasing needs for better forecasting models, numerous computational intelligence based FOREX predictor models are proposed in the literature. Due to the ability to discover complicated nonlinear relationship present in input data set without prior knowledge of input output relationship and to approximate any nonlinear continuous function to desired accuracy, the utilization of Artificial Neural Network (ANN) is extending rapidly in financial time series prediction especially in currency exchange rate prediction. Number of studies have introduced variety of neural networks such as Multi Layer Perceptron Network (MLP) [1], Radial Basis Function Neural Network (RBF) [2] and Functional Link Artificial Neural Network (FLANN) [3,4] for predictions of currency exchange rates with daily, weekly or monthly setup. The traditional back propagation algorithm with gradient descent method is the commonly used learning technique for ANNs. But it suffers from the issues of imprecise learning rate, local minimal and slow rate of convergence. To avoid the common drawbacks of back propagation algorithm and to increase the accuracy, several evolutionary algorithms such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Differential Evolution (DE), Harmony search (HS) and Shuffled Frog Leaping (SFL) algorithms are also proposed by some scholars in literature.

From extensive literature studies, although it is found that, various kinds of neural network have been applied for currency exchange rate prediction and several optimization algorithms have been used for its parameter estimation, still literature survey hardly reveals the application of Computationally Efficient Functional Link Neural Network (CEFLANN) in domain of FOREX prediction. Also there is a lack of SFL applications in currency exchange rate prediction. Motivated by the promising outputs of CEFLANN in other financial time series analysis [5–8] and the capability of Shuffled Frog Leaping algorithm in the field of optimization, in this study, the author has aimed to develop a hybrid evolutionary predictor model using the CEFLANN network for predicting the successive currency exchange rate values from past observations. Further the unseen parameters of the network are estimated by an improved shuffled frog leaping (ISFL) algorithm through minimization of the prediction error. Improved shuffled frog leaping technique is a variant of original shuffled frog leaping algorithm, which proposes a new frog leaping rule including a search acceleration factor and a leaping inertia component to enhance the local exploration and performance of the SFLA [9–11]. Again instead of using a fixed value for search acceleration factor and leaping inertia component, they are adapted iteratively between a large and small value providing a mean of balance in global and local exploration. The improved approach leads to an improvement of the convergence speed of the network as well as the predictive ability of the network. Application of ISFL algorithm for solving parameter estimation of CEFLANN is also new in the scope of currency exchange rate prediction. A comparative performance of CEFLANN is also analyzed with proposed ISFL learning technique and other evolutionary learning schemes such as shuffled frog leaping (SFL) and Particle Swarm Optimization (PSO) algorithm. Empirically the model validation is realized over three currency exchange data sets such as USD/CAD, USD/CHF, and USD/JPY accumulated within same period of time. The data set consists of monthly exchange rates of US Dollar with respect to Canadian Dollar, Swiss franc and Japanese Yen. Result investigation clearly illustrates that the proposed network not only provides a higher degree of predictability with ISFL learning technique but also contributes statistically better than other evaluated learning techniques and predictor models included in the study.

The rest of the paper is organized as follows. Section 2 covers the related work focusing on use of neural networks for currency exchange rate forecasting, and different evolutionary learning algorithms used for neural network. The proposed evolutionary framework using the ISFL learning algorithm with CEFLANN is discussed in details in Section 3. The simulation study for demonstrating the prediction performance of the proposed model along with a comparative result of various learning approaches is presented in Section 4. Finally last section presents the conclusion.

2. Literature survey

In literature many scientific contributions have proposed Artificial Neural Network (ANN) as a promising technique in development of various predictor models. The domain of currency exchange rate prediction is already rich with application of different types of neural networks such as Multi Layer Perceptron Network (MLP), Radial Basis Function Neural Network (RBF) and Functional Link Artificial Neural Network (FLANN) for predictions of currency exchange rates with daily, weekly or monthly setup.

Galeshchuk [1] has examined the prediction ability of a multilayer perceptron network over three exchange rates such as EUR/USD, GBP/USD and USD/JPY with daily, monthly and quarterly setup. The network was tested for short term prediction and was also producing good accuracy for one step ahead prediction with all the three setups.

Yu et al. [2] has produced a comparative analysis of the prediction performance of a multistage radial basis function neural network based ensemble forecasting model with individual RBF model and four existing ensemble forecasting models. The
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