Evaluation of PSO-BiLSTM Hybrid Method for Stock Price Forecasting Using Stock Price Time Series Data (Case Study: Iran Stock Exchange and the OTC Stocks)[1]

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Introduction

In recent years, with the increase in the penetration rate of the capital market, more people are inclined to invest in the stock market. Accurate stock price forecasting with minimal error can reduce investment risk and increase investment returns. Stock price forecasting due to nonlinear volatility is often described as a nonlinear time series problem that is influenced by many factors. Analyzing and forecasting stock prices in the market are done using different methods including technical and fundamental analysis, regression analysis, time series, fuzzy theory, machine learning, and different algorithms. While most of the time series in the financial field tend to be non-linear (Khashei, Bijari, and Ardali, 2012), deep learning is a new method that can be used in this field. Deep Recurrent Neural Network (RNN) is one of the widely used techniques (Liu et al., 2020). These techniques can remember previous data inputs while using current data to learn network weights. Various types of deep RNNs, including long-term memory (LSTM), have been developed to improve the ability of RNNs in

retaining previous states of the network and understanding long-term dependencies. The original LSTM was developed to extend the memory state of the RNN to handle longer input sequences (Yu et al., 2019). Another form of RNN is the bidirectional LSTM (BiLSTM), where previous and subsequent input sequences can be used to exploit all the input data in order to provide the best performance in the learning process.

In this research, to evaluate the performance of the PSO-BiLSTM method, several machine learning techniques are used to predict value stock prices using time series data, and finally, two deep learning methods including the LSTM and the BiLSTM, as well as the PSO-BiLSTM hybrid model, are implemented and their results are compared.

Materials and Methods

This research was done using the Crisp data mining algorithm. In the first step, the related sources and the background of the research were studied, and in the next step, the data available from different sources, and how to extract, collect and assemble them were included in the agenda. Data pre-processing was the next important step, and finally modeling and evaluation of the models were done, and the third, fourth, and fifth steps were repeated to finally prepare the final models. The scope of research, or in other words, the statistical community of the research, is the companies accepted in the Tehran stock exchange, whose shares have been traded from the beginning of 2012 to the end of 2018, their fiscal year is 12/29. Also, financial intermediary companies such as banks, insurance, holdings, and leasing companies were not investigated in this research. The studied stocks are sorted in ascending order based on the P/B ratio, and finally, one-third of them were selected as value stocks. In this way, out of 180 companies, the shares of 60 companies from 16 different groups were selected as value stocks.

In this research, BiLSTM (Bidirectional Long Short-Term Memory) method is evaluated for stock price prediction. In this regard, several machine learning techniques are used to predict stock prices using time series data of stock prices, and finally, two deep learning methods including (LSTM) Long Short-Term Memory, and BiLSTM are implemented and their results are compared. Implementing the BiLSTM method and the combined PSO-BiLSTM model to predict the prices of the studied stocks and comparing the results with the results of some other widely used machine learning methods is important because the prediction of the accepted stocks prices in the Tehran stock market using the BiLSTM method and its combination with the particle swarm optimization algorithm has not been evaluated so far.

Results and discussion

The normalized error rate of the predicted price compared to the actual price resulting from the implementation of the multilayer perceptron neural network algorithm (MLP), classification and regression decision tree (CART), support vector regression (SVR), long short-term memory neural network (LSTM), bidirectional long-short-term memory (BiLSTM) as well as the LSTM and BiLSTM optimized by the particle swarm optimization algorithm (PSO) on the time series data were calculated. To evaluate the performance of the regression models built in this research, evaluation criteria of the mean squared error and the coefficient of determination were used. The mean squared error is the difference between the value predicted by the model or statistical estimator and the actual value. Also, the coefficient of determination shows the power of predicting the dependent variable based on the independent variables.

The results showed that the dispersion of the normalized error of the predicted price compared to the actual price of each share using the hybrid model of PSO-BiLSTM is lower compared to other implemented machine learning algorithms. As well, the combined PSO-BiLSTM model has the R2 criterion equal to 0.89, which is the highest value, and the RMSE criterion equal to 160/849, which is the lowest value among other models. Therefore, using the data of the price characteristics of value stocks studied in this research, the combined PSO-BiLSTM model has a better performance than other methods.

Conclusion

According to the results, the hybrid PSO-BiLSTM model in stock price prediction performs better than other machine learning algorithms and has less error. Also, the RMSE and R-Square performance evaluation criteria confirmed the numerical results and the research hypothesis that PSO-BiLSTM performs better than other conventional methods including MLP, CART, SVR, LSTM, BiLSTM, and PSO-LSTM.

Keywords: Price Forecasting, Time Series, Bidirectional Long Short-term emory, Particle Swarm Optimization Algorithm, Value Stocks.

JEL Classification: C22, C45, G17.

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