Prediction of Bitcoin Cryptocurrency Prices Using Artificial Neural Networks Optimized by Metaheuristic Optimization Algorithms

Extended Abstract

Purpose

Digital currencies, or cryptocurrencies, are electronic assets that utilize blockchain technology to ensure the security and transparency of transactions. These currencies operate in a decentralized manner and are not controlled by any central authority. Bitcoin, as the first and most well-known cryptocurrency, was created in 2009 by an anonymous individual or group under the name Satoshi Nakamoto. Subsequently, other cryptocurrencies such as Ethereum, Ripple, and Litecoin were developed.

Transactions using cryptocurrencies are often faster and less expensive than traditional banking methods. These digital currencies have become a popular investment option, but their extreme volatility can increase investment risks. In many countries, clear regulations regarding the use of cryptocurrencies have not yet been established, which may pose legal challenges for users. The application of artificial intelligence and machine learning models, particularly artificial neural networks, is crucial for predicting cryptocurrency prices. These digital currencies are accompanied by vast amounts of data, and analyzing them manually can be challenging. AI can process and analyze this extensive data. Artificial neural networks can identify complex, nonlinear patterns in data that may not be detectable by traditional methods. Machine learning models, using advanced algorithms, can enhance the accuracy of cryptocurrency price predictions and assist investors in making better decisions. These models can perform analyses faster than traditional methods, which is highly significant in the volatile cryptocurrency markets.

Methodology

Artificial neural networks consist of numerous processing units called neurons that operate in coordination, similar to human brain neurons, to solve problems. The connections between these neurons determine the network's performance. In these networks, a data structure is designed through programming to act like neurons, and then connections between the neurons are established, followed by the application of a training algorithm to train the network. Artificial neural networks learn similarly to humans through examples.

Artificial neural networks have the ability to adapt to rapid market changes and can identify new patterns. Utilizing AI can help reduce errors caused by emotional decision-making or human biases. These models can simultaneously analyze the impact of various factors, such as economic news, regulatory changes, and social trends. Machine learning models, with access to more data and continuous feedback, can continuously improve their performance. The more precise information and deeper analyses provided by these technologies can serve as powerful tools for investors, minimizing risks. The real-time implementation of these models is possible, which is a significant advantage for active traders.

Based on the aforementioned considerations in this research, the focus has been on predicting Bitcoin prices over short-term (10-day) and long-term (30-day) periods. For this purpose, an artificial neural network optimized by six metaheuristic optimization algorithms has been employed. These algorithms include the Political Optimizer (PO), Hierarchical Rank-based Optimization (HBO), Stochastic Colors Optimizer (SPO), Giza Pyramid Construction (GPC), Firefly Optimizer (FHO), and Fox Optimizer (FOX). Finally, the results obtained from these algorithms have been compared.

In this study, Bitcoin price data were collected and examined over a 13-year period, from July 13, 2010, to December 6, 2023. This dataset includes 4,895 samples and six variables. The variables include the opening price of Bitcoin, the highest price, the lowest price, trading volume, and market value as inputs, with the final price of Bitcoin considered as the output.

Finding

This research is designed as an applied study, aiming to create a framework for predicting Bitcoin prices over short-term (10-day) and long-term (30-day) periods using the machine learning method known as artificial neural networks, optimized with the six metaheuristic algorithms: PO, HBO, SPO, GPC, FHO, and FOX.

The steps of the work are as follows: Initially, in MATLAB software, the necessary data for modeling is preprocessed, and missing or unavailable values are removed. Then, to reduce the impact of data scaling on the results, data normalization is performed within the range of 0 to 1, as entering raw data can decrease the model's speed and accuracy. Subsequently, 80 percent of the initial Bitcoin price data is divided into training data, while the remaining 20 percent is allocated as test data.

Afterward, using the training dataset, the artificial neural network (ANN) is trained with the mentioned optimization algorithms. In the next stage, the optimized neural network models are tested using the test dataset. Finally, the results and accuracy of various models in predicting Bitcoin prices in both training and testing scenarios are compared. Evaluation criteria include the coefficient of determination (R^2), root mean square error (RMSE), mean square error (MSE), mean absolute error (MAE), relative square error (RSE), and explained variance (EVS). All modeling steps are conducted in MATLAB R2023b.

Conclusion

The results of this research indicate that in the short-term (10-day) period, the neural network optimized with the GPC algorithm achieved a coefficient of determination of 0.88, and in the long-term (30-day) period, this network again performed best compared to other algorithms with a coefficient of determination of 0.7.