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Employing Artificial Intelligence Algorithms to Predict the Financial Indicators of APPLE and NFLX Stocks

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ABSTRACT

This research explores the use of artificial intelligence algorithms to improve the forecasting of financial indicators for APPLE and Netflix stocks. It aims to explore how financial markets can benefit from modern techniques to analyze financial data and make accurate predictions about future stock movements.
The research included a number of cases depending on the Data-set source NFLX, APPLE recorded variable close price, high price, low price, open price, volume price), predict methods Intelligent Neural Networks, Honey Bee Algorithm Activation Function Sigmoid, Tanh, ReLU, number of bees 10,30,50. Results are compared using the mean square error MSE.
Best result was for the case Honey Bee Algorithm, APPLE, high price, 30 with MSE= 0.0013. Other methods can be taken convolutional neural networks, random neural network.

1. Introduction

Financial markets are among the most prominent fields that benefit greatly from modern technologies such as artificial intelligence (AI) and machine learning.

With the increasing volume and complexity of financial data, it has become necessary to employ artificial intelligence algorithms to analyze this data and infer patterns that may help predict the movements of financial markets, especially in stock markets. The ability to accurately predict the future of stocks is one of the basic factors that investors rely on in making their investment decisions.

APPLE and NFLX enjoy a strong reputation in global stock markets, which makes their shares of wide interest to investors. However, investors face significant challenges in predicting the price movements of these stocks due to the high volatility in financial markets and influential external factors such as economic crises and technological changes. In this context, it has become necessary to explore how to benefit from artificial intelligence algorithms to provide effective solutions to predict the prices of these companies' stocks.

Within the scope of this research, many studies were presented, including:-

Research presented by (Nirob, Foysal Ahamed, and Mohammad Mahmudul Hasan.) in (2023)

The research presents a model for predicting stock price changes based on (LSTM, SMA, EMA). The data included daily stock prices for Yahoo and the closing price

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was relied upon. The research included comparing the results based on the mean square error, the mean absolute square error and the trend accuracy. The results showed the superiority of (LSTM) over other methods. [1]

Research presented by (Smith, Harrison) in (2024)

The research included predicting stock prices through employing machine learning for the opening price of stocks and by adopting artificial intelligence algorithms and analyzing and investing in future prediction. This research presented five machine learning models by adopting linear regression models, neural networks and random forests. The results showed the accuracy of the neural network model compared to regression models. [2]

The current research presents the estimation of stock prices for different sources and types according to different methods and functions in addition to different numbers of bees. Different cases and results were compared and the significance of the differences between them was tested according to the t-test and the mean square error.

2. Research Problem

The sharp and rapid fluctuation in stock prices, which makes estimation and prediction accompanied by challenges in absorbing these fluctuations, in addition to the existence of a large variance in these fluctuations.

3. Research objective

The research aims to provide the best case for estimating stock prices based on several cases, which are the type of data, the type of source, the estimation method, the function used, and the number of bees.

4. Importance of research

Estimating stock prices has increasing importance because it is the main influence in making buying and selling decisions based on expectations closer to the real values.

5. Artificial intelligence (AI)

is a field of computer science that focuses on developing systems and software that can simulate human mental processes such as learning, understanding, and decision-making. In the financial context, AI is used to analyze big data, discover hidden patterns, and make predictions about financial markets. The use of AI in financial markets has increased dramatically in recent years, becoming a powerful tool for analyzing stocks, currencies, and commodities and making accurate predictions.[3]

6. Machine Learning Algorithms

Machine learning is a branch of artificial intelligence that relies on developing algorithms capable of learning from data and making decisions based on experience. In the field of financial market prediction, many machine learning algorithms are used[4]
such as:

a-Artificial Neural Networks (ANNs)

Artificial neural networks are one of the most prominent machine learning techniques used in predicting stock prices. These networks simulate the way the human brain works through layers of neurons that process data. These networks are used to predict stock movements based on historical data and analyze future patterns.[5]

b-Deep Learning

It is a type of machine learning that relies on the use of deep neural networks consisting of several layers. This type of learning relies on the model's ability to discover complex and deep patterns in data. LSTM (Long Short-Term Memory) networks are particularly used in predicting temporal data such as stock movements, as they are characterized by their ability to process time series and save information of long-term importance.[6]

c-Support Vector Machines (SVM)

It is a machine learning algorithm used for classification and prediction. It relies on identifying the boundaries between different categories in data. In financial market forecasting, it can be used to predict market trends (such as determining whether stocks will rise or fall).[7]

7. Financial Data Analysis

Financial data used in forecasting financial indicators includes many types such as:[8]

a-Historical price data

includes daily or monthly stock price data that represents the historical movement of prices in financial markets.

b-Corporate financial data

includes profits, revenues, expenses, assets, and liabilities, which are basic indicators used to determine the financial health of companies.

c-Macroeconomic indicators

such as interest rates, inflation, and economic growth, which directly affect the movement of stocks.

8. Challenges in Using AI to Predict Stock Markets

Despite the many benefits of using AI to predict financial markets, there are some challenges that must be taken into consideration:

a-Sudden fluctuations

Financial markets are often affected by unexpected factors such as economic crises or geopolitical events. These factors can be difficult to predict using algorithms.

b-Incomplete data

Financial data may contain missing or distorted information, which negatively impacts the accuracy of predictions.

c- Rapid changes

Financial markets change rapidly in response to economic and political developments, making it difficult for models trained on old data to keep up with these changes.

9. Intelligent Neural Networks (INN)

are a type of artificial neural network that mimics the way the human brain processes information. These networks are used in a wide range of applications such as image recognition, text classification, machine translation, self-driving cars, and more. Intelligent neural networks include several layers of nodes (or neurons), which connect inputs to outputs via enhanced or reduced links using weights.[9]

a- Intelligent Neural Network Components

1. Layers: A neural network consists of three main layers:[10,11,12]

Input Layer: Contains the inputs that represent the data.

Hidden Layer: These layers are used to process the data in different ways according to the parameters and weight.

Output Layer: This layer contains the results or predictions.

2. Weights: Weights represent the strength with which the signal sent between neurons is modified.

3. Activation Function: Converts inputs into outputs based on specific criteria. Common examples include the ReLU function and the Sigmoid function.

4. Training: The neural network is trained using algorithms such as Backpropagation to adjust the weights based on the error between the actual outputs and the predictions.

b-Applications of Intelligent Neural Networks:

1. Classification: Classifying images or texts.

2. Speech Recognition: Such as converting voice to text.

3. Prediction and Analysis: In areas such as financial market forecasting or medical analysis.

4. Autonomous Driving: Smart cars that use neural networks to drive without human intervention.

Intelligent Neural Networks are one of the most widely used frameworks in the field of Deep Learning, which is a branch of artificial intelligence.

c- Intelligent Neural Network Steps

Intelligent neural networks rely on a set of mathematical formulas to guide the training and prediction steps which they are: -

1.ganglion formation

Each neuron within the network processes inputs and produces outputs through

$$z = \sum_{i=1}^{n} w_i x_i + b \quad \dots (1)$$

With

(w_i) Represent weights

(b) The bias term

2. Activation Functions

An activation function is a mathematical function that determines whether a node will be activated or not based on

Sigmoid function with

$$f(z) = \frac{1}{1 + e^{-z}} \quad \dots (2)$$

Tanh function with

$$f(z) = \frac{e^{z} - e^{-z}}{e^{z} + e^{-z}} \quad \dots (3)$$

Rectified Linear Unit function with
$f(z) = \max(0, z)$ ... (4)
3. Forward Propagation
Forward propagation is the process of calculating the output of a neural network based on the inputs. In a multilayer neural network, the inputs are passed through multiple layers of neurons until the final output is obtained.
$z^{(l)} = W^{(l)} a^{(l-1)} + b^{(l)}$ ... (5)
$W^{(l)}$ $Weight\ matrix\ for\ layer\ (l)$
$a^{(l-1)}$ $The\ output\ of\ previous\ layer$
$b^{(l)}$ $Bias\ layer\ (l)$
4. activation function
$a^{(l)} = f\left(z^{(l)}\right)$ ... (6)
5.Loss Function
After obtaining the outputs in the final layer, the error between the actual outputs and the obtained output by mean square error
$$Mse = \frac{\sum_{i=1}^{m} [\hat{y}_i - y_i]^2}{m} \quad \dots (7)$$
6.Cross-Entropy Loss
$$L = -\sum_{i=1}^{m} [y_i\, log(\hat{y}_i) + (1 - y_i) \log(1 - \hat{y}_i)] \quad \dots (8)$$
7.Backpropagation
is the algorithm used to update the weights in a neural network. The goal is to minimize the error by gradually adjusting the weights in the direction that minimizes the error function.
First, the gradient of the error function for the weights in each layer is calculated using the chain rule
$$\frac{\partial L}{\partial w^l} = \frac{\partial L}{\partial a^l} \frac{\partial a^l}{\partial z^l} \frac{\partial z^l}{\partial w^l} \quad \dots (9)$$

10. Honey Bee Algorithm

It is a hybrid technique that uses the Artificial Bee Colony Neural Network (ABC) algorithm to train neural networks. This method aims to improve the performance of neural networks by finding optimal values for weights and biases in the neural network
Algorithm can be determined to be [13,14]

1. Initialization phase(IP)
construct optimal function such that
$Min\ or\ Max\ f(x), x \in [x_{min}\ , x_{max}]$
$x_{ij} = x_{min} + Rand[0,1] * (x_{max} - x_{min})$ ... (10)
2.Employed Bee Phase(EBP)
$v_{ij} = x_{ij} + \varphi_{ij} * \left(x_{ij} - x_{kj}\right)$ ... (11)
φ_{ij} $Rand[-1,1]$
$k \neq i$
$fitness\ (v_i)$
$$= \begin{cases} \frac{1}{1 + f(v_i)} & f(v_i) \geq 0 \\ 1 + |f(v_i)| & f(v_i) < 0 \end{cases} \quad \dots (12)$$
3. Onlooker Bee Phase(OBP)
$$p_i = \frac{fitness\ (x_i)}{\sum_{j=1}^{N} fitness\ (x_j)} \quad \dots (13)$$

4. Scout Bee Phase (SBP
$x_{ij} = x_{\min j} + Rand[0,1] * \left(x_{\max j} - x_{\min j}\right)$ ... (14)

5. No significant changes(NSC)
Repeat (2-4) till
No significant changes in fitness function for sequence iterations [13]

11. Research Data-Set

The research data set represent historical (by day recording) data for two sources which they are (NFLX&APPLE) each one with (open price, high price, low price, close price, volume price) such that (n=4528) .
The total data set was represented as (5) recorded variables for each data source.

12. Numerical Results

The numerical results was according to the following tables and figures

Table 1: MSE for each method and experiment cases

		Intelligent Neural Networks		Honey Bee Algorithm	
Data-set source	recorded variable	Activation Function	Mean Square Error	Number of Bees	Mean Square Error
NFLX	close price	Sigmoid	0.1381	10	0.1192
		Tanh	0.1564	30	0.0412
		ReLU	0.1779	50	0.018
APPLE	close price	Sigmoid	0.1148	10	0.0035
		Tanh	0.0696	30	0.0065
		ReLU	0.2067	50	0.0019
NFLX	high price	Sigmoid	0.3206	10	0.024
		Tanh	0.3461	30	0.1105
		ReLU	0.109	50	0.0525
APPLE	high price	Sigmoid	0.079	10	0.0211
		Tanh	0.0102	30	0.0013
		ReLU	0.2057	50	0.0017
NFLX	low price	Sigmoid	0.5561	10	0.0548
		Tanh	0.5705	30	0.0779
		ReLU	0.6894	50	0.0473
APPLE	low price	Sigmoid	0.1965	10	0.0414
		Tanh	0.0098	30	0.0048
		ReLU	0.0766	50	0.0021
NFLX	open price	Sigmoid	0.3052	10	0.0641
		Tanh	0.2977	30	0.1193
		ReLU	0.5838	50	0.0624
APPLE	open price	Sigmoid	0.2021	10	0.3593
		Tanh	0.0174	30	0.0323
		ReLU	0.2049	50	0.0188
NFLX	volume price	Sigmoid	0.1828	10	0.0803
		Tanh	0.2325	30	0.0917
		ReLU	0.0744	50	0.0929
APPLE	volume price	Sigmoid	0.18	10	0.0308
		Tanh	0.0282	30	0.0305
		ReLU	0.1528	50	0.0309

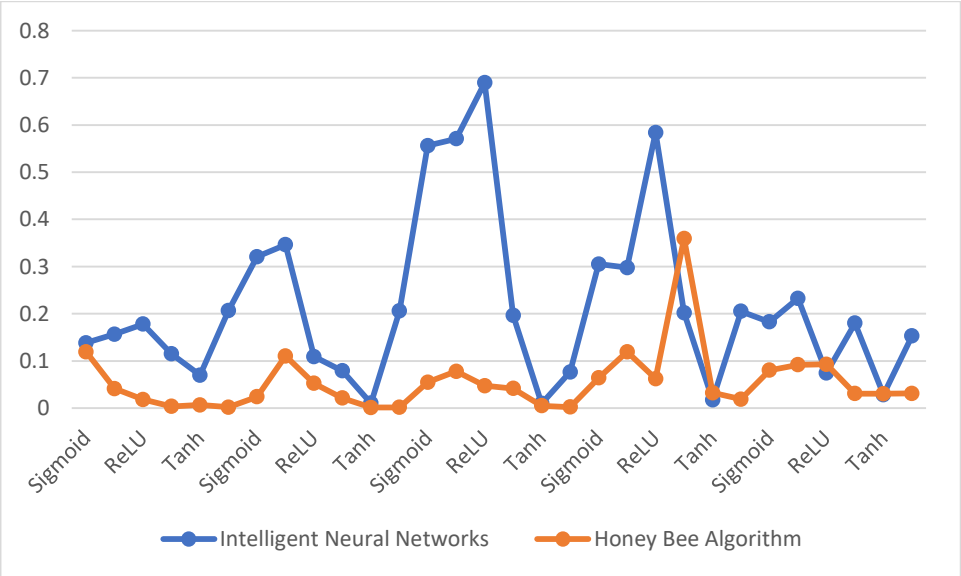

Figure 1. MSE for (Intelligent Neural Networks& Honey Bee Algorithm)

Comparing the results from previous table and figure we can see that (Intelligent Neural Networks) gives minimum MSE=0.0098, maximum MSE=0.6894, average MSE=0.216493333)
(Honey Bee Algorithm) gives minimum MSE=0.0013, maximum MSE=0.3593, average MSE=0.054766667)
Comparing the average, max, min showed the best was Honey Bee Algorithm with testing deference by using (paired sample (t) test = 4.948 with Sig=0.000) that's mean there is significant deference between (Intelligent Neural Networks and Honey Bee Algorithm).
For Intelligent Neural Networks the best results for (APPLE, low price, Tanh) details

For Honey Bee Algorithm the best results for (APPLE, high price, 30) details

12. Conclusions and Suggestions

1.The number of bees affects the method (Honey Bee Algorithm) so choosing the best number ensures getting the best results.
2. The activation function affects the results of the (Intelligent Neural Networks) method.
3. The method (Honey Bee Algorithm) is superior to the method (Intelligent Neural Networks) because it gave lower results and the average results of the two methods differ significantly.
4. Other methods can be used to estimate stock prices (RNN,ANN)
5. Taking more detailed price series (hourly, minute) and investigating the impact of rapid and urgent volatility on stock price estimation

References

[1] Nirob, Foysal Ahamed, and Mohammad Mahmudul Hasan. "Predicting Stock Price from Historical Data using LSTM Technique." Journal of Artificial Intelligence and Data Science 3.1 (2023): 36-49.

[2] Smith, Harrison. "The utilization of Artificial Intelligence to predict Apple Inc. stock price." Journal of High School Science 8.3 (2024): 16-29

[3] Korteling, JE (Hans, et al. "Human-versus artificial intelligence." Frontiers in artificial intelligence 4 (2021): 622364,

[4] Mahesh, Batta. "Machine learning algorithms-a review." International Journal of Science and Research (IJSR).[Internet] 9.1 (2020): 381-386.

[5] Meerasri, Jitrawadee, and Rungsinee Sothornvit. "Artificial neural networks (ANNs) and multiple linear regression (MLR) for prediction of moisture content for coated pineapple cubes." Case Studies in Thermal Engineering 33 (2022): 101942.

[6] Dong, Shi, Ping Wang, and Khushnood Abbas. "A survey on deep learning and its applications." Computer Science Review 40 (2021): 100379.

[7] Pisner, Derek A., and David M. Schnyer. "Support vector machine." Machine learning. Academic Press, 2020. 101-121.

[8] Al-Okaily, Manaf, and Aws Al-Okaily. "Financial data modeling: an analysis of factors influencing big data analytics-driven financial decision quality." Journal of Modelling in Management (2024).

[9] Boudardara, Fateh, et al. "INNAbstract: An INN-based abstraction method for large-scale neural network verification." IEEE Transactions on Neural Networks and Learning Systems (2023).

[10] Cui, Zhenhua, et al. "A comprehensive review on the state of charge estimation for lithium-ion battery based on neural network." International Journal of Energy Research 46.5 (2022): 5423-5440.

[11] Abdolrasol, Maher GM, et al. "Artificial neural networks based optimization techniques: A review." Electronics 10.21 (2021): 2689.

[12] Li, Yan-Wen, and Ke Cao. "Establishment and application of intelligent city building information model based on BP neural network model." Computer Communications 153 (2020): 382-389.

[13] Nayak, Soumen, et al. "Regression test optimization and prioritization using Honey Bee optimization algorithm with fuzzy rule base." Soft Computing 25 (2021): 9925-9942.

[14] Thapliyal, Nitin, and Priti Dimri. "Load balancing in cloud computing based on honey bee foraging behavior and load balance min-min scheduling algorithm." International Journal of Electrical and Electronics Research (IJEER) 10.1 (2022): 1-6.