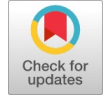


Real-Time Forecasting of Stock Trends using Particle Swarm Optimization



Suraj Kumar Sahu, Zubair Ahmed Khan, Abhishek Guru, Ankita Singh Baghel, Divya Soni

Abstract: The traditional neural network algorithm for stock price forecasting is prone to local optima. To enhance the accuracy of stock price forecasting and reduce forecasting time, this paper introduces an improved Particle Optimisation Neural Network Algorithm. By integrating neural networks and particle swarm optimisation algorithms, a more effective forecasting model is constructed that better reflects the dynamic changes in stock prices. Meanwhile, introducing chaos-interference and mutation factors can enhance the algorithm's diversity, thereby further improving forecast accuracy and stability. This method presents a novel solution for research and application in stock price forecasting, offering a valuable reference for relevant practitioners.

Keywords: Stock Market Forecasting, Real-Time Prediction, Stock Trend Analysis, PSO, Algorithmic Trading

Abbreviations:

SVM: Support Vector Machines
ANNs: Artificial Neural Networks
LSTM: Long Short-Term Memory
RNN: Recurrent Neural Network
AI: Artificial Intelligence
GA: Genetic Algorithm
ARIMA: Autoregressive Moving Average
PSO: Particle Swarm Optimization

I. INTRODUCTION

The traditional neural network algorithm is applied to forecasting stock prices, which can easily fall into local optima.

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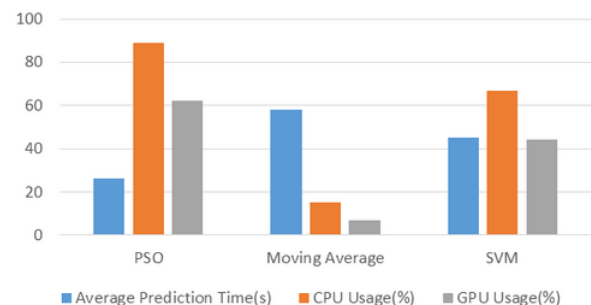
To enhance the accuracy of stock price forecasting and reduce the forecasting time, this paper introduces the improved Particle Optimization Neural Network Algorithm [1]. By integrating neural networks and particle swarm optimisation algorithms, a more effective forecasting model is constructed that better reflects the dynamic changes in stock prices. Meanwhile, introducing chaos interference factors and mutation factors can increase the diversity of the algorithm, further improving the accuracy and stability of forecasting [2]. This method offers a new solution for research and application in the field of stock price forecasting, providing a valuable reference for relevant practitioners [3].

II. TRADITIONAL STATISTICAL ANALYSIS METHODS

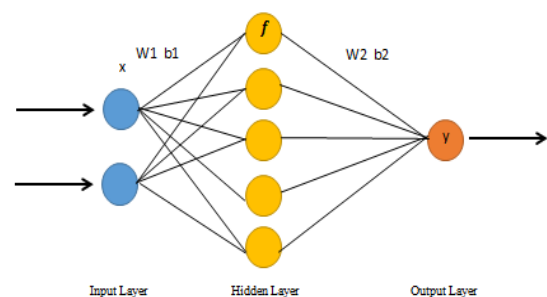
The moving average method is a fundamental smoothing technique that predicts future stock prices by averaging over a specific period. However, this method performs poorly when dealing with nonlinear trends and sudden events [4].

The formula is as follows (1):

$$MA_t = P_1 + \dots + P_{tt} \quad MA_t = P_1 + \dots + P_{tt} \quad \dots \quad (1)$$



[Fig.1: Forecasting Time Consumption and Efficiency]

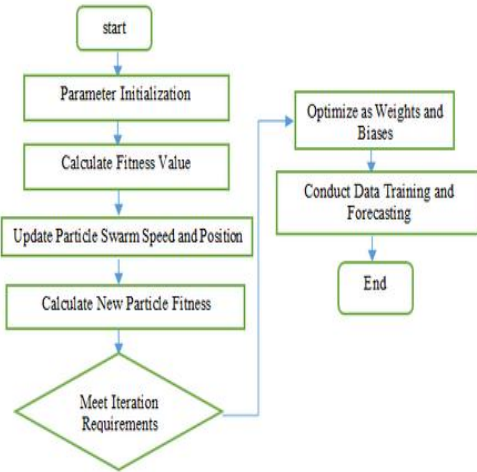


[Fig.2: Neural Network Model Diagram]

It stores information in only one direction, whereas a QR code stores it in both vertical and horizontal directions.



III. CONCEPT PARTICLE SWARM OPTIMIZATION



[Fig.3: Flow Chart of PSO Neural Network Algorithm]

IV. PROPOSED METHOD

The moving average method is a fundamental smoothing technique that predicts future stock prices by averaging over a specific period. However, this method performs poorly when dealing with nonlinear trends and sudden events.

The formula is as follows (2):

$$MA_t = P_1 + \dots + P_{tt} \quad MA_t = P_1 + \dots + P_{tt} \dots (2)$$

Among them, MA_t represents the moving average at time t , P_t represents the stock price at the first time point, and t is the time window size for the moving average.

A. Exponential Smoothing Method

The exponential smoothing method is based on weighted averaging. It applies exponential weighting to historical data to predict future stock prices. However, this method fails to capture complex market fluctuations and nonlinear changes accurately.

The formula is as follows (3):

$$EST = \alpha \cdot P_t + (1 - \alpha)EST - 1EST = \alpha \cdot P_t + (1 - \alpha)EST - 1 \dots (1)$$

EST represents the exponential smoothing value at time t , P_t represents the stock price at time t , and α is the smoothing coefficient.

B. Autoregressive Moving Average Model

The Autoregressive Moving Average (ARIMA) model is a commonly used time-series analysis method that accounts for the autocorrelation and moving-average properties of data to capture trends and periodic changes in time series. However, this model requires data to be stationary and linearly related, making it inadequate for handling nonlinear relationships and complex market conditions [5].

V. APPLICATION

A. Machine Learning Methods

Support vector machines (SVMs) perform well in classification and regression problems and are widely applied to stock price prediction and portfolio optimisation. Kim (2003) showed that SVM outperforms traditional linear

regression models in stock market prediction. Lee et al. (2020) also demonstrated that SVM effectively identifies market trends and outperforms conventional linear regression models. Decision tree models are constructed as tree structures, which are easy to interpret. Random forests enhance prediction accuracy and stability by integrating multiple decision trees (Breiman, 2001), yielding effective results in financial fraud detection and credit scoring. Liu et al. (2021) used random forest algorithms for financial fraud detection, showing high efficiency and accuracy in big data environments [6].

B. Deep Learning Methods

The initial concept of artificial neural networks (ANNs) was proposed by psychologists McCulloch and Pitts in 1943, which included a mathematical model of neurons, thus opening the door to research on ANNs. Subsequently, many different neural network models emerged, but most were simple in structure and were hence called "first-generation neural network models." ANNs, by simulating biological neural networks, can handle complex nonlinear relationships. In recent years, ANNs have performed well in stock price forecasting, option pricing [7], and more (Zhang et al., 1998). Wu and Zhao (2022) used deep neural networks to predict stock market returns, finding that they outperformed traditional models at capturing market dynamics. Long short-term memory networks (LSTMs) are a specialised type of recurrent neural network (RNN) well-suited for handling time series data. Fischer and Krauss (2023) demonstrated that LSTMs outperform traditional time-series models in stock market forecasting, effectively capturing both long- and short-term market dependencies. Ensemble learning methods combine multiple models to improve forecasting accuracy and stability [14].

C. Intelligent Optimization Algorithms

With the rapid development of artificial intelligence (AI) technology, this paper examines QR Codes and how they can be composed, scanned and decoded by a camera. QR code is a dimensional barcode used for quick response in promotional and marketing purposes [10]. The paper describes how QR codes differ from barcodes, their formation, Capacity, and error correction code. Its application is in India and worldwide [12]. Intelligent optimisation algorithms are increasingly used in stock price forecasting. These algorithms, by simulating human intelligence or the behavior of biological populations, and utilizing the laws of natural phenomena [11], provide new perspectives and methods for solving complex stock price forecasting problems. Intelligent optimization algorithms such as Genetic Algorithms, Particle Swarm Optimization, and Ant Colony Algorithms have been widely used in stock price forecasting optimization [13].

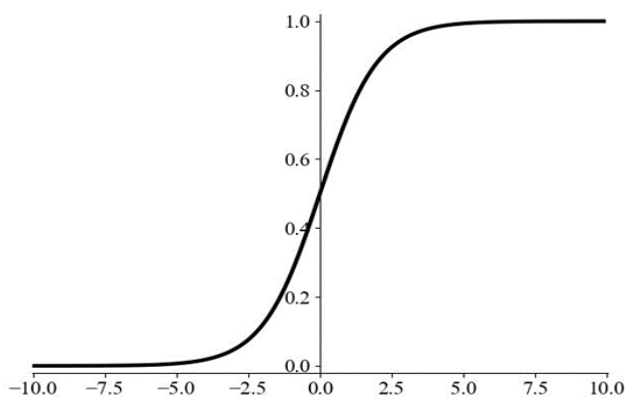
A Genetic Algorithm (GA) is an optimisation algorithm that simulates natural selection and genetic mechanisms, widely used in portfolio optimisation and the formulation of trading strategies. Chen et al. (2021) employed a Genetic Algorithm to optimise portfolios, resulting in significantly improved investment returns and risk management capabilities [9]. In another study, Rani et al. (2020) combined GA with Support Vector Machines

(SVMs). They achieved excellent results in stock market forecasting, demonstrating the potential of the GA for multi-objective optimisation. Particle Swarm Optimisation (PSO) is an effective optimisation algorithm that simulates group behaviour for global search. Liu et al. [14] (2020) combined Particle Swarm Optimization with deep learning, improving the accuracy of financial time series forecasting. Kumar et al. (2022) used Particle Swarm Optimisation to optimise trading strategies [8], significantly enhancing returns and stability, and demonstrating its adaptability and robustness in dynamic environments [15].

VI. FORECASTING RESULTS ANALYSIS

A. Algorithm Effect and Accuracy

Forecasting results for stock indexes/prices using different algorithms are shown in Table 1. Experimental results indicate that the particle swarm optimization neural network algorithm achieves relatively low error values across all scenarios, making it more accurate in predicting stock prices [16]. Compared to traditional moving average methods and SVM, the PSO-based neural network method achieves higher forecasting accuracy, particularly for individual stocks such as Sg Micro Corp (300661), with accuracy exceeding 80%, demonstrating its superiority in individual stock forecasting. PSO accurately captures overall market trends, providing investors with more reliable references [17].



[Fig.4: Sigmoid Activation Function]

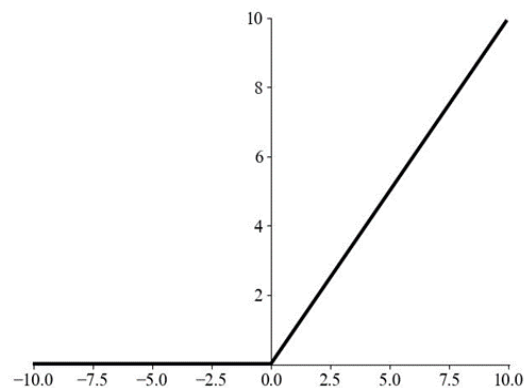
Table 1: Forecasting Results of Index/Stock Price by Different Algorithms

Index/Stock	Algorithm	RMSE	MAE	Forecasting Accuracy (%)
CSI 300 Index	PSO	10.35	7.79	75.86
	Moving Average	19.73	15.42	58.84
	SVM	12.67	11.68	69.56
CSI 500 Index	PSO	12.84	9.56	75.46
	Moving Average	20.16	15.92	57.86
	SVM	13.78	14.22	64.29
Sg Micro Corp (300661)	PSO	8.68	6.82	80.57
	Moving Average	16.27	12.33	64.12
	SVM	10.83	8.09	73.58

B. Forecasting Time Consumption and Efficiency.

As shown in Figure 2, the stock price forecasting based on the PSO neural network algorithm has a shorter average

forecasting time compared to MA and SVM, indicating that this method exhibits higher computational efficiency in forecasting and can generate results more quickly. Additionally, it has been observed that PSO can utilise computer resources more efficiently, particularly CPU and GPU resources.



[Fig.5: ReLU Activation Function]

VII. CONCLUSION

Numerous research methods for stock price forecasting have emerged as the economy and society have developed. Due to the ease of implementation and strong fitting ability of neural network algorithms, they have become a favourite among many experts and scholars. As a result, they hold significant potential for stock market forecasting, financial time-series analysis, and risk assessment. To date, an increasing number of intelligent algorithms have been developed to optimise artificial neural network algorithms, aiming to enhance the effectiveness of stock price forecasting.

DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

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