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Literature Review on Stock Market Prediction using ANN

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Abstract: *Artificial Neural Networks (ANNs) have been widely explored as a tool for stock market prediction. These machine learning algorithms use historical data, such as stock prices and trading volume, financial statements, and economic indicators to make predictions. We examined thirty journal papers published between 1998-2021. The main object of this paper is to show the systematic and comprehensive evaluation of ANN in stock prediction. We find that the success of ANNs in stock market prediction also depends on factors such as the size and quality of the dataset, the design of the network, and the choice of hyperparameters. Therefore, ANNs should be used with caution and interpreted critically to get the best results.*

Keywords - Artificial Neural Network, Machine Learning, Stock Market Prediction.

1. INTRODUCTION

Researchers and experts have been intrigued by the use of Artificial Neural Networks (ANNs) to forecast stock market performance. ANNs, a kind of machine learning algorithm, have been used to estimate stock prices by constructing a connection between stock prices and multiple economic and financial elements. There is multiple application of ANN in the stock market. Some regular techniques for making use of ANNs to predict the stock market are:

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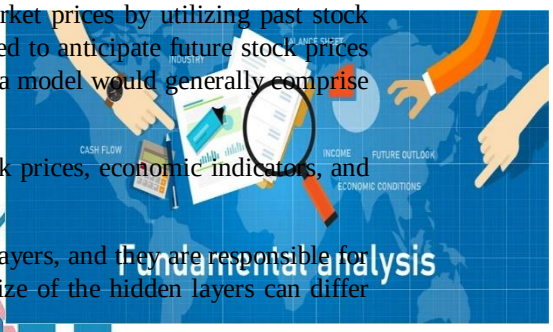
Fig 1 Fig 2

Technical Approach: This method uses past stock prices and amount of trading activity to find trends and make forecasts (Fig (1)).

Fundamental Approach: This method of forecasting potential stock market movements by utilizing financial statements, economic indicators, and other related facts and figures (Fig 2).

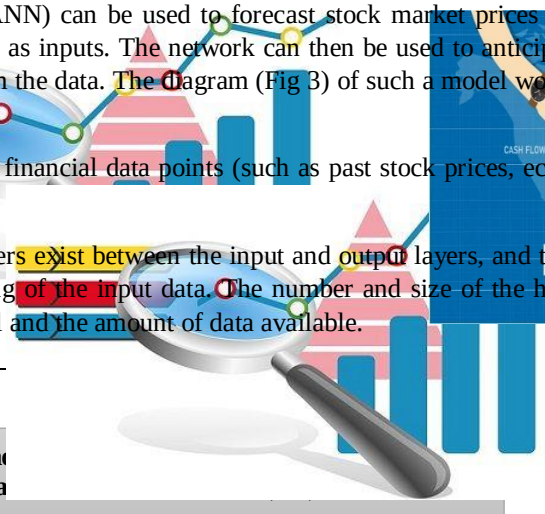
Hybrid Models: The hybrid model is a combination of the two main approaches to forecasting, which are technical and fundamental analysis.

An Artificial Neural Network (ANN) can be used to forecast stock market prices by utilizing past stock costs and other financial information as inputs. The network can then be used to anticipate future stock prices based on the patterns it acquired from the data. The diagram (Fig 3) of such a model would generally comprise of the following components:



Input Layer: This layer utilizes financial data points (such as past stock prices, economic indicators, and corporation specifics) as its input.

Hidden Layers: The hidden layers exist between the input and output layers, and they are responsible for the actual calculations and processing of the input data. The number and size of the hidden layers can differ based on the complexity of the model and the amount of data available.



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Output Layer: This part of the system yields the anticipated stock price as the outcome of the neural network.

Activation Functions: Mathematical functions are used to modify the outputs of each layer in the model to introduce non-linearity, thus enabling the model to understand more intricate associations in the information.

Loss Function: This feature calculates the deviation between the actual and forecasted stock prices and supplies a response to the network in the course of the training process. The network exploits this feedback to improve its predictions by regulating its weights and biases.

Optimizer: This technique is employed for altering the weights and biases in the system depending on the outcome of the loss function.

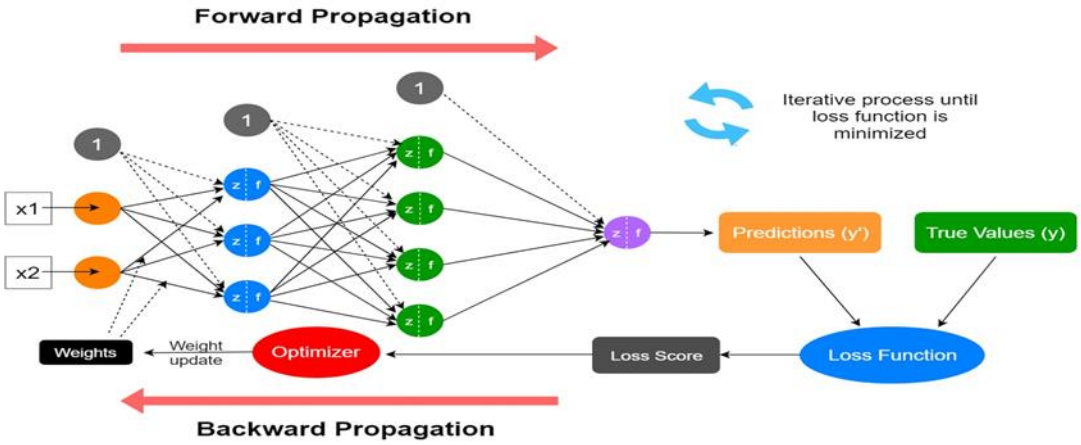

Fig 3 - Artificial Neural Network (ANN) in Stock market. (Image by Rukshan Pramoditha, made with draw.io)

Overall, the ANN model can be trained using historical stock market data, and then used to make predictions on new data. However, it's important to keep in mind that stock market prediction is a difficult task and no model can provide perfect predictions all the time.

2. STATE OF ART

The paper [6] proposes a neural network approach to predict stock exchange movements using external factors such as interest rates, exchange rates, and inflation rates. The authors trained a neural network model with historical data and external factors, and then used the trained model to predict future stock exchange movements. The paper discusses the methodology used for data preprocessing, feature selection, and model training. The authors also present the results of their experiments, which show that their proposed neural network approach can provide accurate predictions of stock exchange movements. Overall, the paper demonstrates the potential of using neural network models for predicting stock exchange movements and highlights the importance of considering external factors in these predictions.

The paper [8] compares the performance of two popular machine learning techniques, Support Vector Machines (SVM) and Random Forest (RF), in predicting the movement of a stock index. The authors used historical data of the National Stock Exchange (NSE) index and trained SVM and RF models to predict the future movement of the index. The paper discusses the methodology used for data preprocessing, feature selection, and model training. The authors also present the results of their experiments, which show that both SVM and RF models can provide accurate predictions of the NSE index movement, with SVM performing slightly better than RF.

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The paper [9] proposes a nonlinear metamodeling approach for financial time series forecasting using neural networks. The authors first extract a set of relevant technical indicators from the historical financial data and then train a neural network to model the relationship between the indicators and the target variable. The paper discusses the methodology used for data preprocessing, feature extraction, and model training. The authors also present the results of their experiments, which show that their proposed approach can provide accurate predictions of financial time series.

The paper [10] proposes a hybrid approach for predicting the Brazilian stock market using both neural networks and adaptive exponential smoothing methods. The authors first apply adaptive exponential smoothing to smooth the historical data and remove noise. Then, they use a neural network to model the relationship between the smoothed data and the target variable. The paper discusses the methodology used for data preprocessing, feature selection, and model training. The authors also present the results of their experiments, which show that their proposed hybrid approach can provide accurate predictions of the Brazilian stock market.

The paper [11] proposes a novel approach for forecasting the Korean Composite Stock Price Index (KOSPI) using a neural network with weighted fuzzy membership functions. The authors first apply a fuzzy logic system to generate fuzzy sets for the input variables, which are then used to train a neural network model with weighted fuzzy membership functions.

The paper [12] provides a comprehensive review of the literature on the use of artificial neural networks (ANN) for stock market prediction. The authors review various studies that have applied ANN techniques to predict stock prices, stock indices, and other financial variables. The paper also discusses the different ANN architectures and learning algorithms used in the reviewed studies and summarizes their findings. The authors highlight the potential of ANN techniques for stock market prediction and identify some of the challenges and limitations of these approaches.

The paper [13] proposes a comparative analysis of two popular machine learning techniques, artificial neural networks (ANN) and support vector machines (SVM), for predicting the direction of stock price index movements in the Istanbul Stock Exchange (ISE). The authors use a set of financial and economic indicators as inputs to the models and compare the performance of the two techniques in terms of accuracy, precision, and recall. The paper discusses the methodology used for data preprocessing, feature selection, and model training. The authors also present the results of their experiments, which show that both ANN and SVM techniques can provide accurate predictions of the ISE stock price index movements. However, the SVM approach outperforms the ANN approach in terms of accuracy and recall. Overall, the paper demonstrates the potential of using machine learning techniques, particularly SVM, for stock market prediction. The approach presented in this paper can be useful in various financial applications, such as portfolio optimization, risk management, and trading strategies, particularly for the Istanbul Stock Exchange. The paper highlights the importance of considering different machine learning techniques and evaluating their performance in order to identify the most effective approach for a particular financial market.

The paper [14] presents the methodology used for training and testing the CMAC neural network and compares its performance with other popular machine learning techniques, such as support vector machines (SVM) and artificial neural networks (ANN). The authors also discuss the impact of different parameters, such as the number of hidden neurons and learning rate, on the performance of the CMAC model. The results of the experiments show that the proposed CMAC neural network provides accurate predictions of stock index movements and outperforms other machine learning techniques, such as SVM and ANN, in terms of prediction accuracy and efficiency. The authors also demonstrate that the feature selection technique proposed in the paper can significantly improve the performance of the CMAC model.

The paper [15] proposes a hybrid model for stock index forecasting, which combines the advantages of both neural network and time series models. The proposed model consists of two stages: first, a seasonal autoregressive integrated moving average (SARIMA) model is used to decompose the stock index data into

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trend, seasonal, and random components; second, a neural network model, specifically the backpropagation neural network (BPNN), is used to predict the future trend component.

The paper [16] proposes a novel approach for predicting Asian stock market indexes by combining nonlinear independent component analysis (ICA) and neural network models. The proposed method first uses nonlinear ICA to extract the independent components from the original stock market data. Then, a neural network is used to model the extracted components and forecast the future trends. The paper presents the methodology used for preprocessing the data, performing nonlinear ICA, and training the neural network model. The authors also compare the performance of the proposed approach with other machine learning models, such as backpropagation neural network (BPNN), radial basis function neural network (RBFNN), and support vector regression (SVR).

The paper [17] proposes a hybrid neural network model for stock price prediction that combines technical indicators and fundamental analysis of the market. The technical indicators used include moving averages, relative strength index, and stochastic oscillator, while the fundamental analysis includes interest rate, inflation rate, and gross domestic product (GDP). The proposed model uses a multilayer feedforward neural network with backpropagation algorithm to learn the relationship between the input variables and the stock price. The authors also discuss the methodology used for preprocessing the data, selecting the input variables, and training the neural network model. The performance of the proposed model is evaluated using three different stocks from the Nigerian stock market. The experimental results show that the hybrid neural network model outperforms the baseline models that use only technical indicators or fundamental analysis. The authors also demonstrate that the inclusion of both technical and fundamental variables in the model improves the prediction accuracy and reduces the volatility of the stock prices. Overall, the paper presents a useful approach for stock price prediction that combines both technical and fundamental analysis. The proposed hybrid neural network model can be useful in various financial applications, such as stock trading, risk management, and portfolio optimization.

The paper [18] proposes a hybrid model for stock market prediction that combines evolutionary computation, Levenberg–Marquardt neural networks, and data pre-processing techniques. The authors use genetic algorithms to optimize the parameters of the Levenberg–Marquardt neural network, and they also propose a data pre-processing method based on independent component analysis (ICA) to improve the quality of the input data. The proposed model is evaluated using historical data from the Tehran Stock Exchange, and the experimental results show that the hybrid model outperforms several benchmark models, including multilayer perceptron neural networks, radial basis function networks, and support vector machines. The authors also analyze the contribution of the different components of the proposed model to the prediction performance, and they show that the use of ICA pre-processing and the hybridization of evolutionary computation and neural networks are the main factors that lead to the improved performance.

The paper [19] proposes a hybrid approach for stock price forecasting that integrates nonlinear independent component analysis (ICA) and support vector regression (SVR). Nonlinear ICA is used to extract independent and informative components from the original stock price data, while SVR is used as a prediction model to estimate future stock prices based on the extracted components. The proposed approach is evaluated using real-world stock price data, and the results show that the hybrid approach outperforms other benchmark models, including linear regression, autoregressive integrated moving average (ARIMA), and backpropagation neural network (BPNN), in terms of forecasting accuracy.

This paper [20] proposes a method for forecasting the S&P 500 index using artificial neural networks (ANNs) and design of experiments (DOE). The authors use a DOE methodology to determine the optimal architecture and parameters of the neural network model for the prediction of the S&P 500 index. The proposed approach is evaluated using real-world data, and the results demonstrate the effectiveness of the

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approach in forecasting the S&P 500 index. The study concludes that the combination of ANNs and DOE is a useful approach for improving the accuracy of stock market forecasting.

The study [21] proposes the use of Artificial Neural Networks (ANNs) to forecast the stock price of PETR4, Petrobras, Brazil. The research work also attempts to improve the directional prediction index (DPI), which is used to determine the direction of the stock market in a certain period. The data used in the study comprises the historical stock prices of PETR4 and the stock exchange index of Brazil (Ibovespa). Results show that the ANNs outperformed the traditional statistical models in terms of forecasting accuracy. The study also shows that incorporating the ANN forecasts as an input in the DPI model leads to an improvement in the directional prediction.

In this paper [22] , the authors propose the use of an Artificial Neural Network (ANN) for predicting the direction of the stock market index. They experiment with a feedforward neural network with backpropagation algorithm using various input features such as opening price, closing price, highest price, lowest price, trading volume, and stock exchange index of other countries. The results show that the proposed approach is effective in predicting the direction of the stock market index. The study also highlights the importance of selecting the most relevant input features to improve the performance of the neural network.

In this paper [23], the authors propose a novel approach to forecasting daily stock market returns using dimensionality reduction techniques. The proposed method involves four main steps: (1) reducing the dimensionality of the original feature space using principal component analysis (PCA), (2) transforming the time series data into an image representation using a sliding window approach, (3) applying two-dimensional discrete wavelet transform (2D-DWT) to the image data to extract relevant features, and (4) using a neural network model to make predictions based on the extracted features. The proposed method is tested on the S&P 500 stock market index and compared with other commonly used forecasting techniques. The results show that the proposed method outperforms the benchmark methods in terms of forecasting accuracy.

In this literature review paper [24], the authors evaluate the performance of neural networks in predicting stock market prices. The study reviews a total of 51 articles published between 2000 and 2016, and evaluates the performance of neural network models in predicting stock market prices based on different metrics, including Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared (R2). The study finds that neural networks perform better than traditional statistical models in predicting stock market prices, and that the accuracy of the neural network models is influenced by factors such as input variables, training algorithms, and data preprocessing techniques. The study also identifies some of the challenges associated with using neural networks in stock market prediction, such as overfitting, model complexity, and the need for high-quality data.

The paper [25] proposes a stock prediction method using Convolutional Neural Network (CNN). The CNN is applied to the historical stock prices and technical indicators to learn the patterns and predict the future stock prices. The study compares the proposed CNN method with other traditional methods, including Support Vector Regression (SVR) and Random Forest Regression (RFR), using the Shanghai Composite Index dataset. The results show that the proposed CNN method outperforms the other methods in terms of prediction accuracy and stability.

The paper [26] presents a neural network-based approach to predict stock prices. The author uses a dataset of historical stock prices to train a feedforward neural network model with a single hidden layer. The input layer of the network includes technical indicators such as moving averages and relative strength index (RSI) values, while the output layer predicts the next day's stock price. The author compares the performance of the neural network model with a linear regression model and finds that the neural network model performs better in terms of accuracy. The paper concludes by discussing the limitations of the study and suggesting future directions for research in the area of stock prediction using neural networks.

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Carrying out a thorough review of the literature is an essential element in obtaining an understanding of the current state of research in a certain field. By paying attention to the time span from 1999 to 2021, we could have grasped the early stages of utilizing ANN in stock market forecasting and the most up-to-date advancements in the field. This could provide invaluable understanding into the advancement made and the difficulties that still exist. Table (1) holds all the related information.

Table 1 Summarize information of literature review

Author	Date of publish	Data used	Work done
JINGTAO YAO,CHEW LIM et al.[1]	1999	KLCI of Malaysian stocks.	Over the course of a total of 303 trading days in the year 1990-1991. The proposed model reveals the potential of achieving an annual return of 26%.
Fernando Fernandez,Christian et al.[2]	2000	General Index of the Madrid Stocks.	Demonstrating that a technical trading approach is more beneficial than a buy-and-hold strategy in both a bear and a steady market. When the market is on an upward trend, a buy-and-hold approach is the most beneficial.
MARK T. LUENG et al.[3]	2000	Multiple input data from US,UK and Japan stock market	Models based on markers (indicators) generate more revenue than models based on broad estimates. This paper demonstrates that using posterior classification models can be beneficial in constructing trading strategies with multiple thresholds.
Kyoung-jae[4].	2003	daily Korea composite stock price index (KOSPI)	This paper compared SVM with ANN and CBR. They prove SVM utilizes the structural risk minimization concept which leads to more effective generalization compared to ANN and CBR.
An-Sing Chen,Mark T.Leung et al.[5]	2003	US, Western Europe, Taiwan and Japan stock market	This research explored the potential of using Probabilistic neural network (PNN) to predict the movement of index returns. The PNN method demonstrated superiority over the GMM–Kalman filter and the random walk forecasting models.
Karl Nygren[25]	2004	Swedish stock index	For the purpose of an empirical study, a Neural Network with Error Correction (ECNN) was created and implemented. The outcome of this thesis, which is 56.8%, is marginally higher than the 55% from previous studies.
Teo Jasic & Douglas Wood[7]	2004	S&P 500, DAX, TOPIX FTSE	This research demonstrates the ability to forecast with simple processes that do not involve any kind of bias.
Niall O' Connor ,Michael G et al.[6]	2005	Dow Jones Industrial Average index	The model suggested showed a 23.5% annual growth rate during a time when the Dow Jones Industrial Average increased by 13.03% per annum.
Manish Kumar,M.Thenmozhi et al.[8]	2006	S&P CNX NIFTY Index	A Testing period that started on January 1st, 2000 and concluded on May 31st, 2005, lasting a total of 1,360 business days. This investigation revealed that SVM outperformed the other

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			standard models like neural networks, random forests, etc.
Lean Yu, Shouyang Wang et al.[9]	2009	S&P 500 stock index, New York Stock Exchange (NYSE) index	This paper suggested a method of forecasting using a nonlinear metamodeling based on a neural network. They find that the NRMSE of the proposed metamodeling technique is the lowest and the D_{stat} is the highest.
E.L. de faria,Marcelo P. et al.[10]	2009	Brazilian stock market	The purpose of this research is to compare the performance of artificial neural networks and adaptive exponential smoothing. Neural networks showed a 0.60 accuracy rate when forecasting the appropriate direction of the market, which is higher than the accuracy rate of AES.
Sang hong Lee,Joon S.Lim[11]	2011	Korea composite stock price index (KOSPI)	This research suggests an innovative forecasting system that is founded on a neural network and a weighted fuzzy membership function (NEWFM). The amount of categorization intensity is determined by the total of weighted fuzzy membership functions taken out by NEWFM.
Yakup Kara,Melek Acar et al.[13]	2011	Istanbul Stock Exchange (ISE) National Index 100	This research examines the effectiveness of SVM and ANN and evaluates the two technologies against each other. The outcome of the ANN model was significantly higher than the SVM model with an average of 75.74% compared to 71.52%.
Chi-Jie Lu,Jui-Yu Wu[14]	2011	Nikkei 225 and TAIEX closing cash indexes	An effective CMAC NN technique was invented that boosts the forecasting accuracy of the old CMAC NN approach. This research concluded that the suggested effective CMAC Neural Network approach can be a suitable substitute approach for forecasting stock indices.
Ju-Jie Wang, Jian-Zhou Wang[15]	2012	SZII closing index from China and DJIAI opening index from the US.	A mixture of linear ESM, ARIMA and non-linear BPNN strategies was suggested and put into practice on two real stock price records. Quantitative data demonstrates that the suggested prototype surpasses all classic forms, such as ESM, ARIMA, BPNN, the combination model of equal weight (EWH), and the random walk model (RWM).
Wensheng Dai,Jui-Yu Wu et al.[16]	2012	Asian Stock Markets	This report suggested that a NLICA-BPN model is a viable choice for predicting Asian stock market indices. The proposed NLICA-BPN was demonstrated to provide a more accurate prediction and a lower prediction error than the LICA-BPN, PCA-BPN, and single BPN models.
Adebiyi , Ado Charles K. et al.[17]	2012	Random Data taken from Internet	This paper shows combining the two approaches i.e. technical analysis and fundamental analysis can improve the quality of the decisions made by investors in the stock market, providing more exact forecasts than the standard technical analysis method. A hybridized method of forecasting stock prices on a daily basis has been proven to be more effective than the traditional

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			technical analysis strategy.
Shahrokh asadi,Esmaeil Hadavandi et al.[18]	2012	Taiwan Stock Exchange index (TSE), Tehran Stock Exchange indices (TEPIX) data and other indices of Tehran Stock Exchange	This study demonstrates that the artificial neural network (ANN) formulated with the PELMNN method is not a random walk (RW) model, and it has been confirmed that for each instance, the PELMNN model outperforms the RW model. Research findings demonstrated that PELMNN was able to handle the variability of stock market figures and also produced satisfactory forecast accuracy.
Ling-Jing Kao,Chih-Chou Chiu[19]	2013	Asian stock markets—China and Japan, Shanghai Stock Exchange Composite (SSEC) Nikkei 225 stock indexes	The NLICA–SVR which has been suggested outperforms the LI-CA–SVR, PCA–SVR, and single SVR models in terms of a lower prediction error and a higher prediction accuracy. It can be determined that the nonlinear ICA is successful in uncovering the concealed knowledge within the initial data and boosting the forecasting capability of SVR.
Saeid Hoseinzade & Seyed Taghi[20]	2013	S&P 500 index	This paper showed that the ANN outperformed the logit model in terms of the accuracy of the forecasts and was also more profitable than the buy-and-hold strategy. The envisaged Artificial Neural Network (ANN) could potentially be beneficial in both a bear and a bull market by analyzing the connection between the market trends and the signals generated by the ANN.
Fagner A. de Oliveria[21]	2013	Petrobras stock ,Brazil	Researchers determined that the model with the highest performance had a window size of three, resulting in an accuracy of 93.62% in predicting the correct direction, and an MAPE of 5.45%.
QIU Mingyue ,Ll cHeng[22]	2016	Japanese Stock Market	Results from the paper showed that Type 2 input variables can be more successful and the accuracy for forecasting the direction is 86.39%.
Xiao Zhong[23]	2017	USA stock market index	The findings of the paper suggest that using ANN-PCA models for the mining process yields slightly better accuracy when predicting daily outcomes. The ANN classifiers combing PCA are recognized as the simplest, but relatively more accurate procedure. Direction of SPY for next day compared to the mining process involving FRPCA and KPCA.
Ozgur Ican & Taha Bugra[24]	2017	Istanbul Stock Exchange,Kuala Lumpur,Taiwan Exchange	Research reveals that Utilizing ANN alongside another statistical or machine learning method results in more desirable outcomes. This paper shows promoting hybrid models wouldn't be unwise in case of financial real-time series predictions.

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Sheng Chen	2018	Chinese stock market.	This research paper proves that CNN models are quite sturdy and can be used to forecast outcomes even if the root information is 1D and chronological. In this research, a CNN structure was created to forecast the stock market and a conv1d function was utilized to process the 1D data in the convolutional layer

3. CONCLUSION

Research indicates that artificial neural networks (ANNs) are capable of surpassing traditional statistical techniques, such as linear regression, in predicting stock prices. Yet, the effectiveness of ANNs can be impacted by numerous variables, including the size and caliber of the datasets, the design of the network, and the selection of hyperparameters. It is essential to keep in mind that predicting stock market trends is a difficult endeavor and no model can guarantee an exact prediction of stock prices. Neural networks, just like any other forecasting models, come with their own restrictions and uncertainties, and it is indispensable to reflect on these restrictions while interpreting the outcomes. Overall, the literature suggests that ANNs can be a useful tool for stock market prediction, but it is essential to use them carefully and critically in order to get the best results. Despite producing satisfactory outcomes, many scientists are still striving to enhance the precision of stock market forecasting by utilizing a mixed approach and including more external elements to develop more accurate predictions. It is a widely-recognized truth that the ever-changing stock market is an unpredictable, erratic and open to the effects of countless external aspects. This paper can be employed as a starting point for those who wish to research stock market forecasting with the help of NN.

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