Hybrid Approach of Wavelet Transform and ANN for Stock Market Prediction

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Abstract: Time series data analysis is today's financial need which is to be predicted with highest accuracy. A stock market data with some input variables like open, low, high and close price may influence the accuracy of a predictive model, therefore, it is necessary to decide input and output parameters for the model. In this proposed work we have used hybrid of two techniques called Wavelet Transform and Artificial Neural Network (ANN) for prediction of BSE30 stock data. Mean Absolute Percentage Error (MAPE) measures the accuracy of model.

Key Words- ***Artificial Neural Network (ANN), Wavelet Transform, Stock Data.***

I. Introduction

Forecasting in the financial scenario especially in the stock market is full of uncertainty which makes the stock prediction very difficult tasks for investors and financial managers. Various statistical as well as intelligent techniques are used for time series prediction. Statistical techniques some how are not able to predict the time series data due to its non-linear nature[1]. On the other hand intelligent techniques are being used for taking trading decision for non linear, uncertain and non-stationary stock market data. In order to provide better tools to predict stock price movement, a good and reliable system must be developed. Intelligent techniques like Artificial Neural Network (ANN) [2] is widely used technique now days and able to produce more accuracy in forecasting model as compared to any statistical model. In this research work we have worked with wavelet denoising to remove inconsistency from stock data and make data smooth. These two techniques are applied to BSE30 data to find out next day ahead prediction.

The objective of this study is to explore the predicting capabilities of Hybrid model [3] for stock market time series data on the basis of two intelligent technique i.e wavelet denoising [4] and Artificial Neural Network (ANN).

In addition, to see how data preprocessing is beneficial in terms of performance of model. The experiment of this proposed work is carried out using self-written MATLAB code. The empirical result shows that model is performing accurately for next day ahead prediction of BSE30 stock data by using error measure Mean Absolute Percentage Error (MAPE).

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II. Literature Review

The literature survey suggests many solutions for financial prediction. Many author have used different ANN techniques and some author have suggested some useful technique with the combination of ANN for the better solution. Here in this proposed work we have reviewed papers based on stock market prediction, ANN techniques, Wavelet and hybridization of various techniques.

Authors [5] examine the effect and usefulness of network indicators for determining strategies via several ML techniques like logistic regression, support vector machine, and random forest. A literature has been reviewed by authors [6] in ML techniques that are applied for financial market and found that ML models is necessary to select the best parameters for future forecasting.

Authors [7] proposed a new approach to forecasting the stock prices via the Wavelet De-noising-based Back Propagation (WDBP) neural network and to show the advantage of this new approach for stock index forecast, the WDBP neural network is compared with the single Back Propagation (BP) neural network using the real data set.

Taiwanese export trade forecasting is explored by authors [8] using Support Vector Regression (SVR), wavelet transform and k-means clustering. Authors [9] propose a novel hybrid model of bootstrap and double bootstrap artificial neural networks which are commonly used as alternative methods through the reconstruction of an ANN–ARIMA standard error.

The empirical result shows that the proposed model gives better accuracy and efficiency for forecasting time series data. Authors [10] present an integrated system with wavelet transforms and recurrent neural network (RNN) based on artificial bee colony (abc) algorithm (called ABC-RNN) for stock price forecasting. Authors [11] propose an enhanced version of hybrid neural based models, incorporating the autoregressive integrated moving average (ARIMA) and artificial neural networks (ANNs) for financial time series forecasting.

III. Methodology

A. Wavelet

Wavelet analysis is a mathematical function used to decompose original signals into different scale components [12]. Wavelet is useful for signal processing and it also has an important application of signal de-noising [13], [14] .Wavelet analysis has become a popular tool due to its ability to reveal information within the signal in both the time and scale (frequency) domains [14]. This model is suitable for non-stationary data, i.e the data that is very fluctuating in nature like financial time series data.

In this study we have worked with stationary wavelet transform for stock market prediction. The Stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform (DWT). In the proposed work, we use Stationary Wavelet Transform (SWT) to remove noise from feature of financial time series data [15]. The block diagram of SWT is depicted in figure 1.

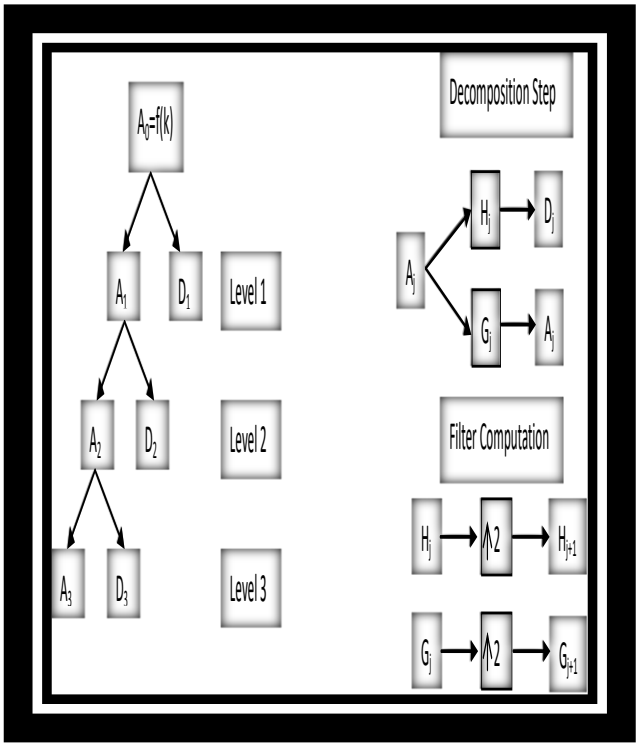


Fig.1. Block Diagram of SWT

B. Artificial Neural Network (ANN)

A neural network can be used to predict future values of possibly noisy multivariate time-series based on past histories and can be described as a network of simple processing nodes or neurons that are interconnected to each other in a specific order to perform simple numerical manipulations [16]. An Artificial Neural Network (ANN) is introduced as a network which is able to obtain, store and utilize the experienced knowledge that is related to network's performance and its capability [17]. ANN can also be defined as a computational model that is based on the working on neurons in brain as neurons are the basic building block of neural network , they often operated in parallel with regular architecture. These networks are organized in layers and have feed forward [18] and feedback connection [19] both. Before training of network, we must decide and specify the number of units in the input layer, the number of hidden layers (if more than one), the number of units in each hidden layer, and the number of units in the output layer. Each connection between the layers has some numeric value called weight, which can be changed and depends on the behavior and architecture of network model. The architecture of ANN is depicted in figure 2.

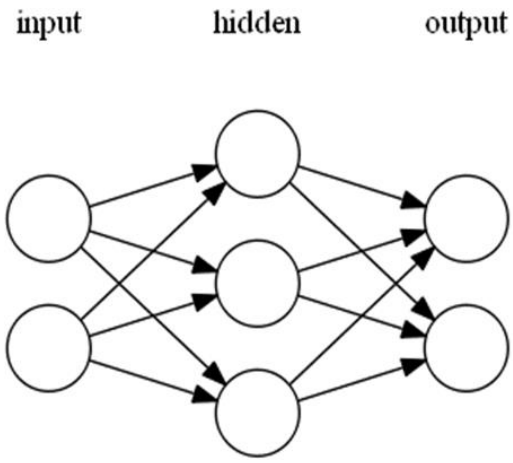


Fig.2. Architecture of single layer feed forward Neural Network.

IV. Data Set

A. Dataset

To develop a forecasting model, it is necessary to collect the financial time series data. In this proposed work we have collected BSE30 stock data from www.bseindia.com. We have collected 3 years time series data from April 1, 2018 to March, 30, 2021. After data collection normalization has been done to range the data between [0 1].

After normalization data is partitioned into training and testing dataset in 80-20 ratio, where 80% data is used from training and 20% data has been used for testing purpose. After data partitioning, wavelet is apply to data to make the stock data smooth by removing noise from data.

After noise reduction from data it is given to ANN model for next day ahead prediction. Summary of data collection is shown in table 1.

Table.1. Summary of data collection.

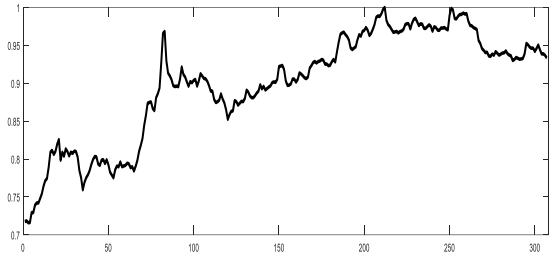
Particular	Detail
Index Data	BSE30 stock data (Daily)
Period	01-April-2018 to 30-March-2021 (3 years)
Total # of Samples	740
Downloaded From	**www.bseindia.com**
Data Partition	• Training (80%) • Testing (20%)
Total Observation	(Training-592. Testing-148)

V. Result Analysis

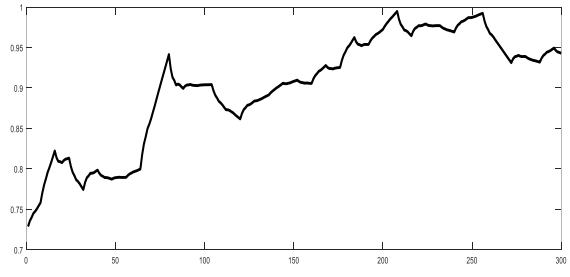
In this research work we have worked with 3 years BSE30 stock data from January 2018 to December 2020, collected from www.bseindia.com. This stock data has 4 indices: Open, High, Low and Close. All five indices are normalized using equation 1 for scaling the data between 0 and 1.

$$X_{new} = \frac{x}{x_{max}} \quad (1)$$

After performing normalization, the data is portioned into training and testing dataset, where 80% data is used for training and 20% is used for testing. After partitioning, data preprocessing is done by wavelet denoising, used to smooth the data by removing noise from stock data as shown in figure 3 (a) and (b). In this study MATLAB is used for wavelet analysis of signals using wavelet analyzer tools. There are various wavelet functions are used for wavelet de-noising, here in this work we have used Daubechies 2 (db2) wavelet at level 5 for reducing noise from BSE30 stock data then analyze signal by decomposition at different scale. This de-noised signal is then fed to the ANN model as input signals and the result comes from this model is compared with original signal without wavelet de-noising.



(a)



(b)

Fig.3. (a) Original signal (b) signal after de-noising using wavelet.

The performance of model is measured by error measure called Mean Absolute Percentage Error (MAPE) as shown in equation 2.

$$\text{MAPE} = \frac{\sum_{i=0}^{n} |Y_{a,i} - Y_{p,i}|}{n} \quad (2)$$

Where Ya=Actual observation, Yp= Predicted observation and n=Total number of observations.

Table.2. Comparative analysis for next day ahead prediction of BSE30 stock data.

Technique	Data Partition	
	Training	Testing
ANN	1.204	1.693
Hybrid (Wavelet & ANN)	0.630	0.962

The above table 2 depicts the comparative analysis between model with single technique ANN without wavelet transform and the hybrid model with hybridization of wavelet transform and ANN. While analyzing the table it is found that hybrid model is outperform than the model with single technique in both training and testing. Figure 4 show the comparative graph between ANN and Hybrid technique.

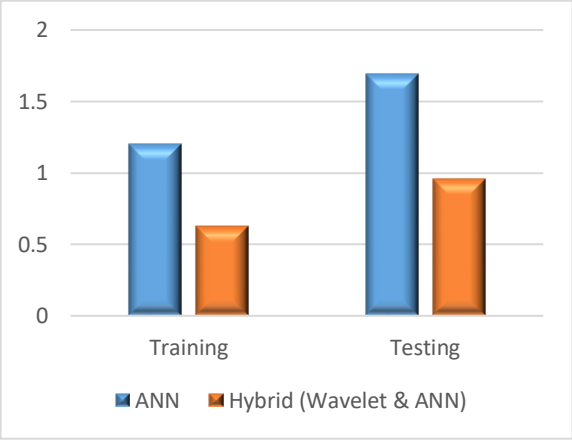


Fig. 4. Comparative graph between ANN and hybrid model.

VI. Conclusion

Stock market is very fluctuating in nature, so it is very challenging for researchers to predict it. ANN is very widely used technique for prediction of stock market data. In this study we have worked with hybrid of wavelet and ANN for stock data forecasting and done comparative analysis between model with individual technique ANN and model with hybrid technique of wavelet and ANN and found that hybrid model is performing better than the model with individual technique, as hybrid techniques have strength of all the techniques combined with. The model is evaluated by error measure Mean Absolute Percentage Error (MAPE) with MAPE=0.630 in training dataset and MAPE= 0.962 for testing dataset.

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