

Stock Market Prediction Module Using Ann & Swarm Intelligence

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Abstract: *The forecasting of prices movements in financial market on daily or certain time period basis is one of the prime concerns and challenging for both researchers and investors. The characteristics of ripples of stock prices movements reflect unpredictable, non-stationary, non-linear, noisy, and chaotic tendency. A stock market is a public market for securities where the organized issuance and trading of company stocks take place either through exchange or over the counter in physical or electronic forms. It is now a day commonly known that huge amounts of capital are traded through stock markets across the world. However, the accurate prediction of stock market movements is highly challenging as well as being an important issue for investors, and it has received much attention from practitioners and experts in financial time series research. This research work develop the module which can be useful in the predication of Indian Stock exchange with the help of ANN (Artificial Neural Network and Swarm intelligence techniques).*

Keywords: Indian Stock market predication, forecasting, Artificial Neural Networks (ANNs); Swarm intelligence

1. Introduction

Expectation of Stock market returns is an essential issue and exceptionally complex in budgetary establishments. The forecast of stock costs has dependably been a testing task. It is no more specifically connected with the monetary advancement of the nation or specific zone [1].

A stock market is the market that people use to trade (= buy and sell) shares, which are like small pieces of the company that a person can own. The value of the share depends on how many people want to buy it and how many people are selling it. If many people want to buy a stock, the price will go up. If there are more sellers than buyers, the price will go down. People usually trade shares in stocks through a broker. A broker or stockbroker is a person who buys or sells stocks for their customers on the stock market. A broker can also help customers make good choices in stocks. Most brokers have recommendations for most of the stocks, based on the information about companies and what is expected from them. Brokers usually recommend customers to BUY, HOLD or SELL. In time series prediction the task is to forecast the next value (values) in a data set. There are several fields in which time series prediction is of central importance, e.g. meteorology, geology, finance, and macroeconomics. Typically in those fields, there exists no accurate models of the system, and therefore the series are studied from a phenomenological, model-free point of view. In the physical sciences, where models are common, the use of model-free time series prediction is less common. Artificial neural networks (ANNs) are often used for time series prediction because of their ability to build their own internal models.

Bio-inspired evolutionary algorithms are probabilistic search methods that mimic natural biological evolution. They show the behavior of the biological entities interacting locally with one another or with their environment to solve complex problems. Swarm Intelligence (SI) is the property of a system whereby the collective behaviors of (unsophisticated) agents

interacting locally with their environment cause coherent functional global patterns to emerge. Bio-inspired algorithms takes into account the collective behavior of decentralized and self-organizing nature of natural habitats and this concept is applied to reach into a sub-optimal solution from all feasible solutions.

Particle Swarm Optimization (PSO) is a stochastic optimization technique. The algorithm is based on the behavior of swarms, such as groups of birds. The PSO idea has expanded to become a common heuristic optimization algorithm with many interpretations of its concepts, issues, and applications. Despite the relative simplicity of individuals, swarm systems display complex behavior. They are made up of numerous individuals and tend to be flexible and robust. Swarm intelligence thus provides a framework for the design and implementation of systems made up of many agents that are capable of cooperation for the solution of highly complex non-linear optimization problems and thus suitable to combine with the neural network technique.

Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on an exchange. The successful prediction of a stock's future price could yield significant profit. The efficient-market hypothesis suggests that stock prices reflect all currently available information and any price changes that are not based on newly revealed information thus are inherently unpredictable. Others disagree and those with this viewpoint possess myriad methods and technologies which purportedly allow them to gain future price information.

2. Literature Survey

Vaibhav V. Thutte and et al [1] states that the event of stock exchange prediction is particularly tough and outlined reasons behind it, some of them are drastic change in economic and legal changes, lack of technical knowledge, lack of expertise etc. further they developed a system using ANN to predict stock exchange values for next day.

Manjul Saini and A. K. Singh [2] outlined reasons how ANN offers qualitative methods for business, economic and medical systems that no other traditional method is able to provide. Further states that the Neural Network tools are able to increase its efficiency, scalability, effectiveness to predict, classify the unseen data. Manjul and et al focuses on the Advanced Backpropagation algorithm learning method which seeks to minimize the error term between the output of the neural net and the actual desired output value. The process is repeated until the error reaches a minimum value.

Snehasoni surveys recent literature in the domain of machine learning techniques and artificial intelligence used to predict stock market movements in her paper "Applications of ANNs in Stock Market Prediction: A Survey" [3]. Artificial Neural Networks (ANNs) are identified to be the dominant machine learning technique in stock market prediction area. She further surveys how Different stock market parameter are used i.e. movement of SET index, fundamental analysis, closing value of the index, moving average crossover inputs, stock share value, daily returns of stock and many others for analyse stock market prediction.

Mruga Gurjar and et al train the ANN model by using historical stock data [4]. Features such as stochastic indicator, moving averages, RSI are extracted from the historical stock data. The dataset is then divided into training and testing sets which are used for training and testing the accuracy of the ANN model. The predicted stock prices help investors make smart investment decisions.

Abid Shaikh et al. [5] conducted experiments on datasets and conclude that the predictive patterns generated using the data mining technique can help to predict stock prices movements on the next day. However it was also found that these rules can only be applied when the left side have a patterns occur.

Mahbub Alam and et al [6] propose a model constructed using the nearest neighbour algorithm, whose main foundation lies behind the fact that stock event/data reflects its own behaviour along the time span.

Radu Iacomin generated a new algorithm on predicting the stock markets [7]. PCASVM was implemented to both eliminate the false predictions and to determine what features are important. For the GASVM algorithm the Rate of Recognition, ROR, that counts the overlapping buying or selling points, is 55%, meaning that only this amount of decisions are going to generate profit. Whereas for PCASVM algorithm, which has a slightly increased ROR of 68%.

In paper [8], Rohit Choudhry, and Kumkum Garg proposed a hybrid GA-SVM system for predicting the future direction of stock prices. A set of technical indicators, obtained from the stock to be predicted, and also from the stocks exhibiting high correlation with that stock were used as input features. The results showed that the correlation concept & the GA helped in improving the performance of the SVM system significantly.

In paper [9], an attempt was made by A. Subashini and et al to forecast the stock market prices of the APPLE stock by

developing a prediction model based on technical analysis of historical time series data and data mining techniques. The potential of the ARIMA model in finding future stock price indices which will enable stock brokers/investors to make profitable investment is huge. The only drawback of this model as compared to its competitors is the tendency to compute the mean of the historical data as forecast when it comes to long term prediction. Thus it is not advisable to use this model for long-term forecasting of stock price indices.

Dr. P. K. Sahoo and et al investigates to predict the stock prices using auto regressive model in paper [10]. The auto regression model is used because of its simplicity and wide acceptability. We have also conducted a study on the effectiveness of auto regressive model. The Moore and Penrose technique is used to estimate the coefficients of the regression equation. We have also studied accuracy of the prediction by comparing the predicted values with the actual values over a period of time.

R. Lakshman Naik and et al [11] inferred that the age of beneficial exchanging rules for securities exchange ventures is a troublesome errand yet appreciated issue. First stage is arranging the inclined course of the cost for BSE file (India concrete stock value file (ICSPI)) fates with a few specialized markers utilizing man-made brainpower strategies. What's more, second stage is mining the exchanging tenets to decided clash among the yields of the main stage utilizing the advance learning. We have discovered exchanging rule which would have yield the most elevated return over a specific timespan utilizing verifiable information. These basis results recommend that hereditary calculations are promising model returns most astounding benefit than other equivalent models and purchase and-move system. Trial aftereffects of purchasing and moving of exchanging rules were remarkable.

The Stock market forecaster's centre around building up an effective way to deal with anticipates stock costs. The crucial plan to effective securities exchange expectation isn't just accomplishing best outcomes yet additionally to limit the off base gauge of stock costs. This paper endeavors to plan and actualize a prescient framework for directing financial exchange speculation. The curiosity of our methodology is the blend of both sensex focuses and Really Simple Syndication (RSS) channels for compelling forecast. Our case is that the conclusion examination of RSS news channels affects financial exchange esteems. Henceforth RSS news channel information are gathered alongside the financial exchange venture information for a timeframe. Utilizing our calculation for supposition examination, the connection between's the financial exchange esteems and feelings in RSS news sources are built up.

This prepared model is utilized for forecast of financial exchange rates. In our trial examine the financial exchange costs and RSS news channels are gathered for the organization ARBK from Amman Stock Exchange (ASE). Our exploratory examination has demonstrated an enhancement of 14.43% precision expectation, when contrasted and the standard calculation of ID3, C4.5 and moving normal stock dimension pointer. [12]

Foreseeing financial exchange precisely has dependably interested the market analysts. During the previous couple of decades different machine learning procedures have been connected to contemplate the exceedingly stochastic nature of securities exchange by catching and utilizing dull patterns. Different organizations utilize diverse investigation devices for anticipating and the principle point is the exactness with which they anticipate which set of stocks would return the greatest measure of benefit. This paper gives a concise prologue to different methods utilized for expectation so it is simple for purchaser/dealer to choose. [13]

3. Proposed System

The concept of artificial neural networks [8] is very much relevant and analogous to natural nervous systems in human brain. It can be considered as substantially parallel adaptive networks of neurons. Neurons are here cognitive to simple nonlinear computing components. The prime intention of neural networks is to perform both analysis and establishment of such substantive parallel computing systems. Neurons are categorized into three types: input, hidden, and output. Input neurons receive inputs from external sources as stimulant to the network. Output of neurons produces output signals of the network. The intermediate functions are calculated by hidden neurons, and these neurons are not visible from the external sites. A neural network model can be created as a weighted directed graph containing neurons as nodes and weighted edges as links. The basic structure of the artificial neural networks is as shown in following figure.

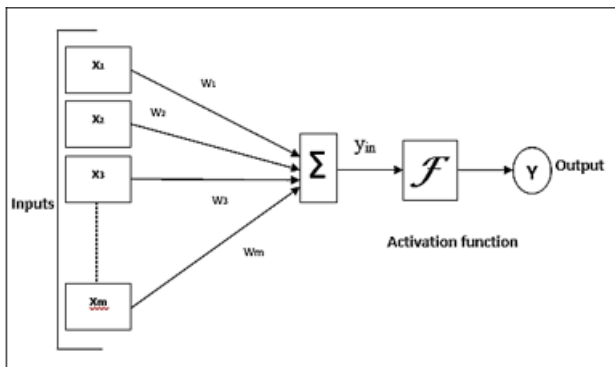


Figure 1: Illustration of a network of neurons.

For this research work, the training set represents all available data from the stock's start from January 2020 to January 2021. Out of this data set, the seventy percentages of data values as training set, which is a set for optimizing the parameter selection process also twenty percentages for test set and finally the validation set is taken as ten percentage of the data set available. The open, high, low, close, and volume are parsed into their own lists. Before the five lists are transformed into a training set, the individual lists are linearly scaled.

After download the prices from the Yahoo Finance web services, the programming code will save the historical prices into the pricing info as Data Frame. As a first step of processing, the index of the Data Frame is change from 'dates' to 'timeline' which is an integer index.

Exploratory visualization is the process that involves a discipline expert creating maps and other graphics while dealing with relatively unknown geographic data. These maps are generally for a single purpose, and function as an expedient in the expert's attempt to solve a (geo) problem.

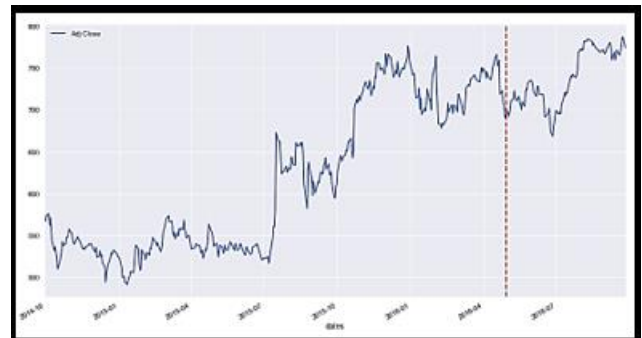


Table 1: Learning data-frame showing Rolling Mean 60

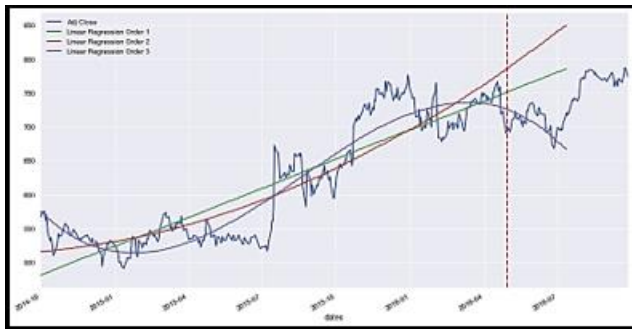
Timeline	Adj Close	dates	timeline	Rolling Mean-60
0	12182.500000	2020-01-01	0	11327.525863
1	12282.200195	2020-01-02	1	11327.525863
2	12226.650391	2020-01-03	2	11327.525863
3	11993.049805	2020-01-06	3	11327.525863
4	12052.950195	2020-01-07	4	11327.525863

Polynomial Regression is a regression algorithm that models the relationship between a dependent(y) and independent variable(x) as nth degree polynomial. The Polynomial Regression equation is given below:

$$y = \beta_0 + \beta_1x + \beta_2x^2 + \epsilon$$

$$y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_{11}x_1^2 + \beta_{22}x_2^2 + \beta_{12}x_1x_2 + \epsilon$$

The coefficients β_1 and β_2 are called the linear effect parameter and quadratic effect parameter, respectively. The interpretation of parameter β_0 is $\beta_0 = E(y)$ when $x = 0$ and it can be included in the model provided the range of data includes $x = 0$. If $x = 0$ is not included, then β_0 has no interpretation. The order of the polynomial model is kept as low as possible. Some transformations can be used to keep the model to be of the first order. If this is not satisfactory, then the second-order polynomial is tried. Arbitrary fitting of higher-order polynomials can be a serious abuse of regression analysis. A model which is consistent with the knowledge of data and its environment should be taken into account. It is always possible for a polynomial of order (n-1) to pass through 'n' points so that a polynomial of sufficiently high degree can always be found that provides a "good" fit to the data. Such models neither enhance the understanding of the unknown function nor be a good predictor



Different stock market parameters are used for analyse stock market prediction are as follows:

- SET index:** The SET Index is a composite stock market index which is calculated from the prices of all common stocks on the main board of the Stock Exchange, except for stocks that have been suspended for more than one year.
- Fundamental analysis:** Fundamental analysis of stocks is a technique which is helpful in making investment decisions. Its basic importance lies in determining the intrinsic value of a security. It can then be compared to the current stock price and determined if the stock is overvalued or undervalued.
- Closing value of the index:** "Closing price" generally refers to the last price at which a stock trades during a regular trading session. For many U.S. markets, regular trading sessions run from 9:30 a.m. to 4:00 p.m.
- Moving average crossover inputs:** The most basic type of crossover is when the price of an asset moves from one side of a moving average and closes on the other. Price crossovers are used by traders to identify shifts in momentum and can be used as a basic entry or exit strategy.
- Stock share value:** A share price is the price of a single share of a number of saleable stocks of a company, derivative or other financial asset. In layman's terms, the stock price is the highest amount someone is willing to pay for the stock, or the lowest amount that it can be bought for.

ANN is a mathematical model that has been inspired by the animal nervous system consisting of neurons and the way information is travelled from every part of human body to the brain. Information in the form of some data values is fed into the network (interconnection between neurons). Based on specific function used at each layer and the input value the output can be evaluated. It has three types of layers:-

- The input layer receives the values on which the computation has to be done. These are the different values of the tuples in the dataset.
- In the hidden layer the computations are done as the values are passed through each level. The number of hidden layers may vary in different architectures and applications.
- In the output layer we receive the value of the parameter after have been processed and computed by specific activation function according to the application for which it is designed. It may be a numeric, binary or a categorical value.

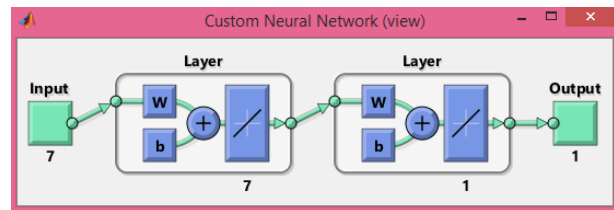


Figure 1: Neural Network to for prediction

ANN has found its application in classification, robotics, regression, time series evaluation and many more. Learning is done by calculating the mean square error for each subsequent observation and a model is chosen that has the least error and high predictive power.

The integration of Artificial Neural Networks (ANNs) and Swarm Intelligence (SI) is promoting unified development in computational models for soft computing filed [12]. Recently swarm intelligence methods like PSO have been successfully applied for training feed-forward and recurrent ANNs. Some authors have reviewed recent theoretical and applied research on swarm intelligence (SI) and artificial neural networks.

Artificial neural networks (ANNs) have the ability to learn and adapt although it is very difficult to obtain optimal neural network architecture with, for example, the optimal numbers of hidden layers and hidden neurons in each hidden layer. They argue that the use of swarm intelligence will allow more robust and rapid solutions to be found. Furthermore, the potential of higher order neural networks and their possible integration with swarm intelligence is also discussed. Some literature survey explore data mining utilizing neural network and swarm intelligence algorithms. These techniques have an advantage over conventional statistical techniques because they require no prior knowledge of the distribution of data. The extraction of information from a dataset is possible in the form of weights and rules using various neural network and swarm intelligence techniques. Performance analysis is based on per class and overall accuracy. Furthermore, the computational complexity of neural network and swarm intelligence techniques are evaluated. Swarm intelligence meta-heuristic methods are mainly characterized by their distributiveness, flexibility, capacity of interaction among simple agents, and robustness [11]. They have been successfully applied to single-objective optimization problems and have great potential to cope with multi-objective optimization problems. Here, taxonomy of the types of swarm intelligence (i.e. ant colony optimization) for multi-objective optimization is proposed that would be helpful in multi-objective optimization problems. The wavelet transform (WT) is one of the most frequently used signal processing techniques for the extraction of information in different frequency sub-bands from non-stationary signals such as time series. WT-derived features are used to identify the nature of the signals.

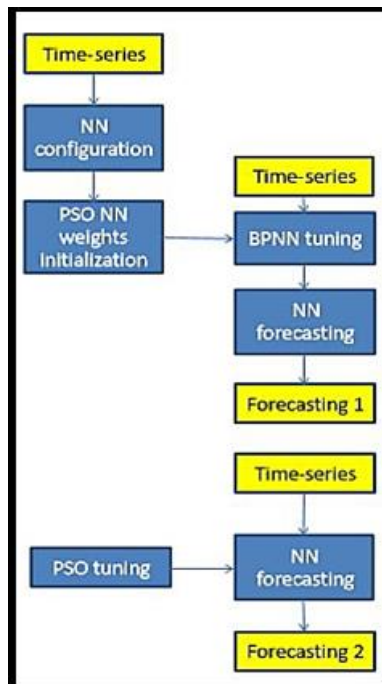


Figure: Hybrid BPNN and PSO Model

4. Result and Conclusion

For the stock exchange prediction using ANN, we have used database from yahoo finance webservice. And the result is given as below.

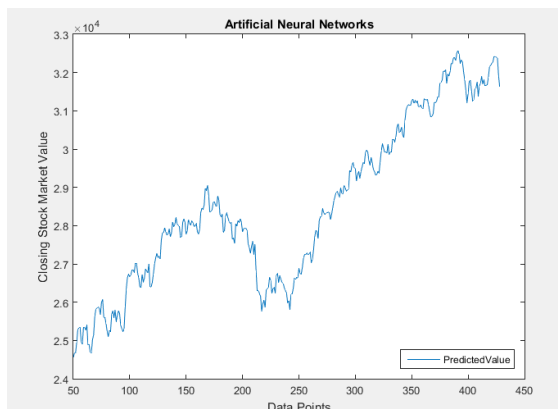


Figure 2: Result of ANN algorithm

Predicting the stock market price is very popular among investors as investors want to know the return that they will get for their investments. Traditionally the technical analysts and brokers used to predict the stock prices based on historical prices, volumes, price patterns and the basic trends. Today the stock price prediction has become very complex than before as stock prices are not only affected due to company's financial status but also due to socio economical condition of the country, political atmosphere and natural disasters etc. The return from the share market is always uncertain and ambiguity in nature hence traditional techniques will not give accurate prediction. A lot research has been made in this area and advanced intelligent techniques ranging from pure mathematical models and expert systems to neural networks have also been proposed by many financial trading systems for stock price prediction. In this paper we are going to use ANN (Artificial Neural Network) for predicting stocks value for next day.

Recently there have been significant research efforts to apply evolutionary computation techniques such as PSO for the purposes of developing one or more aspects of artificial neural networks [11]. Various approaches using PSO to replace the back-propagation learning algorithm in ANNs have been proposed in recent years. These have shown that PSO is a promising method in training ANNs. It is faster and gets better results in most cases. Further hybrid models with combinations of PSO and BPNN are very promising. These techniques have been applied to three main attributes of neural networks: network connection weights, the network topology and learning algorithms. Here the work was conducted on the network weight parameters.

The code, integrating the PSO and NN weights techniques is apparently very technically complex. Both the NN and PSO are very sensitive to initial state randomness. There are many parameters in PSO that need to be adjusted to get better results in different trials, but the main ones are the number of hidden layers and the range of the weights. The typical number of particles is 20 to 40, but for most problems such as time series forecasting 10 particles is large enough to get good results. The dimensionality of particles is determined by the problem to be optimized, and in the case of neural networks the number of weight parameters massively increases [12]. In the experiment, there are over 500, comprising the number of NN node weights times the number of time series samples. The range of particles (NN weights) is also determined by the problem to be optimized.

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