STOCK MARKET TRENDS PREDICTION USING NEURAL NETWORK BASED HYBRID MODEL

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ABSTRACT

It is difficult to find out which is more effective and accurate method for stock rate prediction so that a buy or sell signal can be generated for given stocks. This paper presents a number of technical indicators and Back Propagation Neural Network to predict the stock price of the day. Stock rate prediction accuracy of different technical indicators and backpropagation neural network has been compared. The results showed that the backpropagation neural network predict stock price more accurately as compared to other techniques.

KEYWORDS: Back Propagation Neural Network, Moving Average, MACD, ROC, RSI

INTRODUCTION

Prediction of financial markets has long been an attraction in the minds of equity investors. Technical Analysis [1] provides a framework for studying investor behavior, and generally focuses only on price and volume data. Technical Analysis using this approach has short-term investment horizons, and access to only price and exchange data. With the advent of powerful computers much attention has been focused on this field. Equity market prices depend on many influences. Key factors that influence future equity prices can be broadly divided into quantitative and qualitative types. Primary quantitative factors include open rate, high rate, low rate, close rate and volume for individual equities. Qualitative factors include socio-economic, political, international, regional and performance factors to name but a few. The aim of this paper is to compare different popular technical indicators with backpropagation neural network to find technique that can predict stock price more accurately as compared to other techniques.

Preliminary research performed on Indian National Stock Exchange market has suggested that the inputs to the system may be taken as: previous day’s closing rate for Moving Average, MACD, ROC and RSI. Previous day’s closing rate and volume of last trading day for backpropagation neural network. After the inputs have been determined, the data have been gathered of ONGC stock for the period of 01-Jan-2004 to 29-Dec-2006 for training backpropagation neural network. For testing purpose we have used Testing data of ONGC Stock for the period of 02-Jan-2007 to 29-jun-2007. Training and testing is performed using one hidden layer BPN network architecture. The results are compared between technical indicators –MA (Moving Averages), MACD (Moving Average Convergence Divergence), ROC(Rate Of Change) and RSI (Relative Strength Index)with BPN (Backpropagation Neural Network). It has been found that BPN is having better performances than Moving Averages, MACD, ROC and RSI.

TECHNICAL ANALYSIS

Technical analysis is a method of evaluating securities by analyzing the statistics generated by market activity, such as past prices and volume. Technical analysts do not attempt to measure a security's intrinsic value, but instead use charts and other tools to identify patterns that can suggest future activity. Just as there are many investment styles on the
fundamental side, there are also many different types of technical traders. Some rely on chart patterns; others use technical indicators and oscillators, and most use some combination of the two. In any case, technical analysts' exclusive use of historical price and volume data is what separates them from their fundamental counterparts. Unlike fundamental analysts, technical analysts don't care whether a stock is undervalued - the only thing that matters is a security's past trading data and what information this data can provide about where the security might move in the future. The field of technical analysis is based on three assumptions

1. The market discounts every thing.
2. Price moves in trends.
3. History tends to repeat itself.

Despite all the fancy and exotic tools it employs, technical analysis really just studies supply and demand in a market in an attempt to determine what direction, or trend, will continue in the future. In other words, technical analysis attempts to understand the emotions in the market by studying the market itself, as opposed to its components. Moving Average, MACD, ROC and RSI are mostly used technical indicators [2].

Moving Average

It is an indicator used in technical analysis that shows a stock's average price over a certain period of time. It is good to show a stock's momentum and it's propensity to move above or below a point. Combination of two moving averages is mostly used. In this system, the buy and the sell signals are generated by the intersection of the two moving averages. When a stock is falling, the short-term average would be below the longer term average. If the scrip were to reverse directions, the short-term average would move above the longer term average. The cross-over is taken as a valid signal to buy and sell the stock.

MACD

It is based on 3 exponential moving averages, or EMA. These averages can be of any period, though the most common combination, and the one we have focused on, is the 12-26-9 days MACD. If the MACD is above the 9-days EMA buy signal is generated and If MACD is below the 9-days EMA sell signal is generated

ROC

The Price Rate-of-Change ("ROC") indicator displays the difference between the current price and the price x-time periods ago. The difference can be displayed in either points or as a percentage. The ROC displays the wave-like motion in an oscillator format by measuring the amount that prices have changed over a given time period. As prices increase, the ROC rises; as prices fall, the ROC falls. The greater the change in prices, the greater the change in the ROC. 9-days exponential moving average of the ROC data is used as a trigger line. A buy signal is generated as and when the ROC line moves above the average line.

RSI

The name "Relative Strength Index" is slightly misleading as the RSI does not compare the relative strength of two securities, but rather the internal strength of a single security. A more appropriate name might be "Internal Strength Index". The RSI usually tops above 70 and bottoms below 30. It usually forms these tops and bottoms before the underlying price chart. 9-day RSI is used for calculation.
APPLICATION OF NEURAL NETWORKS IN MARKET PREDICTION

Overview

The ability of neural networks to discover nonlinear relationships [3] in input data makes them ideal for modeling nonlinear dynamic systems such as the stock market. Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A neural network method can enhance an investor's forecasting ability [4]. Neural networks are also gaining popularity in forecasting market variables [5]. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Asif Ullah Khan et al [6] used the back propagation neural networks with different number of hidden layers to analyze the prediction of the buy/sell prediction. Neural networks using back propagation algorithms having one hidden layer give more accurate results in comparison to two, three, four and five layers.

Back Propagation Neural Network Training

Initialize all weights in network;

While terminating condition is not satisfied { for each training sample X in sample

{ // propagate the inputs forward:

for each hidden or output layer unit

j { I_j=\sum_i W_{ij} O_i ; //Compute the net input of unit j with respect to the previous layer, i

O_j=1/(1+e^{-I_j});}

//Compute the output of each unit j

//Backpropagate the errors

for each unit j in the output layer

Err_j=O_j(1-O_j)(T_j-O_j);//Compute the
error for each unit j in the hidden layers, from the last to the first hidden layer

Err_j=O_j(1-O_j)\sum_k Err_k W_{jk};//Compute the error with respect to the next higher layer, k

for each weight W_{ij} in network

\{ \Delta W_{ij}=(l)Err_j O_i;

//Weight increment

W_{ij}=W_{ij}+\Delta W_{ij};}//weight update

} }
The weights in the network are initialized to small random numbers (e.g., ranging from –0.0 to 1.0). Then propagate the inputs forward, the input and output of each unit in the hidden and output layers are computed. First, the training sample is fed to the input layer of the network. For unit j in the input layer, its output is equal to its input, that is, \( O_j = I_j \). The net input to each unit in the hidden and output layers is computed as a linear combination of its inputs. The inputs to the unit are, in fact, the outputs of the units connected to it in the previous layer. To compute the net input to the unit, each input connected to the unit is multiplied by its corresponding weight, and this is summed. Given a unit j in a hidden or output layer, the net input, \( I_j \), to unit j is \( I_j = \sum_i W_{ij} O_i \), where \( W_{ij} \) is the weight of the connection from unit i in the previous layer to unit j; \( O_i \) is the output of unit i from the previous layer. Each unit in the hidden and output layers takes its net input and then applies an activation function to it. The function symbolizes the activation of the neuron represented by the unit. The logistic or sigmoid function is used. Given the net input \( I_j \) to unit j, then \( O_j \) is computed as \( O_j = \frac{1}{1+e^{-I_j}} \). This function is also referred to as a squashing function [7], since it maps a large input domain onto the smaller range of 0 to 1.

The error is then propagated backwards by updating the weights to reflect the error of the network’s prediction. For a unit j in the output layer, the error \( \text{Err}_j \) is computed by \( \text{Err}_j = O_j (1-O_j) (T_j - O_j) \), where \( O_j \) is the actual output of unit j, and \( T_j \) is the true output, based on the known class label of the given training sample. \( O_j (1-O_j) \) is the derivative of the logistic function. To compute the error of a hidden layer unit j, the weighted sum of the errors of the units connected to unit j in the next layer is considered. The error of a hidden layer unit j is \( \text{Err}_j = O_j (1-O_j) \sum_k \text{Err}_k W_{jk} \), where \( W_{jk} \) is the weight of the connection from unit j to a unit k in the next higher layer, and \( \text{Err}_k \) is the error of unit k. The weights are updated to reflect the propagated errors. Weights are updated by the following equations, where \( \Delta W_{ij} \) is the change in weight \( W_{ij} \):

\[
\Delta W_{ij} = (l) \text{Err}_j O_i \\
w_{ij} = w_{ij} + \Delta W_{ij}
\]

The variable l is the learning rate, a constant typically having a value between 0.0 and 1.0.

Training stops when

- all \( \Delta W_{ij} \) in the previous epoch were so small as to below some specified threshold, or
- the percentage of samples misclassified in the previous epoch is below some threshold, or
- a prespecified number of epochs has expired.

**Back Propagation Neural Network Organizations**

Back propagation networks are the most commonly used network because they offer good generalization abilities and are relatively straightforward to implement. Although it may be difficult to determine the optimal network configuration and network parameters. The architecture of neural network used is as given below:-

- Input layer with 2 nodes
- One hidden layer with 2 nodes
- Output layer with one node.

**Back Propagation Neural Network Performance**

A network’s performance is often measured on how well the system predicts market direction. Ideally, the system should predict market direction better than current methods with less error. Input attributes should be carefully selected to keep the dimensionality of input vectors relatively small [8]. Traditionally forecasting research and practice had been
dominated by statistical methods but results were insufficient in prediction accuracy [9]. Monica et al.’s work [10] supported the potential of NNs for forecasting and prediction. BPN network is trained on data set of ONGC for the years of Jan 2004 to Dec 2006 after training testing is done on data set of 2nd Jan 2007 to 29th Jun 2007 of ONGC stock. The BPN based system demonstrated superior performance and was able to predict short term market direction more accurately as compare to different technical indicators as specified before. The technical indicators used are not having generalization power which BPN has. BPN and other technical indicators performance is compared on stock rates of ONGC for a specified period. On the bases of the comparison we found that, BPN based system is able to predict stock price movement of ONGC correctly 91.74% as shown in Fig.1.

![Figure 1: Prediction Accuracy and Graph using BPN](image1)

While performance of technical indicators - Moving Average is 52.11%, MACD is 48.84%, ROC is 48.00 and RSI is 55.88 as shown in Fig.2, Fig.3, Fig.4 and Fig.5

![Figure 2: Prediction Accuracy and Graph using Moving Averages](image2)

![Figure 3: Prediction Accuracy and Graph Using MACD](image3)
Thus, a neural network with BPN gives much better performance in stock rate prediction as compared to above specified technical indicators.

**EXPERIMENTAL RESULTS**

The system has been developed and tested on Windows 98SE operating system. We have used Visual Basic and Microsoft Access as Front End and Back End Tool. Normalisation is a key part of data pre-processing for neural networks and should enable more accurate predictable rates. Normalised data is used for training neural network with backpropagation algorithm. We normalize inputs so that input values lies between 0 and 1. Simulation data was sourced from Indian National Stock Exchange (NSE) As we know close rate and volume are primary quantitative factors for individual equities and from quantitative factors the key qualitative factor of the market sentiment can be derived. So we used close rate for Moving Averages, MACD, ROC and RSI, close rate and volume of stocks as our input in backpropagation neural network and next stock rate as our target for training networks. Prediction accuracies of different method on stock – ONGC for the testing period of 02 January 07 to 29 June 07 are as shown in Table1.

**Table 1: Prediction Accuracy of Different Technical Indicators and BPN**

<table>
<thead>
<tr>
<th></th>
<th>MA</th>
<th>MACD</th>
<th>ROC</th>
<th>RSI</th>
<th>BPN</th>
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<tbody>
<tr>
<td></td>
<td>52.11%</td>
<td>48.84%</td>
<td>48.00%</td>
<td>55.88%</td>
<td>91.74%</td>
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CONCLUSIONS

This Paper has compared the forecasting accuracies of different technical indicators like MA, MACD, ROC and RSI with Backpropagation Neural Network. Results showed that for this stock, Backpropagation Neural Network has given more accurate prediction in comparison to other methods.

REFERENCES


