CHAPTER 6

THE NATIONAL STOCK EXCHANGE AND PREDICTION OF NIFTY TEN WEEKS AHEAD USING NEURAL NETWORKS
The stock, in simple words, is defined as a share in the ownership of a company. Stock represents a claim on the company’s assets and earnings. Ownership stake in the company increases on acquiring more stocks. Stock is also referred to as share or equity. Over the last few decades, the participation of average person in stock market has grown significantly leading to more investments from first time investors. This demand, coupled with the advances in the trading technology, has opened up the markets significantly. Consequently anybody can plan to own stocks. The objective of this attempt is to develop an optimized neural network for prediction of Nifty rates ten weeks ahead. The neural network has to be optimized in terms of momentum, learning rate, number of hidden layers and number of neurons in them. The second objective is to observe the performance of the model and compare it with the market.

6.1 TYPES OF STOCK

Stocks can be classified into two categories, namely, common stock and preferred stock.

6.1.1 Common Stock

Common stock is, well common. In fact, the majority of stocks issued are in this form. Common shares represent ownership in a company and hence claim (dividend) on a portion of profits. Investors get one vote per share to elect the board members, who are charged with the responsibility of managing the company. The investors have the tendency of investing in the common stock as this type of stocks yields the maximum gain. The speculators prefer to invest for long durations in it.

Over the long term, common stock, by virtue of capital growth, yields higher returns than any other investment. This higher return comes at a cost of large amount of risk of loss of investment due to a large number of factors. If a company goes bankrupt and liquidates, the common shareholder shall not receive his investment back until the creditors, bondholders, and preferred shareholders are paid. These type stocks have this as an inherent risk. The
performance of the stock is dependant on the decisions taken by the people managing the policies of the company. Normally the managers with good track record attract the investors.

6.1.2 Preferred Stock

Preferred stock represents some degree of ownership in company but usually does not come with the same voting rights. (This may depend on company). For the preferred shares the investors are usually guaranteed a fixed dividend forever. This is the basic difference between preferred and common stock. Common stock may get a variable dividend, which is not guaranteed. In the event of liquidation, preferred share holders are paid of before the common share holders (but after clearing dues of debit holders). Preferred shares are also callable, meaning that the company has the option of purchasing the shares from stockholders at anytime for any reasons. Normally these are purchased at premium.

6.2 THE STOCK MARKET

Stock market is defined as an organized market place for securities featured by centralization of the supply and demand for transactions of orders by member brokers for institutional and individual investors.

Most stocks are traded on exchanges which are platforms where buyers and sellers meet and decide on the price. Some exchanges are physical locations, where transactions are carried out on the trading floor. The stock markets facilitate the exchange of securities between buyers and sellers, thus reducing risk of investing. In reality, a stock market is nothing but a super sophisticated farmers market linking buyers with the sellers.

There are two types of stock markets. The first is primary market, where securities are created (by means of initial public offering, IPO). The second kind of markets is known as secondary markets. In these kind of markets, the investors trade previously-issued securities without the involvement of issuing companies. The secondary market is mostly named as “the stock market”. There are three types of persons who are active in stock market.
a) First type is an investor who invests in stock market to earn from the investments made. This type of person has the maximum knowledge about the stock market and is always interested in the prediction of market in advance to achieve maximum profits.

b) Second type is of spectators who just watch the market and analyze the market movements.

c) The third type is of gamblers, who just gamble with the market without having much knowledge of the market.

6.3 STOCK EXCHANGES OF INDIA

Two important and major stock exchanges in India are Bombay Stock Exchange, Mumbai (BSE) and the National Stock Exchange (NSE).

6.3.1 The Stock Exchange, Mumbai

BSE is the premier stock exchange that has pioneered the concept of stock market brokering in India. It has been in existence for more than 135 years now. A lot has changed since 1875 when 318 persons became members of “The Stock Exchange, Mumbai” by paying a princely sum of Re. 1. Since then, India’s capital market has seen good and bad periods. Till the decade of eighties, there was no scale to measure the changes taking place in the Indian stock market. In 1986, BSE came out with an index called SENSEX. This is a barometer of Indian stock market. It is scientifically designed and incorporates globally accepted construction and review methodology. It is a basket of 30 stocks representing a sample of large, liquid and representative companies. It is widely reported in both domestic and international markets.

6.3.2 The National Stock Exchange

The National Stock Exchange of India Limited has genesis in the report of the High Powered Study Group of Establishment of New Stock Exchanges, which recommended promotion of a National Stock Exchange by financial institutions (FIs), to provide access to investors from all across the country on an equal footing. Based on recommendations, NSE was promoted by leading financial institutions at the behest of the Government of India and was
incorporated in November 1992 as a tax-paying company unlike other stock exchange in the country.


The national stock index, S&P CNX Nifty, is a well diversified 50 stock index accounting for 24 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index based derivatives and index funds, S&P CNX Nifty is owned and managed by IISL. IISL is India’s first specialized company focused upon the index as a core product. IISL have a consulting and licensing agreement with Standard & Poor’s (S&P), who are world leaders in index services. Some of the important facts about the Nifty are

a) Stocks listed under the NSE index named as S&P CNX Nifty represent about 61% of the total market capitalization as on August 31, 2004.

b) S&P CNX Nifty is professionally maintained and is ideal for derivatives trading

An attempt has been made to abstract the information from collected data of S&P CNX Nifty index and forecast its future values by recognizing the patterns of the market.

6.4 STOCK MARKET ANALYSIS

Before the age of the computers, people traded stock and commodities primarily on intuition. As the level of investing and trading grew, people searched for tools and methods that would increase their gains while minimizing their risk. Statistics, technical analysis, fundamental analysis and linear regression are all used to attempt to predict to be consistently correct prediction and benefit from the market’s direction. None of these techniques has proven to be consistently correct prediction tool that is desired and many analysts argue about the usefulness of many of the approaches. However, these methods are presented
as they are commonly used in practice and represent a base-level standard for which neural networks should outperform. Also, many of these techniques are used to preprocess raw data inputs and their results are fed into neural networks as input. There are many types of analysis that can be performed on stock market. The main analysis that are used for stock analysis are

1) Fundamental Analysis
2) Technical Analysis
3) Statistical Analysis
4) Regression Analysis

6.4.1 Fundamental Analysis

Fundamental analysis involves the in-depth analysis of a company’s performance and profitability to determine its share price. By studying the overall economic conditions the company’s competition and other factors, it is possible to determine expected returns and intrinsic value of shares. This type of analysis assumes that a share's current (and future) price depends on its intrinsic value and anticipated return on investment. As new information is released pertaining to the company’s status, the expected return on the company’s shares will change, which affects the stock price.

The advantages of fundamental analysis are its systematic approach and its ability to predict changes before they show up on the charts. Companies are compared with one and another, and their growth prospects are related to the current economic environment. This allows the investor to become more familiar with the company. Unfortunately, it becomes harder to formalize all this knowledge for the purposes of automation (with a neural network for example) and interpretation of this knowledge may be subjective. Also, it is hard to time the market using fundamental analysis.

Although the outstanding information may warrant stock movement, the actual movement may be delayed due to unknown factors or until the rest of the market interprets the information in the same way. However, fundamental analysis is a superior method for long-term stability and growth. Basically, fundamental analysis assumes that investors are 90% logical and are examining
their investments in detail, whereas technical analysis assumes investors are 90% psychological, reacting to changes in the market environment in a predicable way.

6.4.2 Technical Analysis

The idea behind technical analysis is that share prices move in trends dictated by the constantly changing attitudes of investors in response to different forces. Using price, volume and open interest statistics the technical analyst uses charts to predict future stock movements. Technical analysis rests on the assumption that history repeats itself and that future market direction can be determined by examining past prices. Thus technical analysis is controversial and contradicts the Efficient Market Hypothesis. However, it is used by approximately 90% of the major stock traders. Despite its widespread use, technical analysis is criticized because it is highly subjective. There are a variety of technical indicators derived from chart analysis which can be formalized into trading rules or used as inputs to neural networks. Some technical indicators categories include filters indicators, wave analysis and pattern analysis. Indicators may provide short or long term information, help identify trends or cycles in the market or indicate the strength of the stock price using support and resistance levels. There are various theories given by technical analysis for the stock market analysis and prediction like Dow's theory, Chaos Theory and short term analysis etc. Some of the common technical indicators are the moving average and comparative relative strength indicators.

6.4.2.1 The Moving Average

Moving averages are used to help the trend of prices. By creating an average of prices that "moves" with the addition of new data, the price action on the security being analyzed is "smoothed". In other words, by calculating the average value of a underlying security or indicator, the effect of day to day fluctuations are reduced in importance and what remains is stronger indication of the trend of prices over the period being analyzed. The term "Moving" refers to the method of calculation which takes the average value over a fixed period of time and adds the latest period data to the calculation of the average while
dropping the first period of the calculation so that the average continues to be calculated by the same number of periods but moves with each new period of data that occurs. Thus the average “moves” along with price and changes in value as price data is generated. For example, an eighteen day moving average represents the trend in prices over a period of eighteen days. A longer fifty day moving average is smoothed more than an eighteen day moving average with each new day's data making less impact on the calculation of the moving average value than a shorter term moving average such as the eighteen day moving average. A basic approach to using moving averages is to identify which term of price trend one wishes to monitor and produce an appropriate period moving average. In this approach, while price is above the moving average is an indication of behavior in relation to the trend length being viewed. A second approach is to plot two or more moving averages and look for crossover points to help identify periods of significant change in underlying bias for the tradable security. When a shorter term moving average crosses from below longer period moving average, to above it, it is a sign of bullish bias. When a shorter term moving average crosses from above to below period moving average, it is a sign that a bearish bias is present in price trend development.

There are a number of different types of moving averages that have been developed by technical analysis in the study of trends for use with price and indicators.

1) Arithmetic Moving Average which is the sum of the closing prices over a certain number of time periods divided by the number of time periods to get an average price of the security for that period.

2) Exponential Moving Average (EMA) is calculated by adding a percentage of yesterday's moving average to a percentage of today's closing value. In this way an investor can put more emphasis on more recent data and less weight age on past data in the calculation of the moving average.

3) Other types of moving average calculations include time series moving average, triangular moving average, volume adjusted moving average
and weighted moving average. In addition to the variations in calculations, investors can also shift a moving average horizontally or vertically on a graph and base the calculation on the open, close, high, low or average price rather than the close.

The most commonly used moving average is the exponential moving average based on closing prices without an shift. The value of knowing the most commonly used moving average lies in the fact that signals may influence a larger group of investors and therefore become more significant as response unfolds in the market place.

6.4.2.2 Comparative Relative Strength

This is a comparison of the price movement of a stock with another stock or index. It allows for a development of strategies based on the relationships between movements of different underlying interests. Using critical day analysis which has had an 80% success rate at pre determining the short term pivot points for the markets, traders can then look at stocks, sectors or a broad selection of indices to help build evidence of trade opportunities and apply forethought to various market relationships that occur.

6.4.3. Multiple Linear Regressions

Multiple regressions are a mathematical technique used in both technical and fundamental analysis. The technique uses a number of variables to predict some unknown variable. If for instance it was felt that the growth rate, debt to equity ratio and the yield of a stock might be useful in predicting a valid range for a price earnings ratio, then multiple linear regression would be used by a financial analyst with a range for each input, producing a range of possible fundamentals of a stock or stocks in question. In technical analysis simple regression of terms of valuation levels and projects those acceptable levels into the future. Different time periods produce different regression result and can help identify potential price projections when the major long term trends of the market change direction. Regression studies can also help identify potential trend reversal areas. Early identification of trend reversals is one of the most important functions of good analysis. Using regression lines and channels an investor can
look for early identification of reversals in price after crossing of previously validated regression levels.

6.5 INDEX OF STOCK MARKET

The main reason of changing the mood of the market is the collective influence of various factors like economic, psychological and political factors. The stock index is a single figure that sums a number of factors, facilitating thereby measurement of the change that may have taken place in an earlier period to the present stage. As the market comprises predominately of the equity shares, an index of the equity prices becomes the only tool available to stock market analysis for studying the present position of the market and predicting the future outcome. In conclusion it can be stated that the index prices movement depends on the share prices movement of the companies listed under the index. For example the S&P CNX Nifty index movement is based on the movements of the share prices of the fifty companies listed under the index. Some of the factors which cause the change in index prices and have influence on the share prices are.

6.5.1 Demand and Supply

Stock prices change everyday as a result of market forces like share prices change because of supply and demand. If demand of a stock is greater than supply, or if more people want to purchase a stock than to sell it, then the price moves up. Conversely, if more people wanted to sell a stock than buy it, there would be greater supply than demand, and the price would fall.

6.5.2 Value

The principal theory is that the price movement of a stock indicates what investors feel a company is worth. The value of a company is its market capitalization, which is the stock price multiplied by the number of shares outstanding. For example, a company that trades at 100 rupees per share and has 1,000,000 shares outstanding has a lesser value than a company that trades at 50 rupees but has 5,000,000 shares outstanding (Rs.100x1,000,000 = Rs.100,000,000 while Rs.50x5,000,000=Rs.250,000,000). To further complicate
things, the price of a stock doesn’t only reflect a company’s current value, it also reflects the growth that investors expect in the future.

The most important factor that affects the value of a company is its earnings. Earnings are the profit a company makes, and in the long run no company can survive without them. Public companies are required to report their earnings four times a year (once each quarter). Investors have developed hundreds of variables, ratios and indicators to calculate value of the stock which also effects the index prices like Price/Earning (P/E) ratio, Dividend yields and Price/Book value (P/Bv).

6.5.2.1 Price/Earnings Ratio

This is calculated by dividing the current stock price by earnings per share from the last four quarters. It is valuation ratio of a company’s current share price compared to its per-share earnings. Mathematically

\[ \text{P/E Ratio} = \frac{\text{Current value per share}}{\text{Earning per share (EPS)}} \]

EPS is usually from the last four quarters (trailing P/E), but sometimes can be taken from the estimates of earnings expected in the next four quarters (projected or forward P/E). A third variation is the sum of the last two actual quarters and the estimates of the next two quarters. Sometimes the P/E is referred to as the “multiple”, because it shows how investors are willing to pay per Rupee of earnings.

In general, a high P/E means high projected earnings in the future. For example, a P/E ratio of twenty suggests that investors in the stock are willing to pay Rs. twenty for every Re. one of earnings that the company generates. If a company has a P/E higher than the market or industry average, this means the market is expecting big things over the next few months or years. A company with a high P/E ratio will eventually have to live up to the rating by substantially increasing its earnings or the stock price will need to drop.

The P/E ratio is much better indicator of the value of stock than the market price along. For example, all things being equal, a Rs. ten stock with a P/E of seventy five is much more “expensive than a Rs. hundred stock with a P/E
of twenty. So, one can not just compare the P/Es of two different companies to determine which is a better value.

It's difficult to determine whether a particular P/E is high or low without taking into account two main factors;

- **Company Growth Rates**: How fast has the company been growing in the past, and are these rates expected to increase or at least continue into the future? Something might be wrong if a company has only grown at 5% in the past and still has a stratospheric P/E. If projected growth rates don't justify the P/E then a stock might be overpriced. In this situation, the P/E has to be calculated using projected EPS.

- **Nature of Industry**: It is only useful to compare companies, if they are in the same industry. For example, utilities typically have low multiples because they are low growth, stable industries. In contrast, the technology industry is characterized by phenomenal growth rates and constant change.

However, this is too simplistic way of viewing the P/E because it fails to take into account the company's growth prospects. The P/E ratio actually doesn't tell a whole lot by itself. Usually it is only useful to compare the P/E ratios of companies in the same industry, or to the market in general, or against the company's own historical P/E.

### 6.5.2.2 Dividend Yield

Dividends may be in the form of cash, stock or property. Most secure and stable companies offer dividends to their stockholders. Their share prices might not move all that much, but the dividend attempts to make up for this. High growth companies don't offer dividends because all their profits are reinvested to help sustain higher than average growth.

The dividend yield states the percentage return on the dividend, calculated as annual dividends per share divided by price per share. The dividend yield plus return on capital gains equals total return.
6.5.2.3 Price/Book Value

The price to book value ratio for each company generally tends to remain more or less same over a period of time. The ratio represents the market valuation of every rupee of equity of the company. The same ratio indicates to what extent the market value of equity is protected by the assets of the company taken at their book value. A low or high ratio signifies that the protection is relatively adequate or inadequate. It can be calculated as.

\[
\text{The price/ book value} = \frac{\text{Market Price}}{\text{Book Value}}
\]

The book value per share is an important aspect of investment analysis and can be calculated as.

\[
\text{Equity Share Capital + Reserves/ Total number of Equity Share Subscribed} \text{ book value per share or the book value, indicates the amount that will be left for each equity share after the company has met all its liabilities to creditors, debenture holders and preference shareholders, Book value can also be calculated using other formulas. A high book value denotes high reserves. High reserves denote high profits and high level of retained earnings in the past.}
\]

6.5.2.4 Price/Cash Flow

The price by cash flow ratio indicates the relationship between the market price of the share and the cash flow per share. The cash flow per share is derived by the net profit plus non cash expenses by the number of shares. This ratio is a variant to P/E ratio to the extent that it takes into account the cash generated because a new business may have a lower price by cash flow ratio than that established and old business with higher P/E ratio because a new business has a larger depreciation than the old one.

6.5.3 Gross Profit Margin

It shows the proportion of sales after meeting the incidental costs and is extremely useful as an indicator of cost control and sales promotion. It should be large enough to cover depreciation and interest charges and to provide adequate income in respect to sales and shareholders equity.
Gross Profit Margin = \( \text{Gross Profit/Sales} \times 100 \)

This factor affects the investment strategy for shareholders.

6.5.4 Close

The close is the last trading price recorded when the market closes on a day. If the closing price is up or down more than 5% than the previous day’s close, the entire listing for that stock is bold faced. However, it is not guaranteed to get this price if the stock is bought on the next day because the price is constantly changing (even after the exchange is closed for the day). The close is merely an indicator of past performance and except in extreme circumstances serves as an approximate of what one should expect to pay.

6.5.5 Important Terms Related to Market

- **The Bulls** - A bull market is when everything in the economy is great, people are finding jobs, Gross Domestic Profit (GDP) is growing, and stocks are rising. Picking stocks during a bull market is easier because everything is going up. Bull markets cannot last forever though; sometimes they can lead to dangerous situations if stocks become overvalued. If a person is optimistic, believing that stocks will go up, he or she is called a “bull” and said to have a “bullish outlook”.

- **The Bears** - A bear market is when the economy is bad, recession is looming, and stock prices are falling. Bear markets make it tough for investors to pick profitable stocks. One solution to this is to make money when stock are falling using a technique called short selling. Another strategy is to wait on the sidelines until you feel that the near market is nearing its end, only starting to buy in anticipation of a bull market. If a person is pessimistic, believing that stocks are going to drop. He or she is called a “bear” and said to have a “bearish outlook”.

- **Chickens and Pigs** - Chickens are afraid to lose anything. Their fear overrides their need to make profits and so they turn only to money market securities or get out of the markets all together. Pigs are high risk investors looking for the one big score in a short period of time. Pigs buy on hot tips and invest in companies without doing their due diligence. They
get impatient, greedy and emotional about their investments and they are
drawn to high risk securities without putting in the proper time or money to
learn about these investment vehicles. Professional traders love the pigs,
as it’s often their losses that the bulls and bears reap their profits.

6.6 DEVELOPMENT OF ANN MODEL

An attempt is made to abstract the information from collected data of S&P
CNX Nifty index and forecast its future values by recognizing the patterns of the
Indian Stock Market (Nifty) using EasyNN. Optimization has been achieved by
varying parameters of the neural network such as learning rate, momentum,
number of hidden layers and the number of neurons in them. The neural network
is to be trained with weekly historical data of NSE index Nifty so that the network
is able to extract some deterministic patterns from the input data and to predict
the future trend of Nifty based on these patterns with fair amount of accuracy.

6.6.1 Methodology Used

The methodology used in the development of a financial model using neural
network comprises of following

- Decision of target and the input indicators.
- Determination of the time frame of forecasting.
- Gathering the required information and data to be used in the model.
- Getting a feel for each input’s relation to the target.
- Preprocessing of input data.
- Transforming the indicators as are appropriate to neural network.
- Scale and Bias the final target according to network’s requirements.
- Development of neural network.
- Repeat Training/ Testing/ Redesign loop for optimizing the NN topology to
  achieve minimum learning error as well as predicting the result based on
test data.

6.6.1.1 The Target and The Time Frame

The first step towards development of neural network is the decision of the
target and the time frame. There can be different objectives to be achieved like,
the prediction of the level of the index or prediction of the change in the level
rather than the absolute value. As the output has to be between the specified range of zero to one, due to use of sigmoid function, percentage change in the level of index is the target rather than absolute value of level. Since the difference between week to week is over a small range, the developer has much more variability with such type of targets.

The time frame, for which price index is to be predicted, is another important parameter. It is easy to create neural network model for longer term predictions, as a lot of random noise chaotic variation could be taken into consideration at the time of training. The final target chosen is percentage change in S&P CNX Nifty index of NSE from current week to ten weeks from now.

6.6.1.2 Selection of Inputs

Four factors are considered as the raw inputs which greatly affect the target index. These indicators are

- Price/ Earning ratio
- Price/ Book value ratio
- Dividend Yields
- The closing price of index itself.

6.6.1.3 Preprocessing

Input and output preprocessing means extracting features from the inputs and transform the target outputs in a way that makes it easier for network to extract useful information from inputs and associate it with the required outputs. Preprocessing is considered an 'art', and there are no set rules to choose it. As is the case with many neural-network applications, by preprocessing the inputs, the outputs can improve the results significantly.

6.6.1.3.1 Preprocessing of Inputs

For this work, main inputs are the previous time series values. The normalization of raw indicators and Rate of Change (ROC) values of all four indicators are used as preprocessing tools. Therefore the inputs are combination of following:

- The normalized value of P/E ratio, P/BV ratio, Dividend Fields and Close prices of the index.
- The ROC (3) values of all the four indicators.
- The ROC (6) values of all the four indicators.
- The ROC (10) values of all the four indicators.

The scaling or normalization of the input data is essential to limit the data between 0 and 1. The middle layer of neurons uses sigmoid function that squashes large inputs to either 0 or +1. This ensures that the neurons of neural network do not saturate or are overwhelmed. The normalized values are found by the equation

\[
\text{Normalized value} = \frac{\text{input} - \text{mean}}{\text{Maximum value of data set}}
\]

The data set close to 0 needs special attention. The weight change law is proportional to input values close to zero means that weight will not participate in learning. To avoid such a situation a constant value is added to ensure that the value goes near 0.5. The rate of change is calculated as

\[
\text{ROC}(n) = \frac{\text{input}(t) - \text{BA}(t-n)}{\text{input}(t) + \text{BA}(t-n)}
\]

where, input (t) is the input's current value and Block Average (BA(t-n)) is a five unit block average of adjacent values centered on n periods ago to the current value at time t.

The table 6.1 shows the process of calculating ROC(3) and ROC (6) for P/E ratio indicator. The first column contains the dates. The second column has the value of P/E indicator. The block average (BA(n)) values are given in third column. N can have any value. Here n is taken as 5. As an example average of P/E values from 1-Jan-99 to 29-Jan-99 is 12.454 and it appears in third row of third column. This row is the centre of first five rows. BA can be of any number of input units. To calculate ROC(3) for 5-Feb-99, just use the formula given above, where input(t) has value 12.43 and BA (t-3) is three weeks previous value of block, i.e., 12.454.

<table>
<thead>
<tr>
<th>Date</th>
<th>P/E</th>
<th>P/E BA(5)</th>
<th>P/E ROC(3)</th>
<th>P/E ROC(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Jan-99</td>
<td>11.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Jan-99</td>
<td>12.92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.1: ROC(3) and ROC(6) Indicators calculated from Input Indicator.

The ROC(3) for these values is -0.000964475. Similarly ROC(6) and ROC(10) are also calculated. The same methodology is used to ROC values of all other indicators.

6.6.1.3.2 Preprocessing of Target

The objective of this work is to predict the percentage change for ten weeks ahead from the current value of the closing price of S&P CNX nifty. So, it is necessary to shift time of CNX Nifty index closing price ten weeks back, and then calculate the value as percentage change as given the table below.

\[
\text{Result}=100 \times \left( \frac{\text{S&P 10 weeks ahead} - \text{S&P this week}}{\text{S&P this week}} \right)
\]

<table>
<thead>
<tr>
<th>Date</th>
<th>Close Price(A)</th>
<th>Result(t)</th>
<th>Scaled Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-Feb-99</td>
<td>941.2</td>
<td>8.409477263</td>
<td>0.714522283</td>
</tr>
<tr>
<td>5-Mar-99</td>
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<td>1041.25</td>
<td>0.547418968</td>
<td>0.543978719</td>
</tr>
</tbody>
</table>

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Table 6.2 Scaled Target

It is assumed that the value of "Result" lies between $-X$ and $+Y$. The values are required in the range of 0 to +1 as the threshold function being used is sigmoid. To meet this requirement a term equal to X is added to all values and scaled by a constant, such that the target varies only upto +1.

The scaled target = \( \frac{\text{Result} + X}{\text{Constant factor}} \)

Table 6.2 gives the scaled target with the value of x and constant factors as 24.59 and 53.295 respectively.

6.7 RESULTS

The results of this study are the predicted closing price of NIFTY (NSE stock index) that is calculated from the test samples output through the query files of EasyNN-plus. The comparison chart between the actual closing price and the forecasted closing price of the index on the test sample dates are drawn by Excel Software for different topology. The results for the optimum topology of the neural network are also in form of special files saved using EasyNN-plus. Special files contain information about the number and values of weights, values of bias, the input training patterns, and cycle by cycle learning process. While testing, EasyNN-plus requires a test file containing the test samples. It also generates a text file that contains the normalized outputs of the test samples. From the result files, the closing price of the index in the demoralized form is calculated through Excel Software.

A complete compilation of results can be found the CD-ROM attached with report. Graphical interpretations of these results are presented here with the
required explanations and conclusions. Different cases are considered one by one.

6.7.1 Learning Rate/Momentum

This dissertation uses back propagation algorithm in sequential mode of operation, so the maximum/minimum error represents the maximum/minimum value of error among all training samples after each cycle. Similarly the average error is the average of error values in each of the training samples. The network converges of the training stops when the network achieves the target error.

Network gets tripped in many Local minima before reaching the actual minima. These local minima increase the training time. Proper learning must avoid the local minima. Local minima can be seen in the graph as fluctuations in error plots. However, the Backprop parameters like learning rate and momentum have significant impact on the training time.

The small value of learning rate and momentum make the training time too large which is not desirable.

The optimum value of these parameters has to be achieved by hit and trial only as there is no specific rule for setting these values. The values may be slightly different for different topology of neural network but these values mostly depend on the type of data which is provided to the neural network for training.

Although increment in the value of learning rate/momentum is supposed to decrease the time of convergence or the number of training cycles, but this is not found to be always true after observing graphs of figure 6.1.
For the same training data, but with different topology, the optimum value of learning rate and momentum is slightly different as shown by the graph in figure 6.2. In this case two hidden layers are used with 12 and 10 nodes respectively. The optimum value of learning rate and momentum in this case are 0.6 and 0.5 respectively.

From the above discussion, it can be concluded that there is applicable impact of the value of learning rate and momentum. As the values of learning rate and momentum are increased, the size of step, which network takes toward convergence, increases. Due to this increased step size, sometimes the network keeps oscillating about the required convergence value, and sometime fails to
converge. Using small values of learning rate and momentum can make the convergence pattern of the network more uniform (lesser oscillations). But, for too small values, the network may take ages to converge. So, values for these parameters must be decided only after fair amount of trials and observations. For the given data samples of NSE stock index (NIFTY), the training time has been optimized by keeping the value of momentum equal to 0.5 and learning rate values in the range of 0.5 to 0.6.

6.7.2 Effect to Preprocessing of inputs

The effect of preprocessing, on the percentage error between actual closing price of Nifty and the predicted closing price of the same, is studied by changing the size of the Block Average (BA(n)) and the number of transformed input indicators i.e. ROC indicators. The optimum topology which provides minimum error between the actual and predicted output of closing price is calculated for different Block Average size. The effect of each Rate of Change (ROC) indicator is studied for each block average size value. For example, with Block Average of 5, various combinations of ROC(3), ROC(6) and ROC (10) are applied with the normalized values of various input indicators. The detailed results are given in the CD-ROM. The graph between the denormalised output from the best topology for the best combination and the actual closing price of the index are given in this dissertation.

The table 6.3 gives the best topology the provides minimum average percentage error between the predicted and actual closing prices for the ten test samples among the various combinations of transformed indicators applied as the inputs to neural network and for changed block average size. The table clearly indicates that ROC (3) does not contribute towards the accuracy in the predicted results for BA size of 5 and 7 but the accuracy increases by adding ROC(3) indicators as inputs to the neural network for Block Average size of 9 & 11.
<table>
<thead>
<tr>
<th>Block Average Value</th>
<th>ROC indicators used</th>
<th>Hidden Layers in Optimum Topology</th>
<th>Nodes in 1st Layer</th>
<th>Nodes in 2nd Layer</th>
<th>Average % Error for 10 test samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA(5)</td>
<td>ROC(6) &amp; ROC(10)</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>1.84394</td>
</tr>
<tr>
<td>BA(7)</td>
<td>ROC(6) &amp; ROC(10)</td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>1.34168</td>
</tr>
<tr>
<td>BA(9)</td>
<td>ROC(3), ROC(6) &amp; ROC(10)</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>1.03384</td>
</tr>
<tr>
<td>BA(11)</td>
<td>ROC(3), ROC(6) &amp; ROC(10)</td>
<td>2</td>
<td>12</td>
<td>4</td>
<td>2.26477</td>
</tr>
</tbody>
</table>

Table 6.3: Best Topology of Neural Network with Different Block Average Size

The table also indicates that the average accuracy increases as the size of the block average increases from five to seven and than seven to nine, accuracy decreases or average percentage error increases when BA size increases from nine to eleven. The large size of block average makes the input data more smooth and eliminates the effect of the fluctuations. But after a particular limit, the date can not be further improved which can be concluded from the above results. Figure 6.3 shows the graph between the denormalized outputs of best topology of neural network for different block average size.

The "original denormalized" data is the actual percentage change in closing price of NIFTY on the particular dates. Data is denormalized using inverse formula as used during preprocessing of the inputs.

Mathematically,

\[
\text{The denormalized output} = [(\text{Neural Output} \times 53.295) - (24.59)]
\]

The graph shows that the data with BA (9) shows maximum accuracy
The ten weeks ahead predicted rates of the closing price of NIFTY can be calculated using the output of test samples from the neural network. The figure 6.4 shows the graph between the actual closing price and the predicted closing price of the nifty for the ten future week samples from 10/01/03 to 07/03/03.

Figure 6.4: Comparison of Actual and Predicted Closing Price of NIFTY from Best Neural Network Topologies with Different Block Average Size.
The percentage error for each test samples for different topologies with different preprocessing is given in the graph of figure 6.5. It is observed from the graph that as the topology of neural network related to BA (9) provides output with accuracy of ninety nine percent for eight future weeks consecutive to the learning sample but the error increases for next test samples. Various topologies were created and subjected to varying number of samples. Its effect is analyzed in section 6.7.3 later.

Figure 6.5: Percentage Error Between Actual and Predicted Closing Price in Each Test Sample from Best Neural Network Topologies with Different Block Average Size

The Final graph between the actual and the most accurate predicted data from test samples are given in figure 6.6.
Figure 6.6: Comparison of Actual and Predicted Closing Price of NIFTY from the Best Neural Network Topologies with Block Size 9 (BA(9))

These are the output of test samples applied to the network with BA(9) having ROC(3), ROC(6) & ROC(10).

Figure 6.7 shows the reprocessed output from a trained neural network when complete set of the preprocessed data (Learning data and Training data set) is applied to the neural network for query.

The graph shows the variations in original closing price, predicted closing price achieved using the training data and the predicted closing price achieved using the test data. The first two are plotted for fifteen specific date. The prediction using test data is only for one week. The results are favorable.
6.7.2 Effect of Increase in the Training Samples

Up to this point, only the outputs from the ten future weeks test samples are studied which are adjacent to the training data sample set. In this section, the outputs from that test samples are studied that are not close to the training set samples. For example the graph in figure 6.8 shows the output of 7 test samples from 10th January, 2003 to 16th May, 2003. This network is trained by the weekly samples from 8th April, 1999 to 25th October, 2003. The Graph shows very good accuracy for first eight weeks sample and high errors for the next samples.
6.8 CONCLUSION

There were three objectives of the attempt.

The first objective was to optimize the neural network model with respect to its various parameters like momentum, learning rate, number of hidden layers, and number of nodes in the hidden layers etc. to achieve least error in the learning data as well as test data.

To find the best ANN model for a particular problem is always a very difficult task. There is no theoretical or empirical formula to model a network as an optimum one. This task must be performed by trial and observation technique as is done here. After doing fair amount of training and testing through the networks discussed in section 6.7., the search for an optimum ANN model for prediction of Indian National Stock Exchange Index S&P CNX NIFTY concludes as follows.

From result shown in section 7, some very efficient networks are found. The factors to judge the efficiency of a network are accuracy in the test sample prediction outputs.
From the discussion, it is concluded that for the prediction of NSE stock index S & P CNX NIFTY, the optimum topology of the neural network contains following specifications:

1. Number of Hidden Layer 2
2. No. of nodes in first Hidden Layer 10
3. No., of nodes in second Hidden Layer 4
4. Number of input nodes 16
5. Number of output nodes 1
6. Learning Rate 0.6
7. Momentum value 0.6
8. Training Error for Training 0.03
9. Input Indicators:
   i. Normalized value of P/E ratio
   ii. Normalized value of P/BV ratio
   iii. Normalized value of Dividend Yield
   iv. Normalized value of Close price of NIFTY
   v. ROC(3) indicator of P/E ratio
   vi. ROC(3) indicator of P/BV ratio
   vii. ROC(3) indicator of Dividend Yield
   viii. Rock(3) indicator of Close price of NIFTY
   ix. ROC(6) indicator of P/E ratio
   x. ROC(6) indicator of P/BV ratio
   xi. ROC(6) indicator of Dividend Yield
   xii. Rock(6) indicator of Close price of NIFTY
   xiii. ROC(10) indicator of P/E ratio
   xiv. ROC(10) indicator of P/BV ratio
   xv. ROC(10) indicator of Dividend Yield
   xvi. Rock(10) indicator of Close price of NIFTY
10. Output indicator
Normalized value of ten weeks ahead percentage change in the closing price of NIFTY.

The second objective was to find out the neural network's ability and accuracy to predict the Indian market. Based on results, it is concluded that neural network is able to predict the Indian stock market with good accuracy despite its highly random nature. The optimum network with above features provides average accuracy of about ninety nine percent for the nine future weeks test samples, which is a good accuracy of prediction and is better than reported.

The third objective was to predict stock market of India with the neural network approach, which is achieved. This has become possible due to the fact that the optimized neural network has been able to abstract the information from the data used for its training/learning. It is also able to recognize the patterns of variation. It is therefore able to predict the future value of index. The accuracy achieved is very high.