

SMART INVESTING DECISION MAKING

A PROJECT REPORT

Submitted by

RAMANATHAN R

312315205125

RANJITH KUMAR S

312315205130

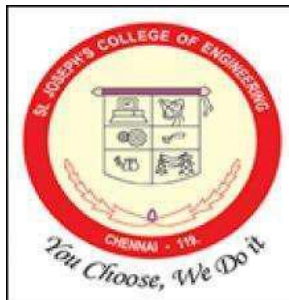
in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

in

INFORMATION TECHNOLOGY



St.JOSEPH'S COLLEGE OF ENGINEERING, CHENNAI 600119

ANNA UNIVERSITY: CHENNAI 600 025 APRIL 2018

ANNA UNIVERSITY: CHENNAI 600 025



BONAFIDE CERTIFICATE

Certified that this project report “**Smart Investing Decision Making using ANN, Machine Learning, Indicators and Oscillators**” is the bonafide work of **RAMANATHAN R (312315205125)** and **RANJITH KUMAR S (31235205130)** who carried out the project work under my supervision, for the partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Information Technology.

SIGNATURE

Dr. V.Muthulakshmi M.E., Ph.D.,
Professor

HEAD OF THE DEPARTMENT

(LAB AFFAIRS)

Department of Information Technology
St.Joseph's College of Engineering
Old Mamallapuram Road
Chennai-600119

SIGNATURE

Mr.Duraimurugan
Associate Professor

SUPERVISOR

Department of Information Technology
St.Joseph's College of Engineering
Old Mamallapuram Road
Chennai-600119

Submitted for the Viva -Voce held on _____

(INTERNAL EXAMINER)

(EXTERNAL EXAMINER)

CERTIFICATE OF EVALUATION

College Name : St.Joseph's College of Engineering

Branch & Semester : Information Technology (VIII)

S.NO	NAME OF THE STUDENTS	TITLE OF THE PROJECT	NAME OF THE SUPERVISOR WITH DESIGNATION
1.	RAMANATHAN R (312315205125)	Smart Investing Decision Making using ANN, Machine Learning	Mr.Duraimurugan
2.	RANJITH KUMAR S (312315205130)		

The report of the project work submitted by the above students in partial fulfillment for the award of Bachelor of Technology degree in Information Technology of Anna University were evaluated and confirmed to be reports of the work done by the above students.

(INTERNAL EXAMINER)

(EXTERNAL EXAMINER)

ACKNOWLEDGEMENT

The contentment and elation that accompany the successful completion of any work be incomplete without mentioning the people who made it possible.

We express our gratitude in thanking our Chairman **Dr. B.Babu Manoharan M.A., M.B.A., Ph.D.**, our respected Managing Director Madam **Mrs. B.Jessie Priya M.Com.**, our Director Sir **Mr.B.Shashi Sekar M.Sc.**, our respected Principal **Dr.Vaddi Seshagiri Rao M.E., M.B.A., Ph.D** for having encouraged us to do our under graduation in Information Technology in this esteemed college.

We express our sincere thanks and most heartfelt sense of gratitude to our eminent Head of the Department(Lab Affairs) **Dr. V.Muthulakshmi M.E., Ph.D.**, for having extended her helping hand at all times.

It is with deep sense of gratitude that we acknowledge our indebtedness to our supervisor **Mr.Duraimurugan** a perfectionist for his expert guidance and connoisseur suggestion.

Last but not the least, we thank our family members and friends who have been the greatest source of support to us.

Table of Contents

ABSTRACT	1
LIST OF ABBREVIATIONS	2
LIST OF EQUATIONS	2
CHAPTER 1:Introduction	3
1.1 About	3
CHAPTER 2: Literature Survey	4
CHAPTER 3: Existing Method	11
CHAPTER 4: Proposed Method	13
4.1 Data Collection	13
4.2 Implementation of Indicators and Oscillators	13
4.2.1 SMA	13
4.2.2 EMA	14
4.2.3 MACD	14
4.2.4 RSI	15
4.2.5 Bollinger Band	15
4.2.6 Statistical Regression	16
4.3 Determining Buy/Sell Signals	16
4.4 Predicting Stock Price	17
4.5 Flow Chart	18
CHAPTER 5: Conclusion and Future Work	19
5.1 Conclusion	19
References	20

ABSTRACT

Stock Market is the aggregation of buyers and sellers of stocks which represents shares in a company. A stock exchange is a place where individuals and organizations can trade stocks. This is a great area of interest of traders as one can generate profit by buying and selling stocks at right time. Determining right price and right time for trading stock is a challenging problem for traders. Techniques like fundamental analysis, technical analysis, predicting stock prices have been used and they are effective then randomly buying or selling. This project deals with providing a smart decision for buying and selling signals on the basis of technical indicators and oscillators. It also tries to predict the next day stock price.

LIST OF ABBREVIATIONS

MA	Moving Average
LS-SVM	Least Square Support Vector Machine
RBF	Radial Basis Function
NSE	National Stock Exchange
SMA	Simple Moving Average
EMA	Exponential Moving Average
MACD	Moving Average Convergence Divergence
RSI	Relative Strength Index
VWMA	Volume Weighted Moving Average
MLP	Multi-Layer Perceptron

LIST OF EQUATIONS

EQUATION 1.1	13
EQUATION 1.2	14
EQUATION 1.3	14
EQUATION 1.4	14
EQUATION 1.5	15
EQUATION 1.6	15
EQUATION 1.7	16
EQUATION 1.8	16
EQUATION 1.9	16
EQUATION 2.0	16
EQUATION 2.1	16

CHAPTER-1

INTRODUCTION

1.1 About

Stock Market is the aggregation of buyers and sellers who buys and sell stock. A stock represent share in a company but that does not mean that you own the power to influence decision of the top management and leaders in a company. A Stock Exchange is a place where trading of stocks take place. Investors buy stocks for making profits and companies sell stocks to raise funds for finance of the company. Investors buy stock at a price and then sell it for a higher price and make profit.

Smart Investors look for trends, fundamental data, finance of company, history of the company, technical charts etc. and then decide whether to invest or not. Trading strategies are divided into two categories (i) fundamental analysis (ii) technical analysis.

Fundamental analysis is the study of financial statements and determining the true value of the stock and then taking decision.

Technical analysis is the study of charts and then determining the trend based on past stock data and then making a decision. It deals with looking for patterns.

There are 3 principles in technical analysis:

- Technical analysis believes that it is important to understand what investors think of stock and what they know and what they perceive.
- Stock Prices follow trends.
- History repeats itself.

Various technical tools like SMA, EMA, RSI, MACD, Bollinger Bands etc. have been in use for a long time. They are used by technical analysts. This project has also made an attempt of making a smart decision based on indicators, oscillators. An attempt to predict stock price has also made. Statistical Regression is used for determining relationship between index and stock price.

CHAPTER-2

LITERATURE SURVEY

1) AUTHOR :Abidatul Izzah,Yuita Arum Sari,Ratna Widyastuti,Toga Aldila

TITLE :Moblie app for stock prediction using Improved Multiple Linear Regression

ALGORITHM USED : Improved Multiple Linear Regression

OBJECTIVE :

The Improved Multiple Linear Regression (IMLR) was built into a mobile application based android platform for stock price prediction. IMLR is a hybrid Multiple Linear Regression with Moving Average technique. The app was built in several steps, which are requirement analysis, system design, implementation, and testing. Data were collected from the finance.yahoo.com page with category "Jakarta Composite Index (^A JKSE)" which were automatically taken by using Yahoo Finance API. In the app, users not only could see daily stock history but also stock price predictions in real time. The mobile app accuracy prediction gave the better result than the common algorithm with the value are 15087.465 in MSE, 122.831 in RMSE, and 3.255 in MAPE.

2) AUTHOR :Abhinandan Gupta,Dev Kumar Chaudhary,Tanupriya Choudhury

TITLE :Stock Prediction Using Functional Link Artificial Neural Network

ALGORITHM USED :Functional Link Artificial Neural Networks

OBJECTIVE:

Neural Networks once again have become famous for prediction of stock. This was due to their ability to deal with non-linear data. The use of Artificial Neural Networks to for predicting the stock prices was proposed in this paper. The input features to the model sometimes can be

non-related to the output. Hence, Functional Link Artificial Neural Networks was used here to increase the number of related features in the form of inputs. The data was taken from NSE and was converted into a suitable form for FLANN and then prediction was carried out using Multi-layer feed forward Perceptron model.

3) AUTHOR :Short and long term stock prediction using decision tree

TITLE :Rupesh A.Kamble

ALGORITHM USED : Decision tree

OBJECTIVE :

This paper presented the results of method designed to predict

Price trends in the stock market. First objective of this research was to optimize the stock price trend prediction for short term using some oscillators and indicators: Moving Average Convergence Divergence (MACD), the Relative Strength Index (RSI), the Stochastic Oscillator (KDJ) and Bollinger Band (BB). It was observed that using appropriate pre-processing technique and Machine learning model, it was possible to improve accuracy rate of short-term trend prediction. Applying Preprocessing and then using combination of data yielded a better Accuracy rate in Short term Trades, while predicting for Long-term Trend of Stock this Technical indicators were not sufficient. Along with some of those Technical data and Fundamental Data of the company, it was possible to predict Long term stock movement. For Long term Prediction its Debt to Equity, Net profit of previous 3 year, Promoters holding, Dividend yield and PE ratio was used along with Technical Factors. It was observed that using Fundamental and Technical Data, Long term Stock Prediction was Possible

4) AUTHOR:R.S.T.Lee

TITLE :iJADE stock advisor:an intelligent agent based stock prediction system using hybrid RBF recurrent network

ALGORITHM USED :Hybrid RBF Recurrent Network

OBJECTIVE :

In this paper, the author introduced the iJADE Stock Advisor-an intelligent agent-based stock prediction system using our proposed hybrid radial basis-function recurrent network (HRBFN). By using ten-year stock pricing information (1990-1999), consisting of 33 major Hong Kong stocks for testing, the iJADE Stock Advisor has achieved promising results in terms of efficiency, accuracy, and mobility as compared with other contemporary stock prediction models. Also, various analyzes on this stock advisory system have been performed: including round trip time (RTT) analysis, window-size evaluation test (for both long-term trend and short-term prediction), and stock prediction performance test.

5) AUTHOR :Mingying Wei

TITLE :Shuhong Zhang

ALGORITHM USED :Doble-layer Network

OBJECTIVE: :

In this paper, based on the international investment and trade data of 155 countries from 2007 to 2010, a double-layer network was constructed to analyze the economic crisis's influence that how countries' economic situation evolves over time and affects each other. First, an improved epidemic model was developed on the double-layer network, where each country possesses three candidate states including susceptible, contagious and influenced. Second, DebtRank of each layer was calculated to quantify the propagation of financial distress and crisis, which shows that DebtRank was basically consistent with the

GDP of countries, and countries with small DebtRank are more vulnerable in trade network, while countries with big DebtRank are more vulnerable in investment network.

6) AUTHOR :Xi Chen,Zhi-Jie He

TITLE :Prediction of Stock Trading Signal Based on Support Vector Machine

ALGORITHM USED : Support Vector Machine

OBJECTIVE :

The prediction of stock trading signal was done in this paper.

Considering the excellent performance of Support Vector Machine (SVM) in pattern recognition, we apply SVM to construct a prediction model to find the stock trading signal. In addition, Piecewise linear representation (PLR) was good at extracting valuable information from a time sequence. PLR was used for checking of turning points in this study. The experiments on some real stocks show that SVM obtains a better result in prediction accuracy and profitability than traditional Back Propagation neural network does.

7) AUTHOR :Si-Shu Luo, Yang Weng, Wei Wei Wang, Wei Xing Hong

TITLE : L1- regularised logistic regression for event-driven stock market prediction

ALGORITHM USED :Logistics Regression

OBJECTIVE :

This paper presented a machine learning method for event-driven stock prediction, using L1 regularized Logistic regression model. It studied the

stock price movement after listed companies make announcements. The model used specific events extracted from these announcements and combine with financial indicators of listed companies, macro indicators, and technical indicators as dependent variables. The listed companies were divided into sample sets based on market value size and industry. Experiments show that this model can be a good predictor of stock within one week after events occur. In addition, compared with commonly used machine learning methods, our model has a better overall ability.

8) AUTHOR :David M.Q.Nelson,Adriana C.M.Pereira,Renato A deOliveira

TITLE :Stock market's movement prediction with LSTM neural networks.

ALGORITHM USED :LSTM

OBJECTIVE :

This article studied the usage of LSTM networks on that scenario, to predict future trends of stock prices based on the price history, alongside with technical analysis indicators. For that goal, a prediction model was built, and a series of experiments were executed and theirs results analyzed against a number of metrics to assess if this type of algorithm presents and improvements when compared to other Machine Learning methods and investment strategies. The results that were obtained were promising, getting up to an average of 55.9% of accuracy when predicting if the price of a particular stock is going to go up or not in the near future.

9) AUTHOR :Elena Bautu,Sun Kim,Andrei Bautu

TITLE :Evolving hypernetwork models of binary time series for forecasting price movements on stock markets.

ALGORITHM USED : Hypernetwork-based method

OBJECTIVE :

The paper proposed a hypernetwork-based method for stock market prediction through a binary time series problem. Hypernetworks were a random hypergraph structure of higher-order probabilistic relations of data. The problem they tackled concerned the prediction of price movements (up/down) on stock markets. Compared to previous approaches, the proposed method discovers a large population of variable subpatterns, i.e. local and global patterns, using a novel evolutionary hypernetwork. An output was obtained from combining these patterns. In the paper, they described two methods for assessing the prediction quality of the hypernetwork approach. Applied to the Dow Jones Industrial Average Index and the Korea Composite Stock Price Index data, the experimental results show that the proposed method effectively learns and predicts the time series information. In particular, the hypernetwork approach outperformed other machine learning methods such as support vector machines, naive Bayes, multilayer perceptrons, and k-nearest neighbors

10) AUTHOR :Haoming Huang,Michel Pasquier,Chai Quek

TITLE :Financial Market Trading System With a Hierarchical Coevolutionary Fuzzy Predictive Model

ALGORITHM USED :Fuzzy Predictive Model

OBJECTIVE :

This paper demonstrated the application of a hierarchical coevolutionary fuzzy system called HiCEFS for predicting financial time series. A novel financial trading system using HiCEFS as a predictive model and employing a prudent trading strategy based on the price percentage oscillator (PPO) was proposed. In order to construct an accurate predictive model, a form of generic membership function named irregular shaped membership function (ISMF) was employed and a hierarchical coevolutionary genetic algorithm (HCGA) is adopted to automatically derive the ISMFs for each input feature in HiCEFS. With the accurate prediction from HiCEFS and the prudent trading strategy, the proposed system outperforms the simple buy-and-hold strategy, the trading system without prediction and the trading system with other predictive models (EFuNN, DENFIS and RSPOP) on real-world financial data.

Michel Pasquier

CHAPTER-3

EXISTING METHODOLOGY

The fundamental analysis involves the in-depth analysis of a company's performance and the profitability to measure its intrinsic value by studying the company physically in terms of its product sales, manpower quality, infrastructure, profitability on investment. It uses revenues, earnings, future growth, return on equity, profit margins, and other data to determine a company's underlying value and potential for future growth. To a fundamentalist, the market price of a stock tends to move towards its "real value" or "intrinsic value". If this value of a stock is above the current market price, the investor can decide to purchase the stock because the stock price will be bound to rise and move towards its "intrinsic or real value". If this value of a stock is below the market price, the investor may decide to sell the stock because the stock price is bound to fall and come closer to its intrinsic value. To start finding out the intrinsic value, the fundamentalist analyzer makes an examination of the current and future overall health of the economy as a whole.

Technical analysis is a method of evaluating stocks by analyzing statistics generated by market activity, past prices, and volume. It looks for peaks, bottoms, trends, patterns, and other factors affecting a stock's price movement. Future values of stock prices often depend on their past values and the past values of other correlated variables. Technical analysis looks for patterns and indicators on stock charts that will determine a stock's future performance. 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. Different individuals can interpret charts in different manners. Recently, neural networks have been successfully applied in time-series problems to improve multivariate prediction ability. Neural networks

have good generalization capabilities by mapping input values and output values of given patterns. Neural networks are usually robust against noisy or missing data, all of which are highly desirable properties in time series prediction problems. Various neural network models have already been developed for the stock market analysis.

DISADVANTAGE

- It becomes harder to formalize all this knowledge for purposes of automation (with a neural network for example), and interpretation of this knowledge may be subjective.
- It is hard to time the market using fundamental analysis.
- Despite its widespread use, technical analysis is criticized because it is highly subjective.
- Different individuals can interpret charts in different manners.

CHAPTER-4

PROPOSED METHODOLOGY

4.1 Data Collection:

Quandl API is used to fetch the stock quote of any company under NSE. Stock Quote consist of Close Price, High, Low, Volume, Open etc. as a data-frame. A data-frame is a labelled two dimensionnal data structure that stores data of different types in different columns. A data-frame consists of columns and a single column represent a series.

Series of Close price is extracted and is used as data source for every indicator, oscillator and neural network. Date is the index of the series and is also used as data for indicators and oscillators. This series represents the past closing prices of a company under NSE.

4.2 Implementation of Indicators and Oscillators:

The following are implemented:

- SMA
- EMA
- MACD
- RSI
- Bollinger Band
- Statistical Regression(Not an indicator/Oscillator)

4.2.1 SMA (Simple Moving Average):

It is a type of moving average in which mean is calculated over the price of n-periods. Using it, we get a series of averages of different subsets of full dataset.

$$SMA = (p_m + p_{m-1} + p_{m-2} + + p_{m-(n-1)})/n \quad 1.1$$

n = 20 but it can have any value.

Where numerator is the summation of previous n-periods prices and n is the length of period.

If the data used are not centered around the mean, a simple moving average lags behind the latest datum point by half the sample width. An SMA can also be disproportionately influenced by old datum points dropping out or new data coming in. One characteristic of the SMA is that if the data have a periodic fluctuation, then applying an SMA of that period will eliminate that variation. But a perfectly regular cycle is rarely encountered.

4.2.2 EMA (Exponential Moving Average):

EMA or EWMA is a type of moving average that is similar to a simple moving average, except that more weight is given to the latest data. It's also known as the exponentially weighted moving average. This type of moving average reacts faster to recent price changes than a simple moving average.

Calculating EMA is a 3 step process:

- Calculate the SMA
- Calculate the multiplier
- Calculate the current EMA

$$\text{Multiplier} = 2 / (n+1), \quad 1.2$$

$$\text{EMA} = (\text{Closing Price} - \text{EMA (previous day)}) * \text{multiplier} + \text{EMA (previous day)} \quad 1.3$$

4.2.3 MACD (Moving Average Convergence Divergence)

Moving average convergence divergence (MACD) is a trend-following momentum indicator that shows the relationship between two moving averages of prices. The MACD is calculated by subtracting the 26-day EMA from the 12-day EMA. A nine-day EMA of the MACD, called the "signal line", is then plotted on top of the MACD, functioning as a trigger for buy and sell signals.

$$\text{MACD} = ((12\text{-day EMA}) - (26\text{-day EMA})) \quad 1.4$$

4.2.4 RSI (Relative Strength Index)

The relative strength index (RSI) is a momentum indicator developed by noted technical analyst Welles Wilder , that compares the magnitude of recent gains and losses over a specified time period to measure speed and change of price movements of a security. It is primarily used to attempt to identify overbought or oversold conditions in the trading of an asset.

$$RSI = 100 - 100 / (1 + RS) \quad 1.5$$

Where RS = Average gain of up periods during the specified time frame / Average loss of down periods during the specified time frame

RSI values range from 0 to 100. The default time frame for comparing up periods to down periods is 14, as in 14 trading days. Traditional interpretation and usage of the RSI is that RSI values of 70 or above indicate that a security is becoming overbought or overvalued, and therefore may be primed for a trend reversal or corrective pullback in price.

On the other side of RSI values, an RSI reading of 30 or below is commonly interpreted as indicating an oversold or undervalued condition that may signal a trend change or corrective price reversal to the upside.

4.2.5 Bollinger Band

A Bollinger Band, developed by famous technical trader John Bollinger, is plotted two standard deviations away from a simple moving average. Many traders believe the closer the prices move to the upper band, the more overbought the market, and the closer the prices move to the lower band, the more oversold the market. John Bollinger has a set of 22 rules to follow when using the bands as a trading system.

$$\text{Upper-Band} = \text{SMA-20} + 2 * \text{standard deviation of 20 day closing} \quad 1.6$$

$$\text{Lower-Band} = \text{SMA-20} + 2 * \text{standard deviation of 20 day closing} \quad 1.7$$

$$\%B = ((\text{price} - \text{lower band}) / (\text{upper band} - \text{lower band})) * 100 \quad 1.8$$

%B quantifies a security's price relative to the upper and lower Bollinger Band.

There are six basic relationship levels:

- %B equals 1 when price is at the upper band
- %B equals 0 when price is at the lower band
- %B is above 1 when price is above the upper band
- %B is below 0 when price is below the lower band

4.2.6 Statistical Regression

It is a way of determining a relation between variables. There are 2 independent variables here.

(i) Index

(ii) Stock Price

$$y = mx + c \rightarrow \text{trend line equation} \quad 1.9$$

where y = closing price , x = nth number, m =slope

$$m = (\text{sum}(x*y) - \text{sum}(y)*\text{sum}(x)) / \text{sum}((x - \text{mean}(x))^2) \quad 2.0$$

$$c = y - mx \quad 2.1$$

4.3 Determining Buy/Sell Signals:

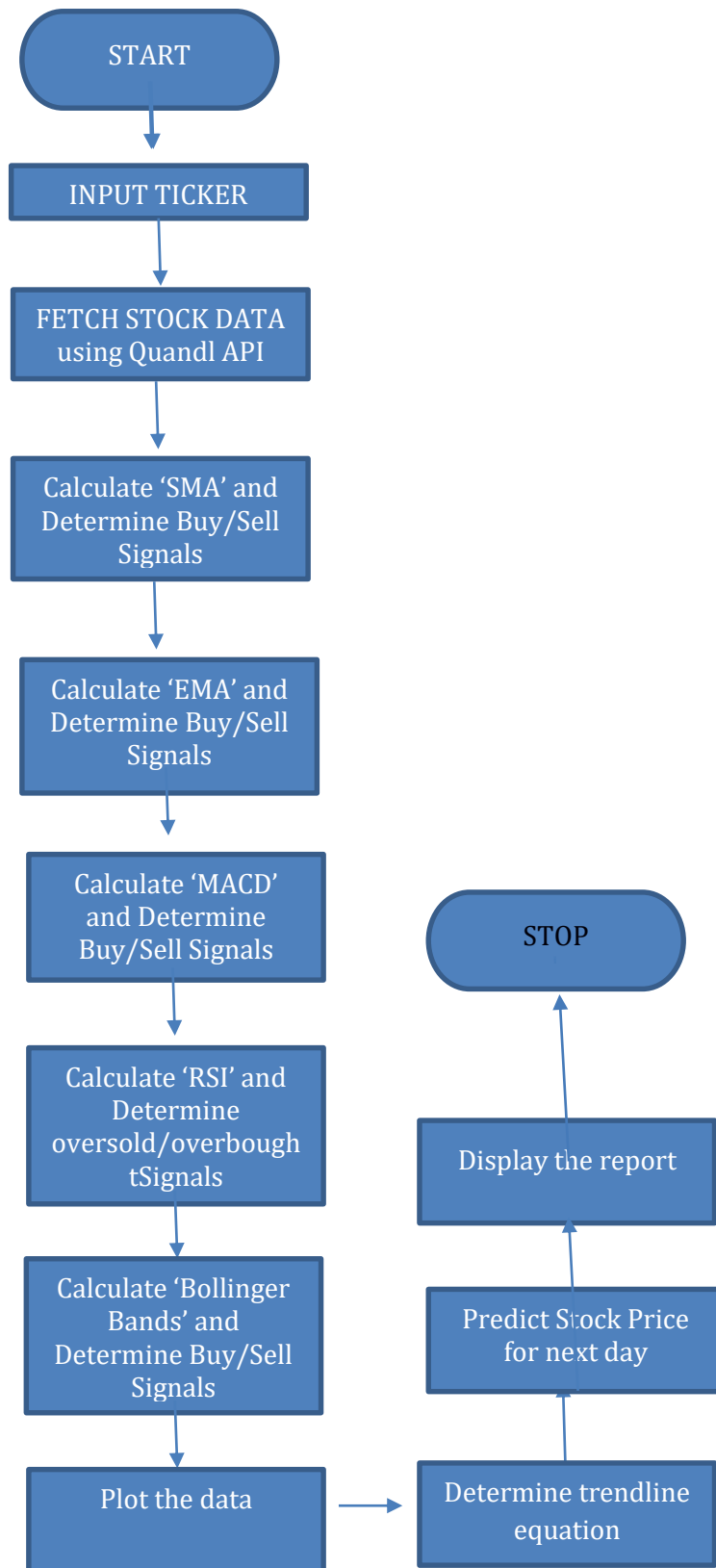
- If previous SMA is lower than the previous Close Price and current SMA is greater than current Close Price then Buy Signal is generated.
- If previous SMA is greater than the previous Close Price and current SMA is lower than current Close Price then Sell Signal is generated.
- If previous EMA-20 is lower than the previous EMA-50 and current EMA-20 is greater than current EMA-50 then Buy Signal is generated.

- If previous EMA-20 is greater than the previous EMA-50 and current EMA-20 is lower than current EMA-50 then Sell Signal is generated.
- If previous MACD value is less than previous EMA-9 and current MACD value is greater than current EMA9 then Buy Signal is generated.
- If previous MACD value is greater than previous EMA-9 and current MACD value is lower than current EMA-9 then Sell Signal is generated.
- If $[\text{Close Price} - \text{lower band}] < [\text{Upper Band} - \text{Close Price}]$ and both the differences are greater than 0 then buy Signal is generated
- If $[\text{Upper band} - \text{Close Price}] < [\text{Close Price} - \text{Lower Band}]$ and both the differences are greater than 0 then Sell signal is generated

4.4 Predicting Stock Price:

- RBF Neural Network is used for predicting stock price for the next day.
- Previous 30 day stock price is used as training data.
- For ex., for index n , output is X . where n can be anything between 1 – 30
- For index 31^{st} , stock price is predicted which is the next day stock price
- Sklearn Library is used for implementing RBFNN

4.5 Flow Chart:



CHAPTER-5

CONCLUSION & FUTURE WORK

5.1 Conclusion

- Technical Analysis of stock market is a method of evaluating securities by analyzing statistics generated by market activity. Chartist uses these data to determine whether they are going to invest in that stock. They look for the buy and sell signals. This project has also performed technical analysis over stock prices by using some of the mostly used indicators and oscillators. We have also tried to predict stock price for the next day.
- Stock price is influenced by many factors including –internal information, news, speeches of ministers etc. So this does not give accurate results all the time. But it is better than blindly investing.
- Hence, it can be concluded that a smart investing decision can be made if one uses technical indicators and oscillators and other sorts of information like news etc. before making an investment.

REFERENCES

1. Appel, Gerald (2005). *Technical Analysis Power Tools for Active Investors*. Financial Times Prentice Hall. p. 166. ISBN 0-13-147902-4.
2. J. Welles Wilder, *New Concepts in Technical Trading Systems*, ISBN 0-89459-027-8
3. Bollinger, John. *Bollinger on Bollinger Bands*. McGraw Hill, 2002. ISBN 978-0-07-137368-5
4. NIST/SEMATECH e-Handbook of Statistical Methods: Single Exponential Smoothing at the National Institute of Standards and Technology
5. Jelena Stankovic, Ivana Markovic , Milos Stojanovic ,”Investment Strategy Optimization Using Technical Analysis and Predictive Modeling in Emerging Markets”, The Economies of Balkan and Eastern Europe Countries in the changed world, EBEEC 2014 ,Nis, Serbia
6. Mayankkumar B Patel, Sunil R Yalamalle, “Stock Price Prediction Using Artificial Neural Network”, *International Journal of Innovative Research in Science, Engineering and Technology* 2014, (volume :3), 6-June-2014
7. Gang LI, Jin Zhu, ”Research on Effectiveness of Technical Indicators with the Volume”, *International Conference on Education, Management and Computing Technology(ICEMCT 2014)*
8. Darmadi Komo, Chein-I Chang, Hanseok KO , “Neural Network Technology for Stock Market Index Prediction”, *International Symposium on Speech, Image Processing and Neural Networks*, 13-16 April 1994