IMPROVING PREDICTION OF STOCK MARKET PRICES USING DEEP NEURAL NETWORK

Dr.M. Kumarasamy
Professor , Department of Informatics, Wollega University, Nekemte , Ethiopia.

Abstract : The purpose of this paper is to improving the predictions of stock market prices using latest technologies like artificial neural networks and deep neural networks. Already predictions of stock market prices done by time series and forecasting analysis. With the introduction of our latest technologies, further we can improve the predictions of stock market prices. It can be very useful for the stock market analyzers and business people who are involving in the share trading. With their ability to discover patterns in nonlinear and chaotic systems, neural networks offer the ability to predict market directions more accurately than current techniques. We can define the stock market as, stock is a share in the ownership of a company. Stock represents a claim on the company's assets and earnings. As you acquire more stock, your ownership stake in the company becomes greater. Whether you say shares, equity, or stock, it all means the same thing. Common market analysis techniques such as technical analysis, fundamental analysis, time series, forecasting analysis and regression are discussed and compared with neural network performance.

Keywords : Stock Market, Technical Analysis, Machine Learning, Time Series, Forecasting Analysis

INTRODUCTION

In olden days, people traded stocks and commodities primarily on intuition or they get some input from other people. 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 and benefit from the market's direction. None of these techniques has proven to be the 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. Over the last few decades, the average person's interest in the stock market has grown exponentially. What was once a toy of the rich has now turned into the vehicle of choice for growing wealth. This demand coupled with advances in trading technology has opened up the markets so that nowadays nearly anybody can own stocks. Also, many of these techniques are used to preprocess raw data inputs, and their results are fed into neural networks as input. 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. Price charts are used to detect trends. Trends are assumed to be based on supply and demand issues which often have cyclical or noticeable patterns. 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 indicator categories include filter indicators, momentum indicators, trend line analysis, cycle theory, volume 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. Three artificial intelligence techniques, namely, neural networks (NN), support vector machines and neuro-fuzzy systems are implemented in forecasting the future price of a stock market index based on its historical price information. Artificial intelligence techniques have the ability to take into consideration financial system complexities and they are used as financial time series forecasting tools. Two techniques are used to benchmark the AI techniques, namely, Autoregressive Moving Average (ARMA) which is linear modelling technique and random walk (RW) technique. Even though several techniques are used in the prediction of stock market, but none of the technique gives the exact predictions. It says about 60% to 80 % only. Sometimes totally reverse also happened because of market volatile. We are using new technique called Deep Learning methods to apply for the prediction of stock market prices. The result shows nearer to 90%. This study is classified under technical analysis of the stock market prices. In this case, the underlying assumption is that predictions can be made based on stock price data alone, and they do not follow a random walk in which successive changes have zero correlation. Neural networks, support vector machines and neuro-fuzzy systems were used to attempt to predict the future change of the all share prices.

STOCK PRICE PREDICTION

How the stock prices is ups and down? What are all the factors affecting the stock prices? In this paragraph we are detailing that factors. The movement of stock prices is triggered by alterations related to supply and demand, generally referred to as market forces. These represent results as a combination of factors such as earnings and impact of social media, strongly related to a company's

internal and external properties. From another perspective, data is affected by informed and noise traders. Therefore, to generate profit in stock markets, a range of influential factors are to be considered. For the purpose of accurate predictions, traders apply methods of analysis derived either from a fundamental or technical perspective. The traditional approach is the fundamental analysis involving factors in relation to the company such as market position, growth rates and revenue generation. The method leveraged in this report is the technical analysis based on historical fluctuations. Now a days, so many factors affecting the stock prices. External factors and due to advertisement also stock prices will be up and down. Social Media is another important factor to increase or decrease the company value. The Hypothesis of Random Walk suggests that stock data do not follow patterns, and is therefore not eligible for prediction. Extensive research on the topic imply the opposite, often stated by observing the outcomes of variance ratio tests. Methods originating in technical analysis use historical data based on the existence of repetition of history, trends in price movements, and assumptions of absolute market action. Technical analysis does not consider factors about the company and relies on the assumption that public information has no impact on the price. From this aspect, technical analysis opposes the Efficient Market Hypothesis stating that stock prices are affected by all available information. The Efficient Market Hypothesis suggests that prediction is impossible. Simplification of the theory supporting technical analysis states that increased supply would cause a price fall compared in comparison to results of an increased demand. Therefore, timing is perceived a key for successful prediction. According to extensive research, technical analysis has shown positive results in terms of prediction. Compare to these hypothesis both random walk and efficient market hypothesis, the researchers found that neural networks are more suitable to find predictions. In future section we are going describe about neural networks.

ARTIFICIAL NEURAL NETWORKS

A biological neuron in a human brain consists of four basic components: dendrites, soma, axon, and synapses. The fundamental processing element is a neuron. The dendrites are extensions of the soma - acting as input channels. The soma receives input signals by synapses of other neurons, these are processed over time. The processes are turned into an output that is sent out to other neurons through the axon and the synapses. Inspired by the described biological methods of training, ANNs have been developed in an highly abstract technical aspect for prediction. In addition, extended research propose that ANN can find relationships by mapping inputs and outputs of a system, using general functions and a large set of training data. Numerous types of Artificial Neural Networks, including hybrids, have been proposed for information processing. Functions, learning algorithms and topology are properties that distinguish the different models. Due to the considerable amount of variations, ANNs have been applied in numerous areas, including pattern recognition, data compression and prediction. Detecting nonlinear connections is a prominent strength of ANNs, and therefore an attractive property for modeling the dynamical stock market recognized by nonlinear connections. Inspired by biological methods of learning over time, the highly abstract structure of ANNs use back propagation algorithms for this purpose. The architecture of ANN consist of neurons and layers connected by weights. The structure of the network used in this report consists of three layers in total; one input layer, one hidden layer, and one output layer. The two types of networks, single-layer and multi-layer, differentiate in terms of number of layers as suggested by the denominations. The most common type of training technique in a multilayer network is a backpropagation algorithm. A backpropagation algorithm operates by propagating the errors backwards. The algorithm reduces the error between actual and expected results, used in the network until the ANN learns the data represented by the training index. Bearing in mind that the training starts with random weights, the goal is to adjust the weights in order to minimise the errors. In this report, multilayer networks are used together with a the backpropagation algorithm named Bayesian Regularisation. The ideal way to predict the stock market would be to choose a model that both accurately captures the regularities in its training data and generalise unseen data well. An issue that can occur when training ANNs is overfitting. The phenomena occurs due to a small difference in number of parameters in the network, compared to the total number of data points in the training set. An ANN with too high complexity might also get overfit with respect to the bias-variance tradeoff. In short, the bias-variance tradeoff concerns two main points: error due to bias, and error due to variances. For randomness in underlying data sets, the performed models will consist of a range of predictions. In this case, bias measures how far off the predictions are from the correct value. Likewise, the variance measure how the predictions vary amongst realisations of the mode. The effect of overfitting is generalisations based on unknown data, hence bad prediction ability. The most secure way to get more accurate weights and models is to have a quantity of data large enough to be able to train a network with complex issues. Fig.1 explains the architecture of neural networks.

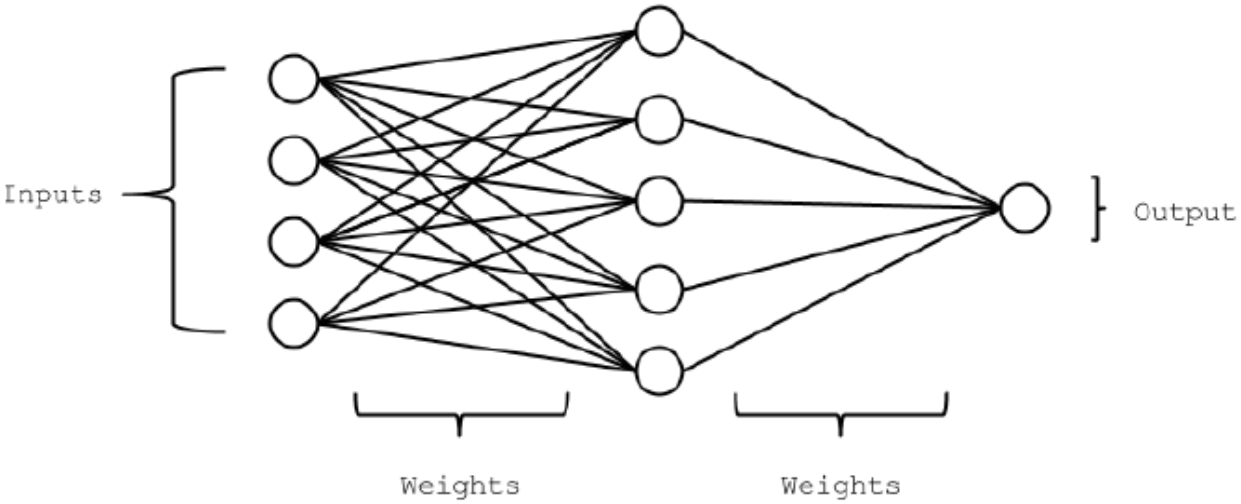

Fig.1 – Architecture of Neural Networks

There are three main aspects that are required to be improved for ANN model. First, the selection of the input variables for ANN model. The data of stock market is commonly abundant and complex, and the model can easily reach regional minimum convergence without preprocessing of input variables. The selection of effective indicators that can be used to forecast the output variable of ANN model is significant prior to modeling. Second, the setting of parameters of ANN model. Different combination of parameters which include the number of layers, hidden neurons, iterations and learning rate of ANN model may present quite different performance. The optimization and selection of the parameters should be discussed and concerned in the training procedure of ANN model. Third, the learning algorithm of ANN model. The back propagation (BP) algorithm is a widely applied classical learning algorithm for neural networks. However, the BP algorithm has significant drawbacks that need to be improved by other training algorithms.

DEEP LEARNING MODEL

In recent years, artificial neural networks became a focal point of increased public interest in machine learning due to the possibility to train deep-layered models with advanced computing equipment. Although deep learning, as describing a high number of processing layers mostly used for deep-layered neural network models, has received criticism as a marketing term for long-established machine learning methods, its usage is now established in the academic community. For deep-layered feed forward artificial neural networks, these models' graph structures are identical with the exception of a number of additional hidden layers. The primary advantage of such model architectures is their high non-linearity, which allows for the automatic identification of complex relationships in data. Glorot and Bengio [5] summarise the reason to use deep-layered feed forward neural networks as the model's ability to extract features from features learned by previous hidden layers, which reduces the need for time-intensive feature engineering. They also criticize the use of the sigmoid function in hidden layers, as its non-zero mean is shown to decelerate the learning process, and support the use of zero-mean activation functions like the hyperbolic tangent function. While there are many varieties of deep neural network models, e.g. convolutional networks and deep belief networks, sufficiently deep feed forward models without such complexities reached the then-best performance of 99.75% accuracy on the MNIST handwritten digit database Cires¸an et al., [6].

ANALYSIS OF PREDICTION MODEL

Fundamental Analysis

Fundamental Analysis are concerned with the company that underlies the stock itself. They evaluate a company's past performance as well as the credibility of its accounts.

Technical Analysis

Technical analysis are not concerned with any of the company's fundamentals. They seek to determine the future price of a stock based solely on the trends of the past price. The most prominent technique involves the use of artificial neural networks (ANNs) and Deep Learning.

In the last few years, predicting stock return or a stock index is an important financial subject which has attracted great popularity in major financial markets around the world. Scholars and investors tried to use many different kinds of algorithms to predict the stock market return. McCulloch and Pitts[3] created a computational model for neural networks based on mathematics and algorithms. From then on, the study of applying ANN to financial and investment decision has been examined by researchers for many years. The most interesting characteristic of ANN model is mimicking the human brain and nervous system to model non-linear processes from historical data. We can predict the stock return form the complexity data by using ANN, which do not contain prior standard formulas and have the ability to map the nonlinear relations between input variables and output variables. Various models have been used by researchers to forecast market value by using ANN, and ANN models train via the BP algorithm is one of the models which are most

commonly studied now. Funahashi[1], Hornik, Stinchcombe and White[2] have shown that neural networks with sufficient complexity could approximate any unknown function to any degree of desired accuracy with only one hidden layer. Therefore, the ANN model in this study consists of an input layer, a hidden layer and an output layer, and each of which is connected to the other. The architecture of the ANN is shown in Fig.1. The input layer corresponds to the input variables, with one node for each input variable. The hidden layer is used for capturing the nonlinear relationships among variables. Note that an appropriate number of neurons in the hidden layer needs to be determined by repeated training. The output layer consists of only one neuron that represents the predicted value of the output variable. The architecture of our experimental process is shown in Fig.2. First, we applied fuzzy surfaces to the selection of effective input variables prior to modeling. Then, we performed BP algorithm experiments 900 times to determine the most appropriate parameter combination for the ANN. We selected the best BP model for predicting the stock returns. Using the BP algorithm, we can obtain the optimized weights and biases of the network by repeated training. We then trained the network using the BP algorithm with the improved weights and biases. Inspired by fundamental analysis, many authors propose the use of text mining techniques and machine learning techniques to analyze textual data and extract information that can be relevant to the forecast process. Some authors proposes hybrid models that combine text mining techniques with technical information. This approach outperforms other baseline strategies. Recently, with more computational capabilities and the availability to handle massive databases, it is possible to use more complex machine learning models, such as deep learning models, which presents superior performance in traditional Natural Language Processing (NLP) tasks. The outstanding deep learning models are: CNN, RNN, specifically the Long Short-Term Memory (LSTM) architecture, and Recurrent Convolutional Neural Network (RCNN). Deep learning is part of a broader family of ML methods based on learning data representations, as opposed to task specific algorithms. Deep learning models use a cascade of multi layered non-linear processing units called as neurons, which can perform feature extraction

and transformation automatically. The network of such neurons is called an Artificial Neural Network. Artificial Neural Networks(ANN) are an example for non-parametric representation of information in which the outcome is a nonlinear function of the input variables. ANN is an interconnected group of nodes which simulate the structure of neurons present in the human brain. These neurons are organized in the form of consecutive layers, where output of the current layer of neurons is passed to the successive layer as the input. If the interconnections between the layers of neurons do not form a cycle, that neural network is called a feed forward neural network. In a feed forward neural network, each layer applies a function on the previous layer's output. The hidden layer transforms its inputs into something that output layer can use and the output layer applies activations on its inputs for final predictions. Recurrent Neural Network (RNN) is a class of ANN in which connections between the neurons form a directed graph, or in simpler words, having a self-loop in the hidden layers. This helps RNNs to utilize the previous state of the hidden neurons to learn current state. Along with the current input example, RNNs take the information they have learnt previously in time. They use internal state or memory to learn sequential information. This enables them to learn a variety of tasks such as handwriting recognition, speech recognition, etc.

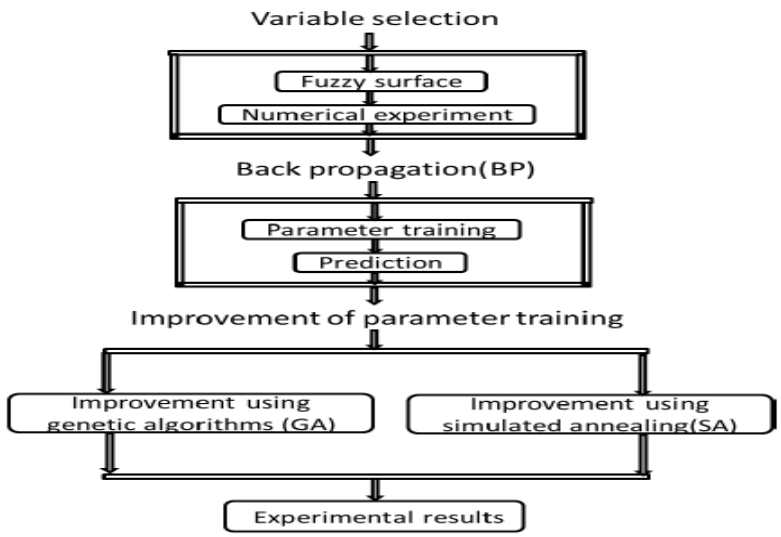

Fig 2 Architecture of Experimental Process

TRENDS IN SHARE MARKET

a) Factors affecting the prices of shares

- The share price is the price at which a particular share can be bought or sold. The share price is determined by the supply and demand for a particular company's shares.
- When you have **more buyers than sellers** for a particular company's shares, share prices usually **rise**because these shares are in demand.

- When you have **more sellers than buyers** for a particular company's shares, share prices usually **fall** because there are more of these shares available.
- If a company is very **profitable**, a share in that company will become **more valuable** because more people think that it is a good investment.
- Factors such as **economic**and **political events** also influence share prices.

b) Suggestions for Minimizing the Risk Factors

- Investing on the stock market is riskier than some other investments. The reason for this is that share prices rise and fall all the time as economic and market forces change.
- However, the higher risk involved also means that you have an opportunity to make a greater profit. Usually, higher risk means a higher return (profit).
- It is important to realize that share trading normally does not make you rich overnight, but that it should be treated as a long term investment.
- You can minimize your investment risk by diversifying your investment.
- To diversify means to invest in a variety of different investments. To protect your investment you should avoid putting all your 'eggs' in one 'basket'. When one company's share price doesn't perform well, you can still benefit when your other company's share price does well.
- Consider choosing your investments from a variety of sectors, companies and investment products.
- To help you with this decision consider regularly reading financial literature, attending investment courses and seeking a qualified expert's advice.

OUR PROPOSED SYSTEM

Proposed System means to put into effect or to carry out. The system Proposed phase of the software deals with the translation of the design specifications into the source code. The ultimate goal of the implementation is to write the source code and the internal documentation so that it can be verified easily. The following software are used for our proposed system :

- SQLite Data Base
- Java and Eclipse IDE
- Neuroph Framework - Neuroph is lightweight Java neural network framework
- Predictor Framework Model
- R Language
- Sample Data Bases

The code and documentation should be written in a manner that eases debugging, testing and modification. A post-implementation review is an evaluation of the extent to which the system accomplishes stated objectives and actual project costs exceed initial estimates. A post implementation review measures the systems performance against predetermined requirements. It determines how well the system continues to meet performance specifications. It also provides information to determine whether major re-design or modification is required. SQLite has many bindings to programming languages. Database is used to store the user details, the stocks he has bought or sold, the transactions he has performed and also used to historical values of the stock values for a set of 19 stocks for our sample data base.

EXTRACTION OF DATA

The extraction of historical prices was done by using the set of tools provided by finance.yahoo.com. The historical prices were obtained by framing the required url and using the java get URL code. The historical prices were downloaded in the csv format and then parsed to store the required data on to the database. Neuroph is lightweight Java neural network framework to develop common neural network architectures. It contains well designed, open source Java library with small number of basic classes which correspond to basic NN concepts. Also has nice GUI neural network editor to quickly create Java neural network components. Fig.3 represents the basic concepts in Neuroph Framework.

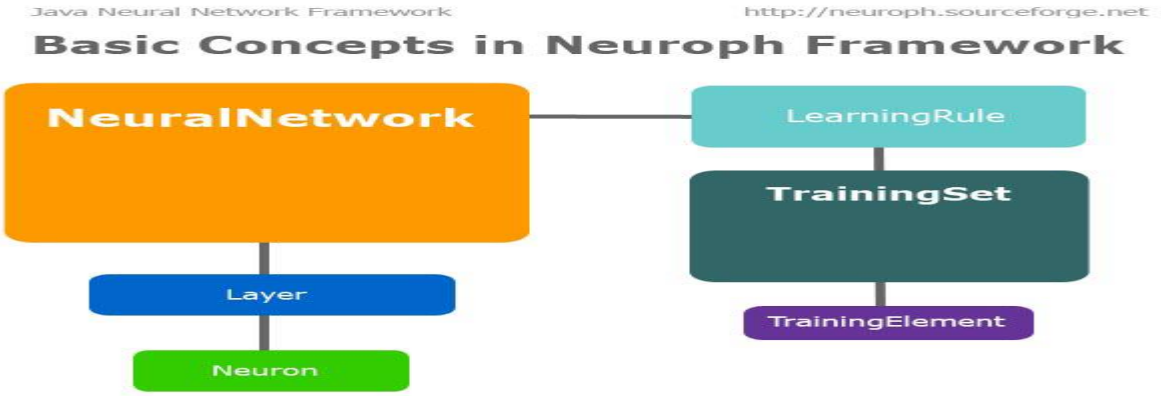

Fig. 3 Basic concepts in Neuroph Framework

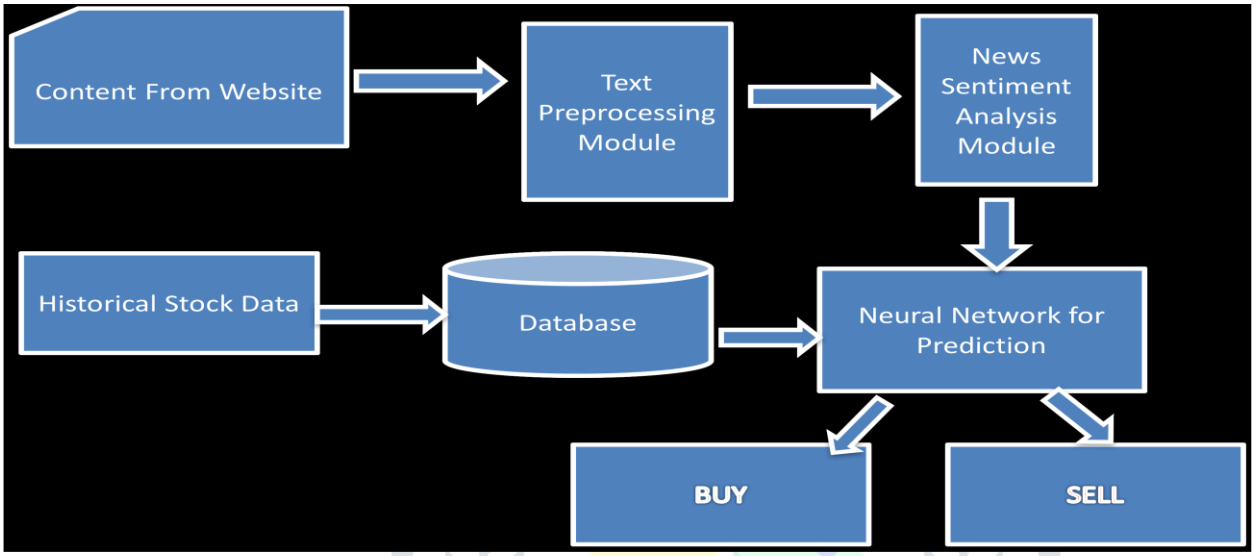

Fig. 4 Predictor Framework

Fig.4 represents the predictor framework and how we are going to collecting data and processing the data. The predicted gain or fall using the historical values and sentiments for the year of 2018 and for the stock of INFY was calculated for different number of nodes in the hidden layers is shown below. We have one input layer with 5 inputs and one output layer with one output. The neural network is trained using 150 trading days and the network is tested for 107 days.

No. of nodes in the Ist Hidden Layer	No. of nodes in the IInd Hidden Layer	Training Set Accuracy	Testing Set Accuracy
20	10	80.12 %	79 %
5	4	80.12 %	71 %
10	10	78 %	74.75 %
30	25	52 %	58 %

R is a language and environment for statistical computing and graphics. It is a GNU project which is similar to the S language and environment. R can be considered as a different implementation of S. There are some important differences, but much code written for S runs unaltered under R. R provides a wide variety of statistical and graphical techniques, and is highly extensible. The S language is often the vehicle of choice for research in statistical methodology, and R provides an Open Source route to participation in that activity.

CONCLUSION

Using neural networks and deep learning to forecast stock market prices will be a continuing area of research as researchers and investors strive to outperform the market, with the ultimate goal of bettering their returns. In certain applications involving big data, data sets get so large and complex that it becomes difficult to analyze using traditional data processing applications. In order to overcome these challenges, we can extract useful information from big data to an understandable structure using Data Mining. We can also use algorithms that learn from this data and automatically predict further trends. This branch of Artificial Intelligence is called Machine Learning and Artificial Neural Networks is the approach we are using to implement this. The stock market is a platform where an enormous amount of data exists and constantly needs to be scrutinized for business opportunities. Therefore, we are applying these aforementioned methods to simulate a brokerage system and analyze the stock market while at the same time learning the fundamentals of investment, without risking your own money. For future research, interesting aspects for performance of the ANN includes tests on intraday real time data. Two weeks of intra price data for the short-term perspective could be important to certify the profitability of the strategy made in this report. Albeit, the quantity of data might limit the scope of the results, this could possibly result in a more precise prediction model. Performances might also be done using ANN with inputs spread over the entire market instead of concentrating on a particular sector. We were able to extract large amounts of data in the field of stock market through the Internet at runtime for the purpose of analysis and simulating a trade environment. We also performed analysis using algorithms related to the field of data mining, machine learning and neural networks to predict the future trends. The simulated trade system is also implemented by developing a portfolio management system to help train users in the stock market world and also for the purpose of understanding and testing the algorithms developed. Finally, this helps clients to get into the driver's seat by broadening their market knowledge and confidence so that they can make informed trading and investment decisions in the future.

REFERENCES

[1] Funahashi K., On the approximate realization of continuous mappings by neural networks. *Neural networks* 1989, 2 (3):183-192.

[2] Hornik K., Stinchcombe M., White H., Multilayer feedforward networks are universal approximators. *Neural networks* 1989, 2 (5):359-366.

[3] McCulloch W.S., Pitts W., A logical calculus of the ideas immanent in nervous activity. *The Bulletin of Mathematical Biophysics* 1943, 5 (4):115-133.

[4] Wlodarczak, P.; Soar, J.; Ally, M. (2015), "Multimedia data mining using deep learning", Proceedings of the 5th Int. Conference on Digital Information Processing and Communications, pp. 190-196, University of Southern Queensland (Australia)

[5] Glorot, X.; Bengio, Y. (2010), "Understanding the difficulty of training deep feedforward neural networks", Proceedings of the 13th International Conference on Artificial Intelligence and Statistics, pp. 249-256, University of Montreal (Canada)

[6] Cires¸an, D. C.; Meier, U.; Gambardella, L. M.; Schmidhuber, J. (2010), "Deep, big, simple neural nets for handwritten digit recognition", Neural Computation, Vol. 22, No. 12, pp. 3207-3220, University of Lugano (Switzerland)

[7] Robert J. Van Eyden. The Application of Neural Networks in the Forecasting of Share Prices. Finance and Technology Publishing, 1996.

[8] McMillan, D., 2002, Non-Linear Predictability of UK Stock Market Returns, [online] Available at: http://repec.org/mmfc03/McMillan.pdf

[9] Larsen. J. L., 2010, Predicting Stock Prices Using Technical Analysis and Machine Learning, http://www.diva-portal.org/smash/get/diva2:354463/FULLTEXT01.pdf

[10] W. Bao, J. Yue and Y. Rao, "A deep learning framework for financial time series using stacked autoencoders and longshort term memory," *PLoS ONE*, vol. 12, no. 7, 2017.

[11] "Understanding LSTM networks," [Online]. Available: http://colah.github.io/posts/2015-08-Understanding-LSTMs

[12] "Recurrent neural Network - Wikipedia," [Online]. Available: https://en.wikipedia.org/wiki/Recurrent_neural_network.

[13] H. G. J. H. Yuling Lin, "An SVM-based approach for stock market trend prediction," in Proceedings of the International Joint Conference on Neural Networks, Dallas, TX, 2013.

[14] "Understanding Support Vector Machines," https://www.analyticsvidhya.com/blog/2017/09/understaing-support-vector machine-example-code

[15] Chollet, F. (2015), "Keras", GitHub, available at: https://github.com/fchollet/keras