Comparative Study on Stock Market Prediction Techniques Based On Artificial Intelligence

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Abstract

Stock index prediction techniques have been followed for more than decade to create reliable, scalable and automated systems (algorithms) to assist organisations in stock trading. The challenge lies in creating systems that adapt to dynamic markets which are susceptible to constant change. Thus, stable, robust and adaptive approaches which can provide models to accurately predict stock index are of highest importance. In this paper, we explore the working of Artificial Neural Networks (ANNs), Support Vector Machines (SVM), traditional models such as Multiple Linear Regression (MLR) to build prediction models for stock markets. We will also show how previously widely used techniques using numerical time series forecasting and textual data perform. The developed models are compared based on a number of criteria. Because the supporting factors and parameters play a crucial role in the success of each of these models, the paper highlights areas suitable for the use of each prediction model. This forms one of the most prime factors to be considered when choosing a prediction model to provide the maximum success rate.

KeyWords – Artificial Neural Networks, Candlestick Patterns, Regression, Support Vector Machines, Technical Analysis.

1. INTRODUCTION

Stock index prediction techniques are used mainly, to forecast the closing price of stock(s), based on the input of various stock parameters over an interval of time. Such prediction techniques are used in the form of prediction models customised for different types of stock markets and securities trading, or in the form algorithm-based software available in the market to be used by traders, investors or organisation to fulfil their stock forecasting requirements.

2. CLASSIFICATION OF PREDICTION MODELS

There are many kinds of prediction algorithms described in the literature. They can be divided into two main classes:

1. Algorithms that use Artificial Intelligence methods
2. Algorithms based on mathematical models

Models based on Artificial Intelligence include machine leaning structures such as Artificial Neural Networks (ANNs) and Support Vector Machines (SVMs). Genetic algorithms, decision trees, decision rules are other techniques used in the field of finance. Soft computing techniques such as Fuzzy Logic are also used to design prediction models.

Algorithms using mathematical models include regression models, Analysis of Variance (ANOVA) and linear discriminant analysis models.
3. BRIDGING THE GAP BETWEEN TRADERS AND PREDICTION MODELS

Although prediction models guarantee a considerable amount of success when performed during training demonstrations or in labs, testing environments, obtaining results from these techniques in real-time environments still remains a major problem faced by independent stock market investors, small to mid-sized organisations and traders. There are several reasons for the above mentioned situation.

Firstly, it is crucial to understand that prediction models are not readymade tools that can be directly used on a given stock index. Therefore, the same prediction model may not produce the same success rate across different stock indices. In the case of Artificial Intelligence methods such as Neural Networks, the prediction model must first be trained on a sample dataset before being used over real-time data for prediction.

Secondly, various technical indicators are used as input to these prediction models. The success of the model depends on which set of indicators should be considered for the algorithm and which should be omitted. For independent investors and traders who have little or no technical knowledge of the working of stock index prediction techniques, it is difficult to choose the best performing set of indicators.

Therefore, along with the rapid advancement in the field of stock index prediction, it is vital that scalable, industry-ready prediction models be available in the market for use by independent investors, traders and small organisations, and not just multi-national corporations or hedge funds.

4. OVERVIEW OF PREDICTION TECHNIQUES

IV.I. Artificial Neural Networks

Artificial Neural Networks have been developed as mathematical models of human cognition or neural biology, based in the assumptions that:
   1. Information processing occurs at many simple elements called neurons.
   2. Signals are passed between neurons over connection links.
   3. Each connection link has an associated weight, which, in a typical neural net, multiplies the signal transmitted.
   4. Each neuron applies an activation function (usually nonlinear) to its net input (sum of weighted input signals) to determine its output signal. \[ \text{Equations (1) represents the summation function. Equations (2) and (3) represent the sigmoid activation function and hyperbolic tangent (tan(h)) activation respectively.} \]

\[
\begin{align*}
S &= \sum_{i=0}^{n} w_i x_i \\
\phi(S) &= \frac{1}{1+e^{-S}} \\
\phi(S) &= \frac{1}{e^S - e^{-S}}
\end{align*}
\]

Fig. 1. ANN consists of an input layer, one or more hidden layer (where the computation takes place), and an output layer.
IV.II. Support Vector Machines

“Support Vector Machine” (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. The basic idea of SVM is to map the training data into higher dimensional space using a nonlinear mapping function and then perform linear regression in higher dimensional space in order to separate the data \[ ^4 \]. Data mapping is performed using a predetermined kernel function. Data separation is done by finding the optimal hyperplane (called the Support Vector with the maximum margin from the separated classes. \[ ^3 \]

![Figure 2. Classification of datasets by SVM](image)

IV.III. Technical Analysis

Technical analysis is a method of evaluating securities and identifying the optimum timing for investments by analysing the statistics generated by market activity, such as past prices and volume. Technical analysis does not attempt to measure a security’s intrinsic value, but instead studies stock price graphs, charts and other momentum indicators to identify patterns that can suggest future activity.

Technical analysts aim to discredit the EMH (Efficient Market Hypothesis) which states that at any given time and in a liquid market, security prices fully reflect all available information. This theory contends that since markets are efficient and current prices reflect all information, attempts to outperform the market are essentially a game of chance rather than one of skill.

IV.III.I. Candlestick Patterns

In technical analysis, a candlestick pattern is a movement in prices shown graphically on a candlestick chart that some believe can predict a particular market movement. The recognition of the pattern is subjective and programs that are used for charting have to rely on predefined rules to match the pattern.

IV.III.I.1 Bullish Patterns

A bullish trend on the stock market is characterized by rising stock prices. Investors who believe that a stock price will increase over time are said to be bullish.

![Figure 3. A few common bullish candlestick patterns](image)

IV.III.I.2 Bearish Patterns

A bearish trend on the stock market is characterized by declining stock prices. Investors who believe that a stock price will decline are said to be bearish.
IV.IV. Regression Model
Regression analysis is a statistical technique to analyse quantitative data to estimate model parameters and make forecasts. [5]

5. EXPERIMENTAL RESULTS

1. Neural networks are better suited for short term forecasting, such as the case of day-to-day prediction.

   As the time duration between the input data date and the required prediction date increases, uncertainty in the market increases in the form of the firms’ management decisions, acquisitions, quarterly reports and other news that may affect the stock price. Therefore, longer the time period, lesser the accuracy of prediction.

   But, some prediction models using neural networks have been devised that analyse textual data in the form of news articles and financial reports and assign a value of +1, 0 or -1 depending on the tone of the data (i.e positive, neutral or negative). Such neural network prediction models are better suited to give accurate indicators over a longer duration of time.

2. Technical analysis is useful for geared trading. Therefore short-term trading such as day trading can utilise technical analysis indicators.

3. Results of Regression Analysis are dependent on the input price indicators. Prediction rate varies depending on the number of input data with the rate marginally increasing with increase in the input values.

4. The performance of Support Vector Machines is in the same range as that of neural networks. It is also better suited for predictions over a shorter period of time.
6. CONCLUSION

Prediction models involving both, artificial intelligence methods as well as mathematical models are beneficial in predictions spanning a short duration of time. For example, stock index forecasting is beneficial most to day traders or investors who actively participate in trading over regular periods of time. Forecasting in the case of value investing does not produce favourable results.

REFERENCES


