Bio-Inspired Computing Based Approaches for Stock Market Forecasting

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Abstract

It is very difficult to predict the price of shares or stocks in share market because there is no full proof significant rules available for estimation. In literature many prediction methods are available including technical analysis, fundamental analysis, statistical analysis, machine learning etc but no one is acceptable as a significant and accurate prediction tools. In this paper, we found that bio-inspired computing is the better solution than other analysis methods listed above to improve the prediction model accuracy. This paper makes a survey of recent approaches in the wide area of Bio-Inspired Computing for prediction of stock market movements. This paper also presents our own proposed hybrid model for stock market forecasting, which is the combination of ANN, Neuro-fuzzy logic and bio-inspired algorithm. Finally, we have suggested some observations useful at the time of development of such models.

Key Words: stocks, shares, forecasting models, bio-inspired computing, machine learning, soft computing.
1 Introduction

The economy of any country in the word is more importantly depends on the stock market. The stock market is nothing but the public market for buying and selling of stocks at a particular price. All this is set up and managed by some group of members registered with SEBI. The stock market is the core part plays a vital role in the tremendous growth of industry of respective countries. The stock market triggers the commerce of the country. As stock market is the basis economy of the country, government, various industries as well as a central bank of country has a close and keen watch on stock market daily movements [5]. The stock market attracts every industry as well as stock investors. It arises the need of stock market prediction techniques.

1.1 Importance of Stock Market Forecasting

The stock market has two important terms like shares and stocks. Both are the kind of document provided by the company, which proves that the share holder is one of the owners of the company. The share is provided by the company or it can be purchased from stock market. With this share, share holder can get the profit of companys profit. The buying or selling the shares can lead to both profit and loss. On the other hand, stock is the collection of shares. So it is very important take the proper decision at the time of selling or purchasing the shares or stocks. For this purpose, various stock market prediction systems have been emerging [19].

The stock market prediction systems are used to predict the future value of stocks. If we can predict the value of some entity, it yields good return of investment. Before digital world evolution, various prediction methods are used such as fundamental analysis, technical analysis etc. These methods include lots of paper work with a lot of time. But it did not guarantee the accuracy of results. After this, various technical methods are used and they are also very useful. These methods include SMA, EMA and MACD. But with the advancement in computer technology, prediction system is extended and advanced with various technologies. Such prediction systems are built with techniques like data mining, machine learning etc. This paper studies various stock market prediction systems
1.2 Stock Market Prediction Methods

1. Fundamental Analysis
   This fundamental analysis includes the physical study of any kind of stock company. It studies product sales, manpower required, quality of product and infrastructure etc. From this study, this analysis method predicts the ability of profit or loss earn belong to investment [23]. This method makes use of static data for prediction of market price, which is the limitation of the fundamental analysis method. Because of this limitation, fundamental analysis method can only be used for long-term basis share market prediction.

2. Technical Analysis
   This method is very popular and used to identify the approximate time to purchase or sell the shares. This kind of time-related information is useful for investors to invest their money at right time to earn more profit. For this, price charts are used as an input for prediction. This method makes use of some patterns of supply and demand issue. Some parameters are used to identify the company and its profit through its share price. Such parameters are known as indicators and oscillators [13]. The subjective nature is the big limitation of this method. Because of this, different rules may be predicted with same charts.

3. Machine Learning
   The working of this method is related to the learning principle of training and experience [21]. Artificial neural network is the example of machine learning in which connection weights are used to improve the network performance.

2 Bio-Inspired Computing for Stock Market Forecasting

Bio-inspired computing is inspired from the subset of natural computation. In this, computers are used to implement the phenomena of living agents for studying the life and improving the computers

with the help of Bio-Inspired computing algorithms [22].
These kinds of bio inspired models are more suitable for stock market forecasting, because they can handle the non-linear complex data. Many researchers have been proved that these models perform better than other economic and statistical models of forecasting. Bio-inspired computing includes various models named as the Genetic Algorithms (GA), the Fuzzy Logic (FL), the Particle Swarm Optimization (PSO), the Artificial Neural Networks (ANN), etc. The various models are discussed in [6]. The figure 1.1 depicts the basic classification of bio-inspired optimization. Bio-inspired computing models are classified as evolutionary computing and swarm intelligence, discussed below.

Evolutionary Computing:

This is the group of algorithms inspired by the biological evolution. It is used for the global optimization of output. It belongs to the field of artificial intelligence and soft computing systems. In this computing, the problem is treated as population-based trial and error problem and it is solved with the help of meta-heuristic [1]. Evolutionary computing includes various algorithms such as Genetic Algorithm (GA), Differential Evolution, etc.

Swarm Intelligence:

Swarm intelligence includes the self-organized and decentralized models. They are the natural and artificial models. This is the
subfield of artificial intelligence. These kinds of models are introduced by Gerardo Beni and Jing Wang in 1989 for cellular robotic systems [2]. These models inspired from nature and biological systems. Swarm Intelligence includes various algorithmic approaches such as PSO, ACO, and Bacterial Foraging Optimization (BFO) etc.

3 Literature Survey

This section describes the various bio-inspired computing models for stock market forecasting along with their advantages and limitations.

The combination of bio-inspired algorithms is used in [3] for stock market forecasting and prove its better performance. There are a lot of hybrid approaches are available for forecasting, but this approach has some novelty. The novelty is that, this approach is applied for Dhaka Stock Exchange (DSE), Bangladesh. The forecasting model is consisting of genetic algorithm along with ANN feature discretization and some salient feature of Neighborhood Replica scheme is added there. The system is analyzed with 24-month stock data with other 10 companys data. The simulation results prove the system performance in terms of traded price, closing price, maximum or minimum price along with other statistical measures.

Another combination of GA and ANN for forecasting of the stock price is presented in [20]. It mitigates the problem of data redundancy with dimensionality reduction and eliminating irrelevant patterns. In this model, GA is used for the optimal and near-optimal solution searching for learning algorithm. It is also used for the prediction of optimal and near-optimal feature discretization threshold, which is further used for dimensionality reduction. From this, author has concluded that the GAFD reduce the dimensionality of feature space which improves the empirical results of the classification process.

Limitations:

- A static processing element is set at hidden layer.
- Optimization process only considers limited parameters
• Feature discretization is not achieved with GA. Case based reasoning or decision tree may work for the same.

The Differential Evolution Support Vector Machine (DE-SVM) model to predict the stock market price is proposed in [10]. DE is used to select the combination of best free parameters. This combination is used in SVM for improving the results. The DE-SVM algorithm performance is clearly compared with SVM based model and PSO-SVM based model. To improve the accuracy of prediction results, data normalization technique is used.

**Limitations:**

- After a time lag, DE leads to the progress of population.
- Until the new population obtained, current total population in DE remains unchanged.
- Therefore process of convergence becomes slower.

The powerful and robust hybrid algorithmic solution is presented in [12] for stock market forecasting. This approach combines the GA with PSO to find the global minimum output. It combines the feature of GA, in which individual evolve originally and features of PSO, in which global minimum is identified. Because of this model become simple and effective to handle various continuous optimization problems.

**Limitations:**

- System cannot be able to find global maximum. This problem can be solved with the Simplex Nelder-Mead based algorithm.
- Time of global minimum searching can be enhanced with the combination of taboo search, simulated annealing, and neural network.

The stock time series forecasting problem is handled with the help of soft computing concepts in [11]. The solution to this problem requires accurate non-linear models. The proposed solution involves fuzzy rule-based model with effective evolution algorithm.
The system performance is tested with 23 daily series of the Dow Jones Industrial Average index. The final results prove that the proposed system continuously performed better than the other available methods.

**Limitations:**

- Minimum interpretability of the system with more complexity.

The short and long-term stock price forecasting model is proposed in [18]. This model has based on Bacterial Foraging Optimization (BFO) Technique. This model has adaptive linear combined structure, where weights are adjusted by using BFO tool. The simulations are used with known stock indices to test the system performance. The experimental results prove that the prediction with BFO is better than MLP forecasting model. BFO based model has less computational complexity, higher accuracy and minimum training time as compared to MLP based model.

The study of Thai stock market is conducted in [15]. It investigates the efficiency of soft computing based techniques to forecast the stock price in SET. The author identifies some important factors that affecting the SET. Here, the soft computing approach is proposed which is based on SET forecasting method. This approach proves the main driving indicators, the Dow Jones, the Nikkei index, the Hang Seng index, the Minimum Loan Rate, the value of the Thai baht and the gold price. The authors prove that the neural network, genetic algorithm and fuzzy logic is the better combination for stock forecasting.

The hybrid approach for improving the stock market forecasting performance is proposed in [14]. This model combines following:

- Cumulative Probability Distribution Approach (CDPA)
- Minimize the Entropy Principle Approach (MEPA) for technical indicator value and daily price fluctuation partitioning into linguistic values
- Rough Sets Theory (RST) for extraction of linguistic rules
- Genetic Algorithm (GA) for rule extraction to get more accuracy
The proposed approach creates the return of positive stock, where the stock market is bullish or bearish.

Limitations:

- The RST, GAs and the proposed data mining model perform lower if there are many violent fluctuations creating in the stock market.
- In preprocessing phase, proposed model can be enhanced with the help of data discretization techniques.
- In forecasting process, the performance can be enhanced with artificial intelligence based algorithmic approaches.

The effectiveness of time-dependent prediction domain is illustrated in [16]. For this purpose hybrid approach is used, where the Adaptive Time Delay Neural Networks (ATNNs) and Time Delay Neural Networks (TDNNs) are used along with GA. The global solution for the ATNN and the TDNN model is found by the fitness of time delay evaluation of different sets. The simulation results prove that the GAATNN and GATDNN are accurate that the ATNN, TDNN and RNN models.

Limitations:

- There is high computational complexity for the factors of optimal sets of time delay and the network architecture.
- Learning of the ATNN and the TDNN require high computational requirements.
- The results are affected by various parameter values including stop condition, size of population, rate of crossover, rate of mutation and so on.

The novel time series forecasting tool is proposed in [17]. To predict the financial market behavior, the proposed model combines a Hidden Markov Model (HMM), ANN and GA. The simulation results prove that the proposed system is better than a single HMM-based model for stock price forecasting. The proposed hybrid system can be used without analyzing the dataset.
Limitations:

- To simplify, the proposed system has selected the number of attributes (states) in the observation vectors.
- Sometimes it is not preferable for some kind of instances.
- To overcome the above problem for given dataset, it is necessary to apply another GA for finding the best HMM architecture.

The Ant Colony Optimization (ACO) based approach is proposed in [8] for constructing a forecasting model of the stock price movement. This is the special model which makes use of public mood data as an input to the prediction model. This input data is collected from various social networking sites. This model is called as novel as it combines the structure elements of the individual system rather than their outputs. It improves the prediction accuracy as well as preserves the interpretability of model. For the stock market, interpretability is difficult to find out the set of mood states and mood scores which causes a stock movement. The combinatorial complexity of the proposed system is helped by an ACO algorithm created for Bayesian Classifiers.

Limitations:

- System can achieve the higher performance prediction with better calibration of ACO algorithm.
- The model can be used for other types of prediction tasks.

4 Proposed Methodology

In future, we are planning to develop our own stock market price prediction model based on the concept of Bio-Inspired Computing. This model is depicted in figure 1.2.
This proposed research work is an intelligent approach to forecast stock volatility using Neuro-fuzzy computing with swarm intelligence. In this approach we will first verify the functionality of existing algorithms, and then by using artificial neural network we will develop the highly efficient algorithm. Next section is Neuro-fuzzy system (NFS) [23] which can be used like a human brain, using fuzzy logic and neural network, to form human mentality in some degree for decision-making and adaptation. This Proposed Neuro-fuzzy system and swarm intelligence techniques are combine by introducing multi group PSO (MGPSO) method which will apply with the famous Recursive Least Squares Estimator (RLSE) method to become the MGPSO-RLSE hybrid learning method. There are many parameters available to forecast stock market. This proposed work will focus on IT sector in National Stock Exchange of Indian stock market. It is assume that this hybrid learning approach will shown excellent performance with the comparison with existing techniques.

5 Observations

Following are some important observations while preparing to construct the stock market price forecasting model with bio-inspired algorithms.
The selection of input data, the time periods requirement and the methodologies are the key issues while constructing the stock forecasting models.

For choosing the input data, we have to target the study of specific stock market.

We have to keep in mind that the stock market circumstances are continuously varying according to the time.

The normal and crisis periods have different impact on the prediction output.

Stock data is the time series data and there is no need of exact answers.

Various soft computing based techniques including the neural networks, the genetic algorithms and the fuzzy logic etc, are suitable for stock market forecasting systems.

6 Conclusion

In this paper, we have studied the basic concepts of stock market along with the forecasting techniques of the stock price. We mainly focused on the bio-Inspired Computing models for time series stock market price prediction system. Initially, we have explained the concept of stock market and need of forecasting methods from investors point of view. Then we have explained how bio-inspired computing is better than other analysis models for accurate stock price prediction. After this, we make a survey of the various hybrid forecasting models proposed by various author on their own criteria along with their limitations. From this survey we have concluded that the selection of input, algorithmic approaches and time periods highly affecting the performance and results of prediction models. Therefore it is very important to choose all these parameters very carefully at the time of development of such prediction models.
References


