International Journal of Academic Research in Accounting, Finance and Management Sciences
Vol. 4, No.1, January 2014, pp. 352–357
E-ISSN: 2225-8329, P-ISSN: 2308-0337

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# Index Prediction in Tehran Stock Exchange Using Hybrid Model of Artificial Neural Networks and Genetic Algorithms

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***Abstract*** *Nowadays, investment in the bource organizes the important part of country economy. So the prediction of stocks index is very important for stockholders to earn the highest return from their investment. The changes of stock market influence by several factors such as political, economical and social factors and maybe, using the classic methods for stock market prediction result in exact results. since, the intelligent method have this capability that consider the complex effects of above factors in the analysis, so we can use them in stock index prediction. Therefore, we can use the artificial neural network for predicting and the genetic algorithm for optimizing the input variable in the neural network. This research has studied the efficiency of compound model, artificial neural network and genetic algorithm for predicting the stock index of Tehran negotiable documents bourse. For this reason, the economical data such as open market price of foreign exchange, bubble of coin price, the price of each ounce of gold in international market and the price of OPEK oil basket as inputs of compound model and total index of bource that compared with outputs of compound model, and have collected from 23st of September in 2010 until 18th of March in 2013 daily. The results indicated that the compound model, artificial neural network and genetic algorithm, can accomplish the exact prediction and this model operate efficiently.*

***Key words*** Stocks index, artificial neural network, genetic algorithm

DOI: 10.6007/IJARAFMS/v4-i1/658 URL: http://dx.doi.org/10.6007/IJARAFMS/v4-i1/658

## 1. Introduction

Economic development and growth depends on capital accumulation and productivity (Motmeni, 2010). On the other hand capital formation is the most important Functions of financial markets, and Financial markets, including the stock exchange is doing well these tasks (capital accumulation and productivity)(Saeedi, 2010).

Trade decisions on a stock market are made on the basis of predicting the trend and are driven by many direct and indirect factors. Effective decisions depend on accurate prediction (Mandziuk & Jaruszewicz, 2011).

Many techniques applied to the task of stock market prediction are presented in the literature and method is the preferred than error rate of prediction is less. Statistical models can be used for predict. Usually either the Markov models (Tino *et al.*, 2001) or more sophisticated, based on analysis of variance, ARIMA and GARCH models (Mantegna & Stanley, 2000). Despite remarkable effort devoted to stock market prediction, the problem remains difficult and in general case unsolved.

The main reason for this difficulty is complex and varying in time dependencies between factors affecting the price (Thawornwong & Enke, 2004). According to some theories, changes on stock markets are chaotic (Mantegna & Stanley, 2000). The Efficient Market Hypothesis (EMH) says that all available information (or only past prices in the weak variant of the hypothesis) is already reflected in the current price. Therefore it is not possible to predict future values. Several researches deny this hypothesis.

Computational Intelligence (CI) methods such as neural networks are widely used for stock market prediction. The question concerning the superiority of CI methods over statistical models is still open although according to some papers (Kohzadi *et al.*, 1996). The efficacy of ARIMA or GARCH is not satisfactory compared to neural networks. Artificial neural networks compared to other methods have this capability that considers the complex effects of Factors influencing the prediction of stock index in the analysis.

Most of the neural methods described above require specific set up of steering parameters and suitable selection of the input data. Both these issues can be effectively approached with the help of genetic algorithms (GA) (Thawornwong and Enke, 2004). Therefore, we can use the artificial neural network for predicting and the genetic algorithm for optimizing the input variable in the neural network and the combination of the two can be combined into a model for predicting stock index gained.

## 2. Artificial Neural Network (ANN)

The theory of neural network computation provides interesting techniques that mimic the human brain and nervous system. A neural network is characterized by the pattern of connections among the various network layers, the numbers of neurons in each layer, the learning algorithm, and the neuron activation functions.

In general, a neural network is a set of connected input and output units where each connection has a weight associated with it. During the learning phase, the network learns by adjusting the weights so as to be able to correctly predict or classify the output target of a given set of input samples.

Artificial Neural Networks have characteristics such as ability to learn, generalize, parallel processing capabilities and the ability to repair errors and more. One of the most common neural networks used are Multilayer Perceptron Neural Network.

The structure of multi-layer perceptron neural network includes an input layer, one or more hidden layers and output layer. Each of these layersis formed by one or more nodes. The input layer has nodes with the same number of independent variables and similarly the output layer has the same number of dependent variable, but defining the hidden layer is difficult (Hagan, 2002; Hoglund, 2012).

## 3. Genetic Algorithms

Genetic Algorithm (GA) is a search heuristic that mimics the process of natural selection. This heuristic (also sometimes called a metaheuristic) is routinely used to generate useful solutions to optimization and search problems (Mitchell, 1996).

Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. Differences in genetic algorithms and other optimization methods as follow:

1. Genetic Algorithms work with the code of solutions and the solutions will not work.
2. Genetic Algorithms in search of solutions to the population, not a single answer.
3. This algorithm uses only the information required by the objective function, not derivatives or other auxiliary information.
4. Genetic Algorithm uses probabilistic rules, not deterministic rules.

## 4. Combinations of Genetic Algorithms and Neural Networks

Various schemes for combining genetic algorithms and neural networks were proposed or compared (Branke, 1995). This paper focuses on how GAs can be used to assist neural networks. Combinations can be collaborative where they are used simultaneously or supportive where they are used sequentially.

Collaborative combinations typically involve using genetic algorithms to determine the neural network weights or the network topology, or both. A usually avoids local minima by searching in several regions simultaneously and needs no gradient information. Supportive combinations typically use genetic algorithms to prepare data for neural networks.

They achieved some success on real world tasks, especially classification problems. Feature selection is a representative example.

Steps of hybrid models combining neural networks and genetic algorithms to predict stock index Tehran Stock Exchange are as follows (Zare'zade & Hadad, 2011):

*Step 1:* At this stage, the population of each generation and maximum number of generations is determined. (Random initial population is determined)

*Step 2:* Using the values of the genes in each population created an artificial neural network structure is determined.

*Step 3:* Using the normalized input data network trained.

*Step 4:* After the network did predict, root mean square error is calculated.

*Step 5:* By operators such as transplants, genetic mutation and Roulette Wheel The next generation is created.

*Step 6:* At this stage new population is replaced with previous population.

## 5. Research variables and hypotheses

**$H_1$:** Hybrid model of artificial neural networks and genetic algorithms to efficiently index predicts.

In this study, USD market price, gold coin bubbling price, world price of an ounce of 24 carat gold and OPEC oil price are independent variables and Tehran Stock exchange stock index is dependent variable.

## 6. Research methodology

The network inputs are: USD market price, gold coin bubbling price, world price of an ounce of 24 carat gold and OPEC oil price. Also the network output is the stock index. Activation function in the hidden layer is hyperbolic tangent sigmoid. To test the hypothesized, number of neurons in hidden layer changed from 1 to 20 and the hybrid model trained 20 times.

Because the model was stable after 800 generations and did not fluctuate dramatically, from 800 generations was used. Other features and characteristics of genetic algorithm are described in the following table:

*Tabel 1.* General Characteristics of hybrid model of neural networks and genetic algorithms

| Three -Layer Perceptron, Forward, Each neuron is fully connected to the next layer | Network Type |
|---|---|
| Hyperbolic tangent sigmoid | The activation function |
| %80 | Percentage of training |
| 100 | Number of Population |
| 800 | Number of generations |
| %60 | Percent combined |
| %30 | Percent of mutant |
| Tournament | Selection method |
| Root mean square error | Measure of performance |

Our measure for evaluating the hybrid model of neural networks, genetic algorithm is the root mean square error and calculated from the following equation:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Z_i - Z_p)2}{n}} \quad (1)$$

Where:

$Z_0$ = predicted values;

N= number of data;

$Z_p$= observed value.

The following table reflects the results of the hybrid model with different number of neurons in the hidden layer And amount of root mean square error (RMSE) and correlation coefficient data input and output, and average errors.

*Table 2.* Results from the hybrid model training

| Average errors | The output of the correlation coefficient with real data | RMSE | The number of hidden layer neurons |
|---|---|---|---|
| -13/46 | 0/9642 | 1135 | 1 |
| -14/34 | 0/9642 | 1135 | 2 |
| -3/83 | 0/9655 | 1114 | 3 |
| -4/56 | 0/9623 | 1163 | 4 |
| 7/21 | 0/9622 | 1164 | 5 |
| -10/66 | 0/9614 | 1178 | 6 |
| -8/44 | 0/9610 | 1183 | 7 |
| 14/97 | 0/9662 | 1103 | 8 |
| -1/20 | 0/9591 | 1211 | 9 |
| 0/41 | 0/9559 | 1256 | 10 |
| 12/36 | 0/9658 | 1110 | 11 |
| -16/79 | 0/9581 | 1226 | 12 |
| 43/91 | 0/9606 | 1190 | 13 |
| -2/25 | 0/9598 | 1201 | 14 |
| 1/72 | 0/9576 | 1232 | 15 |
| -2/57 | 0/9531 | 1294 | 16 |
| -20/47 | 0/9578 | 1231 | 17 |
| -66/64 | 0/9541 | 1284 | 18 |
| -0/27 | 0/9530 | 1297 | 19 |
| -3/46 | 0/9617 | 1173 | 20 |

As indicate in the table, when the neural network has 8 neurons in the hidden layer, there is the least root mean squared error and the maximum correlation between dependent and independent variables.

The least root mean squared error is 1103/7282 and it means that mean error of network equals to 14/9788 toman and the neural network and genetic algorithm compound model can forecast the stock index to 95/08% precisely, and because the error percent is less than 5%, the hypothesis confirm and the neural network and genetic algorithm compound model can forecast stock index efficiently.

According to research results, it propose to bourse organization, investor firms and other financial organizations to use this model to forecasting the future trend of stock index.

The results diagrams of model with 8 neurons in the hidden layer are as the follow:

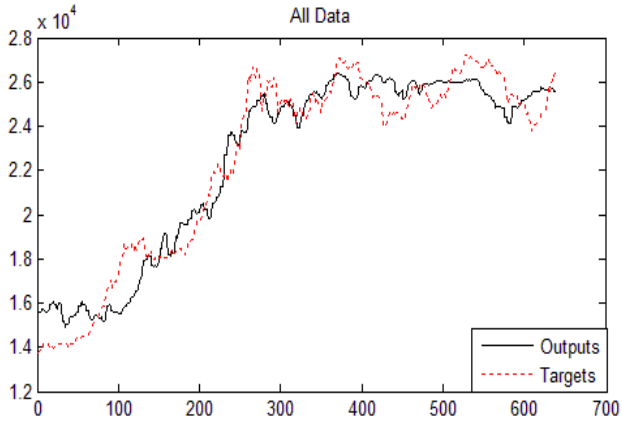


*Figure 1.* Targets data and Outputs data

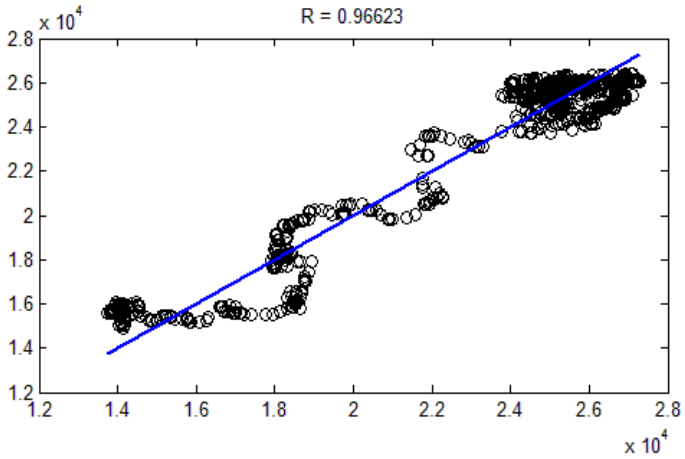


*Figure 2.* Output of the correlation coefficient with real data

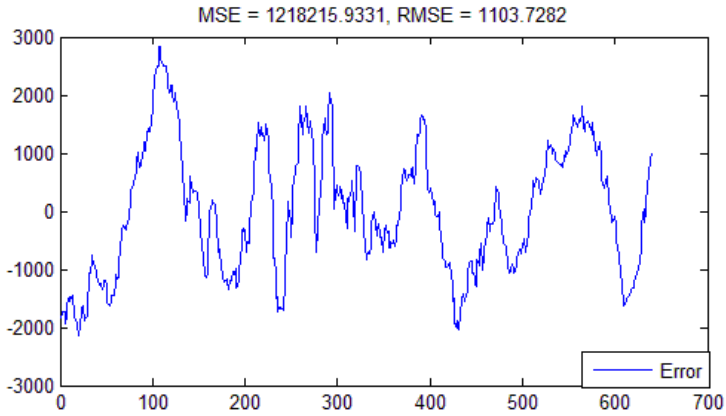


*Figure 3.* Root Mean Squared Error

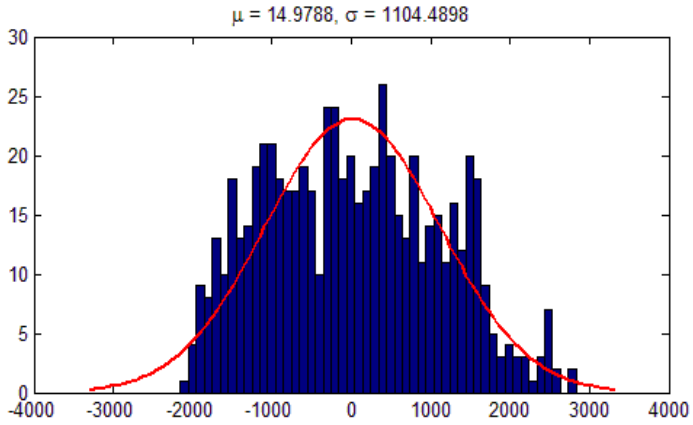


*Figure 4.* Normal curve and model error abundance

The limitations of this research include:

1) Discooperation of referring organizations for propagating the economical data such as Central Bank.

2) Unavailability of other variables which have effect on stock index in negotiable documents bource of Iran.

3) There are some matters in scientific research process especially in human sciences such as accounting which are out of researchers control and can effect on the research results potentially.

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