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PREDICTION OF STOCKS NORM USING WAVELET NEURAL NETWORKS IN TEHRAN STOCK EXCHANGE

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ABSTRACT

The aim of present study is making WDBP wavelet neural network in order to prediction stock index and comparing it with predicted values of stock index in BP neural network. The present study is an applied research which has done in 10 years from the beginning of 2002 to the end of 2011. Data gathering carry out from available statistics and information of Tehran stock exchange's database. In order to create the WDBP model db5 wavelet is used for removing noise in five steps. The criterion used for measuring the prediction error is root mean square error (RMSE). Wilcoxon hypothesis test is conducted on results after prediction by neural networks.Test results indicate the significance level of overall index is less than 0.05.Therefore, null hypothesis is rejected. Itmeans there is a significant difference between prediction of neural network method and wavelet neural network.

Keywords: Artificial neural network (ANN), Wavelet transform, Stock inside,Single-level discrete, WDPB wavelet neural network

INTRODUCTION

Investment companies are one of the financial brokers which are participating in all advanced exchanges of world in order to establish a balance at stock exchange markets with goal of increasing performance and improving investment, whereas mentioned sources are used in efficiency manner. Using efficient sources need to accurate planning

and decision. Because these planning belong to the future which is unknown, so to making proper decision; anticipation the future is important. Whereas, the primary and main factor to making decisions of investment in stock exchange and its cost is located beyond the investor, choosing prediction method which has the most accuracy and less error is important.

If a system can determine winner and loser in dynamic financial market, whoever is owner of that system will have more interest. So, most of the researchers, professional investors and common investors are following for better system which has a higher yield.

Doubtlessly, nowadays most capital value is exchanged by stock exchange markets all over the world. In addition to this, stock exchange market as an investment tool is available for both great investments and common people [1]. Stock exchange markets not only are affected by great factors, but also are affected by thousands of other factors. Huge numbers and being unknown of efficiency factors on stock exchange market cause to unreliability in investment field. It is clear unreliability property is undesired, also for investors who select stock exchange for capital place, this property is unavoidable. So, all investor effort is reduction of unreliability and in this regards, prediction of stock exchange is a tool for reduction of unreliability.

Index is an important comparing and measuring tools for aspects. It has a distinct nature which can study created vibrations of specific variables during a period. Index in terms of operating is a quantitative which is scale of several harmonies variables. According to the obtained resultant in investment market, cost of stock index in view of investors is used widely for buying stock and in terms of macroeconomics is used as an economic index in the society.

Stock exchange is so important tools in capital markets where has special role in economic growth. It provides reduction of risk, pricing and optimize allocation of sources and capital in order to improvement of economic situation [2]. So subject of prediction in accurate management of stock changes has an important act in order to achieving sustainable development. It causes to making decision in uncertain status will be easy for administration of stock decision makers [3].

Stock index

Nowadays, investment in exchange includes the important part of economic in the country. So that, prediction of stock price has a

particular importance for investors in order to obtains highest yields from itself investment. On the other hand, index of stock price shows the whole status of market and it can help shareholders to prediction of investment [4].

Price of stock is a dynamic, nonlinear and non-parametric. It suggests investors must challenge with variables time series and frequent structural failure [5]. So, accurate prediction of stock price changing not only is challenging, but also is serious interesting of investors.

Direct prediction of stock index by data which have noise has usually error. Whereas stocks market is a nonlinear system where are active in a political, economical and psychological conditions, so using traditional methods to accurate decision making is too difficult for both managers and investors [6].

In the past different prediction models has been used. The most important kinds of them include: linear or polynomial regression techniques, spontaneous regression, moving average, Box & Jenkins methods, structural methods and time series. But these methods have some problems which do not consider to complex and nonlinear factors of prediction.

In recent decayed, a new method of prediction is invented which is called Artificial Neural Networks (ANN).This method can discover relations between complex and nonlinear variables by learning process of human brain.

Neural networks use for prediction stocks index because of ability to design nonlinear relations between inputs and outputs. Instead of efficient market some studies have demonstrated that financial market and other complex systems are disordered. Disordered is certain nonlinear process which happens randomly because it is not easy to explain it. Using neural networks in disordered and nonlinear educational systems can have higher function instead of tradition analysis and other computer methods.

Wavelet theory can analysis time series by various scales and for recognizing cycle in time series has better operation than other methods [7]. So in the present study wavelet neural networks is used for prediction.

Artificial Neural Network (ANN)

Artificial neural networks are simpler model of real neural networks which have a lot usage in solving various types of science. They contain classified usages such as: interpolated use, estimate and detection. The most benefit of these networks is high ability of them beside easier use of them [8].

ANN is a structure which includes some unit (artificial neurons) that is linked into the network. Each unit has an I/O property and

carries out partial action or calculates. Each unit determines internal connections with other units and/or inputs of output according to itself properties [9].

Wavelet transform

Wavelets are mathematical functions which have separated data to frequency components and study each component with proper showing of tat component scale. One of the wavelet benefits is high ability of analysis in the condition which signals have quick jump and tear [10].

Wavelet has root in the Fourier analysis, but there are serious differences between them. Continues wavelet transform id defended as follows:

1)

$$CWT_x^{\psi}(\tau,s) = \psi_x^{\psi}(\tau,s) = \frac{1}{\sqrt{|s|}} \int_{-\infty}^{+\infty} x(t)\, \psi^*(\frac{t-\tau}{s}) dt$$

T and S are showing transform and scale parameters. Transform concept is exactly similar to timing transform concept in Fourier transform of short time which determines transform range; also it is include transform timing information. Instead scale parameter is in connection with frequency as converse. On the other word, S= 1/f. in formula No.1 sign ψ is window function which is called mother wavelet. Mother lexis uses because all the transformed and scaled versions obtain from the primary function. In scientific express, mother wavelet is a template function in order to producing other functions.

Principle of Direct wavelet transform (DWT) is derived from sub-band coding method which has invented in 1976. This technique is similar to CWT which presents a kind of time scaling description in direct signal by digital filters. In direct mode signal resolution determines by filters operation.

Process of DWT begins with passing a signal from low-pass digital filter by response to the h[n] impulse. So, filter output is equal to input convolution and impulse response of filter. As a result of mentioned filtering, all the frequency elements which are more than half of biggest frequency will be removing. Because of removing one sample signal length will be half without losing the data. Similar process happen using high-pass filter by response to g[n] impulse. As a result in the first output step of wavelet transform two copies are obtained which are high and low pass with half length of primary signal as follows:

2) $$y_{high}[k] = \sum_n x[n].g[2k-n]$$

$$y_{low}[k] = \sum_n x[n].h[2k-n]$$

With this work time resolution is halved and frequency is doubled. This process can be

applied in the low-pass copy and in each level by increasing time resolution to the semi range of previous level, frequency resolution will be doubled. This idea is famous for calculation DWT to filter bank. Output coefficients of low-pass filter fallow the primary signal shape, so these coefficients are called approximation. Also, output coefficients of high-pass contain high frequency of signals, so these coefficients are called details. By increasing transform steps number of details decreases.

Single-level discrete

Stock index data have a lot noise. These noises can remove from data by Direct Wavelet Transform. There are lots of violets to administrating DWT. They have their own operation with resolution and administration capacity, calculating cost and other individual properties. In the present study, violet Daubechies (db5) has been used which happens in five levels **(Figure 2)**.

In the present study, sample data noise of stock index is reduced by db5 wavelet analysis. For instance, wavelet analysis of whole stock index in years 2002 and 2003 are shown in following **Figure 3**.

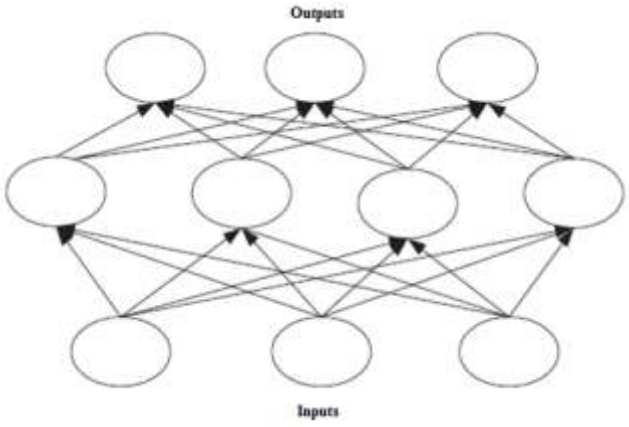

Figure 1: Artificial Neural Network

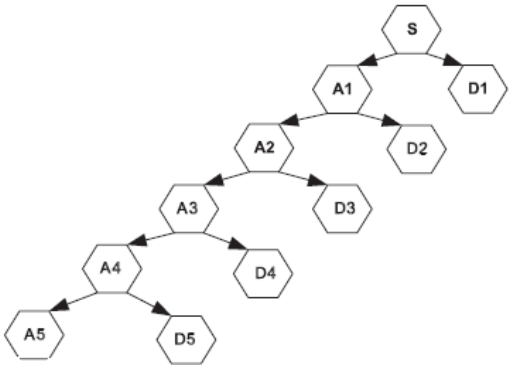

Figure 2: Five surface of wavelet analysis

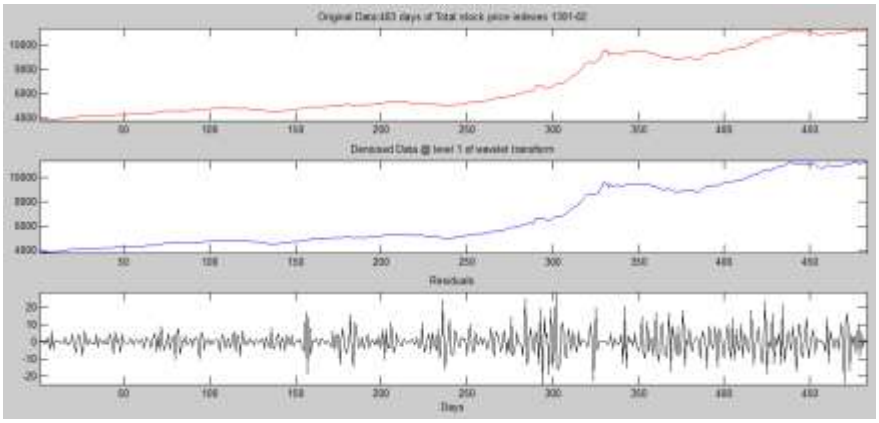

Figure 3: wavelet analysis of total index in years 2002-2003

WDBP wavelet neural network

Various methods of neural network have been applied on investment. In the present study, neural network of Bp is selected because of its common usage in short time prediction. Instead other BP methods which create directly by primary data, in the present study at first primary data decompose into layers by wavelet transform.

In the present study, a BP neural network is selected which has an input layer of three neuron, a hidden layer of ten neuron and an output layer of three neuron.

Literature

Efforts for stock market forecasting began from the beginning of the twentieth century. Investors in Stock exchange market believed historical study on prices includes suitable information in order to prediction prices in the future. So that changes samples are known by obtaining prices process. These thoughts are called chartist because of focusing on charts. In their opinion fundamental analysis is not important and their supporters believe history will be repeated.

Another study was started in opposite of mentioned idea from 1930s.Primary focus of this study was on random behavior of prices and disobeying prices of specific process. Results of these studies have been entranced to economic and investment subjects as an intellectual and theoretical follow, and prices behavior theory was shaped.

After 1960s studies have gone to the economical properties of stock market which caused to random changes and statistical shape of prices behavior had been removed. This issue causes to appearing market theory. Fundamentalists believe by analysis of key financial and economical functions can evaluate real value. According to this theory, no one cannot achieve yield in long terms as systematic more than that risk which is paid. In that market the price of stocks is reflection of related information to them, also prices do not have a specific template and are not predictable [11].

However, conducted studies on Stocks data markets have demonstrated market is predictable. White (1998) had presented clear sign that market does not follow the random step. This issue was correct for market data and his study period time. In the recent years published reports have shown efficient market hypothesis is so far from reality. Anderloo & Mckinley Creek (1988) have conducted the study which demonstrates stocks yield is not follow random step. They investigated weekly stocks yield and compared data variance in various times, so they refuse random step method in total data from 1963 to 1985. Also in an investigation by Fama (1991) indicated that efficient market hypothesis is definitely wrong.

BACKGROUND

According to the present study, Dr. Raee & Chavoshi have conducted a study under the title of "Prediction of stock index in Tehran stock exchange: neural network and multi-factorial method." They considered stocking yield behavior in Tehran stock exchange by functional-liner model and ANN. In order to examination of this issue daily stock yield of industrial development company in Behshahr has selected as a sample. Independent input variables are five great economic variables like: total yield index of Tehran stock exchanges, exchanges rate(dollars) in free market, petro and gold yield. In the present study, neural network had fewer errors towards multi-factorial method in sample prediction [12].

In another study Dr. Tabrizi.H & Panahian. H have conducted a research under the title of "prediction of stock yield using artificial

neural network: investigating Tehran Stock Exchanges." They used ANN to find and determine the relation between some independent parameters on the stock indexas a dependent variable. Results have shown ANN was better than other parametric models such as Regression and statistics techniques.

Dr. Namazi Mohammad & Kiamehr Mehdi have conducted an investigation on stock yield behavior of Tehran stock exchange under the title of "prediction of daily stock yield of accepted companies in Tehran stock exchange using ANN." According to the study result, behavior of stock timing series is not accidental during years 1998-2003 and it has a memory. Also ANN can predict daily yield with quiet fewer errors.

Iskandar Nadia &Saskatchewan Regina (2005) has conducted a study under the title of "ANN method to short time prediction of stock price index." They tried using ANN predict stock price index.At presented method some economic index are gave as an input. They had done predictions for next day, next week, next two weeks and next month. Also structure of their network was a neural network as 1-10-1 and repeated twenty-five times in order to investigating random primary weight. Results have shown ANN can do short time prediction well. It means next day and week prediction was acceptable. But in long time prediction (for e.g. next two weeks and month) presented method couldn't have a good result.

Hoajeng (2003) has used artificial neural network to prediction final price of future stock. In present study, three different portfolios have been created to comparing between them. In the first portfolio judgmental forecasts is used. In second portfolio neural network is used for forecasts, and in the third portfolio optimized CAPM method is used by ANN which has achieved more than yield toward other portfolios.

Jian Wang and et al. (2011)in a study using Wavelet neural network based on confusion reduction have considered on stock price index forecast after producing error. They have compared themselves ANN model with producing error algorithm. They are found confusion reduction of data causes to improvement of ANN forecast.

METHODOLOGY

Hypothesis in the present study indicate that there is significant difference between forecasted values of stock index in WDBP method with forecasted values in BP method.

The aim of present study is applied and using analytical method. Applied study finds a solution for available problem in society and

industrial organizations. But fundamental research need generalities and knowledge is goal of it. Also present study is applied because researcher cans analysis and evaluates them by available data and truths [13].

Data collection is obtained by available data and statistics in database of Tehran Stock Exchange and Tehran Securities Exchange Technology Management Co.

After data collection forecast has been done by MATLAB software and programming in system. In the present study evaluation norm was root-mean-square error (RMSE) in order to comparing forecasted and real values.

Statistical society in the present study includes all the accepted companies in Stock Exchange where are active in Tehran Stock Exchange during the study time. The statistical sample contains total stock index in Tehran Stock Exchange. Period time of present study was from beginning of the 2002 to 2011.Sampling method is judgmental as daily information of indexes is available for mentioned time. In the present study due to creating the method for prediction of stock index 2585 extracted data is used from daily transactions of stock exchange.

Nine steps in designing Wavelet neural network is shown in the following **Table 1**.

Table 1: Designing step in wavelet neural network

Step 1	**Selecting variables**
Step2	**Data collection**
Step3	**Wavelet transform and extraction of primary data**
Step4	**Separating learning and testing data**
Step5	**Neural network basis contain number of input, hidden and output layers, transition function**
Step6	**Evaluation norms**
Step7	**Artificial neural network training and number of repetition in network training**
Step8	**Data testing using new data**
Step 9	**Comparing neural network forecast and wavelet neural network**

RESULTS

After performing the plan for six different modes of input data has happened in two years in order to final fifty days prediction of total index. They have shown in the follows as a sample of years 2002 and 2003.

In the mentioned **Figures 4-9** green lines are indicated neural network prediction, blue lines are indicated main data and red lines are indicated prediction error rate of main data. Obtained values by B Pare prediction neural network with primary data. Also, obtained values from BP1to BP5 are neural network prediction with obtained data from different surface of wavelet analysis.

After happening forecast, results compare together by evaluation norm (RMSE). Model which has fewer errors is desired response. Error rate of each model is shown in the **Table 2**.

Obtained results from BP0 column is root-mean-square errors of artificial neural network and obtained values from BP1 to BP5 columns is root-mean-square errors of Wavelet neural network. Values which are obtained from out of the table are lowest value of RMSE between different kinds of Wavelet neural network.

After determining error rate by RMSE, Wilcoxon examination was used in order to identify signification difference between artificial neural network forecast and wavelet neural network forecast. Wilcoxon is a nonparametric examination and belongs to variables with ranking scale. By this examination before and after compared of variable statues is possible.

Obtained results from Wilcoxon examination are shown in the **Table 3**:

Analysis's results of SPSS by Wilcoxon examination for research hypothesis indicate significant is less than 0.05 and H0 hypothesis will be refuse. So, prediction of wavelet neural network method is better than prediction of neural network.

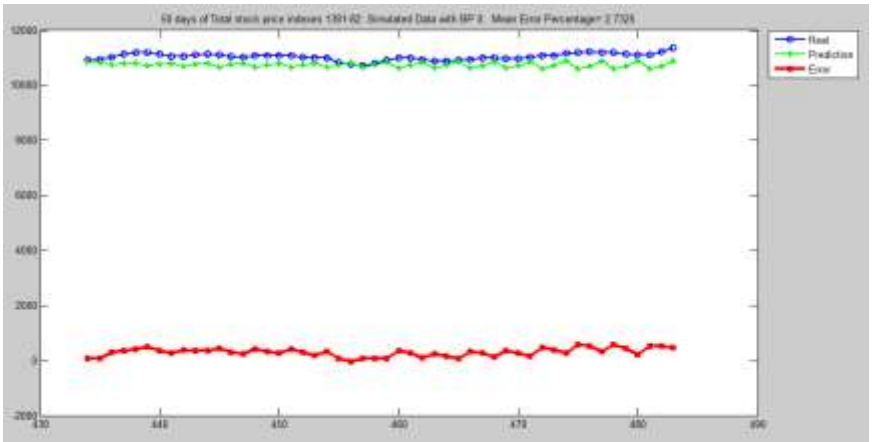

Figure 4: total index prediction in years 2002-2003 by BP Neural Network

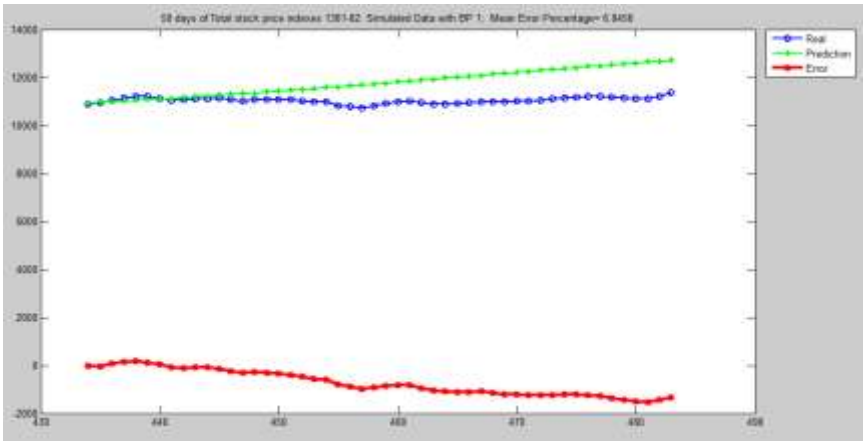

Figure 5: total index prediction in years 2002-2003 by BP1 Neural Network

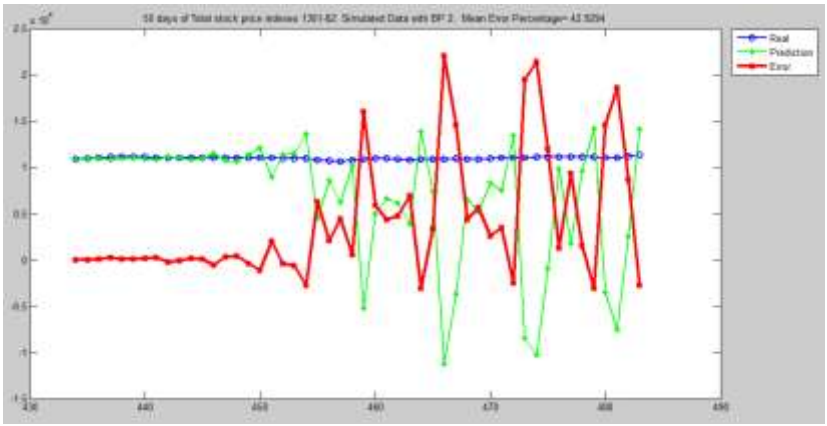

Figure 6: total index prediction in years 2002-2003 by BP2 Neural Network

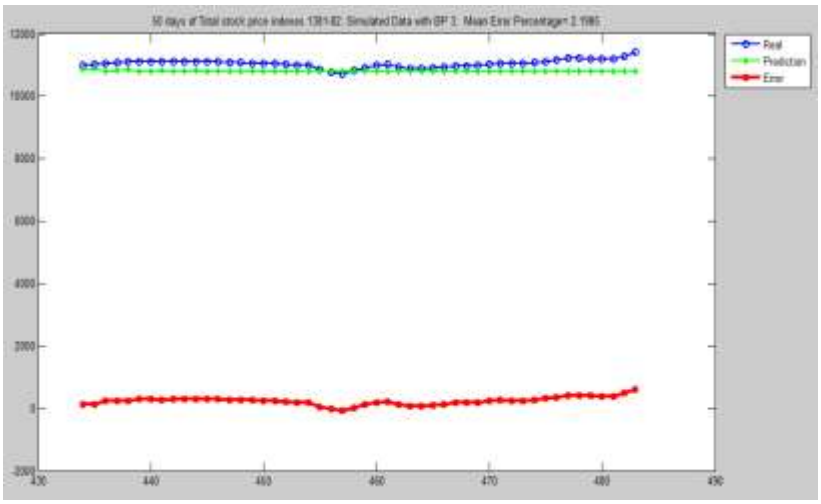

Figure 7: total index prediction in years 2002-2003 by BP3 Neural Network

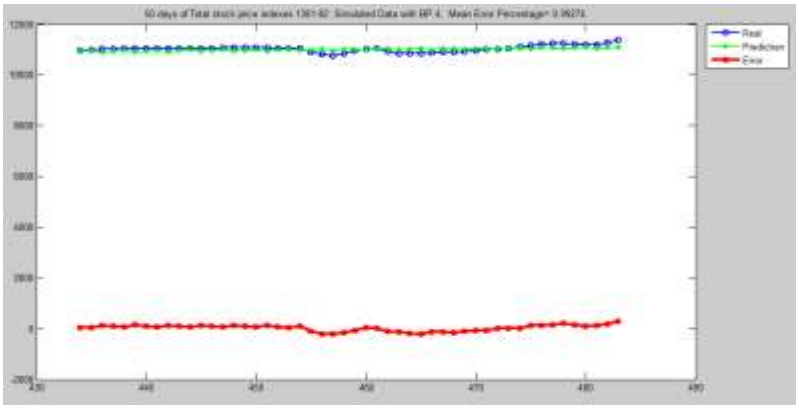

Figure 8: total index prediction in years 2002-2003 by BP4 Neural Network

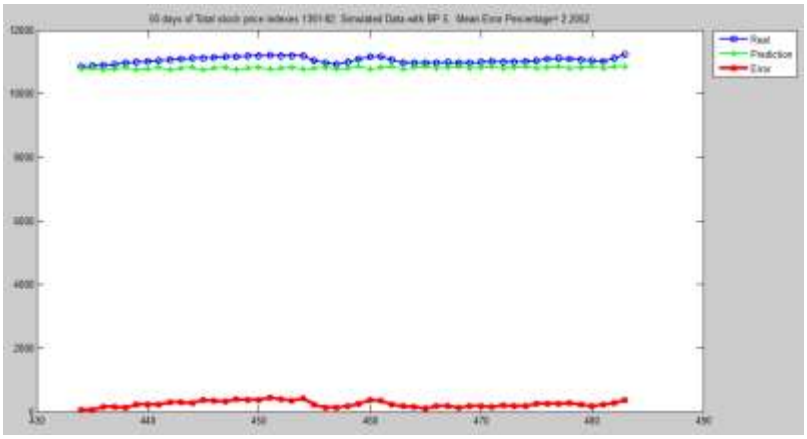

Figure 9: Total index prediction in years 2002-2003 by BP5 Neural Network

Table 2: Comparing RMSE for total index forecast in each yield

RMSE	BP0	BP1	BP2	BP3	BP4	BP5

Total 1381-82	**335.479**	**904.238**	**7753.775**	**270.44**	**123.471**	**261.981**
Total 1383-84	**3222.495**	**3755.974**	**586.4447**	**2576.967**	**2248.118**	**631.816**
Total1385-86	**382.61**	**2263.022**	**1377.909**	**513.661**	**1073.866**	**264.259**
Total 1387-88	**3204.592**	**3759.755**	**1547.027**	**557.655**	**670.946**	**4957.994**
Total 1389-90	**8491.275**	**11460.609**	**6574.137**	**8862.985**	**8595.396**	**18321.511**

Table 3: Information representation for Wilcoxon examination

Descriptive Statistics					
	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
bBP0	**5**	**3127.2902**	**3320.95060**	**335.48**	**8491.28**
bBP1	**5**	**1621.1938**	**2775.69395**	**123.47**	**6574.14**

Table 4: Obtained results by Wilcoxon examination

Teststatistic*b*	
	bBP1 - bBP0
Z	**-2.023[a]**
Asymp. Sig. (2-tailed)	**.043**
a. Based on positive ranks. **b. Wilcoxon Signed Ranks Test**	

CONCLUSION

Present study is trying to forecast total stock index of active companies which are in Tehran Stock Exchange. Investigation is indicated artificial neural networks have high potential in order to prognosticate. Also, wavelet transform can reduce errors which obtained by stock index forecast.

In present study has been tried to find best model for stock index forecast of active company in Tehran Stock Exchange by investigation different models of Artificial Neural Network. According to the ANN properties; since, artificial neural network has a good structure and using proper data be taught, prediction of short time future is possible.

According to the stock prices many economic factors are affected, such as political events, companies' policies, conditions of global economic, goods prices index, banks rate, investors expects,organizational choices of investors and psychological factors of investors. As a result, direct prediction of stock index using data which have noise usually has great errors. Present study has indicated using wavelet transform for removing data noisecauses to better and accurate forecast.

Suggestions

- It is suggested for future studies other methods of removing noise such as independent compounds analysis (ICA)is examined.On the other word, ability of different removing noise methods compare with each other. Also, it should be determined which removing noise method has high ability in prediction of time series.
- It is possible to investigate other variables effect like activation of function type, artificial neural network and/or wavelet function type on neural network method.
- Also it is suggested with consideration to research hypothesis people who are stepping to forecast of stock index or other financial functions in series time shape, is better at first,remove all the data noise and then proceed to forecast method. After that, they should transfer removed data noises to forecasted method as an input.

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