Forecasting Stock Market Using Wavelet Transforms and Neural Networks: An integrated system based on Fuzzy Genetic algorithm (Case study of price index of Tehran Stock Exchange)

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Abstract

The major purpose of the present research is to predict the total stock market index of Tehran Stock Exchange, using a combined method of Wavelet transforms, Fuzzy genetics, and neural network in order to predict the active participations of finance market as well as macro decision makers.

To do so, first the prediction was made by neural network, then a series of price index was decomposed by wavelet transform and the prediction made by neural network was repeated, finally, the extracted pattern from the neural network was stated through discernible rules using Fuzzy theory. The main focus of this paper is based on a theory in which investors and traders achieve a method for predicting stock market. Concerning the results of previous researches, which confirmed the relative superiority of non-linear models in price index prediction, an appropriate model has been offered in this research by combining the non-linear methods such as Wavelet transforms, Fuzzy genetics, and neural network, The results indicated the superiority of the designed system in predicting price index of Tehran Stock Exchange.

Keywords: Artificial neural network, Wavelet Transforms, Genetic Algorithm, Fuzzy Theory and Fuzzy Genetic System.

1. Introduction and Review of the Related Literature

Forecasting for stock price trend is a major requirement of planning. The stock market has become the main outlet for investment recently in many countries such as Iran. The futures indicator, investment foundations, foreign capitals are diverse choices for investors. (Chang et al,2009)

Two common analytical approaches to stock market analysis are fundamental and technical analysis. A fundamental analysis relies on the statistics of the macroeconomics data such as interest rates, money supply, inflationary rates, and foreign exchange rates, as well as the basic financial status of a company. After taking all these factors into account, the analyst can then make a decision to sell or buy a stock. A technical analysis is based on the historical financial time-series data. However, financial time series exhibit quite complicated patterns (for example, trends, abrupt changes, and volatility clustering) and such series are often nonstationary, whereby a variable has no clear tendency to move to a fixed value or a linear trend. During the last decade, stocks and future traders have come to rely upon various types of intelligent systems to make trading decisions. Lately, artificial neural networks (ANNs) have been applied to this area (Aiken & Bsat, 1999; Chang, Wang, & Yang, 2004; Chi, Chen, & Cheng, 1999; Kimoto & Asakawa, 1990; Lee, 2001; Yao & Poh, 1995; Yoon & Swales, 1991).

Other soft computing methods are also applied in the prediction of stock price. These approaches are to use quantitative inputs, like technical indices, and qualitative factors, like political effects, to automate stock market forecasting and trend analysis. Kuo, Chen, and Hwang (2001) used a genetic algorithm base fuzzy neural network to measure the qualitative effects on the stock price. They applied their system to the Taiwan stock market. Aiken and Bsat (1999) used a FNN trained by a genetic algorithm (GA) to forecast three-month US Treasury Bill rates. They concluded that a neural network (NN) can be used to accurately predict these rates.

Stock market forecasters focus on developing approaches to successfully forecast/predict index values or stock prices, aiming at high profits using well defined trading strategies. ‘‘The central idea to successful stock market prediction is achieving best results using minimum required input data and the least complex stock market model” (George & Kimon,2009). Considering this idea an obvious complexity of the problem paves the way for the importance of intelligent prediction paradigms (Abraham et al, 2001).

Studying literature shows, Forecasting techniques has advantages and disadvantages. One approach to deal with complex real-world problems is to integrate the use of several AI technologies in order to combine their different strengths and overcome a single technology’s weakness to generate hybrid models that provides better results than the ones achieved with the use of each isolated technique. Using hybrid models or combining several models has become a common practice to improve forecasting accuracy and the literature on this topic has expanded dramatically (Khashei et al, 2009).

Since decision making is always carried on with uncertainty, we are seeking to model uncertainty in decisions related to value investigating and to offer a method compounding Wavelet transforms and Fuzzy theory and Genetic algorithm and neural networks in order to predict price index of Tehran Stock Exchange.(TEPIX)

Tang et al (2010) proposed a model for the prediction of stock prices, using a compound of wavelet transform, recurrent neural network and bee colony algorithm. First, they disintegrated the price time series using har wavelet then the prediction was done by recurrent neural network and the obtained weights of neural network were optimized by bee colony algorithm. The offered model was examined on data of Dow Jones Industrial Average (DJIA), FTSE 100 index, London Stock Exchange (FTSE), Nikkei 225, Tokyo Stock Exchange (Nikkei) and Taiex index, Taiwan Stock Exchange. The given model was compared to compound model of neural network and bee colony algorithm, Fuzzy time series and Fuzzy neural network (ANFIS). The suggested model had less error than the other models in the all examined cases.

Hadavandi et al (2010) proposed a model for the prediction of stock price, using a compound of neural network and Fuzzy genetic. They examined the mentioned model on gathered information for IT and airline industry of New York Stock Exchange. The suggested model was compared to ARIMA and genetic algorithm and neural network which were used in prediction and in all cases it resulted better than the previous models.

Kuo et al (2001) proposed a genetic algorithm based fuzzy neural network (GFNN) to formulate the knowledge base of fuzzy inference rules which could measure the qualitative effect on the stock market. Next, the effect was further integrated with the technical indexes through the artificial neural network. An example based on the Taiwan stock market was utilized to assess the proposed intelligent system. Evaluation results indicated that the neural network considering both the quantitative and qualitative factors

excels the neural network considering only the quantitative factors both in the clarity of buying–selling points and buying–selling performance.

Wang (2002) proposed a hybrid model that uses a data mart to reduce the size of stock data and combined fuzzification techniques with the grey theory to develop a fuzzy grey prediction to predict stock price in Taiwan stock market. He concluded that the proposed

model can effectively help stock dealers deal with day trading.

Chang and Liu (2008) used a Takagi–Sugeno–Kang (TSK) type fuzzy rule based system (FRBS) for stock price prediction. They used simulated annealing (SA) for training the best parameters of fuzzy systems. They found that the forecasted results from TSK fuzzy rule based model were much better than those of back propagation network (BPN) or multiple regressions.

Hung (2009) proposed a new application of fuzzy systems designed for a generalized auto-regressive conditional heteroskedasticity (GARCH) model to forecast stock returns. The optimal parameters of the fuzzy membership functions and GARCH model were extracted using a GA to achieve a global optimal solution with a fast convergence rate for this fuzzy GARCH model estimation problem. The proposed model was also compared with the other methods, such as GARCH, EGARCH and outperformed them.

Majhi et al (2009) proposed a trigonometric functional link artificial neural network (FLANN) model for short (one-day) as well as long term (one month, two months) prediction of stock price of leading stock market indices: DJIA and S&P 500. They concluded that proposed model is an effective approach both computationally as well as performance wise to foresee the market levels both in short and medium terms future.

In 2007 Chung et al used a Fuzzy time series model for short-term prediction of Taiwan and Hong Kong stock market price. The obtained experimental results of this research indicate the fact that the traditional statistical method and offered model both makes it clear that stock price patterns are short-term in these two markets.

Lin et al (2007) used the genetic algorithm to predict stock market. The significant factor in a trading rule success is the selection of degrees for all parameters and their combinations. However, the range of parameters changes in a large area and the problem is to find the optimum parameter combinations. Genetic algorithm is used in this article to solve the problem.

Chen et al in 2007 used Fuzzy time series based on Fibonacci sequence to predict stock price. A time period of five years of data for TSMC and a time period of 13 years for TAIEX was taken in this research. The obtained model is superior to the prevalent Fuzzy time series model.

A review of existing literature indicates that traditional predicting methods have been mostly used in Tehran Stock Exchange and other areas in the world. Concerning the fact that in making use of the traditional pattern, one should use static time series and since most economic time series are non-static, the traditional patterns are faced with a great prediction troublesome. Moreover, the artificial intelligence methods do not meet the problems of the traditional methods because of concerning static time series. Regarding these issues, wavelet transforms are utilized to combine one of the capable artificial intelligences' algorithm called genetic algorithm to neural network and fuzzy concepts in order to offer a prediction method for price index of Tehran Stock Exchange. (TEPIX)

1.2. Methodology

1.2.1. Wavelet transforms

Wavelet theory is applied for data preprocessing, since the representation of a wavelet can deal with the non-stationarity involved in the economic and financial time series (Ramsey, 1999). The key property of wavelets for economic analysis is decomposition by time scale. Economic and financial systems contain variables that operate on various time scales simultaneously; thus, the relations between variables may differ across time scales. One of the benefits of the wavelet approach is that it is flexible in handling highly irregular data series (Popoola & Ahmad, 2006).

This study applies the Daubechies wavelet as the main wavelet transform tool. A wavelet not only decomposes the data interms of times and frequency, but also significantly reduces the processing time. Let n denote the time series size, then the wavelet decomposition used in this study can be determined in O (n) time (Abramovich et al, 2002) Wavelets theory is based on Fourier analysis, which represents any function as the sum of the sine and cosine functions. A wavelet ψ(t) is simply a function of time t that obeys a basic rule, known as the wavelet admissibility condition (Gancay, 2002):

$$c_{\psi} = \int_{0}^{\infty} \frac{|\psi(f)|}{f} \, df < \infty \qquad (1)$$

Where ψ(f) is the Fourier transform and a function of frequency f, of ψ(t). The wavelet transform (WT) is a mathematical tool that can be applied to numerous applications, such as image analysis and signal processing. It was introduced to solve problems associated with the Fourier transform as they occur. This occurrence can take place when dealing with non-stationary signals, or when dealing with signals that are localized in time, space, or frequency. Depending on the normalization rules, there are two types of wavelets within a given function/family. Father wavelets describe the smooth and low-frequency parts of a signal, and mother wavelets describe the detailed and high-frequency components. In the following equations, (2a) represents the father wavelet and (2b) represents the mother wavelet, with j=1, . . ., J in the J-level wavelet decomposition: (Ramsey et al, 1998)

$$\phi_{j,k} = 2^{-j/2}\, \phi(t - 2^j k/2^j)$$

$$\psi_{j,k} = 2^{-j/2}\, \psi(t - 2^j k/2^j)$$

Where J denotes the maximum scale sustainable by the number of data points and the two types of wavelets stated above, namely father wavelets and mother wavelets, and satisfies:

$$\int \phi(t)dt = 1 \text{and} \int \psi(t)\, dt = 0 \qquad (3)$$

Time series data, i.e., function f(t), is an input represented by wavelet analysis, and can be built up as a sequence of projections onto father and mother wavelets indexed by both {k}, k = {0, 1, 2,. . .} and by {s}=2^j, {j=1,2,3,. . .J}. Analyzing real discretely sampled data requires creating a lattice for making calculations. Mathematically, it is convenient to use a dyadic expansion, as shown in equation (3). The expansion coefficients are given by the projections:

$$s_{j,k} = \int \phi_{j,k}\, f(t)dt$$
$$d_{j,k} = \int \psi_{j,k}\, f(t)dt \ (j = 1,2,\ldots,J) \qquad (4)$$

The orthogonal wavelet series approximation to f (t) is defined by:

$$F(t) = \sum_k s_{j,k}\, \phi_{j,k}(t) + \sum_k d_{j,k}\, \psi_{j,k}(t) + \sum_k d_{j-1,k}\, \psi_{j-1,k}(t) + \cdots + \sum_k d_{1,k}\, \psi_{1,k}(t) \qquad (5)$$

Another brief form can also be represented:
F(t) = $S_j\,(t) + \, D_j\,(t) + D_{j-1}(t) + \cdots + \, D_1\,(t)$
$S_j(t) = \, \sum_k s_{j,k}\, \phi_{j,k}(t)$
$D_j(t) = \, \sum_k d_{j,k}\, \psi_{j,k}(t)$ (6)

The WT is used to calculate the coefficient of the wavelet series approximation in Eq. (5) for a discrete signal$f_1, \; f_2, \; \ldots \; , f_n$ with finite extent. The WT maps the vector f = (f_1, f_2, … , f_n) to a vector of n wavelet coefficients w= ($w_1, \; w_2, \; \ldots \; , w_n$), which contains both the smoothing coefficient $s_{j,k}$ and the detail coefficients $d_{j,k}$, j = 1,2, . . ., J. The symbol $s_{j,k}$ describes the underlying smooth behavior of the signal at coarse scale2^j, while $d_{j,k}$ describes the coarse scale deviations from the smooth behavior, and $d_{j-1,k}$, . . . , $d_{1,k}$ provides progressively finer scale deviations from the smooth behavior (Adel et al, 2006).

When n is divisible by 2^j, $d_{1,k}$ contains n/2 observations at the finest scale 2^1 = 2, and n/4 observations in $d_{2,k}$ at the second finest scale, 2^1 = 2. Likewise, each of $d_{j,k}$ and $s_{j,k}$ contain n/2^j observations, where

n= $n/2$ + $n/4$ +…+ $n/2^{j-1}$+$n/2^j$ (7)

Let f (t) denote the original data, s_1, represents an approximation signal, and D_1 is a detailed signal. This study defines the multi-resolution decomposition of a signal by specifying: S_j is the coarsest scale and S_{J-1} = S_J +D_J. Generally, S_{j-1} = S_j +D_j where {S_J, S_{J-1},. . ., S_1} is a sequence of multi-resolution approximations of the function f(t), with ever increasing levels of refinement. The corresponding multi-resolution decomposition of f(t) is given by{S_J, D_J, D_{J-1},. . . D_j,. .. ,D_1}.

The sequence of termsS_J, D_J, D_{J-1},. . ., D_j,. . ., D_1 represents a set of orthogonal signal components that represent the signal at resolutions 1to J. Each D_{J-K} provides the orthogonal increment to the representation of the function f (t) at the scale (or resolution)2^{J-K}.

When the data pattern is very rough, the wavelet process is repeatedly applied. The aim of preprocessing is to minimize the Root Mean Squared Error (RMSE) between the signal before and after transformation. The noise in the original data can thus be removed. Importantly, the adaptive noise in the training pattern may reduce the risk of overfitting in training phase (Patterson, 1996). Thus, we adopt WT twice for the preprocessing of training data in this study.

1.2.2. Genetic Algorithm

Inspired by evolution theory and heredity and genetic principles, genetic algorithm seeks to find an appropriate solution for problems (Goldberg, 1989). To do so, first some accidental response are produced to the given problem and these primary responses are then evolved, using genetic principles and are converted to the appropriate response.
In the following part, genetics algorithm steps will be explained (Haupt, 1980)

1) First generation production: The production of N_{pop} accidental responses to the problem, each of which being appropriately codified in form of a chromosome.
2) Valuation: The criterion function determines the value of each chromosome with respect to their success in solving the problem. The best chromosome of each generation is called the elite chromosome.
3) The chromosomes are ordered descendingly according to criterion function and only %X of chromosomes are preserves and the rest will be thrown away. The possibility of a chromosome's conservation depends on its merit in such a way that those chromosomes which worth more, one more possible to survive. To substitute the thrown away chromosomes, those remained ones are chosen two by two as parents to generate chromosomes of the child. There are different methods for parents' selection. The Tournament Selection has been used in this article. First, a small collection of chromosomes is accidentally selected in this method and then the two chromosomes

with the highest value are selected as parents.

4) Genetic crossover: The parent chromosomes produce child chromosomes by crossing over their genes. There are different methods of gene crossovers. Two point crossovers is used in this article. Two parts of parents chromosomes are selected in this method which can be seen in the figure (1) . To produce child chromosome this way, gene-strings are copied from the beginning to the first determined place from one parent and the gene-strings between two determined places from the second parents and the rest of the genes are copied from the first parent.

Figure1. Two Point Crossover

5) Mutation: Some genes of the new generation chromosomes except the elite chromosome are selected randomly and their value will be changed. This way, completely new chromosomes will be obtained.

A return to the second step and the repetition of steps until the stop condition is provided which includes algorithm convergence and lack of change of the best chromosome for the number of pre-defined generations and the completion of the pre-defined generation. The structure of genetics algorithm is as figure2.

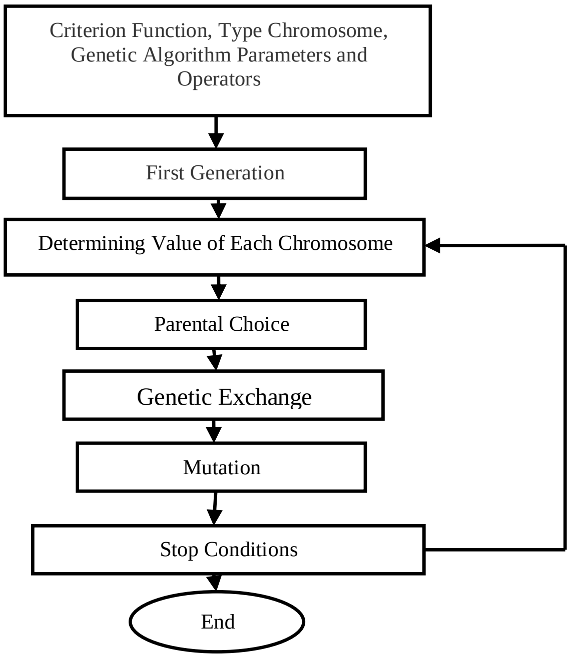

Figure2. Genetic Algorithm Structure

1.2.2.1. Extracting rule from neural network:

The major and main disadvantage of artificial neural networks is their disability in explanation and analysis. (Anderson et al, 1996). Neural networks are like continuous black boxes which make it difficult for neural network to perceive a solution. (Mantas et al, 2006). Therefore, the information used by neural network to achieve the solution is not clear to the users and that may cause trouble in some cases. (Huang, 2002)

To solve this problem, researchers tended to create a palpable and understandable technique for neural network. They believe that they could achieve their goal by extracting the produced rule of neural network. (Huang, 2002) The purported form of extracting a rule from the neural network is in the following way. (figure3)

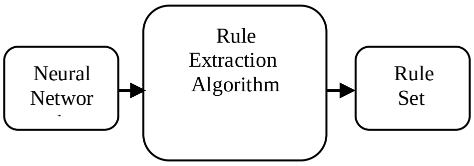

Figure3. Rule Extraction Structure

We use genetic Fuzzy system in this research to extract rule from neural network whose basic concepts are defined in the following way:

- Membership function: Every single input variable is transformed from the numerical form to Fuzzy form using fuzzy membership functions.
- Information base: This section includes necessary information about input and output variables and their governing rules. This section is itself constituted of databases and rule bases.
- Database: This section provides necessary definition about membership functions related to verbal terms and functions.
- Rule bases: This section is constructed of rules in conditional sentence form of "if-then" which are used to determine the output.
- Inference system: In this section, the controlling output is determined regarding Fuzzy making input, the information of rule bases and using fuzzy concluding methods.
- Difuzzifier: Difuzzifier displays the output Fuzzy set of conclusion system at a non-Fuzzy point. Actually, this section determines a point which is the best representative of Fuzzy collection.

The purported form of genetic Fuzzy system is in the following way (figure4):

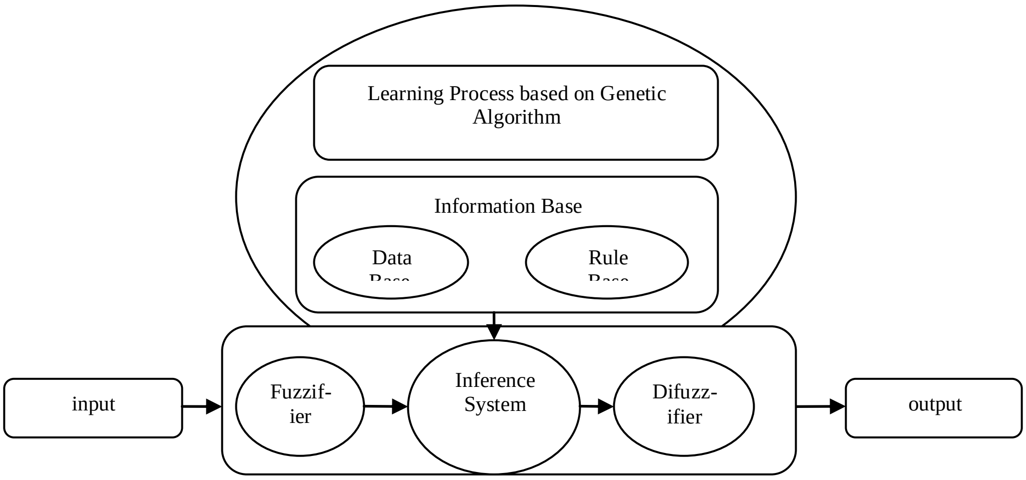

Figure4. Genetic Algorithm System

1.2.3. Research methodology

This research is carried out based on two dimensions: it is practical because of its purposes and it's analytical-descriptive because of its nature. A descriptive method combination including utilizing different related books and essays have been used to collect materials related to the research background. As well, reports of Stock Exchange Corporation and websites have been used to gather data for research information. Framework of proposed method has shown in Figure5.

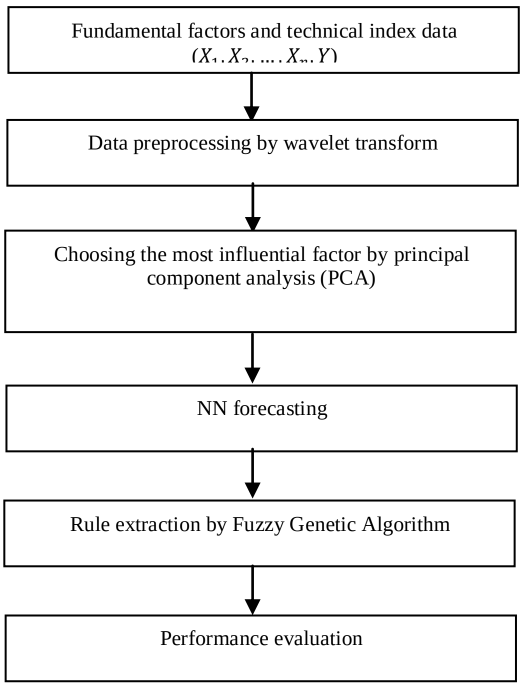

Figure5. Framework of W-FGA-NN

1.3. Results and Discussion

The daily price index of Tehran Stock Exchange from 2005 to 2011 has been selected as the statistical population, 1383 data were accumulated for each variable from related databases in the aforementioned period. The above-mentioned data were divided to two groups of training and experimental regarding the structure of neural network. Each group is respectively consisted of 1341 and 42 data and it should be also noted that mainly the accomplished prediction for the experimental period was selected as the comparison criterion for models used in prediction. In this study, 15 economic variables have been extracted by using (Gan et al, 2006 ; M. Ibrahim et al,2003; Adam,2008; Gay et al, 2008) the explanation that illustrates the relationship between economic variables and stock market with special focus on Johnson's co-integration method considering the economic situation of Iran. Principal Component Analysis (PCA) was performed for refining data and eliciting 4 variables (S&P 500, oil price, exchange rate) that explain 89.3% of changing these data. After that the stock market forecasting has been defined.

Methods of price index modeling will be explained in this section:

Preparing data is one of the complicated steps of neural network applications, since the best condition for neural network is when all the inputs and outputs are between 0 and 1. One of the reasons which emphasizes on inserting inputs in range of 0 and 1 is the fact that transfer functions (such as sigmoid function) are unable to differentiate between large amounts. Therefore, the whole data were normalized using this formula: $X_n=X/X_{max}$

Then, variables of S&P500 index of New York Exchange Stock, world gold price, Iran basket crude oil price and state dollar value were determined as neural network concerning studies based on the effective elements on price index. Prediction using MLP is made in such a way that the best output weight with the least prediction error is selected by imposing training and learning on the network. After normalizing data, they were given to the network. That is, data were delivered to two groups in order to examine the consistency of the output weight focusing on a way that first acquisiton is done according to obtained data from predictions in order to examine the accuracy of network prediction. About %97 of the total data were considered as training data and the rest were used to examine the network. The amount of network learning was continuously examined during the learning process and finally a network with the least error was selected. The parameters of final neural network were determined as is shown in the following table1:

mom	Epoch	Hidden	Learning rate	Activation function
0/01	90000	3	0/1	Non-linear Sigmoid

Table1. MLP character

In the Figure6, the prediction done by neural network has been compared to real values for experimental data:

In addition, values of examination criterion of functionality which is used for this model is demonstrated in table2:

ADJR^2	R^2	MAPE	MSE
0/9541	0/9586	0/0055	0/0048

Table2. Examination criterion of MLP

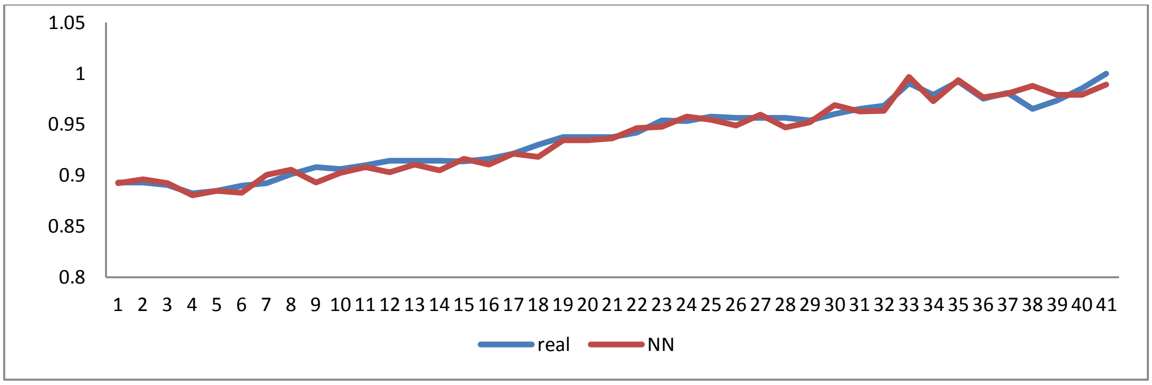

Figure6. Neural Network Prediction

Concerning the amount of R^2 and adjusted R^2 obtained from fitting model, it can be concluded that the presented neural networks model is an appropriate model of price index prediction. It was confirmed that the model with R^2 has been able to predict correctly the trend of price index of Tehran Stock Exchange for %95.

In this sections Daubechies wavelet has been used and the first set for two levels has been analyzed, so that the smooth's set was separated from low-frequency parts of a signal. Then MLP was utilized for stock forecasting, the parameters of final neural network were determined as it is shown in table3:

mom	Epoch	Hidden	Learning rate	Activation function
0/15	50000	3	0/2	Non-linear Sigmoid

Table3. MLP character

Since Fuzzy principles and rules have been used in this research to extract rule with the help of genetic algorithm and data exits and entrances, first step is to introduce membership functions to each variable. Triangular membership functions have been used in this article. The triangular membership function which is used here consists of five sizes of Small (S), Medium Small (MS), Medium (M), Medium Large (ML) and Large (L) which are shown table4:

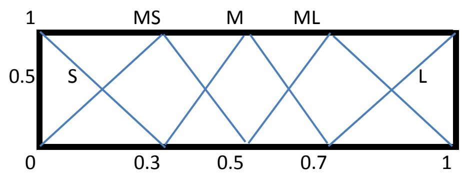

Table4. Membership Size Function

Next step is to acquire genetic algorithm to elicit a set of rules. However, its necessary condition is to introduce the fitness function in

order to begin learning genetic algorithm and achieve appropriate rules. Fitness function is the least space between the estimated output by genetic algorithm and MLP network output in this research which is selected as the appropriate rules.
There are different parameters in genetic algorithm as well in order to train and learn genetic algorithm whose sizes are selected through trial and error methods to reach appropriate rules. After learning with so much of these parameters, Fuzzy genetic algorithm was finally selected as the final model with the following parameters.

Membership Size	**Mutation prob**	**Cross prob**	**Swarm Size**	**Iteration**	**Chromosome Size**
5	0/5	0/6	5	150	120

Table5. Fuzzy Genetic Algorithm Parameter

The rules of examination criterion of functionality which are used for this model are shown in table6:

If X_1 is ML and X_2 is MS and X_3 is M and X_4 is M then Y is L
If X_1 is ML and X_2 is MS and X_3 is L and X_4 is L then Y is L
If X_1 is L and X_2 is ML and X_3 is M and X_4 is M then Y is ML
If X_1 is L and X_2 is L and X_3 is ML and X_4 is ML then Y is ML
If X_1 is M and X_2 is MS and X_3 is ML and X_4 is ML then Y is M
If X_1 is ML and X_2 is M and X_3 is ML and X_4 is ML then Y is M
If X_1 is ML and X_2 is MS and X_3 is MS and X_4 is M then Y is L

S=SMALL, MS=MEDIUM SMALL, M=MEDIUM, ML=MEDIUM LARGE, L=LARGE
Table6

After extracting the set of rules, we attempted to predict the price index relying on experimental data in order to examine the function and accuracy of the prediction techniques, so that it has predicted the trend of price index of Tehran Stock Exchange with an appropriate accuracy as is shown in the figure7:

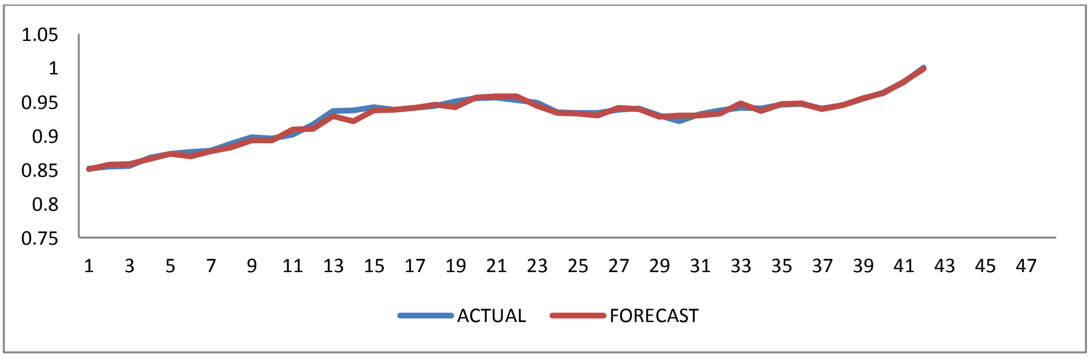

Figure7. W-FGA-NN System Prediction

In addition, values of examination criterion of functionality which is used for this model is illustrated in table7:

ADJR^2	**R^2**	**MAPE**	**MSE**
0/9803	0/9822	0/0035	0/0021

Table7. Examination Criterion of W-FGA-NN

Regarding the value of R^2 and the adjusted R^2 obtained from fitting the model, it can be concluded that the presented Fuzzy genetic model is an appropriated model for price index prediction, so that this model with R^2 has been able to predict correctly the trend of price index of Tehran Stock Exchange for %98.

1.4. Conclusion

The general goal of the current research was to offer an appropriate model for price index prediction of Tehran Stock Exchange. Concerning the results of previous researches which confirm the relative superiority of non-linear models in price index prediction, an appropriate model has been offered in this research by combining the non-linear methods including Wavelet transforms, Neural networks, and genetics algorithm with Fuzzy theory in order to predict price index of Tehran Stock Exchange. The technique we used for price index prediction has had a better result, as shown in table8, Regarding the R^2 examination criterion, these techniques also indicated its relative superiority when compared to neural network technique, ARIMA and Fuzzy Genetic Algorithm (FGA). The extracted rules can help the investors in their decision making related to investment.

R2 ADJ	R2	MAPE	MSE	
0/9541	0/9586	0/0055	0/0048	MLP
0/9263	0/9333	0/0075	0/0088	ARIMA(3,1,2)
0/9656	0/9673	0/0050	0/0042	FGA
0/9803	0/9822	0/0035	0/0021	W-FGA-NN

Table8. Comparison Method

References

* Abraham,A., & B. Nath, P.K. Mahanti.(2001). Hybrid intelligent systems for stock market analysis, in: V.N. Alexandrov, J. Dongarra, B.A. Julianno, R.S. Renner, C.J.K. Tan (Eds.), Computational Science, Springer-Verlag, Germany, pp. 337–345.
* Abramovich,F. & Besbeas,P.& Sapatinas,T.(2002). Empirical Bayes approach to block wavelet function estimation. Computational Statistics and Data Analysis , 435–451.
* Adam, A,M. & Twenboah, G. (2008). Macroeconomic factors and stock market movement: Evidence Ghana, Monich Personal RePEc Archive.
* Aiken, M., & Bsat, M. (1999). Forecasting market trends with neural networks. Information Systems Management, 16(4), 42–48.
* Anderson J.A. (1996). Neural models with cognitive implications. In Basic Processes in Reading Perception and Comprehension Models, pp.27-90.
* Chen, T,L.,& Cheng, C,H.,& Teoh, H, Jong. (2007). Fuzzy time-series basedon Fibonacci sequence for stock price forecasting. Physica A 380, 377–390.
* Chang, P, C., & Liu, C, H. (2008). A TSK type fuzzy rule based system for stock price prediction, Expert Systems with Applications 34, 135–144.
* Chang, P. C., Chen, H.L., & Jun, L.L., & Chin, Y.F,, & Celeste, S.P.Ng.(2009) . A neural network with a case based dynamic window for stock trading prediction. Expert Systems with Applications,36,6889-6898.
* Chang, P. C., Wang, Y. W., & Yang, W. N. (2004). An investigation of the hybrid forecasting models for stock price variation in Taiwan. Journal of the Chinese Institute of Industrial Engineering, 21(4), 358–368.
* Chi, S. C., Chen, H. P., & Cheng, C. H. (1999). A forecasting approach for stock index future using Grey theory and neural networks. In IEEE international joint conference on neural networks (pp. 3850–3855).
* Gay, R,D.(2008). Effect of macroeconomic variable on stock market returns for four emerging economies: Brazil, Russia, India and China, International Business and Economics Research Journal 7, 8.
* Gan, C., & Lee, M., &Yong, H.H.A, & Zhang, I. (2006). Macroeconomic variables and stock market interactions: New Zealand evidence. Investment management and financial innovations,3.
* Gencay,R. & Selcuk,F. & Whitcher,B.(2002). An Introduction to Wavelets and Other Filtering Methods in Finance and Economics. Academic Press, New York .
* Goldberg,D. (1989). Genetic Algorithms in Search, Optimization and Machine Learning , Addison-Wesley.

* George,S,A., & Kimon,P,V.(2009) .Surveying stock market forecasting techniques – Part II: soft computing methods, Expert Syst. Appl. 36, 5932–5941.
* Hadavandi,E.,& H, Shavandi , A, Ghanbari. (2010). Integration of genetic fuzzy systems and artificial neural networks for stock price forecasting. Knowledge based system 23, 800-808.
* Haupt, R,L., & Haupt, S,E. (1980). Practical Genetic Algorithms. Second Edition.
* Hung, J,C.(2009).A fuzzy GARCH model applied to stock market scenario using a genetic algorithm, Expert Syst. Appl. 36, 11710–11717.
* Huang, S. (2002). Extract intelligible and concise fuzzy rules from neural networks. Fuzzy Sets and Systems, 132, 233-243.
* Ibrahim, M.H. & Aziz, H. (2003). Macroeconomic Variable and the Malaysian Equity market: A view through rolling su sample. Journal of Economic studies,30,22.
* Khashei,M., & M. Bijaria, G.A. Ardali.(2009). Improvement of auto-regressive integrated moving average models using fuzzy logic and artificial neural networks (ANNs). Neurocomputing 72, 956–967.
* Kimoto, T., & Asakawa, K. (1990). Stock market prediction system with modular neural network. IEEE International Joint Conference on Neural Network, 1, 1–6.
* Kuo, R. J., Chen, C. H., & Hwang, Y. C. (2001). An intelligent stock trading decision support system through integration of genetic algorithm based fuzzy neural network and artificial neural network. Fuzzy Sets and Systems, 118, 21–24.
* Lee, J. W. (2001). Stock price prediction using reinforcement learning. IEEE International Joint Conference on Neural Networks, 1, 690–695.
* Lin, L., & Cao, L., &Wang, J.,& Zhang, Ch. (2007).The Application of Genetic Algorithms in Stock Market Data Mining Optimization, Faculty of Information Technology, University of Technology, Sydney, NSW, Australia.
* Majhi,R.,& Panda,G., & Sahoo, G.(2009). Development and performance evaluation of FLANN based model for forecasting of stock markets, Expert Syst. Appl. 36, 6800–6808.
* Mantas, C. (2006). Extraction of similarity based fuzzy rules from artificial neural networks. International Journal of Approximate Reasoning, 43, 202-221.
* Patterson, D.W.(1996). Artificial Neural Networks: Theory and Applications, Prentice Hall.
* Popoola,A. & Ahmad,K. (2006).Testing the suitability of wavelet preprocessing for TSK fuzzy models. in: Proceeding of FUZZ-IEEE: International Conference Fuzzy System Network , pp.1305–1309.
* Ramsey,J,B. (1999). The contribution of wavelets to the analysis of economic and financial data. Philosophical Transactions of the Royal Society of London Series A-Mathematical Physical and Engineering Sciences ,2593–2606.
* Tang, J, H., & H. F, Hsiao,& W. C, Yeh. (2010). Forecasting Stock Market Using Wavelet Transform and neural networks: An Integrated system based on artificial bee colony alghoritm, Applied soft computing , Gmodel.
* Wang, Y,F.(2002). Predicting stock price using fuzzy grey prediction system, Expert Syst. Appl. 22, 33–39.
* Yao, J., & Poh, H. L. (1995). Forecasting the KLSE index using neural networks. IEEE International Conference on Neural Networks, 2, 1012–1017.
* Yoon, Y., & Swales, J. (1991). Prediction stock price performance: A neural network approach. Proceedings of twenty-fourth annual Hawaii international conference on system science, 156–162.