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Designing a Prediction Model for Stock Exchange Market based on Self-Organizing Neural Network (SONN) Algorithm

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ABSTRACT

The present article uses self-organizing neural network algorithm to predict the changes in the stock exchange market. Following the investigations, it was found that little work has been done on the fundamental data of securities exchange market. Therefore, the fundamental and technical data and a combination of both data types were compared and it was made clear that the combined data are better for prediction. Aiming at improving the prediction power, the head and shoulder pattern was added to the stock exchange market's data. It has been shown using this pattern and assisted by the MATLAB's box of neural network tool that this pattern causes improvement in the predictions.

Key words: predict model,self-organazing neural network,stok exchange market ,meta-heuristic algorithms

1. INTRODUCT,

In the today's world, people are seeking for a method to improve and advance their economic state considering the changes made in their lifestyles. Income increase is amongst the most important methods for improving the financial status. One of the easiest ways is investment that also features various dimensions. In Iran, more individuals are dashing towards the stock exchange market every day considering the severe changes in the gold coin and foreign currencies' variations. One of the most fascinating issues in the stock market is achieving a method that increases the capital and reduces the losses to the maximum possible extent. Shares in the stock market can be riskily bought and sold and there are either a lot of profits or a lot of losses in such deals.

Since 1409, the goods and money exchange plazas and other means of making payments were created in Finland [1]. The money changers gathered around every day in Tobroes Square in front of the house of the well-known tradesman Vander Bourse for transactions. The theories posited till 1980s are well-indicating the behavior of the stock shares' prices in the exchange market. Afterwards, the changes in New York's stock exchange market in 1987 intensively questioned the validity of the theories on the efficient capital market and models like the prices' randomness [2]. When proper algorithms were presented for predicting the stock market, many tools were also introduced and subjected to trial and error in this regard. Amongst the most famous and most important instruments and algorithms, regression, neural networks and genetic algorithm can be pointed out. In between the investigated cases, neural networks algorithm have been more frequently applied for their more efficient performance [3].

Literature Review

The first work in the area of the stock market prediction using neural networks was done by a person named White [4]. He was looking for an answer to the question that whether neural networks can identify the nonlinear rules of the assets' prices variations and stock market changes or not? White's objective of presenting this article was showing the quality with which the neural networks can do so. After the preliminary study in 1988, the neural networks entered the financial area and numerous

researches were carried out in this regard. This method was applied for the market's previous prices found iterated in the form of an organized patter and the search for the organized patterns was found having a large effect on the prediction of the future changes. He showed how the neural networks can be used for recognizing the organized patterns from the irregular ones. Paul et al utilized neural networks and genetic algorithm for predicting the stock exchange market's index in Singapore and achieved an accurate rate [5]. Kim and Han (2000) endeavored to improve White's work. Neural networks and genetic algorithms were applied for predicting the stock exchange market's index of Korea. In this research, an adjusted neural network was used for by genetic algorithm for the future prices' time series complexities. In this case, genetic algorithm was utilized for predicting the weekly stock exchange market that was constantly undulating [6]. Chiang et al used a neural network to predict the net prices of the assets belonging to investment companies in the end of the fiscal years [7]. They compared the network's data and the results of their works with the findings obtained from the other previously invented techniques and found out that the neural networks specifically outperform the regression methods. In another research, the insertion of such quality factors as political effects along with the other factors into the genetic algorithm was investigated and it was concluded that the evolutionary trend like propagation, mutation and crossover influence the explorations of the complexities [8].

To perform the prediction operation by the aid of the neural networks, it is of a great importance to choose the right neural network; for example, the subset of the proper optimization features, determination of the optimal number of process layers and selection of a type of network to be trained are matters that should be taken into account in this regard. Many of the studies have compared the neural networks with statistical methods for pattern detection [9&10]. Yon et al have pointed to the superiority of the neural networks based on common and distinct analyses [11].

There is an increasing body of research recently on the SVM-assisted market prediction [12&13]. One of the best researches has been done in this area by Kim [14]. He applied SVM method for financial predictions and compared it with back propagation which is conducted in neural networks. Then, he applied case-based reasoning and the results of the studies indicated that SVM output features reduced risk structure for essential cases and that SVM leads to more generalizations in comparison to the old techniques. The method proposed by Kim is a mixture of genetic algorithm (GA) and CBR [15] and the result of this research was that the choice of the weight assignment method or the subset-allocation technique is of a great importance for reaching accurate results. In [16], data mining has been applied for obtaining association rules that can be utilized for extracting consecutive patterns wherein the customers' behaviors are analyzed in regard of a given goods and a purchase pattern is eventually attained for the retailing businesses.

Since the neural networks (NNs) can be widely applied in the operational environments, the present article uses this tool for improving the stock market's status and proper prediction of the stock exchange market's price variations. As an activity in the stock exchange market, the prediction of the financial time series is noteworthy. Prediction is the essence of the works in stock exchange market because it is prone to numerous variations. Many of the factors mutually influence one another in the stock shares' transactions such as the political events, the general economic conditions and the shareholders' expectations. Therefore, the stock shares' future prices can be figured out nonlinearly through time series data extraction based on many indicators rendering the prediction of such variations a lot difficult. The stock exchange market's factors underline the achievement of a lot of profits through the identification of index amounts or stock shares' prices. In fact, in order to find a solution, one should search for techniques that follow the time series rules. One useful tool for the prediction of the time series is the NNs which constitute a proper and favorable method for preventing the companies' financial bankruptcy. This area has drawn the attentions of various individuals from different fields due to its being widespread and useful. Using the data existing in the stock exchange market (new and old data), the stock exchange market is predicted on a daily basis. This helps the businessmen and businesswomen and companies in their purchases of the interested shares, their chosen shares of the other firms or their keeping or selling of certain companies' shares. The other point is that the NNs investigate the processes featuring various parameters with different degrees of importance so as to reach appropriate answers for various cases.

2. Proposed Method:

In capital market, the shares' values are determined based on their prospective profits and sureness of

these profits' actualization and the higher the sureness of the achievement of higher profit, the lower the risk of losing the principal and its interests and profits. Many factors and variables influence in capital market and in macro-level the profit certainty or uncertainty as well as the financial assets' price variations. Due to the same reason, the fundamental method tries precisely examining the environmental factors that might influence the stock shares' prices movement hence the financial assets' output. In this method and in order to analyze the options available for making investment I the securities exchange market, attention should be normally paid to three essential stages, namely company analyses, investigation of the country's economic situation and investigation of the industry of choice. In this regard, the data classifications include the amount of profit obtained within a year, the mean value of the offered prices within a year, the mean value of the demands within a year and the one-year status of the company's stock shares' index.

The technical analysts believe that all of the required information is latent inside the prices in the stock market. Concentration on the prices of the previous and current shares and prediction of their future changes enable making a good choice in the stock exchange market. In fact, the proponents of the technical method, unlike the fundamentalists who emphasize on why the prices are so, focus on the quiddity of the prices. This kind of investment is made through studying the behavior and movements of the stock shares' prices in the past and determination of the prices and their future trends and the possibility of a similar patter's repetition in the upcoming year. In this regard, the supporters of the technical method express that all of the current events of a country's economy as well as industry and the shareholders' expectations finally exert their own specific effects on the stock shares' prices. Thus, it is needed to carefully examine the historical background and diagram of the shares' prices.

It is necessary to point out that the studies conducted so far have used technical data in more than 90% of the cases. In this study, the fundamental and technical data and a combination of both have been dealt with. The thing that causes the researches distance away from such a kind of study is the unavailability of reliable and accessible resources. In this article, the nonstandard and sporadic data have been procured from Tehran's securities exchange market with a lot of struggles and they were subsequently found nonstandard, scattered and full of noise and a lot of time was spent on data preparation and data preprocessing. In general, data collection and data preparation for implementing the prediction operation is a very time-consuming process and appropriate data were eventually prepared with a lot of efforts and struggles for the prediction operation. Data preparation is important in that a correct answer cannot be reached in case of the least error in the data that would render prediction unreliable. It is hoped that better conditions are readied in future for performing researches on the securities exchange market so that better results can be obtained. The technical and fundamental data analyses of the selected company were analyzed based on the data acquired from Tehran's securities exchange market for 2011 by the assistance of MATLAB and through the neural network toolbox. To do so, two input and target datasets were separately needed for the technical and fundamental data analyses of the foresaid company. Figure (1) exhibits the stages of the proposed prediction method's implementation by the assistance of the neural network.

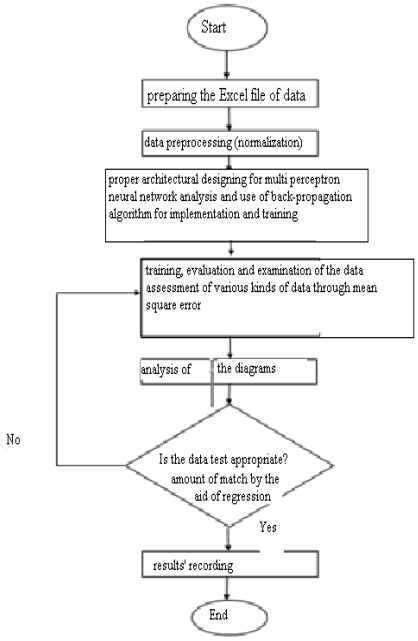

Figure (1): stages of implementing the NN-assisted proposed prediction method

2.1. TRAINLM Algorithm:

This algorithm is also called Levenberg-Marquardt and it is amongst the fast self-organizing algorithms using standard numerical optimization techniques. This method tries reducing the calculations by computing Hessian Matrix (the second derivative of data matrix). When the efficiency function takes the total sum of squares (as it is common in the feedforward neural networks), the Hessian matrix can be estimated by the aid of relations (1) and (2)

wherein j is the Jacobean Matrix including the first derivatives of the network errors in respect to the weights and biases and e is the network's error vector. Jacobean matrix is calculable by means of the standard self-organizing techniques and the complexity of its calculations is a lot lower in comparison to Hessian matrix's calculation.

$$H = JJ^T \quad (1)$$

$$g = eJ^T \quad (2)$$

Levenberg-Marquardt algorithm uses the approximation in relation (3) to compute Hessian matrix with X_k being the current vector of the weights and biases and X_{k+1} being the new amount (weights and biases).

$$X_{k+1} = X_k - [J^T J + \mu I]^{-1} \quad J^T e \quad (3)$$

When the amount of μ (mean) is zero, this transfer function can be transformed through approximation using a Newtonian method to Hessian Matrix. When μ is a large value, this transformation method is downsized by means of stepwise gradient method. Therefore, μ is reduced after every successful step which takes place when the target data and the data to be predicted are similar to a large extent. This amount of μ is increased only when the test step increases the efficiency function. In this way, the efficiency function is always being reduced in every reiteration.

2.2. Gradient Descent Training Set:

Gradient descent is a method for back-propagation networks' training set. In this method, the weights and the biases are updated conversely in respect to the efficiency function's gradient. Seven parameters are effective in the performance of this network. These parameters are epoch, min-grad, goal, show, max-fail time and max-fail. The rate of learning speed (Ir) is multiplied by the gradient and the result is used for updating the weights and biases. The training speed's rate causes an increase in the size of every correction step. If the learning speed is increased very much, the training would not have sufficient stability. In the meanwhile, the algorithm would take a lot of time to converge in case of this value's being too small. Cessation occurs when the number of reiteration specified in epoch parameter is reached or when the efficiency function's value decreases to a value smaller than goal value or when the gradient's value is decreased below the min-grad value and/or when the training takes a time longer than the period specified in time value.

2.3. Gradient Descent Training Set with Momentum:

TRAINGDM algorithm features a faster convergence for the training of the feed forward networks. Momentum allows the network to react to the gradient variations as well as the error level changes. Momentum causes the negligence of trivial errors. In this method, the maximum extent to which the weights can be changed is kept in a constant named mc and it can be a value between zero and unity. When mc is a value equal to zero, the weights' variations are calculated only based on the efficiency function's gradient. When mc takes a value equal to unity, the weights change only based on the latest variations of the previous weights and the gradient is ignored. If the amount of the efficiency function exceeds in one reiteration the amount in the previous iteration or a given amount, saying 1.04, the new weight and bias values are discarded and the mc amount is set at zero.

2.4. Determination of the Layer and Neuron Numbers:

In neural network, it is possible to change the number of layers and neurons. A given number cannot be set as the number of layers or the number of neurons because their numbers change depending on the type and threshold. Therefore, assisted by the mean square error, the numbers of neurons were investigated for different numbers of layers. All of the cases include the number of layers, the number of neurons and the mean square error as presented in table (1) [17].

Table 1: the layering types and neuron numbers

Number	Number of neurons	Mean	Square
2	10	0.009	
2	5	0.006	
3	20	0.0119	
3	20-10	0.009	
3	5-20	0.0495	
3	10-5	0.017	
4	10-20-5	0.042	
4	5-15-20	0.009	
4	15-5-10	0.008	
5	20	0.023	
5	5-10-	0.004	

	15-20		
5	20-15-10-5	0.010	

Table (1) shows that the mean square error is lower in the layer with 5-10-15-20 neurons as highlighted therein. Thus, the use of the multilayer self-organizing model is useful for performing training. The mean square error is calculated by means of relation (4). In this relation $\mathbf{x'_t}$ is the predicted value and $\mathbf{x_t}$ is the real value and N is the size of the dataset.

$$MSE = \frac{1}{N}\sum_{t=1}^{N}(x_t - x'_t) \quad (4)$$

3. Results' Analysis:

The proposed method has been implemented by MATLAB's neural network toolbox. The neural network used herein is a self-organizing five-layer neural network with its layers being respectively 5, 10, 15 and 20 in number. The algorithm used for training the parameters is the error back propagation algorithm. 100 data have been used for training; 60 data for training, 20 data for evaluation and 20 data for testing. These data have been prepared in Excel form and with a window-3 size. The number of the target data is also 100. The transfer function selected for the neurons is TANSIG. TRAINLM is the train function. LEARNGDM is the comparative learn function. The operation function is of the mean square error (MSE) type. It is worth mentioning that these conditions have been considered identical for all three kinds of technical data, fundamental data and a combination of both. It is also notable that TANSIG is a transfer function. Transfer functions are used for determining the neuron specifications in line with solving various problems. Figure (2) displays the status of this function. Figure (3) demonstrates the general status of the neural network as the sample. Information including the used function, number of layer, period, training time and test time has been depicted in figure (4).

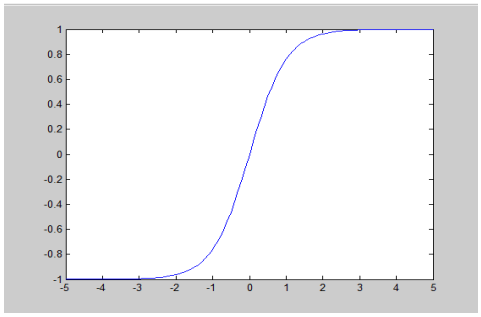

Figure (2): performance of TANSIG function

In figure (4), the status of the neural network and the structure of each layer have been shown. This network is consisted of one input, five hidden layers and one output and the weight and bias and the type of the transfer function have been specified in every layer. After determining and exhibiting the structure, the specifications of the neural network used herein are completely displayed. These specifications include the selected neural network, applied algorithms (type of the training algorithm and its performance), amount of the work's progress by the aid of the period, time, gradient and evaluations, performance diagrams, training status and regression.

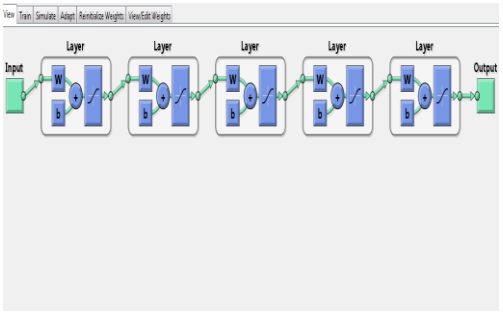

Figure (3): the status of the neural network selected for training, evaluation and test

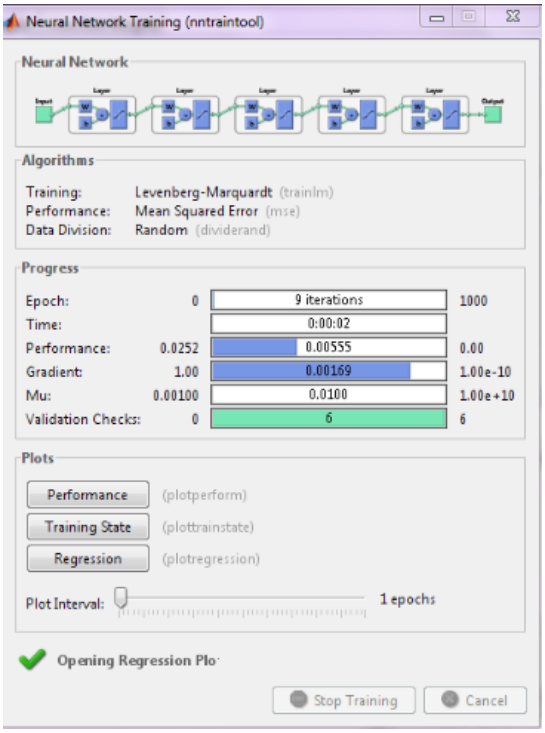

Figure (4): a sample of the fundamental data's overall status

After preparing and normalizing the data, the process shown in figure (1) is carried out based on the proper architectural designing of the training,

evaluation and test stages as performed in the fourth stage. As it is seen in figure (5), the assessment scale is MSE with the best status having been reached in the third period of time with an error value of 0.0125. In figure (6), these stages have been performed for the technical data and, as seen, the best status has been reached in the fourth period of time with an error value of 0.018. In figure (7), these stages have been carried out for the combined fundamental and technical data and the best status has been reached in the 20th period of time with an error value of 0.004. Although the time period of the combined data is longer, the lower amount of error is reflective of the combined data's being better. The investigation of the error amount has been conducted by the aid of the MSE. Therefore, according to figure (5), the higher the decrease in the error rate, the better it would be. The other point is that the lower the error rate, the better it would be. In figure (5), the error rate is 0.012 which has been obtained for the 3 time period. It is evident that the earlier the error time period is identified, the better the implementation process would be.

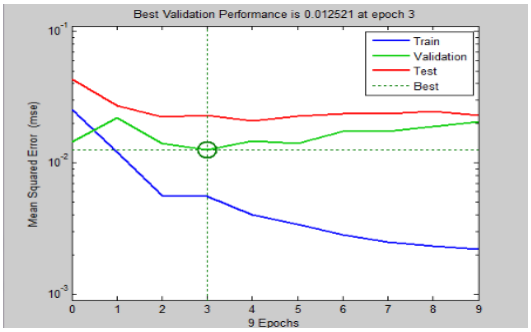

Figure (5): the performance of the fundamental data

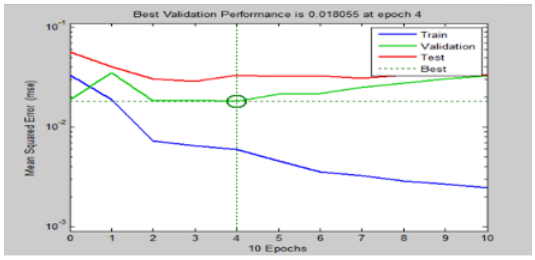

Figure (6): performance of the technical data

In figure (6) and based on the specifications mentioned for the technical data, the amount of error is 0.018 which is larger than the amount of error in the technical data. In terms of the time period, as well, it has happened in the fourth period of time and, as seen, they have outperformed the fundamental data in this regard, as well. In figure (7), although the time period is found increased for the combined data (technical and fundamental data), the error rate has been decreased to 0.004.

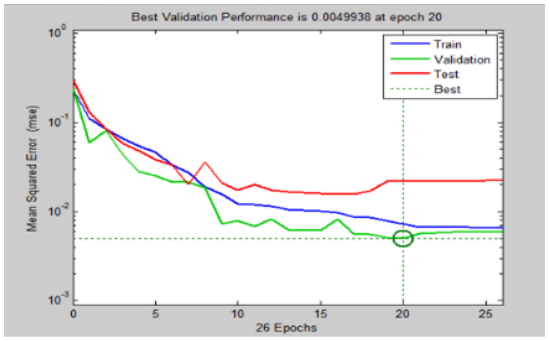

Figure (7): performance of the combined data

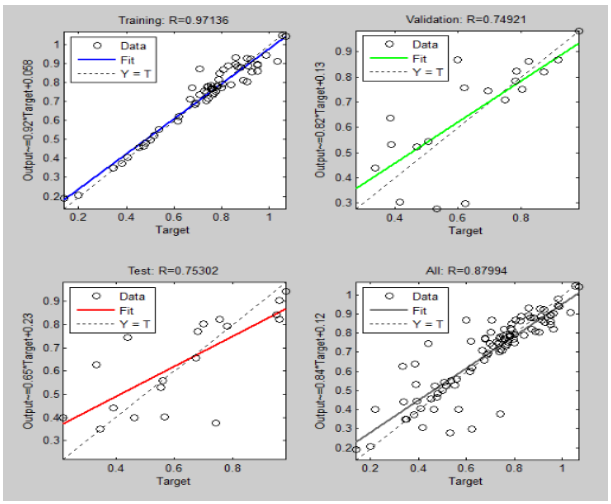

Figure (8): fundamental data regression analysis

In figure (8), the amount of the final regression for the fundamental data is 0.879 and, compared with figure 9, this amount of regression is equal to 0.8669 for technical data so, evidently, the results are indicative of the superiority of the fundamental data for training because training based on the fundamental data has been a lot better (comparison between the obtained and real data). In figure (10), the regression rate for the combined fundamental and technical data is 0.911 which is a better result than the regression rates of the technical and fundamental data alone.

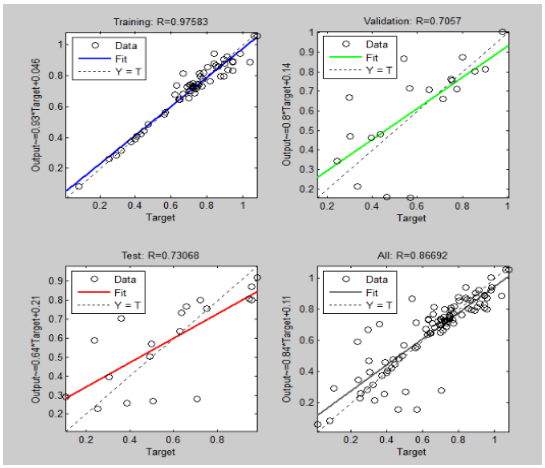

Figure (9): regression analysis of the technical data

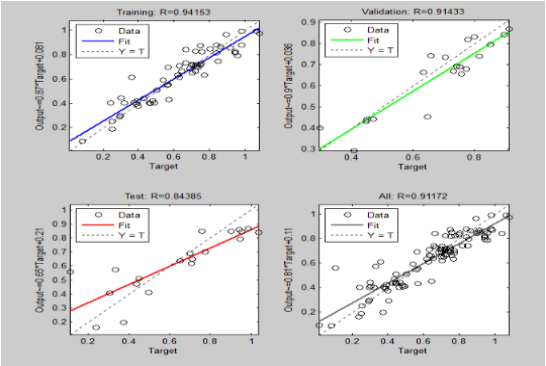

Figure (10): regression analysis of the combined data

In the second stage, the statuses of the data are briefly compared. As it is clear, the best status goes to the combined data followed by fundamental data and, then, the technical data. It can be generally stated that if the companies holding shares in securities exchange market present the securities exchange organization with their data on a monthly and annual basis, they can succeed in their investments by being provided back with more and more exact information. That is because it is clear based on table (2) that the combination of the fundamental and technical data causes more success in the prediction process.

Table 2: comparing the statuses of the data following training, evaluation and testing

Type	Mean value	Data regression rate
Fundamental	0.012	879
Technical	0.018	866
Combined	0.004	911

3.1. Head and Shoulder Pattern:

There are diverse kinds of technical indices in stock exchange market. One of the most reliable and most useful types of technical transactions is head and shoulder pattern [17]. Next, we will deal with the identification and performance quality of this pattern. Figure (11) shows the head and shoulder pattern; as seen, this pattern has been marked in the figure with one head and two shoulders on the right and left sides as well as the neck line.

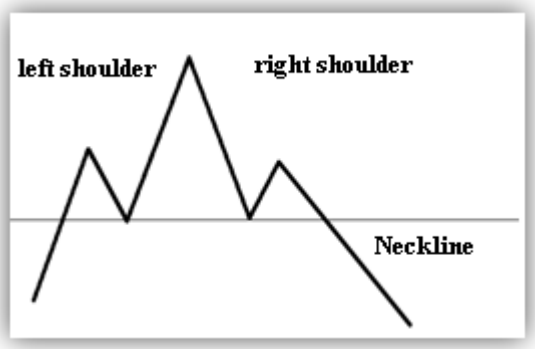

Figure (11): head and shoulder pattern [17]

Usually, this pattern is ascending and upward (above the neck line) and/or descending and downward (below the neckline). No matter what the type of the head and shoulder pattern, it possesses four essential points: two shoulders, one head and a neckline. This pattern is confirmed when the neckline is allowed to be passed exactly post the second shoulder as shown in figure (11). In technical analysis, head and shoulder pattern has been introduced as one of the most credible patterns. The confirmation and supplementation of this pattern take place when the neckline can be delineated at which time the values are reduced following the pass through the neckline in case that the pattern is found ascending hence the prices are predicted to be reduced. This can also happen reversely; in case of the descending pattern and the neckline is found falling above the head and shoulder, the values are increased post the neckline and this is reflective of the prediction of price increases. In figure (12), the head and shoulder pattern has been exhibited in both the descending and ascending forms. In figure (13), the head and shoulder price pattern has been defined. This pattern is composed of four consecutive ascending points named p_0, p_1, p_2 and p_3 and three consecutive descending points between them, namely T_0, T_1 and T_2 [17].

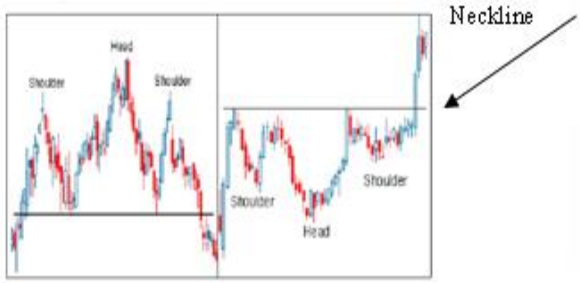

Figure (12): left side: descending head and shoulder pattern; right side: ascending head and shoulder pattern

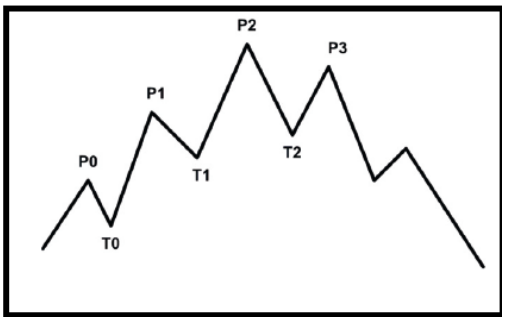

Figure (13): pattern of value-assignment to the data

Head and shoulder pattern predicts the stock shares' prices through the previously made purchases or sales. The ascending head and shoulder patterns show that the investors should sell their shares for the prices would be decreased as evidenced by the pattern otherwise they will have to sell their shares for a lower price in future. But, in case of the descending pattern, the investigators are advised to buy shares because the prices will be increased in future and, in case of not buying at present, they will have to buy for a higher price. The essential point is the recognition of the points featuring the required conditions for this pattern. In order to identify these points, relations (5), (6) and (7) are used. According to table (3), if these data are found matching with head and shoulder pattern (calculated based on relations (5-7)), the data take a status to which a value equal to unity is assigned otherwise the data take a status assigned with a value equal to zero.

$$p_{2>Max(p_1,p_3)} \quad (5)$$

$$p_{1>}p_0 \ , \ T_1 > T_0 \quad (6)$$

$$p_{1\geqslant}0.5(P_3 + T_2) \ , \ p_{3\geqslant}0.5(P_1 + T_1) \quad (7)$$

Table 3: examples of the neural networks' training data

status	P_3	T_3	P_2	T_1	P_1	T_0	P_0
1	1.000	0.792	0.865	0.687	0.800	0.798	0.654
0	0.966	1.002	1.036	1.021	0.998	0.997	0.942

3.2. Determination of the Number of Layers and the Number of Neurons on Each Layer:

In table (4), various kinds of layering and number of neurons have been given. The important point is that the lower the amount of the mean error and the higher the regression, then, the more appropriate the method would be. However, the simultaneous increase in the regression and decrease in the mean square error is not possible (as shown in table 5). Based on the explanations, the regression rate is a lot more important than the mean square error. Thus, considering the highlighted values in table (5), the number of layers is set at three with three neurons being in each layer.

Table 4: various kinds of layering and the number of neurons for the data training by the assistance of head and shoulder pattern

Number of layer	Number of neuron in each layer	MSE	Regression rate (%)
2	**3**	**0**	**89**
2	4	0	85
2	5	0	84
3	3	0	84
3	4	0	85
3	3	0	86
4	3	0	86
4	5	0	80
4	4	0	67
5	3	0	82
5	4	0	81
5	5	0	86
5	3	0	87
5	6	0	86

Table 5: various kinds of layering and number of neurons for data without the use of head and shoulder pattern

Number	Number of neuron	MSE	Regression rate
2	5	0.155	72
2	10	0.147	73
3	**3-3**	**0.304**	**81**
3	6-5	0.292	75
3	3-5	0.719	72
3	10-10	0.138	78
3	5-5	0.086	73
4	5-4-3	0.291	79
4	3-4-5	0.345	79
4	5-3-4	0.587	78

5	3-4-5-6	0.241	77
5	5-5-5-5	0.997	79
6	3-4-5-6-7	0.350	72
6	6-6-6-6-6	0.523	77

The other important point is that the number of neurons in each layer ranges from three to six in head and shoulder pattern [17] because the neural networks give improper answers and run the risk of becoming problematic with values below or above these amounts. As for the data for which head and shoulder pattern has not been applied, the number of the neurons can reach ten. All of the various states have been examined for the studied data and some examples of them have been given in tables (4) and (5).

In order to perform the prediction, 360 lines of data have been used. In each line, there are seven points. 180 data have been produced via the random steps. 90 data have been constructed using ascending head and shoulder pattern and 90 other data by means of the descending head and shoulder pattern. Considering the comparisons of the results obtained from the data prediction using this pattern and the simple prediction without the use of this head and shoulder pattern, it can be stated that the results' success and reliability are more when data are constructed by means of the head and shoulder pattern. Figures (14), (15) and (16) showcase the status of this pattern. Next, the figures will be precisely explicated.

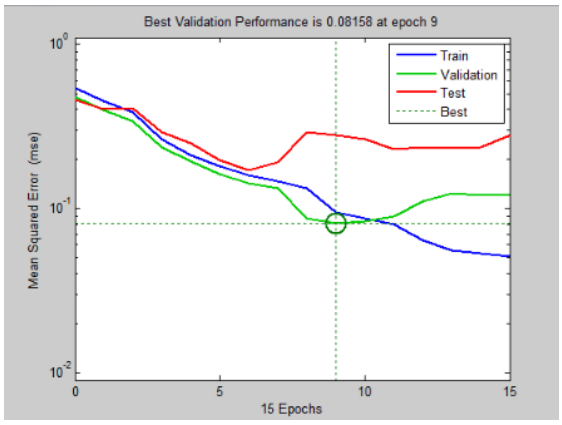

Figure (14): the MSE in the data constructed using head and shoulder pattern

As it is specified in figure (14), the MSE equal to 0.081 has occurred in the ninth time period and, considering the diagram, it is decreasing; so, the lower the error level, the higher the reliability of the prediction would be. In figure (15), the same rate (MSE) has been used for the ordinary data (data prediction without the use of the head and shoulder pattern). The MSE is equal to 0.304. In fact, the training, evaluation and test error rates of the ordinary data are higher than those of the data the training, evaluation and testing of which have been conducted using head and shoulder pattern. So, it can be stated that this pattern can be effective in improving the prediction process. It is worth mentioning that MSE has been obtained using relation (4) and the lower the MSE, then, the better.

The next diagram shows regression analysis results and, as it was mentioned before, it is one of the important and authentic diagrams. Figure (16) showcases the statuses of the data by the use of the head and shoulder pattern. The higher the amount of the regression, the better the data can be trained hence the evaluation and testing are better performed. Therefore, in comparisons of the data constructed with and without head and shoulder patter, as shown in figure (16), the regression is 0.893 and, as shown in figure (17), the regression rate is 0.812 for data construction without the use of head and shoulder pattern. In order to analyze the diagrams, figures (5) to (10), (14) and (15) have been used and, then, the authentic results are recorded. These stages are in match with the steps five to seven in process shown in figure (1).

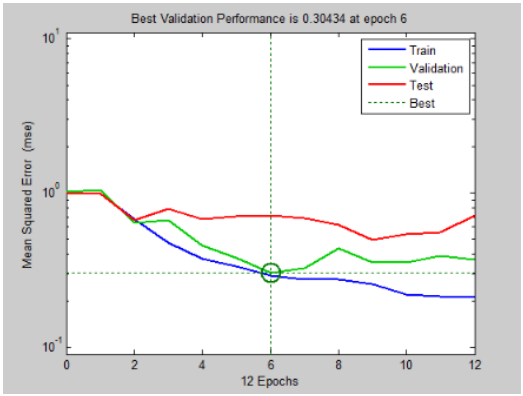

Figure (15): MSE of the data constructed without the use of head and shoulder pattern

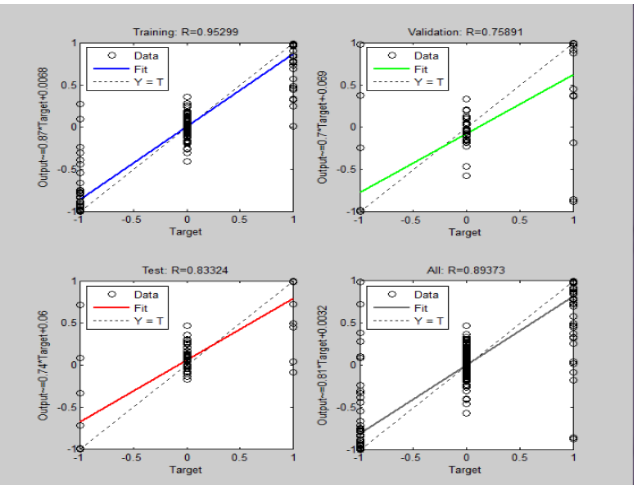

Figure (16): data regression analysis using head and shoulder pattern

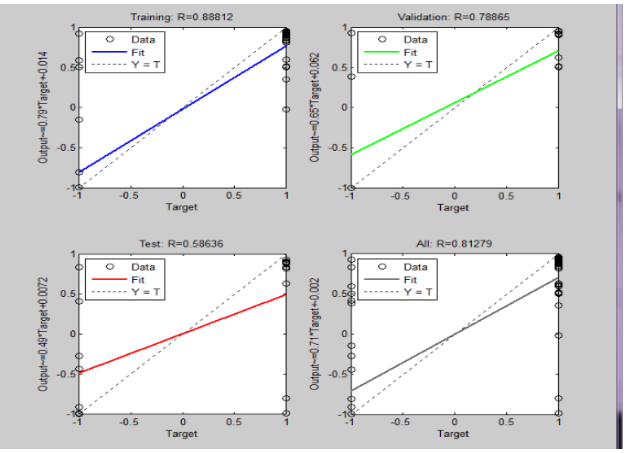

Figure (17): data regression analysis using head and shoulder pattern

4. Conclusion:

In Iran, many individuals have become inclined to enter securities exchange market considering the frequent ascending and descending trends of the gold coin and foreign currency markets and the unreliability for investment. On the other hand, securities exchange market is one of the important centers of investment mirroring the economic status of every country. Therefore, if investors and companies are assisted in prediction, they will be prevented from falling into bankruptcy and a step can be taken forward in advancing the country's economy. Based thereon, two kinds of prediction, i.e. the next day and purchase or sale of the shares or keeping of the shares, has been used herein. Considering the works performed in Iran, the accuracy of prediction was investigated based on the fundamental and technical data in separate and it was found out that the prediction based on the fundamental data is better than that based on the technical data. Afterwards, the combined fundamental and technical data were explored. Prediction based on the combined data was found better than the other two methods. Another type of prediction was carried out herein by the aid of the head and shoulder pattern. It was shown that the prediction by the assistance of this pattern is a lot better and more reliable than the prediction without it. It is worth mentioning that data from Tehran's securities exchange market has been utilized for these predictions. As for the training, evaluation and testing of the data, MATLAB's neural network toolbox was applied. The neural network used in this research is of the five-layer self-organizing type for the fundamental, technical and combined data. As for the data constructed through the use of head and shoulder pattern, as well, back-propagation self-organizing neural network has been utilized.

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