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Combining Neural Network and Firefly Algorithm to Predict Stock Price in Tehran exchange

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Abstract In the present research, prediction of stock price index in Tehran stock exchange by using neural networks and firefly algorithm in chaotic behavior of price index stock exchange are studied. Two data sets are selected for neural network input. Various breaks of index and macro economic factors are considered as independent variables. Also, firefly algorithm is used to [redict price index in next week. The results of research show that combining neural networks and firefly optimization algorithm has better performance than neural network to predict the price index. In addition, acceptable value of error-sequre means for network error in test data show that there are chaotic mevements in behaviour of price index.

Keywords: Tehran stock exchange, neural network, firefly

1 INTRODUCTION

Investment companities are one of financial intermediaries that have role in all developed stocks of the world to create balance and discipline in stock market by purpose of increasing efficiency and investment boom. In this way, resources are effectively and efficiently are used. Hence, it's not wonderful that much researches are carried out to predict the market. A system that can determine wrinner and closer in dynamic financial market produces much interest and profit for that system [1].

Nowadays, stock investemnt is an important part of country economy. Therefore, prediction of stock price has great importance for investors to obtain the highest return from their investment. stock price index shows general position of stock market, and it helps to predict shareholders for investment [2].

The main purpose of this research is to predict stock index in Tehran stock exchange. stock price data are considered as the most important information for investors. stock prices have basically dynamic, nonlinear and non-parametric nature. It shows that investors should handle variable time series with continuous structural breaks. Therefore, not only precise prediction of stock price changes is challenging, but also investors are interested in this issue [4]. In the past, various prediction models are used. The most important models are linear regression or polynomials, average of structural models and other time series. Above models have

weaknesses. It allows the researcher to consider complex and nonlinear factors affecting the prediction.

This paper is organized in three sections. In the first section, literature review is presented. The proposed algorithm is explained in the second section, The research results are presented in the third section.

2. LITERATURE REVIEW

Mazhari presented a prediction model of economic firm bankruptcy in stock by using the learner automata in 2011. This research is carried out for 200 companies from 2001 to 2009. The data results show that an equation can be presented to predict financial bunkruptcy of firms [5].

In 2012, Afsar presented in model to predict stock price by using fuzzy neural networks. In this research, the model of fuzzy neural networks is designed to predict stock price. It is computed in terms of six critera of performance evaluation. Its features are rapid convergence, high precision and strong function approximation. These researches are carried out for stock four petrochemical company of Abadan, Irankhodro, Behshahr industry development and Ghadir investment from 1999-2012. This shows that Tehran stock is almost predictable [4].

Moeinoldin presented a prediction model in 2012 to predict index of Tehran stock exchange price. This research was carried out from 2001 to 2008, and it was computed statistically, but accuracy of computations was not computed [6].

In 2014 Jusmin, in his article, predicted stock exchange in stock of stockholm, Barcelona and south korea. In this research, information of three stocks were used form 2009 to 2010 to evaluate accuracy of parameter. In figure 2-2, accuracy parameter was evaluated. Jusmin showed that fuzzy neural method was the best output [8].

Adam and his colleagues studied exchange of Persian Gulf states. The purpose of this research is to predict the price of Qatar stock, and transactions were used from 2010 to 2012. The leading neural network with 10 inputs were used. The results showed that data algorithm has higher precision to predict stock [7].

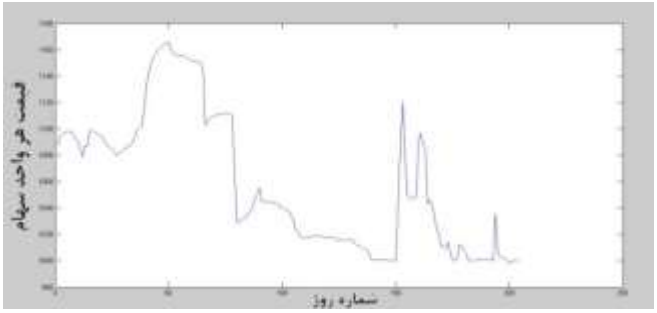
3. THE PROPOSED ALGORITHM

The problem is divided into three parts. In the first step, neural network algorithm is used, while, in the second step, firefly algorithm is used. firefly optimization algorithm is inspired from the nature, and it is proposed to solve optimization problems. This algorithm is proposed by yong in 2008 (10). This algorithm is based on food searching behavior of firefly. Minimum distance of each firefly from the aggregation of other fireflies are considered as an objective function for movement of a firefly. In firefly optimization algorithm, the movement of fireflies are formulated by the main factor: (1) movement of other creatures, 2) The behavior of searching food, 3) random distribution. In the following sections, this algorithm is precisely explained the first and second steps of this algorithm work interactively, and finally, stock equation is explained. This algorithm is implemented by Matlub.

3.1. structure of solving the problem

In order to solve the prediction problem of stock, time series are used. At first, information are gathered about a firm, and this information contains stock price in all days in one year. In figure 1, a1 example is presented

the price of each stock unit



the number of day

figure 1: information of stock price in 2012 in Saderat bank

In time seies problem, it is supposed that many changes are not observed in system behavior. Hence, it is predictable because if its behavior continuously changes, the problem is no longest predictable. Therefore, on the basis of previous information and behavior, the future of system can be estimated. This feature follows Markov approach modelling; that is, a function is extracted from the future and present behavior of system.

Generally, time-series equation is computed according to equation (1), and present time is a function of d in the past.

$$x(t) = \boldsymbol{f}(x(t-1), x(t-2), x(t-3), \dots, x(t-d)) \quad (1)$$

In figure 2, equation (1) can be observed. It is system input of $x(t-1), x(t-2), x(t-3), \dots, x(t-d)$

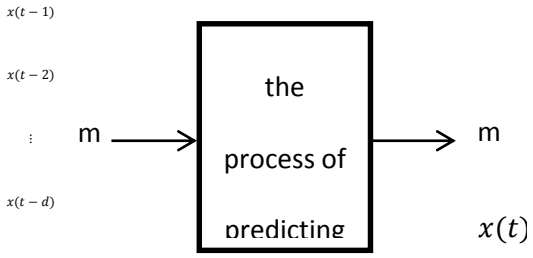


figure 2: The process of exchange prediction

It is a non-linear difference equation involving discrete time. This equation is presented in figure 3.

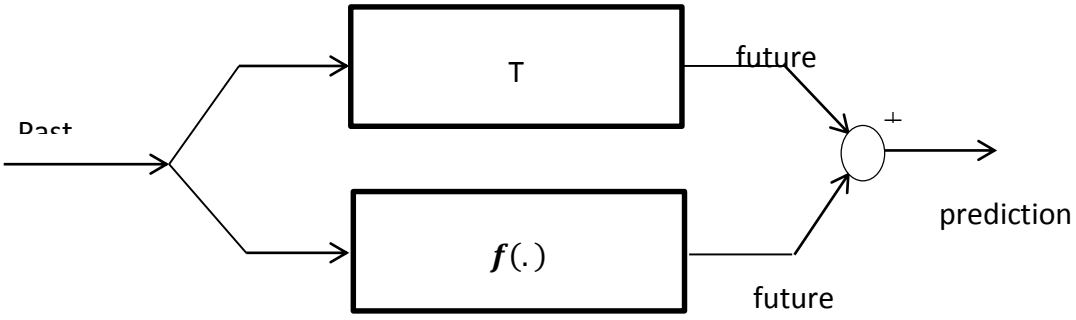


Figure 3: Comparing the process of function and stock prediction

Function should be defined in a way that prediction error is minimzed. Therefore, the prediction problem is converted to nonlinear function approximation, and it can be modelled by artificial neural network. In order to solve the problem about previous price of stock exchange, information about exchange of a firm during one year is taken into account.

Time series of stock information

If time delay (2) is considered, then equation is defined as follows.

$$x_t = f(x_{t-1}, x_{t-2}) \Longrightarrow \begin{cases} input & target \\ x_1, x_2 \rightarrow x_3 \\ x_2, x_3 \rightarrow x_4 \\ \vdots \\ x_{363}, x_{364} \rightarrow x_{365} \end{cases}$$

In the problem of predicting the stock, time delay (10) is considered (this value is computed by trial and error), and equation is considered as follows.

$$x_t = f(x_{t-19}, x_{t-18}, \dots, x_{t-10})$$

$$\Longrightarrow \begin{cases} input & target \\ x_1, x_2, \dots, x_{10} & \rightarrow x_{20} \\ x_2, x_3, \dots, x_{11} & \rightarrow x_{21} \\ \vdots & \\ x_{346}, x_{347}, \dots, x_{355} & \rightarrow x_{365} \end{cases}$$

In following sections, the proposed method is investigated.

In the proposed method, the problem is divided into two parts:

1) Artificial neural network

2) Firefly algorithm

Feed forward neural network algorithm involving three layers is used for appropriate approximation (three-layers neural network is selected since it can approximate each nonlinear function). The number of neurons in middle layer is to (Value pf 10 is computed by trial and errors, then, weights value is comuted by firefly algorithm to make neural network output better. The structure of weighting is observes in figure 4). As it can be observed in figure 4, weights of neural network is located in arrays. Figure 1 presents artificial fireflies on the basis of neural network weights.

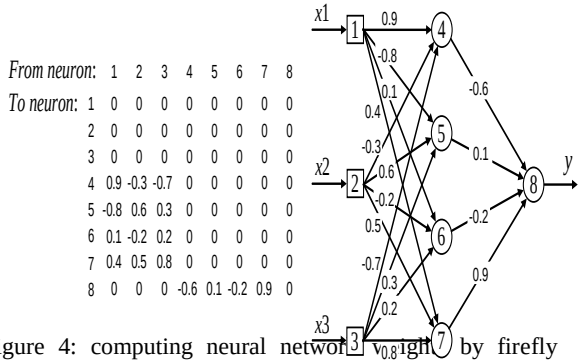


Figure 4: computing neural network weight by firefly algorithm

Firefly :

0.9	-0.3	-0.7	-0.8	0.6	0.3	0.1	-0.2	0.2	0.4	0.5	0.8	-0.6	0.1	-0.2	0.9

table 1: The structure of artificial firefly algorithm on the basis of figure 4.

Flowchart of the proposed algorithm structure is observed in figure 5. As it can be observed in figure 5, the best output of artificial firefly algorithm determines the weight of neural network. Then, neural network is evaluated by stock data, and accuracy of neural network is considered as fitness function.

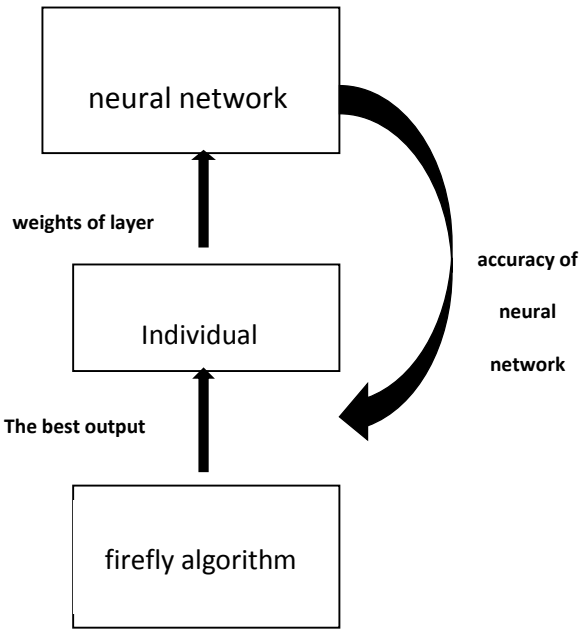


Figure 5: flowchart of the proposed algorithm structure

3.2. Algorithm parameters

The parameters of proposed firefly algorithm is observed in figure 2.

Table 2: The parameters of proposed algorithm

The value of parameter	The name of parameter
500	initial population
80	combination probability
20	mutation probability
uniform	combination type
selection algorithm	roulette wheel

4. EVALUATION OF THE PROPOSED ALGORITHM

In order to do experments window operating system in seven-core computer with processors of 5.2 GH and RAM 8G is used. For comparison, information data of twenty firms in stock gathered during one year is used.

Due to using probability-based algorithm, the program is repeated 10times to evaluated the model, and out of range data is deleted.The average of remaining data is considered as the final answer. since there many graphs, information of Behshahr food industry is only displayed with details.

4.1. Executing the algorithm of predicting the stock price for Mellat Bank

Information of Mellat Bank in 2012 involving 221 records are considered as input in firefly algorithm.

Then data is divided into two test and training sets. Data test is on the basis of minimum value of time-series that is equal to 10. Among 201 inputs, 191 data are firstly selected for training, and 10 ending data are used for test.

191 data must be trained by neural network. with regard to the type of proposed algorithm, %90 of them are selevted to train the weights of neural network and %10 are selected for testing.

In table 3, two proposed algorithms are compared in terms of two criteria involving the mean of error squares and maximum profit.

Table 3: evaluating the proposed algorithm for 20 firms in stock exchange

profit percent		mean of error squares		the name of company	
with optimization of firefly algorithm	without optimization of firefly algorithm	with optimization of firefly algorithm	without optimization of firefly algorithm		
72.78036	24.18138	0.016313	*0.003018*	Mellat Bank	1
53.77511	23.76694	0.020553	*0.008562*	Saderat Bank of Iran	2
52.17256	13.37498	0.093758	*0.005629*	oil refinery of Bandr Abbas	3
42.42715	21.01204	0.091239	*0.009169*	Iran Khodro	4
21.78661	15.26607	0.049174	*0.005682*	Azar Ab Industries	5
39.01078	33.10636	0.042241	*0.007749*	oil and gas development company of Parsian	6
53.94646	44.70523	0.066753	*0.005422*	oil and gas of Tamin petrochemical	7
77.46734	25.2383	0.049019	*0.005758*	Dey Bank	8
81.84557	21.83098	0.093828	*0.004337*	oil refinery of Lavan	9
47.58577	17.50285	0.062516	*0.006479*	oil refinery of Tehran	10
84.11289	26.43155	0.084376	*0.008235*	stock of Zob Ahan Isfahan	11
29.00943	7.961876	0.055175	*0.003415*	sugar factory of Shirvan and Bojnourd	12
26.22025	12.51758	0.055589	*0.003647*	petrochemical group of Iranian	13
22.76308	11.62872	0.039502	*0.004307*	Tehran cements	14
20.46126	38.88488	0.096874	*0.005206*	Iran telecommunications	15
66.44125	40.64264	0.013337	*0.0077*	sugar factory of Naghshe Jahan	16
55.56366	9.232228	0.045607	*0.007591*	dish factory of Iran	17
42.55618	27.91901	0.057075	*0.006678*	Mihan Insurance	18
75.25859	41.8176	0.087342	*0.00723*	Sobhan Daru	19
35.098	22.59051	0.091218	*0.004866*	credit company of Iran	20

In table 3, Information of 20 firms about two criteria involving MSE and profit percent is investigated. As it can be observed, profit increases in 14 firms by using the proposed algorithm, and the profit decreases by mistake in 6 firms. Hence, it can be concluded that, by using the proposed algorithm, 70 percent of increasing profit and 30 percent of profit reduction can be observed. MSE increases considerably by adding optimization algorithm. It can be shown that the proposed algorithm involves 20-60 percent of precision.

5. CONCLUSION

In firefly algorithm, it is clear that this algorithm has higher speed in convergence of continuous problems. Also it is specified that, by changing evolutionary algorithm parameters dynamically, algorithm performs better. One of firefly algorithm problems is being stuck to local optimization. By using 10 percent of low population in each generatio, it doesn't face with the problem of local optimization in next generation of the algorithm.

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