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Using the Multistage RBF Neural Network in order to Predict the Deposits of Eghtesad Novin Bank and Comparing this Method with other Methods

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ABSTRACT

Due to the spread of banking system in the recent world, one of the greatest concerns of the banking system is the absorption of the financial resources. There are two important issues that are related to people's depository in the banks: Firstly the money that people may save in the bank will increase the power of bank's lending, therefore banks would be able to prepare more new loans for producers and investment from the collected money. The second importance of increasing the people's deposit is that, when the people prefer to save their money in the banks and spending less money the amount of money in the financial circulation will decrease and as a result the inflation rate will decrease hence purchasing power of the people would be increased. Thus, due to the importance of the banking deposits we need to predict the amount of deposits more accurately. In this study we have noted to the a particular neural model of network that is similar to the radius of the orbit of a multi-linear function (RBF) that is one of the most widely used neural model of network in order to predict the deposits of Eghtesad Novin bank and then in order to check the accuracy of the model the obtained results would be compared with other models.

KEYWORDS: Bank – Deposit – Predict – RBF Neural Networks

1- INTRODUCTION

Due to the increasing level of competition among the banks and profitability of this field, many institutions are interested to work in this area and as a result, in recent years, the speed of development in several banks and private financial institutions due to their communication services, the process of globalization, de-regulation, the advancement of the technology and particularly developing the information technology have raised up.

There are various internal and external factors that are effective to the profitability of the banks. The internal factors that are under control are related to the activities of the banks. The external factors are related to the context of the banking market that the management systems of the banks cannot control them. One of the most important factors among the internal factors which always have been effective to the profitability of the banks is the amount of collected deposit. The reason of this issue is that if the volume of the collected deposits in the banks reduce the level of financial risk in the bank will be increased and as a result the risk of bankruptcy of the bank will increase hence it will tremendously effects the granting financial deposits to the clients. Meanwhile, the high inflation rate in our country will seriously decrease the level of interests of the banks client to save their investments.

We have used the method of neural network model in order to analyze data.

Therefore, the large number of neural network models (RBF) would be produced. In the next step, a method for minimizing the conditional generalized variance (CGV) in order to select appropriate member would be used and in the final stage, using another RBF network for summarizing the neural network has predicted. Then we have tried to check the accuracy of the method by comparing this method with the previous models.

2- REVIEW OF THE LITERATURE

It's been so long that using non-classical methods in order to predict the behavior of the complex systems in the scientific and professional discussions is common. In many complex systems and especially nonlinear models that predicting and controlling them by using classical and analyzing methods are very difficult and sometimes impossible, the non-classic methods that are intelligence will be used. Although is less than 50 years that neural networks are using but the neural networks has developed in various fields like making models, understanding the model, categorization and prediction have been used and the obtained results were useful [1].

Dr. Fereydoon Rahnama and Mr. Seyed Reza Mousavi in their paper "Comparison of the classical series of time model and artificial neural network in the field of prediction of financial need of banks" have compared the power of artificial neural network prediction with other prediction methods in the field of predicting financial

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needs of banks and they have used classical series of the time model like unstable averages, Holtz model, ARIMA mode and Artificial Neural Network of Multilayer Perceptron in order to predict the total amount of money and due to their obtained results they have realized that the Neural Network models have the lowest error in last month of the year 1385 (first months of year 2006) hence they have introduced as the best model [2].

Mr. Mohammad Ghavam Zade in his master thesis "Prediction of the organized transactional market" in Tehran University in the year 1376 (year 1997) has predicted the index of Tehran's Stock Exchange. In order to do these predictions two share prices of the global prices of the gold and oil were used. In the simulations of the study firstly the model of ARIMA was fitted to the series and its performance investigated [3].

Clara Astovysk in her article "Predicting the inflation rate of Slovenia by ARMA models" in 2007 has tried to predict the inflation rate by ARMA model.

Trafalys in an article with the title of "Integrated model to predict the exchange rate" has indicated that how ARIMA models and Neural Networks can be used to predict the exchange rate and based on the acquired results Neural Networks have provided more accurate answers.

Housein Hadipour in his master thesis "Determination of the best model to predict the stock prices in the fields of food's industry and beverages of Tehran's Stock Exchange" by the guidance of Reza Tehrani in High Educational Management and Planning and Research Institute in 1382 (year 2002) in the group of food's industry has predicted the prices. Therefore, at first they predicted the weekly prices of the stock between the years 1377 to 1379 (1998 to 2001) and they collected the data by the software of Excel, Eviews, Statgraph and then in the same process by using exponential smoothing models, unstable average and the method of Box and Jenkins for the last 14 weeks of year 1379 (year 2001) they have compared the obtained index of MSE with other methods and finally this research has indicated that there is not any specific model to predict the stock prices in the group of food's industry and beverage and each group of data has its own characteristic and limitation and in order to predict the price of each company's stock, firstly we need to use its own specifications and the time data series, appropriate model and methodology in the process of our prediction and then by using those models we would be able to predict the stock prices of the companies [4].

Mr. Ali Rajabzadeh Qatrmy in his mater thesis "Combination Analysis of prediction methods and providing an optimal model for predicting the Tehran's Stock Exchange prices" by the guidance of Mr. Adel Azar in Tarbiyat Modares University in the year 1377 (year 1998) in order to reduce the prediction error has used the methods of prediction and compositions. The target prediction methods are prediction of the time series (with one variation) that are based on the future prediction data. Several researches have been done to combine the prediction methods and the obtained results have indicated that prediction error have reduced indeed. In this study each of prediction methods of the time series and privet methods, and also the combination of these methods is called combinational method. We use the multivariate regression models to combine privet methods that have the ability of testing statistically in order to confirm the model and the obtained results from independent variations and compositional prediction have defined as the dependent variable. The collected data was related to the stock price of the Pars Electric company for 3 years with the weekly period from Tehran's Stock Exchange and the stock prices were predicted by 14 different methods that among these methods 6 methods of unstable average, linear smoothing, Holt, first order of autoregressive, process of power and quadratic trends that are more compatible with other data and had the lowest error were chosen and they have used in the combination process [5].

Mr. Mohammad Botshekan has completed his master thesis "Prediction of stock prices by Neural and Fuzzy networks and comparing them with linear prediction models" by the guidance of Mr. Reza Rayi and with the consultation of Mr. Mohammad reza Mehregan in Modiriat University of Tehran in 1379 (year 2001). In this study, one of the techniques of Artificial Intelligence by the name of Neural and Fuzzy Network of ANFIS has used to predict the stock price and at the end the prediction the ability of this model has compared with the linear model of IARIMA. The acquired results are indicating that the prediction of the model of ANFS network is more accurate than ARIMIA models [6].

Mr. Sinayi, Mortazavi and Teimouri Asl in their article "Prediction of Tehran's Stock Exchange index by Neural and Artificial Networks" in 1384 (year 2005) have predicted the stock price of Tehran's Stock Exchange by Neural networks and provided evidences related to chaotic behavior of the indicators. The Neural networks that have used in the study were multilayer perceptron (MLP) that were arranged by the method of propagation algorithm and the obtained results have indicated that Neural networks have better performance in comparison with ARIMA network [7].

Mr. Sarafraz and Afsar in their article "Study of effective factors to the price of gold and providing prediction model based on the Neural and Fuzzy networks" in 1384 (year 2005) and in the Journal of Economic Research after reviewing the historical importance of gold and effective factors to the gold's price fluctuation that were used for the Neural and Fuzzy network based on the Takagi and Sugeno model in order to predict the price of gold and the obtained results from the method of regression analysis indicates that Neural and Fuzzy networks are more accurate at the predicting the price of gold in comparison with the method of regression [8].

Ms. Fatemeh Sadat Mirfeizi has completed her thesis "Prediction of 5 years banking deposits of Tejarat bank based on the model of ARMA" by the guidance of Ms. Mariam Kambiz Peikar Jou in the Modiriat and Oulom and Tahghighat Tehran University in years 1387-1388 (years 2007-2008). In this research the researcher have used the models of ARMA and ARIMA that were provided by Box and Jenkins in 1970 to predict the time series of deposits during 5 years and the obtained results have indicated that the amount of deposits are decreasing during these 5 years [9].

Chen and Peng and Abraham in their article "Modeling stock index by HIRBF" in 2007 that is a network model based on the method of radius orbit series (HIRBF) which a RBF Neural network used to predict 3 common international prices in the recent years.

Lin Yu, Cain Qiong Lai and Wang in an article by the name of "General learning of the multistage RBF neural networks " have focused on the prediction of trade's prices in 2008 by using the multistage RBF neural network.

3- Reviewing the RBF Neural Networks

The RBF network is one of the most important types of the forward orbit radius functions. This network has developed based on its various performances and as a result it has changed to one of the most widely used types of networks thus this network is one the most competitive networks for multilayer perceptron (MLP) network [10].

The methods of RBF networks are very similar to statistical techniques of classification models that essentially are known as the useful neural networks. Although the number of these techniques are limited but by placing RBFs in the classification of based neural networks, this type of network has widely used [10].

The basic structure of RBF consist a three-layer network. As you can see in the Figure 4 the input layer is just a receiver and there is no processing. The second layer is a hidden layer between the input space and a bigger space and there is a non-linear link between these two spaces and as a result the models can be separated from each other by a linear method. Finally the third layer will produce a weighted and linear sum. If we use the RBF method to predict the approximation of the function the output of the function would be useful but when classification of the models are needed we can put a hard limiter or a sigmoid function on the output of nerves and then the output of 0 or 1 will be produced.

The unique feature of the RBF has located in its processing in the hidden layer. The main idea of this method is that model of input spaces make clusters. If the center of the clusters is identified we can measure the distance from the center of clusters. Moreover, the measurement of the distances is performed by a non-linear model therefore when there is a model in the area of the cluster's center the method would be closer to produce a numerical value. The obtained value out of this region will be reduced rapidly. The important point is that this area is being symmetrically around the center of clusters. Therefore, the function would be known as non-linear function.

The process of calculation in the RBF neural network is as follow:

When the network takes vector X and input K the network will calculate the numerical value by the equation 1:

$$Y = f(X) = W_o + \sum_{i=1}^{m} W_i \, \varphi(D_i) \qquad 1$$

When W0 is center and Wi is weight, the number of hidden layers of the network is m and $\varphi(D_i)$ is the function of the orbit. As you can see in this research we have used the Gaussian function (equation 2) as the method of RBF:

$$\varphi(D_i) = e^{\left(-D_i^2 / \sigma^2\right)} \qquad 2$$

The σ indicates the radius of cluster from the center and Di indicates the distance between vector X and all the data centers. It's clear that $\varphi(D_i)$ will return the values between 0 and 1. Usually the method of Euclidean average is used to calculate the distance by the equation 3 as follow:

$$D_i = \sqrt{\sum_{j=1}^{k} \left(x_j - c_{ji}\right)^2} \qquad 3$$

In the equation C is the center of cluster for the nodes in the hidden layer.

Modeling of complex nonlinear systems by using linear regression methodology is difficult. Unlike the regression method the neural networks are nonlinear and their parameters would be determined by a number of learning techniques and algorithms [10].

3-1- The 3-stage Neural RBF Networks method

In this study we have focused on the three-stage neural network model of learning in order to predict the volume of deposits [24].

In the first stage the predictors of the neural network of RBF will produce many independent networks. In the second stage an appropriate number of neural networks of RBF will be selected from the previous stage between those we were focused on. Therefore there is an acceptable sample in the last two stages. In the final stage the predictors of the selected RBF neural network in a combined output by using a learning method is combined with another RBF neural network.

3-1-1- Producing a number of predictor of the neural network:

According to the principle of bias-variance trade-off providing a general model with a little conflict would be acceptable. Therefore, the thing that various models are producing is a decisive factor. Several methods have focused on the producing general members for neural networks of RBF. These types of methods are essentially dependent to the parameters of the RBF neural network or using different training packages. In particular, the main methods include the following four approaches:

1) By changing the style of the neural network of RBF and changing the number of nodes in the hidden layer several different neural network can be produced.

2) By using the center of clusters in the RBF neural networks the changes of the center of cluster C of the neural network and various neural networks can be produced.

3) By updating radius of the cluster of the various RBF neural networks the center of the cluster O of neural networks of RBF and also various RBF neural networks can be produced.

4) By using the various training data and by the taking resampling we would be able to produce new training groups. The index methods are CV Stacking, Bagging and Boosting.

We can use all the four above stages. Also the candidate of RBF neural network can be connected to each other thus new method of RBF networks in addition to the training data would be produced. We select an independent way to create the general members. Previously a number of RBF neural networks have produced and we have tried to collect a number of representative members in order to saving computational costs and accelerating the process of calculation [24].

3-1-2- Selecting the appropriate general members:

In order to develop the performance of the process we need to collect new representatives. Therefore, it's very important to select and determine a number of independent neural networks to predict the final target from an appropriate method. Generally, we select some members with the lowest error and we use the technique of PCA to collect appropriate members and their acceptable performance would be obtained from the method of experimental analysis. The method of PCA is a type of reduction technique that does not follow the solidarity of the members. In order to overcome this problem we have focused on the method of ambushing of CGV.

We assume that predictor is p and amount of prediction of the network is n. And then the error matrix of (e1, e2, …,ep) from p predictor can be indicated as the following equation 4:

$$E = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1p} \\ e_{21} & e_{22} & \cdots & e_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ e_{n1} & e_{n2} & \cdots & e_{np} \end{bmatrix} \quad 4$$

The variance and the covariance of E can be calculated as follow by the above matrix:

$$\text{Avreage} = \bar{e}_i = \frac{1}{n}\sum_{k=1}^{n} e_{ki} \qquad (i = 1,2,\dots,p) \qquad 5$$

$$\text{Variance} = v_{ii} = \frac{1}{n}\sum_{k=1}^{n} (e_{ki} - \bar{e}_i)^2 \qquad (i = 1,2,\dots,p) \qquad 6$$

$$\text{Covariance} = v_{ij} = \frac{1}{n}\sum_{k=1}^{n} (e_{ki} - \bar{e}_i)(e_{kj} - \bar{e}_j) \qquad (i,j = 1,2,\dots,p) \qquad 7$$

By the equation 6 and 7 we can calculate the variance and covariance as follow:

$$V_{p\times p} = (v_{ij}) \qquad 8$$

When p=1 we use the determinant of V (The determinant of V indicates the correlation of p predictors). The variance of p is greater than 1 when $|V|=|V_1| = e_1$ therefore determinant of V can produce the variance. Thus we named the determinant of V as the variance of the producer. It is clear that when p predictors are correlated then the produced variance would be equal to 0 and when p predictors are independent the produced variance would be Maximum.

When the predictors of p are not correlated the produced variance would be indicated the correlation of the indicators.
Now we introduce the concept of the CGV. Matrix of V can be formulated in a matrix. The process is as follow: The (e1, e2, …,ep) based on the e(1) and e(2) has divided to the two parts of (e1,e2, …,ep1) and (ep1+1, ep1+2, …,ep1).

$$E = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_P \end{bmatrix} = \begin{pmatrix} e_{(1)} \\ e_{(2)} \end{pmatrix}^{\mathrm{P}_1 \times 1}_{\mathrm{P}_2 \times 1}, \mathrm{P}_1 + \mathrm{P}_2 = \mathrm{P} \qquad 9$$

$$V = \begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix}^{p_1}_{p_2} \qquad 10$$
$$p_1 \quad p_2$$

When the V11 and V12 is indicating the matrix covariance, the obtained e(1) from CGV and e(2) can be introduced as the $\mathrm{V}\left(\mathrm{e}_{(2)} \middle| \mathrm{e}_{(1)} \right)$ therefore it can be written as the following equation:

$$V\left(e_{(2)} \middle| e_{(1)} \right) = V_{22} - V_{21} V_{11}^{-1} V_{12} \qquad 11$$

The above equation is indicating the obtained e(2) from e(1). If there is a small difference between e(2) and e(1) therefore may the indicators are removed. This fact implies that e(1) predictors can be achieved by e(2). Now we can obtain an algorithm by the minimizing CGV as following stages:

1- Given that p prediction error can be divided into two parts: First part is the (e1,e2, …, ep-1) and the second part is e(1), (ep) and e(2).
2- The produced conditional variance $\mathrm{V}\left(\mathrm{e}_{(2)} \middle| \mathrm{e}_{(1)} \right)$ can be calculated from the equation 11 and we need to remind it the $V\left(e_{(2)} \middle| e_{(1)} \right)$ have an answer by the name of tp.
3- By the similar method, the predictor number i (i=1, 2, …, p) can be calculated from (ei) like e(2) and p-l predictor, and also it can be estimated like e(1) therefore we can predict the answer number I from CVG and then we can calculate the ti with the equation 11.
4- For a preset threshold of 0, if $\mathrm{t_i} < 0$ the prediction I should be predicted from p removed prediction. And if $\mathrm{t_i} > 0$ the prediction i should be saved.
5- For the saved predictors, we can do same thing as the previous method from stage 1 to 4 and we can obtained the satisfactory results by the repeating this method [24].

3-1-1- Combining the selected members
We have collected the appropriate members from the previous stage. The next stage is combining the selected members in a combined predictor under an appropriate overall strategy. The first predictors are identified. We assume that there are n single RBF neural network in the $D = \{x_i, y_i\}$ and (i=1, 2, …, n) and after working on this method the output of n single neural network would be produced as the $\hat{\mathrm{f}}_1(\mathrm{x}), \hat{\mathrm{f}}_2(\mathrm{x}), \ldots, \hat{\mathrm{f}}_\mathrm{n}(\mathrm{x})$. As it is explained in the selection process from m total members of RBF the members would be selected based on the,$\hat{\mathrm{f}}_1(\mathrm{x}), \hat{\mathrm{f}}_2(\mathrm{x}), \ldots, \hat{\mathrm{f}}_m(\mathrm{x})$ and the selected members will assume in the output of the $\hat{\mathrm{y}} = \hat{\mathrm{f}}(\mathrm{x})$ therefore the output would be more accurate and the general model of the predictor would be as the formula 12:

$$\hat{f}(X) = \sum_{i=1}^{m} W_i \hat{\mathrm{f}}_\mathrm{i}(\mathrm{x}) \qquad 12$$

Where the wi is weight of fi(x) total weight equals 1. There is a key issue which determines the total weight in a RBF neural network. Determination method of the total weight has noted in the study of the previous study. Generally there are four strategies as follow:

Average of sample and weight:
There are two general strategy and there are 3 average strategy: MSE approach, The sample mass regression and Weight of the variance.

Simple average method:
This method is one the most widely use methods that is easy to understand indeed. Several experiments have indicated that this method is and effective methods on the performance of the neural networks, particularly, in the case that the local minimum of the members are different. It means their average can reduce their variance. Usually the sample average method would be used to do total predictions as the equation 13:

$$\hat{f}(X) = \sum_{i=1}^{m} W_i \hat{f}_i(x) = \frac{1}{m}\sum_{i=1}^{m} \hat{f}_i(x) \qquad 13$$

Although this approach has been treating for the equal members but the weight of the single network is $w_{opt,i} = 1/m$. In the case that variance of the networks are so different it is not expected to obtain better results from the sample average. Totally obtained weights are so unstable therefore the sample average can be the best option.

Method of MSE:

The sample linear parameter of weight would be estimated by the minimums of the MSE for i=1, 2, …, m.

$$W_{opt,i} = \underset{w_i}{\arg min}\left\{\sum_{j=1}^{k}\left(w_i^T \hat{f}_i(x_j) - d_{ji}(x_j)\right)^2\right\} = \left(\sum_{j=1}^{k} \hat{f}_i(x_j) f_i^T(x_j)\right)^{-1} \sum_{j=1}^{k} d_{ji}(x_j)\hat{f}_i(x_j) \qquad 14$$

Where d(x) is the expected value, the sample method of MSE seems appropriate but Berryman has indicated that there is a key problem in this method that is reducing the abilities of the method:

The involved data in the prediction of each training and estimation of the wi and the single predictors have a strong correlation.

Mass regression method:

This method has prepared by Berryman to solve the related MSE problems with MSE method and this method has focused of the previous method. It means that the method of Mass Regression is corrected version of the MSE method. This method would be used for CV data and solving methods of sample MSE.

$$W_{opt,i} = \underset{w_i}{\arg min}\left\{\sum_{j=1}^{k}\left(w_i^T \hat{g}_i(x_j) - d_{ji}(x_j)\right)^2\right\} \qquad 15$$
$$i = 1,2,\dots,m$$

Where the weight of CV is $g_i(x_j) = \left(\hat{f}_i^{(1)}(x_j; D_{cv}), \dots, \hat{f}_i^{(k)}(x_j; D_{cv})\right)^T \in R^K$, and also the $\hat{f}_i(x_j) = R^K$, and D_{cv} are CV's data.

Although this approach can overcome the limitations of the MSE but the solution is based on the assumption that each collection of the created error is normal.

There is another general method based on the variance of errors that we have focused on. Essentially the general approach of the weighted variance of errors is useful to estimate the weight parameters of wi to minimize the error of variance σ_i^2 . Therefore all the predictions are apart from the errors of the network and the obtained weights would be determined by the equation 16:

$$W_{opt,i} = \underset{w_i}{\arg min}\left\{\sum_{i=1}^{m}(w_i\sigma_i^2)^2\right\} \qquad (i = 1,2,\dots,m) \qquad 16$$

Due to the limitations of $w_i \geq 0$ and $\sum_{i=1}^{m} w_i = 1$ the weights would be calculated by the equation 17:

$$W_{opt,i} = \frac{(\sigma_i^2)^{-1}}{\sum_{j=1}^{n}(\sigma_i^2)^{-1}} \qquad (i = 1,2,\dots,m) \qquad 17$$

The method of the weighted variance is based on the assumption that there is no error in this method. As it's mentioned previously the predictors of the errors are strongly linked to each other. This suggestion indicates that there is a major obstacle to the approach of minimizing the error of variance and the neural predictors are correlated with each other.

Thus the four above strategies are widely used but we can also find the weights of these total approaches in the case of facing with error. In fact the network model is dependent from the error and the errors are dependent to each other and they usually cannot have the appropriate performance. The output of the overall strategies is insufficient and as a result we have used other RBF neural networks as a general tool for integrating whole members.

The acquired basic results of the members have specifically selected. With the general selected members we can produce the selected output (X1, X2, …, Xm). By using the obtained outputs as the next inputs for the RBF neural network the general models of the RBF neural networks are located and formulated in the following table.

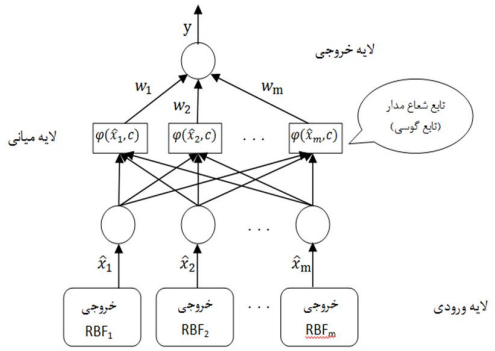

Figure 1: General multistage of the RBF neural network

As you can see in the Figure 1 the overall prediction model of the RBF neural network can be provided as a non-linear process as follow:

$$\hat{y} = f(\hat{x}_1, \hat{x}_2, \dots, \hat{x}_m) \qquad 18$$

Where the output of the neural network is single like$(\hat{x}_1, \hat{x}_2, \dots, \hat{x}_m)$, y is the obtained result of the overall outputs and the function of f(0) is determined RBF.

5- Specific case study

The provided data in this study are obtained from the deposits if the Eghtesad Novin bank in the tenth, twentieth and the end of each month and from 271 views in 1382 (year 2001) to 1390 (year 2011) and then by MATLAB software the process of short-term and long-term deposits of the bank based on the three-stage neural network analyzed and predicted for the future periods.

5-2- Definition of the parameters:

In order to realize future comments firstly we have defined the provided parameters. Input and output parameters for each group of data as follow:

Figure 2: The overview of the program's input and output

Other important parameters are as follow:

Nets: basic produced RBF networks
Reminder 1: Selected network for the first deposit (Saving bank account)
Reminder 2: Selected network for the deposit type 2 (Short-term)
Reminder 3: Selected network for the deposit type 3 (long-term)

5-1: Calculation:

In order to produce the basic networks we have 273 collected data that are classified in 11 time series like month, day, price of Pound, price of Euro and Dollar, profit of the short-term deposits, profit of the long-term deposits, reminded amount in the short-term deposits and reminded amount in the long-term deposits.

Before starting the analysis and classification of data we need to categorize the type of collected data as follow:

By choosing a suitable data we can create the basic data. At first we produce Lag=1 because usually changes of each parameter is related to basic parameters, in fact, after a while it would be effective on the basic parameters. Therefore it means that every time the program of first group of the data will be selected and then 3 types of deposits for the second time series would be predicted.

In the step one several single RBF neural networks in order to primary predictions have to be produced. This process will be changed by changing the structure of network (Changing neurons from 10 to 150 with the spread of 1 to 5 by the spaces of 0.5). Now we have 135 single RBF neural networks as the predictor.

In the second stage some of the neural predictor RBF networks that is the previous stage were produced (135 networks) would be selected.

In this model in order to increase the performance of the network, a new representative is needed. Therefore, it is so important to select specific number of single neural network models to predict the target by an appropriate method. In this research a method to minimize the CGV would be used.

There are 135 predictor networks thus we provide the matrix of errors like (e1, e2, …,e135) by the predictors.

$$E = \begin{bmatrix} e_{11} & e_{12} & \cdots & e_{1p} \\ e_{21} & e_{22} & \cdots & e_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ e_{n1} & e_{n2} & \cdots & e_{np} \end{bmatrix} \qquad 19$$

We use the above average matrix, variance and the covariance of the matrix E in the equation 5, 6 and 7 in our calculation and then we determine the correlation rate between the both networks and comparing the two networks in order to remove the higher errors that will impose a special method for the prediction.

It is clear that when p predictors are correlated the produced variance will equals 0 and when p predictors are independent the produced variance would be maximum.

Therefore when p predictors are not correlated the produced variance will indicate the correlation between predictors. We have selected 30 networks by the mentioned method.

In the final stage, by a general RBF neural network the selected members are combined. Follow the previous stage with 30 selected networks the next combination of the networks that would be operated under an appropriate overall strategy. Now the primary predictors are identified. As the stages of the process have explained 30 networks like $\hat{f}_1(x), \hat{f}_2(x), \ldots, \hat{f}_{30}(x)$ are chosen for each types of deposits.

Several methods are provided to combine the prepared networks but we can also see that there are some errors in the obtained results. The general model of the network would be able to achieve a better performance due to the correlation rate of the errors to each other. Therefore, other RBF neural networks as an overall tool would be used to combine the members to each other. Thus we use another neural network are an overall tool to combine the members.

By the obtained results from 2 primary stages of the selected members would be determined. The selected members will produce from the overall members of (X1, X2, …, X30). By the using the outputs as the next inputs for another RBF neural networks the general model of the neural networks as Figure 1 can be obtained.
The final prediction would be provided for each 3 types of deposits. The obtained results would be as follow:
Multi RBF out 1 mse = 0.004033
Multi RBF out 2 mse = 0.0007995
Multi RBF out 3 mse = 0.00044117
At the end for testing the accuracy of the model, the primary data would be predicted by 3 other methods:

1- The method of simple average is one the most widely used overall approaches that is easy to realize. Usually, the sample average method is for the overall prediction as the equation 20 in follow:

$$\hat{f}(X) = \sum_{i=1}^{m} W_i \hat{f}_i(x) = \frac{1}{m}\sum_{i=1}^{m} \hat{f}_i(x) \qquad 20$$

Where the obtained weight of each single network is $w_{opt,i} = 1/m$ the
acquired answers from each 3 deposit are as follow:
Simple average out 1 mes = 0.0069571
Simple average out 2 mse = 0.0010093
Simple average out 3 mse = 0.00067307

Method of simple MSE:
By using the method of simple MSE the parameter of wi by the minimum of MSE for i=1, 2, …,m can be estimated.

$$W_{opt,i} = \underset{w_i}{\arg min}\left\{\sum_{j=1}^{k}\left(w_i^T \hat{f}_i(x_j) - d_{ji}(x_j)\right)^2\right\} = \left(\sum_{j=1}^{k}\hat{f}_i(x_j)f_i^T(x_j)\right)^{-1}\sum_{j=1}^{k} d_{ji}(x_j)\hat{f}_i(x_j) \qquad 21$$

Where d(x) is the expected value the data which have been used in the training program and predicting wi and single predictors often have a strong correlation. The obtained responses for each type of deposit are as follow:
Weighted average out 1 mse = 0.0090757
Weighted average out 2 mse = 0.00073477
Weighted average out 3 mse = 0.0004663
Method of RBF single neural network:
The obtained responses from this method are as follow:
Single RBF out 1 mse = 0.010442
Single RBF out 2 mse= 0.00097124
Single RBF out 3 mse = 0.00058118
All the obtained responses from each four method are repeated in the attachment P.
Evaluation of the results
Generally we have compared the two indexes of Dstat and NMSE in this study. There are N acquired pairs of the real value of the (yt) and prediction of (yt) from each four methods therefore we can normalize the NMSE and MSE values by the equation 22 as follow:

$$NMSE = \frac{\sum_{t=1}^{N}(y_t - \hat{y}_t)^2}{\sum_{t=1}^{N}(y_t - \bar{y}_t)^2} = \frac{1}{\sigma}\frac{1}{N}\sum_{t=1}^{N}(y_t - \hat{y}_t)^2 \qquad 22$$

Where the σ is the predicted variance from the obtained average data it clearly can be seen that the prediction of NMSE is the only prediction in levels of the courses. This method is one of the most accurate methods to compare the predict models with each other. By using the above method the obtained results would be as follow:

Table 1: The obtained results from NMSE method

models		Single RBF	Simple MSE	Simple average	RBF-based ensemble
Deposit 1	Rank	4	3	2	1
	NMSE	0.39368	0.342169	0.262296	0.14229
Deposit 2	Rank	4	2	3	1
	NMSE	0.023264	0.011484	0.015775	0.009999
Deposit 3	Rank	4	1	3	2
	NMSE	0.014287	0.007258	0.010476	0.008297

The ability of prediction of changes or the U-turns in the prediction approaches are calculated by the Yao and Tan. Formula Dstat is as the equation 22:

$$Dstat = \frac{1}{N}\sum_{t=1}^{N} a_t \times 100\% \qquad 23$$

When N indicates the number of tested samples we will have the equation 24:

$$a_t = \begin{cases} 1, & (y_{t+1} - y_t)(\hat{y}_{t+1} - y_t) \geq 0 \\ 0, & \text{Otherwise} \end{cases} \qquad 24$$

By the implementing the above method on data the acquired results of the study would be as follow:

Table 2: The obtained results from Dstat method

models		Single RBF	Simple MSE	Simple average	RBF-based ensemble
Deposit 1	Rank	2	1	1	1
	D_{stat}	92.593	94.444	94.444	94.444
Deposit 2	Rank	2	2	2	1
	D_{stat}	98.148	98.148	98.148	100
Deposit 3	Rank	3	2	2	1
	D_{stat}	96.296	98.148	98.148	100

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