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Optimization of Customers Credit Evaluation for Iran Khodro Leasing Company using the Neural Network Algorithm

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Abstract

Background/Objectives: Although in recent decades the capability of computers in data saving, recovering, office automation and other affairs are undeniable, there are also cases where a person is forced to do them by himself. **Methods/Statistical Analysis:** This study focuses on the developing a proper model for investigation of credit behavior of the facilities costumers by using a neural network for credit rating. In this way, the model firstly identifies the credit behavior of the costumers and then calculates their creditworthy points. In the next step, the neural network models were tested by experimental data followed by designing and training using training data. **Results:** The results of fitting and analysis of the data showed that this model could be applied as one of the models for determining the credit ratings of the customers. Thus, since the lending the facilities for purchase of cars are as the main business of the company leasing companies do not desire to refuse receiving mortgage lending, except in special cases. If by the help of rating process, the branch manager determines that a loan will be deferred or fuel, he can cancel the applicant's lending or requests for more guarantees. **Conclusion/Application:** Since the lending the facilities for purchase of cars are as the main business of the company leasing companies do not desire to refuse receiving mortgage lending, except in special cases. If by the help of rating process, the branch manager determines that a loan will be deferred or fuel, he can cancel the applicant's lending or requests for more guarantees.

Keywords: Credit and Loan, Credit Rating, Neural Network, Optimization

1. Introduction

The first use of neural networks was happened in the late 50th decade of the 20th century while introduction of the perceptronnetwork and developed until the 70th decade. During 80th decade, the microprocessors technology was developed accompanied by generation of new ideas. These achievements could help the human in the case of decision making, the science whichhas always been associated with human kind and by emergence of organizations, companies and particularly by rapid change of environment undergoes a great development. So, lots of researchers have focused in this area to develop more accurate models for improvement of decision making systems[1].

Giving facilities is one of the most prominent activities of the banks and credit institutions that required the specification of credit rating besides therepayment ability of principal and interest to make an accurate decision and decrease the risks in this case.

One of the reliable methods to decrease such risks is to design a system for determination of credit rating for these facilities recipients, concentrated on the rating or credit evaluating model[2,3]. It should be noted that evaluation and rating of costumer's credit or validity is one of the most complicated tasks in the financial systems[4] whichmust be done by professional experts and evaluators[1]. But often because of lack of time, high expenses, lack of professional experts and number of evaluating cases, this approach is not economically effective.

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So, using the information and communication technology that creates a great revolution in banking system (besides novel opportunities and also challenges), it is possible to design the credit evaluating models and apply a scientific approach instead of traditional judgments for specification of costumers background by optimum time and cost.

2. Problem Definition and Need for Research

As mentioned above, giving banking facilities is economically important, but also puts banks at credit risk danger. There are some solutions to manage this kind of credit risk including design of credit rating system for facilities recipients. Regarding the credit market condition, different types of credit ranting systems and appropriate performance of neural networks, the main purpose of this study is to design a model by neural network and apply it for giving bank facilities to the credit customers with less risk during optimum period of time.

Also, considering the mass of nonperforming assets and customer's debts to Iran Khodro Leasing Co., it is essential to apply such method based on the novel scientific approaches to evaluate the customers.

3. Purpose of the Research

The purpose of this research is to develop a credit evaluation model and specify the indicators for evaluation of new costumers of Iran Khodro Leasing Co, including:

- Identification of main characteristics of the costumers for effective rating.
- Design of a model for evaluation of customers rating by Artificial Neural Networks (ANN).
- Prevent the formation of nonperforming assets in next leasing sales.
- Increase of the accuracy in costumers credit rating.

4. Temporal and Local Limitation of the Research

The present study deals with the credit documents of real customers of Iran Khordo Leasing Co. (local aspect) since 2003 (temporal aspect).

5. Iran Khordo Leasing Co

Iran Khordo Leasing Co. (private sector) was established in Iran and registered at Tehran Registration Office of Companies and industrial properties in Oct 2003. This Company is working in the various aspects of industrial activities including financial, administrative, credit and leasing, so that aims to develop the leasing capacity in different areas and gain a greater share of the domestic and international markets. In this way, the Company believes on the increase of the customer's satisfaction level by continuous development, considering strategies as described below:

- Developing the car market of Iran Khodro Co. via sale development methods.
- Pioneering in the leasing industry by market development, application of modern technologies and design of novel services based on the costumer's requirements.
- Preparation of beds and following the services during the predicted time with appropriate pricing based on the costumer's requirements.
- Activation and use of the potential and actual facilities of Iran Khodor Co., besides interacting with customers in the identification, problem definition, design and implementation of solutions to meet the final objectives.

6. Giving Facilities Criteria

Regarding the need to return of the initial financial resources, while giving such facilities firstly it's essential to be wise and accurate and consider related standards. In the credit evaluation (validation) models of leasing industry, besides credit risk, other risks related to the product seller and property re-sale must be also considered.

There are 3 major types of risks in the case of leasing deals and lending, including:

- Customer risk: Customer's tendency and ability to pay the rents.
- Seller risk: Credit sellers would introduce the reliable customers. Also, this point can be so helpful while you need to re-sale the product.
- Property re-sale risk: Price of property while selling them in the secondary market.

Customer credit evaluation model in leasing industry must establish a balanced and logical relation between

the customer credit risk and profits or losses of selling the property (a combination of seller risk and re-sale risk).

Unlike the traditional banking models, leasing makes it possible to gain profitability by selling the property while credit risking of the customer.

In addition, it should be noted that paying specific attention to each of the credit standards is not essential in credit decision making processes, but a set of general criteria and attitudes can be a reliable basis for commenting, suggesting or credit decision making. On the other hand, besides having adequate knowledge about the rules and standards, it's essential to have enough skill and experience, so that without having experience, talent and passion, this point cannot be achieved.

In this way, credit rules and standards are introduced and analyzed as mentioned below:

- Reliability and trust.
- Business capability and competency.
- Financial capacity and credit capacity.
- Guarantees and collateral.

7. Credit Rating

Since banks are always concerned about the return of their capital and profits, it is essential to consider the probability of return of such issues. In this way, banks and leasing companies try to give the facilities to a person who is able to repay the capital and profits on time with the less risk[5].

Basically, credit rating is one of the prominent methods to detect differences of a group in a population. Danhem (1938) developed the first system for evaluation of credit demands using five criteria including: position hold, income statement, financial condition, collateral and loan repayment data from bank.

He also argued that different criteria should be determined based on the experiences. Credit rating is a statistical method applied for prediction of the future or present borrower's missing (failure) possibility. In this way, this method aims to determine the effects of customer's personality and characteristics on the risk and errors level.

A credit financial institution has four specific decision making steps[6]:

- Should the applicant of credit facilities be provided?
- Under what condition the applicant should be provided by any kinds of credit facilities?
- Is it necessary to intervene in the deal processes for any reason like delay in repayments, change of banking condition, change of customer's condition and so on?
- If it's necessary to intervent, how should the deal be continued? (Modification of installments condition, re-scheduling, legal action and etc).

Credit rating models are basically applied for finding answers to the first two questions. But recently new versions of some models are applied for finding answers to the last two questions, too. However, Thomas believed that the first decision (Lending or not lending to the new customers) is made based on the credit rating methods while the second decision (how to behave with the customers) is made based on the behavioral rating models.

7.1 Credit Rating Systems

Credit rating systems can be classified in three categories[7]:

- Judgment systems.
- Rating based on the statistical techniques.
- Intelligent Systems.

7.2 Credit Rating Models

Frans Kiss classified the credit rating models in the two general categories[7]:

- Parametric credit rating models including the linear probability models, probit validate , audit analysis and neural network-based models.
- Non-parametric credit rating models including the mathematical programming, classification trees, nearest neighbours models, AHP (Analytical Hierarchy Process) and expert system.

8. Neural Network

The concept of artificial intelligence was firstly introduced by MardinMinskey in the Dartmouth conference (1956). Today, artificial intelligence is a developing knowledge considering as the active research area. In reality, it can be considered as the practical application of theoretical science with its limitations[8].

Early attempts in this regard were done by Mac Klouke and Walter Pitts, by using a logical model which nowadays is the basis building blocks of most neural networks. Since the second half of the 40th decade, the practical systems of artificial intelligence were developed, but the main progress was happened in the 70th decade. In 1972, Teo Kohonen and James Anderson introduced

the novel networks independently, which were able to behave like the storage elements. In the 80th decade, by development of microprocessors technology, researches on neural networks was progressed, so that the feed back and error back algorithms were originated from such researches[9].

8.1 Biological Basis of the Neural Network

Neural networks are described as a data-processing technique based on the behavior of biological neural systems like human brain. The basic concept of neural networks is the data-processing system, includinga large number of processing units (Neurons) linked to the networks[10]. In simulation of main systems of the brain, parallel models should be able to hold the knowledge paralleled inside and process it in the same way. However, it is possible to use a successive simulation approach for these structures. In this way, it is not necessary to develop parallel computing systems, resembling the brain.

However, the naturally parallel structure of the neural network systems makes them efficient to be applied in the parallel machines and possessing more advantages in the case of speed and reliability factors. Furthermore, we know that brain behaves in the same manner. As the saying goes, right tool is essential for the right job[4]. As a parallel data processing system, the brain is made of hundred billions of linked neurons (with 1016 connections). Neuron is the basic component of the brain and can act as a logical processing unit. Every natural neuron is composed of three main parts:

- Cell body (soma), including the nucleus and other parts of the cell are originated by it.
- Dendrites.
- Axons[11].

Dendrites act as connections to deliver the inputs into the neurons, while axons act as the neuron outputs. Axon sequences are cut off in a specific contact point named synapses and re-connect to the dendrites belonged to another cells. Dendrites are the most important members of the neurons which receive the signals and axons also help the other neurons to improve the processed data. Also, the valuable role of the synapses in data processing is to connect the axons to the other neuron's dendrites[12].

Mathematical modeling of neuron behavior is almost simple. In this way a given function processes the data obtained by the dendrites and if the input signal exceeds the threshold, the information is pushed by the axons. The main characteristic of the neuron is that it changes the action based on the received data continuously, called training. Synapses play an important role in this case. The first artificial neuron was formulated by Mac Culloch-Pitts (1943) in the form of biological neuron, as shown below.

- Axon: A connector that relates the neuron output signal to the other neurons.
- Synapses: The connection place of a axon to a neuron is called synapses or synapses group.
- UI(0): Activation Function, which acts as a network or linear collactor of the inputs.
- FI(0)=Transaction Function, which specifies the cell activation limits.
- I: Number of input pattern.

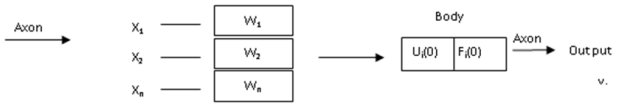

Figure 1. Schematic of the First Artificial Neural Cell (*Φαυσεττ,* 2000, Π 52).

Obviously (Scheme 1), body of the cell is composed of two main parts: the combination function and transaction function, respectively. The latter would transfer the value of activation function to the cell output (also named activation function).

8.2 Characteristics of a Neural Network

Neural networks can be distinguished from each other by computational models, rules of learning, training and network architecture[13].

- Computational models: artificial neurons would add the signals received from the neurons to the bios,after multiplying them by connection weights (synapses). The output of the activation function results in stimulation or inhibition of neurons. Practically, just a limited number of activation functions are used as mentioned below:
- The linear activation function.
- Extreme two-valued threshold activation function.
- Sigmoid activation function.
- Linear threshold function.
- Rules of learning: The neural networks as the learning systems are able to gain experiences from the past results and improve their behavior while training. Their behaviors are defined by the recursive algorithms and hence they are called the learning rules.
- Network Architecture (structure), which means the neurons connection type. The architecture of artifi-

cial neural networks is like directed uniform graphs including the artificial neurons as the nodes while directed arrows (together with weights) have shown the relations between the neurons inputs and outputs. Artificial neural networks are categorized in two general groups based on their architecture (topology), so that each group is composed of some types of networks (Scheme 2).

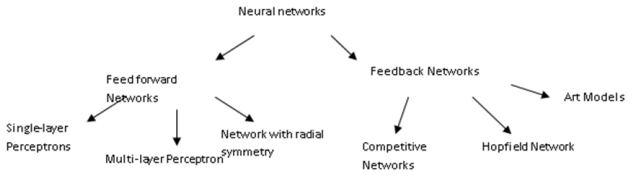

Figure 2. Schematic of Network Architecture.

8.3 Application of Neural Networks

Mao and Mohiuddin have explained the application of neural networks as described below[14]:

- Pattern classification: This task is described as specifying a pattern of data to one of the pre-determined categories, using a feature vector. One of these kinds of applications is about rating of bonds.
- Clustering: A clustering algorithm discovers the similarity of patterns and classifies the same patterns in a specific cluster. This ponit is so valuable in data mining and extracting.
- Function approximation: Its task is about approximation of a function from the unknown functions.
- Forecasting: Regarding a ν-element set of $\psi_{(+1)}$, $\psi_{(+2)}$, $\psi_{(TV)}$, in the τ_1, τ_2, τ_V time sequence the task of the network is to forecast the $\psi(\tau_{V+1})$ sample in some of τ_{V+1} Prediction of stock market and corporate bankruptcy are from the examples in thos case.
- Optimizing: purpose of an optimization problem is to find a solution that is valid in a set of limitations, and also can optimize (maximize or minimize) the objective function.
- Associative memory: Using the associative memory, it is possible to access the data by their content. So that the content available in the memory can be reviewed even by an imperfect data or a disrupted content. While in the available computational models, a data in the memory can be accessible just by its address.
- Control: The purpose of a control model is to create a control input so that the system can follow an optimal path determined by the reference model.

9. Research Background

As Δεσαι and coworkers have reported in 90th decade, they used some techniques like linear audit analysis and logistic regression, for classification of loans of international clients in USA, Germany and Australia ingood, bad and poor levels. Finally they concluded that it's prefered to do the classification in good and bad levels. Also, using the data related to the achieved credits in the mentioned countries during 1988-1991, researchers found a list of credit predictive variables including: the number of main credit cards, housing, salary and other incomes, honesty score while reporting the data based on the bank credit cycle, the duration of current occupation number of dependents, number of inquires in thepast seven months, monthly payment proportional to income, bad pay during the last 12 months, the total debt in proportion to income, the applicant's age, time spent in the current address, number of credit accounts according to the credit circular, the number of active accounts according to financial circles, the number of loans in the past and a data score based on credits circle reports[15].

Another research was conducted by Ωεστ (2000) by using neural networks and numerical analysis techniques, to divide the customers into two categories: good and bad. They also used different variables to develop a credit evaluation (validation) system including account lifetime, credit history, job classification, checking account status, personal properties, duration of stay, other gained loans, settlement classification, amount of loan, purpose of loan, employment duration (experience), and the status of accounts[16].

In another research conducted by Ψοβασ et al. (1997), they used fuzzy inference method and decision trees, to classify the credit customer's performance in two good-payers and bad-payers categories. They also used different factors including: employment status of the applicant, the time spent in the bank, mortgage value, number of children, time spent in current job, residential status, account type, other individual cards, the estimated home prices, home phone, the applicant's income, spouse's income, credit cards in an individual expenditures.

Hφφμανν et al. also used fuzzy genetic regulation basis (Genetic fuzzy-rule based systems). These systems are included of evolutionary methods toimplement and improve the overall knowledge basis.

Χηενγ et al. also used a hybrid methodfor evaluation of customer's credit (validation). In this way they applied a neural network system to classify the customers in good and bad categories and then useda genetic algorithm to do a preferedapproximation on the bank bad customers. But, the main application of these methods was about

their considerable ability in learning of fuzzy classification rules for customers[17].

In 1993, Taftiand and Nikbakht discussed about the use of neural networks by financial corporations and organizations for different credit rating purposes.

Tan and DeHardjou (2001) investigated the effects of increase of time and model predictive period to develop a predictive model from primary researches on the application of neural networks to predict the financial stress in Australian credit unions. The results were acceptable in comparison with the results obtained from the mean deviation from the mean.

In a research named 'evaluation of customer's loans by the help of vector machine', researches examined the 100 loan requests demanded by Taiwan Leasing Companies in 2001-2002. Also, 12 factors were examined for evaluation of every loan including; Sex, age, marriage status, work condition, work experiences, education, each installment, repayment, repayment time, discount rate, bank credits, and banks and leasing companies. In addition, K-φολδ Method was used for sampling in addition to a 5-layer model so that 4 layers (80%) were applied for training and forecasting while the rest were used for model generalization. Also, the selections were in random order to equalize the errors in each layer.

Evaluation of customer's loan by neural networks (2005): In this study a total of 12 credit institutions were examined to identify the factors affecting the creation of a good or bad loans. The purpose of this study was to realize the higher capability of neural network for clarifying the customers obvious and hidden mistakes and risks. The results have shown that although there is not a basic difference between the performance of MΔA and neural network method in classification of good and bad loans, neural network has a stronger ability in identification of problems. The data for applicant evaluation were divided into two groups. The first group was successful in receiving loans and also showed creditworthy in repaying process, while the second group were accepted for receiving the loan, but failed for repaying. In addition, data were about applicant's characteristics including: age, tenants or landlords, the income from various sources, the total amount of debt, monthly rent, the mortgage, credit card, credit institutions and financial credibility.

ShadiHaghdoust, in her study entitled 'Modeling of prediction of stock prices, using neural network and comparison with mathematical prediction methods (2005)' applied regression and neural network to predict the stock price. To do this, she obtained data from companies such as Iran Khodro, Isfahan Petrochemical, Shahd Iran and etc. She also used P^2 ΜΣΕ ΜΑΠΕ methods for comparison[17].

9.1 Research Methodology

The study tried to identify factors affecting the credit consumer's behavior (granted leasing facilities) and modeling of such behaviors. On the other hand, since the application of this research is to predict the behavior of customers of Iran Khodro leasing company facilities, it can be considered as an applied research. In the case of methodology, also a field research method was used regarding the nature of research in the field of financial research study. In addition, Delphi method and survey of experts were used in identifying and ranking of effective factors on the credit worthy customers to do these affairs.

Population: In this study population included 50,672 of individuals from installment sales facilities customers of Iran Khodro leasing company during 2003-2007. A total of 1,000 customers were selected as a benchmark for research and study of customer behavior.

9.2 Hypothesis

The main hypothesis in this research is that by using characteristics (occupation, income and etc.) of the credit customers, it's possible to rate the credit customers and credit institutions (leasing companies and banks). According to the assessment made by Delphi method and expert's opinion, some measures and indicators affecting a person's credit rating were considered.

The more important case in investigation of customer's invoices is their authenticity. So, some factors are considered as the customer's characteristics (features) showing the status of dependent variables of each customer besides having validity and authenticity. In this study, these factors are referred as the evaluating factors. In this survey, the questionnarie No. 1 was distributed among the 25 experts of leasing industry. Also, to evaluate the person's credit rating, after doing essential studies in the case of different indicators, the relation mentioned below was selected as the final indicator for evaluation of customer's credit worthy score:

Customer(Χρε-Σχο) = (Number of installments paid Credit worthy score/(Number of installments due by)

This point was considered as a kind of input in training step while in testing step the trained system compared the results of calculations with credit worthy score of the customer and determined the errors.

10. Data Collection

In this study three important recommendations should be considered for data selection including:

- Features diversity of input data must be met.
- Regarding the issues of generalizability and convergenceing the neural networks, we tried to use 800/1000 of selected samples as the training samples and the rest (200/1000) as the testing samples.
- One of the most important methods in training of networks is to recognize the training stop time. In fact, failure of network training is one of the major problems in the network. The more number of hidden layers and nods increases the possibility of this problem. But, 20000 times training was approximately an acceptable answer for this network. The mean error decreased with successive repetitions and increased the capacity besides learning ability. Of course, there are some disagreements about the repetitions. But regarding the research results, by increasing the repetitions up to 20000, error possibility was also increased and the 20000 times was fixed as the proper point, so that it was in a good agreement with balancing of required time and model accuracy. The required data must be gathered from the customers or their files and be applied.

Table 1. Number of Samples for Training and Testing

Composition of deferred payments	Number of samples in each set	Number of samples for training	Number of samples for testing
No deffered payment	485	388	97
1-10	260	208	52
11-20	80	64	16
21-30	60	48	12
31-40	50	40	10
41-50	50	40	10
51-60	10	8	2
Total	1000	800	200

10.1 Sample and Determining the Sample Size

After reviewing the records, it was found that 48% of the files were related to the facility with low credit risk (credit worthy), 25.6% were for facility with average credit risk (owing 1-10 deferred payments) and 26.4% for high risk facilities (owing 11-60 deferred payments). With respect to the above mentioned materials, composition of samples for training and testing were randomly selected from the Table 1.

10.2 The Method of Data Analysis

The collected data are analyzed and evaluated in several stages.

Firstly: The data collected from leasing system has been investigated and appropriate measures to remove unnecessary data is done to correct it.

Second stage: The research data is encoded using ΕΞΧΕΛ software that classified the information as worksheet.

Third stage: Using MATLAB software, the data were studied and data processing was done.

Fourth stage: Using MATLAB software, research variables were classified and using the improved calculations of this software, the variables with meaningful relations to the dependent variable were identified and finally by applying such variables, neural network model was designed by MATLAB software. Mathematical calculations are briefly discussed below:

The input vector including 7 values is distributed to the activation vector with a layer toward the upper layer including the product of the factor in activation values. In this way, a Σιγμοιδ function was used to determine the activation value of a unit, Αφ, in the upper layer.

$$Aj^{(l)} = \frac{1}{1+\exp\left[\sum_{i=0}^{n} WxAi^{(L-1)(L)} - Oj\right]}$$

If the top layer is not an output layer, the forward spreading of the vector continues again. Λ-1, Λ signs refer to the upper and lower layers, respectively. Else, if the top layer is an output layer, the activation value of each output value is compared with the target values and the error is determined using the formula below:

$$E = \frac{1}{2}\sum_{j=0}^{n}\left(Di - Aj\right)^2$$

10.3 The Error Function

A typical learning algorithm adjusts coefficients in order to reduce the error. So ΒΠΛΑ is a radical reduction algorithm in which the coefficients of the network are adjust respectively to minimize the overall mean squared

error between the desired values of (Δϑ)and actual (Aϑ) values of all output on the input patterns.

Coefficients values for every input pattern based on the error function derivates are determined as below;

$$\Delta Wji = -\alpha \frac{\partial E}{\partial Wji}$$

This derivates determines the error value for an output unit:

$$\delta j = (Dj - Aj)Aj(1 - Aj)$$

and for hidden layers:

$$\delta j = Aj(1 - Aj)\sum_{K=0}^{n} \partial_R W_{Ri}$$

Finally, the connection coefficients between the φth unit in the Λth layer and φth unit in the Λ-1th layer are adjusted as below:

$$\delta j = Aj(1 - Aj)\sum_{K=0}^{n} \partial_R W_{Rj}$$

So that Aι and α are the activation value of ιth value, respectively to determine the training process speed.

10.4 Model Tests and Results Analysis

In this part, the results of model that determine the kind of goodness or badness, have been compared regarding the determination factor coefficient (P^2 and MΣE) and final conclusion is done based on such results. In the testing stage, the network testes the data and examines their accuracy. In this way, data testing and maintaining was done by ΕΞΧΛΕ 2003 software. Also Ματηλ*αβ* software was applied for simulation of network models.

11. Research Achievements

In this section, we survey the modeling and rating of facilities customers by using feedback neural network.

- Preparation of input data for customers rating by the help of neural networks

For preparation of data, firstly forms of recognition of design important indicators and idea of 25 leasing industry experts were gathered. These experts were selected from total of 180 members of company experts, regarding the factors like employment place, work experience in selected leasing company and educational background. After surveying and gathering of summary scores, indicators were chosen as the most important indicators for assessing the status of customers creditworthy. Also, according to the survey of all participants at the meeting, it was approved to select the indicators for evaluation of customers creditworthy so that they possess about 75% of total votes, so indicators with values bigger that 1875 were selected.

Then, required data were prepared from customers facility files and the essential variables were also determined. In addition, for selecting the customers and extracting data from their files, a random approach was used which resulted in the equality of errors in each layer. Also, we tried to select the files with more completed documents. In this study, values of P^2 and MΣE were calculated for rating using neural networks. The final input variables used based on the experts idea and results of researches are as mentioned below:

- Applicant's income.
- Applicant's education.
- Applicant's occupation.
- Collateral 's occupation.
- Applicant's age.
- Applicant's sex.
- The province of residence.

11.1 Network Architecture

A generalized feed forward neural network with 4 layers including the 7 elements in the first layer, one element in the last layer and different elements in the two hidden layers (in models A and B), was used for network training. Number of neurons in the last layer was selected to be equal with the number of outputs (here is 1). Number of neurons in the first layer was equal to number of inputs (7) and number of neurons in the middle layer was determined based on the network effectiveness. Number of nods in the model A was about 10 (first layer) and 5 (second layer), as shown below.

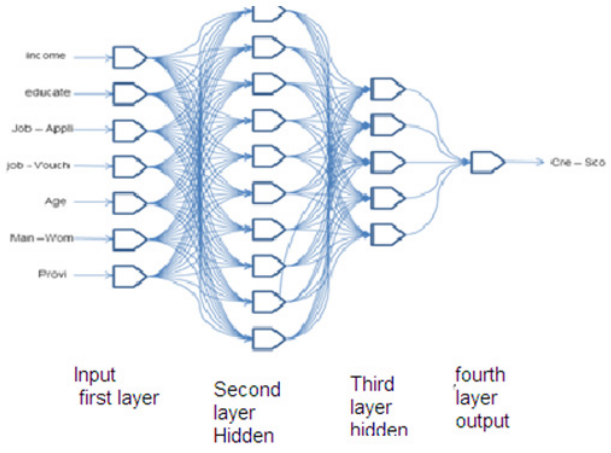

Figure 1. Schematic of Layers and Neurons in Model A.

Number of nodes in the model B was 20 (first layer) and 10 (second layer), as shown below:

The used software was able to do 50000 training units, but here 20000 times was considered, because the results of 20000 times showed lower errors. Then, we concluded to use a generalized multi-layer feedback perceptron network, owing two hidden layers with hidden elements (1-5-10-7) for model A, and (1-10-20-7) for model B, and a tangent function with 20000 times training for model A and B.

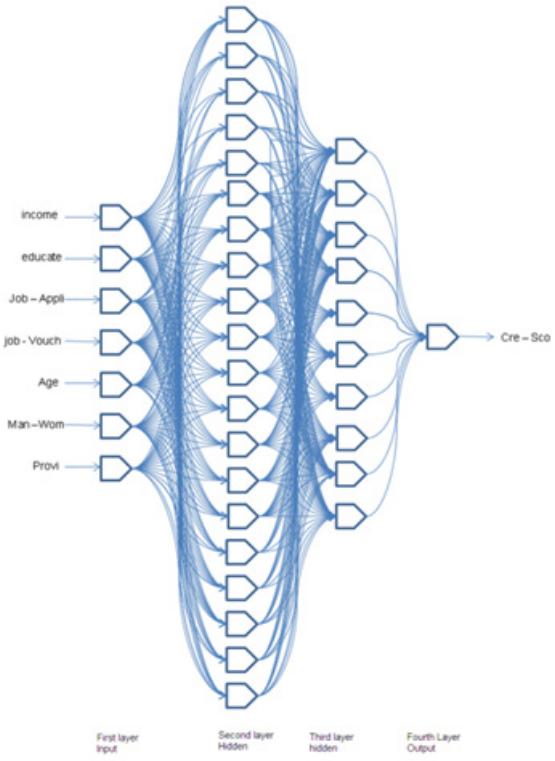

Figure 2. Schematic of Layers and Neurons in Model B.

The neural network with training data included 800 examples, 386 of low risk and 203 of high risk examples. In the final model, the variables mentioned here are considered as the input: income, education, applicant's occupation, collateral's occupation, applicant's sex, applicant's age andresidential province.

11.2 Running the Model

After running the model and applying 20000 replications, errors were decreased and reached the 0.050 level.

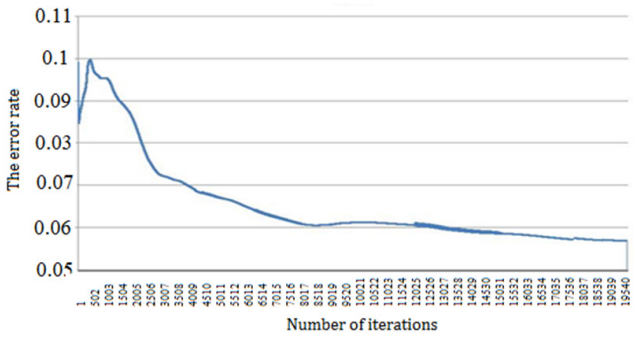

Figure 3. The Error Decrease Rate Versus the Iterations.

As shown in the Figure 3, the network with two hidden layers could efficiently train the input data and reduce the errors. It also should be noted that by increasing the number of iterations, the errors would be modified.

Results of model running have shown that the model could efficiently satisfy the customer's credit worthy point (Table 2).

Table 2. Results of Model Running

Performance	Results of Model A	Results of Model B
MSE	0.05964872	0.050905325
NMSE	0.23859488	0.203621298
r	0.87285756	0.892427956
Percent correct	94.01709402	94.87179487

Table 3. BestNetwork in Traning a and b

Best Network	TraningA	TraningB
Epoch #	20000	20000
Minimum MSE	0.085888677	0.072960933
Final MSE	0.131171759	0.075751159

As it is clear in Table 3, the network in model A could be trained with 0.085 error factor (MΣE) and then evaluate the credit worthy point with variance of about 0.87. In model, the network could be trained with 0.072 error factor and then evaluate the credit worthy point with variance of about 0.89.

Results of model A have shown that the model could forecast the customer's credit score with 94.01 % of accuracy. In addition, results of model B have shown that the model could forecast the customer's credit score with 94.87 % of accuracy. Obviously, model B has the highest resolution, because it owns more percentage in rating of facilities customers.

11.3 Running the Model for New Customers

Since the model was finalized (Feb 2010), it was applied for 50 of new applicants which had great results. According to the received data, the credit worthy scores of new applicants were evaluated by the system and based on it the requests were classified in three categories including: acceptable, conditionally acceptable (if the guarantees become increased) and non-acceptable. Table 4 shows the credit worthy score of the applicants:

Table 4. The Creditworthy Score of the New Customers

1	0.85	11	0.55	21	0.47	31	0.83	41	0.89
2	0.83	12	0.73	22	0.75	32	0.69	42	0.82
3	0.98	13	0.39	23	0.87	33	0.85	43	0.87
4	0.58	14	0.52	24	0.92	34	0.97	44	0.95
5	0.91	15	0.96	25	0.42	35	0.76	45	0.91
6	0.83	16	0.81	26	0.62	36	0.83	46	0.49
7	0.38	17	0.90	27	0.82	37	0.68	47	0.65
8	0.58	18	0.98	28	0.88	38	0.78	48	0.87
9	0.91	19	0.61	29	0.34	39	0.98	49	0.92
10	0.44	20	0.78	30	0.98	40	0.45	50	0.86

So, classification of new customers is as described in Table 5.

Table 5. Classification of New Customers

Topic	Number
Acceptable	28
Conditionally Acceptable	14
Not-acceptable	8

12. Conclusion

Lending to qualified customers is one of the most complicated tasks of credit and financial institutions like banks and leasing companies. The lending process of these resources to the customers can be effective and ensure the profitability, just if these facilities become allocated to the qualified customers to guarantee the generation of more occupation in the country.

In this study, we investigated the hypothesis of using multi-layer perceptron neural network for rating of bank credit customers. This hypothesis (the research innovations) was developed to examine the effectiveness of neural network models in fitness of an appropriate model for evaluation of customers rating and credit worthy scores. The results have shown that the neural network model is capable to be applied in this regard. So, after identifying a meaningful relation between the set of customer's characteristics and their rating as the main elements of allocation of effective credits by MATLAB software, the main effective characteristics of the neural networks model was designed. In this model, the main characteristics were identified and introduced to the multi-layer perceptron neural network by MATLAB software, as the input layer (input vector). Then, the corresponding neural network models were fitted. The results of fitting and analysis of the data showed that this model could be applied as one of the models for determining the credit ratings of the customers.

Thus, since the lending the facilities for purchase of cars are as the main business of the company leasing companies do not desire to refuse receiving mortgage lending, except in special cases. If by the help of rating process, the branch manager determines that a loan will be deferred or fuel, he can cancel the applicant'slending or requests for more guarantees.

13. Suggestions

Regarding the theoretical and practical aspects of this study, the suggestions are reported in the two specific parts including the practical suggestions in banking and leasing systems and theoretical suggestions for next studies.

13.1 Practical Suggestions in Banking and Leasing Systems

- Formulating the guidelines and instructions for the-assessment of customers based on the results of the-model.
- Design of an intelligent software system to be used in sale management of Iran Khodro leasing Co.
- Increase of information received from customers, especially considering the credit history of customer's design of an efficient data gathering system to provide credit customer's information.
- Training of credit facilities division personnel in order to use the system.

13.2 Suggestions for Future Studies

- Implementation of this model in other financial credit institutions of Iran.
- Design of a model for assessment of business activities of leasing companies.
- Design of Intelligent design system for rating of country's leasing companies.

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