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An estimation of economic, recreational and aesthetic value of Margoon Waterfall - Iran "A comparison of Logit and artificial neural networks"

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ABSTRACT

In the present study, the efficiency of neural network model and a Logit regression model are compared to predict willingness to pay to preserve Margoon Waterfall. To do so, first, a logit regression model was estimated and then using the same set of regressors (input variables) an artificial neural network model was designed and estimated. For this purpose, 329 questionnaires were collected through simple random sampling method, of which about 90% of data (289 data) were used to design and train neural network and the remaining 10 percents were used to examine the predictive power of the models. Error percentages of the two models for predicting the tendency to pay were compared. The results of the study indicate that neural network model is more efficient in predicting the willingness to pay (with fewer errors) than the Logit regression model.
KEYWORDS: Margoon Waterfall, recreational and aesthetic values, artificial neural network, willingness to pay

INTRODUCTION

Aesthetic issues are concerned with our understanding of the beauty of the nature. For example, many individuals regard natural landscapes and wildlife as attractive and prefer to live in a world where there are such striking scenes, not living without them (Butckin, 2003). Besides, environmental goods and services are often without price tag and there is much doubt about their true value (Asafu, 2002) and in modern economics, several methods are provided for estimating the value of such goods.

Many studies have been conducted to determine the economic benefits of forest areas. For instance, Nakhaee et al., (2010) estimated the protective of Noor Forest Park and determined people's willingness to pay for the park preservation using contingent valuation method and two-dimensional two-pronged questionnaire. In order to examine the effects of explanatory variables on people's willingness to pay, the Logit model was used and the parameters of this model were estimated using the maximum likelihood approach. The results indicate that 70% of the individuals under study are willing to pay to protect Noor Forest Park. The average amount each household was ready to pay for the protection of the park was determined as 12646 riyals per month. In other words, each family is willing to pay 151752 riyals of its annual earning for the protection of the park. In addition, the annual protective value for each hectare of the park was estimated as 229707314 riyals. Balkayali et al., (2010) determined the economic value of Goreme National- Historic Park through contingent valuation method. They employed a questionnaire in assessing individuals' willingness to pay to understand tourist and recreational value of this national park. The data collected were analyzed by SPSS Software. According to the results and data collected in the study through the questionnaire, the annual willingness to pay to protect the park amounted to $ 8672781. Besides, given the very high capacity of the neural network in data analysis, several studies have investigated the issue, including Kohzadi et al., (1995) who in addition to predicting corn futures prices, compared the neural network model with the ARIMA process. The results of their study suggested that based on MSE and MAPE criteria, the predictive error in the neural network models is 18 to 40% less than that of the ARIMA process. Henry and Boosarawongse (2007) predicted Thai rice export using autoregressive integrated moving average (ARIMA) and the neural network. Then, they compared results obtained by the two models and concluded that the model is achieved the neural network model can efficiently process and predict the data related to export rice compared to autoregressive integrated moving average.

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MATERIALS AND METHODOLOGY

By definition, forecasting future events and conditions are called prediction and the way this is done is called prediction. The predictor obtains a model generalizable to the future by a set of data obtained from the past and analyzing the data. In the present study, the visitors' willingness to pay for the protection of Margoon Waterfall was analyzed through artificial neural network and regression model.

Logit regression model

Logit contingent model utilizes normal and logistic distribution and shows the acceptance probability value (P_i) or rejection probability value ($1 - P_i$) of a proposal which can be determined through following equation:

$$P_i = F(X_i^* \beta) = \frac{1}{1 + e^{-X_i^* \beta}}$$

$$1 - P_i = \frac{1}{1 + e^{zi}} = \frac{1}{1 + e^{X_i^* \beta}}$$

The egression model used in this study is as follows:

$$Y = \alpha_0 + \alpha_1 D_1 + \beta_2 LX_2 + \beta_3 LX_3 + \ldots + \beta_6 LX_6 + u_i$$

Where, y is the dependent variable, showing the willingness or unwillingness to pay for recreational and aesthetic value of Margoon Waterfall. If a person is willing to pay for maintaining and visiting the waterfall, y will be 1, otherwise it is 0. In the above equation, D_1 is the interest TV nature and wildlife shows, = X_2 is increase in taxes, X_3 is the proposed tax, X_4 the suggested payment, X_5 the distance from the place of residence, and X_6 is respondents' income.

Artificial neural networks

Artificial neural networks are simplified models of central nervous system and like the brain transmit the rules hidden behind the data to the network structure by processing and analyzing experimental data. An artificial neural network is composed of neurons that make up the basis of neural networks functions. Each neuron receives the inputs, processes them, and generates an output signal according to the following equation (Wow, 1995).

$$a = f(wp + b)$$

The driving function *f* is chosen by the designer and then based on the choice of *f* and type of learning algorithm, *w* and *b* parameters are adjusted. Learning means *w* and *b* are changed so that the relationship between neurons' input and output are matched with the specific goal. Typically, a neuron has more than one input. In Figure (1), a neuron model with input R is shown.

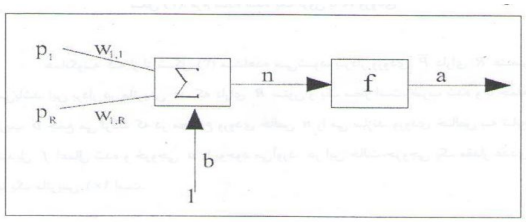

Figure 1: Multi-input model of a neuron

In Figure (1), *pi* is input vector element ($\bar{P}$) which make the net input as an equation, using the weight matrix *w* and the diagonal term *(b)* as follows:

$$n = \sum_{i=1}^{R} p_i W_{1,i} + b = W\bar{P} + b_0 \qquad \bar{P} = [P_1, P_2, \ldots, P_R]^T$$

$$W = [w_1, 1, w_2, 2, \ldots, w_{1,R}]$$

And finally, the net output is applied on conversion function F and generates the outputs *a* as follows:

$$a = f(w\bar{p} + b)$$

A reduced multiple input neuron model can be also shown as Figure (2):

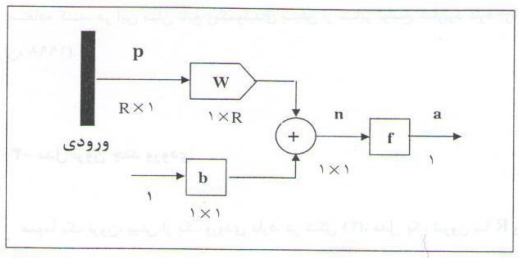

Figure 2: Simplified form of a neuron with Input R

As it can be seen in Figure (2), input vector $\bar{p}$ has an R element. This vector is multiplied by the matrix w containing R columns and a row and is added to the diagonal term *b*, resulting in the total net input *n.* The net input is applied to the conversion function *f* and generates the output *a*. In this case, the output is a numeric value with a 1 × 1 matrix. Usually a neuron even with a large number of inputs is not sufficient by itself to solve problems (Menhaj, 1998). Therefore, in most cases, several neurons are used as a layer. Artificial neural networks can be organized in different ways like biological neural networks, indicating that neurons can be connected in different ways to produce different neural network structures. In the present study, Microfit and MATLAB software packages are used.

RESULTS AND DISCUSSION

In the present study, of 329 data, 289 were used in designing and training neural networks and the remaining were employed to assess the predictive power of the models under study (cross validation method). Therefore, the data set is divided into two subsets of training and test in this method. Then the model is trained by the use of the training data and is validated through the employment of the test data. The process will be repeated for several times and the means of the obtained results are considered as final estimates. In this study, the data were used eight times in the form of a torque as test data. The results of predicting the Logit model are given in the following table.

Table 1: Results of predicting Logit regression model

No.	Samples	Number of correct predictions	Percentage of correct predictions	Error %
1	40-1	31	77/5	22/5
2	80-40	35	85	15
3	120-80	38	95	5
4	160-120	35	85	15
5	200-160	35	85	156
6	240-200	40	100	0
7	280-240	33	82/5	17/5
8	320-280	35	85	15

Source: findings of the study

In an artificial neural network, the data are divided into two parts as done in typical methods for training and testing the network. In the present study, the pre-feed network was designed with a hidden layer and the number of neurons in the hidden layer was determined through an error and trial process. The number of neurons in the input layer is 8 and the number neurons in the hidden layer ranges from 1 to 5 neurons. Logistic functions were used in the hidden layer and linear functions with a neuron were employed in the output layer. Then, the network was trained by employing the algorithm after error dissemination. Finally, using the accuracy criteria, the best network was chosen to forecast the product price, results of which are presented in Table (2):

Table (2): Results of predicting the Artificial Neural Network Model

No.	samples	Number of optimal neurons	Number of optimal iterations	Number of correct predictions	% of correct predictions	Error %
1	40-1	3	12	37	92/5	7.5
2	80-40	4	5	37	92/5	7.5
3	120-80	5	18	28	95	
4	160-120	4	4	39	97/5	2.5
5	200-160	5	12	38	95	5
6	240-200	5	19	37	92/5	7.5
7	280-240	5	15	40	100	0
8	320-280	4	13	37	92/5	7.5

Source: findings of the study

In summary, it was found that the prediction based on artificial neural network model with error percentage of 13.1 is in general more efficient than that estimated by the Logit regression model with error percentage of 13.1%. In addition, the artificial neural network model in seventh order torque with 5 neurons in the hidden layer was selected as the best network with 100% accuracy in the present study.

RESULTS AND SUGGESTIONS

The results of the present study indicated that the predicted trend by pre-feed neural network with eight neurons in the input layer, five neurons in the hidden layer along with logistic activation function was \more efficient in minimizing errors for predicting the price of this product compared to other networks. Building upon the results of the study, it is suggested that the related experts and professionals in addition to be trained in the field of artificial neural networks be equipped with a variety of techniques employed in such networks.

Besides, it is recommended related organizations conduct investigations as what was done in the present study and to employ advanced methods of predicting willingness to pay in order to provide a justification for the decision makers and authorities so that they support the quality of the environment and protected areas such as Margoon Waterfall and stop their disregard with such areas.

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