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Assessment and forecast of yearly temperatures Using artificial neural networks and regression analysis, Case Study: Mazandaran Province, Behshahr City, Iran

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Abstract: In this study annual temperature data of Behshar during the period 1951-2008 is used to compare and predict the temperature using regression analysis and artificial neural network. After assessment of the statistical characteristics of annual temperature, assuming normality of the data was accepted by using the Kolmogorov-Smirnov method and drawing graphs. In Continue the regression methods for analyzing of time series component, R^2 values for explaining performance of simple linear regression models and polynomial regression power and exponentially for predicting trend of time series compared with artificial neural network are used. The result of this study indicated that a direct and meaningful correlation exists in increasing trend of annual temperature in Behshar. Also the results show that artificial neural network is as precise as regression methods for simulation Behshar temperature in this study.
Keywords: Prediction, Annual Temperature, Regression Analysis, Artificial Neural Network, Behshar

INTRODUCTION

Temperature as an index of the intensity of the heat is one element of cognition of weather. According to the solar energy received by the earth, the air temperature at ground level has a lot of changes. Such evidence comes from the weather over the years has undergone a fundamental transformation and the changes led to the creation of numerous environmental and natural disasters such as floods, droughts and occurrence the storms and Hurricanes. Domroes and El-Tantawi studied the changes of temporal-Spatial the temperature of the stations in Egypt and those changes correlated with changes in global temperature have been approved [1]. Turkes and Colleagues have studied variability of the mean annual temperature in Turkey[2]. The results of their study at the regional scale, shows the process of the temperature increase in eastern Anatolia and the it's process of decrease in coastal regions of turkey In the past two decades. Young has studied multilayer perceptron artificial neural network according to the global temperature anomalies with temperature changes of the Korean peninsula and determine the amount of influence for the coming years[3]. Researchers believe that to achieve better results in modeling climate change should use combination techniques such as factor analysis and neural network techniques[4] but it is also believe that in the modeling of temperature changes caused by the greenhouse effect [5], the results of neural network and nonlinear models are more accurate than combined and linear methods, because the climate system is nonlinear and random system [6].

According to the above the purpose of this study is comparison and forecast of annual temperature Behshahr city by regression analysis and artificial neural network technique.

MATERIALS AND METHODS

In this study, the annual temperature data of Behshahr city during statistical period 1951-2008 AD that obtaining from meteorological organization of Iran is used. To predict future temperature trends until 2015 AD, simple linear regression methods, semi-linear, polynomial, degree six, statistical power and Exponential statistics for prospective and comparison artificial neural network were tested(Due to the generality of regression methods, mention of applied equations are forborne). Also in this study in the method of artificial neural network a perceptron with a hidden layer is used. In this perception, the input layer is year and outputs are Behshahr annual temperature. Each of these layers is composed of a number of weighted and non-linear activation functions. As was found in the study multilayer perceptron method,

number 1 Progressive method with learning coefficient Luneburg Margo and Tan axon activation function are used. This function compresses every neuron between the two values, -1 and +1, which is the same correlation coefficient. To the knowledge of the neural network performance and operation, 2 indexes of root mean square error and coefficient of determination are used above index equations are as follows:

$$R_2 = 1 - (\Sigma(y_i - y_j)^2/(\Sigma(y_i - ym)2 \quad 1$$

$$RMSE = (\Sigma(y_i - y_j)^2/N_1/2 \quad 2$$

In equations (1 and 2), R^2 is the coefficient of determination in the range 0 to 1 variable and RMSE is the root mean square error. Whatever the R^2 is closer to 1 and RMSE be smaller, results are more favorable. In equations 1 and 2, y_i is temperature measurement, y_j is the estimated temperature, Y_M is average temperature and N is number of samples.

RESULTS AND DISCUSSION

The first step after data quality control is statistical feature extraction trends to center and distribution annual temperature data of Behshahr city. Statistical properties as described in Table 1 are provided parameters including central values and measures of dispersion are studied for a period of 55 years. The mean annual temperature at the stations studied, 5/24 degrees Celsius. Relatively low coefficient of variation that is (57/2) percent and is expected to the mean annual temperature be more applicable to a normal distribution [8]. According to Kolmogorov–Smirnov test and goodness of fit tests and at the 95% significance level was accepted with assumption of normal data (P>15).

Table-1: Statistical characteristics of annual temperature trends distributional data

Values	Parameters	row	Values	Parameters	row
24.4	Median	1	5	Average	1
2.57	Coefficient of Variation	2	0.084	standard deviation error	2
0.63	Standard deviation	3	0.39	Variance	3
2.8	Domain	4	0.23	Skewness	4
23.1	Minimum	5	25.9	Maximum	5
24	first quartile	6	24.9	Third quartile	6

As we know, regression analysis is a statistical technique for investigating and modeling of the relationship between variables. In fact, regression analysis is one of the most useful statistical methods. One of the important purposes of using regression analysis is estimating the unknown parameters of the model. For example, in the case of two variables, many lines can be drawn between the dispersion points of data But only one of this lines justify relationship of between two variables in the best way and it is one line that it's parameters are on base of the least squares method. This method, called Fitting of the data model[7]. Generally regression equations are suitable for interpolation. In other words, the regression equations are valid only in the domain of independent variables and appear to be not suitable for extrapolation. According to the above description, in the following figures, regression analysis, linear, polynomial degree 6, pyrotechnics, and power can be seen that the time series of annual temperatures in Behshahr and future trends indicate a positive trend and rise with rather remarkable slope. In this case, annual temperature of Behshahr over time has relatively intense increase and in the during of relevant statistical period according to the methods of Measurement the power model 7/31, exponential model 18, polynomial degree 6 and simple linear shows respectively, 40% and 31% changes until 2015 AD. Correlation coefficient mentioned, in polynomial degree 6 models 0.64 Percentage (coefficient of determination 0.40) that are sign of rising temperatures and itself is evidence of elements the non-linear nature annual temperature Behshahr. Correlation coefficients and coefficients of determination in exponential model and simple linear are significant and respectively 0.5643 and (coefficient of determination, 0.317) And 0.5656 Percent (coefficient of determination, 0.319).

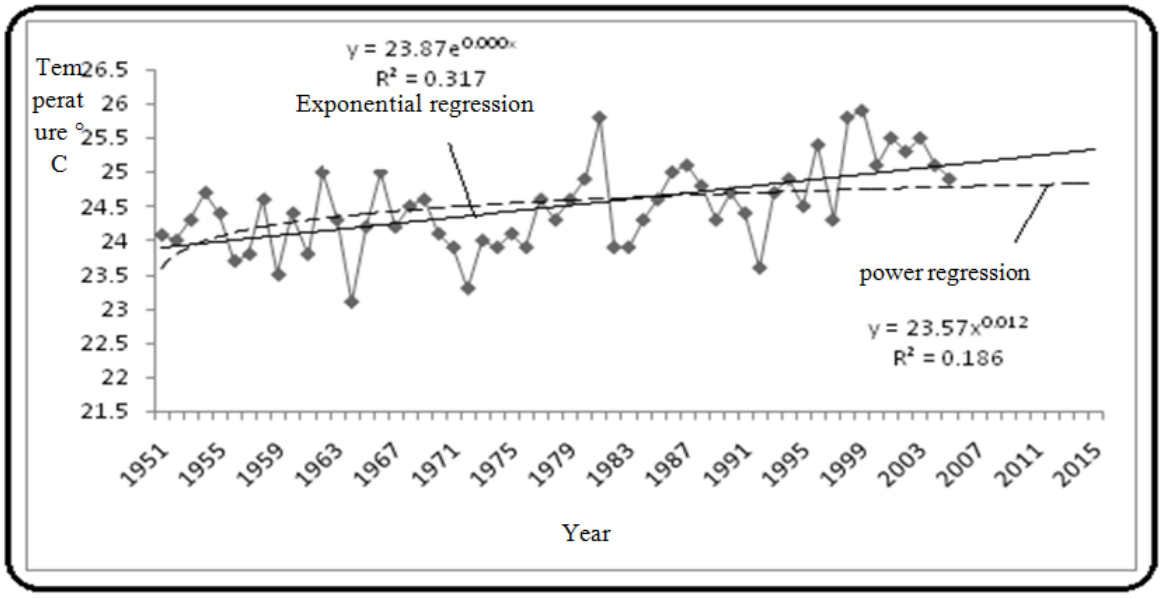

Fig-1: forecast time series of annual temperature trends of Behshahr by using exponential and power regression method until (2015) AD.

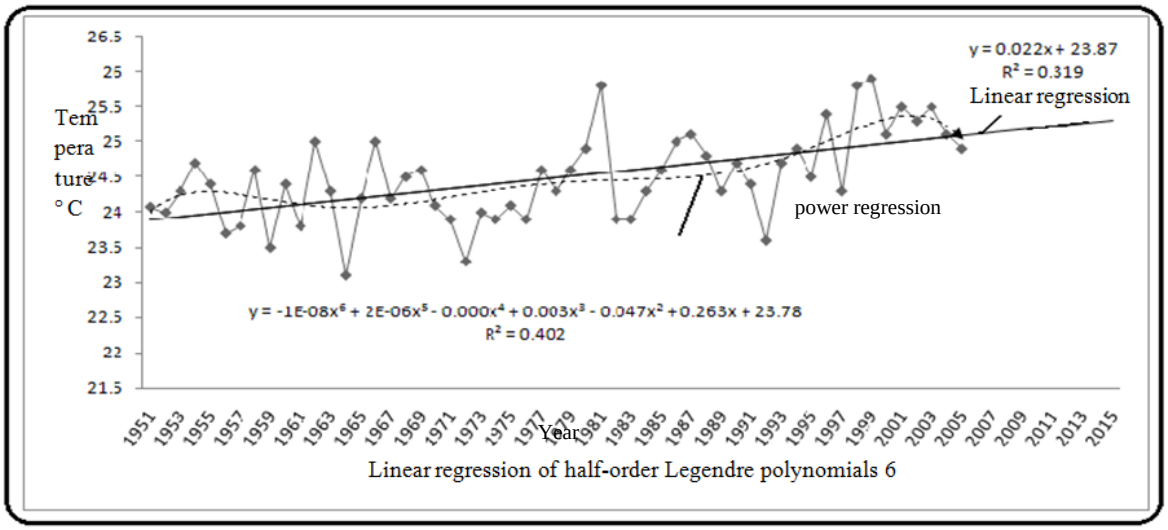

Fig-2: forecast time series of annual temperature trends of behshahr by using linear regression and polynomial degree 6 until 2015 AD.

The rate of coefficient of determination and positive correlation coefficient used in the models indicate a good direct relationship of temperature changes compared to years and the increasing trend of climate change in Behshahr. Due to the nonlinear reactions climatic elements and degree of coefficient of determination, regression models compared with the neural network which determines better prediction ability of nonlinear elements indicate the strength of the neural network in predicting climate purposes and identify the parameters, (temperature, precipitation, moisture and evapotranspiration). According to above it can be acknowledged that the artificial neural network in upcoming way with Tan Axons activation function and the Lionberg learning coefficient has managed to find non-linear relationship with coefficients of determination 0.86 and the correlation coefficient 0.93 percent between actual values and expected values. As we know that climate parameters are complex, not simple and linear, then simple linear methods cannot study accurate and necessary climate relationships as well. As explained above and as shown in the above figure, the polynomial semi-linear method is better than linear regression, exponential and power could better show role of annual temperature anomalies in Behshahr. Accordingly, with the assumption the complexity of climatic factors (temperature) attempted to use artificial neural networks as a non-linear manner is the hope of finding a high correlation coefficient and more relationship. In figure 4 the output of simulation results (forecast) annual temperature with the actual temperature input is shown. Evaluation criteria showing

a correlation coefficient of 0.93% and the coefficient of determination 0.86% and the mean squared error (RMSE) is equal to 0.22% to achieve the desired network (table 2).

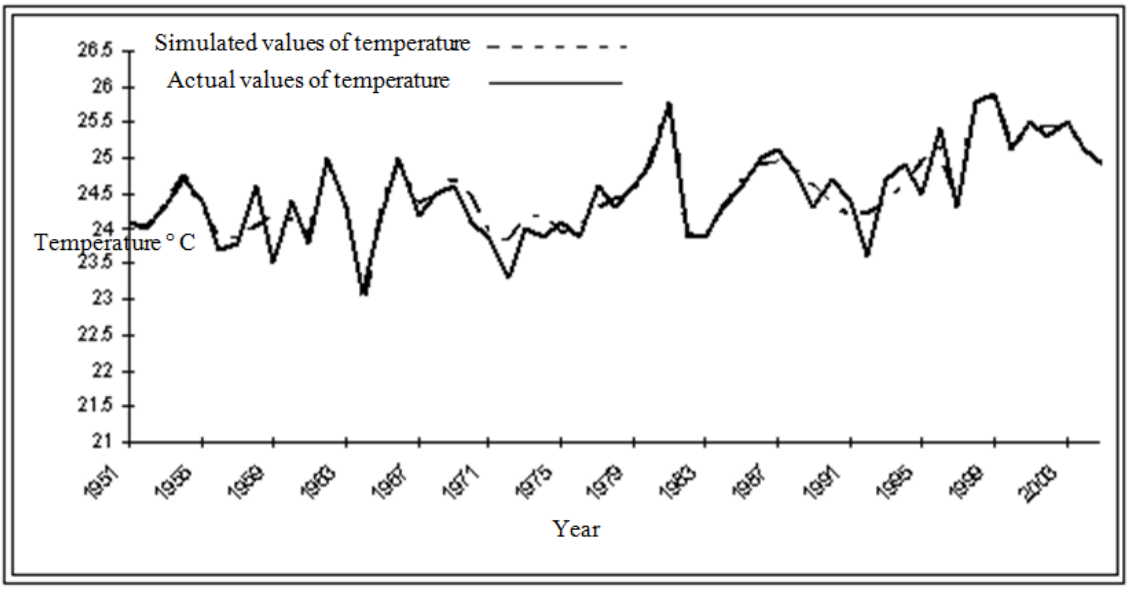

Fig-3: Comparison of actual values and simulated annual temperature of Behshahr by network.

Table-2: Results of the statistical parameters of the ANN model to estimate the anticipated annual temperature values in Behshahr

Evaluation criteria	values
RMSE	0.22
NMSE	0.13
MAE	0.15
Min Abs Error	0.00038
Max Abs Error	0.68
R	0.93
R^2	0.8672

The regression fitting line in Figure (4) related to simulated and actual amounts shows annual temperature, the model is a good estimate.

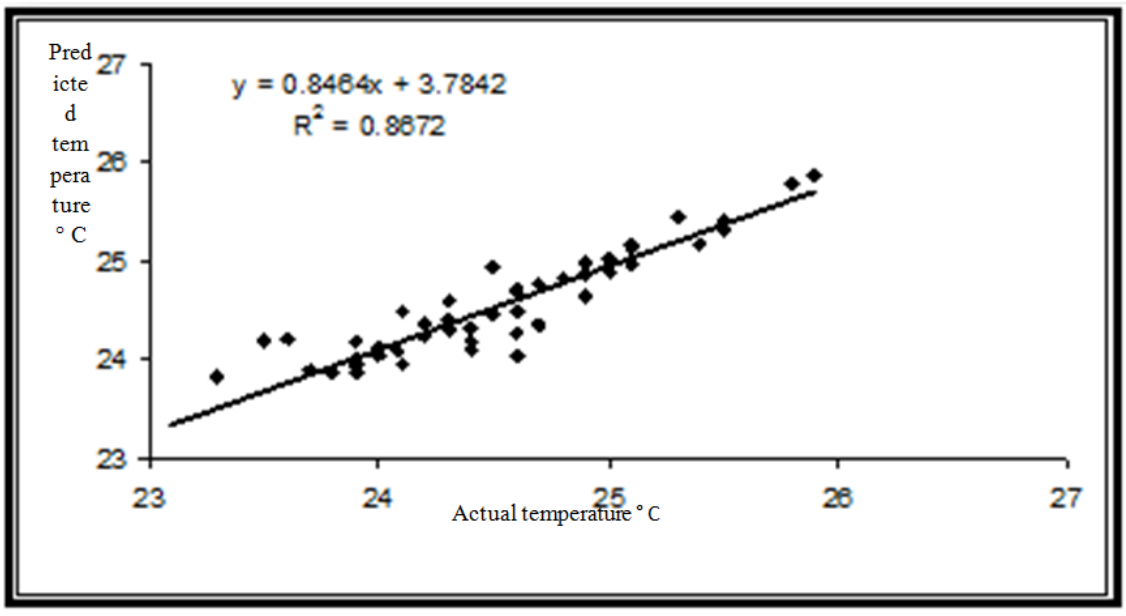

Fig-4: Correlation between actual values and simulated (anticipated) annual temperature in Behshahr

Therefore, according to the results accepted by artificial neural networks compared with the performance of linear and semi-linear models, it becomes clear that the performances of the fitted model compared to above models are much greater and temperature forecast up to 2015 AD is requested from artificial neural network that represents a fairly significant increase in the coming years and will be synchronous trend with today's climate change (Figure 5).

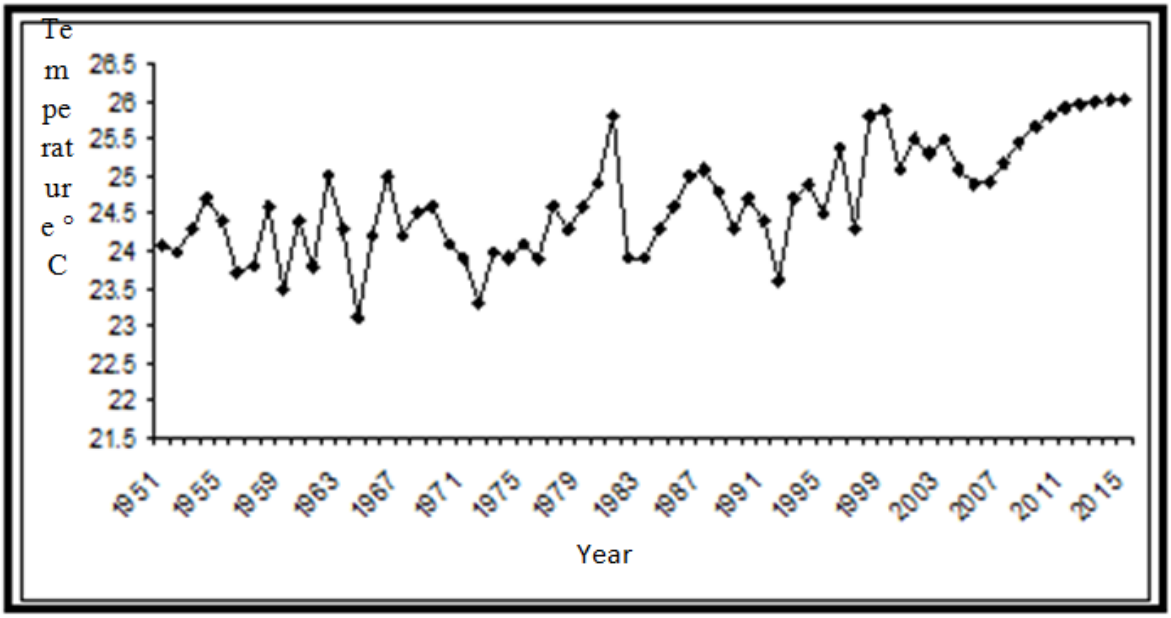

Fig- 5: Forecast annual temperature changes in behshahr by neural networks up to 2015 AD.

The results of this study showed that the mean and coefficient of variation of annual temperature in Behshahr based on the tendency to central and dispersion of data, respectively, 24.5 ° C and 2.52 percent. Statistical assumption of normal distribution of data by Kolmogorov–Smirnov test was accepted at the 95% significance level. Then, using regression methods, ranging from simple linear, six degree polynomial, exponential and power analysis of time-series process and the coefficient of determination values for performance of models have been used to compared with the neural network was proceeded. According to the contents expressed the results indicate the fact that based on regression procedure and corresponding values of coefficients of determination, positive correlation and significant about increase in annual temperature trends can be seen. Temperature time series trend also with using artificial neural network method was evaluated and showed that network procedure against regression has functionality and special excellence. The final results indicate that using multi-layer Perceptron education forward way with Tan Axon activation function and Lionberg Maroga learning algorithm have excellent capability in predicting the time series correlation in Behshahr temperature compared with regression models. Due to the this also temperature predict up to 2015 AD the artificial neural network has been requested, which represents a relatively significant increase in temperature over coming years.

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