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Temperature Prediction in Jordan using ANN

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Abstract: In this work artificial neural network (ANN) approach is used to predict the minimum temperature of 4 months periods during a year January, April, July and October in Jordan. The actual data for 40 years were obtained from Arabia Weather in Jordan which are used to train the data in the ANN.

The main type that is found to be convenient for the prediction is the Feed Forward (FFN) with Tansig function. It is found also that a long period of weather data is the best for the prediction with an approximately of 1% error.

INTRODUCTION:

Weather temperature prediction is of a concern for environment in many aspects for example in global warming, agriculture, industries and many other fields.

Artificial Neural Networks (ANN) is an effective tool for predicting the surface air temperature. Many studies have been done using this tool. ANN had a wide range of applications in the last few years for Finance, Medicine, Engineering, Geology and Physics. Its mostly used for prediction, classification or control, look for example to Haykin et al (199) [1]and Demuth et al in ((2007) [2]. Dombeyc et al in 2009 [3] have studied the prediction of an ambient air temperature for the case of Turkey using the ANN. They used the data of the years of 2003, 2005 and 2006 using the feed forward back propagation algorithms. Kostas Philippo[poulos [4] used the ANN for predicting the minimum and maximum temperature for ten years 2000 to 2009 for the case of Crete island in Southern Mediterranean.

Mahbouben Afzali et al [5] in 2011 have used 43 years data for predicting the ambient air temperature using two tools in the ANN, they are the Feed Forward Networks FFN and Elman Networks, they found that the Elman Networks are more precise than the FFN. Kumar Abhishek et al [6] have used the ANN model for predicting the maximum temperature for 3 years using different transfer functions, hidden layers and neurons. Maqsood et al [7] make a comparative study of multi-layer perceptron MLP and Elman recurrent. Another work has been done by Sanjay Mathur [8] used the multilayer Feed Forward ANN with back propagation. They have used a 15 week short period. Another researchers Mohsen et al (2007) [9], Santhosh et al (2010) [10] and Sergio et al (2001) [11] , Meera et al [12], h. Jyosthna Ch [13] have used the MLP.

In this paper we use the weather data for 40 years for Amman Jordan and study it as a function of different transfer function, hidden layers and neurons to predict the minimum temperatures. We will take 4 periods during the years January, April, July and October for 40 year

MATERIALS AND METHODS:

Input data: Daily minimum temperatures for four months periods during a year January, April, July and October for a period of 40 years starting 1973. The data are from the Arabia Weather in Jordan. The days of each month is 30 or 31 days arranged row wise while the number of years arranged column wise in an Excel sheets. Each month has a 39 consecutive years for the input with a target of the 40th year.

ANN: After many trials using ELMAN, non-linear autoregressive exogenous mode (NARX) and FEED FORWARD network (FFN) we have found that using the FFN is the most convenient for predicting the temperature in terms of the determination coefficient R and the MS (It's the square of the difference between the predicted and the target data). Therefore we have used the Feed Forward with Back propagation network characterized by three layers input layer, a hidden layer and an output layer. We train the ANN using the nn tool in the mathlab with a Levenberge Marguardt Algorithm. Out of the 40 years 60% used for training, 20 % is used for validation to measure the generalization of the network and 20 % is used to test the data in terms of the coefficient of determination R and the mean square error MSE. Trainoss function is used for the network. The number of hidden layer is selected to be 3 after many trials and errors. Tangent sigmoid function is used for the hidden layer and linear function is used in the output layer, so the structure of the network is as follow (40,3,1). A full description about this technique is found in [14].

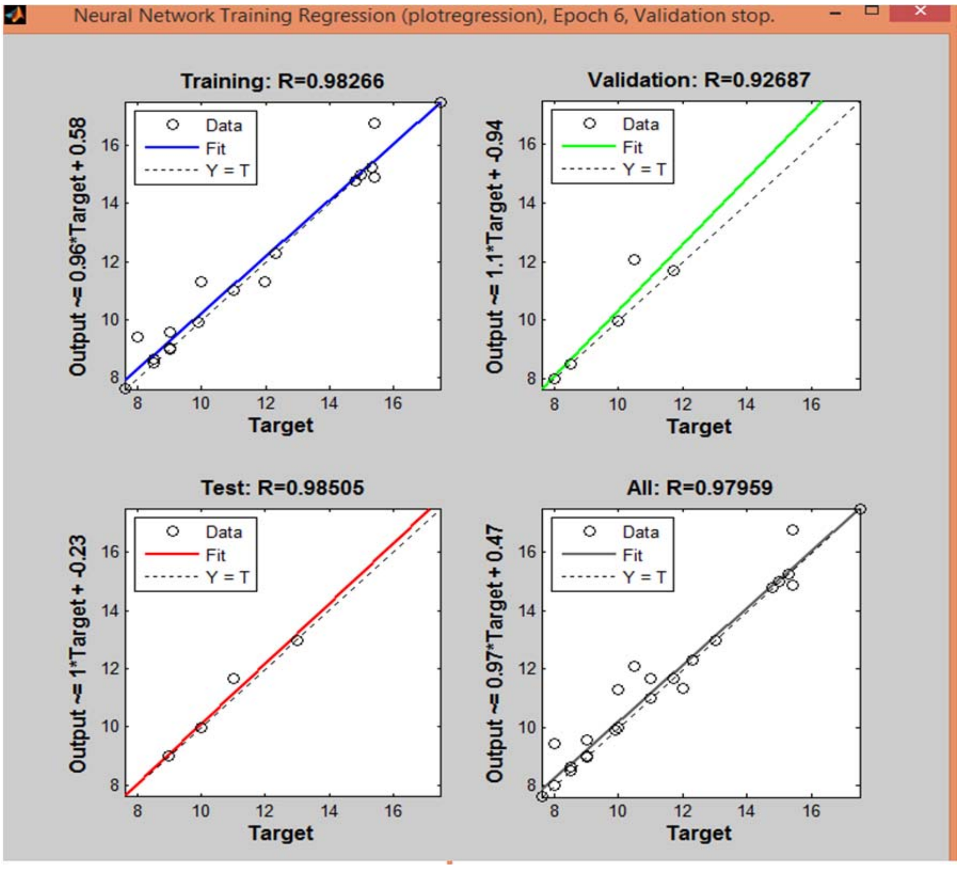
RESULTS:

The obtained results of the scatter plot of the Training, Validation and Testing of the experimental data are presented in figure (1). As indicated in the figure the value of R for the Training, Validation, Test and all for the 4 months are shown in this table

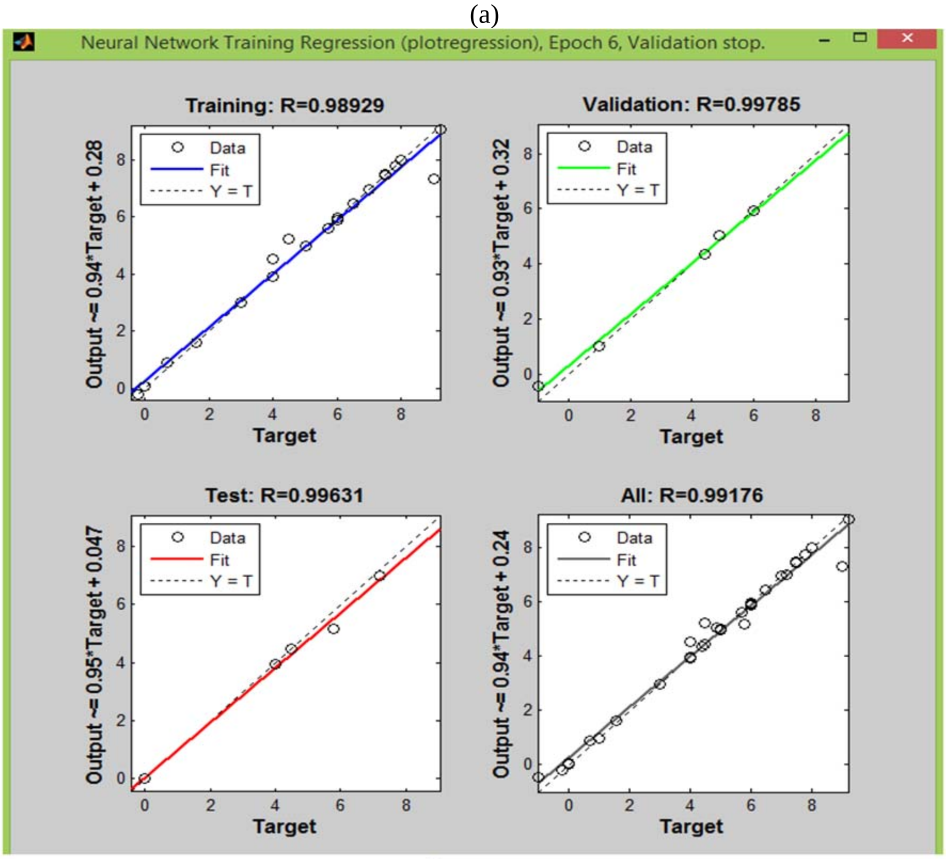
Months	Training	Validation	Testing	All
January	0.98929	0.99785	0.99631	0.99176
April	0.98266	0.92687	0.98505	0.97969
July	0.99973	0.91216	0.99972	0.9944
October	0.90935	1	0.99965	0.9362

These values indicate that the FFN has the best ability for weather minimum or even maximum temperature prediction.

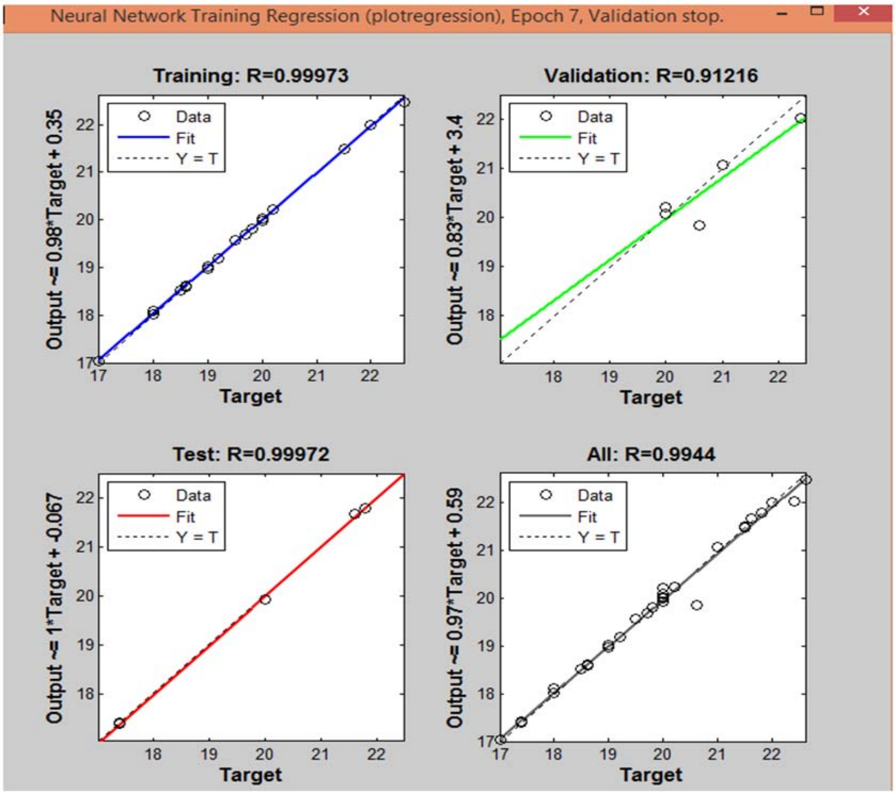
Figure (2) shows a comparison between the real values and the results predicted by the FFN tool for the 4 months (a) January (b) April (c) July (d) October. As can be seen from the figures for these months the errors are at most is about 1%.


Neural Network Training Regression (plotregression), Epoch 6, Validation stop.
Training: R=0.98266
Output ~= 0.96*Target + 0.58
Validation: R=0.92687
Output ~= 1.1*Target + -0.94
Test: R=0.98505
Output ~= 1*Target + -0.23
All: R=0.97959
Output ~= 0.97*Target + 0.47
Data
Fit
Y = T
Target

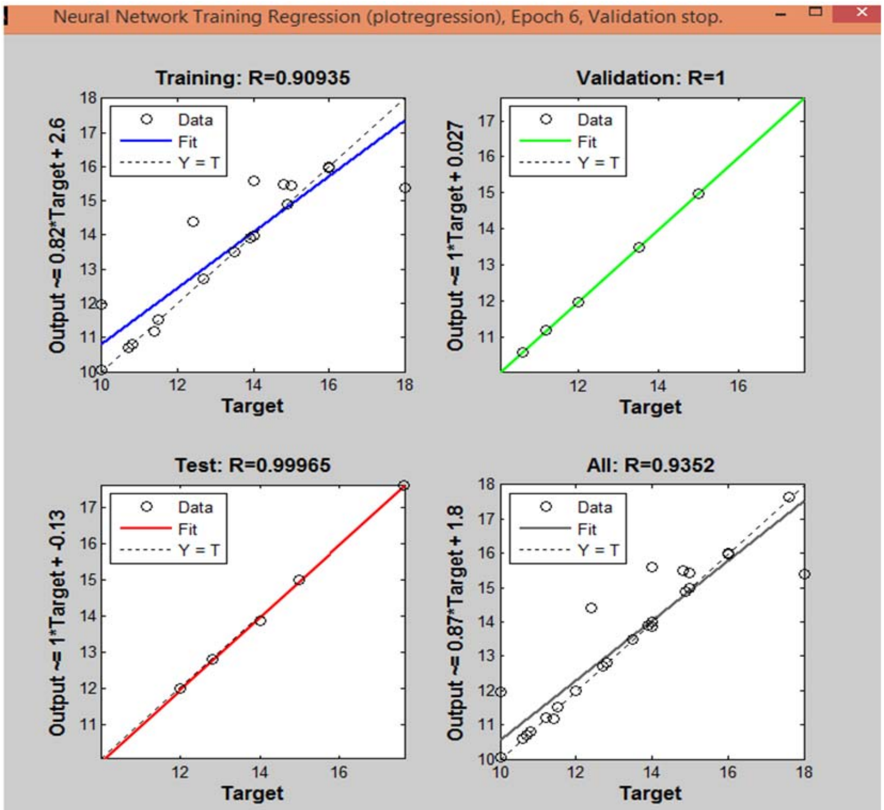
(a)


Neural Network Training Regression (plotregression), Epoch 6, Validation stop.
Training: R=0.98929
Output ~= 0.94*Target + 0.28
Validation: R=0.99785
Output ~= 0.93*Target + 0.32
Test: R=0.99631
Output ~= 0.95*Target + 0.047
All: R=0.99176
Output ~= 0.94*Target + 0.24
Data
Fit
Y = T
Target

(b)

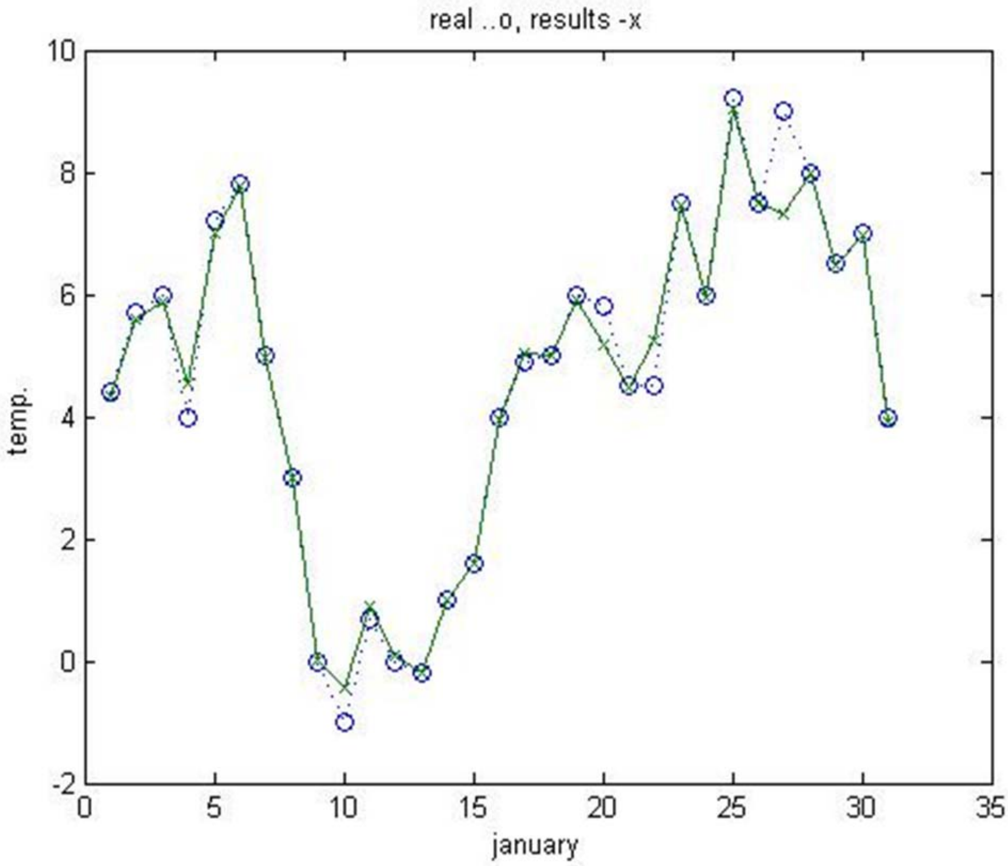


(c)

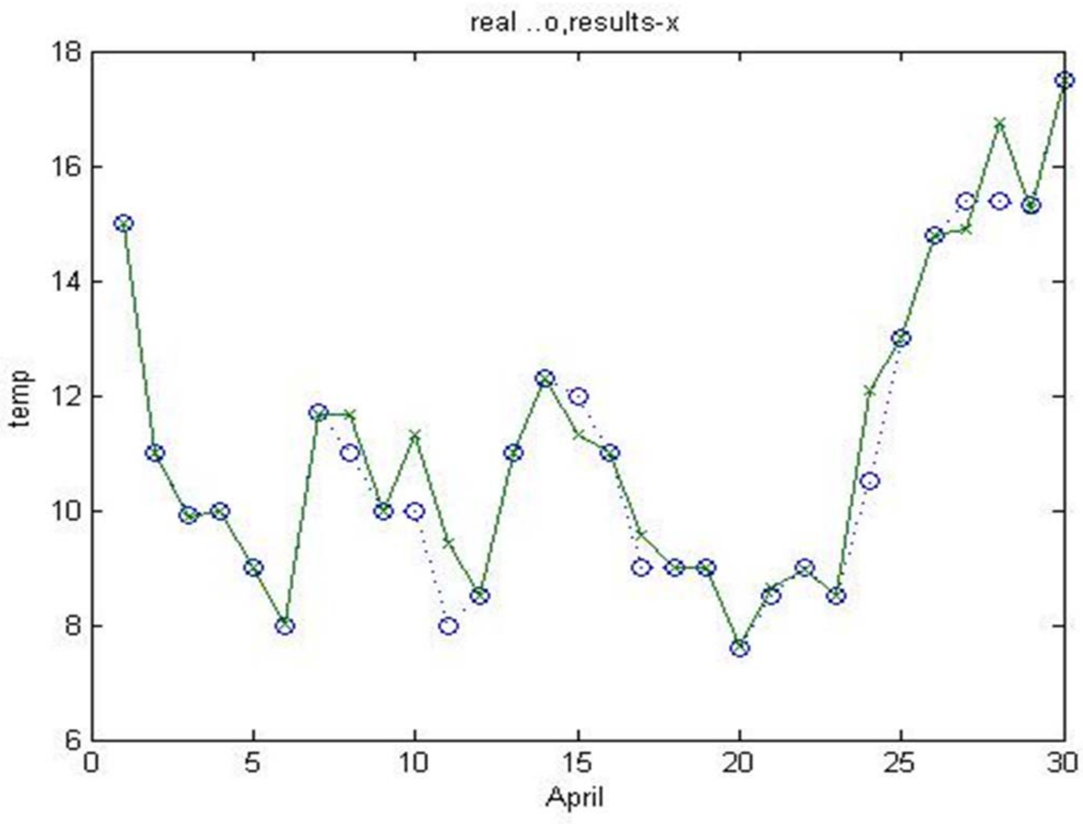


(d)

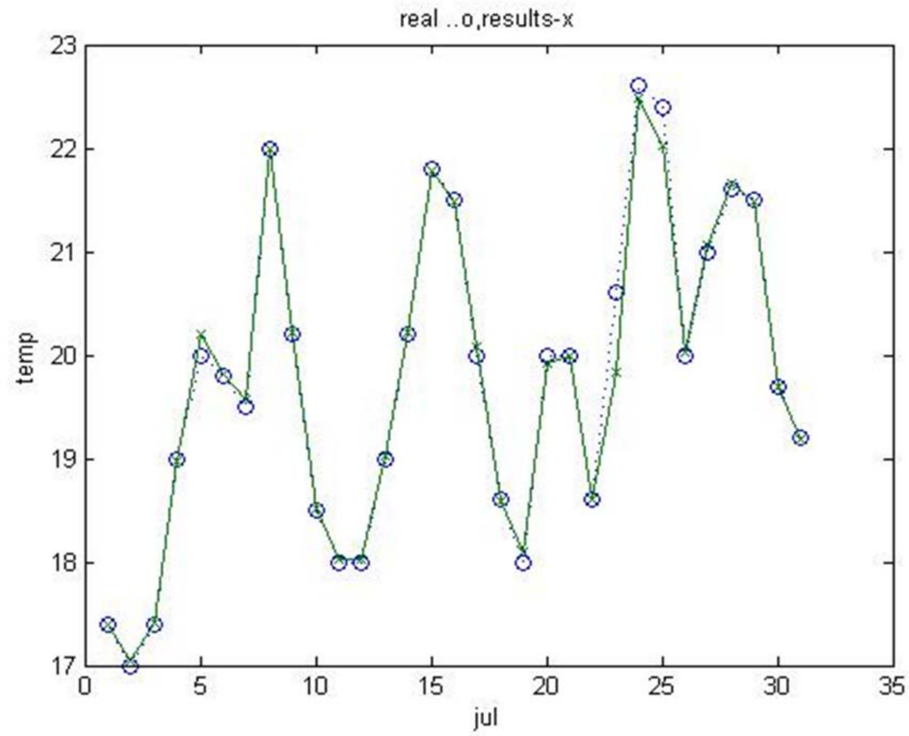
Fig (1) Scatter plot of Training, Validation, Test and all the Data for FFN for (a) January (b)April (c)July and (d)October


real ..o, results -x
temp.
january
10
8
6
4
2
0
-2
0
5
10
15
20
25
30
35

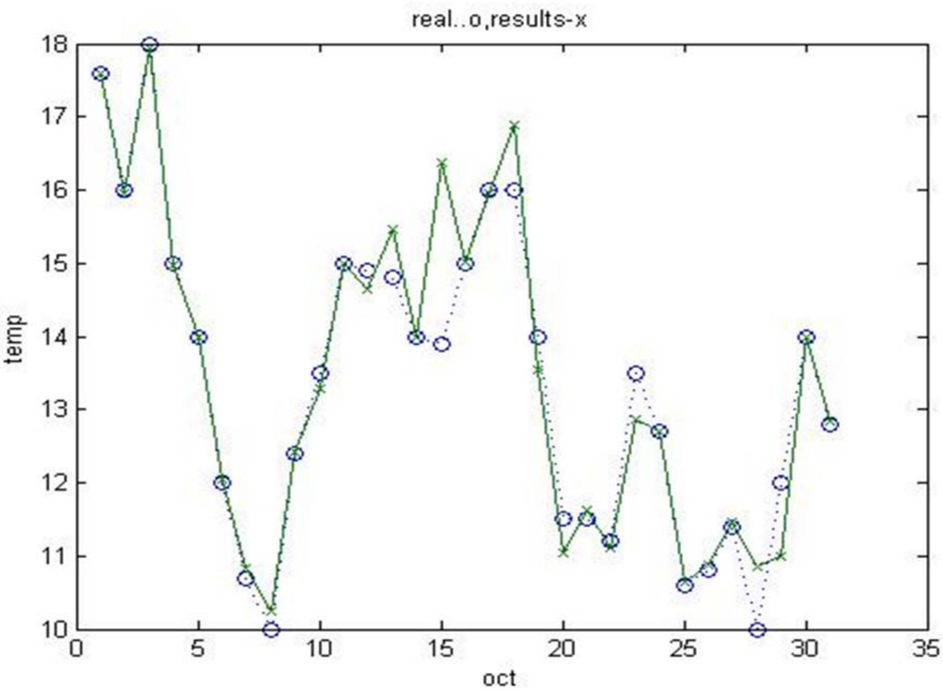
(a)


real ..o,results-x
temp
April
18
16
14
12
10
8
6
0
5
10
15
20
25
30

(b)



(c)



(d)

Fig (2) A comparison between the real data and the results value using the ANN for (a)January (b)April (c)July (d) October

DISCUSSION AND CONCLUSION:

In this work an actual weather data of 40 years was taken to predict the minimum temperature for Jordan and look for the most covenant type of the ANN after many trials and errors taking into consideration of avoiding overfitting through the MSE by choosing the best value of R. This work is in agreement with the work by Kumar et al for the Tansig function prediction and for a long period of time but not by doubling or tripling the number of days of the year. While Mahboubeh et al have found that Elman is more precise than FFN

In the next paper we will study the effects of other parameters like humidity, wind speed etc. on the temperature and the weather forecasting in general

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