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Modeling Cognitive Process for solving Balance Scale Task using Feed Forward Neural Networks

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Abstract :- The Neural Networks are biologically inspired computational models which can be used to perform various tasks such as pattern recognition, function fitting etc. Proposed work tries to model cognitive process of solving Balance Scale Task which itself is a psychological test using Artificial Neural Networks.

Keywords:- Cognitive Process, Artificial Neural Networks, Balance Scale Task.

I. INTRODUCTION

Artificial Neural Networks are statistical tools which are inspired by biological neural networks. In artificial neural networks parameters are interconnecting weights denoting strength of neural connections by which in turn input is passed to form weighted sum. This weighted sum or Net is then passed through an activation function. This activation function is often chosen as differentiable non linear function. Because of it, these can be used effectively for function fitting, pattern recognition, clustering and many other areas. As these models are inspired from biological neural network they can be used to model cognitive learning process used by human brain.

II. LITERATURE REVIEW

Gaurav Kumar and Pradeep Kumar Bhatia [1] proposed neural networks for character recognition. They have used Otsu's method for gray scale conversion followed by thresholding and normalization as their preprocessing step. After that feature extraction phase is done and by training feed forward neural networks image characters are successfully recognized. P. Enyindah and Onwuachu Uzochukwu C. [2] tried to predict interest rate on loan investment with the help of ANN. They have used neural tool box of matlab to train their neural network by offline learning.

Qeethara Kadhim Al-Shayea [3] have used ANN of medical diagnosis. They have used neural toolbox to build two neural networks. One is to analyze patient's data to classify that a he is suffering from heart disease or not based on some symptoms. Other is used to diagnose a patient for acute nephritis. In both cases they have found significant results. Apurva Biswas and Dr.Bhupesh Gour [4] have used neural toolbox to develop automated number plate recognition system. They have done preprocessing for optical character recognition by applying Gaussian filter followed by wavelet transform for feature extraction. After doing vector generation to generate network compatible data they have classified character using nftool. Namrata Aneja. [6] have presented a survey on various neural network training algorithm. Jayati Holkar and Prof. Vidhya Fulmali [5]

III. METHODOLOGY

In proposed work we have used feed forward neural network to model cognitive process to solve balance scale problem. Balance scale problem is a psychological test designed for children to induce their cognitive process of learning. To model this cognitive process through artificial neural networks we have taken dataset from the UCI machine learning repository. We have used offline error back propagation algorithm to train our ANN. Matlab neural network tool box (nntool) is used to do the necessary classification task.

3.1 BALANCE SCALE WEIGHT & DISTANCE DATABASE

This dataset is used to model balance scale experiment. Balance scale experiment is itself a psychological experiment to demonstrate cognitive learning process by human brain. In this experiment a balance scale has to be balance with the help of some weights and using them at appropriate distance from the balancing tip. In a similar way artificial neural network will try to model this cognitive process by giving results on the basis of weights applied and their distance from the tip. This database contains 625 instance. The Balance Scale Weight & Distance Database Contains the following properties:

1. Left-Weight
2. Left-Distance
3. Right-Weight

4. Right-Distance

On the basis of these four attributes ANN classifies to the data into three classes as L,B,R i.e. left aligned, right aligned or balanced. To find out the class of given instance following rules are to be followed

i. If (left-distance * left-weight) > (right-distance *right-weight) ; left aligned.
ii. If (left-distance * left-weight) < (right-distance *right-weight) ; right aligned.
iii. If (left-distance * left-weight) = (right-distance *right-weight) ; balanced.

This constitutes the matrix of 625*4 and is applied in the course of study.

3.2 CLASSIFICATION

Matlab nftool tool box is used for classification of our data. This balance scale experiment is a three class classification problem. These classes are represented as L,P,R in the dataset. To make it compatible with our network we will represent classes with the help of one hot notation i.e. (1,0,0), (0,1,0), (0,0,1) respectively for L,P,R. So, because of it input layer will consist of four neurons (same as input dimensions) on the other hand output layer will have three neurons. Due to this hidden layer neurons could be reduced since appropriate no. of weights are between input layer and hidden layer and also between hidden layer and output layer. After repeating experiment for various combination of number of neurons at hidden layer most efficient structure is found having 1 hidden layer neuron as shown in fig.1.

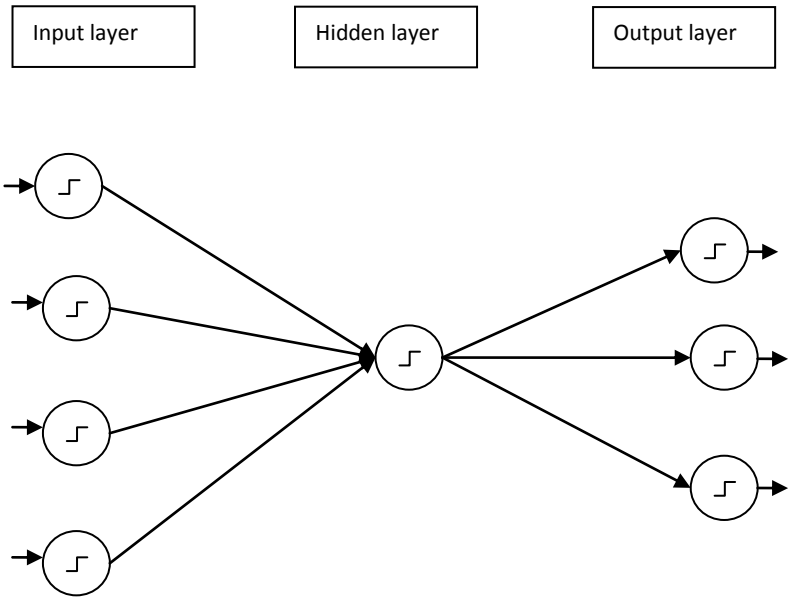

fig1: Proposed Structure of Artificial Neural Network

IV. RESULTS

MATLAB version R2013a is used in our experiment. The balance scale dataset (downloaded from the UCI repository, www.ics.uci.edu), a 625×4 matrix is prepared, as input data. Out of these 625 samples, 75% sample were used for training purpose, to ensure generalizability 15% for validation and 10% for testing.

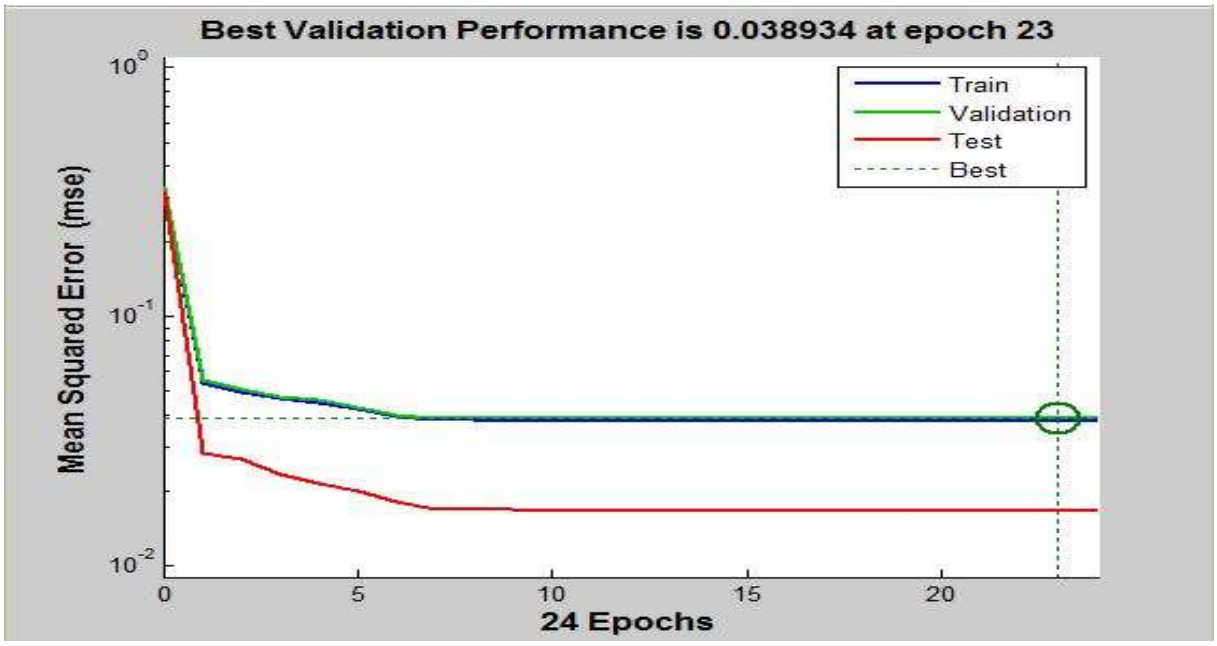

Fig 2.1: Validation Performance

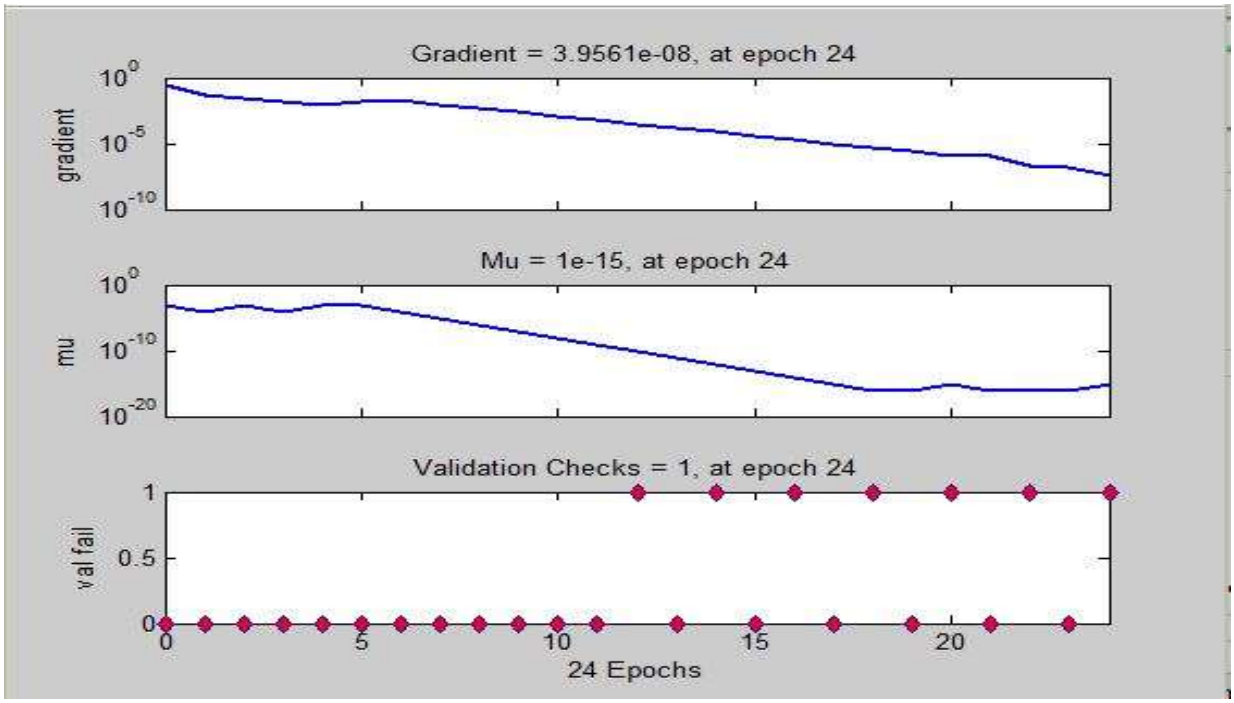

Fig 2.2 Gradient Analysis

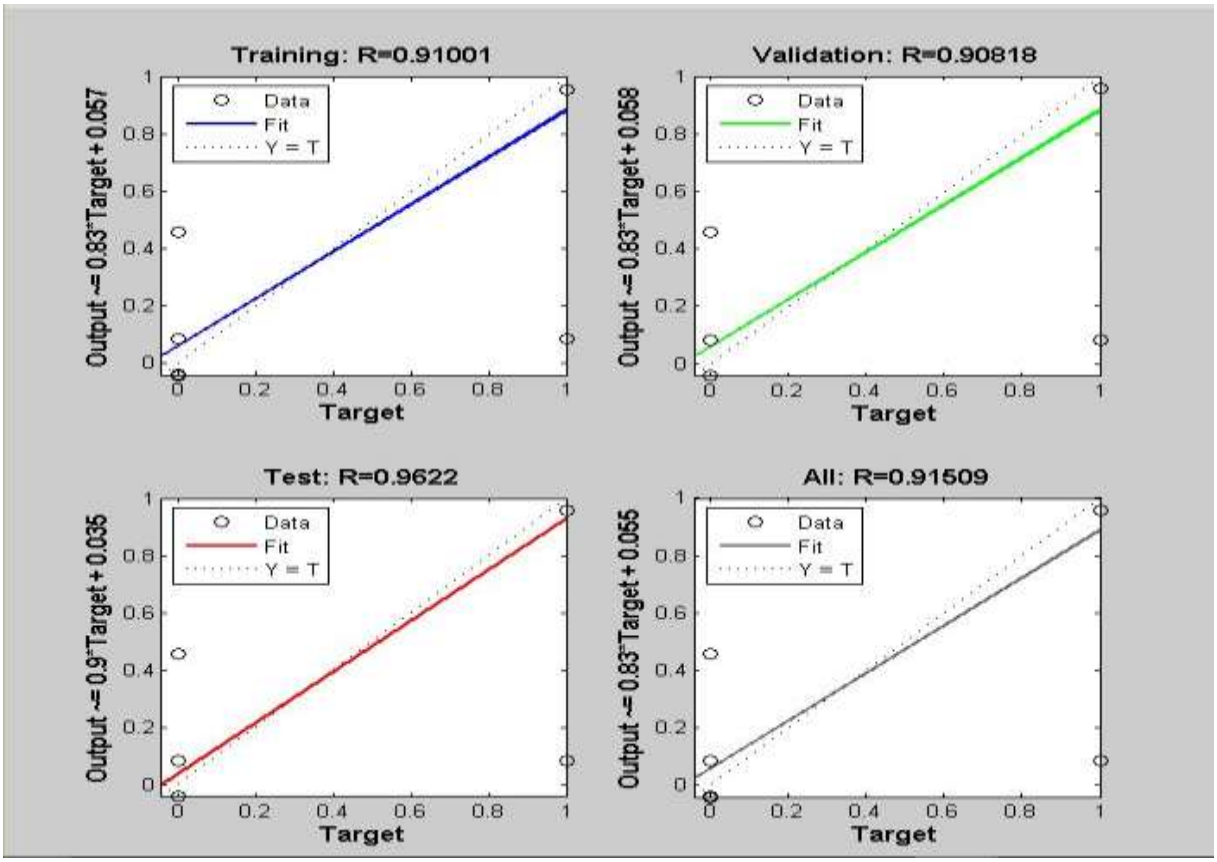

Fig 2.3: Regression Analysis

V. CONCLUSIONS

Multilayer feed forward neural network successfully models the cognitive process of learning. As shown in result 2.1 best genralizable solution is found at 24th Epoch while training error keeps decreasing. Testing result also support this fact. So, from above results and discussion it can be concluded that an artificial neural network can be effectively used to model complex cognitive learning process.

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