Case Study on Classification of Glass using Neural Network Tool in MATLAB

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Abstract:
This paper encompasses application of the Neural Network Tool (NN Tool) in the glass classification problem and also discusses the correlation of the different activation functions with the Mean Square Error (MSE). This paper works on the glass data classification and finds the impact of different Activation functions on the error obtained while training and testing of the neural network model created by the NN Tool provided by the MATLAB Toolbox. Experiment was conducted on the MATLAB (NN tool) with glass data it has been observed that LOGSIG function gives the minimum MSE and gives more accurate results in comparison to the other activation functions provided by MATLAB (NN Tool). This paper highlights the relation of the nature of the dataset and the activation functions on the error obtained from the training of neural network model. In future by observing the limitations and effect of the different parameters such as number of hidden layers, activation functions, nature of the data, adjustments of weights, size of data and many more on the network modeling we will be able to understand and develop an improved algorithm and data mining tool for neural network classification technique with more accurate results.

Keywords*:* Neural Networks, Data mining, Activation Function, MATLAB.

1. INTRODUCTION
Neural network is getting popular now-a-days due to its capability of generalization and resistance to the noisy and erroneous data. A lot of research is undergoing to improve the efficiency and accuracy of the modeling and training of the neural network architecture. Although lot of research work has been done but still there is no profound theory about the exact number of size of the data, architecture of the network and the best suitable algorithm for the NN modeling because selection of these parameters depends on the nature of the data. In this paper we will study glass classification problem and find the values of different parameters suitable for this problem such that we obtain better and accurate results.

In this paper, section 2 describes neural network and tools used for data mining. Section 3 and section 4 discusses the case study and experimental model. Section 5 and section 6 illustrates the result and conclusion.

2. NEURAL NETWORK
Neural Network is the biological structure inspired by the working of human nervous system. Neural Network is being applied widely on different application areas due to its learning ability i.e. capability to extract rules and learn from the data and create a network model which can be used for classification, pattern recognition and forecasting on the data. Most promising feature of the Neural network that other classification techniques do not possess is that it helps to simulate the network and create model which can be used further and applied on the new data which was not previously exposed to the network.

MATLAB is a data mining tool which provides Neural Network Toolbox for Neural Network modeling. Neural Network Toolbox consist of NN tool which helps to create a neural network model to train and test the data for classification of the data, find hidden patterns, clustering and future forecasting. There are several other neural network tools like SPSS but MATLAB NN Tool is popular because of large number of functionality support.

3. GLASS DATASET: CASE STUDY

We have used glass dataset for classification because it can prove to be very useful in crime investigation, behavior of glass material etc. The small pieces of glasses obtained from the crime sites can be very crucial evidence for the investigation purpose. We can create a neural network model and train it on glass data which can further help us to classify the unknown type of glass which was previously not exposed to the model. There are 108 instances in the glass dataset with 10 input attributes and 1 output attribute (Type of glass).
Attribute Information: (Input attributes)

1) Id number 2) RI: refractive index 3) Na: Sodium 4) Mg: Magnesium 5) Al: Aluminum 6) Si: Silicon 7) K: Potassium 8) Ca: Calcium 9) Ba: Barium 10) Fe: Iron
Type of glass: (output attributes)

1. Building_windows_float_processed (20)
2. Building_windows_non_float_processed (20)
3. Vehicle_windows_float_processed (17)
4. Vehicle_windows_non_float_processed (0)
5. Containers (13)
6. Tableware (9)
7. Headlamps (29)

Details of the input and output attributes are explained above. Type of glass will depend on the values of the input attributes and by these values network will be trained and tested to classify that the record will lie in which Type of Glass. In Table 1, sample dataset has been displayed.

4. EXPERIMENTATION

Experiment was performed on the NN Toolbox provided by the MATLAB with the glass dataset as explained above. In this experiment train data set taken is 70% of the total data set and test dataset is 30% of the total data set. We have created the neural network model by the help of the train data set and varied the Activation functions associated with the layers of the network and analyzed its effect on the classification of the type of glass and MSE obtained in the results.

Fig 1: and Fig 2: are the screen shots taken from the MATLAB NN Tool. Fig 1: shows the neural network model created for glass data classification. This figure describes the architecture of the model created and how input parameters are connected to hidden layers and further hidden layers are connected to output layer. Fig 2: shows the detail of the algorithm applied, type of error selected for training the network i.e. MSE (Mean Square Error) and we can also see the performance chart and the regression chart from it. This figure also gives us value of the error obtained while training the network

Table 1. Sample data of the actual glass dataset

RI	Na	Mg	AL	Si	K	ca	Ba	Fe	G
1.5210	13.64	4.49	1.1	71.78	0.06	8.75	0	0	1
1.5176	13.89	3.6	1.36	72.73	0.48	7.83	0	0	1
1.5159	13.02	3.56	1.54	73.11	0.72	7.9	0	0	2
1.5159	13.02	3.58	1.51	73.12	0.69	7.96	0	0	2
1.5161	13.33	3.53	1.34	72.67	0.56	8.33	0	0	3
1.5167	13.24	3.57	1.38	72.7	0.56	8.44	0	0.1	3
1.5151	14.01	2.68	3.5	69.89	1.68	5.87	2.2	0	5
1.5191	12.73	1.85	1.86	72.69	0.6	10.1	0	0	5
1.5111	17.38	0	0.34	75.41	0	6.65	0	0	6
1.5113	13.69	3.2	1.81	72.81	1.76	5.43	1.19	0	7

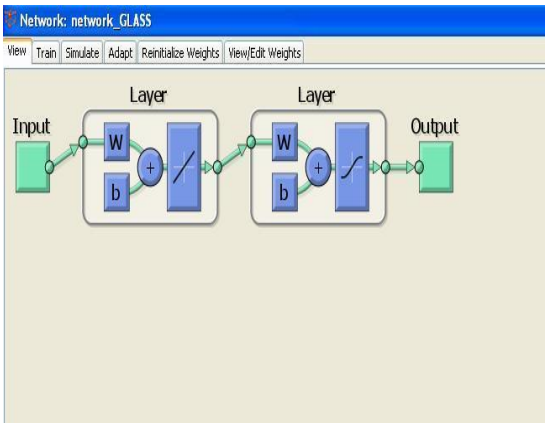

Fig 1: Neural Network Model created by the MATLAB.

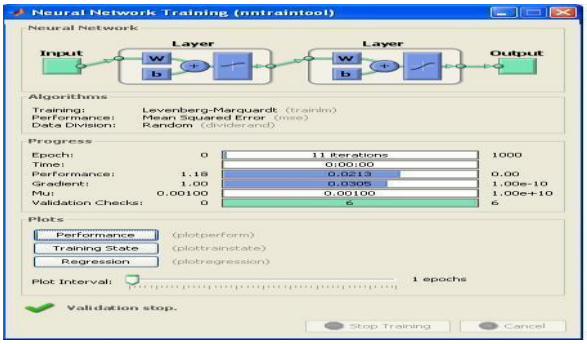

Fig 2: Neural Network model training by the MATLAB

5. RESULT ANALYSIS

Experimental results are shown in Table 2 and Table 3. From Table 2. It has been observed that:

1) The impact of the different activation functions on the error (MSE) while training the neural network model.
2) It also shows that error (MSE) decreases by the number of times we train the network.
3) From the table given below it has been observed that the LOGSIG function on the second training time has obtained the least MSE i.e. 0.00817 of all the activation functions.

Table 3. shows the result obtained by applying the test dataset on the trained model created by the NN Tool in MATLAB for LOGSIG activation function. Target data column consists of the actual result of the glass type which should be obtained by the trained network model for test data and output obtained is the column of the result obtained by the trained network model for activation function LOGSIG.

Table 2. Relationships between activation function and training of network with respect to MSE

No of times training performed onthe network model	Activation Function	MSE(Mean Square Error)
1 (first time)	LOGSIG	0.0213
2 (second time)	LOGSIG	0.00817
1 (first time)	PURELIN	0.365
2 (second time)	PURELIN	1.369
1 (first time)	TANSIG	0.783
2 (second time)	TANSIG	0.089

Table 3. Comparison between actual output and output obtained by neural network model for activation function LOGSIG

Target data(Type of glass)	**Output obtained by MATLAB for LOGSIG function (Type of Glass)**
1	1.0773
1	1.0759
2	1.9898
2	2.8754
3	1.8978
3	3.3664
5	7
5	6.9006
6	6.0912
6	3.4982
7	6.9485
7	6.9559

The graphs obtained between MSE and no. of epochs for all the three activation functions LOGSIG, PURELIN AND TANSIG are described in Fig 3, Fig 4 and Fig 5 respectively as shown below.

6. DISCUSSION ND CONCLUSION

By the above results obtained we have observed that

1. From the three activation functions LOGSIG, PURELIN AND TANSIG provided by NN Tool in MATLAB LOGSIG have produced the least MSE i.e. 0.00871 which is very less error as compared to other functions i.e. LOGSIG function is most suitable activation function for glass dataset
2. It has been found that as the number of times we train our network model MSE decreases as observed from the results obtained from Table 2. but overtraining may also lead to increase in error.
3. Table 3. shows that there are some misclassifications. For example although the actual data has to lie glass type 5 by the trained model shows the record to lie in glass type 7 which is an important point to discuss. It may also happen that nature of the input attributes of that record is such that it must actually lie in class 7 as calculated by neural network.

In future we will study different parameters and find their effect on the results for glass data set. By studying all the aspects we can design a better algorithm and tool for neural network.

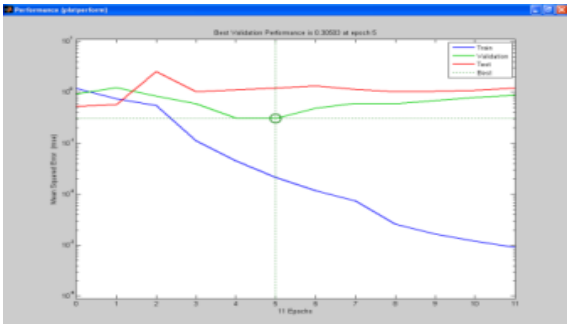

Fig 3: Performance Chart obtained by the MATLAB for LOGSIG function

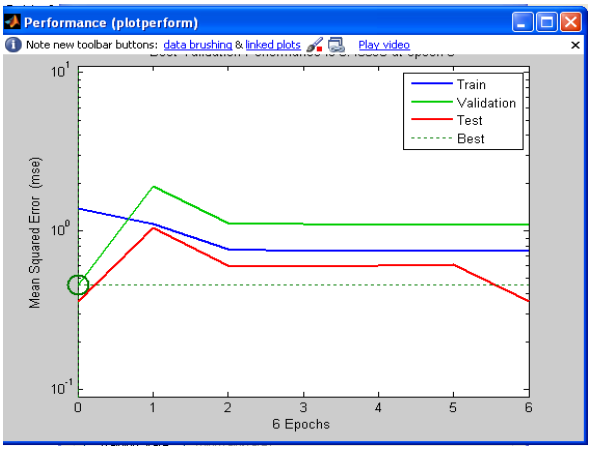

Fig 4: Performance Chart obtained by the MATLAB for PURELIN function

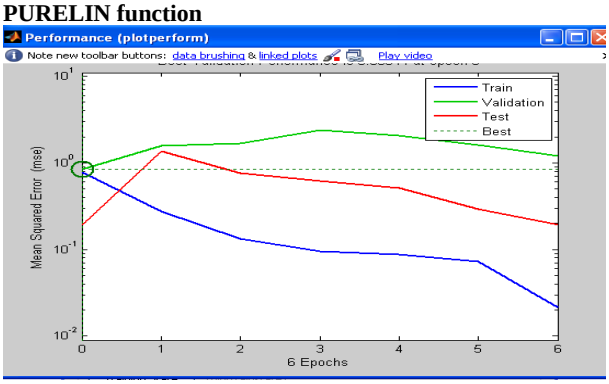

Fig 5: Performance Chart obtained by the MATLAB for TANSIG function

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