A Hybrid ANFIS Technique for Effective Performance Evaluation

Ashwani Kharola
Institute of Technology Management (ITM-DRDO), Mussoorie, India
Graphic Era University, Dehradun

ABSTRACT

This study illustrates a hybrid ANFIS based modelling technique for performance evaluation of employees in an organisation. The working model was built in ANFIS Toolbox of Matlab and shows excellent learning ability using hybrid learning algorithm. The proposed model uses a fuzzy rating scale for converting numerical values of attributes into linguistic grades. The ANFIS control strategy provides faster computation with accurate results based on inputs given by leader or experts in an Organisation. The proposed controller is highly effective when the number of input and output attributes is quite large. The simulation results show the validity of the proposed model.

Keywords: ANFIS, Fuzzy, FIS, Performance evaluation, Hybrid, Training, Takagi-Sugeno, Grid Partition, epochs.

INTRODUCTION

Performance evaluation is one of the most important technique for improving the performance of any individual in an organisation (Arbaiy & Suradi, 2007; Boswell et al. 2002; Fletcher, 2001). It provides a clear performance based feedback to employees (Jawahar, 2006). Performance evaluation involves awarding a numerical or linguistic rating grades to employees. It involves judgements which are based on imprecise data when a superior tries to interpret his/her subordinates (Kuvaas, 2006). Fuzzy logic (Hong & Lee, 1996; Hellmann, 2001) is one of the recently developed technique that has created a paradigm shift through many industrial and management applications (Bih, 2006). A lot of research has been done on performance evaluation using fuzzy logic approach. Ingoley and Bakal (2012) proposed a student performance evaluation technique using fuzzy logic. The system takes into consideration of vagueness in question paper besides accuracy rate, complexity and importance. Nunes and O'Neill (2011) described an experiment to evaluate team performance with fuzzy logic reasoning. They implemented a set of Performance evaluation rules which were verified through experimental results. Li and Chen (2009) presented a new method for student learning achievement evaluation by automatically generating the weights of the attributes. The proposed method provides a much fairer and reasonable inference results. Saleh and Kim (2008) proposed a method for student evaluation using fuzzy systems. The proposed system applies fuzzy logic reasoning in considering the

difficulty, importance and complexity of solutions. Bai and Chen (2007) presented a method to automatically construct the grade membership functions of lenient, strict and normal type for student evaluation. The system performs fuzzy reasoning to infer the scores of student. Shaout & Yousif (2014) performed a design and implementation of a performance appraisal system using step by step fuzzy inference engine process. The proposed controller was able to select and change parameters such as critical elements, fuzzy method and membership functions.

Yadav and Singh (2014) proposed a fuzzy set and regression analysis based model which is capable of dealing with imprecise and missing data. The model automatically converts crisp set into fuzzy sets by using C-means clustering technique. Singh and Kharola (2013) proposed a fuzzy logic controller for evaluating performance rating of employees. The different attributes were identified and given weights according to relative importance. These attributes were further combined using stage-wise fuzzy reasoning approach. Yadav et al. (2012) described two novel models namely SC-FCM (Subtractive Clustering Fuzzy C-Means) and SC-ANFIS (Subtractive Clustering-Adaptive neuro fuzzy inference system) models for determining students academic ranks. These methods not only regulates the division of fuzzy inference system input and output space but also determines the relative member function parameters. In this study a novel Hybrid (Buragohain, 2008) ANFIS controller has been proposed for performance evaluation of an employee in any organisation. The training data for controller has been generated by the knowledge and experience of experts. The designed ANFIS model has three inputs and one output however the number of attributes can be varied. ANFIS provides the flexibility of assigning different weightage to each attribute depending upon their relative importance. The model uses a fuzzy membership rating scale which provides more flexibility in computation as compared to traditional Likert Scale (Edmondson, 2005; Li, 2010). The Simulation results are shown with the help of Matlab-Simulink model which proves the validity of the controller.

DESIGN OF HYBRID ANFIS CONTROLLER

A total of 125 data sets were collected and stored in Workspace of Matlab for training in ANFIS. The total number of input and output attributes considered were three and one respectively which can be further increased. A view of some of the data sets loaded in Workspace is shown in figure 1.0. The first three columns indicate the set of inputs attributes while the last column is the output attribute i.e. performance of employee. The proposed ANFIS controller provides the dual advantage of selecting any number of attributes and assigning relative weightage depending on culture and working environment of any organisation.

DATA <125x4 double>

	1	2	3	4
1	1	1	1	1
2	1	1	2	1.3300
3	1	1	3	1.6700
4	1	1	4	2
5	1	1	5	2.3300
6	1	2	1	1.3300
7	1	2	2	1.6700
8	1	2	3	2
9	1	2	4	2.3300
10	1	2	5	2.6700
11	1	3	1	1.6700
12	1	3	2	2
13	1	3	3	2.3300
14	1	3	4	2.6700
15	1	3	5	3
16	1	4	1	2
17	1	4	2	2.3300
18	1	4	3	2.6700
19	1	4	4	3
20	1	4	5	3.3300

Figure 1.0 Data sets used for training in ANFIS

The data sets were then loaded from the workspace into the ANFIS Toolbox for training. The Optimisation of data sets was done using Hybrid method which is a combination of Back-propagation (Jang, 1993) and Least square method (Petras & Bednarova, 2010). The Grid partition method (Paplinski, 2005) was used for generating the initial Fuzzy inference system (FIS) structure. For training the number of training epochs and error tolerances were set to 10 and 0 respectively. The training error obtained after 10 epochs was 1.0546e-007. A view of loading training data, training of data sets, initial FIS generated and ANFIS architecture are shown from figure 1.1 to figure 1.4.

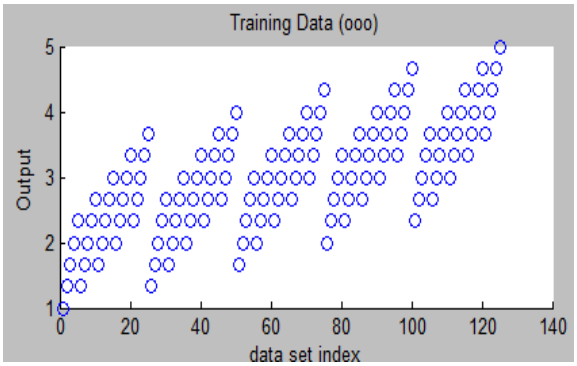

Figure 1.1 loading of training data

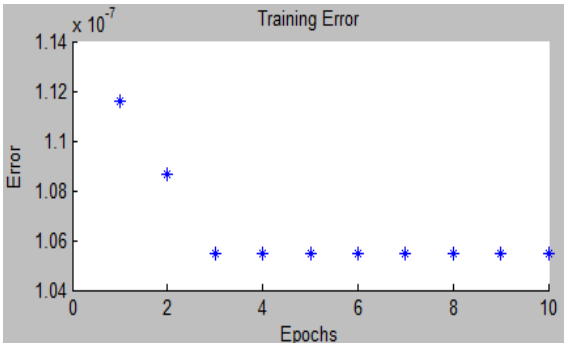

Figure 1.2 Training of data in ANFIS

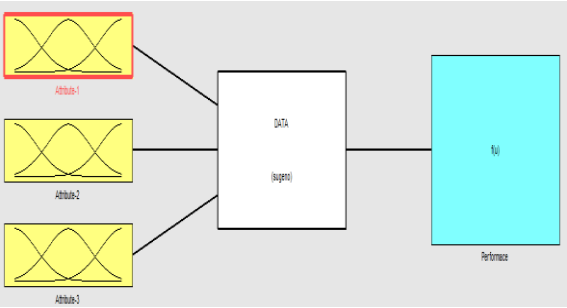

Figure 1.3 Initial FIS generated

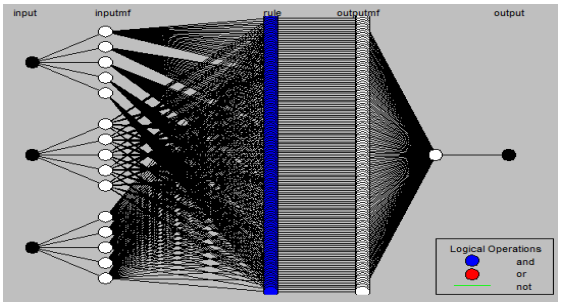

Figure 1.4 ANFIS Architecture

In this study we have used Takagi-Sugeno (Angelov, 2004) model of 125 if-then fuzzy rules and 5 membership functions of gaussian type. The Linguistic variables considered for designing of membership functions were namely very poor, poor, satisfactory, good and very good. ANFIS provides the advantage of self learning ability of membership functions and fuzzy rules through data sets (Zadeh, 1965). A view of membership functions and surface viewer obtained after training is shown in figure 1.5 and figure 1.6 respectively. A surface viewer is basically a 3-D view of if-then fuzzy rules.

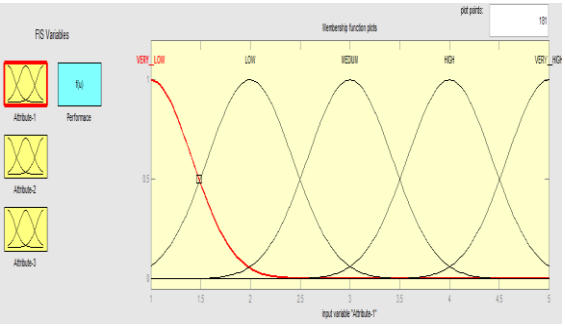

Figure 1.5 Membership functions for Input

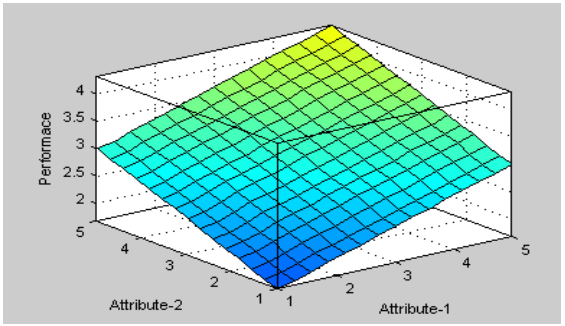

Figure 1.6 Surface Viewer of FIS

RESULTS & COMPARISON

A Matlab-Simulink model was built for carrying out simulations. The results for different sets of inputs were shown from figure 1.7 to figure 2.1. This study illustrates an application of fuzzy rating scale for converting numerical values of attributes into linguistic variables. A view of Fuzzy rating scale and Likert rating scale is shown in Table 1.0. and Table 1.1 respectively. The fuzzy scale provides the advantage of including a certain range of numerical values for grading of attributes which is not feasible using Likert scale. The input attributes were designated by alphabets A, B and C whereas output is mentioned by term 'Performance'.

Likert Scale	Fuzzy Scale	Linguistic Variable/Parameter
0	0-0.99	Very Poor
1	1-1.99	Poor
2	2-2.99	Satisfactory
3	3-3.99	Good
4	4-5	Very Good

Table 1.0 Comparison of Likert and Fuzzy rating scale

I. Experiment No. 1:

Attribute 1 (A)	Attribute 2 (B)	Attribute 3 (C)	Performance
3	**3**	**4**	**3.33 (Good)**

Table 1.1 Data Sets for Experiment 1

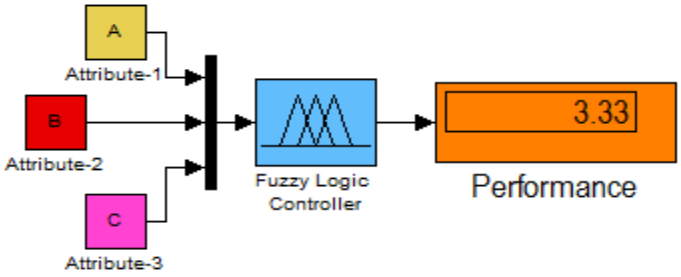

Figure 1.7 Simulation results

II. Experiment No. 2:

Attribute 1 (A)	Attribute 2 (B)	Attribute 3 (C)	Performance
5	**2**	**1**	**2.67 (Satisfactory)**

Table 1.2 Data Sets for Experiment 2

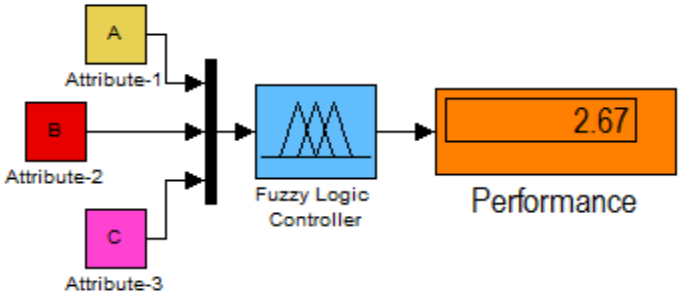

Figure 1.8 Simulation results

III. Experiment No. 3:

Attribute 1 (A)	Attribute 2 (B)	Attribute 3 (C)	Performance
1	**1**	**1**	**1 (Poor)**

Table 1.3 Data Sets for Experiment 3

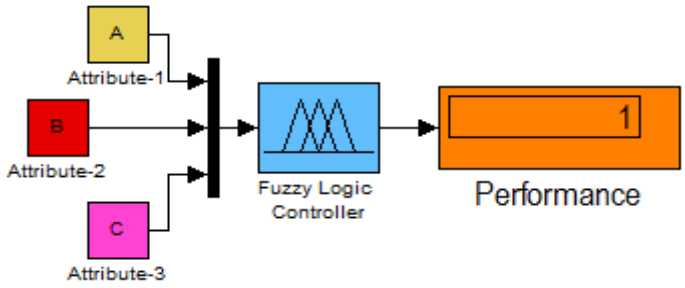

Figure 1.9 Simulation results

IV. Experiment No. 4:

Attribute 1 (A)	Attribute 2 (B)	Attribute 3 (C)	Performance
5	**5**	**4**	**4.67 (Very good)**

Table 1.4 Data Sets for Experiment 4

V. Experiment No. 5:

Attribute 1 (A)	Attribute 2 (B)	Attribute 3 (C)	Performance
2	**1**	**2**	**1.67 (Poor)**

Table 1.5 Data Sets for Experiment 5

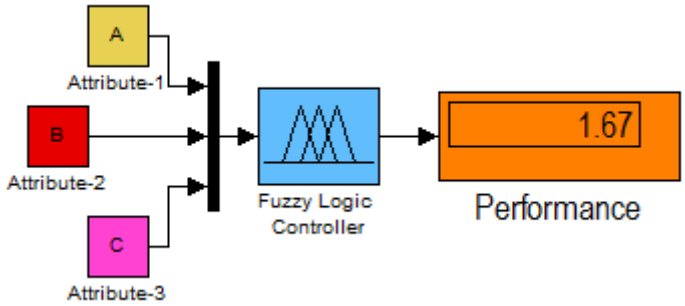

Figure 2.1 Simulation results

CONCLUSION

The research objective of designing a Hybrid Neuro fuzzy ANFIS controller for effective performance evaluation of an employee in any organisation has been achieved. The ANFIS controller shows a good learning ability with negligible error tolerance. The simulation results proves the validity of proposed model. The proposed Matlab-Simulink model allows the user to assign different weightage to each attribute depending on the suitability and need of the organisation. The ANFIS technique also shows an advantage of fast and accurate computation for large number of data sets. As an extension to future work the proposed model can be further implemented to design a hybrid ANFIS controller for evaluation of hidden attributes of an employee using a set of questionnaire to generate data sets. The hidden attributes of employees are difficult to evaluate using other conventional techniques.

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About the Author

Ashwani Kharola

Dehradun, India

Ashwani Kharola received B.Tech (Honours) in Mechanical Engineering from Dehradun Institute of Technology (DIT), Dehradun in 2010 and M.Tech in CAD/CAM & Robotics from Graphic Era University (GEU), Dehradun in 2013. He obtained Silver Medal in M.Tech for (2011-13) batch. Currently he is working as Senior Research Fellow (SRF) in Institute of Technology Management (ITM), one of the premier training institutes of the Defence Research & Development Organisation (DRDO), Ministry of Defence, Govt. of India. He is also pursuing PhD in Mechanical Engineering from Graphic Era University. He has published more than 28 National/International papers in peer reviewed ISSN Journals and IEEE Conferences. His current areas of work includes Fuzzy logic reasoning, Adaptive Neuro-fuzzy inference system (ANFIS), Neural Networks, Mathematical Modeling & Simulation, Control of Non-linear systems etc.

Ashwani Kharola can be contacted at ashwanidaa@gmail.com