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Comparison of Membership Function in Adaptive Neuro Fuzzy Inference System for Prediction of Respiratory Disorder System

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Abstract— These instructions give you guidelines for In this study, Adaptive-Network-Based Fuzzy Inference System (ANFIS) approach, introduced by Jang (1993) was employed to investigate its applicability in predicting Respiratory disorder. The ANFIS combines the explicit knowledge representation of Fuzzy Inference System with the learning power of Artificial Neural Networks, therefore it is a very powerful approach to build complex relationship between a set of input and output data. It also provides a natural framework for combining both numerical information in the form of input/output pairs and linguistic information in the form of IF–THEN rules in a uniform fashion. The results of the modeling were reasonable in terms of statistical performances. Several indices of performance such as average training error, average testing error, and sensitivity, Specificity showed good performance. The results were compared with different type of membership function. The model with Gaussian membership functions gave the best performance among all given models. The capability ANFIS system in producing such reasonable result indicated that this approach has potentially to be used as predictor of Respiratory disorder.

Index Terms— ANFIS, Membership functions, MATLAB, Respiratory disorder, fuzzy, Nural network, Dss.

1 Introduction

Recently, intelligent soft computational techniques such as Artificial Neural Network (ANN), Fuzzy Inference System (FIS) and (ANFIS) can model superiority of human knowledge features. They also re-establish the process without plenty of analysis. Thus these techniques are attracting great attention in an environment that is obvious with the absence of a simple and well-defined mathematical model. Besides, these models are characterized by nonrandom uncertainties which associated with imprecision and elusiveness in real-time systems [1-2]. Many researchers have studied the application of neural networks to overcome most of the problems above outlined. The fuzzy set theory is also used to solve uncertainty problems. The use of neural nets in applications is very sparse due to its implicit knowledge representation, the prohibitive computational effort and so on. The main benefit of fuzzy is that its knowledge shows explicit, using normal IF-THEM relations. However, it is at the same time its major limitation. The groundwater level prediction cannot be easily described by artificial explicit knowledge, because it is affected by many unknown parameters. The integration of neural network into the fuzzy logic system makes it possible to learn from the prior obtained data sets [3-4].

2 DESCRIPTION OF STUDY AREA

Respiratory is constant provocative issue of aviation routes; more often than not it is reversible yet not treatable. Individuals of any age particularly youngsters are influenced by this malady [5, 6]. It's an alert for nationals in the created world and they have as of late centered around Respiratory as a result of its quickly expanding recurrence, influencing no less than one out of four urban kids [7]. Respiratory might be activated by allergens and aggravations which are basic in our own homes, schools, and childcare settings. The indoor bioallergen may assume an essential part in appearance of respiratory hypersensitivity [8]. A study shows that urban individuals invest their 90% energy in the indoor environment; in this manner the danger of respiratory peril is more prominent from indoor poisons [9]. In this way, urban populaces of Lucknow have been considered for present work.

The four parameters which are applicable and for the most part utilized for the conclusion of Respiratory are:

1. Peak Expiratory Flow Rate (PEFR)
2. Forced Expiratory Volume in One Second (FEV1)
3. Forced basic limit (FVC)
4. Forced Expiratory Flow 25–75% (FEF 25-75%)

These four parameters have been utilized as a contribution as a part of fuzzy, neural system and Artificial Neuro Fuzzy demonstrative instruments. In light of these parameters, seriousness of Respiratory has been anticipated as a output. All out 1000 patients' information have been gathered in which 450 unhealthy cases and 550 control cases.

In the present study MATLAB programming bundle applications [10], Fuzzy, Neural Network and Neuro Fuzzy have been utilized. MATLAB is an unusual condition dedicated for processing dialect and instinctive environment for calculation advancement, information representation, information examination, and numeric calculation.

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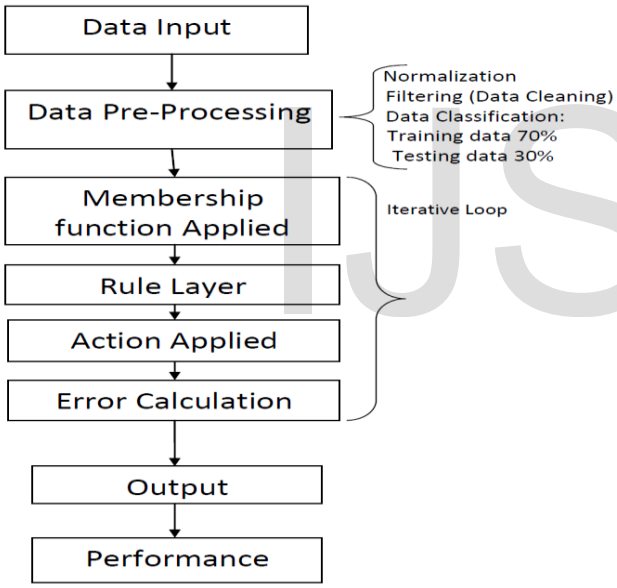
3 THEORY AND METHODOLOGY

Adaptive Network-Based-Fuzzy Inferences System (ANFIS) approach was employed in this study. The ANFIS approche consists of fuzzification layer, defuzzification layer, inferences process and summation as final output layer. Typical models of ANFIS is shown by Fig 1.The main objective of the ANFIS is to determine the optimum values of the equivalent fuzzy inference system parameters by applying a learning algorithm using input-output data sets. The framework optimization is complet in such a way during training session that the error between the objective and the certain output is decrese. Parameters are optimized by hybrid algorithm which combination of least square estimate and gradient descent method. The parameters to be optimized in ANFIS are the premise parameters which describe the shape of the membership functions, and the consequent parameters which describe the overall output of the system. The optimum parameters obtained are then used in testing session to calculate the prediction [11]. A number of 700 data were utilized during training session and 300 data were used during testing session.



A ANFIS MODEL

ANFIS info:
Number of nodes: 551
Number of linear parameters: 256
Number of nonlinear parameters: 48
Total number of parameters: 304
Number of training data pairs: 700
Number of testing data pairs: 300
Number of fuzzy rules: 256

B. Comparison between Membership Functions

Depend upon the model and combinations, the ANFIS system produced different results. To find the most fitted model, the results are compared and discussed as follows. The changes in the MFs before and after training are shown in the following Table.

ANFIS uses either a hybrid learning algorithm (module-1) or the back-propagation (module-2) method to identify the MF parameters of the output. A combination of least-squares and back propagation gradient descent methods can be used for training fuzzy inference system (Sugeno type FIS) membership function parameters to model a given set of input/output data or just the back propagation method. Average errors of Respiratory as predicted by using the back-propagation method and by using the hybrid learning algorithm are shown in Table 2. From this table, the capability of the ANFIS model in predicting the Respiratory using the hybrid learning algorithm is much better than when using the back propagation method. This is because the hybrid method comprises of back propagation and Least-Square methods.

Table 1.1: Testing and training error of different systems for module No.-1

System number	No. of Epochs	Training Error	Average testing Error	Membership function type
1	10	0.01470	0.0865	Trimf
2	30	0.01360	0.0788	
3	50	0.01319	0.0390	
4	100	0.01309	0.0990	
5	10	0.11065	0.13924	Trapmf
6	30	0.11080	0.13435	
7	50	0.10909	0.12108	
8	100	0.10913	0.12109	
9	10	0.01682	0.1574	Gbellmf
10	30	0.01708	0.1688	
11	50	0.01579	0.1275	
12	100	0.01477	0.1189	
13	10	0.1079	0.1615	Gaussmf
14	30	0.1074	0.1676	
15	50	0.1077	0.1688	
16	100	0.1076	0.1635	
17	10	0.1710	0.1487	Gauss2mf
18	30	0.1645	0.1478	
19	50	0.1612	0.1481	
20	100	0.1088	0.1480	
21	10	0.1412	0.1824	Pimf
22	30	0.1310	0.1787	
23	50	0.1301	0.1744	
24	100	0.1292	0.16702	
25	10	0.1084	0.1652	Dsigmf
26	30	0.1086	0.1650	
27	50	0.1085	0.1647	

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28	100	0.1018	0.1626	
29	10	0.1487	0.1852	Psigmf
30	30	0.1486	0.1850	
31	50	0.1485	0.1847	
32	100	0.1478	0.1826	

Table 1.2: Testing and training error of different systems for module No.-2

System number	No. of Epochs	Training Error	Average testing Error	Membership function type
33	10	0.026	0.776	Trimf
34	30	0.025	0.776	
35	50	0.024	0.075	
36	100	0.023	0.076	
37	10	0.602	0.718	Trapmf
38	30	0.198	0.232	
39	50	0.176	0.121	
40	100	0.165	0.128	
41	10	0.709	0.750	Gbellmf
42	30	0.168	0.214	
43	50	0.150	0.216	
44	100	0.149	0.204	
45	10	0.628	0.710	Gaussmf
46	30	0.176	0.222	
47	50	0.156	0.289	
48	100	0.158	0.279	
49	10	0.143	0.254	Gauss2mf
50	30	0.156	0.288	
51	50	0.149	0.231	
52	100	0.147	0.226	
53	10	0.148	0.198	Pimf
54	30	0.153	0.199	
55	50	0.151	0.201	
56	100	0.146	0.195	
57	10	0.151	0.225	Dsigmf
58	30	0.153	0.220	
59	50	0.148	0.197	
60	100	0.147	0.221	
61	10	0.154	0.252	Psigmf
62	30	0.171	0.650	
63	50	0.149	0.743	
64	100	0.166	0.223	

From this table, the capability of the ANFIS model in predicting the Respiratory using the hybrid learning algorithm is much better than when using the back propagation method. This is because the hybrid method comprises of back propagation and Least-Square methods.

Table1.3: Average Errors by the Back-propagation Method and the Hybrid Learning Algorithm

Method	Average training error	Average testing error
Hybrid	0.01309	0.0390
Back propagation	0.023	0.075

4. RESULTS DISCUSSION AND COMPERATIVE STUDY

The ANFIS model for all the memberships are compared based on their performance in training sets and testing sets. The results are summarized in Table 3.It appears that the ANFIS models are accurate and consistent in different subsets. ANFIS model maintains its excellent prediction accuracy throughout the range of respiratory disorder, hence showing consistency and high a degree of generalization capability.

To compare the results obtained in this paper, a study of A. Altaher, utilizes the Adaptive Neuro- Fuzzy Inference framework (ANFIS) for understudy scholastic execution expectation to help understudies enhance their scholastic accomplishments [12] and A.Naveed & J. Shafi demonstrated that the Accuracy of the both analyses show an expanding shift with an increment in the participation capacity to producing straight relationship and the fuzzy derivation framework in output information [13,14] has been done the details are as follows.

In the [12] Author stated the Training error and Testing Error for 100 epochs are 0.624&0.712, 0.127&0.772,0.708&0.759 For Gauss,Trimf and gbell respectively.
In this paper we have calculated the same parameter to match with [12]. The results are as follows in table 1.4

Table 1.4: Comparative results with the same parameter

Membership Function	No. of epochs	Training Error	Testing Error
Gaussmf	100	0.14770	0.1635
Trimf	100	0.01309	0.0990
Gbellmf	100	0.01477	0.1118

As per sham in above table the result are better than [12].

To make a detailed Compression of Accuracy the result of this thesis are compared vis-a-vis [13, 14]. Authors claimed a maximum Accuracy of 91.23 using Back propagation with Gaussian membership function. When the hybrid optimization approach was used to classify same type of data following results are achieved.

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Table 1.5: Comparison of error and accuracy

Membership Function	No. of epochs	Testing Error	Accuracy
Gaussmf	10	0.1615	83.85
	30	0.1676	82.24
	50	0.1688	83.12
	100	0.1635	82.65
Trimf	10	0.1388	86.12
	30	0.0788	92.12
	50	0.0390	96.10
	100	0.0990	90.10
Gbellmf	10	0.1574	84.15
	30	0.1675	83.12
	50	0.1275	87.15
	100	0.1189	89.11

It is evident from above table that the results of current study are better than [13, 14]. Specifically the ANFIS using hybrid optimization method triangular membership function gets 96% Accuracy performed which is much better than Gaussian membership function.

5. CONCLUSION

In this study, we propose the use of a novel neurofuzzy model, the adaptive network-based fuzzy inference system (ANFIS), to construct respiratory disorder system. ANFIS is a powerful fuzzy logic neural network, which provides a method for fuzzy modeling to learn information about the data set that best allow the associated fuzzy inference system to trace the given input/output data. In this study Respiratory disorder problem in Lucknow was predicted by using ANFIS (hybrid) Method. Model with different membership function of Triangular function has given the best performance and the results clearly illustrated that ANFIS has the potential for modeling in clinical decision support system predict disorder problem of a respiratory by applying appropriate membership function .

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