An Approach To Diagnose Neurological Disorder Using Neuro Fuzzy Model

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ABSTRACT

The major problem in medical field is todiagnose disease. Human beings always make mistakes and because of their limitation, diagnosis would give the major issue of human expertise. One of the most important problems of medical diagnosis, in general ,is the subjectivity of the specialist. It can be noted, in particular in pattern recognition activities, that the experience of the professional is closely related to the final diagnosis. This is due to the fact that the result does not depend on a systematized solution but on the interpretation of the input symptoms from the patient. Almost all the physicians are challenged by the task of learning to predict. Hence, there is a need to solve the problem of deducing certain diseases or formulating a treatment based on more or less specified observations and knowledge. Here, a neuro fuzzy model is designed for diagnosis of Autistic Spectrum disorders which is a type of neurological disorder is proposed in this paper. The symptoms and signs are gathered and definitions of fuzzy membership values are defined. Feed forward multi layer network accepts those input fuzzy values and it is trained using back propagation training algorithm. Finally, the fruition of this process is compared with the expertise to know its performance.

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1. INTRODUCTION

Artificial Neural networks are currently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. While analyzing the recent trends, it is clear to have a picture of intrusion of computer decision making in medicine. The conventional way of building medical expert system needs framing rules and analyzing the data. The framing of rules needs extensive knowledge and an expert when the data grows more. But Artificial Neural Networks is considered to be an alternative to the conventional method of rules based one. Artificial Neural Network is an example based approach which helps in diagnosing the disease or disorder of a patient[3]. At the moment, the research is mostly on modeling parts of the human body and recognizing diseases from various scans(e.g. cardiograms, CAT scans, ultrasonic scans etc.,)[8].Artificial Neural Networks are ideal in recognizing diseases using scans.

2. EXISTING STUDY

Many researchers have carried out diagnosis procedure to analyze autistic patients EEG behavior[13]. In a related study, EEG data was used to compare patterns of speech and non-speech sound discrimination between non-autistic and autistic teenagers[18]. Another study addressed about self-organizing maps (SOMs) which offer insights into the development of cortical feature

maps[19]. A recent study of non linear pattern recognition system was explored for its utility in assisting in the classification of autism. Most of the previous work focused on various traits of an autistic individual [20]. A previous review includes identification of students with learning disabilities using ANN [16].

2.1 Kinds of categorizations for neuro-fuzzy models

Buckley and Hayashi[15] have classified fuzzified neural networks as : Networks can possess i)real number inputs, fuzzy outputs and fuzzy weights ii)fuzzy inputs, fuzzy outputs and real number weights iii) fuzzy inputs, fuzzy outputs and fuzzy weights. Hayashi et al[14] fuzzified the delta rule for multilayer perceptron using fuzzy numbers at the input, output, and weight levels. But there were problems with the stopping rule. Ishibuchi et al [16] incorporated triangular or trapezoidal fuzzy number weights , thereby increasing the complexity of the algorithm[5][12].

Table 2 : Second Catagory of ASD

Semantic Pragmatic Communication Disorder	Delay and trouble with the use of language (both semantic and pragmatic), but socialization relatively spared.
Non-Verbal Learning Disabilities	Trouble integrating information in 3 areas: non-verbal difficulties causing the child to miss the major gestalt in language; spatial perception problems; and motoric coordination problems.
High Functioning Autism	For some authors, synonymous with Asperger's, for others, implies milder autism without retardation.
Hyperlexia	Most notable for incredible rote reading skills starting at an early age.
Some aspects of ADHD	Impulse and control difficulties in ADHD may lead to trouble showing their empathy.

some of the problems have been overcome by feuring et al in [17].

2.2 Artificial Neural Networks with Neuro Fuzzy Model

An ANN is an information processing system that has been developed as a generalization of the mathematical model of human cognition. Anderson et al., developed an auto associative network to store large amount of medical records, each of which includes information on the symptoms, the net finds the best diagnosis and treatment. The idea of an ANN model which is proposed in this paper are classified based on the neuro fuzzy network, the activation function applied and the method of training is applied. Neuro Fuzzy computing enables one to build more intelligent decision making systems[1][6].

3. Modeling And Diagnosing The Neurological Disorders

ANN are used experimentally to model the neurological disorder specifically Autistics Spectrum Disorders. Diagnosis can be achieved by building a model of the neurological disorder of an individual and comparing it with the real time physiological measurements taken from the patient. If this routine is carried out regularly, potential harmful medical conditions can be detected at an early stage and thus make the process of combating the disease much easier. A model of an individual's neurological system must mimic the relationship among physiological variables at different physical activity levels. If a model is adapted to an individual, then it becomes a model of the physical condition of that individual. The simulator will have to be able to adapt to the features of any individual without the supervision of an expert.

3.1 Autistic Spectrum Disorders (ASD)

Those people whose primary difficulty understands the literal meaning of words are considered to have

"traditional" speech and language disabilities. Those people who have difficulty in the non-verbal parts of communication (including their desire and ability to use language in a social context) may be considered to have an Autistic Spectrum Disorder (ASD).And also include non-spoken communication problems in particular, problems with socialization /empathy. It shares trouble with theory of mind, socialization, the pragmatics of language, and representational play. They may occur with or without additional verbal speech problems[10]. The Autistic Spectrum Disorders are classified into two categories. These are summarized in the two tables table 1 & table 2.

The Pervasive Developmental Disorders (PDD), are a series of diagnoses of which autism is the most commonly discussed. "Pervasive" means that the problem cuts across multiple types of communication [2]. The classification of the Autistic Spectrum Disorders is in a state of flux. The problems can overlap, cause each other, occur simultaneously in different combinations and severity, change over time, and don't even have one group attempting the classification of the whole spectrum. However, every possible symptom are squeezed into the same category or two.

Table 1 : First category of ASD

Autistic Disorder	Severely disordered verbal and non-verbal language, unusual behaviors.
Asperger's Syndrome	Relatively good verbal language, with "milder" non-verbal language problems, restricted range of interests and relatedness.
PDD-NOS	Non-verbal language problems not meeting strict criteria for other PDD disorders.

4. Proposed Study

4.1 Describing Proposed System Design

At the front end, a user interface shell offers symptom selections. A symptom consists of an attribute which is of fuzzy nature (eg., Milestones achieved by the child) and a linguistic property which can be crisp (eg., true or false) or fuzzy (eg., a few, some, most, all). The user selects the attribute first and then finds the best linguistic property which goes with the attribute. The user can add new attributes and define new linguistic terms if needed[9]. When a new linguistic property is defined, its associated characteristics (crisp or fuzzy) have to be defined as well. The symptoms are then used as input to the inference engine which is realized by a fuzzy logic–based neural network. FNN suggests a set of diagnoses with different confidence values based on its learned knowledge. Another user interface shell interprets these outputs and gives an ordered list of the most likely diagnoses which is shown in the figure 2. After classifying the symptoms, an artificial domain is created .For ex., IQ can be described by the fuzzy set as low, average and high. Membership function is applied and a number [0 1] interval matches with every symptom can be defined as membership values. Scale could be assigned to the symptoms like SPLD, NLVD etc.,[2]

4.2 Artificial Neural Networks

ANN model which is proposed in this paper are classified based on the network, the activation function applied and the method of training. A multi layer ANN consists of one or more layers of units between the input and output layers and a multi layer net with non linear activation function can solve any type of problem[11].

4.3 Activation Functions

The artificial neuron has a set of 'n' inputs x_i, each representing the output of another neuron. Each input is weighed before it reaches the main body of the processing

element by the connection strength or the weight factor. The artificial neuron has a bias term w_o, a threshold value'q' that has to be reached or extended for the neuron to produce a signal ,a nonlinear function F that acts on the produced signal 'net' and an output 'y' after the non linearity function[4].

The transfer function of the neuron model can be expressed as :

$Y = F(net)$ Where net $= w_o + \Sigma x_i w_i$ and $F(net) >= \theta$, i $= 0\text{-}n$

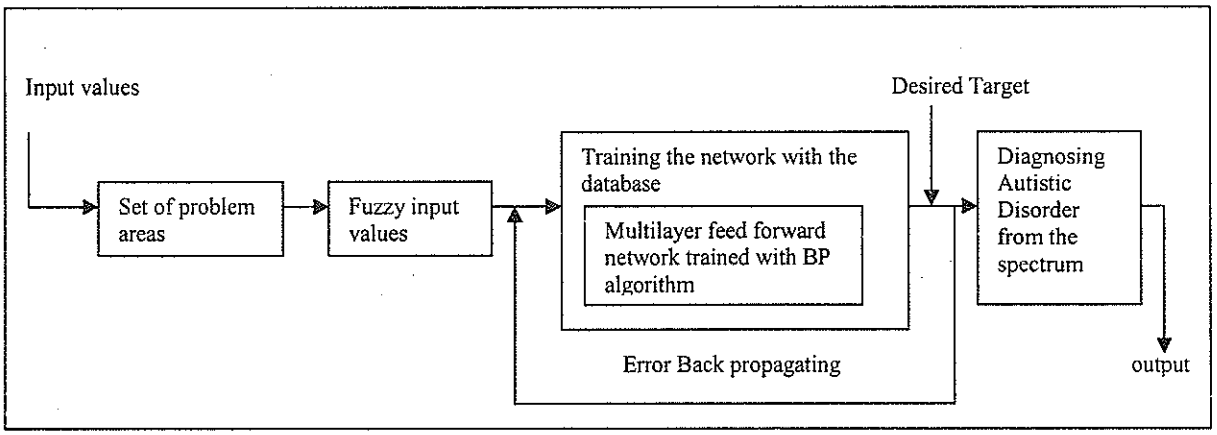

Figure 1: A block diagram respecting a model of diagramming Autistic Disorder

4.4 Back Propagation Technique

The activation functions used for this back propagation net is binary sigmoidal which has a range [0,1]. The derivation of learning rule for the back propagation procedure is made for an activation function selected. The stages in training a back propagation net involves three stages like the feed forward of the input training pattern, the calculation and back propagation of the associated error and the weights adjustments. The weights and threshold values for network are assigned values that are uniformly distributed over a small range. Here in this model the inputs are fed to the back propagation net and the weights of the NN are updated through the process of propagating backwards the error related to the output neuron results. During training of this proposed model, the net output is compared with the target value and the appropriate error is calculated and the error factor is distributed back to the hidden layer. The weights are updated accordingly.

4.5 Design Of The System Proposed

Data are collected from the parents of the child are recorded as linguistic values. Those inputs are converted into values of fuzzy membership values and used as an input to Multi Layer Feed Forward Network. While the network is trained by back propagation algorithm, for each iteration the error value is calculated. The connection weights are adjusted to minimize the error rate. The computed mean square error is compared with the previous epoch values. The training is stopped when the error begins to rise or epochs grow more. After creating a diagnostic model as in the Fig 1, the performance can be evaluated with a set of inputs by a psychologist or a medical expert.

Table 1 .Parameters used to train the Algorithm

No of Hidden layers	2	2	2	2	2	2	2	2	2	3	3	3
Nodes in HiddenLayer-1	25	25	25	25	25	25	25	25	25	25	25	25
Nodes in HiddenLayer-2 and 3	25,0	25,0	25,0	25,0	25,0	25,0	25,0	25,0	25,0	25,25(III)	25,25(III)	25,25(III)
Epochs	50	100	150	200	250	300	350	400	450	500	550	600
Learning Rate	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2
Root Mean Square Error	0.561	0.553	0.557	0.6	0.649	0.64	0.64	0.638	0.635	0.549	0.56	0.571
Average Error Rate	0.249	0.145	0.136	0.124	0.07	0.08	0.1	0.09	0.09	0.01	0.01	0.06

5. Experimental Results

In this model, the input data for the six problem areas which are considered as core area for predicting autism are stored in the database and then converted into fuzzy membership values. The output will be the Autistic disorder. For this model, 60 samples are collected for both training and testing. In each training epochs, the connection weights are adjusted to minimize the error in the output. Parameters like learning rate, more number of hidden layers and bias improves the performance of the network which is shown in table 1. In this neuro-fuzzy model, network learns quickly and gives the output error rate of 0.01 and remains constant after 550 epochs as shown in Fig 2. The overall performance of this model is 85-90%.

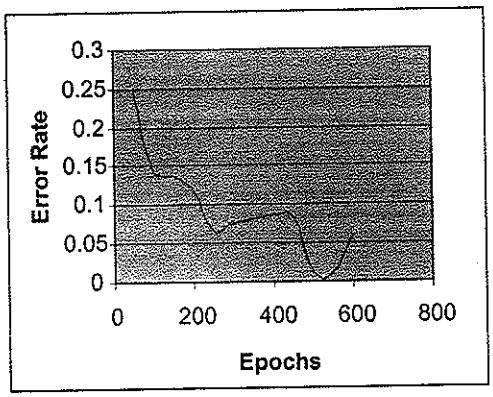

Figure 2 Graph showing Epochs and Errors

6. Conclusion

The reliability of this model depends on data collected from the patients. Computers in medicine cannot replace medical expertise in diagnosing or decision making, but it provides a way of better classification and provides supportive tools for the medical experts or for a psychologist. It can be used to generate models for different medical applications in diagnosing the disorder.

7. References

1. A.Adami,D.Barore, *"A Speaker Identification System Using a Model of Artificial Neural Networks for an elevator application"*, Information Sciences.2001
2. M.L Bauman and T.L Kemper, *"The Neurobiology of Autism"*.
3. K.S.Leung & W.Lam, *"Fuzzy Concepts in Expert Systems"*, IEEE Transactions on Fuzzy Systems, 1988.
4. S.N.Sivanandam & M.Paulraj , *"Introduction to Artificial Neural Networks"* , Vikas Publishing.
5. Susmitha Mitra, *"Neuro Fuzzy Rule Generation – Survey in Soft Computing Framework"*,IEEE Transactions on Neural Networks, 2000.
6. Sushmita Mitra, *"Neuro-Fuzzy Rule Generation: Survey in Soft Computing Framework"*, IEEE

transactions on neural networks, Vol. 11, No.3, May 2000.

7. Z-Q. Liu and F. Yan, *"Fuzzy neural network in case-based diagnostic system"*, IEEE transactions on Fuzzy systems", Vol. 5, No. 2, May 1997, PP 11-39.
8. Y.Hayashi, J.J Buckley and E.Czogala, *"Fuzzy Neural Network with fuzzy signals and weights"*, Int.Jour.Intelligent Systems, Vol.8, No. 4, PP 527-537, 1993.
9. H. Ishibuchi, K.Kwon and H.Tanaka, *"A Learning algorithm of Fuzzy Neural Networks with Triangular Fuzzy Weights"*, Fuzzy Sets Systems Vol. 71, PP 277-293, 1995.
10. *"Autistic Disorder"* The journal of American Medical Association Vol 285, No13 April 2001
11. T.Feuring, J.J Buckley and Y.Hayashi, *"A gradient descent learning Algorithm for Fuzzy Neural Networks"*, in Proceedings IEEE Int. Conf. Fuzzy Systems FUZZ: IEEE '98, Anchorage, AK, PP 1136-1141, May 1998.
12. J.M. Keller, R.R. Yager and H. Tahani, *"Neural Network Implementation of Fuzzy Logic"*, Fuzzy Sets Syst., Vol. 45, PP 1-12,1992.
13. M. Kriegsman and R.Barletta, *"Building a case-based help desk application"*, IEEE Expert: Intell. Syst. Applications Vol. 8, PP 18-26,Dec 1993.
14. Tung-Kuang Wu, Ying-Ru Meng, Shian-Chang Huang, *"Application of ANN to the Identification of Students with Learning Disabilities"*, Proceedings of 2006 world Congress in Computer Science, Computer Engineering and Applied Computing, USA, June, 2006.
15. J.J Buckley and Y.Hayashi," *"Fuzzy Neural Networks: A survey"*, Fuzzy sets systems Vol. 66 PP 1-13, 1994.
16. H. Ishibuchi, K.Kwon and H.Tanaka, *"A Learning algorithm of Fuzzy Neural Networks with Triangular Fuzzy Weights"*, Fuzzy Sets Systems Vol. 71, PP 277-293, 1995.
17. T.Feuring, J.J Buckley and Y.Hayashi, *"A gradient descent learning Algorithm for Fuzzy Neural Networks"*, in Proceedings IEEE Int. Conf. Fuzzy Systems FUZZ: IEEE '98, Anchorage, AK, PP1136-1141, May 1998.
18. X. You, M. Ayala, M. Adjouadi, N. Teng, L. Wang, *"A Practical Study on Autism Detection from EEG using ANN"*, the IASTED international Conference on graphics and Visualization in Engineering , Florida,USA, Jan 2007.
19. L. Gustafsson, Andrew P.Paplinski, *"Self – Organization of an ANN subjected to Attention shift impairments and familiarity preference, Characteristics studied in Autism"*, Journal of Autism and Developmental Disorder, 26th Oct, 2004.
20. Ira L. Cohen ,Vicki Sudhalter, Donna Landon Jimenez and Maryellen Keogh, *"A neural Network approach to the classification of autism"*, Journal of autism and Developmental disorders, Jan 2005.

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