Neurofuzzy Inference System for Diagnosis of Malaria

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Abstract - In this paper, a structure of adaptive system is proposed with the help of Neurofuzzy System (NFS) for diagnosis of Malaria. Investigation of malaria using Neurofuzzy system has been used for decision making ability based on predefined rules and learning by the backpropagation algorithm. Mapping Network in backpropagation algorithm is applied to minimize the errors in the output . Investigation of malaria by the proposed system is illustrated and good performance is achieved with maximum instant error of 0.06144.

Keywords: Neurofuzzy inference system, Backpropagation algorithm , Malaria

I INTRODUCTION

The word Malaria was coined by Dr. Francisco Torti, Italy which means 'bad air' . Malaria is a mosquito-borne infectious disease caused by parasitic protozoa of the genus plasmodium .The main protozoa responsible for malaria is plasmodium falciparum. Leafing through the latest estimates ,there were 219 million cases of malaria and an estimated record of 660,000 deaths .Malaria mortality rate is high in Africa Every minute a child dies from Malaria in that region. World's one tenth cases of malaria are recorded in India.

Telemedicine can play a life sustaining role in the medical field .It is the implementation of telecommunication and information technologies in order to provide medical assistance to the countrified areas. It is helpful for providing health services at a reasonable cost .It can be used to diagnose a disease so that we can take subtle precautions at the primary level. The concept of Telemedicine is applied with the help of computing technique such as the concept of Fuzzy logic. It is mainly adopted in this research due to its capability of making decisions in an environment of uncertainity and lack of complete information .As a matter of fact, Fuzzy logic resembles human decision making, working with reasoning and finding a precise solution. Fuzzy logic when combined with artificial neural networks is known as neurofuzzy. This hybridisation provides a hybrid intelligent network which has its ability of reasoning along with learning.

The technique of incorporation of fluorescent dyes in the nucleic acid of parasite's nuclei is used for the diagnosis of Malaria. Various stages of Malaria are diagnosed using this technique [1]. A experiment concluded that the analytical errors in the performance of Remote Diagnostic Technologies (RTD) are rare [2] and [9]. A method based on automated image processing of thin blood smears is discussed for the diagnosis of malaria. It is an exclusive effort for providing aid to medical practioners but it is limited as it is expensive and its slide quality degrade with time [3]. An expert system is created which provide aid for the diagnosis of tropical endemic diseases .The system comprised of large knowledge bank helpful for practioners [4] and [8]. An experiment concluded that computer aided medical diagnostic system implementing fuzzy logic is not effectively accurate but efficient [5] and [9]. A comparative test is designed between Analytic Hierarchy Process (AHP) and fuzzy logic. The results proved the superiority of concept of fuzzy over AHP [6]. Fuzzy Cognitive Map (FCM) is a approach based on fuzzy logic used in medical decision making [10-13].

This paper proposes a proficient system based on neurofuzzy concept for the diagnosis of Malaria. It is a design based upon clinical observations, expert's advice on diagnosis of Malaria. Section II discusses Fuzzy and Neural Approach in diagnosis of Malaria Disease. Section III discusses Simulated Result for diagnosis of Malaria and in the last section collects all the ideas discussed in this research and the scope of this work in future .The motive of this research is to skeletonise a platform based on decision support to the healthcare practioners, physicians in malarial endemic regions. It will also ensure the tedious task of diagnosing malaria in countrified areas.

II FUZZY AND NEURAL APPROACH IN DIAGNOSIS OF MALARIA DISEASE

The process of converting the scalar value into fuzzy value is known as fuzzification. Triangular fuzzifiers, Gaussian fuzzifiers, Trapezoidal fuzzifiers and singleton fuzzifier are some type of fuzzifiers used for the process of fuzzification [7]. In this research, Triangular fuzzifier is used to create a knowledge based system as per made by expert opinion to get appropriate results .

The degree of membership functions is determined by the process of fuzzification of data, in which input parameters are selected on horizontal axis and projected vertically to upper boundary of member function . The transformation of raw data to fuzzy value using functions marked the beginning of fuzzification.

The main issue is generalisation i.e. we want the neural network to generalize from the training examples to the entire domain. The design of the network architecture and the training algorithm is aimed at improving this capability. A related issue is overtraining, which refers to the deterioration of the network performance against test (instead of training) examples beyond a certain number of the training cycles .This issue is akin to over fitting data. When the network is over trained, it tends to fit the training data so closely as to sacrifice its performance on the test data.

Mapping Networks deals with the approximation of a mathematical function .It implements a bounded mapping or function from a bounded set of n dimensions to another bounded set of m dimensions (where n≠m or n=m). Let F_{NN} denote the function directly encoding the network operation. The network is trained so that F_{NN} approximates f, i.e., $F_{NN} \approx$ f. For the purpose of training, a set of training examples are selected from the domain. Each example is represented by (x,y) where y=f(x). The ideal goal is that after training, y = f(x) = F_{NN}(x), for every x in the domain, not limited to the training set.

In the training process, we want to minimise the difference between F_{NN} and f .There are several criteria to define the difference .Among these, mean squared error is most commonly used .The squared error for a single training example is

$$E^2(X) = |f(x) - F_{NN}(x)|^2 \quad (1)$$

The mean squared error over N training examples is given by

$$\overline{E^2} = \frac{1}{N}\sum E^2(x) \quad (2)$$

Alternately ,we can us the probability integral

$$\overline{E^2} = \int E^2\,(x)\rho(x)dx \quad (3)$$

Where ρ(x) is the probability density function. The least mean square (LMS) has traditionally been used in fields as diverse as control, pattern recognition and statistics and gained a great deal of success.

The use of the LMS rule often leads one to wonder whether the neural network actually performs regression analysis. However the nonlinear nature of a multilayer network makes it transcend linear regression techniques. Experimental evidence has suggested that mapping networks are in general comparable to the best nonlinear statistical regression approaches and that mapping network usually approximate a function more accurately than linear regression techniques. In fact, it is acceptable to regard the mapping neural network as a kind of non linear statistical technique. Yet it is more powerful than traditional techniques by offering more functional forms and adaptive capabilities.

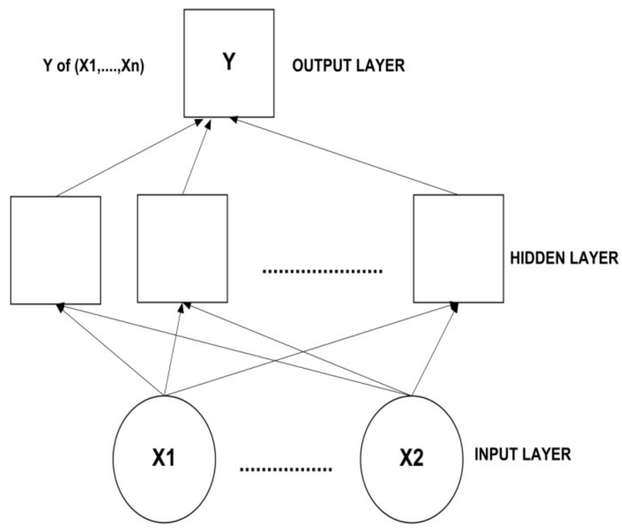


Figure 1: A mapping neural network

The neurofuzzy architecture of Malaria is proposed. An architecture is designed which is based on the data gathered on the disease malaria. There are following parameters which are connected to Malaria:

- Fever
- Headache
- Nausea
- Vomiting
- Bodyache
- General Malaise
- Dizziness
- Loss of Appetite

Figure 2 shows the methodology for neurofuzzy of Malaria:

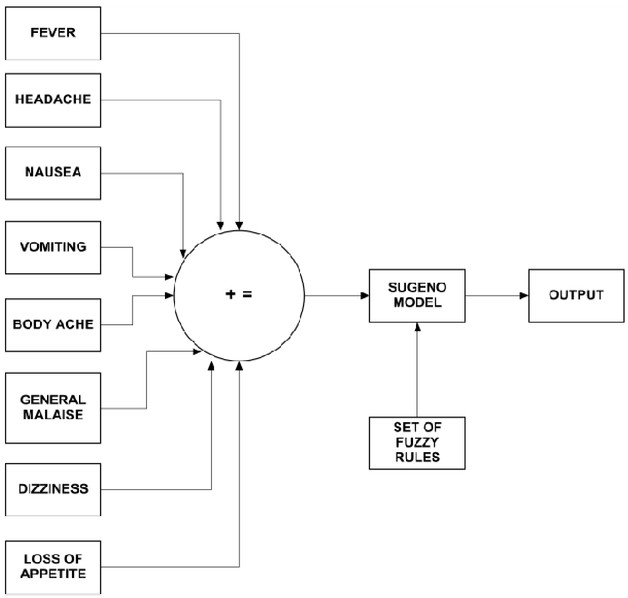


Figure 2: Block diagram of neurofuzzy of malaria

We have defined certain rules concerning the symptoms in this research for the diagnosis of malaria. Following are the interpretation of some rules used in this research :

- IF fever = mild and headache = moderate and nausea = moderate and vomiting = mild and Body ache = mild then malaria = mild.
- IF fever = mild and headache = mild and nausea = moderate and vomiting = moderate and Body ache = severe and then malaria = severe .
- IF fever = moderate and headache = moderate and nausea = moderate and vomiting = moderate and Body ache = moderate and then malaria = moderate .
- IF fever = mild and headache = moderate and nausea = moderate and vomiting = moderate and Body ache = mild then malaria = moderate.
- IF fever = mild and headache = mild and nausea = mild and vomiting = moderate and Bodyache = mild then malaria = mild .
- IF headache = moderate and nausea =mild and vomiting = moderate and Body ache = mild then malaria = severe .
- IF fever = mild and nausea =moderate and vomiting = moderate and Body ache = mild and malaria = severe .
- IF fever = moderate and vomiting = mild and Body ache = moderate and then malaria = moderate .
- IF headache = severe and nausea = severe and vomiting = severe and Body ache = severe then malaria = very severe .
- IF fever=severe and headache = severe and nausea = severe and vomiting = severe and Body ache = severe then malaria = very severe .

The block diagram shown in figure 3 from the view point of designing of neurofuzzy network for the diagnosis of malaria. The Input variables are required to make the membership function using their selected range. Membership function selected here is triangular member function. When the rules are made up to the satisfactions then the rules are viewed by using the rule viewer. After this, the surface is viewed using the surface viewer. Then the data is loaded and it is trained and tested with the error tolerance. If the tolerance is more than error then rules are modified and the again the process is repeated. Else the final result is obtained and the neural network structure can be viewed.

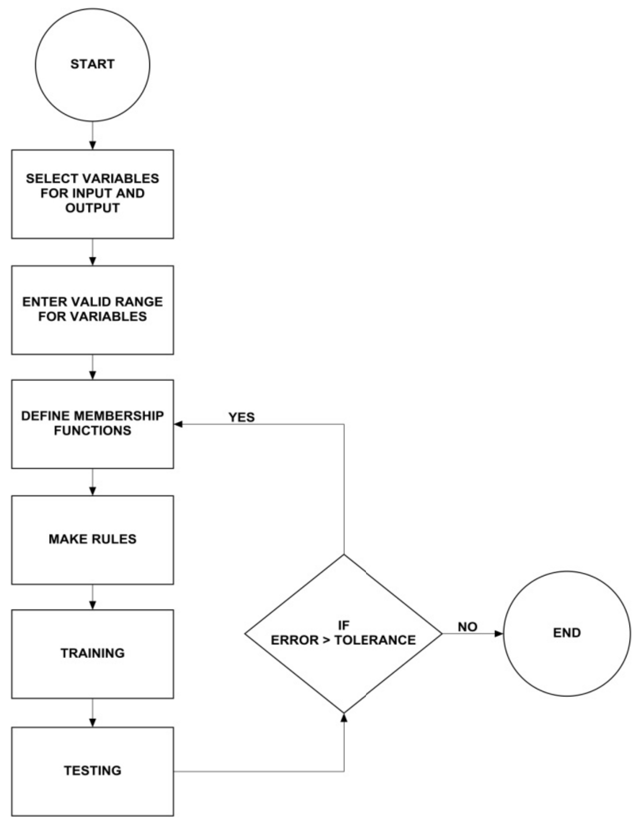


Figure 3: System block diagram for neurofuzzy

III SIMULATED RESULT FOR DIAGNOSIS OF MALARIA

A. Fuzzy Inference System Using Sugeno Method

A sugeno model is developed using Fever, Headache, Nausea, Vomiting, Bodyache as inputs and Malaria as output [14].We apply the fuzzy operator after fuzzifying the input parameters.

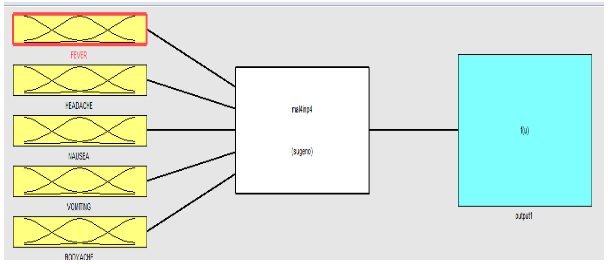


Figure 4: Fuzzy system using Sugeno method

B. Fuzzy Inference System

A set of values is shown in figure 5 after processing if and then rules.

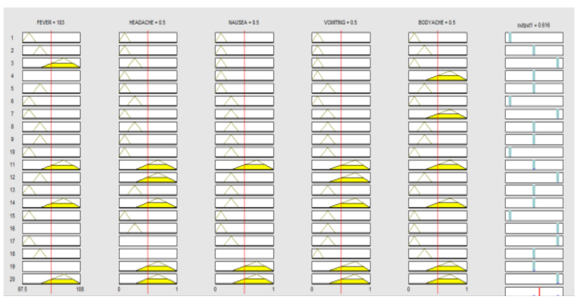


Figure 5: Fuzzy system using Sugeno method

C. Training and testing data

A set of values is used for training and testing the system which is shown in figure 6 where 'o' represent the training data and '.' (dots) represent testing data.

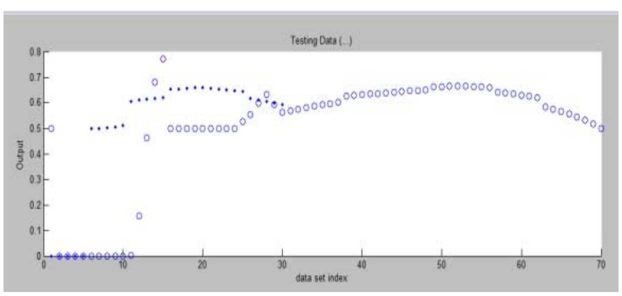
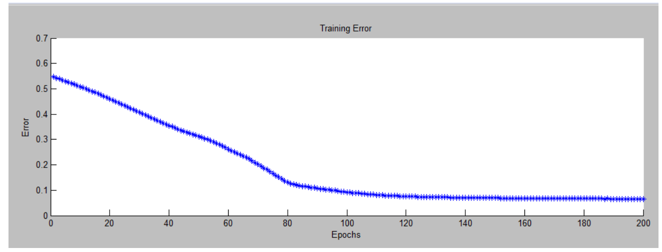


Figure 6: Fuzzy system using Sugeno method

D. Error during Training

After the initialisation of network weights ,the network go through training using backpropogation algorithm with maximum instant error of 0.06144.



Error : 0.06144

Figure 7: Decrement in training error

E. Surface Viewer

Using Sugeno method, We draw a 3-D plot between two inputs and output .This plot gives the output surface of the fis stored file. We can manipulate the surface so that we can examine at different angles .

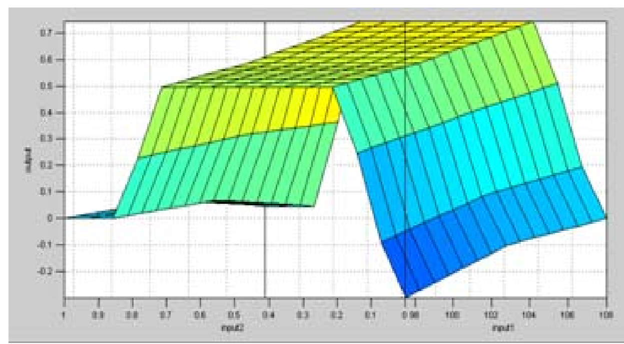


Figure 8: Surface viewer using input as fever, headache and output Malaria

F. Neurofuzzy Model for Malaria

After our system is trained, we get a neurofuzzy model depicting five inputs and their outputs as their combinations.

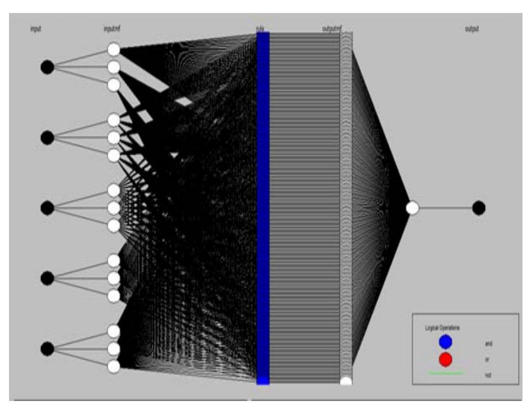


Figure 9: Neurofuzzy model of malaria

IV CONCLUSION

An integrated architecture of neurofuzzy system for malaria with a decision making ability based on predefined rules has been proposed in this paper .This architecture is capable of dealing with complex system which includes rule chaining .This research finds its vital importance in countrified areas where there is poor availability of doctors . This work can be used in the prediagnosis of malaria.

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