REPORT ON DIAGNOSIS OF MALARIA USING NEURO-FUZZY APPROACH

INT-246(SOFT COMPUTING TECHNIQUES)

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ABSTRACT

Malaria is a life-threatening disease. It's typically transmitted through the bite of an infected *Anopheles* mosquito. In this paper, an Adaptive Neuro Fuzzy Inference System (ANFIS) was developed for the diagnosis of malaria. The system was designed to use the triangular membership function and implements back propagation technique and least square mean as its learning algorithm. It uses the tagaki sugeno fuzzy inference model in providing the rules base of the system. The outcome of the system gave an accuracy of 99% in the classification of malaria patients.

Keyword: Malaria, ANFIS

INTRODUCTION

Malaria is a mosquito-borne infectious disease that affects humans and other animals. Malaria causes symptoms that typically include fever, tiredness, vomiting, and headaches.[1] In severe cases, it can cause yellow skin, seizures, coma, or death. Symptoms usually begin ten to fifteen days after being bitten by an infected mosquito. If not properly treated, people may have recurrences of the disease months later. In those who have recently survived an infection, reinfection usually causes milder symptoms. This partial resistance disappears over months to years if the person has no continuing exposure to malaria.

The number of amazing and innovative intelligent systems for accurate medical predictions of state of human health have increased tremendously in recent times as a result of the application of Artificial Intelligence Techniques (AITs) such as Fuzzy logic, Neural Network, Expert System, Genetic Algorithms etc. in health care practices. Artificial intelligent prediction is based on human-like learning ability in pattern recognition better known as Machine Learning5-10.

Since medical decisions are very complex and uncertain, the use of AITs has helped in development of intelligent health care system11. Therefore, this report proposed an **Adaptive Neuro-Fuzzy Inference System in the diagnosis of malaria.** It has advantage of combining the computational power of neural network and the explanatory power of fuzzy inference system making it a powerful hybrid system. It is also capable of learning new patterns of malaria symptoms making it more suitable and better than a rule-based system. (**ANFIS**) is a kind of artificial neural network that is based on Takagi–Sugeno fuzzy inference system. The technique was developed in the early 1990s.[1][2] Since it integrates both neural networks and fuzzy logic principles, it has potential to capture the benefits of both in a single framework. Its inference system corresponds to a set of fuzzy IF–THEN rules that have learning capability to approximate nonlinear functions. Hence, ANFIS is considered to be a universal estimator. For using the ANFIS in a more efficient and optimal way, one can use the best parameters obtained by genetic algorithm. It has uses in intelligent situational aware energy management system.

Model of the Proposed ANFIS System for Malaria

The first step of any medical diagnostic process is the examination of patient by a physician. A set of complaints and physiologic symptoms are collected as pre-hospital data.

FIG-1depict the structure of ANFIS for malaria diagnosis.

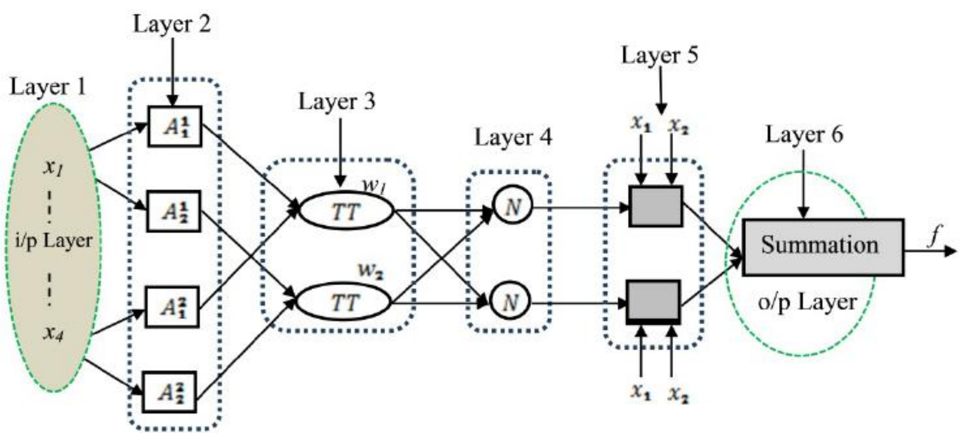

FIG-1: ANFIS Structure for Diagnosis of Malaria

Layer 1: This layer is called the Input Layer and consists of input nodes labelled X1 to X3. This node denotes the symptoms of malaria and they hold values fed into the system which are Temperature, Bloop Pressure and Weight.

Layer 2: This layer is called the membership function layer. The membership function used in this layer is the triangular membership function and was adopted because of its ease of use. The function of each node in this layer is to map the input into this layer which is the output of layer 1(input layer) to the linguistic variable (low[A1] and high[A2]).

Layer 3: This layer is called the rule layer. The nodes in this layer are fixed. They receive input from the membership function layer and calculates the firing strength of each rule node.

Layer 4: This is the normalization layer and made up of fixed nodes labelled N1 to N81. Each node in this layer receives input from the rule layer and computes the ratio of the rule's firing strength to the sum of all the rules firing strength.

Layer 5: This layer is made up of fixed node. The node in this layer receives its input from the fourth layer and also the input value from the first layer called the consequent parameters.

Layer 6: This layer is called the output layer. It consists of a single fixed node labelled Y which sums all the incoming signals and produces the output of the ANFIS system.

The final output of the ANFIS system represents the diagnosis of a patient and is classified either as low or high.

$$\textbf{Output(f)} = \begin{cases} \textit{Low if(f<=100000)} \\ \textit{High if(f>100000)} \end{cases}$$

Methodology:

Table1: Dataset of 20 patients before ANFIS

	Temperature	BP	Weight	Level of malaria
0	28.7	72	7.1	100000
1	36.0	80	37.0	100000
2	35.6	120	85.0	100000
3	36.2	160	9.0	100000
4	37.0	120	9.0	100000
5	38.5	127	9.0	101000
6	37.0	80	30.0	101000
7	36.6	90	45.0	100500
8	36.4	120	41.0	100000
9	36.8	100	29.0	100000
10	38.1	130	30.0	100000
11	35.5	100	33.0	100000
12	36.0	90	18.0	100000
13	35.5	90	66.0	100000
14	36.4	120	64.0	100000
15	36.1	108	53.0	100000
16	28.7	72	7.1	100000
17	36.0	80	37.0	100000
18	35.6	120	85.0	100000
19	36.2	160	9.0	100000

TABLE-2: **Dataset of 20 patients after implementing ANFIS**

	Level of malaria	Obtained Level of malaria	Intensity
0	100000	100024.809942	HIGH
1	100000	100030.775653	HIGH
2	100000	100947.758917	HIGH
3	100000	100469.704751	HIGH
4	100000	100024.809942	HIGH
5	101000	99932.550783	LOW
6	101000	100010.108121	HIGH
7	100500	100927.315529	HIGH
8	100000	100927.315529	HIGH
9	100000	100034.817485	HIGH
10	100000	100030.775653	HIGH
11	100000	99986.505930	LOW
12	100000	100034.817485	HIGH
13	100000	99978.101850	LOW
14	100000	100469.704751	HIGH
15	100000	100124.528533	HIGH
16	100000	100469.704751	HIGH
17	100000	100947.758917	HIGH
18	100000	100000.920981	HIGH
19	100000	100030.775653	HIGH

In Table-2, dataset of 20 patients is given. In this dataset the predicted level of malaria and the obtained level of malaria in patients is shown. This level is further classified to fetch Intensity of malaria in a patient. If the obtained level is less than or equal 100000, then the Intensity is LOW and if it is more than 100000, then the Intensity is HIGH.

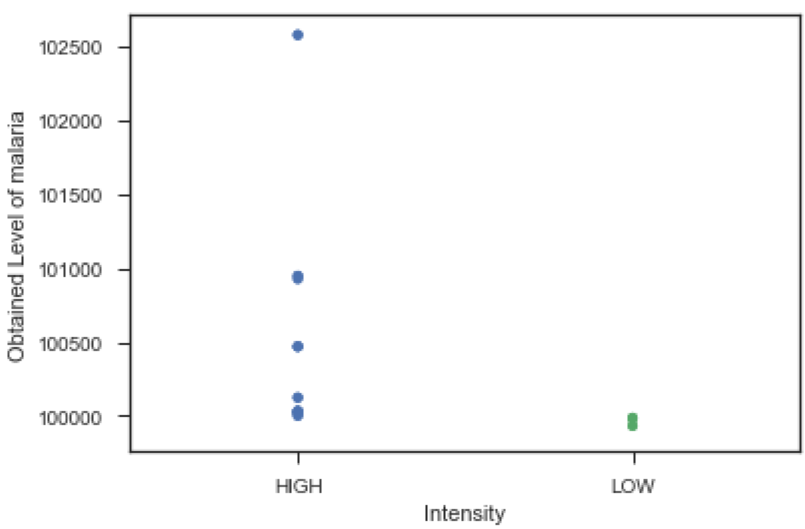

FIG-2: Graph of Intensity and Obtained level of malaria

Results and Discussion:

The dataset used in the ANFIS comprises of 50 cases. 70% (35) of the dataset was used to train the system and 30% (15) each was used in testing and checking.

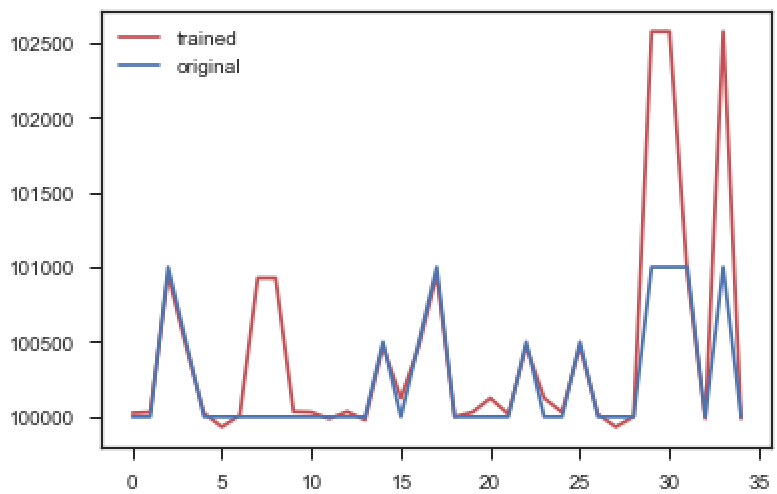

FIG-3: Graph of Trained and Original data

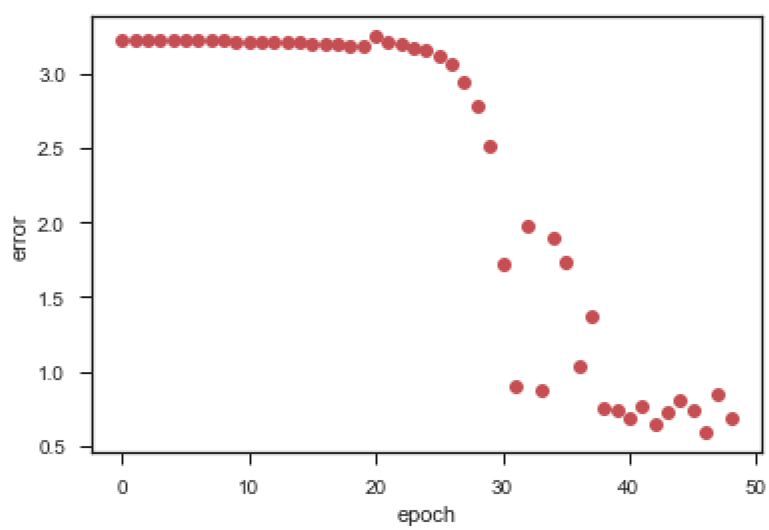

FIG:4- Graph of calculated error and epoch

FIG:5 shows the relationship between each symptom (i.e. Temperature, BP and weight) before a patient can be diagnosed with malaria. It also shows the relationship between Level of malaria and different symptoms in patients

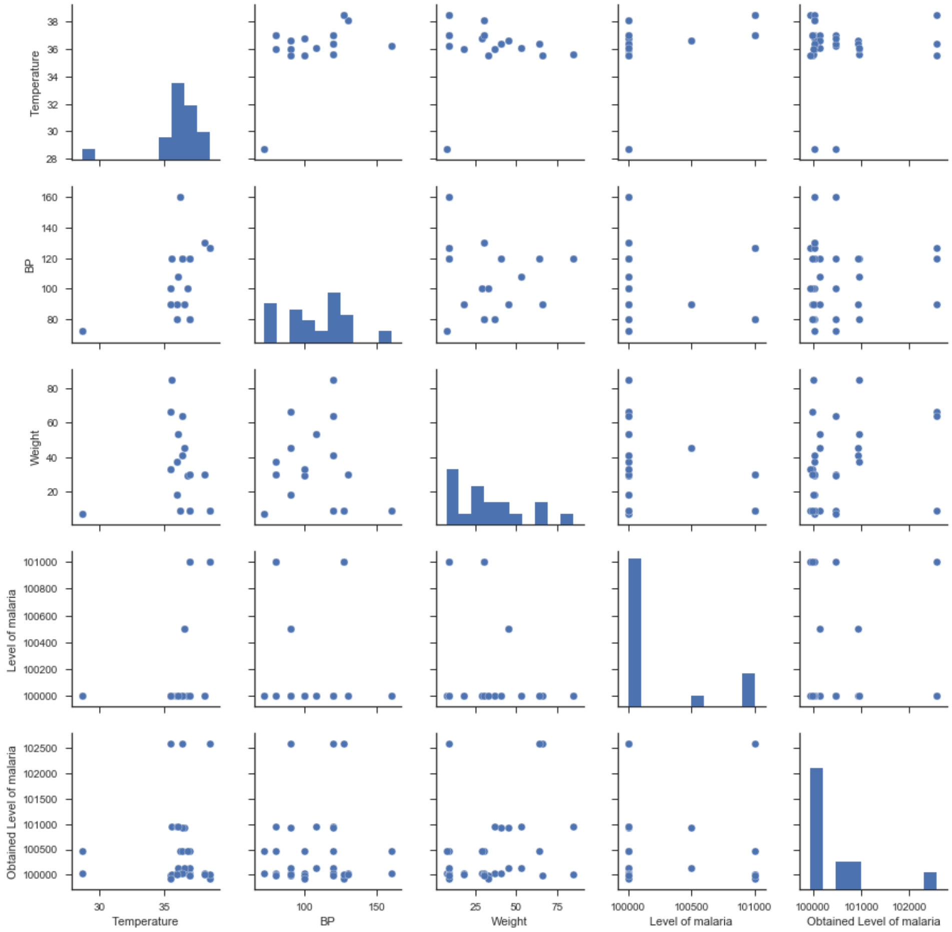

FIG-5 : Graph between various symptoms and level of malaria

The relationship between the predicted Level of malaria in patients and the obtained level of malaria after the implementation of ANFIS is shown in FIG-6.

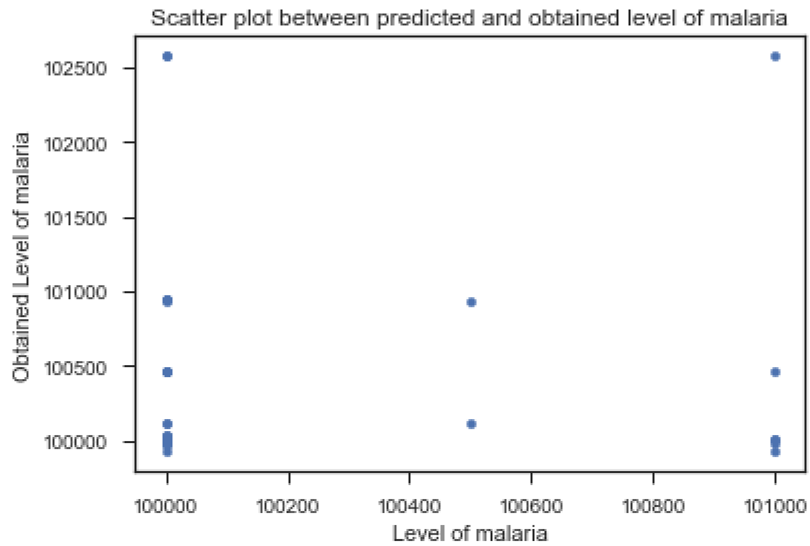

FIG-6: Graph between predicted and obtained level of malaria

Probability density of Obtained level of malaria after implementing ANFIS is shown as a Kernel Density Estimate Plot in FIG-7.

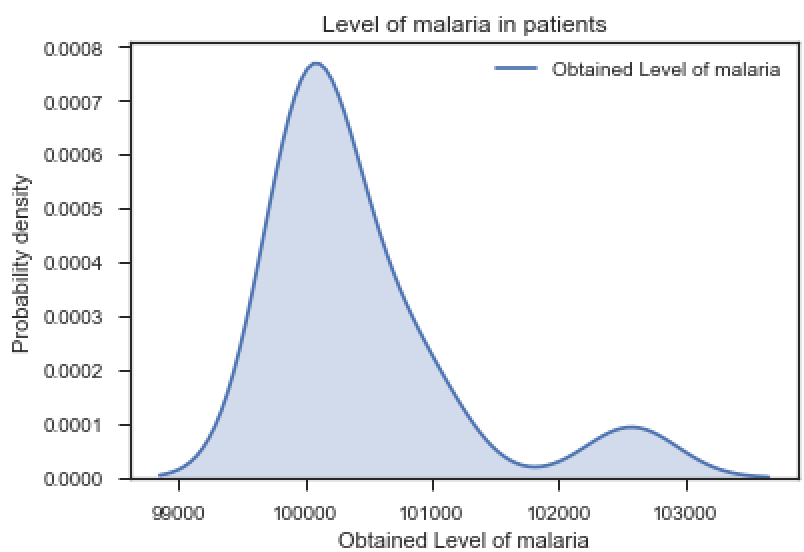

FIG-7: Graph of probability density of obtained level of malaria

The results from the experiment show that an average testing error of 0.63% was detected. This shows that ANFIS was able to classify 99% of test data.

CONCLUSION:

Expert systems have been found to be very useful in our today's world driven by technology. Having a system with the knowledge of a specialist would be indispensable and such system could be replicated and made use of in times of necessity. The proposed Adaptive Neuro Fuzzy Inference System has shown to be an indispensable tool for diagnosing malaria with the system having an accuracy of 99%.

References:

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GITHUB LINK: https://github.com/diyali0811/malaria_diagnosis