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Cardiovascular Disease Diagnosis Using Fuzzy Petri Net

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***Abstract*- Nowadays Heart Disease is on a rise from year to year. However, a proper diagnosis at an early stage can save many lives. But all the physicians are not equally efficient, which can cause for inaccurate diagnosis. A system for automated diagnosis would enhance the accuracy of the diagnosis and reduce the cost effects. The main purpose of the present study is to design Fuzzy Petri Net accompanied with Fuzzy rule based reasoning logic for analyzing the complex heart disease diagnosis. Smoke, cholesterol, blood pressure, diabetes, sex and age are main risk factors that affect on heart disease risk. Because of the many risk factors in the heart disease risks, heart disease diagnosis is difficult. In such a situation diagnosis by a physician is troublesome. So, experts require an accurate automated system.**

Keywords-Fuzzy Logic, membership function, Fuzzy Rule base System

I. INTRODUCTION

Ali.Adeli, Mehdi.Neshat[1] proposed and presented a fuzzy expert system for heart disease diagnosis in Mar 2010 on the International Multi Conference of Engineers and Computer Scientists. This system was based on the V.A. Medical Center, Long Beach and Cleveland Clinic Foundation data base. Here there are 13 input fields and one output field with inputs as chest pain, blood pressure, cholesterol, blood sugar, maximum heart rate, ECG, exercise, old peak (ST depression induced by exercise relative to rest), thallium scan, sex and age. Presence of heart disease that is an integer value from 0-4 is the output field. Integer value 0 indicates no presence and values 1, 2, 3 and 4 shows increasing value for heart disease risk.

Vanisree K,Jyothi Singaraju[2] have proposed a Decision Support System for the Congenital heart disease diagnosis from the available database .Here a back propagation neural network have been used which contains an input layer and more than hidden layers .Also it contains only one output layer. The parameters that are used to perform Congenital Heart Disease Diagnosis classification is the signs, symptoms and physical evaluation of a patient. This system depends on examples of the previous cases it gives more accurate results than the human diagnosis. A Decision Support System for this system is developed by using MATLAB's GUI feature and implementing the Backpropagation Neural Network Model. A BackPropagation Neural Network is built with 36 input nodes, 10 hidden nodes and one output node using MATLAB 7.3. The network is trained using a supervised training and a Delta Learning Rule.

E.P.Ephzibah,V.Sundarapandian[4] have proposed a neuro fuzzy expert system that finds a solution to diagnose the disease. They uses the concept of fuzzy rule based learning,genetic algorithm and neural networks. They proposed combination of artificial neural network and fuzzy logic based system in which the 13 attributes have been applied taken from UCI Machine learning repository. The result from this system has helped to arrive at a conclusion about the presence or absence of heart disease.

Ranjana Raut, S. V. Dudul[5] used a neural network based approach for intelligent system of heart disease diagnosis. They have used classifiers such as multilayer perceptron, Jordan recurrent neural network, generalized feed forward neural network, Modular Radial Basic Function, Self Organizing Feature Map, other techniques like Support Vector Machine and conventional statistical techniques such as Data Analysis and CART.

Manisha Barman, J Pal Choudhury made an effort to diagnose the heart disease by using fuzzy rule base. In this system 7 attributes of patients have been used as input values from the Clevand database. The data values are partioned into several intervals. It is based on certain intermediate values of the available data values. After that fuzzy rule base has been applied on the partitioned input data values. Based on the fuzzy value of the output variable, the heart disease presence can be determined.

II. METHODOLOGY

This system is based on the V.A. Medical Center, Long Beach and Cleveland Clinic Foundation dataset. This dataset is part of the collection of databases at the University of California. In this database there are 76 attributes and 303 patient examples. This system consists of 11 attributes for input and 1 attribute for result case. Input fields (attributes) are chest pain, cholesterol, blood sugar, maximum heart rate, blood pressure, sex, ECG, exercise, old peak, age and thallium scan. The output field indicates the presence of heart disease. Integer value 0 indicates no presence of heart disease and values 1, 2, 3 and 4 shows

increasing value for heart disease occurance. Several membership functions are used such as trapezoidal function, triangular function.

Triangular function: It is defined by a lower limit a, an upper limit b and a value m, where a<m<b.

$$\mu_A(x) = \begin{cases} 0, & x \le a \\ \frac{x-a}{m-a}, & a<x\le m \\ \frac{b-x}{b-m}, & m<x<b \\ 0, & x\ge b \end{cases}$$

Trapezoidal function: It can be defined by a lower limit a, an upper limit d with a lower support limit b and an upper support limit c, where a < b < c < d.

$$\mu_A(x) = \begin{cases} 0, & (x < a) \text{ or } (x>d) \\ \frac{x-a}{b-a}, & a\le x\le b \\ 1, & b\le x\le c \\ \frac{d-x}{d-c}, & c\le x\le d \end{cases}$$

III. IMPLEMENTATION

A. *Attribute Set Creation*

An input field varies in different range values. The first input field "Chest pain type" comprises of four types as denoted by numerical value. The value 1 shows typical angina, 2 shows atypical angina, 3 shows non-angina and 4 shows asymptomatic angina .The second is blood pressure measured in mm and input variable has divided to 4 fuzzy sets. This Fuzzy sets include Low, Medium, High and Very high. Membership functions of Low and Very high sets are trapezoidal and membership functions of medium and high sets are triangular. The third input field is Cholesterol. This input field use the value of low density lipoprotein (LDL) cholesterol. Cholesterol field has 4 fuzzy sets (Low, Medium, High and Very high). Membership functions of Low& Very high sets are trapezoidal and membership functions of Medium& High sets are triangular. The third input field is blood sugar. In this system, we have defined that if the amount value of blood sugar is higher than 120 (>120) the patient has blood sugar. The fifth input field is resting electrocardiography (ECG). In this field, we have 3 fuzzy sets. They are normal, ST_T abnormal & Hypertrophy. Membership functions of Normal & Hypertrophy fuzzy sets are trapezoidal and membership Function of ST_Tabnormal fuzzy set is triangular. The sixth input field is maximum heart rate. The value of this input field is the maximum heart rate of a man in 24 hours. The seventh input field is exercise. This input field has just 2 values and one fuzzy set .If doctor determines exercise test for patient, value 1 will be entered, otherwise, value 0 will enter in it. The eighth input field is old peak. It means ST depression induced by exercise relative to rest. The nineth field is Thallium Scan. Its input field consists 3 fuzzy sets. These are Normal, Reversible Defect and Fixed Defect. The tenth field is Sex. This input field just has 2 values (0, 1) and sets (Female, Male). Value 0 means that patient is male and value1 means that patient is female. The eleventh field is age. This input field divides to 4 fuzzy sets (Young, Mild, Old, Very old).

Output field refers to the presence of heart disease, that is an integer value from 0-4 is the output field. Integer value 0 indicates no presence and values 1, 2, 3 and 4 shows increasing value for heart disease risk. There are 5 fuzzy sets (Healthy, Sick (s1), Sick (s2), Sick (s3), sick (s4)). Membership functions of Healthy & Sick (s4) fuzzy sets are trapezoidal and membership functions of Sick (s1), Sick (s2) and Sick (s3) are triangular.

B. *Fuzzy Rule-Based System*

Rule base system is the main part in fuzzy system and fuzzy rules form an important part in the quality of results obtained. Our system includes 44 rules. Antecedent part of all rules has one section. That means there is no AND/OR operation in the antecedent part. There is only one consequent part. Each fuzzy rule consists of two propositions. Each such proposition is represented with one place. In that way our system can be represented using 37 places. Out of those 37 places, 32 are input places and 5 output places. A petri net can also be drawn with this fuzzy rule base. The rule base is indicated by associating each transition with some certainty factor. A certainity factor is determined for transition rule.

IV. CONCLUSION AND FUTURE WORK

In the present study we have discussed the symptoms of heart disease in a fuzzy environment. Here the fuzzy rule based reasoning logic is appropriately matched to the disease diagnosis. Here we analyze symptoms of heart disease through fuzzy rule based system. Thus determining the healthiness and sickness of patients through fuzzy approximate rule. The whole system is put in fuzzy Petri net. This system can also be used for other medical disease diagnosis and it can also be processed through automata theory. There are many other applications for Fuzzy Petri nets including fuzzy performance evaluation, financial planners, diagnostic systems, navigation system, , decision support system etc.

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