INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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SPECIAL ISSUE FOR
INTERNATIONAL CONFERENCE ON
"INNOVATIONS IN SCIENCE & TECHNOLOGY: OPPORTUNITIES & CHALLENGES"

FUZZY EXPERT SYSTEM FOR THE NON INVASIVE METHOD OF THE LIVER CIRRHOSIS

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Accepted Date: 07/09/2016; Published Date: 24/09/2016

Abstract: *Cirrhosis is a serious disease of the liver which replaces heal thy liver tissue with scar tissue. The scar tissue blocks the flow of blood in the liver and slows down the vital functions of liver. Various possible causes of cirrhosis are: Cirrhosis can cause loss of appetite, weakness, jaundice, itching and fatigue. Complication of Cirrhosis includes edema and ascites, bleeding from varices, hepatopulmonary syndrome and liver cancer. Patient's history, physical examination of patient and blood test can suggest the diagnosis of Cirrhosis. The conformation can be done by the liver biopsy, but biopsy may cause complications. Several non-invasive tests which includes routine laboratory test can predict cirrhosis. Decision support through expert systems becomes part of everyday life. The aim of this study is to design a fuzzy expert system for the diagnosis of Cirrhosis which is one of the common diseases of the liver. The designed system is based on the sequential combination of the Bononcini score, which includes AST/ALT ratio, Platelet count and INR. The system has 3 input fields and one output field. Input fields are AST/ALT ratio, Platelet count and INR and the output field refers to the risk of cirrhosis. It is integer valued from 0 to 6. The system uses Mamdani Inference method. The results obtained from the designed system are compared with the actual data of patients in the database and observed results of the designed system are well within the limits set by the domain expert. The system can be used as decision support for the prediction of the cirrhosis and can avoid the need of the liver biopsy.*

Keywords: *Semisolid, Infant's, Steeping, Kilning, Malt, Alpha-Amylase, Yield.*

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How to Cite This Article:

Ravindra M. Khandar, IJPRET, 2016; Volume 5 (2): 692-701

PAPER-QR CODE

INTRODUCTION

FUZZY LOGIC & FUZZY EXPERT SYSTEM :

Fuzzy Logic :

Fuzzy logic was first proposed by Lotfi A. Zadeh of the University of California at Berkeley in the year 1965 [8]. He elaborated on his ideas in the year 1973 [9] introducing the concept of 'linguistic variables', which he equates to a variable defined as a 'fuzzy set'. The primary objective of fuzzy logic is to map an input space to an output space. The way of controlling this mapping is to use IF-THEN statements known as rules. The order in which these rules are carried out is insignificant, since all rules run concurrently. Fuzzy logic is a powerful problem-solving methodology with a myriad of applications in embedded control and information processing. It provides a remarkably simple way to draw definite conclusions from vague, ambiguous, or imprecise information. In a sense, it resembles human decision making with its ability to work with approximate data yet find precise solutions.

Fuzzy Sets:

A fuzzy set A in a universe of discourse U is characterized by a membership function μ_A which takes the values in the unit interval $[0,1]$,i.e.

$$\mu_A : U \to [0,1]. \qquad (1)$$

The value of μ_A at $u(\varepsilon U), \mu_A(u)$, represents the grade of membership (grade for short) of u in A and B is a point in $[0,1]$.

Fuzzy Expert System:

An Expert System is a computer program that simulates the judgment and behavior of a human that has expert knowledge and experience in a particular field.

Expert System are used to advice non experts in a situations where a human expert is not available.

If *A* is *low* and *B* is *high* then *X* = *medium* where *A* and *B* are input variables, *X* is an output variable.

Here low, high, and medium are fuzzy sets defined on *A, B*, and *X* respectively. The antecedent (the rule's premise) describes to what degree the rule applies, while the rule's consequent assigns a membership function to each of one or more output variables.

Let *X* be a space of objects and *x* be a generic element of *X*. A classical set *A*,$A \subseteq X$, is defined as a collection of elements or objects $x \in X$, such that *x* can either belong or not belong to the set *A*. A fuzzy set *A* in *X* is defined as a set of ordered pairs $A = \{(x, \mu A(x)) \mid x \in X\}$ (1)

where $\mu A(x)$ is called the membership function (MF) for the fuzzy set *A*. The MF maps each element of *X* to a membership grade (or membership value) between zero and one. Obviously (1) is a simple extension of the definition of a classical set in which the characteristic function is emitted to have any values between zero and one. Expert System is made up of three main components

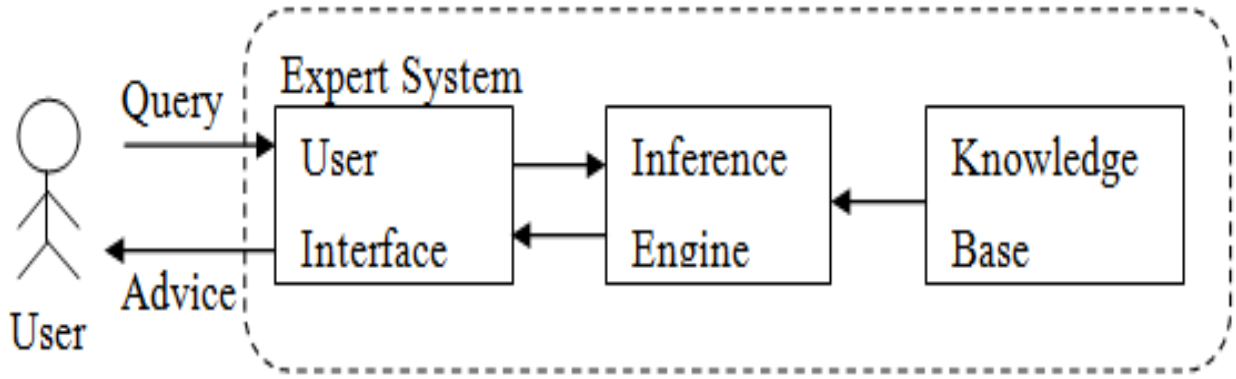

Figure 4.1: Expert System

.A user's interface: - Users interface allows a user to query the E.S. and to receive advice. User friendly interfaces are popular in E.S.

- A knowledge base: - Knowledge base is created from information provided by the domain experts and is a collection of facts and rules.
- An interface engine: - Inference engine examines the knowledge base for information that matches the user query using various search strategies.

MEMBERSHIP FUNCTIONS:

One of the most commonly used examples of a fuzzy set is the set of tall people. In this case, the universe of discourse is all potential heights, say from 3 feet to 9 feet, and the word tall would correspond to a curve that defines the degree to which any person is tall. If the set of tall

people is given the well-defined (crisp) boundary of a classical set, you might say all people taller than 6 feet are officially considered tall. However, such a distinction is clearly absurd. It may make sense to consider the set of all real numbers greater than 6 because numbers belong on an abstract plane, but when we want to talk about real people, it is unreasonable to call one person short and another one tall when they differ in height by the width of a hair.

Types of Membership Function:

The Fuzzy Logic includes 11 built-in membership function types. Functions are, in turn, built from several basic functions: piecewise linear functions, the Gaussian distribution function, the sigmoid curve, and quadratic and cubic polynomial curves. The simplest membership functions are formed using straight lines. Of these, the simplest is the triangular membership function, and it has the function name trimf. It is nothing more than a collection of three points forming a triangle. The graphical representation of triangular and trapezoidal membership functions.

1. **Trimf**(triangular membership function) : The simplest membership functions are formed using straight lines. Of these, the simplest is the *triangular* membership function, and it has the function name trimf. It's nothing more than a collection of three points forming a triangle.

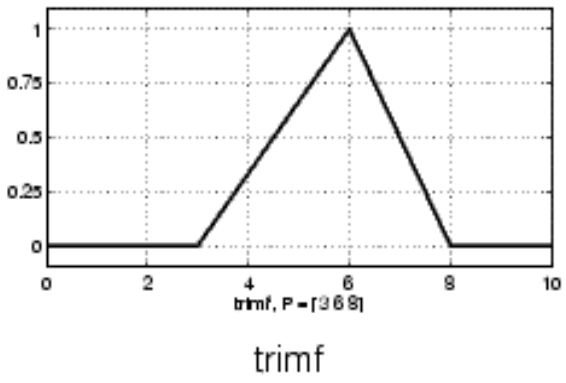

Figure (a)

2. **Trapmf** (trapezoidal membership function): The *trapezoidal* membership function, trapmf, has a flat top and really is just a truncated triangle curve. These straight line membership functions have the advantage of simplicity.

Fuzzy SETS AND THEIR O Fuzzy SETS AND THEIR OPERATIONSPERATIONS

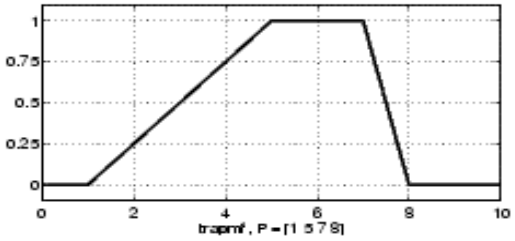

Figure (b)

3. gbellmf(*generalized bell* membership function): The *generalized bell* membership function is specified by three parameters and has the function name gbellmf. The bell membership function has one more parameter than the Gaussian membership function, so it can approach a non-fuzzy set if the free parameter is tuned. Because of their smoothness and concise notation, Gaussian and bell membership functions are popular methods for specifying fuzzy sets. Both of these curves have the advantage of being smooth and nonzero at all points.

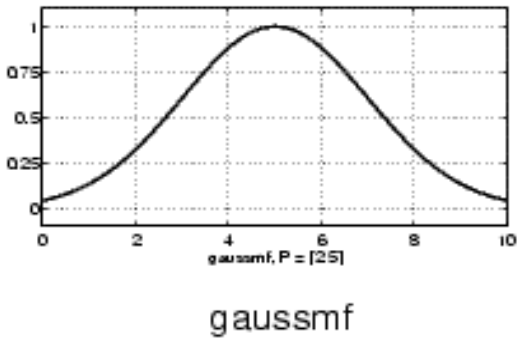

Figure (c)

SYSTEM DESIGN AND TESTING:

Input Variables

AST/ALT Ratio

The aspartame aminotransferase/alanime aminotransferase (AST/ALT) ratio differentiate between various causes of liver damage. AST/ALT values less than 2 indicate normal condition.

Value greater than 2 indicates presence of alcoholic injury to liver. Fuzzy set range of AST/ALT Ratio is shown in Table 1.

Membership functions for fuzzy sets are trapezoidal and triangular and are shown in Figure 1.

Input field	Range	Fuzzy sets
AST/ALT ratio	>1.7	Score0
	1.2-1.7	Score1
	0.6-1.19	Score2
	< 0.6	**Score3**

Table 1: Fuzzy sets of AST/ALT Ratio

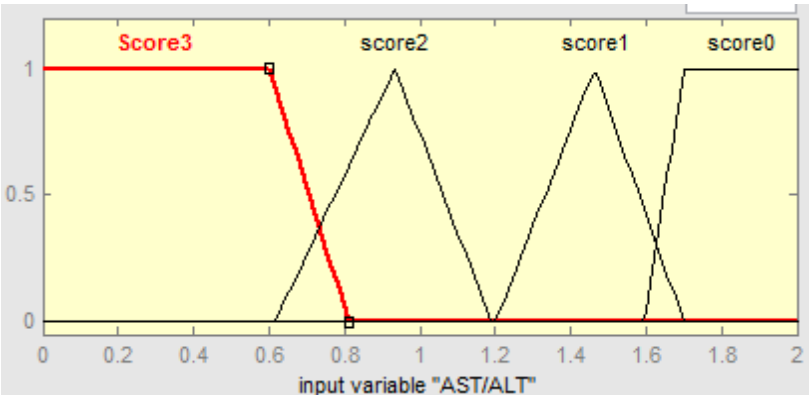

Figure 1: Membership function for AST/ALT Ratio

INR

Stands for international Normalized ratio. PROTIME INR or PT/INR test is used to determine bloods clotting tendency and is measure of liver damage. The results of prothrombin time vary due to variable in the material used to perform the result. The INR was devised to standardize the result [10].This variable has three fuzzy sets score0, score1 and score2. Table 2 shows fuzzy set range of INR.

Membership functions for fuzzy sets are trapezoidal and triangular and are shown in Figure 2.

Input field	Range	Fuzzy set
INR	< 1.1	Score0
	1.1-1.4	Score1
	>1.4	Score2

Table 2: Fuzzy Sets of INR

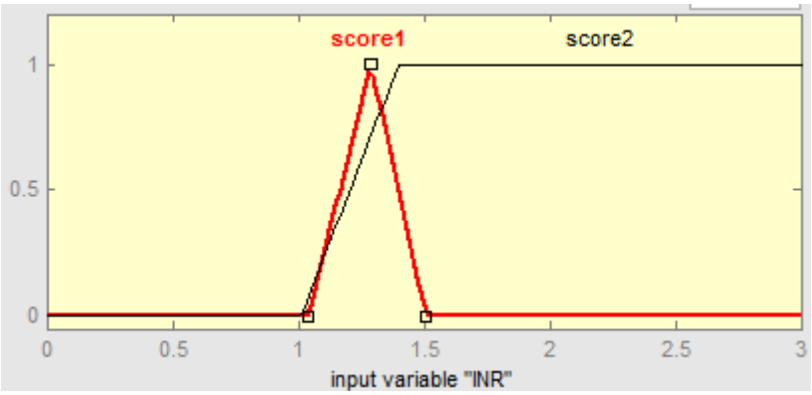

Figure 2: Membership Functions for INR

1. PLT

Platelets are the cells present within our blood. Whenever any blood vessel gets damage platelet bind the damaged vessel and cause blood to clot. Liver damage due to alcohol or due to any other reasons may drop platelet count .

This variable has 5 fuzzy sets score0, score1, score2, score3, score4 and score5. Fuzzy set range of PLT is shown in table3. Membership functions for fuzzy set are trapezoidal and triangular and are shown in Figure 3.

Input field	Range	Fuzzy set
PLT	> 340	Score0
	280-340	Score1
	220-279	Score2
	219-260	Score3

	100-159	Score4
	40-99	Score5
	<40	Score6

Table 3: Fuzzy sets of PLT

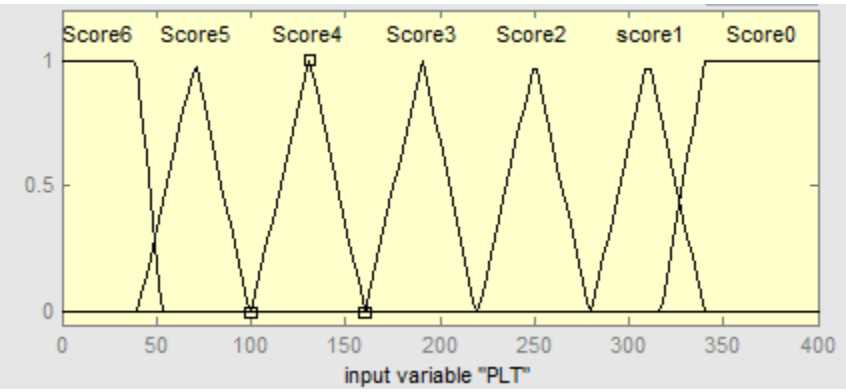

Figure 3: Membership functions for PLT

B. Output Variable

The aim of the system is to identify risk status of Cirrhosis. The output is a value from 0 to 10

representing Low risk, Intermediate risk & High risk. This output variable has three fuzzy sets Low risk, Intermediate risk and high risk. These fuzzy sets and its ranges are shown in Table 4. The membership functions of these fuzzy sets are triangular and trapezoidal and are shown in Figure 4.

Output	Range	Fuzzy set
Risk Status	< 3	Low Risk
	3-7	Intermediate Risk
	> 7	High Risk

Table 4: Fuzzy sets of Output variable Risk Status

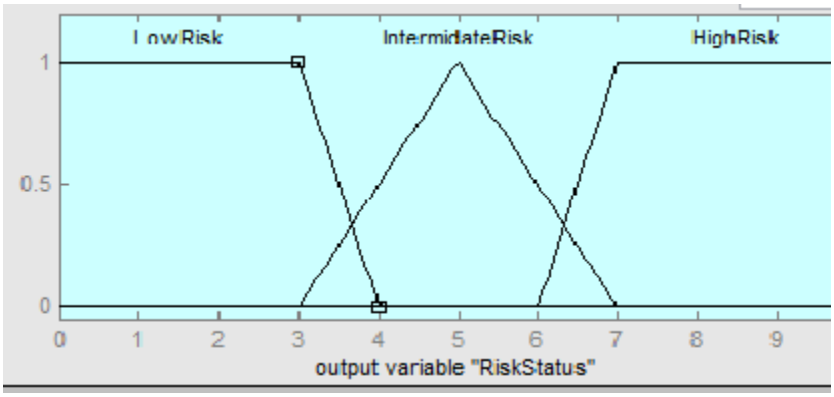

Figure 4: Membership function for output variable Risk Status.

C. Fuzzy Rule Base

The rule base is determined with the help of an expert doctor. The rule base consists of 85 well defined rules that determine the risk status by the evaluation of the input variables. The rule base is shown in Table 5.

Rule	INR	AST/ALT	PLT	Risk Status
1	Score0	Score0	Score0	Low Risk
2	Score0	Score0	Score1	Low Risk
3	Score0	Score0	Score2	Low Risk
4	Score0	Score0	Score3	Intermediate Risk
5	Score0	Score0	Score4	Intermediate Risk
6	Score0	Score0	Score5	Intermediate Risk
7	Score0	Score0	Score6	Intermediate Risk
8	Score0	Score1	Score0	Low Risk
9	Score0	Score1	Score1	Low Risk
10	Score0	Score1	Score2	Intermediate Risk
84	Score2	Score3	Score6	High Risk

Table 5: Fuzzy Rule Base

RESULT AND DISCUSSION:

Fuzzy expert system for the risk identification of cirrhosis has been developed. The development system is used to evaluate the study of twenty patients. It is fond that the results obtained are in the predefined limits set by the domain expert.

Patient Name	INR	AST/ALT	PLT	Risk Status
1	1.5	1	200	5
2	1.28	0.349	330	6.74

CONCLUSION :

The goal of this project is design of a fuzzy expert system for the risk identification of cirrhosis using Bononcini Score. Using this system the need of the liver biopsy can be avoided. The use of the fuzzy logic in design of the system enhances the reasoning even in case of imprecise data. Combination of fuzzy logic and expert system increases the system performance.

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