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Hybrid Fuzzy Medical Expert Systems

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Abstract

Expert Systems are intelligent programs of Artificial Intelligence (AI). In many applications, information available to the expert system is incomplete like medical diagnosis. This incomplete information is fuzzy rather than probable. Hybrid fuzzy expert systems (HFMES) combination of different fuzzy expert systems of same type co-ordinate and co-operated. In this paper, Hybrid fuzzy medical expert Systems are studied. Fuzzy inference and fuzzy reasoning are discussed for HFMES Fuzzy knowledge representation is disused for HFMES. Some examples are given for HFMES.

Index terms— medical knowledge representation, fuzzy inference, fuzzy reasoning, fuzzy medical expert systems, hybrid fuzzy medical expert systems

1 I. INTRODUCTION

he Medical diagnosis is inexact, imprecise and uncertain reasoning rather than exact. Various theories are there to deal with inexact, imprecise and uncertain information in Medical diagnosis [1]. Fuzzy logic [15] will deal with the belief where as others are deal with probable (likelihood).The Medical diagnosis is of belief rather than likelihood.

Hybrid fuzzy expert systems combination of different fuzzy expert systems of same type co-ordinate and co-operated. For instance, fuzzy medical expert systems are with symptoms and fuzzy medical expert systems are with medical tests. Hybrid Fuzzy Medical Expert Systems are in cloud environment.

The Medial diagnosis is Hybrid, This system may be viewed as a collection of Medical Expert Systems and these HFMS are to be co-operated and co-ordinate in cloud environment. The medical diagnosis will h deals with independent component in the diagnosis system, each of which reasons based on the Medical Knowledge available and combined for total systems.

2 II. FUZZY LOGIC AND FUZZY REASONING

Fuzziness occurs when the body of information is not clearly known. In medical knowledge [1] symptoms and diagnosis are fuzzy rather than likelihood. For example "John has headache (0.9)", "John has chest pain (0.6)" where 0.9 0.6 are fuzzy values. Given some universe of discourse X, a fuzzy subset A of X is defined by its membership function µA taking values on unit interval [0,1] , i.e., : X?[0,1] Suppose X is finite set. The fuzzy subset A of X may be represented as The fuzzy set type 2 is given by Headache= {0.4/mild, 0.6/moderate, 0.9/severe John has "mild headache" with fuzziness 0.4 etc., Similarly Rash = {0.4/mild, 0.6/moderate, 0.8/serious}

The propositions may contain quantifiers like "very", "more or less", etc. these propositions can be reduced to simple propositions by using power operators. The square operator is used for "very", "most", (concentration), etc. the square root operator is used for "more or less"(diffusion), etc. For instance, Very headache = =0. 16 The fuzziness in medical knowledge may be divided into two kinds, one is fuzzy number set and the other is discrete fuzzy set. The fuzzy number set contains usually integers or real numbers. The discrete fuzzy set contains usually linguistic variables.

For example, fuzzy number set in medical knowledge is given by Malaria-test {in cycles}={0.0/1), 0. Suppose A, B, C is Fuzzy sets, and the operations on Fuzzy sets are given belowAVB=max(µ A (x), µ B (x)} Disjunction

A?B=min(μ A (x), μ B (x)} Conjunction A?=1-μ A (x) Negation A?B=min {1, (1-μ A (x) +μ B (x)} Implication AoB=min x {μ A (x), μ B (x)}/x Composition

The fuzzy conditional proposition is of the form "if <precedent> then <consequent-part>" Zadeh [12] fuzzy conditional inference is given by ifx is A ten x is B A?B= A x B=min {1, 1-μ A (x), μ B (x)} Implication If x is A 1 and x is A 2 and,?,and x is A n then x is B= min {1, 1-(A 1 ,A 2 ,?, A n)+ B) Mamdani 5] fuzzy conditional inference is given by if x is A ten x is B A?B= A x B=min {μ A (x), μ B (x)} Implication If x is A 1 and x is A 2 and,?,and x is A n then x is B= min {A 1 ,A 2 ,?, A n , B)

In medical diagnosis, the consequent part is derived from precedent part [6].

If x is A 1 and x is A 2 and,?,andx is A n then x is B = min {A 1 ,A 2 ,?, A n)

The Fuzzy propositions may contain quantifiers like "Very", "More or Less" etc. These Fuzzy quantifiers may be eliminated as μ Very (x) =μ A (x) ² Concentration μ More or Less (x) = μ A (x) ½ Diffusion Fuzzy reasoning is drawing conclusions from Fuzzy propositions using fuzzy inference rules [5]. Some of the Fuzzy inference rules are given bellow R1: x is A

x and y are B

x and z area A? B R4: x or y are A y or z is Bx or z are A V B R5: x is A if x is A then y is B y is Ao (A?B) III.

3 FUZZY MEDICAL XPERT SYSTEMS(FMES)

Expert Systems have been a rapidly developing field. A recent trend in Expert Systems is the development of Fuzzy Expert Systems for solving particular problems ranging from Medicine, Scientific,

The object of the expert systems is to capture the knowledge of an expert in particular problem domain, represent it in a modular, expandable structure, and transform it to their users in the same problem domain. Many times knowledge available to the expert system falls under uncertain, imprecise, vague, incomplete, inconsistent and inexact. Zadeh [15] introduced fuzzy logic to deal such information which is based on belief rather than probable.

An Expert System is called Fuzzy Expert System if it reasons about fuzzy information. The components of fuzzy expert system are shown in fig. **??**. It is necessary to understand the components of fuzzy Expert system. The Fuzzy Expert System contains Fuzzy knowledge base (Fuzzy rule based), Interference engine, Working memory, Explanation subsystem, Natural language interference and knowledge question. We mainly concentrate on fuzzy knowledge bases because the others are vastly developed **??**11, 12, and

4 Domain expert

The knowledge and experience have been used to specific area of interest to store it in the fuzzy expert system.

5 a) Knowledge Engineering

The knowledge engineering is the problem solving strategy consists of problem solution such as control architecture(search strategies), Fuzzy knowledge representation and problem solution strategy, which determine, what knowledge to apply.

6 b) Inference engine

It is responsible for interpreting the contents of the Fuzzy knowledge base in order to reach a goal or conclusion. The inference engine can be divided into three parts.

7 c) Context Block

This part contains the current state of the problem and solution.

8 d) Inference (Reasoning) Mechanism

These parts search the appropriate set of knowledge and data with the help of context block in order to reach a goal or conclusion.

9 e) Explanation Facility

The facility helps the user to understand the line of reasoning.

10 f) Knowledge acquisition facility

New knowledge is generated with the assistance of this facility.

The module of the Fuzzy expert system permits the user to benefit from the system. EMYCIN] is Medical expert system shell in which medical diagnosis shall be defined [7, **??**]. The fuzzy information shall also be possible to define in EMYCIN.

11 CF [h,e]=MB [h,e] -MD [h,e]

Where The fuzzy certainty factor (FCF) for proposition "x is A"is defined asFCF [x,A]= µ A FCF (x) = MB [x,A] -MD [x,A]. µ A FCF (x)?[0, 1] is single membership function. µ A FCF (x)= µ A Belief (x)-µ A Disbelief (x)

for instance,µ cough FCF (x)= µ cough A Belief (x)-µ cough Disbelief (x)

The conjunction and disjunction, negation and implication are given below.

12 G. User Interface g) Work Space

It is storage structure of problem description and the levels of problem states (knowledge sources). The Fuzzy rule based knowledge to be stored can be schematically represented in a net form.FCF[x, A v B] = max {FCF[x, A], FCF[x, B] FCF[x, A^B] = min {FCF[x, A], FCF[x, B] FCF [x, A'] = 1-FCF [x, A] FCF[x, A?B] = {FCF [x , A] } FCF[x , A1, A2, An?B] = min { FCF[x , A1] , FCF[x , A2] + FCF[x , B] , FCF[x , An] }

The fuzzy medical expert systems are is problem solving systems using Fuzzy medical reasoning with Fuzzy medical facts and rules. These Fuzzy facts and rules are modulated to represent the Medical Knowledge available to the system. The Fuzzy Medical Expert System is independent component which performs Fuzzy reasoning in HFMES.

13 Consider the following fuzzy facts and fuzzy rules.

Rule 1: if fever (0.8,0.1) and rash(0.95,01) and body ache(0.9,0.3) and chills(0.9, 0.25) Then the patient has chickenpox Rule 2:if cough(0.85,0.1) and swollen glance(0.9,0. Then the patient has diagnosis wooping_cough (0.7)

For rule-1, fuzzy expert system is given fever , rash, body_ache and chills the system will reason diagnose chickenpox with fuzziness of 0.9.

IV.

14 FUZZY MEDICAL KNOWLEDGE REPRESENTATION

The knowledge representation is essential module of all Fuzzy expert systems for learning [15]. It is a formal representation of the fuzzy information provided by domain expert (Doctor) as encoded by the knowledge engineer.

Information provided by the domain expert may be certain and uncertain, imprecise, vague, incomplete, inconsistent and inexact in Medical diagnosis. v Fuzzy Medical knowledge representation deal with the structure used to represent the knowledge provided by the Domain expert. Fuzzy medical expert systems used standard techniques for representing Fuzzy medical knowledge including fuzzy facts and Fuzzy rules. [1]

User interface	Fuzzy Inference	Fuzzy Medical Knowledge Base	
Explanation sub-system	engine	FuzzyInfe rence	Fuzzy
		rules	facts
Natural Language interface	Working space		
	Knowledge states	Fuzzy	
	State space representa-tion	Knowledge Acquisition subsystem	
		Question	
	Domain Expert (Doctor)	Kwledge Engineer	
		Answering	

Figure 1:

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FKR is useful for learning fuzzy propositions.

.1 V. HYBRID FUZZY MEDICAL EXPERT SYSTEMS

HFMES is collection of expert system and is combined the solutions of the different type of expert systems in the cloud environment in which the Fuzzy Medical Expert Systems are to be co-ordinate and cooperated HFMES performs reasoning with the Fuzzy Medical Expert Systems. In the First, the Fuzzy Medical Expert System and Fuzzy modulations are defined for the Fuzzy information. In the Second, if the local Fuzzy Medical Expert System has no sufficient information, it connects to other Fuzzy Medical Expert System for required information. Third, the HFMES is to co-operate and co-ordinate to get the final solution.

FMES is the individual problem solving expert system. It will give individul solution. The HFMES system is shown in Fig. **??**.

.2 Fig. 3: FMES

Hybrid Fuzzy Medical Expert Systems. is collection of different types of Medical Expert Systems, individual solution will be found and combined for total solution. The HFMES system is shown in Fig. **??**. The FMSE2 is give by 0.7 HFMES=FMES1 ? FMES2= 0.65

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