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Social Perception Grading of Hospitals using Fuzzy Knowledge Base Systems

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Abstract. Proper health is an important parameter to ensure the socio-economic development of the country. Hospitals are playing vital role to improve the health standards in the life and serves the society very effectively. The assessment of quality and ease of medical facilities provided by the hospitals is an important research line. The higher quality of medical care improves the patient satisfaction leading to social perception enhancement. In this paper, we are investigating a new Expert System to assess the quality of medical care of any hospital depending on few parameters. The system is developed using fuzzy knowledge based systems and implemented in Guaje. The system would be generating the grades of different hospitals as per the quality care provided by them.

Keywords: Fuzzy Logic, Fuzzy Knowledge Base System, Interpretability, Social Perception.

1 Introduction

Health is an important parameter for the economic and social growth of any country. The increasing pollutions and mixing in food items

resulted into big problem of deteriorating health in the society [1]. At result we get exponential growth in the number and types of chronic health problems. Due to exceptional growth in the diseases, the demand of hospital and medical services has incremented in the society. As per the definition given by WHO (World Health Organization), the hospital is an integral part of social and medical organization, the function of which, is to provide complete health care for the population. The health care may be preventive and curative. Apart from this, the hospitals also provide the training to health workers and carry out bio-social research. The government has opened many hospitals in the cities and even in rural areas. The private hospitals and paramedical institutes are also playing vital role in the sector social health care.

The public preview about the quality of medical care delivered by any hospital is the social perception of the hospitals. Due to growth of number of hospitals, it is important to quantify the social perception of hospitals that can be used by the public to get better medical care. Several parameters are identified to assess the social perception of the hospitals. These identified parameters are as follows; behavior of medical staff, availability of emergency medical services, availability of medical instruments, behavior of doctors, ease of distance, cost of medical facilities, cleanliness in the hospitals etc.

We have proposed a Knowledge Base System (KBS) which estimates and calculates the Social Perception Index (SPI) for all the hospitals depending on the parameters discussed above. This KBS is developed using Fuzzy Logic and implemented in the open access software 'Guaje' [17,18]. The interpretability and accuracy parameters are also identified and evaluated during the experiment.

2 Related work

Fuzzy logic [2,3] and set theory is the expanded version of Boolean and crisp logic and set theory. It deals with the imprecision, uncertainty, partial truth and vagueness of the information of any system. It is basically the implementation of the human decision making and handles the linguistic information based systems. These are qualitative, descriptive and subjective which may contain overlapping degrees and represented by the membership functions. The membership functions produce membership grade μ with the condition $0 \leq \mu \leq 1$ for each possible value of fuzzy predicate [4,5].

Several issues are concerned during the development of fuzzy knowledge based systems. The interpretability and accuracy parameters assess the performance and efficiency of the proposed system.

Interpretability [15] is the quality of designed system which shows if its behaviour is human understandable or not by seeing its functioning. On the other hand, accuracy is the feature in which the closeness between real and designed system is judged. Accuracy and interpretability features are contradictory with each other; one can be improved at the cost of the other. This is called the interpretability-accuracy trade-off [6,8,14]. Few of the knowledge base systems are also developed in advanced fuzzy methods, like interval type-2 fuzzy sets [7, 13].

Evolutionary multi-objective optimization is one of the strategies to deal with interpretability-accuracy trade-off fuzzy knowledge base system or fuzzy classifiers [9-12].

3 Proposed System for grading of Social Perception

The working of SPI-KBS is based on five input parameters; behavior of doctor (BOD), behavior of medical staff (BMS), availability of medical instruments (AMI), rate of medical facilities (RMF), availability of emergency medical facility (EMF).

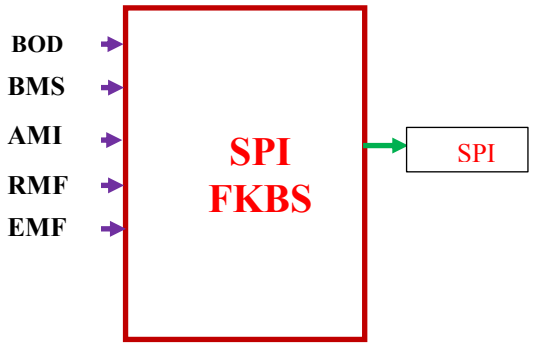

Fig. 1. Block diagram for SPI-FKBS

The parameters of the system are explained in Table 1 given below.

Table 1. Input parameters of SPI-FKBS

Attributes	Details
BOD	This parameter shows the behavior of doctor towards the patients. This is an important parameter because the behavior of doctor plays crucial role during the sickness of any person.
BMS	Similarly if medical staff is treating patients in a well manner, it affects the perception of patients and related persons. BMS shows the behavior of medical staff, like nurses, ward boys towards the patients.
AMI	Medical instruments are the important assets of any hospital. During critical situations of patients, artificial support via medical instruments is important. This parameter shows the richness of hospital in terms of medical instruments.
RMF	The expenditure of medical care is important parameter because it is directly related to economic condition of some person. This parameter shows the cost/rates of medical facilities in any hospital.
EMF	Emergency medical services are very important in the case of road accident or any other health problem occurred suddenly. EMF is the quantification of medical services in case of emergency.

4 Implementation and results

The proposed system has been implemented using open access software tool "Guaje" developed by Alonso and Magdalena [17, 18]. The rule base generation methods are Fuzzy Decision Tree Method and Wang Mendel Method [19].
The data for this experiment has been collected from the patients of different hospitals at Lucknow, UP, India. The description of data set is as follows;

Table 2. Characteristics of data set

S. No.	Characteristics	Value
1	Type	Classification
2	Number of attributes	5
3	Number of instances	250
4	Attribute characteristics	Integer

In the experiment the membership functions of attributes and their data distribution are as follows;

Attribute 1: BOD

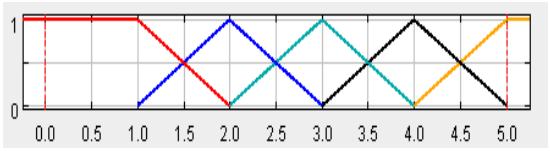

Fig. 2. Membership function of BOD

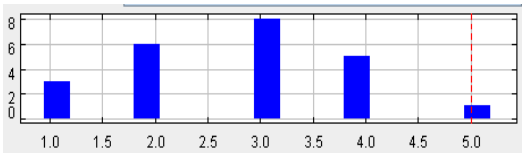

Fig. 3. Data distribution of BOD

Attribute 2: BMS

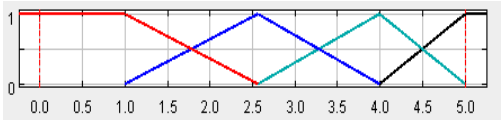

Fig. 4. Membership function of BMS

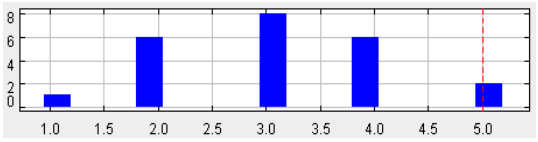

Fig. 5. Data distribution of BMS

Attribute 3: AMI

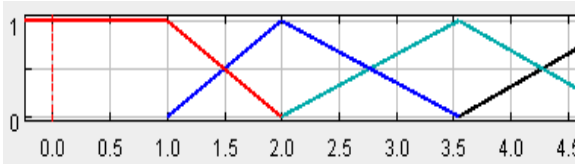

Fig. 6. Membership function of AMI

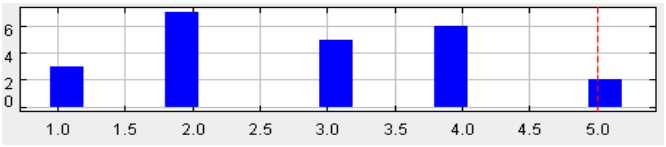

Fig. 7. Data distribution of AMI

Attribute 4: RMF

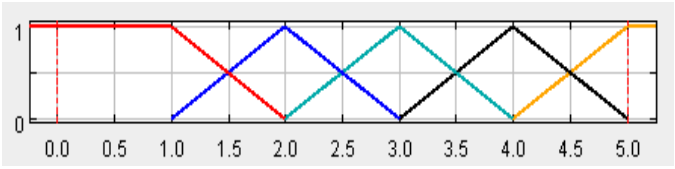

Fig. 8. Membership function of RMF

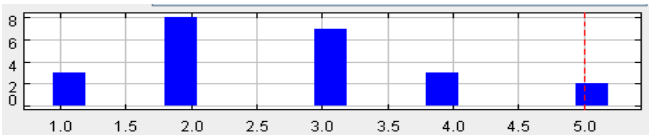

Fig. 9. Data distribution of RMF

Attribute 5: EMF

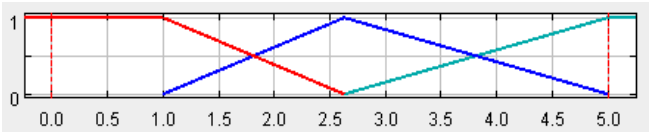

Fig. 10. Membership function of EMF

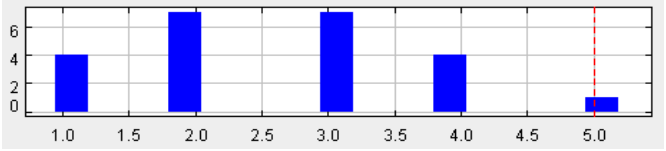

Fig. 11. Data distribution of EMF

Attribute 6 SPI FKBS

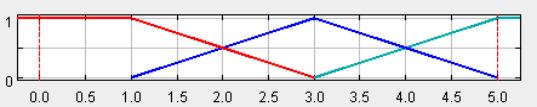

Fig. 12. Membership function of SPI-FKBS

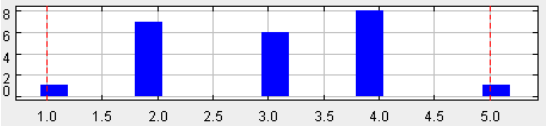

Fig. 13. Data distribution of SPI-FKBS

4.2 Experimental results

4.2.1 Fuzzy decision trees

The settings of the experiment are as follows,
Maximum tree depth=5
Minimum significant level=0.2
Leaf minimum cardinality=1
Tolerance threshold=0.1
Relative loss of performance=0.1
Coverage threshold=0.9
Minimum entropy=0.001

Table 3. Experimental results in Fuzzy Decision Tree Method

Interpretability		Error	
Nauck's Index	0.008	MSE	0.834
NOR	31	SE	1.026
TRL	122		
ARL	3.935		
ARC	30.036		
TFR	12.032		
IFR	2.348		
LVI	0.365		

4.2.2 Wang Mendel Method

Interpretability		Error	
Nauck's Index	0.01	MSE	0.984
NOR	21	RMSE	1.403
TRL	105		
ARL	5		
ARC	21.036		
TFR	6		
IFR	1.348		
LVI	0.478		

Table 4. Experimental results in Wang Mendel Method

ARC=Average Rule Complexity, NOR=Number of Rules, TRL=Total Rule Length, ARL=Average Rule Length, TFR=Theoretical Fired Rules, IFR=Inferential Fired Rules, LVI=Logical View Index.

5 Conclusion

Fuzzy based knowledge base systems have proven their capabilities in the implementation of human like decision making. In this paper, we have proposed and implemented the fuzzy knowledge based system for making decision about the social perception of hospitals. The system has been developed based on the data collected by patients from the different hospitals of the Lucknow, UP, India. The developed system is found interpretable and accurate as per the results of various experiments carried out.

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