A NOTE ON DECISION MAKING SOFT COMPUTING SYSTEM FOR MALARIA DIAGNOSIS USING FUZZY EXPERT SYSTEM

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Abstract: Today's hectic life has made humans time bounded. They need each and every decision at their table top. Malaria remains one of the world's most deadly infectious diseases and arguably, the greatest menace to modern society in terms of morbidity and mortality. Adverse effects of this disease on the human body differ from person to person. To choose the right treatment and to ensure a quality of life suitable for a specific patient condition, early and accurate diagnosis of malaria is essential. It reduces disease and prevents deaths. It also contributes to reducing malaria transmission. In this paper Fuzzy expert system is developed by collecting information from doctors so as to personally check intensity of disease on particular body with the help of computer. It is simple to use, portable, low cost and makes malaria diagnosis more rapid and accurate. It supports medical practitioners and assists malaria researchers to deal with the vagueness, imprecision and time-consuming found in traditional laboratory diagnosis of malaria, and provide accurate output based on the input data.

Keywords: Fuzzy expert system, Malaria diagnosis, soft computing.

Introduction: Malaria (meaning "bad air") is an infectious and life-threatening disease caused by a parasite (plasmodium) which is transmitted from human to human by the bite of infected female Anopheles mosquitoes, About 3.2 billion people – almost half of the world's population – are at risk of malaria. Young children, pregnant women and non-immune travelers from malaria-free areas are particularly vulnerable to the disease when they become infected. Malaria is preventable and curable, and increased efforts are dramatically reducing the malaria burden in many places. Between 2000 and 2015, malaria incidence among populations at risk (the rate of new cases) fell by 37% globally. In that same period, malaria death rates among populations at risk fell by 60% globally among all age groups and by 65% among children under 5[15].

Foundation of soft computing and medical diagnosis: Soft computing is a multi-disciplinary field proposed by Dr. Lotfi Zadeh in 1981 in his first paper on soft data. Soft computing is an innovative approach to construct computationally intelligent system that possesses human like expertise. Soft computing techniques are useful in design and development of mathematical models. [3]

Medical diagnostic investigations are very complex. The doctor confronts with a patient who has his own personal experiences, knowledge from books and mental endowment. The doctor notes the patients' signs and symptoms, combines these with the patients' medical history, physical examination and laboratory findings and diagnoses the diseases. Medical practitioners exhibit variation in decision making because of their approaches to deal with uncertainties and vagueness in the knowledge and information.

How do physicians consider and treat potential diagnosis? What is the medical way of thinking? Can the process of medical diagnosis be described in a scientific model? How does a medical doctor decide which disease the patient suffers from? Why does he ignores diagnoses and accept others as lightly ones?

The Polish medical scientist and philosopher Ludwig Fleck said: "Why even the best diagnosticians are most frequently unable to give a specific basis for their diagnosis; they only explain that the entire appearance is characteristic of such or another disease,"

Based on this information they have to make a list of provisional diagnoses for the patients. The physicians have to study numerous relationship of obligatory or optimal evidence, symptoms for diagnosis available in books and journals as well as he/she has to fall back on his / her practical experience.

The diagnostic decisions also depend upon experience, expertise and perception of the practitioner. As the complexity of system increases, it is not easy to follow a particular path of diagnosis without any mistake. Fuzzy logic presents powerful reasoning methods that can handle uncertainties and vagueness. Fuzzy logic has proved to be the remarkable tool for building intelligent decision making systems based on the expert's knowledge and observations.

The Fuzzy Expert System (FES) define imprecise knowledge and offers linguistic concept with excellent approximation to medical texts. Fuzzy logic is a method to render precise what is imprecise in the world of medicine. FES plays an important role in medicine for symptomatic diagnostic remedies. The technocrats identified potential and possible areas for implementation of FES for medical diagnosis. The communications between medical scientists and

computer engineers have led to an interdisciplinary advance in the development of intelligent supporting tools and systems. The expert systems are reported for the patient monitoring, prediction of conditions, handling of fuzzy queries in medical applications as well as evaluation and comparison of the performances with existing practices [23].

In this paper, the need, importance, potential, necessity of fuzzification and approaches for designing of medical diagnosis of malaria expert system is discussed. Some studies have been conducted to verify the suitability of fuzzy set theory and its derived theories for developing knowledge based systems and fuzzy sets to model the medical concepts.[1],[2],[19]Decision support systems for diagnostic purposes of human diseases helped patients and practitioners to a great extent. [11], [7], [16], [4], [18] Developers have extended the use of fuzzy logic theory in designing disease specific and decision theoretic expert systems for common diseases. [22], [14], [5], [8] Fuzzy approach has been explored to deal with phenomenon of vagueness in the physician's style of thinking and computer assisted expert systems for decision making. [20], [9], [21] The fuzzy expert system for different sounds produced by different organs in the human body using fuzzy logic toolbox of MATLAB has also been reported [10].

The suggested approaches and methods are successfully implemented by various researchers in the medical field. [26], [27], [28] The medical practitioners and patients are using FES laden diagnostic tool with an ease and effective way. Investigation implies that, 21% papers are contributed towards the modeling and methodologies. The inclination of most of the researchers is found towards the development of fuzzy expert system specific to expertise and problem oriented domain. It is suggested that different social science methodologies, such as psychology, cognitive science, and human behavior could implement FES as another kind of methodology. Integration of qualitative, quantitative and scientific methods and integration of FES methodologies studies may broaden the horizon of the research in medical field. The present article introduces a new soft computing model that measures risk factor for the malaria.

Materials & method: In order to develop the system, some parameters are of special important and deserve frequent attention which we are taken as input parameters fever, chills, headache, sweats, fatigue, nausea and vomiting as essentially features to determine the malaria risk. So these parameters will be used as input to design a system and malaria risk is an output.

In this paper, a classification model was presented with a simple fuzzy framework that can be applied to resolve uncertainty problems in Standards for issues. Each input parameters are classified in the following four fuzzy sets with their range given in following

Linguistic Variables	Fuzzy Values
Mild	0.1 <x <0.3
Moderate	0.3 <x <0.6
Severe	0.6 <x <0.8
Very Severe	0.8 <x <1.0

Table 1: The membership function for these fuzzy sets is Gaussian membership function.

The Gaussian function depends on two parameters σ and c as given by

$$\mu_x(A) = \exp(-(x-c)^2/(2\sigma^2))$$

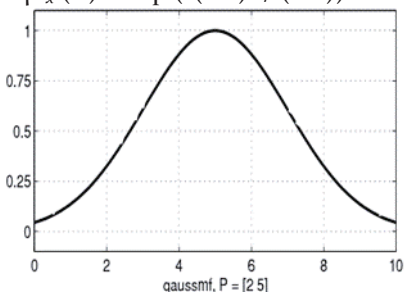

Fig.1 Gaussian membership function

Fuzzy inference system: A fuzzy inference system is a way of mapping an input space to an output space using fuzzy logic. A fuzzy inference system tries to formalize the reasoning process of human language by means of fuzzy logic (i.e. by building fuzzy IF-THEN rules).

The structure of fuzzy inference system is composed of three components rule base, database and reasoning mechanism.

1. **Rule base:** In 1973 Prof. L. Zadeh suggested capturing human knowledge using fuzzy rules. To perform linguistic computations with the fuzzy database, fuzzy rules can be declared. They are similar to natural language communication [17]. A fuzzy rule can be defined as a conditional statement of the form:
   "IF premise (antecedent) *x* is A THEN conclusion (consequent) *y* is B."
   Where *x* and *y* are linguistic variables; and A and B are linguistic values, determined by fuzzy sets on the universe of discourses X and Y, respectively.
2. **Data base:** A database defines membership functions used in fuzzy rules. With this membership function membership degree is decided for the objects of the set so that they can be included in fuzzy sets with the membership degree [17].
3. **Fuzzy reasoning:** Fuzzy reasoning performs inference procedure which uses the input information and available fuzzy rules to conclude the output of reasoning mechanism [17].

Each inference stage or inference engine has its own set of rules or rule base. The inference engine uses product-sum algebra to compute the membership grades of the output indicator to the corresponding fuzzy sets. Products and sums correspond to the logical operations of conjunction ("and") and disjunction ("or"). The operation "and" is involved in the rules and the operation "or" corresponds to an operation that aggregates all rules. Each rule is assigned a firing strength which measures the degree to which the rule matches the inputs. The firing strength of a rule is given by the product of the input membership grades and this value is passed to the membership grade of the output to the corresponding fuzzy set. If several rules assign the same fuzzy set to the output variable (here we have a disjunction or union of rules), then the overall membership grade of the output is the sum of the individual firing strengths. A Fuzzy inference system is used to solve decision problems, i.e. to make a decision and act accordingly. Using the Rule editors and Rule viewers in the Fuzzy Logic Toolbox, we can build the rules set, define the membership functions, and analyze the behavior of a fuzzy inference system (FIS). The following editors and viewers are provided for malaria diagnosis:

FIS Editor: Displays general information about a fuzzy inference system.

Membership Function Editor: Displays and edits the membership functions associated with the input and output variables of the FIS.

Rule Editor: Views and edits fuzzy rules using one of three formats: full English-like syntax, concise symbolic notation or an indexed notation.

Rule Viewer: Views detailed behavior of a FES to help diagnose the behavior of specific rules or study the effect of changing input variables.

Following fig.2 and fig. 3 shows Rule viewer and Rule editor of a person under observation having Fever =0.496, chills =0.715, headache =0.715, sweats =0.636, fatigue =0.88, and nausea and vomiting=0.89 having Malaria risk= 0.582. The decision layer of the system for the concerned human being is shown in following figure. The FES shows that the malaria risk belongs to the category moderate. So it is advised to take proper treatment.

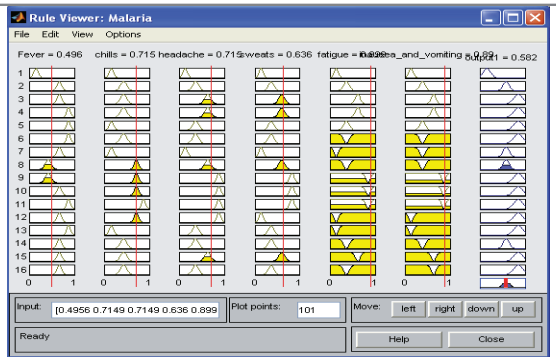

Fig.2: Rule viewer for Malaria

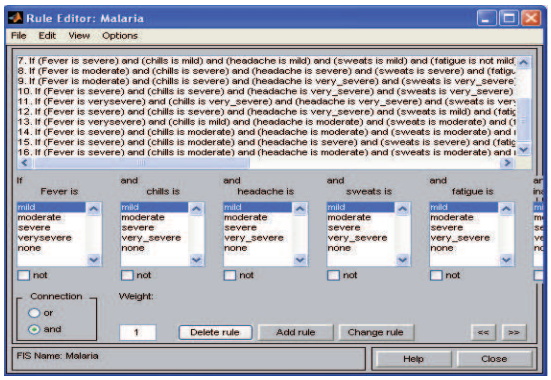

Fig.3: Rule Editor for Malaria

Defuzzification: The main objective of this study is to determine malaria risk analysis on the linguistic description of the input parametersfever, chills, headache, sweats, fatigue, and nausea and vomitingMalaria risk will be assessed with the help of defuzzified values by using centroid defuzzification method and expert's opinion. Mathematically it is given as

$$x^* = \frac{\int \mu_A(x).x\,dx}{\int \mu_A(x)\,dx}$$

Conclusion: The computer based diagnostic tools and knowledge base certainly helps for early diagnosis of malaria diseases. The Fuzzy Expert System has proved its usefulness significantly in the medical diagnosis for the quantitative analysis and qualitative evaluation of medical data, consequently achieving the correctness of results. The development of web based applications and interfaces enabled the medical practitioners to share their experiences and expertise across the world.

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