



A FUZZY RULE-BASED EXPERT SYSTEM FOR DIAGNOSING DIABETES

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ABSTRACT

Diabetes is a chronic disease that has no cure. It occurs when your body does not make enough insulin or cannot use the insulin it makes. Insulin is a hormone; it controls the amount of sugar (called glucose) in your blood. This fuzzy expert system consists of expert specified input and IF-THEN rules. This research reviews the early detection of diabetes for patients without symptoms as well as it reviews the designing of a rule based expert system for diabetes diagnosis. Fuzzy rule-based expert system has been designed and implemented with Matrix Laboratory (MATLAB).

KEYWORDS: fuzzy logic, diabetes, fuzzy set, expert system, fuzzification, defuzzification, linguistic variables.

INTRODUCTION

In Nigeria millions are living with diabetes, Although Nigeria lacks an aggregate data, the physicians' states that no fewer than six million Nigerians are living with diabetes mellitus (punch, 2013). Many people are living with the condition unaware of the seriousness of the disease and its consequences as those diagnosed are often poorly managed due to lack of resources or because the health care professionals who care for them have poor knowledge about diabetes and how to provide good care Diabetes might overtake those suffering from Tuberculosis, Malaria, HIV/AIDS, and other terminal diseases by the year 2030 if adequate attention was not paid toward the provision of health education; monitoring, treatment and management are not provided to the masses quickly (Imianvan & Obi, 2014).

Medical practitioners are often sought for anywhere. Their jobs are often considered noble as they help to save lives. Typically, in many developing countries, the ratio of doctors to patient is significantly low (i.e. suggesting the need for more doctors). Consequently, doctors are often overworked and have to deal with many cases

In order to alleviate the burden of a doctor, a system that provides an early warning can be of help. In particular, this research is a step in the aforementioned direction. Fuzzy



rule expert system is designed for early screening of diabetes disease for patients without symptoms. To access this system, patients' needs to undergo some tests and the result of the tests should be input in the expert system. This system works by identifying if you are diabetic or not and tells if you are at risk of having diabetes. Health issues are one of the serious matters that directly affect the wellbeing of our community. One of the major health problems that faced by the community members are the diabetes Mellitus diseases. Thus, these systems have been developing to help to reduce the time between the patient and doctor for quick identification of diabetes without symptoms. Diabetes is a serious disease that affects almost every organ of the body like the heart, eyes, kidney, skin, nerves, blood vessels etc. if left the disease unchecked, it will cause serious complications including death. To understand diabetes, one needs to know how the body converts sugar or glucose for energy. Here are three types of diabetes which are Type I, Type II and Gestational diabetes.

PROBLEM STATEMENT

According to research, not all diabetes patients do have symptoms (Nagor, 2012) which makes it difficult to identify or diagnose people with diabetes without symptoms because most expert systems have been designed for people with symptoms. Basically, it consumes time and expenses for people without symptoms to keep going for checkup before they can be diagnose properly. The reason for developing rule based diabetes expert system for diabetes patients without symptoms. This application can help reduce time between doctor and patient.

VARIABLES

The linguistic variables (High, Low, Normal) and the Inputs are the test results (HbA1c, RBT, FBT, OGTT).

HbA1c (mmol/l)	RBT (mmol/l)	FBT (mmol/l)	OGTT (mmol/l)
High [6.5 - higher]	High [11.1 - higher]	High [7 - higher]	High [11.1 - higher]
Normal [5.7 - 6.9]	Normal [7.0 - 6.9]	Normal [5.6 - 6.9]	Normal [7.8 - 6.9]



6.4] Low [0 – 5.7]	11.0] Low [0 – 7.0]	Low [0 -5.5]	11.0] Low [0 – 7.8]
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Aim

- To introduce the design and development of a rule based expert system to fully diagnose diabetes for patients without symptoms.

Objectives

- To implement a fuzzy rule based expert system to diagnose diabetic patient without symptoms based on test result.
- To provide the early awareness and information regarding this disease so that the individual would take action to prevent it as quickly as possible.

Literature Review

Diabetes is a chronic disease that has no cure, where the body is unable to produce Insulin hormone as normal body do. Diabetes is a disease which due to the blood glucose level is too high in the body. As we know, normal body obtained blood glucose level from the meal that human take daily and the insulin hormone is very important in providing energy to body. However, excessive or high glucose level in body can cause many serious problems such as it can damage eyes, kidney, and nerves. Usually, due to lack of knowledge about diabetes is the reason diabetic patient does no know to selfmanage their illness. Thus, the developed system will help the diabetic patient to monitor their disease and will provide complete information about diabetes.

According to Navjotkaur et al (2013) who opines that a high blood sugar level can cause problems in many parts of your body and review the different types of diabetes as well as designing of an expert system for diabetes diagnosis. Thirumalaimuthu et al (2015) also presents an approach combining support vector machines (SVM) and fuzzy modelling (SVM-Fuzzy). The goal is to evaluate the proposed design for better accuracy in risk classification and to investigate training the machine learning algorithm using sample real world data.



Priynka Sharma et al (2013) main objective is to design the decision support system for mosquito born disease diagnosis, where medical experts are not easily available i.e. Rural areas (or) remote areas. It is a symptom based decision support system, while designing the decision support system we kept this face in mind that the diagnosis can be explored by Para medical human resources or by patient itself.

Nagor Nisah proposes the development of Diabetes Detection System (DDS) capable of detecting potential diabetes based on the rule-based technique. Specifically, DDS enables the user to select the symptoms that they have without having to see the doctor as part of early screening.

Fuzzy logic

Fuzzy logic attempts to systematically and mathematically emulate human reasoning and decision making. Fuzzy logic systems can be used for advanced engineering applications such as intelligent control systems, process diagnostics, fault detection, decision making and expert systems.

Fuzzy logic allows engineers to exploit their empirical knowledge and heuristics represented in the IF-THEN rules and transfer it to a functional block. Fuzzy logic systems can be used for advanced engineering applications such as intelligent control systems, process diagnostics, fault detection, decision making and expert systems.

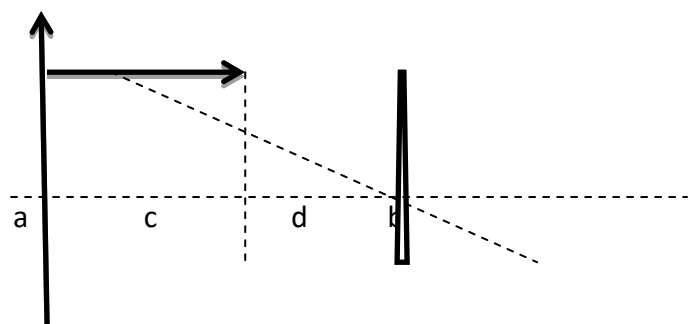
Fuzzy set

A fuzzy set however does not categorically say that an element is in a set or not but rather specifies the degree to which an element belongs to the set.

A fuzzy set whose membership has a trapezium as shape

$$\mu(x) = \begin{cases} \frac{x-a}{c-a} & \text{if } a \leq x \leq c \\ 1 & \text{if } c \leq x \leq b \\ \frac{b-x}{b-d} & \text{if } d \leq x \leq b \\ 0 & \text{otherwise} \end{cases}$$

1





Expert System

An expert system is a computer program designed to model the problem-solving ability of a human expert. The program models the following characteristics of the human expert: Knowledge, Reasoning, Conclusions, and Explanations. Conclusions given by the system must be consistent with the findings of the human expert.

The expert system also provides explanations similar to the human expert. The expert system also provides explanations similar to the human expert. The system can explain "why" various questions are being asked, and "how" a given conclusion was obtained.

One of the principal attractions of expert systems is that they enable computers to assist humans in many fields endeavor with the processes of analyzing and solving complex problems. They extend the application of computers beyond the conventional mathematical processes we have customarily assigned computers, to applications where the computer can carry on a somewhat natural conversation with the user to arrive at a conclusion or recommendation that aids the human decision maker. This is accomplished by encoding in the expert system the knowledge and problem-solving skills of a human expert. This expert computer program can then be used by others to obtain and use this expertise for solving a current problem that would have previously required the expert to be present.

Diabetes

Diabetes is one of the major leading of death mostly in many developed country. Furthermore, diabetes is a disease which related to the blood glucose level is too high in the body. Normally, we obtained glucose (simple sugar) from the meal that we take. The glucose is released into the blood and the pancreas is responsible to release the insulin where it's used as energy. Basically, healthy pancreases adjust the amount of insulin that produced based on the level of glucose in body. However, if the body is affected by diabetes, the pancreas would keep on undergoing the breaks down process causing excessive glucose in body can cause many serious problems such as it can damage eyes, kidney, and nerves.



Types of diabetes

- i. **Type 1** diabetes is usually diagnosed in children and young adults, and was previously known as juvenile diabetes. The body does not produce insulin. 5% of people with diabetes have this form of the disease.
- ii. **Type 2** diabetes, either the body does not produce enough insulin or the cells ignore the insulin. This is the most common form of diabetes.
- iii. **Gestational diabetes** which is a form of diabetes that occurs during the second half of pregnancy. Other than that, gestational diabetes would go away after delivery of the baby and the women with this type of diabetes are more likely to have large sizes of babies.

Pre-Diabetes

Pre-diabetes is the early stage which is known as “gray area” between normal blood sugar and diabetic level. Basically, people with pre-diabetes have glucose level that is higher than normal but it’s not high enough to be declared as diabetes. Usually, the patient with pre-diabetes don’t have any symptoms but they have high risk of developing type 2 diabetes as well as medical problems associated with diabetes.

Why fuzzy logic?

The reason for choosing fuzzy logic is to address uncertainty and vagueness that characterized traditional medical diagnostic practice.

Types of blood test

- i. **Fasting blood sugar** – this is a common test because it’s easy to perform. After fasting overnight you have your blood drawn at early doctor’s visit
- ii. **Oral glucose tolerance test** – you fast over, and the fasting blood sugar level is measured. And test periodically for the next two hours.
- iii. **Random blood sugar** – A blood sugar test is performed regardless of when u last ate a meal
- iv. **Hemoglobin A1C test** - this test measures how much sugar is stuck to your red blood cells, which generally have a lifespan of 3 months.

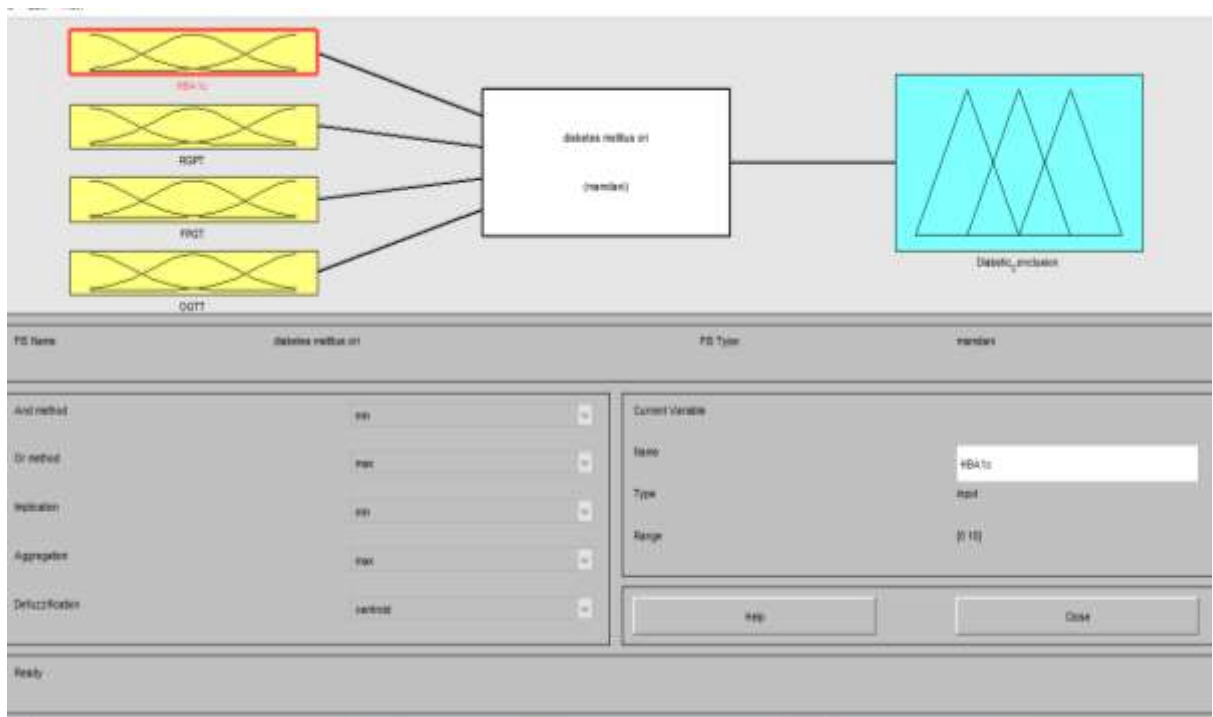


Result

Fuzzy Inference Editor

The FIS Editor Graphical User Interface (GUI) tools allows you to edit the highest level features of the fuzzy inference system, such as the number of input and output variables, in this case, four (4) inputs and one (1) outputs.

The FIS Editor is the high-level display for any fuzzy logic inference system. It allows you to call the various other editors to operate on the FIS. This interface allows convenient access to all other editors with an emphasis on maximum flexibility for interaction with the fuzzy systems. Below is the fuzzy inference editor for diagnosing diabetes.



The Rule Viewer

The rule viewer displays a roadmap to the whole fuzzy inference process. It is made up of plots that represent the antecedent and consequent of rule statement.

It allows you to interpret the entire fuzzy inference process at once. The input values can be adjusted by clicking on any of the plots for each input. This will move the red index line horizontally, to the point where you have clicked.



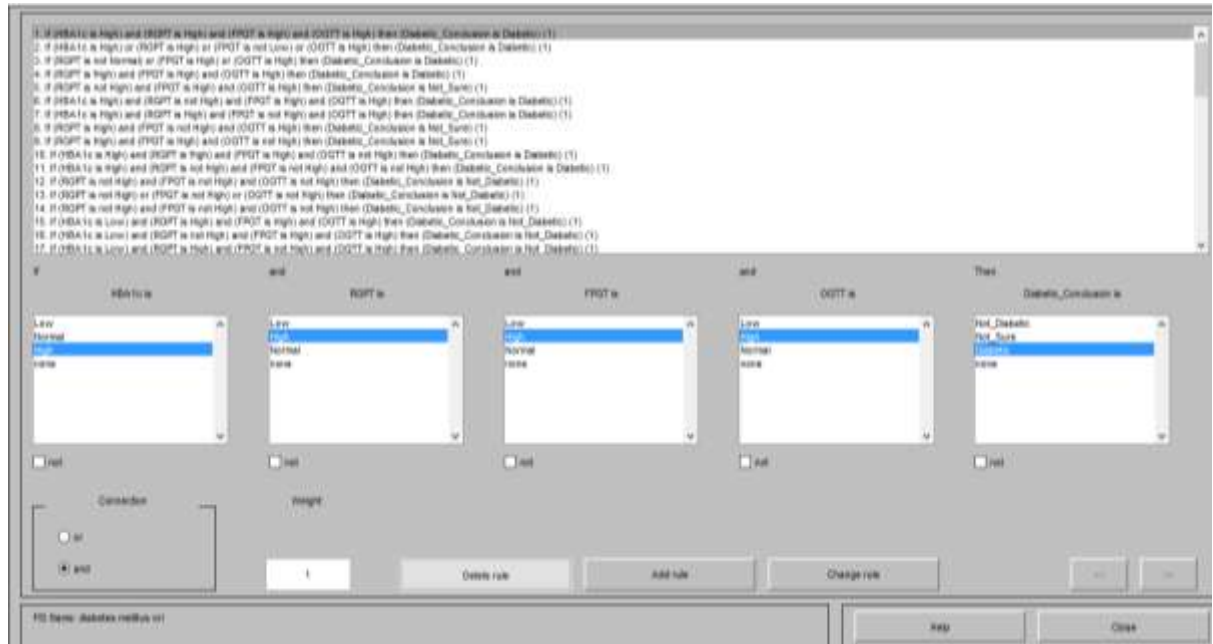
Alternatively, you can also click and drag this line in order to change the input values. When you release the line,(after manually specifying the input) a new calculation is performed and you can see the whole fuzzy inference take place.



The Rule Editor

The rule editor allows you to construct the rule statements automatically.

It provides opportunity to add rules, delete rules, change rules and specified weight applied to the rules.



Summary and Conclusion

The developed system is a medical expert system for diagnosing the disease diabetes. It gives a systematic introduction to concepts in Diabetes as well as fuzzy systems and Expert System. This system is a generic tools for diabetes and can be used by all type of people especially people without symptoms.

Fuzzy expert system makes system more with help of tools. This system enables users to enter the test results, the system will evaluate the test and diagnose weather the user is a diabetic patient or not. The system will find out how much severe the user is. It gives a fast and accurate diagnosis and it also tells if user have a high probability of having diabetes. Diabetes diagnosis via fuzzy expert system is cheap and time saving process.

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