

# Fuzzy Expert System for Early Prediction of Coronary Artery Disease

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## ABSTRACT

Fuzzy logic has been identified as a substantial tool that is used to model human decision making of an expert in a computer program such that the program can imitate the expert ability to solve problem. Due to essential uncertainties and imprecision in medical practice, the advantages provided by fuzzy logic for dealing with indefinite and uncertainty situation, makes it appropriate approach to overcome this complexity in the medical field. Therefore this study utilized of fuzzy logic to representation uncertainty in reasoning of medical experts to estimate Coronary artery disease (CAD) risk and it is essential in present situations due to increasing of death rate by heart attack after covid 19. In this paper we will discussed the fuzzy expert systems deal with Coronary artery disease (CAD).

*Key Words- fuzzy logic, expert system, heart disease, Coronary artery disease (CAD)*

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## INTRODUCTION

When an unexpected blockage occurs in the arteries feeding the heart for any reason, the heart muscle cannot get sufficient oxygen and causes damage to the heart tissue. Substances such as fat and cholesterol accrue in the artery walls responsible for blood flow and form structures called plaques. These plaques multiply as time passes and cause cracks on them by narrowing the vessels. Clots occur in these cracks, occlude the vessels and cause a heart attack [1]. Fat, excessive alcohol consumption, tobacco use, high cholesterol and age factor (men over 40, women over 50), high blood pressure, diabetes, obesity, use of illegal drugs, chronic high levels of stress, previous heart attack, arrhythmia are important risk factors [2,3,4]. The risk of heart attack increases after the age of 40 in men and 50 in women, and women are less likely to have a heart attack than men [1]. Among family members, people who have had a previous heart attack or have a history of heart disease, the old and men are more likely to have a heart attack than other risk factors [5]. The main symptom seen in a heart attack is heart pain in the chest. Apart from this area, pain is felt everywhere from the stomach to the jaw or teeth, from the shoulder blade to the right and left arm, wrists and fingers. Symptoms such as excessive sweating, shortness of breath, restlessness, dizziness, nausea or vomiting and feeling of depression may be experienced [1, 6, 7]. The World Health Organization (WHO) states that heart disease is the cause of death worldwide. Just about 17 million people die from these diseases each year, representing 31% of global deaths. 85% of these deaths are caused by heart attack and stroke [8]. WHO stated that 36% of deaths that will occur in 2020 will be caused by heart disease. In addition, WHO stated that heart diseases increase the risk of Covid-19 [16].

## FUZZY LOGIC

The concept of fuzzy logic was firstly introduced in 1965 by Prof. Dr Zadeh. It emerged with the "FuzySets" article published by Lotfi A. Zadeh .Using the data related to the study to be conducted and at the same time benefiting from the professional experiences of the people, processing the obtained data with algorithms and using mathematical equations depending on the rules to be written is defined as "Fuzzy Logic". Classical set theory and fuzzy set theory are different from each other. While {0, 1} notation is used in classical sets, the interval [0-1] is used in fuzzy sets. Because in classical set theory, an entity is either an element of that set or it is not. In fuzzy set theory, each entity receives a membership degree in the range [0-1].Membership degrees are indicated by membership function  $\mu(x)$ . According to this information, the membership degree of element x in fuzzy set A is,  $\mu_A(x): x \rightarrow [0, 1]$  ie  $0 \leq \mu_A \leq 1$ [6, 8, 15].

## **WHY WE FUZZY LOGIC**

Fuzzy Logic provides an easy way to arrive at a specific conclusion based upon imprecise, vague, noisy ambiguous or missing input information. Fuzzy logic has been applied in all aspects of our daily life. One of the most important parts is the medical field. Fuzzy logic is a method with which to communicate in a more practical way the language full of vagueness that experts use.

## **EXPERT SYSTEM**

Expert system is an artificial intelligence based on system that imitates the decision making capability of human and it is used as the diagnostic tool for many diseases including COVID-19, Cancer, Diabetes, HIV, Asthma, coronary artery disease (CAD), among other diseases. However CAD is worldwide one of the deadliest diseases. An expert system is an information system that seeks to apply human knowledge to computers so that computers can solve problems like experts. The concept of expert systems is a collection of consistent elements to form a single unit to understand data, procedure, store and share out the information. Expert systems are basically used to support the problem-solving behaviour; through this expert system users can easily find quality information from experts in their fields. In addition, expert systems can also help experts with the knowledge needed to support activities. Expert system is a system that use human knowledge recorded in computers to solve problems that generally require human expertise. A good expert system is designed to be able to solve a definite problem by imitating the work of the experts.

## **FUZZY EXPERT SYSTEM**

A fuzzy expert system helps in mapping the inputs to the corresponding output using predefined fuzzy rules available within the knowledge area. The knowledge area consists of if-then rules that identify the connection between the input and output fuzzy sets. Because it requires the input in fuzzy values, the input is fuzzified and for the user to raised understand the output, the output from the inference system is defuzzified. The inference system is developed with the steps 1. Developing the fuzzy rules. 2. Fuzzifying the input values supported the membership function. 3. Combining the fuzzy input and therefore the fuzzy rules to get the rule strength. 4. The rule strength consequence is again combined with the output membership function to generate the output distribution. 5. Finally the output is defuzzified to present the output in crisp value .

## **DISCUSSION**

[9] This research presents a fuzzy logic model for predicting coronary heart disease. This model has been developed with 7 input variables, and 1 output variable, that was implemented for 30 patients in Albania. In this research, the fuzzy logic toolbox is used for this model. Fuzzy model inputs are measured: the cholesterol, blood pressure, diabetes, physical activity, age, BMI and smoking, whereas the output is the disease classification. The fuzzy sets and membership functions are chosen appropriately. The Centroid method is used for defuzzification. The database is taken from University Hospital Centre "Mother Teresa" in Tirana, Albania.

[10] In this study, fuzzy based expert system was developed for diagnosis of coronary heart disease and provided the balancing diagnostic tools for diagnosis of CAD's patients in Nigeria. The improved C4.5 data mining algorithm is used to transfer the human knowledge to the system's knowledge base as an alternative of conventional techniques such as interviews, questionnaires, etc. System has input parameters as: age, cholesterol, blood pressure, glucose, triglycerides, , LDL HDL, body mass index, chest pain and heart rate . The output variable has healthy, mild, moderate, and severe. The performance evaluation system was carried out, and the system has 95.35% sensitivity, 94.55% accuracy and 95.00% specificity. This system has both higher ability of detecting both healthy and unhealthy CAD patients.

[11] This research was conducted using fuzzy logic in line with the data obtained from Kaggle. This Fuzzy Model was created using 7 input parameters and 1 output parameter, and it was approximate whether persons would have a heart attack or not. They used the Mamdani fuzzy inference method and were defined 576 rules .The study was tested with 10 patient data and the results were compared with the actual values. In addition, multiple regression analysis was performed, variables that had an important effect on heart attack were determined, and the relationship between dependent and independent variables was examined.

[12] In this paper researcher used Fuzzy expert system for prediction of heart disease. The fuzzy system is developed with the help of fuzzy rules and membership functions so that classification can be carried out within the fuzzy system designed. This system would help the doctors to mechanize heart condition diagnosis and to support the medical aid.

[13] This system was an extension of the standard Mamdani fuzzy logic controller and contains 44 rules of the type single input–single output. This system worked with 11 variables as inputs and one variable as output. The system has a single output variable that refers to presence of heart disease in the patient.

[14] This study developed a Fuzzy Expert System (FES) for heart disease detection. The designed system supported the V.A middle, Long Beach and Cleveland Clinic Foundation information base. This system has 5 input variables and 1 output variable. Taking input variables as Blood pressure, Chest pain, Cholesterol, Resting Electrocardiography and Heart rate and the output variable refers to the presence or absence of cardiac diseases in the patient. This system was used Mamdani's inference system to compare the result with designed system to get the accurate results. The system was designed in Mat lab computer code and it was corrected for 95%.

### CONCLUSION

Heart attack is a very common health problem worldwide. According to researches, the number 1 cause of deaths is heart attack. Therefore, many studies have been done in the literature and are still being done. Different techniques were used in these studies. Artificial neural networks, data mining, fuzzy logic, deep learning are just a few of these techniques. In this paper we are discussed different research and techniques using fuzzy logic to detect CAD in the patient. There are several factors to analyze the heart disease in the patient and it is not the easier task, which makes the physician's job difficult. However, the experts want a perfect tool which considers and identifies the risk factors on the basis of given information. In this paper we discussed the different types of fuzzy system which was used to early prediction of Coronary artery disease .That helps the physicians and as well as normal people for accurate prediction of heart disease in patients has been devised using fuzzy logic

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