Designing of a New Intuitionistic Fuzzy Based Diabetic Diagnostic System

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ABSTRACT

In this article, fuzzy set theory and other generalized theories are described as having extended the concept of classical set theory to uncertain problems. Fuzzy set theory plays a pivot role in the field of medical sciences to handle the vagueness and impreciseness of the data but no one has explored the field with vague set theory. With this objective, the authors propose a new diabetes diagnosis system called Intuitionistic Fuzzy based Diabetes Diagnostic System (IDDS). IDDS handles the imprecise data of system and helps to predict whether a person is diabetic or not using the concept of Intuitionistic Fuzzy set theory. IDSS uses the Intuitionistic-Fuzzification mechanism which works in two phases. In first phase, it converts the crisp data into intuitionistic fuzzy data and in second phase it generates the fuzzy value for each Intuitionistic value. IDDS has been implemented using MATLAB. The performance of IDDS is evaluated and compared with the Fuzzy Logic Diabetes Diagnosis System (FLDDS). The results prove that IDDS has better performance over FLDDS and it provides more accurate results than FLDDS.

KEYWORDS

Diabetes Diagnosis, Fuzzy Based Diabetes Diagnosis System, Fuzzy Inference System, Intuitionistic Fuzzy Based Diabetes Diagnostic System, Intuitionistic Fuzzy Set Theory, Intuitionistic-Fuzzification

INTRODUCTION

Diabetes is a widely recognized disease. It is common among the group of all ages. Root cause of this type of diabetes is lifestyle in which people have no time for exercise. It should be a major concern for all as it further gives birth to other risky diseases, such as kidney failure, heart attacks, etc. However, different types of medical tests are available to diagnose the diabetes but concurring some cost and time. In light of their importance, different diabetic diagnostic systems have been proposed in literature (Lee et al., 2007; Lee, 2007). Some of the authors have attempted the work with fuzzy logic to handle the uncertain and imprecise information of patients. They have considered only some predefined parameters like due to which their prediction rate of diagnosis was not so much accurate. In this work, there is still a scope of considering other important parameters and the extended theories of fuzzy set by which we can further improve the accuracy of diabetes diagnostic system.

Intuitionistic fuzzy set theory is a generalized form of fuzzy set theory which has been applied on various applications (Wan et al., 2013; Li et al., 2015; Raheja, 2017) however as per our knowledge no one has tried intuitionistic fuzzy set theory with diagnostic system. Fuzzy based systems consider

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a single membership function however intuitionistic fuzzy set theory considers approach of two membership functions, one for the evidences in favour and another for the evidences in against. So, the main concern of this paper is to explore the intuitionistic fuzzy set theory with the diabetic diagnostic system. With this aim authors have designed an Intuitionistic Fuzzy based Diabetic Diagnostic System (IDDS) which improve the prediction rate of diabetes with better accuracy. This work is simulated on the Pima Indians Diabetes Database (Demouy et al., 1995).

BACKGROUND AND RELATED WORK

Diabetes Mellitus commonly known as Diabetes is a hormonal disorder mainly characterized by sugar level in the blood. The problem begins with poor metabolism. When body metabolism rate is poor and the quantity of insulin produced is inadequate, the body cells are unable to take in the glucose, thus raising glucose levels above normal. In this type of disease, immense increase of sugar level in blood owed to grouping of metabolic diseases. Due to this patient often complains of frequent urination, increased hunger, and increased thirst.

Diabetes can be either genetic or caused due to unhealthy lifestyle. However, exact causes may be discovered with proper medical tests. It is found in people of all age groups. So, there is a need of such mechanism that can diagnose the diabetes at its early stage with minimum cost and time without compromise with accuracy rate. Fuzzy set theory is one of the ways that can diagnose the diabetes using the expert’s knowledge stored in their database. This technique can diagnose the diabetes at its early stage by considering some important input parameters and it incur less cost.

Klaus-Peter Adlassnig (2001) demonstrated the importance and role of knowledge base decision support fuzzy system in medicine. The author has proved that fuzzy set theory and its derived theories are broadly suitable in the field of medicine. Lee and Wang (2007) presented a paper on the intelligent healthcare agent based on ontology. The paper presents an intelligent healthcare agent based on ontology to assist the medical staff in the understanding the meaning of the graph readings obtained from ventilators and for the recognition of respiratory waveform.

Kalpana et al. (2011) have illustrated the use of Fuzzy Logic in Diabetes Diagnosis. They have discussed a fuzzy verdict mechanism for the diagnosis of diabetes. They have done analysis on the Pima Indians Data Set and evaluated performance with the previously available systems. Lee (2011) has designed another fuzzy expert system which was based on the process of five-layer fuzzy ontology. Each of the five layers of fuzzy ontology has their significance in the diabetes decision support application. J. Demouy et al. (1995) have further used the study of the Pima Indians. Pima Indians is one of the groups of people which has highest known rate of diabetes. National Institute of Diabetes and Kidney Disease (NIDDK) has been maintaining a database for the Pima Indians population.

In order to further improve the prediction rate of diabetes diagnosis, authors have implemented diabetes diagnosis using fuzzy logic called The Fuzzy logic based Diabetes Diagnosis System (FLDDS), in which fuzzy verdict mechanism is used to interpret the possibilities of any individual developing the diabetes (Jain et al., 2015). Author has used triangular membership function for all the input and the output parameters. They have considered six input parameters which are glucose, insulin, BMI, DPF, age, urine and one output parameter DM. Results are represented in the form of sentences. They have analysed FLDDS with the traditional diagnosis systems and proved that FLDDS give more accurate results as compare to traditional one.

In this paper, authors design an Intuitionistic Fuzzy based Diabetic Diagnostic System (IDDS) using intuitionistic fuzzy set theory. They have evaluated the performance of IDDS with FLDDS and other existing diabetic diagnostic system which is referred as PIDD in this work.