Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 3581-3585| ISSN:2251-6727

Study and examines the evolution of fuzzy logic's application in the healthcare industry

Oinam Tomba Singh,
Associate Professor, DMU,
Salam Rajesh Singh,
Assistant Professor, BM College

(Received: 07 October 2023 Revised: 12 November Accepted: 06 December)

KEYWORDS
Logic, Fuzzy controllers, Fuzzifier, Membership function, Health Care, Fuzzy inference system (FIS), Fuzzy expert systems (FES).

ABSTRACT
An integral part of human existence is fuzzy logic. It has been applied to a number of industries, including vacuum cleaners, air conditioners, washing machines, and facial pattern recognition. This paper's primary goal is to demonstrate how fuzzy logic-based systems are being developed to raise the caliber and dependability of medical diagnosis. The suggested medical diagnostic system was developed using Prolog programming, which also works with visual monitoring and modeling. This article looks at how fuzzy logic has been used in the healthcare industry.

INTRODUCTION

Fuzzy logic is a big part of our daily lives in the health era. Fuzzy set theory is becoming more and more prevalent in contemporary technology, particularly in design for practical applications. The renowned professor Zadeh (1965) of the University of California, Berkeley made the initial discovery of fuzzy set theory, and Mamdani (1974) used it in a variety of real-world applications to control an autonomous steam engine. Concepts or ways of thinking that don't align with the available data or facts are known as fuzzy. A methodology that mimics human reasoning is called fuzzy logic. Depending on the patient, a single disease might present itself in a multitude of ways, and a single symptom, depending on its severity, may be linked to several other diseases.

According to the World Health Organization (WHO): "Health is not just the absence of disease or infirmity; it is a state of total physical, mental, and social well-being." On the other hand, a patient with multiple diseases may interact and cause problems with the standard classification of any one of the disorders. Traditional medical diagnostic techniques have a number of problems, including imprecision and inaccuracy, which have claimed the lives of several innocent individuals. Today, computer-related technologies like models, algorithms, and other tools are used in medical diagnostic processes to ensure accuracy and precision. This has significantly decreased the number of people who pass away every day in hospitals all over the world.

Uncertainty is prevalent in the domains of bioinformatics and medicine. There exist other "fuzzy areas": insufficient or inaccurate patient information, incomplete family medical history, erroneous lab results, and so forth. Along with this rise in mental health issues, humans are also struggling with a lack of a well-defined classification system. A single disease, like COVID-19, may affect multiple patients in differing degrees of severity depending on the regional and demographic characteristics. It appears that fuzzy logic is a useful method for handling a lot of the errors seen in medical data.

Application of Fuzzy Logic

There are numerous applications of fuzzy logic in daily life. It has been used to solve real-life world problem when human may face many uncertain situations.

We use fuzzy logic:

- To determine how well major depressive disorder treatment is working.
- To look into cancer and identify its many stages.
- To enhance the radiation decision-making process.
- To look into diabetic neuropathy and recognize early signs of diabetic retinopathy.
- To look into blood pressure levels.
- To evaluate functional MRI data and calculate the amount of brain tissue using magnetic resonance imaging (MRI).
- To control hypertension while under anesthesia.
- To control the methods used for flexor-tendon repair.
- To identify prostate cancer or other cancers.
- Identify the neurons in a human's brain.
- To demonstrate volumetric drug use

Fuzzy Systems in Medicine

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 3581-3585| ISSN:2251-6727

Medicine has a significant function in the medical field. Despite technological advancements, artificial intelligence is also used in fuzzy logic, which is crucial to medicine because this mathematical model allows for both prompt intervention and effective diagnosis. To differentiate between blood pressure values, a fuzzy classifier has been designed by (Guzman et al., 2019). The main findings of the study show that an interval type-2 fuzzy inference system or a type-1 fuzzy inference system are the best designs for carrying out the aforementioned classification (Guzmán, Miramontes, Melin et al., 2019). Fuzzy logic was also utilized to provide a risk assessment for hypertension.

Fuzzy systems were a crucial component of this research, and in 2018 a model integrating neural networks and fuzzy logic was developed for this purpose as they managed the classification uncertainty. This hybrid model performed better than expected and yielded positive outcomes. Studies have also shown that fuzzy systems can be helpful in the diagnosis of Parkinson's disease. (Abiyev and Abizade, 2016 & Biswas, 1997) proposed a fuzzy systems and neural network based Parkinson's disease monitoring method. The fuzzy neural system (FNS) that Kaur, Trehan, Kaur, et al. (2017) suggested allows for precise classification of healthy individuals, as shown by system simulations that use data from the UCI machine learning repository. Another experiment proclaimed by (Abiyev, Abizade, 2016) to use fuzzy inference systems (FIS) or fuzzy expert systems (FES) to test the system for classifying medical data sets.

Orthopedics

While orthopaedics and surgery are similar in that regard, there is no clear-cut solution for a common orthopedic issue. Two tales, one about medical records and the other about waiting lists for orthopedic patients, appeared to follow the wrong logic. Nevertheless, using fuzzy identification methodologies, fuzzy and non-fuzzy rule-bases were compared in the detection of orthopedic complaints in electrically stimulated walking of paraplegic individuals, beginning with initial condition detection by (Geman, 2013).

Cardiology and Vascular Surgery

The initial studies on fuzzy logic and cardiology focused on fuzzy notions, and (Sau & Chizeck, 1994) has been tested on cardiovascular studies. Fuzzy set theory is utilized in the evaluation of cardiac functions, analysis of cerebrovascular sickness, and ECG analysis. In the mid-1990s, a number of cardiovascular health researchers made reference to fuzzy sets. The use of fuzzy control for an entire artificial heart was one application.

Endocrinology

One important area of the vast medical specialty of internal medicine is endocrinology. A version of an ambiguity-resolving inference engine was used to treat diabetic patients in 1978. In the field of diabetic medicine, an expert system called PROTIS was created to forecast fuzzy rules (Stadelmann et al., 1975). This system suggested a fuzzy categorization-based decision support system for the management of diabetic outpatients.Fuzzy inference was used to build a diagnosis system for diabetic patients based on a quantitative analysis of the dynamical reactions of glucose tolerance tests. Recently, a knowledge-based system based on hierarchical neural networks and fuzzy rules was developed for diabetics.

Surgery

Modern diagnostic instruments have shown to be quite helpful in surgery. Such devices include better control mechanisms and simulating systems in anesthesia, advanced image segmentation, and pathophysiology thinking. In the field of anesthesia, numerous uses of fuzzy inference systems to regulate drug delivery for preserving anesthetic doses, muscle relaxation, patient monitoring, and alarm have been described. The topic will have its own section; virtual reality (VR) training has made use of it. Fuzzy logic is applied, although in an indirect manner. If VR surgical simulators are going to be big business in the future, statistical competency evaluation will be a necessary component. As "too long," "too short," or "too close," or "too far," are characteristics of the "vague," it is possible that fuzzy logic notions might be used to evaluate ability in a virtual reality surgical simulator. In a different field, surgery, an untrained segmentation method is modified using fuzzy logic to create a patient region by (Buisson et al., 1987).

Education

There are numerous applications for fuzzy logic in the classroom. Fuzzy mathematics was disseminated by Rappio et al. (1999) and utilized to teach students in a healthcare setting. Also described was a fuzzy medicine assessment of the self-taught ability of nursing administrators. Virtual reality is a state-of-the-art tool

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 3581-3585| ISSN:2251-6727

that surgeons can use to learn new procedures and evaluate their level of skill prior to operating on a patient. It has been evaluated by Wang and Sun (1996).

Oncology

Fuzzy logic in oncology has focused on therapeutic guidance tasks and classification jobs (i.e., differentiating cancer from normal tissue), according to researchers from throughout the world (McLeish et al., 1989). In treatment, advanced image processing was widely employed. An analysis using magnetic resonance imaging has been conducted on ovarian cancer. To determine brain tumor segmentation, photo clustering approach is used most of the time. Lastly, a fuzzy reasoning system was used to diagnose breast tumors using three-dimensional ultrasonic echographic images. A promising diagnostic technique for enhancing tumor markers is fuzzy logic.

Gerontology

One frequent feature in applications related to gerontology has been the use of fuzzy logic for grouping. This is an example of how cell aging can be predicted using fuzzy logic. Furthermore, the databases needed to build a veterinary expert system were created using a fuzzy relational structure (Ellison & Massaro).

Psychology

Manshi and Poonia developed the fuzzy logical model of perception (FLMP) paradigm to encompass perception. The FLMP combines the findings from two feature investigations, which outperforms an additive model. The weights and links linking the concepts were assigned to the Concept Hierarchy Memory Model (CHMM), a neural network-based cognitive architecture for conceptual knowledge representation and commonsense reasoning with fuzzy interactions between concepts. CHMM solves issues by traditional reasoning.

Blood Pressure

The most recent models use "fuzzy logic" to determine the appropriate amount of cuff inflation for each individual in order to achieve a pressure that is approximately 20 mm Hg above the systolic pressure. It accepts the BP values as input using fuzzy logic. Finally, the values can be compared using a fuzzy technique. This diagram shows what the implementation produced. In the future, we plan to extract fuzzy inference rules using data mining technologies, and we might incorporate a machine learning component.

RESULTS AND DISCUSSION

The results of the fuzzy logic system promise to improve healthcare facilities for both patients and the general public throughout the globe who have been seeking top-notch medical care. The fuzzy approximation method allows us to calculate the COVID-19 scenarios.

A recent study estimates that once the corona virus pandemic begins, it will take almost four weeks for the healthcare system to fail.

The COVID-19 problem is defined by a mathematical model based on four parameters, which are
(i) The number of additional infectious cases predicted per infected case (Xo);
(ii) Incubation period (m) this means the time it takes for an infection to manifest itself as a symptom.
(iii) V= duration of disease
(iv) N= the period of time between the beginning of a symptom and recovery or death.

Assume that one infectious case produces Xo additional infectious cases after one incubation time (m). The total number of cases is currently 1+Xo. After two experimental periods, Xo2 cases are made by the prior Xo instances (2 m).$1+Xo+Xo^2$ is the total number of cases. Considering that the number of cases anticipated by $day_{t.m}$ equals $C_{t.m}$ the total number of cases can be represented as

$$C= \sum C_{t.m}$$

Where C= Total cases that have been forecast.
$C_{t.m=}$ The number of incident cases predicted on $day_{t..m}$
Predicted number of COVID-19 cases using Xo= 4 and m = 7 days.

Table 1: Total no of cases

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 3581-3585| ISSN:2251-6727

Time of incubation(m)	$Day_{t.m}$	Predicted incident cases ($C_{t.m}$)	Total cases that have been forecast. (C)
0	0	$1(=X_o^0)$	1
1	7	$4(=X_0^1)$	5 (=1+4)
2	14	$16(=X_0^2)$	21(=1+4+16)
3	21	$64 (=X_0^3)$	85 (=1+4+16+64)

CONCLUSION

Implementing fundamental concepts like control, communication, adaptation, and structure may be done effectively with fuzzy logic. Building knowledge-based systems in medicine can benefit greatly from the extremely relevant and broadly applicable basis provided by fuzzy set theory and the theories that come after it. To identify medical publications in the MEDLINE database, we used fuzzy logic. As keywords, we used phrases like membership grade and fuzzy logic. Clinical experiments show how well the fuzzy knowledge description and patient data, along with the selected fuzzy inference techniques, meet the requirements for important medical applicability and accurate results. Moreover, using a medical diagnosis system based on fuzzy logic will reduce the amount of work that physicians have to do during consultations and resolve other problems associated with hospital stays. More sophisticated medical diagnosis systems can be developed to help with things like medication prescriptions, patient registration, and patient data and information storage in the medical field.

REFERENCES

1. Abbod M.F., von Keyserling D.G., Linkens D.A., Mahfouf M. (2001). Survey of utilisation of fuzzy technology in Medicine and Healthcare. Fuzzy Sets and Systems, 120(2), 331-349.
2. Abiyev, Abizade (2016). Diagnosing Parkinson's diseases using fuzzy neural system. Compute Math Methods Med.; 2016, 1267919.
3. Biswas R. (1997). Intuitionistic fuzzy relations. Bull. Sous. Ens. Flous. Appl. (BUSEFAL), 70, 22–29.
4. Buisson J.C., Farreny H., Prade H., Turnin M.C., Tauber J.P., Bayard F. (1987). Toulmed an inference engine which deals within precise and uncertain aspects of medical knowledge, Proc. AIME 87, European Conf. on Artificial Intelligence in Medicine, Springer, Berlin, West Germany.
5. Ellison, J. W., & Massaro, D. W. (1997). Featural evaluation, integration, and judgment of facial affect. Journal of Experimental Psychology: Human Perception and Performance, 23(1), 213–226.
6. Geman (2013). Nonlinear dynamics, artificial neural networks and neuro-fuzzy classifier for automatic assessing of tremor severity. E-Health and Bio-engineering Conference (EHB).
7. Guzmán J.C., Miramontes I., Melin P. et al. (2019). Optimal genetic design of Type-1 and interval Type-2 fuzzy systems for blood pressure level classification. Axioms, 8(1), 8
8. Kalmanson D., and Stegall H. F. (1975). Cardiovascular investigations and fuzzy sets theory, Amer. J. Cardiol, 35(1), 80-84,
9. Kaur, Trehan, Kaur et al. (2017). Analysis of adaptive neuro-fuzzy based expert system for Parkinson's disease diagnosis. Int J Adv. Res Ideas Innov Technol., 3, 1120–1127.
10. Kovarlerchuk B., Triantaphyllou E., Ruiz J.F., Clayton J. (1997). Fuzzy logic in computer-aidedbreast cancer diagnosis: analysis of lobulation, Artif. Intell. Med. 11 (1) , 75–85
11. Loslever P. (1993). Error and data coding in the multi-dimensional analysis of human movement signals. Proc. Inst. Mech. Eng. 207(2), 103-10.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 3581-3585| ISSN:2251-6727

12. McLeish M., Cecile M., Lopez S.A. (1989). Database issues for a veterinary medical expert system, Statistical and Scientific database Management, 4thInternet. Working Conf. SSDBM Proc., Springer, Berlin, West Germany.
13. Raposio, E., DiSomma, C., Fato, M., Schenone, A., Andreucci, L., Beltrame, F., & Santi, P. (1997). An "augmented-reality" aid for plastic and reconstructive surgeons. Studies in health technology and informatics, 39, 232–236.
14. Sau K.N. & Chizeck H.J. (1994). Fuzzy vs. non-fuzzy rule base for gait event detection, Proc. 16th Annual Internet. Conf. of the IEEE Engineering in Medicine and Biology Society, Engineering Advances: New Opportunities for Biomedical Engineers, vol. 2, IEEE, New York, NY, USA.
15. Thukral S., Bal S. (2019). Medical Applications on Fuzzy Logic Inference System: A Review, Int. J. Advanced Networking and Applications, 10(4), 3944-3950.
16. Wang R.H., and Sun Z.Q. (1996). Evaluation of self-taught ability of nursing administrators with fuzzy medicine. Chung Hua Hu Li Tsa Chih. 31 (7), 395–396.
17. Zadeh (1965). Fuzzy Sets. Int J. Information Control. 8, 338-353.