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An investigative study of applications of Fuzzy Logic

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Abstract- Fuzzy logic means approximate reasoning, granulation of information, calculation with words, etc. An inference structure provided by Fuzzy logic, permits human reasoning capabilities that can be applied to artificial systems. It provides a means to convert the linguistic strategy into actions and, therefore, offers a high level calculation. In this paper we study and investigate the diverse application areas in which fuzzy logic has been utilized.

Keywords: Fuzzy Logic, Bioinformatics, Chemical Processes, Neurosciences

1. INTRODUCTION

Fuzzy logic has been implemented in many applications, including appliances, consumer electronic products, transit systems, automobiles and industrial processes. Numerous consumer products which exploits the conception of fuzzy technology are presently available and being marketed in Japan, US, Europe and many more countries.

Although US was the first to introduce fuzzy logic in different areas of practical applications, it is in Japan took the leadership to widely implement the associated technology in the fields mentioned above. They use this approach in problems that involve making decisions based on knowledge. Consequently, we can state that Japan has benefited the worldwide community, business, academia and diverse professions.

Fuzzy theory was firstly applied in primarily industrial application, such as process control for cement kilns built in Denmark, coming online in 1975. Conversely, as the technology was adopted, fuzzy logic was used in more valuable applications.

Fuzzy logic has been applied to many different and diverse applications, including categorization of weather patterns and of sea gull behaviors, control of cement kilns, passenger trains, and elevators, scheduling of subway trains and service technicians, and as a prediction mechanism in risk management. Empirically, five general categories have emerged within which a fuzzy logic based system is beneficial, and often even necessary:

- Complex systems, where an adequate system model is difficult or impossible to define.
- Human expert controlled systems.
- Systems with moderately to very complex continuous (or semi- continuous) inputs and outputs, for example PID based control systems.
- Systems with human observations as control rules and/or inputs.
- Systems where vagueness is common, for example in economic systems, natural sciences, and behavioral sciences.

As a mathematical foundation, a generalization on the age-old but quite limiting concept of absolute truth, fuzzy logic can be successfully applied across a broad range of disciplines, and has the potential of having as significant an impact on the types of systems developed.

fuzzy logic may also be applied in the areas of Picture Processing, Environmental Protection, Social Sciences, Economy, Power Systems, Music, Hardware and Telecommunications. Some applications of fuzzy logic in Medicine may be in support of diagnosis, in Medical Image Processing, in medical data mining, and in medical modeling.

2. FUZZY LOGIC IN MEDICINE

Christian et al.,[1] have studied and analysed fuzzy logic, fuzzy sets and relations and fuzzy control and their application in medical science and explained GlucoNotify patient glucose data setting, fuzzy automata concept for Acute Respiratory Distress Syndrome(ARDS) treatment therapies. Yataka Hata et al.,[2] illustrated the realistic application of management system for human health and worked on the scheme to concentrate medical diagnosis as well as healthiness management. For diabetic patient of type I, a fuzzy logic controller was illustrated by

Khanale and Ambilwade [3] to sustain the normoglycaemic.

Djam et al.,[4] developed a decision support system for detecting TB and proved that Fuzzy logic for medical diagnosis provides an proficient way to help inexpert physicians to arrive at the final diagnosis of TB more rapidly and professionally.

Soundarajan et al.,[5] designed a fuzzy rule based system to for tuberculosis diagnosis. This system is premeditated to recognize class of *tuberculosis* and these fuzzy rules are rationalized using rule mining techniques. This method which engenders classes of tuberculosis, suits the needs of pulmonary physicians and decreases the time consumed in generating diagnosis.

Arthritis is a chronic disease numerous patients are suffering from osteoarthritis and rheumatoid arthritis which are undiagnosed and the postponement of revealing may cause the severity of the disease at higher menace. Thus, earlier recognition of arthritis and healing of its type of arthritis and related locomotry abnormalities are of vital significance. MirzamansoorBaid et al., [6] premeditated a system by applying Zadeh's fuzzy set theory for the diagnosis of Arthritis using fuzzy logic controller (FLC). They also proved that it is a budding tool for dealing with uncertainty as well as imprecision.

3. FUZZY LOGIC IN BIOINFORMATICIS

Although bioinformatics is an admired term in science and technology, there is no consensus for its description. As a novel field, its precise definition will take many years to finish. A current semi-national definition for bioinformatics by the US National Institutes of Health (NIH) is "Research, development or application of computational tools and approaches to expand the use of biological, medical, behavioral or health data, including those that are acquired, represented, described, stored, analyzed or visualized such data". The NIH delineates a related field, computational biology, as "the development and application of data and theoretical analytical methods, mathematical models, and computational simulation techniques for the study of biological, behavioral, and social systems." From these definitions, bioinformatics focuses on technology (engineering) for the development of tools and infrastructure, while computational biology is more about science (biology) to generate hypotheses in the understanding of nature.

Chang et al. [7] established a fuzzy PAM matrix using fuzzy logic and then estimated the score for the fitness function of the genetic algorithm using fuzzy arithmetic. Their experimental results evidenced a constructive fuzzy logic to deal with the setback of uncertainties, and they were applied productively to the alignment of protein sequences.

Yue and Tang [8] applied the divide and beat strategy to align three sequences in order to reduce memory usage from O(n3) to O(n2). They used dynamic programming to ensure optimal alignment.

Naznin et al. [9] designed an iterative progressive alignment method for the alignment of multiple sequences by using new techniques both to generate guide trees for randomly selected sequences and to rearrange the sequences in the guide trees. The main objective of this work was to apply various techniques in order to provide competent alignment algorithms in terms of time and memory requirements.

4. FUZZY LOGIC IN CONTROL SYSTEM

The most admired technique is to use the Fuzzy controller in which expert knowledge can be incorporated into the design. Most Fuzzy controllers used in the industry have the same structure as the incremental PD or PID controllers. The controller design using Genetic Algorithm and neural network has been coalesced with the Fuzzy controller to outline an intelligent control scheme.

López et al. [10] proposed a simplified version of the mamdani fuzzy controller called natural logic controller. Kar et al. [11] performed the identification as well as stabilization of nonlinear plants using Fuzzy neural networks and Prem Kumar et al. [12] suggested a viable variable gain controller for nonlinear systems using the Fuzzy T-S model. Coupland et al. [13] studied that FLS Type 1 and Type 2 (fuzzy logic system) have received increasing attention recently. Linda and Manic [14] proposed a method to incorporate the input uncertainty measured experimentally into the IT2 FLS design. Wu [15] explained that the two fundamental differences between IT2 and T1 FLC are: 1) Addictivity, which means that the embedded diffuse sets T1 used to calculate the limits of the reduced type interval change as the input changes;

and, 2) Novelty, which means that the upper and lower membership functions of the same fuzz set of IT2 can be used simultaneously when calculating each limit of the reduced interval type. FLC T1 do not have these properties; therefore, an FLC T1 can not implement the complex control surface of an FLC IT2 given the same rule base.

5. FUZZY EXPERT SYSTEMS

Computer programs that use Artificial Intelligence techniques to help people resolve complicated setbacks involving knowledge, heuristics, and decision making are called expert systems, intelligent systems, or intelligent systems. An expert system can be designed based on a set of rules to determine which action to activate when a certain situation is found.

Iranmanesh and Madadi [16] extracted the WBS project from the mental map obtained from the brainstorming project team using artificial intelligence (AI) tools, which is the Prolong programming language. Biggs et al. [17] used expert systems technology to provide developmental feedback to individuals of different minority ethnic groups.

Melek and Sadeghian, [18] developed a theoretical framework for intelligent expert systems in the evaluation of medical encounters.

6. FUZZY LOGIC IN NEUROSCIENCES

With reference to the applicability of fuzzy logic in medicine and basic sciences, the conception is still novel in the field of neurosciences. Nevertheless, the last decade has seen the recognition of the expediency of fuzzy logic in numerous branches of neurosciences, including basic neurosciences, neurology, neurosurgery, neuroradiology, psychiatry and psychology.

The Fuzzy-Neuro system uses a learning procedure to discover a set of fuzzy membership functions that can be expressed in yes-then rules. Fuzzy-Neuro has many advantages: first, it allows us to incorporate our experience and previous knowledge in the classifier. Second, it provides an understanding of the feature of the data set. Third, it helps find the dependencies in the data sets. Fourth, it gives an explanation that allows us to prove the internal logic.

Juang et al. [19] described a diffuse type 2 interval neuronal network with supportive vectorial regression for noisy regression problems. The Fuzzy-Neuro system can be designed using several architectures. To improve the performance of the system, three questions must be addressed: find the optimal number of rules, discover the appropriate membership functions and adjust both.

7. FUZZY SYSTEMS IN CHEMICAL PROCESSES

Chemical engineering has used fuzzy logic in the detection of chemical agents and the recognition of gases. Fuzzy logic has also been applied to process control, to the discontinuous distillation column, to the production of phosphoric acid, to nuclear research, to the separation process, to the control of the power production of a nuclear reactor and to the kinetics. Markowski et al. [20] explored the application of fuzzy logic for the risk assessment of the main risks related to the transport of flammable substances in long pipelines.

8. CONCLUSION

Fuzzy logic generalizes the conventional logic of two values for reasoning under indistinctness. Fuzzy sets are classes of objects without defined limits where belonging is a matter of degree. Fuzzy logic is a system of computation and approximate reasoning based on the collection of theories and technologies that utilize fuzzy sets. In this work we study the different applications of fuzzy logic in the field of medicines, control systems, bioinformatics, expert system, chemical processes and neurosciences.

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