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# Towards Concept of Fuzziness & Its Realization into Human Life

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**Abstract**

The Fuzzy Logic tool was introduced in 1965, by LotfiZadeh, and is a mathematical tool for dealing with uncertainty. It offers to a soft computing partnership the important concept of computing with words. It provides a technique to deal with imprecision and information granularity. Fuzzy Logic (FL) is a multi valued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc. Notions like rather tall or very fast can be formulated mathematically and processed by computers, in order to apply a more human like way of thinking in the programming of computers. Fuzzy Logic has emerged as a a profitable tool for the controlling and steering of systems and complex industrial processes, as well as for household and entertainment electronics, as well as for other expert systems and applications like the classification of SAR data.

**Keywords:**Fuzzy; Genetic; Uncertainty; Defuzzification.

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## 1. INTRODUCTION

Can computers think and take decisions like human beings? Yes it is possible and the technology of artificial intelligence and fuzzy logic is rapidly advancing towards its achievements. Fuzzy logic is used for developing intelligent control and information systems. A fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy. The precision of mathematics owes its success in large part to the efforts of Aristotle and the philosophers who preceded him. In their efforts to devise a concise theory of logic, and later mathematics, the so−called "Laws of Thought" were posited. One of these, the "Law of the Excluded Middle," states that every proposition must either be true or false. Even when Parmenides proposed the first version of this law (around 400 B.C.) there were strong and immediate objections: for example, Heraclitus proposed that things could be simultaneously true and not true. It was Plato who laid the foundation for what would become fuzzy logic, indicating that there was a third region (beyond True and False) where these opposites "tumbled about." Other, more modern philosophers echoed his sentiments, notably Hegel, Marx, and Engels. But it was Lukasiewicz who first proposed a systematic alternative to the bi−valued logic of Aristotle [7,8].

The door to the development of fuzzy computers was opened in 1985 by the design of the first logic chip by Masaki Togai and Hiroyuki Watanabe at Bell Telephone Laboratories. In the years to come fuzzy computers will employ both fuzzy hardware and fuzzy software, and they will be much closer in structure to the human brain than the present-day computers are. The entire real world is complex; it is found that the complexity arises from uncertainty in the form of ambiguity [10]. According to Dr. LotfiZadeh, Principle of Compatibility, the complexity, and the imprecision are correlated. The closer one looks at a real world problem, the fuzzier becomes its solution.

## 2. CONCEPT OF FUZZINESS

Computers are well known for multiplication, division etc. However in life there are situations where these precise deterministic values cannot solve problems. Human beings are limited in their ability to perceive the world and to profound a result of lack of information (lexical impression, incompleteness), in particular, inaccuracy of measurements. The other limitation factor in our desire for precision is a natural language used for describing/sharing knowledge, communication, etc. We understand core meanings of word and are able to communicate accurately to an acceptable degree, but generally we cannot precisely agree among ourselves on the single word or terms of common sense meaning. In short, natural languages are vague.

Our perception of the real world is dominated by concepts which do not have sharply defined boundaries – for example, many, tall, much larger than, young, etc. are true only to some degree and they are false to some degree as well. These concepts can be called fuzzy or gray (vague) concepts – a human brain works with them, while computers may not do it (they reason with strings of 0s and 1s) [4]. Natural languages, which are much higher in level than programming languages, are fuzzy whereas programming languages are not. So not being precise or certain is being fuzzy. This logic of imprecision or uncertainty is more powerful than fuzzy. It is important to observe that there is an intimate connection between Fuzziness and Complexity. As the complexity of a task (problem), or of a system for performing that task, exceeds a certain threshold, the system must necessarily become fuzzy in nature. Zadeh, originally an engineer and systems scientist, was concerned with the rapid decline in information afforded by traditional mathematical models as the complexity of the target system increased. As he stressed, with the increasing of complexity our ability to make precise and yet significant statements about its behavior diminishes. Real world problems (situations) are too complex, and the complexity involves the degree of uncertainty – as uncertainty increases, so does the complexity of the problem [6]. Traditional system modeling and analysis techniques are too precise for such problems (systems), and in order to make complexity less daunting we introduce appropriate amplifications, assumptions, etc. (i.e., degree of uncertainty or Fuzziness) to achieve a satisfactory compromise between the information we have and the amount of uncertainty we are willing to accept. In this aspect, fuzzy systems theory is similar to other engineering theories, because almost all of them characterize the real world in an approximate manner.

We can give a number of examples to prove that in life we work more on the basis of imprecise data. When we say that a person is healthy, can we define it in some precise terms or mathematical degrees. If the temperature of the body is 98.5, is the person unhealthy? There is no exact value of various parameters to define when a person is healthy and when he is not. Take the concept of old and young. We cannot fix a particular day when we can say today the person is young and the next day he will be old. Even grey hair and weak eyesight cannot tell whether the person is old or young.

Look at the phrase for a long period in the following sentences:

1. Dinosaurs ruled the earth for a long period. Here long period means millions of years,
2. It has not rained for a long period. Here long period may mean a few months.
3. I waited for the doctor for a long period. Here long period may mean a few hours.

In our daily life, we continuously make use of such words and concepts, which cannot be described in mathematical sense. Fuzzy logic tries to capture these notions so that power of reasoning used by human beings can be embedded into computer systems. It will make machines more useful to us.

## 3. APPLICATIONS

Fuzzy systems can be used for estimating, decision-making, and mechanical control systems such as air conditioning, automobile controls, and even “smart” houses, as well as industrial process controllers and a host of other applications.

The main practical use of fuzzy logic has been in the myriad of applications in Japan as process controllers. But the earliest fuzzy control developments took place in Europe.

The British engineer EbrahimMamdani was the first to use fuzzy sets in a practical control system, and it happened almost by accident. In the early 1970s, he was developing an automated control system for a steam engine using the expertise of a human operator. His original plan was to create a system based on Bayesian decision theory, a method of defining probabilities in uncertain situations that considers events after the fact to modify predictions about future outcomes.

The human operator adjusted the throttle and boiler heat as required to maintain the steam engine's speed and boiler pressure. Mamdani incorporated the operator's response into an intelligent algorithm (mathematical formula) that learned to control the engine. But as he soon discovered, the algorithm performed poorly compared to the human operator. A better method, he thought, might be to create an abstract description of machine behavior.

He could have continued to improve the learning controller. Instead, Mamdani and his colleagues decided to use an artificial intelligence method called a rule-based expert system, which combined human expertise with a series of logical rules for using the knowledge. While they were struggling to write traditional rules using the computer language Lisp, they came upon a new paper by LotfiZadeh on the use of fuzzy rules and algorithms for analysis and decision-making in complex systems. Mamdani immediately decided to try fuzziness, and within a "mere week" had read Zadeh's paper and produced a fuzzy controller [2].

The most spectacular fuzzy system functioning today is the subway in the Japanese city of Sendai. Since 1987, a fuzzy control system has kept the trains rolling swiftly along the route, braking and accelerating gently, gliding into stations, stopping precisely, without losing a second or jarring a passenger [5].

Japanese consumer product giants such as Matsushita and Nissan have also climbed aboard the fuzzy bandwagon. Matsushita's fuzzy vacuum cleaner and washing machine are found in many Japanese homes. The washing machine evaluates the load and adjusts itself to the amount of detergent needed, the water temperature, and the type of wash cycle. Tens of thousands of Matsushita's fuzzy camcorders are producing clear pictures by automatically recording the movements the lens is aimed at, not the shakiness of the hand holding it.

Sony's fuzzy TV set automatically adjusts contrast, brightness, sharpness, and color .Nissan's fuzzy automatic transmission and fuzzy antilock brakes are in its cars. Mitsubishi Heavy Industries designed a fuzzy control system for elevators, improving their efficiency at handling crowds all wanting to take the elevator at the same time. This system in particular captured the imagination of companies elsewhere in the world. In the United States, the Otis Elevator Company is developing its own fuzzy product for scheduling elevators for time-varying demand. Some other applications of fuzzy logic are:

### 3.1. Bus Schedules

Bus schedules are formulated on information that does not remain constant. They use fuzzy logic because it is impossible to give an exact answer to when the bus will be at a certain stop. Many unforeseen incidents can occur. There can be accidents, abnormal traffic backups, or the bus could break down. An observant scheduler would take all these possibilities into account, and include them in a formula for figuring out the approximate schedule. It is that formula which imposes the fuzziness.

### 3.2. Genetic traits

Genetic traits are a fuzzy situation for more than one reason. There is the fact that many traits can't be linked to a single gene. So only specific combinations of genes will create a given trait. Secondly, the dominant and recessive genes that are frequently illustrated with Punnetsquares, are sets in fuzzy logic. The degree of membership in those sets is measured by the occurrence of a genetic trait. In clear cases of dominant and recessive genes, the possible degrees in the sets are pretty strict. Take, for instance, eye color. Two brown-eyed parents produce three blue-eyed children. Brown is dominant, so each parent must have the recessive gene within them. Their membership in the blue eye set must be small, but it is still there. So their children have the potential for high membership in the blue eye set, so that trait actually comes through. According to the Punnet square, 25% of their children should have blue eyes, with the other 75% having brown. But in this situation, 100% of their children have the recessive color.

### 3.3. Temperature control

The trick in temperature control is to keep the room at the same temperature consistently. But how much does a room have to cool off before the heat kicks in again? There must be some standard, so the heat (or air conditioning) isn't in a constant state of turning on and off. Therein lies the fuzzy logic. The set is determined by what the temperature is actually set to. Membership in that set weakens as the room temperature varies from the set temperature. Once membership weakens to a certain point, temperature control kicks in to get the room back to the temperature it should be.

### 3.4. Auto focus in cameras

Auto-focus cameras are a great revolution for those who spent years struggling with "old-fashioned" cameras. These cameras somehow figure out, based on multitudes of inputs, what is meant to be the main object of the photo. It takes fuzzy logic to make these assumptions. Perhaps the standard is to focus on the object closest to the center of the viewer. Maybe it focuses on the object closest to the camera. It is not a precise science, and cameras err periodically. This margin of error is acceptable for the average camera owner, whose main usage is for snapshots. However, the "old-fashioned" manual focus cameras are preferred by most professional photographers. For any errors in those photos cannot be attributed to a mechanical glitch. The decision making in focusing a manual camera is fuzzy as well, but it is not controlled by a machine.

### 3.5. Anti braking system

The point of an ABS is to monitor the braking system on the vehicle and release the brakes just before the wheels lock. A computer is involved in determining when the best time to do this is. Two main factors that go into determining this are the speed of the car when the brakes are applied, and how fast the brakes are depressed. Usually, the times you want the ABS to really work are when you're driving fast and slam on the brakes. There is, of course, a margin for error. It is the job of the ABS to be "smart" enough to never allow the error go past the point when the wheels will lock. (In other words, it doesn't allow the membership in the set to become too weak.)

### 3.6. Medical diagnose

The diagnosis of disease involves several levels of uncertainty and imprecision, and it is inherent to medicine. A single disease may manifest itself quite differently, depending on the patient, and with different intensities. A single symptom may correspond to different diseases. On the other hand, several diseases present in a patient may interact and interfere with the usual description of any of the diseases.

Fuzzy logic plays an important role in medicine. Some examples showing that fuzzy logic crosses many disease groups are the following [1].

1. To predict the response to treatment with citalopram in alcohol dependence.
2. To analyze diabetic neuropathy and to detect early diabetic retinopathy.
3. To determine appropriate lithium dosage.
4. To calculate volumes of brain tissue from magnetic resonance imaging (MRI), and to analyze functional MRI data.
5. To characterize stroke subtypes and coexisting causes of ischemic stroke.
6. To improve decision-making in radiation therapy.
7. To control hypertension during anesthesia.
8. To determine flexor-tendon repair techniques.
9. To detect breast cancer, lung cancer, or prostate cancer.
10. To assist the diagnosis of central nervous systems tumors (astrocytic tumors).
11. To discriminate benign skin lesions from malignant melanomas.
12. To visualize nerve fibers in the human brain.
13. To represent quantitative estimates of drug use.
14. To study the auditory P50 component in schizophrenia.
15. Many other areas of application, to mention a few, are
    a. to study fuzzy epidemics,
    b. to make decisions in nursing,
    c. to overcome electro acupuncture accommodation.

### 3.7. Bioinformatics

Bioinformatics derives knowledge from computer analysis of biological data. This data can consist of the information stored in the genetic code, and also experimental results (and hence imprecision) from various sources, patient statistics, and scientific literature. Bioinformatics combines computer science, biology, physical and chemical principles, and tools for analysis and modeling of large sets of biological data, the managing of chronic diseases, the study of molecular computing, cloning, and the development of training tools of bio-computing systems [9]. Bioinformatics is a very active and attractive research field with a high impact in new technological development.

## 4. RESEARCH FRAMEWORK

Research activities related to Fuzzy logic are in progress at Machine Intelligence Unit of the Indian Statistical Institute, Calcutta, India. The members are actively engaged to

-Realize the basic goals of soft computing and hybridizations like neuro-fuzzy, neuro-genetic, fuzzy-rough, neuro-fuzzy-genetic

-develop neuro-fuzzy techniques for image processing

-develop multi valued pattern system using fuzzy logic

-develop reinforcement type learning algorithms for designing adaptive fuzzy controllers

Recently the unit has completed a project sponsored by the Defence Electronics Applications laboratory, Government of India on analyzing remotely sensed data using fuzzy set theoretic techniques.

Dr. AshishGhosh and Dr. Mohua Banerjee of the group got the most coveted **Young Scientist** award from the Indian National Science Academy in 1995 and Dr. JayantaBasak in 1996.

Fuzzy Research is also being pursued at Kyushu Institute of Technology, Japan and Dalian University of Technology, China.

## 5. CONCLUSION

Fuzzy Logic provides a different way to approach a control or classification problem. This method focuses on what the system should do rather than trying to model how it works. One can concentrate on solving the problem rather than trying to model the system mathematically, if that is even possible. On the other hand the fuzzy approach requires a sufficient expert knowledge for the formulation of the rule base, the combination of the sets and the defuzzification. In General, the employment of fuzzy logic might be helpful, for very complex processes, when there is no simple mathematical model (e.g.

Inversion problems), for highly nonlinear processes or if the processing of (linguistically formulated) expert knowledge is to be performed. Despite the promising results, further research is needed to bring the system to its full potential.

## REFERENCES


**[1]** Albin, M.A., Fuzzy Sets and their Applications to Medical Diagnosis and Patterns Recognition, Ph.D. Dissertation, University of California, Berkley, 1975.

[2] Domaratzke, Michael, Kai Salomaa, Eds., Implementation and Application of Automata, Springer, Germany, 2010.

[3] Gesu, Di Vito, Sankar Kumar pal, Alfredo Petrosino, Fuzzy logic and Applications, $8^{th}$ International workshop 2009, Springer, Germany.

[4] Hanss, Michael, Applied Fuzzy Arithmetic, An Introduction with Engineering Application Springer, Germany, 2005.

[5] J. Klir, George, Bo Yuan, Fuzzy Sets and Fuzzy logic, Theory and Applications, Prentice Hall, USA, 1995.

[6] J.Ross, Timothy, Fuzzy Logic with Engineering Applications, John Wiley & Sons, USA, 2004.

[7] L.A., Zadeh, “Making Computers think like people,” IEEE, Spectrum 8/1984, pp.26-32

[8] S.Haack, “Do we need Fuzzy logic?” International Journal of Man-Machine Studies, Vol 11, 1979, pp. 437-445.

[9] Torres, Angela, Juan j. Nieto, Fuzzy Logic in Medicine and Bioinformatics, Published online, 2006.

[10] Fuzzy sets, www.calvin.edu