FUZZY SYSTEMS – DESIGN AND APPLICATIONS

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ABSTRACT

Fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy and applications at the leading edge of artificial intelligence. At despite long standing origins, it has a relatively new field and as such leaves much room for development. This paper will present the foundations of fuzzy systems, along with some of the more note worth objections to its use, with examples drawn from research in the field of artificial intelligence. Ultimately, it will be demonstrated that the use of fuzzy systems makes a viable additions to the field of artificial intelligence and perhaps more generally to formal mathematics as whole.

Fuzzy logic starts with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer and results in much more accurate representations of the way systems behave in the real world. Additional benefits of fuzzy logic include simplicity and its flexibility. Fuzzy logic can handle problems with imprecise and incomplete data and it can model non-linear functions of arbitrary complexity.

Fuzzy logic deals with uncertainty in engineering by attaching degrees of certainty to the answer of a logical question. It is used in commercial and practical purpose. In most of the cases someone with a intermediate technical background can design a fuzzy logic controller. The control system will not be optimal but it can be acceptable. Fuzzy logic is not the answer to all technical problems but for control problems, where simplicity and speed of implementation is important then fuzzy logic is very useful.

Expert systems have been the most obvious recipients of the benefits of fuzzy logic, since their domain is often inherently fuzzy. They include decision support systems, financial planners, diagnostic systems etc.

INTRODUCTION

Fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy and applications at the leading edge of artificial intelligence. At despite long standing origins, it has a relatively new field and as such leaves much room for development. This paper will present the foundations of fuzzy systems, along with some of the more note worth objections to its use, with examples drawn from research in the field of artificial intelligence. Ultimately, it will be demonstrated that the use of fuzzy systems makes a viable additions to the field of artificial intelligence and perhaps more generally to formal mathematics as whole.

BASIC CONCEPTS

The notion central to fuzzy systems is that truth values (in fuzzy logic) or membership values (fuzzy sets) are indicated by a value on the range [0.0, 1.0], with 0.0 representing absolute falseness and 1.0 representing absolute truth.

For example, let us take the statement: 'Roy is old.'

If Roy's age was 75, we might assign the statement the truth value of 0.80. The statement could be translated into set terminology as follows:

'Roy is a member of the set of old people.'

This statement would be rendered symbolically with fuzzy sets as :

m.old(Roy) = 0.80

where, m is the membership function, operating in this case on the fuzzy set of old people, which returns a value between 0.0 and 1.0.

DEFINITION

A fuzzy set is a pair (A,m), where A is a set and $m: A \rightarrow [0,1]$.

For each $x \in A$, m(x) is called the grade of membership of x in (A,m). For a finite set A= $\{x_1, ..., x_n\}$, the fuzzy set (A, m) if often denoted by $\{m(x_1)/x_1, ... ,m(x_n)/x_n\}$.

Let $x \in A$ then,

x is not included in fuzzy set (A,m) if m(x) = 0;

x is called fully included if m(x) = 1 ;

x is called a fuzzy member, if $0 < m(x) < 1$.

The set $\{ x \in A \mid m(x) > 0\}$ is called the Support of (A, m) and the

set $\{ x \in A \mid m(x =1) \}$ is called the Kernel of (A, m).

Using fuzzy sets algorithmic procedures can be devised which translate fuzzy terminology into numeric values, perform reliable operations upon those values and then return natural language statements in a reliable manner.

Fuzzy logic starts with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer and results in much more accurate representations of the way systems behave in the real world.

Additional benefits of fuzzy logic include simplicity and its flexibility. Fuzzy logic can handle problems with imprecise and incomplete data and it can model non-linear functions of arbitrary complexity. 'If you don't have a good plant model or if the system is changing, then fuzzy will produce a better solution than conventional control techniques,' says Bob Varley, a senior systems engineer at Harris Corp., an aerospace company in Palm Bay, Florida.

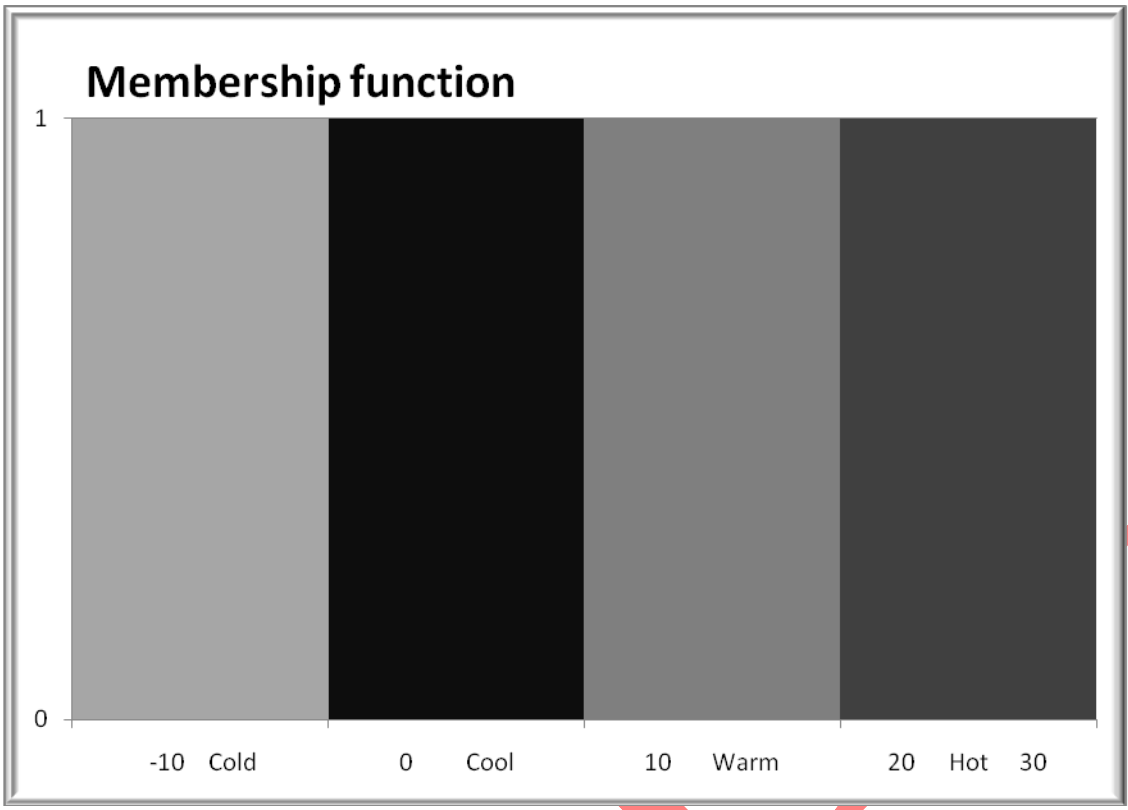
You can create a fuzzy system to match any set of input – output data. The fuzzy logic toolbox makes this particularly easy by supplying adaptive techniques such as Adaptive Neuro – Fuzzy Inference System (ANFIS).

In fuzzy logic, unlike standard conditional logic, the truth of any statement is a matter of degree. Fuzzy inference systems rely on membership functions to explain to the computer how to calculate the correct value between 0 and 1. The degree to which any fuzzy statement is true is denoted by a value between 0 and 1.

FUZZY SETS

Fuzzy set theory was formalized by professor Lofti Zadeh at the University of California in 1965. What Zadeh proposed is very much a paradigm shift from 'conventional bivalent set theory to fuzzy set theory' has first gained acceptance in the far East and its successful application has ensured its adoption around the world.

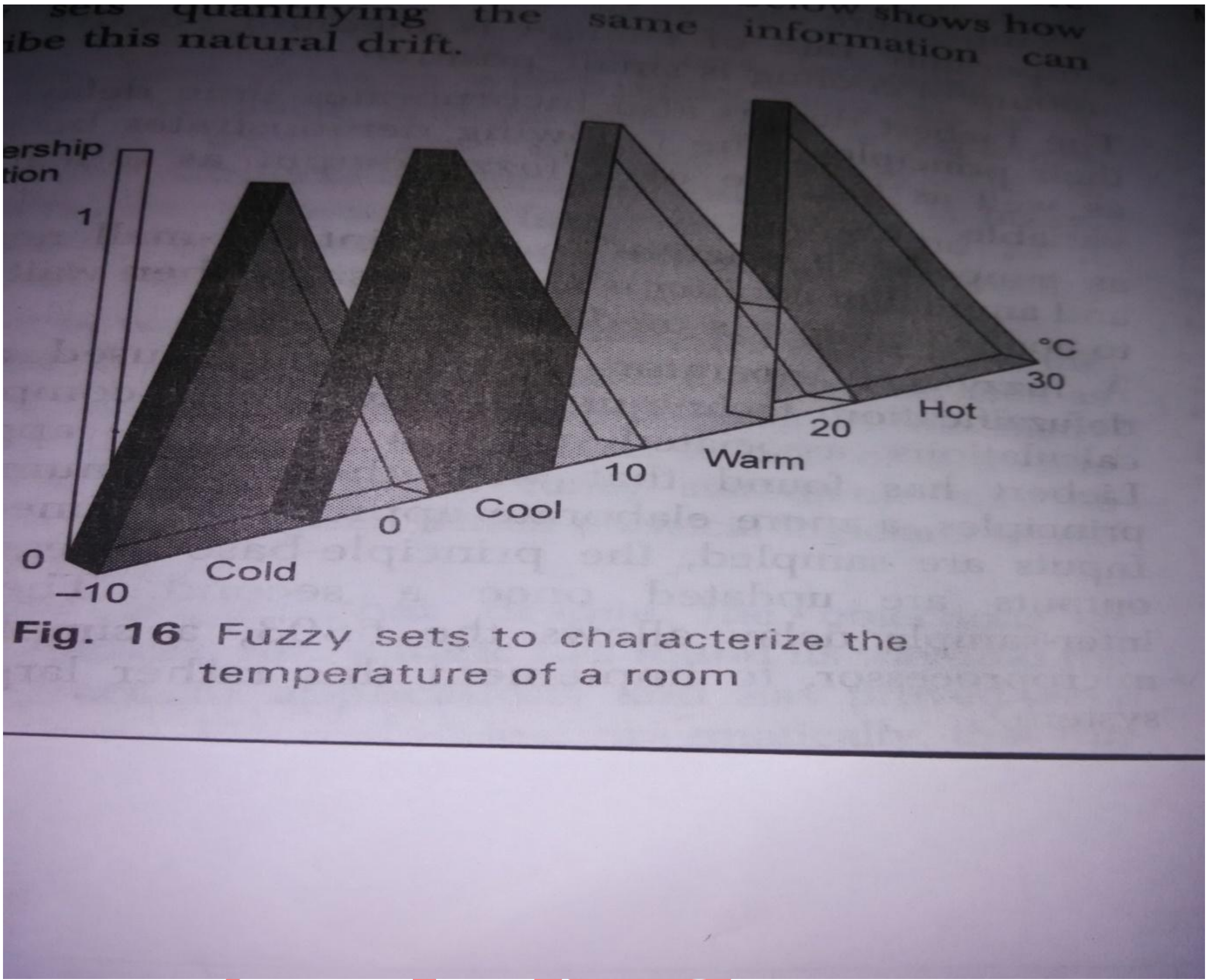
Bivalent set theory can be somewhat limiting if we wish to describe a 'humanistic' problem mathematically. For example, the following fig. illustrates bivalent sets to characterise the temperature of a room.



Bivalent sets to characterize the temperature of a room

The most obvious limiting feature of bivalent sets that can be seen clearly from the figure is that they are mutually exclusive – It is not possible to have membership of more than one set. Clearly it is not accurate to define a transition from a quantity such as 'warm' to 'hot' by the application of 10 F of heat. In real world a smooth drift from warm to hot would occur.

This natural phenomenon can be described more accurately by fuzzy set theory. The below figure.16 illustrates the fuzzy sets quantifying the same information with natural drift.



Fuzzy sets to characterize the temperature of a room

DESIGN GOALS

Control of the environment for large computing systems often a far greater challenge than for rooms inhabited by people. Not only do the systems themselves generate heat, but they are often specified by their manufactures to be maintained in as little as plus or minus 1^0 F range. Humidity is also a challenge, causing for example, corrosion and jamming of associated mechanical system at high humidity levels and the enhanced possibility of static discharge with low levels. Humidity control is often specified to be 50% relative humidity, with a maximum swing of plus or minus 3% per hour.

In addition, the design of precision environmental control system also faces non-linearities, caused by such system behaviour as air flow delay and dead times, uneven airflow distribution patterns and duct work layouts. Uncertainties in system parameters are often present for example, room size and shape, location of head producing equipment, thermal mass of equipment and walls and amount and timing of external air introduction.

Recognising these challenges the design of a control system in general requires the following terms:

- Precision temperature and humidity control
- Minimization of cycling times, thereby increasing reliability and component life and also resulting in increased energy efficiency.
- Straightforward and therefore inexpensive control electronics.

In short a design should be with simple hardware a non-linear system with significant uncertainties. A fuzzy logic approach was investigated and ultimately implemented. Design specifics the LogiCool control system has six fuzzy inputs, three fuzzy outputs and 144 rules. It runs on a Motorola 6803 microprocessor and is programmed in C.

A fuzzy OR operator (maximizer) is used as the defuzzification technique, avoiding the complicated calculations associated with a centroid approach. As it is found that with the large number of principles, a more elaborate approach is unnecessary. Inputs are sampled, the principle-base accessed and the outputs are updated once a second. The long inter-sample delay allows the 6803, a simple 8 bit microprocessor, to implement this rather large fuzzy system.

Applications of Fuzzy Systems:

The applications of fuzzy systems can be in the following areas:

Environmental Control

Under this area fuzzy system can be successfully used in air conditioners and humidifiers.

Domestic Goods

The fuzzy system can be used for the domestic goods. Under this category common applications include washing machines / dryers, vacuum cleaners, toasters, microwave ovens, refrigerators etc.

Consumer Electronics

Under consumer electronics category fuzzy can be used successfully for television, photocopiers, still video cameras, hi-fi systems etc.

Automotive Systems

Under the automotive system category the common areas, where fuzzy systems can be used, are vehicle climate control, automatic gearboxes etc.

Expert Systems

Expert systems have been the most obvious recipients of the benefits of fuzzy logic, since their domain is often inherently fuzzy. They include decision support systems, financial planners, diagnostic systems etc.

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CONCLUSION

Fuzzy logic deals with uncertainty in engineering by attaching degrees of certainty to the answer of a logical question. It is used in commercial and practical purpose. Commercially fuzzy logic has been used with great success to control machines and consumer products. In the right applications, fuzzy logic systems are simple to design and can be understood and implemented by non-specialists in control theory. In most of the cases someone with a intermediate technical background can design a fuzzy logic controller. The control system will not be optimal but it can be acceptable. Fuzzy logic is not the answer to all technical problems but for control problems, where simplicity and speed of implementation is important then fuzzy logic is very useful.

REFERENCES

Neural Networks and Fuzzy Logic – Arihant Publications (India) Ltd.

http://whatis.techtarget.com/definition/fuzzy-logic

http://www.cs.cmu.edu/Groups/AI/html/faqs/ai/fuzzy/part1/faq-doc-2.html