

This Week's Citation Classic

Zadeh L. A. Fuzzy sets. *Inform. Contr.* 8:338-53, 1965.

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Informally, a fuzzy set is a class with unsharp boundaries. The grade of membership of an object in a fuzzy set is a number in the unit interval or, more generally, a point in a partially ordered set. A theory of such sets is developed and its possible applications are indicated. [The SC][®] indicates that this paper has been cited over 305 times since 1965.]

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"As a mathematically oriented systems theorist, I had been conditioned to believe that the analytical tools based on set theory and two-valued logic are all that are needed to build a framework for a precise, rigorous, and effective body of techniques for the analysis of almost any kind of man-made or natural system. Then, in 1961-1963, in the course of writing a book on system theory (with C. A. Desoer),¹ I began to feel that complex systems cannot be dealt with effectively by the use of conventional approaches largely because the description languages based on classical mathematics are not sufficiently expressive to serve as a means of characterization on input-output relations in an environment of imprecision, uncertainty, and incompleteness of information.

"In July 1964, while I was visiting New York, it occurred to me, more or less accidentally, that what is needed is a concept of graded membership, with the grade of membership in a set taking values in a unit interval or, more generally, in a partially ordered set. A

month later, while I was visiting at Rand in Santa Monica, I described a preliminary version of the theory of fuzzy sets to Richard Bellman. His immediate reaction was highly encouraging and he has been my strong supporter and a source of inspiration ever since.

"I realized from the outset that the adjective 'fuzzy' would create some problems because it is both pejorative and unscientific. Nevertheless, I settled on it because it described more accurately than any other term I could think of the type of imprecision which is associated with unsharp class boundaries.

"Since 1965, more than 2,000 papers and a number of books on fuzzy sets have appeared in the literature. The International journal on Fuzzy Sets and Systems was started in 1978 on the initiative of H.J. Zimmerman and is now a respectable bimonthly periodical. Nevertheless, the theory has its critics. Some allege that it is merely a disguised form of the theory of subjective probability. Some point to the lack of an operational definition of the grade of membership of an object in a fuzzy set. And some are simply skeptical of the ability of the theory to come up with better solutions than those provided by conventional techniques.

"In reality, what the theory of fuzzy sets offers is, above all, a much more expressive mathematical language and a much more flexible logic for the characterization and inference from imprecisely defined relations. Viewed as such, the theory of fuzzy sets is finding many applications in a wide variety of fields ranging from industrial process control to medical diagnosis and information analysis. It is already an active field of research in mathematics and is likely to become—in the not distant future—a standard tool for dealing with systems which are too complex or too ill-defined to be susceptible to analysis by conventional techniques."

1. Zadeh L A & Desoer C A. *Linear system theory-the state-space approach*. New York: McGraw Hill, 1963. 628p.