



# If Not Here, Then Where?

David Alan Grier, Djanghe, LLC

*Some additions to our body of knowledge, such as fuzzy sets, surprised us when they took us in a direction we did not anticipate.*

This is a column that really demands a playful and sardonic introduction. “Is ‘Fuzzy Logic’ by Lotfi Zadeh one of *Computer*’s important articles?” we would ask. We would then postulate that there is a set of important articles from *Computer* that is determined by a fuzzy inclusion function  $\Phi()$ , where  $0 \leq \Phi(x) \leq 1$  for  $x \in \{\text{all articles published in } \textit{Computer}\}$ . When it takes the value of one, it has identified an article that is in the set of highly important articles and hence must be highly important. The value of zero indicates the opposite, that the article definitely does not hold society with the most important *Computer* articles. A value between the two extremes gives

us a sense of the extent to which the article is indeed important. The closer that the value of  $\Phi(x)$  is to 0.5, the closer it is to saying “I can make up my mind.”

We can take the joke further, but we risk a certain amount of social nerdiness in the process. We can ask about the properties of  $\Phi()$ , try to demine how it might be changed by the operator  $\text{Very}()$ , (which should give us  $\text{Very}[\Phi()]$ ), which should identify the most important articles

from *Computer*. Finally, of course, we should try to determine a value for  $\Phi(\text{Zadeh, Lotfi, “Fuzzy logic,” } \textit{Computer})$ ,

## ARTICLE FACTS

- » Article: “Fuzzy Logic”
- » Author: Lotfi A. Zadeh
- » Citation: *Computer*, vol. 21, no. 4, pp. 83–93, April 1988
- » *Computer* influence rank: #296 with 1,031 downloads and 893 citations



21:4, 1988). By doing this, we would have applied fuzzy sets to the problem of determining the importance of an article on fuzzy logic.

This joke wears thin very quickly. The data for this article (as well as for many others) would suggest that  $\Phi()$  would have to be a highly subjective function. The data do not suggest that this article is in the top tier of *Computer* articles. It is ranked only number 296 on the IEEE list of influential articles. It has had a little more than 1,000 downloads and a little fewer than that number of citations. Yet few computer scientists would question the importance of fuzzy logic, Dr. Zadeh, or this article itself. It is difficult to dismiss a subject when four active IEEE conferences contain the word “fuzzy” in their titles.

This article might have a low ranking because it is overshadowed by the literature that Zadeh contributed to the IEEE. In all, he wrote more than 100 articles for IEEE periodicals. More than half of them dealt with fuzzy sets or fuzzy logic. Almost any of them could be an entry point for an IEEE researcher and hence compete with the article that we are considering for importance.


But one of the things we must consider is the role that fuzzy sets have come to play versus the way they were introduced to the computing literature. When articles on fuzzy first began to appear in the 1970s and early 1980s, they were grouped into the field that included knowledge engineering or expert systems. In his first article for *Computer*, published in 1983, Zadeh made the connection quite clear. The techniques developed in this article, he explained, are “relevant to managing uncertainty in knowledge bases—especially the knowledge in expert systems.”<sup>1</sup>



Lotfi Zadeh

In the years that have followed, the position that both expert systems and knowledge engineering had in computer science and engineering has shifted. Expert systems has faded as a subject of research, replaced by the topics of machine learning and neural nets. Knowledge engineering has moved toward the fields of data mining and systems engineering. The work on fuzzy sets has actually moved away from both these fields and is now strongly associated control systems. Indeed, fully two-thirds of all articles that are marked with the key words “fuzzy logic” deal with problems of control and control systems. “The most important and visible application today is in a realm not anticipated when fuzzy logic was conceived,” Zadeh would write, “namely, the realm of fuzzy-logic-based process control.”<sup>2</sup>

While *Computer* has regularly devoted space to developments in control, it has never considered the subjects to be a major topic for its pages. Historically, it has generally devoted no more than 5% of its pages to topics of control and much less than that

percentage to topics of fuzzy systems. These numbers gives us one more hint about how *Computer* supports the body of knowledge. While this article is a substantial introduction to a topic by a major author, it failed to build a major literature within *Computer* or the IEEE Computer Society. Still, fuzzy logic, fuzzy sets, and fuzzy systems all remain important topics in computer science and engineering. If we are only to have a few articles from this body of knowledge in *Computer*, should they not come from the best? 

#### ACKNOWLEDGMENT

For these 2020 columns, “Body of Knowledge” takes its information from a report prepared by the IEEE Publications office on 15 November 2019, and the statistics were current as of that date. Other citation services can and do provide different numbers.

#### REFERENCES

1. L. Zadeh, “Commonsense knowledge representation based on fuzzy logic,” *Computer*, vol. 16, no. 10, pp. 61–65, 1983. doi: 10.1109/MC.1983.1654199.
2. L. Zadeh, “Fuzzy logic,” *Computer*, vol. 21, no. 4, pp. 83–93, 1988. doi: 10.1109/2.53.

DAVID ALAN GRIER is a principal with Djaghe, LLC. He is a Fellow of the IEEE. Contact him at grier@gwu.edu.

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