

# Lessons about Science and Life from Lotfi Zadeh

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**Abstract** In this article, we briefly describe what we learned from our teacher and friend Lotfi Zadeh – and what others can learn from our experience.

**How we know Lotfi Zadeh.** While living in the Soviet Union, we read and enjoyed his papers. After coming to the US, starting from the early 1990s, we saw him every year at various conferences, and we learned a lot from him.

**What was – in our opinion and in the opinion of many others – his main idea.** When we started summarizing all that we learned from Lotfi – and we learned a lot – we realized that all this can be derived by what we consider his main idea: that *everything is a matter of degree*.

**What this implies for science: need to understand limitations of your ideas.** With respect to science, it means that while one’s good research idea has potential benefits, it also has limitations.

It is natural for an author and his followers to over-hype a new idea – we see the hype cycles all the time – but we need to understand its limitations. As Lotfi likes to emphasize, if all you have is a hammer, everything starts looking like a nail. This is not a very productive approach to non-nail problems.

**How can we improve our ideas – by asking others to help.** OK, the idea is not perfect. How can this idea be improved? This idea may be the best the author can do now by him/herself – so to improve this idea, we need others to help. The more researchers know about this idea, the better the chance that it will be improved – so we need to promote this idea as much as possible.

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Lotfi himself was an example of how to promote ideas. He gave, on average, a talk a week – and he taught and nurtured many students. Not all of them remain in fuzzy, but all of them know – and many of them use – fuzzy techniques.

**For this help to be most effective, we need to describe our ideas as simply as possible.** In promoting an idea, any unnecessary complexities are an obstacle, so the description must be as simple as possible. Einstein did that, Zadeh did that. This is kind of opposite to what mathematicians often do: they try to generalize each idea as much as possible. This is often helpful – Zadeh himself pioneered interval-valued and other generalizations of fuzzy techniques – but there should *also* be a simple description.

Some of us used to make friendly fun of his 200+ slide packages of which only a few were shown, but they served the purpose of presentation clarity: if someone had a question about the details, instead of waving hand, Lotfi could show clear well-prepared slides.

**Another way to improve our ideas: to combine them with ideas of others.** Another way to improve our idea is to realize that ideas of others have their own benefits, so it is often productive to combine advantages of different ideas. For example, Zadeh actively promoted the need to combine fuzzy, neural, genetic, and probabilistic techniques – he came up with the term Soft Computing for this combination – and such combinations do help: at the latest fuzzy conferences, most successful application papers combine fuzzy with genetic and neural techniques.

**Disputes are helpful.** Not everyone is tolerant to others' ideas, new ideas often face unnecessary criticisms – and occasional “duels” via arguing publications take too long and are counterproductive. Lotfi often got involved in oral disputes. There, he skillfully disarmed the opponents by conforming that his ideas had limitations and that “competing” ideas had advantages – and this way, in many cases, encouraged many folks in the audience to combine these ideas.

*Comment.* We would to emphasize that the fact that we can have peaceful disputes about controversial subjects is possible not only because of Lotfi – although his skills played a big role – but also because of the American debate culture. When our son starting to go to school in the US, we were pleasantly surprised that in organized disputes, kids could skillfully argue for the side with which they did not themselves agree. This requires a good understanding of both sides of the dispute – something many adults in the US and around the world often lack :-)

**How to deal with people.** Lotfi's main idea also affected his attitude to people. He saw good features in everyone, never hesitated to praise people for whatever good they did – both orally and in writing. His reviews and recommendation letters made everyone feel better, even when they also listed limitations.

He liked to say that he took everything as a compliment – there is always something positive. This brings to mind some Russian anti-Semites who did not like the Jews because the Jews were, in their opinion, too smart. As Jews ourselves, we understand that every nation has its geniuses and its dunces; in particular, there were (and are) a lot of ethnic Russian geniuses – but thanks for the compliment :-).

**What about politics.** His general idea also influences his attitude towards politics. Whether it is internal or international politics, many people see it as black and white, angels with wings vs. devils with horns and hooves – the only difference is who are angels and who are devils. But this is rarely true: each side has good features and bad features, and Zadeh understood and explained that.

He was not the only one. For example, in the early 1960s, the US Government asked Stepan (Stephen) Timoshenko, a renowned Ukraine-born US specialist in mechanics, to visit Soviet universities and report on how they teach and research STEM subjects – Science, Technology, Engineering, and Mathematics. Timoshenko honestly reported that while there are severe limitations on political discussion and freedom of speech in general, the government actively supports STEM education and research – so that US can benefit from their experience and their successes. He was criticized for this report – the Left blamed him for describing Soviet drawbacks, the Right blamed him for praising Soviet successes – but his report helped, both to allow US universities to borrow successful practices and to help US politicians to better fight for human rights in the Soviet Union.

Listening to the two sides, seeing good and bad in both – this is the attitude of a true researcher. And Lotfi was such a researcher.

**We were lucky.** One of the most widely used citation from Talmud, the ancient book of Jewish wisdom, says: “Get yourself a teacher, acquire yourself a friend”. We were lucky: Lotfi Zadeh was our teacher and our friends – and he was a teacher and a friend for many others. We all miss him – and his ideas continue to inspire our life and our research.

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