

WE ALL HAVE A DUTY OF LEAVING OUR IDEAS BEHIND

A conversation with creator of fuzzy logic Lotfi Zadeh

Creator of fuzzy logic, fuzzy mathematics and fuzzy sets theory **Lotfi Asker Zadeh** was born in Baku (Soviet Union) in 1921. His father was an Azerbaijani journalist, mother – Russian physician. In the early 1930's family moved to Tehran. In 1942 Lotfi was graduated from the University of Tehran in electrical engineering. Since 1944 he lives in USA, where he took a Master's degree from Massachusetts Institute of Technology (MIT) in 1946 and a Ph.D. from Columbia (New York) in 1949. Since 1959 Zadeh has taught at Berkeley University. He has been officially on retirement since 1991, but his schedule is still tight.



The list of Professor Zadeh's achievements and awards is extraordinarily long – including medals, fellowships, honorary memberships and doctorates, editorships, and chairmanships from all over the world. He was awarded the esteemed Honda Prize Japan in 1991, and in 1995 the IEEE Medal of Honor *For pioneering development of fuzzy logic and its many diverse applications*. Zadeh is also listed in "Who's Who in the World". In 1993 Azerbaijan bestowed him an honorary Professorship from the Azerbaijan State Oil Academy. Since 2005 he is also foreign member of Polish Academy of Sciences, which awarded him Nicolaus Copernicus Medal.

Anna Ladan: Professor, in the year 1973 you proposed new logic, called fuzzy logic. Why fuzzy logic is, described as cheaper and easier than traditional methods of logic?

Lotfi Zadeh: First of all, there are many misconceptions about fuzzy logic. When people hear fuzzy logic they think that logic is fuzzy. The logic is not fuzzy. The logic is precise, but the objects that logic deals with are fuzzy. It is precise logic of imprecision. In classical logic where you have two values: true and false, in fuzzy logic you have many intermediate values. Truth is not so simply as "true – false" rule, it can have degree. The same is true in multiple valued logic, but fuzzy logic is much more general than Łukasiewicz's logic, because fuzzy logic is much more than logical system. Most of the application of fuzzy logic today has nothing to do with logic, for example this recorder may use fuzzy logic. However, there is no logic in it. What is it used are the concept of linguistics variable and fuzzy "if... then..." rules. Linguistics variable is variable whose values are words. For example, age can be one year, two years, three years – you can be young, middle aged, old – and these are linguistics variables. Fuzzy logic tends to be

more like human logic, and because of that fact it is easier to understand. You feel comfortable with fuzzy logic because this is like the logic that you use all the time yourself. Classical two-valued logic is not like human logic. It is very deep, but difficult to understand even for mathematicians. In my first paper on fuzziness, which was published in 1965, I used the term „fuzzy sets“ that had nothing to do with logic. My first paper in which I began use word “logic” I wrote in period 1974-74. Today fuzzy logic has broad sense, it is used in many products, particularly in consumer products: television cameras, microwave ovens, washing machines,

and many others. The word “fuzzy” is usually used in English in a pejorative sense – if something is fuzzy, it is not good. People have some prejudices, because when they use the word “fuzzy” they think that fuzzy logic is something that is not good. As you see, in English-speaking countries the name “fuzzy logic” creates some problems. In non-English-speaking countries it is not a problem. It happened that in Japan they became interested in it and they had starting use this term. Then from Japan it has spread to other countries.

Fuzzy logic was very popular in the Soviet Union before it collapsed. Also in members of Comecon – Poland, Romania, Czech Republic fuzzy logic was well known and acclaimed. In all of these countries fuzzy logic was popular, and it was used in many, many applications. In 1980 there was a big conference in Moscow – all Union conference on fuzzy sets, in 1990 – in Beijing. After the Soviet Union collapsed, works on fuzzy logic in neighbourhood countries went down too. There's not having the kind of government support before the collapse. In Poland today there are many people doing very good work

You have mentioned Japan. I heard Japanese scientists are very interested in fuzzy logic. Is that true?

Yes, it is. In Japan they are very advanced and they have many engineers working on fuzzy logic products. Not only in Japan but in Asian countries; also China, Vietnam, Hong Kong, South Korea, Singapore. What I see that in those countries the governments are pushing development of this branch. This is not done in Europe. Siemens has fuzzy logic products.

Do you really think that the main reason of that are governments' actions?

In general in these countries government pushes all science. Governments are much more active than they are in Europe.

You left Europe many years ago and you have lived in USA to these days.

I am the citizen of the United States. I was born in Baku, but I was not Soviet citizen, I was an Iranian citizen. In 1944 I came to the States as an immigrant, not as a student. Iran is a wonderful country but I could not do scientific work. Becoming rich was possible, but I did not want to be rich and spending my life playing cards. That is why I came to the States. I started my graduate studies at MIT, where in 1946 I received my master degree. I could to stay there to continue my doctoral studies, but my parents moved to New York this time. I wanted to be near them; therefore I started study at Columbia University.

When did you start thinking about fuzzy logic?

My first paper about it was published in 1965. The work was done in 1964, of course, but I felt earlier that something has to be done, because classical mathematics is little too black and white. Human concept is not black and white. You are honest to a certain degree; you are beautiful, young, and tall - all to certain degree. Classical logic consists on two values only, true and false. It does not fit well to reality; it is two-dimensional. At this point there are 50 thousands people in the INSPEC's database with "fuzzy" in title. In another mathematical sciences database there are 14 thousands titles. As you see, today many people do on fuzzy logic. However initially people were very critical. Sometimes I give a lecture. For all hour I talk about all kinds of the bad things that people say about fuzzy logic. Luckily I have very thick skin.

What kinds of application of fuzzy logic are most interesting for you? Not only today, but also in the future.

It is really hard to say, because there are really many applications. At this point, so far as my work is concerned, I am very much interested in application to natural language understanding. I feel this is crucial. This is a central problem, because there are many other problems whose solutions depends on natural language. But things change, so my presentation at London is concerned with something what I called FL+ - "extended fuzzy logic". It is a new direction.

What direction? Could you explain this?

For example you want to climb the mountain. You drive by car as far as you can, but there will be the point, from which you cannot drive a car. You need a mule. Later you have just to climb. This is what I do now. I am climbing. Let me give you an example problem: automation of driving a car in city. You can automate in city with very light traffic, so this impossible in a city like London, New York or Warsaw. If you put together all the computers from the world you can solve the problem. Problem with traffic cannot be solved by using traditional theories. In my London presentation I wanted to start with the problem. Let's take a situation: I called a taxi and I say to a driver: take me to this address the shortest way. And to another driver I say: take me to this address the fastest way. Two different problems. The first is a solution, but the second is not. You can take me but you cannot prove that is a good solution. In the case of the second problem the shortest way you can prove that is the best solution or not. I consider this

problem now. Some problems have scientific solutions, and some problems have not. Only human can do it, but one cannot automate. Problem of automation a car in city traffic does not have a scientific solution.

Another problem which we have difficulties is the problem with summarization. Today we have programs, which can summarize only very simple things. The question is what can I use? Classical logic does not work. Fuzzy logic does not work. I need extended fuzzy logic. Let me tell you how systems became available now. In the USA at this point you can subscribe GPS system, today in combination with databases. If you are looking for sushi, it tells you that nearest sushi restaurant is here. GPS knows where you are.

The nearest does not mean the best. Do not you think the next step should be the best place?

Yes, indeed, GPS shows only the nearest place (laugh). Do you use Google? Google is a search engine. Questionnaire system is a system that answers questions. Google cannot do that. For example, if you ask the question: what is my telephone number? How old was Clinton when he graduated Yale University? It is not able to do it. It cannot answer the questions. Existing search engines do not have deductive capability, they cannot reason. Salesman was demonstrating questionnaire system to the customer. He said, "Ask any question that you wish and the system will answer it". Client asked a question and the system answered. Second question, the system answered. Then client said to the salesman: "You know, I think I can ask your system a question on which it will not ask". Smiling salesman, "Try, but it will answer". Client said, "What is my father doing now?" The system was working for a while and printed, "At this moment your father is fishing in Maine". "It's wrong", said the client, "My father passed away few years ago." The system knows only that what you put on it. It does not know that your father died, you have put this information into the system. System printed second sheet of paper, "You do not understand. The person who passed away ten years ago was the husband of your mother, but your father is fishing in Maine". Therefore, we find out that this client was son of the lover. Now is dangerous to ask questions. The system knows more than you do.

When we are talking about family: your roots are very intriguing. Your father came from Iran and your mother was Russian. Goethe, whose mother was Italian, always stressed that German and Italian elements compounded on his originality and genius. What is your approach to such theories?

Firstly, I am not a man of two cultures! My culture is the Russian culture. My mother was Russian and so I am. Of course, I have been lived in United States for over sixty years, but I speak Russian, I think in Russian, my accent is still Russian, I am totally interested what is going on in Moscow. I am reading Russian writers and listen to Russian music. Shostakovich, Prokofiev - these are my heroes.

Then, if you do not like talking about the past, tell me what would you want to be remembered for most?

I do not like to forecast, because I live today and I could be dead tomorrow. I don't care about fame or something

like that. What I try to do at this point is to take some of my ideas and write them up. Some something will be left. If you have ideas and you do not write them up, they will disappear and no one memorizes them.

What advice would you give to young people as they enter to XXI century?

Basically they are very good feeling with computer science field. Those people who are keen on with computers find good jobs, especially in Poland. It is not for everybody; you have to have some capabilities. There are some people who are unsuited for career in computer sciences. Within computer sciences is computational intelligence – it also very good field. In United States robotics was very popular, but then were expectations, which did not materialise, so robotics starting going down. It became a bad word. So, it used in industry mostly of automation of production. In Japan I visited Matushito factory, where they make VCR's. In the whole factory were two-two people. Everything is doing by machines. Automated assembly, it's not a robot. On the other hand, robotics became popular in Japan, especially if we talk about humanoid robotics. Japan has no competition in this field. Many companies – Honda, Sony – all have humanoids robots. It is prestige. Maybe not useful, but when Honda humanoid robots dancing, people are thinking, "if they can do this, they can also produce good cars". From advertising point of view it's very useful, so they use it mostly for that purpose. Japan is number one in robotics today.

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