

Preface

Valery Tarassov¹, Vadim Borisov² and Boris Kobrinskii³

¹ Russia, Moscow, Bauman Moscow State Technical University

² Russia, Smolensk, Branch of the National Research University “Moscow Power Engineering Institute” in Smolensk

³ Russia, Moscow, Federal Research Center “Computer Science and Control”, RAS

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In front of you, there are the proceedings of the 10th International Scientific and Practical Conference “Integrated Models and Soft Computing in Artificial Intelligence” (IMSC-2021). All previous conferences were also held in the ancient Russian city of “three rivers”, where the quiet river Kolomenka flows into the Moskva River, which carries its waters into the wide Oka. It is a historic city, from where Prince Dmitry Donskoy set out with his army at Kulikovo Field in 1380. The conference venue is located very close to the “heart” of Kolomna – its Kremlin, against the background of the wall of which near the Marinkina tower stands a monument to Dmitry Donskoy on horseback.

Our conference is the same age as the 21st century. Twenty years ago, on May 17-18, 2001 in Kolomna, the first scientific seminar of the IMSC was held under the chairmanship of a leading specialist in the field of intelligent modeling, professor V.V. Emelyanov. The local organizer of the first seminar was E.G. Zafirov.

Since then, the May Kolomna seminars have become traditional and are held once every two years. Since 2007, due to the diversity of topics, the expansion of geography and a significant increase in the number of participants, they have acquired the status of conferences.

Of course, the seminar in 2001 was far from the first scientific event on artificial intelligence (AI) in Kolomna. Moreover, Kolomna is the “cradle” of the Russian scientific community on AI. In May 1989, on the initiative of the founder of artificial intelligence in our country, professor

D.A. Pospelov, the Founding Congress of the Soviet Association of Artificial Intelligence (SAAI) was held in Kolomna, at which the Charter of the Association was adopted, its scientific council and executive committee were elected.

Then, two years later, the II Congress of SAAI and a representative international conference were held in Kolomna.

In this regard, one should recall the early deceased student of professor D.A. Pospelov – A.F. Blishun, a talented scientist, who organized all these scientific events in Kolomna.

In 1996, the Association of Artificial Intelligence became Russian (RAAI), and in 2002 the Eighth National Conference on AI was held in Kolomna. And on May 17, 2005, after the third IMSC seminar, a congress of the Russian Association for Fuzzy Systems (RAFS) was held, at which a memorandum on the transformation of the RAFFS into the Russian Association for Fuzzy Systems and Soft Computing (RAFSSoftCom) was announced. So, both of our scientific communities on artificial intelligence and soft computing, based on the interaction of complementary methods and technologies of fuzzy logic, neural networks, bionic algorithms, Bayesian models, chaos theory, etc., were officially created in Kolomna.

Our conference is timed to coincide with a significant date – the 100th anniversary of the birth of an outstanding scientist of our time, the founder of the theory of fuzzy sets and soft calculations, Professor Lotfi Zadeh. A ceremonial meeting dedicated to the life and scientific heritage of the “Father of Fuzzy Logic” is planned. A large report will be made by a team of authors on the stages of the scientific path and the main results of the outstanding scientist. Well-known Russian experts in the field of fuzzy

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EMAIL: vbulbov@yahoo.com, vbor67@mail.ru, kba_05@mail.ru



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systems and soft computing, who knew Professor Lotfi Zadeh in person and who have met with him many times – A.N. Averkin, S.V. Prokopchina, V.L. Stefanyuk, V.B. Tarassov, A.V. Yazenin, N.G. Yarushkina, I.Z. Batyrshchin (online).

The fate of Lotfi Zadeh is surprisingly intertwined with the history of our country. He was born on February 4, 1921 in Baku (Soviet Azerbaijan) and the first months of his life fell on a difficult period of transition from the Russian Empire to the USSR, which was formed almost two years after the birth of L. Zadeh. Lotfi lived in the USSR for over 10 years, and he studied at a Russian school in Baku, and his native language is Russian. In the early 1930s, his parents took him to Iran, to his father's homeland, from where he left for the United States, where in 1944 he entered the Massachusetts Institute of Technology, from which he graduated with a master's degree in 1946. In 1949 he defended his PhD thesis at Columbia University, where he then quickly went from assistant (1950) to full professor (1957). In 1959, Professor L. Zadeh transferred to the University of California at Berkeley, where he worked all his life. He lived a surprisingly long life in science, which he was actively engaged in for about seven decades, and died in Berkeley on September 6, 2017 at the 97th year of his life, just a couple of months before the 100th anniversary of the October Revolution.

Professor Lotfi Zadeh was a great friend of Soviet and Russian scientists. His close friends in the 1960s–1980s were academicians N.N. Moiseev, R.M. Gamkrelidze, V.A. Ilyin, G.S. Pospelov, Ya.Z. Tsytkin and others.

In a number of interviews, he described himself as “an American professor of applied mathematics who received his basic electrical engineering education in Iran and was born in Russia”. The image of Russia periodically resurfaced in his memory. When we met with him in the 1990s–2000s, he was always keenly interested in how things were in Russia.

Now one should add the following to his characterization of himself: “those who have found eternal peace in their native Baku (Azerbaijan Republic) on the Alley of Honorary Burial”.

In 1965, already a well-known scientist in the field of systems analysis and automatic control, Professor Lotfi Zadeh published the main work of his life in the journal “Information and Control” – the fundamental article “Fuzzy Sets”.

This work of great historical significance gave impetus to a new scientific direction, which caused a powerful resonance throughout the world. L. Zadeh's key idea was that real human reasoning based on natural language cannot be adequately represented within the framework of traditional mathematical formalisms. The introduction of fuzzy sets – of classes with inaccurately defined boundaries, described by membership functions (generalizing the characteristic functions of ordinary sets) – provided the basis for the development of a more flexible approach to the analysis of reasoning and modeling of complex humanistic systems, the behavior of which is described by linguistic rather than numerical variables. This article initiated a huge stream of publications in the field of fuzzy mathematics, which still continues. True, in the 1960s–1970s, L. Zadeh's unorthodox ideas met with a very wary and sometimes cold reception in various scientific circles, especially among “pure mathematicians”. However, the practical potential of the theory of fuzzy sets and fuzzy logic, their ability to model flexible and imprecise constraints, partial manifestation of properties, smooth transition from one situation to another attracted a real army of applied people to this area. Over the past thirty-five years, numerous applications of methods and models of fuzzy mathematics have been developed in pattern recognition, image analysis, expert systems, decision support systems and many, many other areas. Special mention should be made of fuzzy control models, which have found the broadest industrial application, ranging from household appliances (vacuum cleaners, washing machines with fuzzy logic) and ending with the management of complex technological processes (control of a blast furnace process, control of nuclear power units) and dynamic objects (subway trains, cars, helicopters, robots, etc.).

Lotfi Zadeh was one of the very few pioneering scientists who, not stopping at what has been achieved, continue to generate original scientific ideas and form new scientific directions. In addition to the theory of fuzzy sets and linguistic variables, he created fuzzy logic and the theory of approximate reasoning, the theory of possibilities and soft computing, the theory of information granulation and computations with words and perceptual estimates, the generalized theory of constraints and the related general theory of uncertainty, the theory of Z -numbers. Almost every publication of his became an event in the scientific world.

Among the most famous works of L. Zadeh, written in the 1970s, it should be noted: “Foundations of a new approach to the analysis of complex systems and decision-making processes” (1973);

“The concept of a linguistic variable and its application to making approximate decisions” (1975–1976); “Local and Fuzzy Logics” (with R. Bellman) (1977); “Fuzzy sets as the basis of the theory of possibility” (1978); “The theory of approximate reasoning” (1979); “Fuzzy sets and the granular structure of information” (1979).

In the first two works, the concept of a linguistic variable was introduced and described, ways of its application in intelligent systems and control were considered. It was here that the ideas and principles of control based on fuzzy logic were formulated, which were then embodied in the technology of fuzzy controllers. There were also developed such formal constructions as fuzzy sets of type 2 and higher.

In an article on the basics of the theory of possibility, which opened the first issue of the international journal “Fuzzy Sets and Systems”, L. Zadeh proposed a variant of the calculus of uncertainties, based on a non-additive measure of possibility and the interpretation of a fuzzy set as a distribution of possibilities. Unlike a fuzzy set, which expresses the inaccuracy of the assessment of a certain attribute, the measure of possibility describes the uncertainty or incompleteness of information associated with the appearance of a particular event. In fact, this is a way of quantitatively describing (representing the meaning) of expert judgments, which is a generalization of interval analysis and the theory of errors. Currently, the measure of possibility and its dual measure of necessity act as fundamental models of uncertainty in intelligent systems.

The article on local and fuzzy logics develops the origins of Ya. Lukasevich and N.A. Vasiliev, the ideas of logical pluralism and relativism, in the work on the foundations of approximate computations, options for using the methods of the theory of possibility for describing the semantics of natural languages are considered, and in an article on the role of fuzzy sets in the process of granulation of information, the concept of granules is introduced and models of granulation (generalization and detailing) of information are proposed.

In the 1980s, professor L. Zadeh continued his intensive work on the problems of the development of fuzzy logic and the theory of possibilities, as well as their application in intelligent systems. So, in the article “The role of fuzzy logic in the management of uncertainty in expert systems” (1983), he described a way of using fuzzy logic in the interests of presenting inaccurate information and built a number of inference rules based on the combination of evidence. Then he wrote a series of articles devoted to the issues of modeling common sense reasoning: “Theory of common sense knowledge” (1984), “Syllogisms in fuzzy logic and their application to ordinary reasoning and reasoning with dispositions” (1985), “Computational theory dispositions” (1986) and others.

Classical intelligent systems based on symbolic information processing and Boolean logic do not use numerical methods to account for uncertainty and fuzziness, relying on the technology of Hard Computing. The corresponding computer programs are examples of closed systems that are difficult to modify; in them the possibilities of self-organization, cooperation, evolution of components are virtually absent. In his work “Soft computing, fuzzy sets and neural networks” (1992), professor L. Zadeh was one of the first to propose a variant of building a hybrid intelligent system by joint use of heterogeneous models in order to compensate for their shortcomings and combine advantages; in this case, as a consequence, it is possible to obtain synergistic (nonlinear) effects. In soft computing, three aspects of intelligence – uncertainty management, learning, and evolutionary adaptation – are combined by representing fuzzy production models in a trained neural network, which is optimized by using genetic algorithms. More complex hybrids are also possible, including, in addition to the indicated components, chaotic models, evolutionary computations, probabilistic reasoning, Bayesian networks and their extensions, learning models, etc.

In addition to soft computing, in the 1990s L. Zadeh's interests were associated with the development of a methodology for computing with words, as well as the computational theory of perceptual evaluations. Among the works published during this period, one can note “Fuzzy logic = Calculations with words” (1996), “Fuzzy logic and calculus of fuzzy rules and fuzzy graphs” (1997), “From calculations with numbers to calculations with words, from manipulation of measurements to manipulation of perceptual estimates” (1999–2000), “Notes on the computational theory of perceptual estimates based on calculations with words” (2000).

“Father of fuzzy logic” continued active scientific work in the 2000s. So, in 2005 he published the fundamental work “Towards a general theory of uncertainty”, in 2009 – the article “Extended fuzzy logic: first steps”, and in 2011 introduced the concept of Z-numbers.

The viability of any theory is largely determined by its evolutionary potential, the possibility of expanding the basic concepts and constructions, as well as the emergence of new approaches adjoining this theory, and sometimes competing with it. In this regard, the movement generated by

L. Zade's pioneering work on fuzzy sets is developing fruitfully. His students and followers proposed such mathematical constructions as *L*-fuzzy sets with membership values in a distributive lattice, *P*-fuzzy sets with interval membership values at each point, level fuzzy sets, intuitionistic fuzzy sets, etc. (to one degree or another) alternative approaches – random sets, probability sets, Bayesian networks, evidence theory, underdetermined sets, approximate sets, soft sets.

The role of Lotfi Zadeh in the modern world is not limited only to specific areas of science. His unusual personal biography, all his life and international activities made a valuable contribution to the formation of the planetary scientific community of the 21st century, showed the way to the creation of a new scientific worldview, involving a symbiosis of the achievements of Eastern and Western cultures.

After reviewing the X-th International Conference “Integrated Models and Soft Computing in Artificial Intelligence”, 75 papers were accepted. As a result, the conference program was formed, which includes 15 plenary reports of leading scientists and specialists, including 4 online presentations, as well as 60 section reports, distributed in 10 sections. The conference is attended by scientists and specialists from 19 cities of Russia (Moscow, St. Petersburg, Belgorod, Vladivostok, Volgograd, Yekaterinburg, Izhevsk, Kazan, Kaliningrad, Kolomna, Novosibirsk, Orenburg, Rostov-on-Don, Simferopol, Smolensk, Tambov, Taganrog, Tver, Ulyanovsk), from Azerbaijan, Belarus and Mexico. In this collection of proceedings of the conference published 46.

During the preparation for the publication of this collection of works, the sad news came about the sudden death of Valery Tarassov. He was one of the founders of SAI (now RAI), as well as RAFSSoftCom.

From 2019 to 2021, V.B. Tarassov was the president of RAFSSoftCom. He was the founder and organizer of all conferences “Integrated Models and Soft Computing in artificial Intelligence” from 2001 to 2021.

Valery Tarassov was one of the leading experts in the field of AI, distinguished by his encyclopedic knowledge. He has obtained fundamental results in the field of AI methodology, a systematic approach to AI and synergetic AI, semiotic modeling, the theory of agents and multi-agent systems, the theory of fuzzy sets, soft computing and measurements. He actively developed and implemented such areas as intelligent computer- aided design systems, virtual enterprises, organizational design, modeling and reengineering of enterprises, knowledge management, methods of creating network and intelligent enterprises.

We will keep the bright memory of Valery Tarassov, a wonderful and amazing Person, a Friend and a Scientist.