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# Contributions of some scientists to the development of artificial intelligence in Azerbaijan

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## ABSTRACT

Artificial intelligence, which has recently permeated various spheres of society, is one of the key areas of computer science. It is a synthetic and multidisciplinary field that integrates numerous areas of knowledge. Numerous scientific disciplines contribute to the formation and development of artificial intelligence, including mathematics, formal and fuzzy logic, artificial neural networks, soft computing, machine learning, artificial immune systems, linguistics, neurophysiology, psychology, and philosophy. Therefore, the emergence and continuous evolution of artificial intelligence have led to the rapid advancement of science and technology worldwide. The theory developed by Lotfi A. Zadeh, which plays a crucial role in establishing the theoretical foundations of artificial intelligence, occupies a special place in global science. This article examines the study and promotion of Zadeh's fuzzy logic theory in Azerbaijan within the scientific community. Additionally, the article analyses research conducted by Azerbaijani scholars in the field of artificial intelligence, explores the emergence of artificial intelligence in Azerbaijan, highlights key achievements in this area, and evaluates the contributions of certain scientists to the development of artificial intelligence.

## 1. Introduction

In recent years, the realities shaped by artificial intelligence and smart technologies have rapidly permeated human life and increasingly determining the strategic power of states. Artificial intelligence technologies are widely applied in both civilian and military domains, gradually emerging as one of the defining paradigms of the modern era (Alguliyev, 2023). Over the past decade, AI-related technologies have advanced more rapidly and begun to have a profound impact on various aspects of daily life (Tobin et al., 2019).

A retrospective analysis of history indicates that concepts regarding artificial intelligence have appeared in various forms at different periods. In 1920, the Czech writer Karel Capek gained

worldwide recognition with his play R.U.R. (Rossum's Universal Robots). This science fiction work was the first to introduce the term "robot" (derived from the Czech word "robota", meaning "hard labour" or "slavery"), introduced early conceptualizations of robots, and explored the relationships between humans and machines (Capek, 2004).

Another prominent figures in science fiction, Isaac Asimov, proposed a number of influential theories and concepts related to artificial intelligence in his 1950 work I, Robot. In this book, he also formulated fundamental principles concerning the creation and operation of robots. Through his well-known Three Laws of Robotics, Asimov established a set of rules governing human-robot interaction. According to these laws, a robot must follow human commands, not harm

human beings, and defend its own existence. (Igorevich, 2019).

Following the 1940s, a solid scientific, theoretical, and technological foundation was established for the implementation of artificial intelligence concepts, and researchers began to engage intensively in this field. The rapid advancement of science and technology led to the development of computers, which in turn raised fundamental questions among scientists, such as: If a computer is capable of performing certain computational and logical operations, can it also perceive, think, and make decisions? What would occur if a robot were to question its creator? How should the boundaries between humans and machines be defined? (Smith et al., 2006). These reflections provided as a strong impetus for the emergence of artificial intelligence as a scientific area.

In 1943–1944, the renowned English mathematician Alan Turing proposed the concept of an “electronic brain”, an idea that was considered highly speculative and visionary (Numerico, 2005). His seminal article “Computing Machinery and Intelligence”, published in the journal *Mind* in 1950, laid the theoretical foundations of artificial intelligence and made a substantial contribution to the development of the field (Smith et al., 2006). In this work, he introduced “Turing Test”, which provided a framework for human–computer dialogue and aimed to determine whether a computer or other machine could demonstrate intellectual behaviour comparable to that of a human being (Michie, 1993).

In 1943, US scientists Warren McCulloch and Walter Pitts proposed the first mathematical model of a natural (biological) neuron - an artificial neuron (McCulloch et al., 1943).

In the 1950s, the world-renowned Azerbaijani scientist Professor Lotfi A. Zadeh, who made significant contributions to the development of global scientific, philosophical and technological thought, also turned his attention to problems related to artificial intelligence (Trillas, 2011). The early stage of Zadeh’s academic career coincided with the emergence of computers and information theory, as well as with the onset of the Cold War between the United States and the Soviet Union. He began his scientific career at Columbia University, where he conducted research in probability theory, systems theory, and information systems. Simultaneously, he also delivered lectures on information theory and network analysis. In the 1950s and 1960s, Professor Zadeh’s primary research focused on

problems of systems analysis and optimization (Zadeh, 1950).

Professor L. Zadeh’s publications on fuzzy sets and fuzzy logic brought him international recognition in the scientific community. These works were published in leading scientific journals worldwide (Mardanov et al., 2021).

In 1950, Professor Zadeh published his first scientific studies related to artificial intelligence theory, “Thinking Machines: A New Field of Electrical Engineering” and “Extension of Wiener’s Prediction Theory” (Dzitac et al., 2017).

In 1951, Marvin Minsky and Dean Edmonds developed one of the earliest stochastic neural network devices, known as the Stochastic Neural Analog Reinforcement Calculator (SNARC). This system represented one of the first experimental attempts toward the development of artificial intelligence concepts (Zufarova et al., 2023).

In 1955, the Dartmouth Summer Research Project on Artificial Intelligence outlined the initial objectives and future research areas for the systematic study of artificial intelligence, marking a major milestone in the formal establishment of the field (McCarthy et al., 1955).

In 1956, one of the most significant events in the history of artificial intelligence took place. During a summer research seminar at Dartmouth College, which brought together leading scientists and experts in the field (fig. 1), the American researcher John McCarthy introduced the term “artificial intelligence” for the first time (Moor, 2006).



**Fig. 1.** Dartmouth College summer seminar

In 1957, Frank Rosenblatt, an American psychologist and a prominent contributor to the development of computer science and artificial intelligence, introduced the concept of the perceptron, one of the earliest models of artificial neural networks (Cristofaro et al., 2025). This model laid the groundwork for a new phase in the development of neural network architectures and

related conceptual frameworks. The MARK I computing system developed by Rosenblatt in 1958 is widely considered as the first neurocomputer (Yasnitsky, 2015).

Expert systems began to emerge in the mid-1960s. During this time, early systems such as DENDRAL, MYCIN, and PROSPECTOR achieved notable success during this period, marking the formation of artificial intelligence as a scientific area capable of producing practical results. DENDRAL, one of the earliest artificial intelligence systems, was applied in chemistry, particularly for organic compounds analysis. In medicine, The MYCIN system was applied to diagnose bacterial infections, coagulation disorders, and to recommend the best course of antibiotic treatment. The PROSPECTOR system was employed in the exploration and evaluation of mineral deposits, drawing on principles associated with fuzzy logic (Gribeniuk, 2023).

Although ideas related to artificial intelligence were not yet widespread in the mid-1950s and throughout the 1960s and 1970s, advances in computer technology and the development of more effective artificial neural network models gradually increased scientific interest in the field and extended its research scope.

The theory of fuzzy sets and fuzzy logic proposed by Professor L. Zadeh in 1965 marked the beginning of a new era in the development of artificial intelligence, as well as cybernetics and informatics, and brought about a revolutionary shift in scientific thinking (Zadeh, 2021). Compared to classical logic theories, this approach was more general and more closely reflected the nature of human reasoning.

Fuzzy logic theory has since achieved widespread application across science and technology, as well as in numerous industrial domains worldwide (Zadeh, 2015). In 1966, Professor Zadeh presented a report on fuzzy language and its relationship to human and artificial intelligence at the International Congress of Mathematicians in Moscow. Furthermore, his report delivered in Paris in 1979 was particularly important for understanding the evolutionary stages of his ideas on artificial intelligence.

As a result of Professor Zadeh's consistent and systematic research efforts, substantial progress has been achieved in the development of fuzzy logic theory since 1965 (Trillas, 2011).

In the 1980s, the establishment of the "Situation control" (Ситуационное управление) scientific school by the renowned cybernetic scientist

Dmitry Pospelov in the Soviet Union, along with the founding of the USSR Artificial Intelligence Association, played a significant role in advancing artificial intelligence research (Aliyev, 2009).

During the same period, the rapid advances in artificial neural networks and the emergence of the field of soft computing, together with the application of fuzzy set theory and nature-inspired algorithms, provided a strong impetus for the further development of artificial intelligence.

Despite several achievements, the scientific, theoretical, and technological foundations of artificial intelligence were still insufficiently developed at the time. It required considerable time to implement AI concepts and establish its mathematical and physical foundations. However, during the 1980s and 1990s, research in fuzzy logic theory, soft computing, artificial immune systems, genetic algorithms, and particularly artificial neural networks contributed to the revival, rapid advancement, and consolidation of the scientific and theoretical foundations of artificial intelligence (Alguliyev, 2023).

## 2. Related work

Although artificial intelligence is considered a new field of knowledge in the modern era, its origins and conceptual foundations date back to earlier periods (Santos, 2025). The development of the information society is closely linked to the rapid advancement of artificial intelligence technologies and digital technologies (Pashayeva, 2025).

The scientific foundations of artificial intelligence were formed in the middle of the 20th century, and the evolution of this field was closely related to the parallel development in computing technology, mathematical logic, and other exact sciences. Artificial intelligence has radically transformed traditional working methods in all fields of knowledge (Valdiviezo et al., 2023).

The achievements made by Norbert Wiener in the field of cybernetics in the 1940s and 1950s played a crucial role in the development of artificial intelligence (Cristofaro et al., 2025).

Logic Theory Machine (1956) and General Problem Solver (1957), two of the earliest programs were developed at the early stage of artificial intelligence research. The authors of the programs, American scientists Allen Newell and Herbert Simon, were awarded the Turing Award in 1975 for their significant contributions to

fundamental research in artificial intelligence (Newell et al., 1956).

The 1970s–1980s are remembered as the era of expert systems in artificial intelligence research. Systems such as MYCIN demonstrated high accuracy in medical diagnostics and proved the actual application potential of artificial intelligence (Buchanan et al., 1984).

The 1980s are also characterized as the era of the industrialization of artificial intelligence. Advances in computing power and the development of complex artificial intelligence algorithms led to the development of more powerful computers. However, development of artificial intelligence was not always smooth. The decline in funding and reduced interest in artificial intelligence led to slowdown in development, later became known as the “AI winter” (Toosi et al., 2021).

Since the 1990s, statistical methods and machine learning approaches have become dominant in artificial intelligence research. During this period, Bayesian networks, hidden Markov models, and data mining methods have become prevalent, thus significantly expanding the range of application of artificial intelligence (Mitchell, 1997).

In recent years, scientific research has increasingly addressed not only technological, but also social, ethical, and philosophical aspects of artificial intelligence (Russell et al., 2021). This also highlights the importance of analysing the impact of artificial intelligence on society within a historical context and in a phased manner.

The study of the history of artificial intelligence in Azerbaijan is of great relevance for understanding the path of scientific and technological development of the country and formation scientific schools. Moreover, analysing the evolution of artificial intelligence allows to assess the role of Azerbaijan in global scientific and technological processes, to organize future activities in this field more effectively, and to provide scientific support to the state's digital development policy.

**Problem statement.** The primary objective of the research is to provide a systematic historical analysis of the progress of artificial intelligence in Azerbaijan. The article evaluates the formation and development stages of artificial intelligence in Azerbaijan not only in the context of modern digital technologies, but also as a continuation of scientific research conducted in the field of cybernetics and automated control systems since the 1970s and 1980s. This approach allows to

analyse the period in which the ideas in artificial intelligence were formed in Azerbaijan, to assess the role of scientific schools and research initiatives.

### 3. Material and methods

#### 3.1. Research methods

This study is devoted to scientific analysis of historical formation and development of artificial intelligence in Azerbaijan. The research draws on a wide range of international and national scientific sources on artificial intelligence, including articles, monographs, books, and conference proceedings published in journals indexed in Scopus and Web of Science.

Within the framework of the study, theoretical and methodological approaches to the emergence and global development of artificial intelligence are first analysed, followed by an examination of how these approaches were adapted and transformed within the Azerbaijani scientific environment. Particular attention is paid to the dynamics of artificial intelligence concepts in relation to cybernetics, automated control systems, mathematical modelling, and information technologies.

The article employs methods of historical analysis, comparative analysis, and systematic structuring of scientific sources. Historical analysis makes it possible to define the stages of the emergence of artificial intelligence ideas in Azerbaijan, key periods of development, and major institutional transformations. In addition, the study presents a systematic overview of the evolution of artificial intelligence in the context of advances in information and communication technologies, intelligent systems, and related fields during the years of independence, beginning with the development of computer science in Azerbaijan in the Soviet period. The research conducted forms a scientific and methodological basis for a more in-depth study of the history of artificial intelligence in Azerbaijan and for conducting complex research in this direction.

#### 3.2. Problem solution

The rapid development of artificial intelligence at both global and regional levels has highlighted the importance of systematically and comprehensively studying the history of this field. In order to examine the historical challenges of

artificial intelligence in Azerbaijan, it has become necessary to analyse the contributions of scientists who have played a key role in its development, to systematize the research conducted and to investigate the historical development stages of artificial intelligence on a scientific basis. The study examines the chronological phases of artificial intelligence development in Azerbaijan, as well as the activities of leading scientific institutions and research areas.

### 3.2.1 Lotfi Zadeh's theory in Azerbaijan

Lotfi Zadeh is one of the prominent pioneer scientists who led to serious changes in the history of science with his fundamental views and theories. The theory of fuzzy logic, developed as a result of his systematic and long-term research, has significantly influenced the development of numerous scientific disciplines and introduced new methodological approaches. This theory has had a substantial influence on the development of advanced intelligent technologies and has played a significant role in shaping the foundations of modern management systems and information and communication technologies (president.az, 2021).

In the early stages of his scientific career, Professor L. A. Zadeh conducted research on classical logic and mathematics. His studies during this period focused on automatic control theory, the analysis and synthesis of identification systems, filtering problems, and z-transforms (ict.az, 2021).

Professor Zadeh's first visit to Azerbaijan, specifically to the city of Baku, took place in 1965 at the initiative of Academician Ismayil Ibrahimov. This visit followed an international scientific conference on automatic control organized by the International Federation of Automatic Control (IFAC), held aboard the ship Admiral Nakhimov in the Black Sea.

In 2008, at the invitation of the Ministry of Communications and High Technologies of the Republic of Azerbaijan, Professor Lotfi Zadeh took part in the BakuTel International Exhibition and Conference on Telecommunications and Information Technologies, marking his second visit to Azerbaijan. During this visit, Professor Zadeh met with the President of the Republic of Azerbaijan, Ilham Aliyev (fig. 2). On November 10, 2008, a major meeting was held at the Presidium of the Azerbaijan National Academy of Sciences (ANAS) with the participation of Professor Zadeh, during which he was awarded a diploma as a foreign member of ANAS. At this

meeting, Professor Zadeh delivered a comprehensive presentation to Azerbaijani scientists on his scientific achievements and the theory of fuzzy logic (Guliyeva, 2023).



**Fig. 2.** Meeting of Professor Lotfi Zadeh with President Ilham Aliyev

A number of books dedicated to Prof. L. Zadeh, "The Luminary of Modern Science" and "The World Cannot Live Without Geniuses" have been published, the documentary film "Far and Near Lotfi Zadeh" had been produced. Additionally, the "Zadeh Heritage and Artificial Intelligence" Association and the International Academy of Modern Sciences named after Lotfi Zadeh have been established in recognition of his scientific legacy (science.az, 2022). In February 2011, by decree of the President of the Republic of Azerbaijan, Ilham Aliyev, the world-renowned scientist was awarded the "Friendship" order for his contributions to technological development and his services in promoting intercultural dialogue.

At the meeting of the Presidium of ANAS held on April 20, 2016, the scientist was awarded the "Gold Medal of the Republic of Azerbaijan named after Nizami Ganjavi". Prof. Zadeh passed away in 2017 in Berkeley, California, USA, and his body was brought to Azerbaijan in accordance with the scientist's will and buried in the first Alley of Honor.

Professor L. Zadeh's fuzzy logic theory played an important role in the widespread dissemination of research in artificial intelligence in the Azerbaijani scientific environment and the formation of new ideas. Since the late 1970s, a well-known scientist, Corresponding member of ANAS, Professor Rafiq Aliyev has conducted research in the field of fuzzy set theory and fuzzy logic, making significant contributions to the development of the scientific and theoretical foundations of artificial intelligence in Azerbaijan (Aliyev, 2022).

Prof. Rafiq Aliyev's scientific and organizational

activities contributed to the intensification of artificial intelligence research in the country, the establishment of a scientific school, and the publication of numerous books and monographs. His students are currently working successfully not only in scientific and educational institutions in Azerbaijan but also in leading research centres abroad, representing Azerbaijani science internationally (science.az, 2024).

Another scientist who has made notable contributions to the application of artificial intelligence in Azerbaijan is Academician Ali Abbasov. During the 1980s-1990s, the scientist conducted research on the scientific and theoretical foundations of distributed intellectual information systems in a network environment, successfully applied the results in practice. Academician A. Abbasov developed distributed knowledge bases with fuzzy relational structures, adaptive decision-making methods, and expert system synthesis techniques, and proposed a mathematical model of an ideal knowledge base (Abbasov, 2023).

At present, academician Ali Abbasov and his students continue to conduct research in the field of natural language processing and machine translation, developing software products.

The scientific activity of Professor Masuma Mammadova, Corresponding member of ANAS, is related to the study of theoretical problems in a number of areas of artificial intelligence and the development of their scientific and methodological foundations. In the late 1980s, Prof. Mammadova conducted research in the fields of fuzzy logic, decision-making, computer linguistics, human resource management, and electronic medicine. In particular, for the automatic processing and editing of Azerbaijani-language texts, she conducted research on development of multi-level knowledge bases (morphological, syntactic, semantic), logical inference methods, and expert system synthesis technology.

The professor also developed a model for the intellectual management of technological processes based on the synthesis of a fuzzy relational structured knowledge base, and proposed methods for adapting the knowledge base, which allows for the modification of management rules (Mammadova, 2022).

Azerbaijani scientist, Professor Efendi Nasibov, who has been currently working at Dokuz Eylül University in Turkey, also addressed artificial intelligence related problems in the 90s. His research focused on fuzzy mathematics, fuzzy

optimization methods, and fuzzy Data mining. He proposed new formulations and solution algorithms for fuzzy matrix-constrained mathematical programming problems and developed innovative methods for modelling and determining the states of complex systems under conditions of fuzzy information (Nasibov, 2013).

Corresponding Member of ANAS, Doctor of Economic Sciences Professor Gorkhmaz Imanov conducted extensive research in the field of fuzzy economics, particularly in the evaluation of macroeconomic indicators of socio-economic systems using fuzzy logic theory. He obtained significant results in the development of fuzzy models for evaluating the quality of social systems and proposed approaches for analysing uncertainty in economic information and processes at various levels of socio-economic systems (Imanov, 2021).

### 3.3. Development of artificial intelligence in Azerbaijan

The emergence and development of artificial intelligence theory in Azerbaijan can be regarded as a logical continuation of the scientific heritage of Prof. L. Zadeh. The scientist's ideas laid the foundation for the formation of the theoretical basis of artificial intelligence in the country and contributed to the establishment of scientific research centres and scientific schools.

Azerbaijani scientists began to actively address related to the problems of artificial intelligence in the 1970s (Pashayeva, 2024). At that time, the term artificial intelligence was not widely used, however, a variety of theoretical methods were developed to solve AI-related problems. Artificial intelligence was mainly applied in the oil and gas industry, as well as in the field of medicine, for decision-making and image recognition in conditions of incomplete information. The key stages of the development of artificial intelligence in Azerbaijan are displayed in table 1.

Since the 1980s, fuzzy logic theory has been studied in Azerbaijan. At that time, fuzzy logic theory was applied not only in the oil and gas industry, but also in other areas, yielding significant scientific results. As part of Soviet science, Azerbaijani researchers contributed to the development of the scientific and theoretical foundations of the theory of artificial intelligence, proposed new methods, and implemented them in various fields.

In the 1980s, scientific seminars dedicated to the problems of artificial and natural intelligence were

organized at the Institute of Cybernetics of the Azerbaijan Academy of Sciences with the participation of physiologists, philosophers, cyberneticists and representatives of other scientific fields. Prominent researchers in artificial intelligence from Russia, Ukraine, and other countries were invited to these events. It is also worth noting that in April 1977, an international conference on artificial intelligence was held in Repino, near Leningrad (Fig. 3). The conference brought together leading scientists to discuss the application areas of artificial intelligence, including Professors Lotfi A. Zadeh, John McCarthy, and Dmitry Pospelov. Professor Zadeh delivered a presentation at this event (Zadeh, 2022).

The active participation of Professor Zadeh in such international scientific forums significantly accelerated the integration of his artificial intelligence-related ideas into the scientific environment of the Soviet republics, including Azerbaijan, thereby strengthening the development of artificial intelligence research in the country.



Fig. 3. Repino conference, 1977

One of the scientists who contributed to the development of artificial intelligence field in Azerbaijan is Professor Khanbaba Bayramov. The scientist is the author of research on modelling the activity of natural neurons through artificial neurons (bionics) (Aliyev et al., 2010).

The well-known physiologist, Doctor of Biological Sciences, Professor Zakir Mammadov has made significant contributions to the development of neuroscience and neurophysiology in the country. His research primarily focused on the study of cellular and systemic mechanisms underlying the role of monoaminergic neurotransmitter systems in the plasticity of nervous processes (Mammadov, 2023).

Another Azerbaijani scientist, candidate of physical and mathematical sciences Shamil Hajiyev, conducted research in the field of computer modelling of music, made certain

contributions to the development of artificial intelligence in Azerbaijan. His key scientific achievements include the development of software for the identification and analysis of artistic patterns, statistical studies of Azerbaijani folk songs and mugham, and the generation and analysis of their colour images (Hajiyev, 2023).

Under the leadership of Associate Professor Yunis Mahmudov, work was carried out on the individual and group control of small-capacity pumps operating in periodic pumping modes in oil wells. This research also included the study of the operating modes and technical diagnostics of rod-type deep well pumps, the management of the operation and analysis of the operating mode of gas-lift oil wells, and the diagnostics of pre-accident situations during the drilling of oil wells. A large part of these devices was implemented in the oil industry (Aliyev et al., 2010). Moreover, Associate Professor Yunis Mahmudov and his students developed numerous inventions for identification, recognition, and diagnostics of equipment conditions in oil production based on dynamograms.

Academician Telman Aliyev and his students developed methods and technologies for the identification and recognition of signals obtained from various technological objects. Academician Aliyev has created technologies and theory of robust analysis of signals, theories and technologies, enabling reliable identification, recognition and diagnostics for stochastic processes. He also developed technologies for analysing signal noise as a carrier of useful information. Based on this theoretical work, a number of projects of significant practical importance were proposed, including systems for monitoring the latent stages of cardiovascular diseases, intelligent seismoacoustic telemetric monitoring of anomalous seismic processes, pre-flight monitoring of aircraft technical conditions, and robust monitoring systems for the technical state of compressor stations (Aliyev, 2022).

In the 1990s, Associate Professor Zoya Rakhmanova, an employee at the Information and Computing Centre of the Ministry of Health, defended her PhD dissertation entitled "Application of logical-linguistic methods in the construction of diagnostic medical systems" under the supervision of Professor Dmitry Pospelov, a well-known scientist in the field of artificial intelligence. As part of her research, she developed an original expert system based on the medical knowledge base (Rakhmanova, 2010).

Since 1990, work on the development of intelligent information systems in medicine has been carried out at the Institute of Cybernetics (now the Institute of Control Systems). One of the earliest works in this area was the “Surgery” consultant-diagnostic expert system under the leadership of Associate Professor Gulchin Abdullayeva. This work was subsequently expanded to include the creation of expert and intelligent systems for a wide range of medical fields, including cardiology, endocrinology, obstetrics and gynecology, oncology, ophthalmology, abdominal diseases, traumatology and orthopedics, and occupational medicine (Gulchin Abdullayeva, 2023). Additionally, G. Abdullayeva and her students developed methods and algorithms for the automatic identification and classification of hand-woven carpet types. They also developed an expert system for decision-making for the intellectualization of diagnostics of the technological condition of oil extraction equipment and processes of oil and gas fields (Abdullayeva et al., 2014).

Corresponding member of ANAS, Professor Kamil Ayda-zadeh conducted research on models and algorithms based on artificial neural networks for the recognition of printed manuscripts. Under his guidance, intelligent computer systems were developed for the recognition of printed manuscripts, handwritten texts and speech, as well as for speech synthesis and text and speech understanding for the Azerbaijani language. In these systems, he used a mathematical apparatus developed by him based on decomposition, modelling, optimization and fuzzy theories (Ayda-zadeh, 2021).

A number of works have also been carried out at the Institute of Information Technology on the application of artificial intelligence. In particular, academician Rasim Alguliyev developed a number of models and algorithms applying artificial intelligence technologies in the field of the formation of an intelligent e- government and information security (Alguliyev, 2023).

Corresponding Member of ANAS Ramiz Aliguliyev has contributed to the development of the scientific and theoretical foundations of neuromathematics, neural networks, image recognition, natural language processing, big data analytics, machine and deep learning, and has developed a number of models and algorithms (Aliguliyev, 2021).

Adil Bagirov, a graduate of Azerbaijani science and professor at the Federation University Australia, has made significant contributions to

the development of artificial intelligence with his research on optimization, data mining, natural language processing, and big data analytics (federation.edu.au, 2026).

Research conducted in Azerbaijan over the past 20 year on various aspects of artificial intelligence has received highly recognition from the world's leading scientific centres. Since 2020, Academician Rasim Alguliyev and Corresponding Member of ANAS Ramiz Aliguliyev have been consistently included in the rating list of the world's top 2% scientists in the field of artificial intelligence. This rating list, compiled annually by Stanford University since 2019, is based on data from the Scopus database and employs a composite indicator that incorporates multiple scientometric measures, including the number of publications, citation counts, and the Hirsch index (Ioannidis, 2024). (Ioannidis, 2024).

At present, the scientific and theoretical challenges associated with artificial intelligence technologies are considered one of the key priorities of Azerbaijani science. Accordingly, specialists at the master's, doctoral, and postdoctoral levels are being trained in this field at universities and research institutions across the country (Alguliyev, 2023).

In addition, theoretical, practical work is being carried out in Azerbaijan in the field of artificial intelligence on natural language processing, decision-making in conditions of incomplete information, the development of systems based on fuzzy logic theory, and creation of medical expert systems. Scientists and specialists at the Institute of Information Technology conduct comprehensive research on artificial intelligence, natural language processing, cyber-physical systems, cybersecurity, deep learning, big data analytics, the formation of an intelligent e-government, Internet of Things, and cloud technologies, achieving significant results (Azertac, 2023).

**Table 1.** Stages of artificial intelligence development in Azerbaijan

Stage	Years	Main directions
I	1960–1980	Cybernetics, automation, digitalization
II	1980–2000	Fuzzy logic, expert systems, neuroscience
III	2000–present time	Machine learning, deep learning, Big data

## 4. Discussion

The results of the conducted research indicate that the formation and development of artificial intelligence in Azerbaijan have gone through several phases, closely related to both the scientific research activities of scientists in this field, as well as state policy and the development of ICT infrastructure.

In the initial stages, research on artificial intelligence in Azerbaijan was primarily related to the fields of cybernetics and automation. Over time, this focus expanded to encompass data processing, machine learning, and the development of intelligent systems. The article generally reviews the emergence of artificial intelligence, the contribution of Lotfi Zadeh's theory to the formation of this field, as well as the role of scientists who have contributed to its development in Azerbaijan.

The analysis demonstrates that the application of artificial intelligence in various fields and the achievements have made a significant contribution to the country's development as a whole. The study presents an integrated and coherent picture of the evolution of artificial intelligence in Azerbaijan and development phases.

## 5. Conclusion

Artificial intelligence is one of the most important fields of computer science. Research and achievements in various aspects of artificial intelligence worldwide have led to revolutionary advances in computer science and the rapid development of information technologies.

Since the middle of the 20th century, scientific research on artificial intelligence in Azerbaijan, especially the activities of scientists during the 1970s-1980s, has played a crucial role in establishing the foundation and development of this field. The theory of fuzzy logic developed by Lotfi Zadeh played a major role in the formation of the scientific and theoretical basis of artificial intelligence research in Azerbaijan. Since the 1990s, the development of artificial intelligence technologies has entered a new stage, creating broad opportunities for the expansion of this field and the deepening of scientific research.

The article provides an overview of the historical development of artificial intelligence technologies in Azerbaijan, examines their application of these technologies in various

strategically important areas and highlights the achievements of Azerbaijani scientists in the modern era. As this study represents one of the first comprehensive research efforts devoted to the emergence and evolution of artificial intelligence in Azerbaijan, certain gaps or limitations may remain. Currently, research in this area is ongoing, and the authors invite scientists and experts to share relevant information, factual materials, comments, and suggestions to contribute to the development of a more comprehensive and accurate history of artificial intelligence in Azerbaijan.

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