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Development of artificial intelligence in Uzbekistan (Evidence from Education System)

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Abstract

This article is devoted to considering that despite the global pandemic, "artificial intelligence" is rapidly developing in the world and makes a significant impact on the world economy. Furthermore, the article discusses the development of these innovative technologies in Uzbekistan for the first time in various fields, including educating future specialists in the "artificial intelligence" focus area and the use of foreign experience. In addition, the article provides scientific conclusions and recommendations developed for the disciplines taught in the education of personnel (for such areas as medicine, banking and finance and agriculture) in terms of the development of "artificial intelligence" technologies.

1 Introduction

The global coronavirus pandemic in recent years has radically changed the way people live. Under conditions of the pandemic, mankind is investing heavily in the creation of technologies such as "artificial intelligence", "3D model", "Internet of Things" (IoT), driverless control, block chain, immunotherapy. These technologies are admitted as technologies that will radically change the world in the nearest future. Our research will focus on *Artificial Intelligence (AI)*, one of the most innovative technologies that are rapidly evolving in the world and can bring the human lifestyle to a whole new level of quality. According to "Gartner", the international research and consulting organization, the market for artificial intelligence constituted 2.64 billion USD. In 2027 the revenue from this will amount to 15.7 billion USD, which means that the growth rate of artificial intelligence in 2027 compared to 2020 is expected to be higher than 25.0% (Gartner, 2021). In turn, the global pandemic in 2020 is causing an unprecedented increase in the funds spent (made as investments) in artificial intelligence in developed countries.

Currently, artificial intelligence is housed in a cloud infrastructure, which is the most efficient and flexible process for companies and enables minimizing the impact of the pandemic. It is known that the development of artificial intelligence in our country has been identified as one of

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the priority focus areas of the state. In compliance with the Strategy "Digital Uzbekistan – 2030", the main goal of this priority is to accelerate the introduction and widespread use of artificial intelligence technologies in the country, as well as to ensure access to digital data and their high quality and to create favourable conditions for educating qualified personnel (Decree of the President of the Republic of Uzbekistan № 4996, 2021). The Research Institute for Digital Technologies and Artificial Intelligence was established for the first time in the country to pursue this aim. In 2021-2022, it is scheduled to open specialities in the field of artificial intelligence in the education system in order to develop artificial intelligence technologies and educate qualified personnel in priority sectors and areas, such as banking, finance, taxation, transport, energy, health, agriculture, pharmaceuticals, e-government. These tasks will definitely not be easy. They will require research and creativity. Thus, one of the most significant issues is how the rapidly developing artificial intelligence technologies influence the economy of Uzbekistan and what subjects should be taught in the process of educating specialists in the field of artificial intelligence in education. In addition, it is crucially important to identify the foreign most advanced practices that should be under particular consideration and focus.

It must be admitted that artificial intelligence and the technologies used therein, which have already been developed in the advanced countries of the world and are now in the process of development, are considered a novelty for us. There are different views and approaches in the world on the concept of artificial intelligence, which in recent years has changed human life for the better. Artificial intelligence is a feature of intelligent systems to perform creative functions that have traditionally been considered human competence, which is aimed at solving the problems on the basis of the software creation (Averkin, 1992). According to a prominent scientist in artificial intelligence, artificial intelligence in the field of informatics develops intelligent computer systems, that is, systems that we have traditionally connected to the human mind - language comprehension, learning, thinking, problem-solving (Faygenbaum, 1979). Artificial intelligence enables computers to learn from their own experiences, being adjusted in compliance with given parameters, and perform tasks previously only possible for humans (Artificial intelligence, 2021). Artificial intelligence is the use of computers to comprehend the human mind but should not be limited to only biologically acceptable methods (Artificial intelligence, 2021). Furthermore, the opinions of many scientists about these smart technologies can be cited, e.g. McCarthy described artificial intelligence as producing intelligent behavioural machines (McCarthy, 1959). In this regard, the view of Elaine Rich, a scientist in this field, should be mentioned: "Artificial intelligence is the science of teaching computers to do things that make people more successful today" (Elaine Rich, 2019). In addition, the concept of artificial intelligence can also be called "smart" computer programs. Within the framework of research aimed at creating artificial intelligence, there are used such systems that operate like nerve fibres or networks in the human brain. Another aspect to consider when creating artificial intelligence is the threats that arise in the process of using it. This means that artificial intelligence is the science and technology that creates smart computers and machines, which, when implemented, enable computers to process large amounts of data and "*teach*" them to perform specific tasks.

2 Material and Methods

With the aim of developing scientifically grounded proposals and practical recommendations, research methods such as induction and deduction, analysis and synthesis, systematic approach,

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logical thinking, comparison have been widely applied in this research to reveal the features of artificial intelligence in terms of defining the essence of this concept and training future specialists in the education sphere.

3 Results

Among the sectors of the world economy in recent years, artificial intelligence technologies have mainly covered the field of machinery. These technologies accounted for almost 65 per cent of the automobile-manufacturing market segment. In turn, the global market for artificial intelligence has a significant impact on finance, banking, healthcare, manufacturing, insurance, energy, defence, telecommunications, government agencies, and organizations. Particularly rapidly, artificial intelligence technologies have developed in medicine when the coronavirus pandemic has been going on, and according to analytical data, by 2025, the leading role will belong to the public healthcare system. Intending to become one of the leading countries in the world, Uzbekistan has developed a strategy for the development of artificial intelligence. It determines the prior areas and principles of the use of artificial intelligence, as well as the conditions for the complex formation of this industry in the near and long term. In compliance with this strategy, the development of artificial intelligence technologies has been identified as a priority in the following areas.
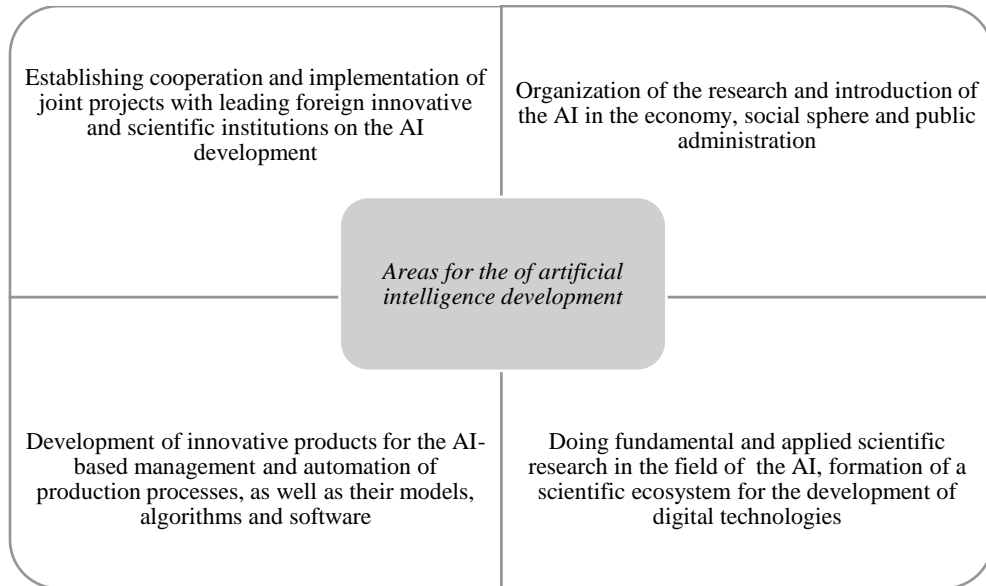
Table 1. Areas of developing artificial intelligence technologies in Uzbekistan

№	Areas of artificial intelligence development	The purpose of the use of artificial intelligence technology
1.	Agriculture	monitoring the condition of soil and agricultural crops, as well as the operation of agricultural machinery on the basis of remote sensing data
2.	Banking	improving efficiency of monitoring activities of commercial banks and simplifying their compliance with regulatory requirements (SubTech and RegTech), analysis of the quality of banking services, remote biometric identification of users (Face-ID) and credit risk assessment
3.	Finance	in the finance area: analysis and efficiency of budget expenditures, pensions, social and insurance payments, as well as pension pay-outs
4.	Taxation	in the taxation area: analysis of tax revenues of legal entities, identification of differences in tax payments
5.	Transport	to monitor the movement of locomotives and warn drivers in dangerous situations, to analyze the movement of public transport and determine their optimal direction, to monitor traffic and traffic congestion
6.	Energy sector	optimization of technological equipment operation in forecasting the production of energy resources and their consumption

7.	Public healthcare	detecting pneumonia on the basis of computed tomography of the human lung and early diagnosis of breast cancer on the basis of mammography
8.	Pharmaceuticals industry	analysis and forecasting of market needs for medicines and medical devices
9.	E-government	remote biometric identification of users in rendering e-government and financial services (Face-ID)

In the process of development of artificial intelligence technologies in the above sectors, it is scheduled to implement the following measures: introduction of more than 280 information systems and software products to automate management, production and logistics processes in enterprises in the real sector of the economy, as well as by 2025 to raise the share of large businesses introducing enterprise resource management system up to 90 per cent, full automation of production and management processes (ERP, MES, SCADA, etc.), robotics, "Internet of Things", "artificial intelligence" technologies applied in industrial enterprises by 2027, and localization of the hardware part based on the public-private partnership by 2030 (Decree of the President of the Republic of Uzbekistan № 6079, 2020). As a result, the development of the national market of digital technologies in the country will create an opportunity to develop "smart solutions" for priority sectors using advanced technologies (Big Data, IoT, AI block chain, etc.) on the basis of IT-park.
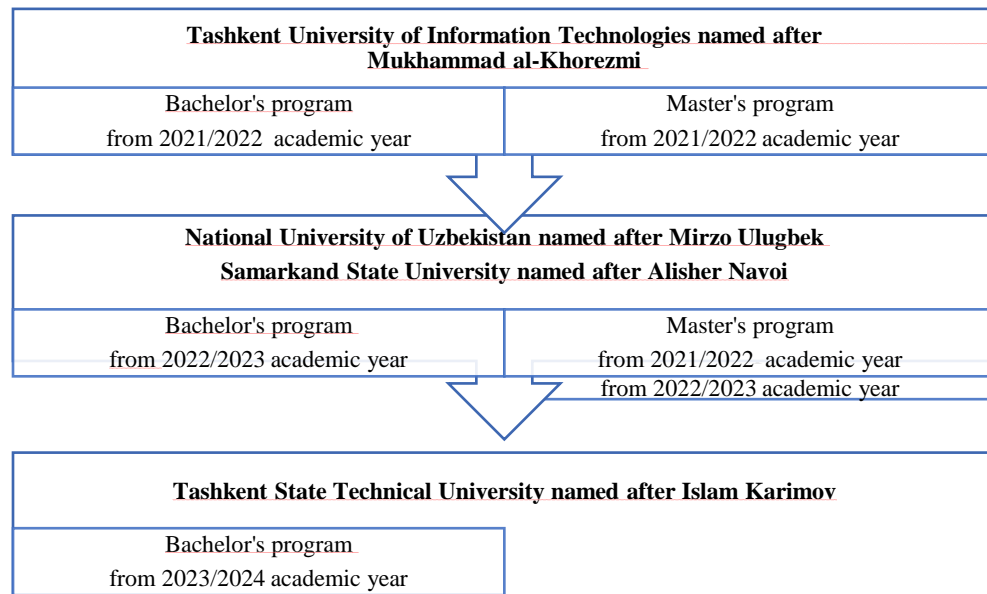

Fig. 1. The main areas of the Research Institute of Digital Technologies and Artificial Intelligence Development in Uzbekistan

Definitely, in order to achieve such high goals, it is required to pay particular attention to the formation of a generation of highly qualified personnel in the field of digital technologies, including artificial intelligence. If we do not educate qualified personnel in this field, any measures (Strategies) developed by our Government will not be effective. That is, we will not invest or finance large investments in the industry, artificial intelligence technologies will not develop as we expect, or we will lag behind the world economy, and consequently, the demand

for personnel will further remain a big challenge. Therefore, the process of educating in the field of artificial intelligence will have to include pre-school education, general education, higher education and post-graduate education. Below there will be considerations about the education of specialists in the field of artificial intelligence technologies in higher education, as well as evidence from foreign experience on this point.

In order to develop artificial intelligence technologies in the country and provide them with qualified personnel, in the 2021-2022 academic year in the system of higher education, it is scheduled to educate specialists in the field of "artificial intelligence". So, this year, a completely new area of educating specialists in "artificial intelligence" will start in the education system for the first time. Herewith, there is a natural question, on the basis of which curricula specialists are educated, that is, what subjects are taught in higher education? And one more aspect – if we are ready for this process today, what foreign best practices can we use in the education of specialists.

Tashkent University of Information Technologies named after Mukhammad al-Khorezmi	
Bachelor's program from 2021/2022 academic year	Master's program from 2021/2022 academic year

National University of Uzbekistan named after Mirzo Ulugbek Samarkand State University named after Alisher Navoi	
Bachelor's program from 2022/2023 academic year	Master's program from 2021/2022 academic year from 2022/2023 academic year

Tashkent State Technical University named after Islam Karimov
Bachelor's program from 2023/2024 academic year

Fig. 2. Stages of educating in the field of "Artificial Intelligence" in the higher education system of Uzbekistan.

Further, we consider the experience of leading foreign universities in this regard, and we are starting with that famous Swiss education system. It is known that Swiss universities have long been ranked first in all educational rankings of ancient Europe, focusing on the number of foreign students (currently, over 50 000 foreign students are studying at universities in this country). Universities have over 40 bachelor programs to educate specialists in "artificial intelligence" and similar innovative technologies. It's a miracle even to imagine that we are still on the threshold of this magical technology. Although the top 20 most promising universities in the world include a few Swiss universities, high-quality education can be obtained at almost any university here.

Table 2. Education in Information Technology (Artificial Intelligence) at the Swiss University of Technology (ETH Zurich)

A block of disciplines taught in the process of educating specialists	
Bachelor's program	*Master's program*
Mathematics	*Informatics theory*
Physics	*Information security*
Fundamentals of Engineering	*Engineering software*
Basics of Computer science	*Robotics*
	Distribution of systems
	Software development
	Visual calculation
	Bioinformatics
	Control systems

It is clear from the data that in this prestigious university, in the process of educating specialists in artificial intelligence technology, the emphasis is mainly laid on the disciplines taught at the master's program level. There is no doubt that a student who has mastered these disciplines will become a professional and demanded specialist in the field of information technology in the future. The reason is that over 20 Nobel laureates, such as Albert Einstein and Santiago Calatrava, graduated from this university.The Swiss Polytechnic University, the only one in Switzerland that educates another well-known micro technician and communication engineer, teaches engineering, cryptography, communication, coding and mobile communications. This University graduates have founded such companies as Synopsys and Logitech (EPFL, 2021).The United States of America can be reasonably called the home of information technology. The country's powerful computer programmers, software designers and mature scientists have become the reason for the emergence of world-renowned brands in the field of information technology, such as "Google Inc.", "Microsoft", and "Apple". Although there are dozens of universities in the United States in the field of information technology, it is possible to single out the education of the three strongest and most prestigious universities among them. The Massachusetts Institute of Technology (MIT) is one of the most prestigious universities in the world, known for its developments in artificial intelligence and robotics. In addition, curricula of such subjects as engineering, IT, economics, physics, chemistry and mathematics are the best in the world. Curricular on Information technology is applied at the Faculty of Engineering. Students will comprehensively study the principles and rules of the design and operation of computer systems. Nowadays, about 60 innovative teams (grants) in computer science operate in the Lincoln Laboratory of the Institute. It is difficult even to imagine that 84 graduates of this Institute alone have become Nobel laureates. How wonderful are the numbers and the education system of any country in the world that can envy these figures? Bachelor students gain theoretical and practical skills in physics, mathematics, engineering and computer science, software and hardware, and learn the principles of creating and improving computers (MIT, 2021).

Table   3.   Education   system   on   Information   technology in the most prestigious universities and institutes of the USA

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Universities and institutes	Disciplines taught in information technology
Massachusetts Institute of Technology (MIT)	IT Artificial intelligence Computer Science (Systems) Computer Science (Theory) Applied physics Biometrics and Engineering
Stanford University	IT Computer science Software System technologies Artificial intelligence Robotics
Carnegie-Mellon University	IT and Information Security (MSIT-IS) IT and mobile system (MSIT-MOB) IT and Software Engineer (MSIT - SM)

Stanford University is considered home to some of the most advanced high-tech industries. Its graduates have founded many of the world's most successful brand companies, including Google, Yahoo!, Hewlett-Packard, Sun Microsystems, and Instagram. The university is proud of 59 Nobel Laureates, 30 billionaires, 17 astronauts and 18 Turing Prize winners. Currently, the university has 18 laboratories and research centres for students to master information technology and develop practical skills.

Carnegie Mellon University is engaged in research activities in the field of science and technology, innovations in the field of IT technology, robotics and artificial intelligence. Moreover, the university is world-renowned in economics, linguistics and management. Currently, the university is recognized as a world leader in developing revolutionary ideas, promoting them and creating successful business start-ups. In addition, it should be noted that British universities should be mentioned among the leaders in artificial intelligence technology education. It is well known that employers have highly valued the practical skills of professionals who have graduated from UK universities. One of the universities that educate specialists in the field of artificial intelligence technology is Oxford University. It is the oldest English-speaking University in the world and today has more than 20 000 students (and 25 per cent of these students are international students. Furthermore, the university's computer technology and IT faculty is a leader in Europe).

Table 4. Studying Information Technologies at the Universities of Great Britain

Universities:		
Oxford	London Imperial College	Manchester
Research teams:		
Algorithms		*Information*

Automatic data verification *Computer biology* *Logical structures* *Information systems* *Programming languages* *Security* *Software*		*management research* *Optimization* *Nano engineering*
Academic curricula:		
Engineering *Informatics* *Software* *Security systems*	*Study of artificial intelligence* *Software engineering* *Development of visual information processes* *Programming languages and systems*	*Informatics* *Mathematics* *Management* *Business programs* *Software*

Nobel laureates, members of the Royal Society of London and the Royal Academy of Engineering of the United Kingdom, have studied at Imperial College London. The Faculty of Computer Science at this University is one of the largest faculties in the UK and a world leader in academic research in computer science. A large number of Manchester University graduates occupy managerial positions at companies that are leaders in global markets. 27 Nobel laureates studied here. In terms of research, this University is one of the best companies in the world and has made important scientific discoveries of the 20th century. IT research at the University is based on the School of Informatics, the oldest educational institution in the UK.

4 Discussion

Above, we have already mentioned the areas of educating specialists in the field of artificial intelligence technologies in the leading universities of developed countries and the academic subjects taught. This means that our country also has a ready for application and tested foreign experience in educating specialists in the field of "artificial intelligence". In our opinion, the inclusion of the following subjects in the curriculum of higher education in preparing the specialists in the field of "artificial intelligence" technology in the universities specified in the Decree of the President of the Republic of Uzbekistan № 4996 "On measures to create conditions for the accelerated introduction of artificial intelligence technology", and their teaching are crucial.

Table 5. Composition of academic subjects in educating specialists in the field of "artificial intelligence" in the education system of Uzbekistan (proposal)

A block of academic subjects taught in the education of specialists	
Bachelor's program	*Master's program*

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Higher mathematics	*Computer biology*
Physics	*Nano-engineering*
Fundamentals of Engineering	*Logical structures*
Basics of computer science	*Information security*
Software	*Engineering software*
Security systems	*Robotics*
The study of artificial intelligence	*Distribution of systems*
Visual information processes	*Software development*
Programming languages and systems	*Visual calculation*
Management	*Information management*
Business programs	*Optimization*
Study of artificial intelligence	*Cryptography*
Biometrics and Engineering	*Coding*

Among the academic subjects taught in this education system, the bachelor's program is mainly represented by the Swiss University of Technology (ETH Zurich). In terms of the master's program, academic subjects are basic subjects taught at the University of Oxford and the University of Manchester in the United Kingdom, i.e. these academic subjects can be assessed as the most acceptable. In turn, within the framework of the Republican higher educational institutions, in terms of preparing the specialists in the field of "Artificial Intelligence", the academic curriculum of "Biometrics and Engineering" of the Massachusetts Institute of Technology (MIT), the academic curriculum of "Robotics" subject of the Stanford University, the academic curriculum of "IT and Mobile Systems (MSIT-MOB)" subject of the Carnegie Mellon University, as well as "Artificial Intelligence Study" of the Imperial College London is considered really important and practically significant.

5 Conclusion

In conclusion, we believe that the development of "artificial intelligence" technologies in our country and educating qualified personnel in this field should focus on the following priorities:
1. Involvement of teachers and interns from leading foreign universities in educating qualified specialists in the field of artificial intelligence for various sectors of our economy.
2. Considering international experience in the development of educational standards of "Artificial Intelligence" academic subject in higher education.
3. Reconsideration of the current Civil Code and other legislation of the Republic of Uzbekistan on the introduction of information on artificial intelligence and similar technologies in the nearest future.
4. Opening the "Artificial Intelligence" education profile in technical universities and institutes and universities that educate specialists in industries and sectors (banking and finance, taxation, insurance, medicine, construction, agriculture).
5. Continuous retraining and professional development of the faculty staff and specialists on the academic subject "Study of artificial intelligence" in the field of information technologies.

6. Creation of the "artificial intelligence ecosystem" for the first time in Uzbekistan and providing mutual integration of universities, innovation parks and manufacturers.

Thus, the main goal in our country is to develop technologies that will radically change the life of the world in the near future, including "artificial intelligence" by 2030, because, as the President has said, "We have set ourselves the great goal of building the Third Renaissance in our country and the development of science and innovation should serve as the basic pillars of our national idea".

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