Artificial intelligence as a focus of digital economy development: Theoretical and practical aspects

Искусственный интеллект как фокус развития цифровой экономики: теоретические и практические аспекты

La inteligencia artificial como foco del desarrollo de la economía digital: aspectos teóricos y prácticos

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Abstract

The article is devoted to the study of the development of artificial intelligence (AI) technologies and its presentation as the fundamental basis of the digital economy concept, which is implemented within the framework of the Industry 4.0. The purpose of the research carried out in the article is to analyze the areas of effective application of AI methods and tools, as well as to assess the potential for introducing AI into the business sphere. The theoretical and practical aspects of the application of AI technologies in various sectors of the economy are considered. It has been determined that the high cost of introducing technologies and establishing the stages of its functioning is a significant barrier to the use of AI. The data obtained during the course showed that organizations that have invested in identifying, aggregating, standardizing and labeling data will be well placed to combine AI with analytics, IoT and other technologies. It has been found that DevOps techniques can be used to successfully integrate and organize teams, placing development teams and operations teams in a feedback loop for ongoing collaboration and interactive changes to new products. Criteria for assessing the level of maturity of the branches of AI have been determined.

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Аннотация

Статья посвящена исследованию развития технологий искусственного интеллекта и представления его фундаментальной основой концепции цифровой экономики, реализующей в рамках концепции «Индустрия 4.0». Целью проводимого в статье исследования является анализ областей эффективного применения методов и инструментов искусственного интеллекта, а также оценка потенциала внедрения искусственного интеллекта в бизнес-сферу. Рассмотрены теоретические и практические аспекты применения технологий искусственного интеллекта в различных секторах экономики. Определено, что высокая цена внедрения технологий и налаживания этапов ее функционирования является значимым барьером для использования искусственного интеллекта. Данные полученные в ходе показали, что организации, которые инвестировали в идентификацию, агрегирование, стандартизацию и маркировку данных, будут иметь хорошие возможности для объединения искусственного интеллекта с аналитикой, IoT и другими технологиями. Установлено, что для успешного объединения и организации работы команд могут быть использованы методы DevOps, которые помещают команды разработки и операционные группы в цикл обратной связи для постоянного сотрудничества и интерактивных изменений новых продуктов. Определены критерии оценки уровня зрелости отраслей искусственного интеллекта.

Ключевые слова: искусственный интеллект, цифровая модель экономики, тренды рынка, методы DevOps, отраслевое применение искусственного интеллекта, трансформация бизнес-процессов, цифровой маркетинг.

Resumen

El artículo está dedicado al estudio del desarrollo de tecnologías de inteligencia artificial (IA) y su presentación como base fundamental del concepto de economía digital, que se implementa en el marco de la Industria 4.0. El propósito de la investigación realizada en el artículo es analizar las áreas de aplicación efectiva de los métodos y herramientas de IA, así como evaluar el potencial para introducir la IA en el ámbito empresarial. Se consideran los aspectos teóricos y prácticos de la aplicación de tecnologías de IA en varios sectores de la economía. Se ha determinado que el alto costo de introducir tecnologías y establecer las etapas de su funcionamiento es una barrera importante para el uso de la IA. Los datos obtenidos durante el curso mostraron que las organizaciones que han invertido en identificar, agregar, estandarizar y etiquetar datos estarán bien posicionadas para combinar IA con análisis, IoT y otras tecnologías. Se ha descubierto que las técnicas de DevOps se pueden utilizar para integrar y organizar equipos con éxito, colocando a los equipos de desarrollo y operaciones en un circuito de retroalimentación para la colaboración continua y los cambios interactivos en nuevos productos. Se han determinado criterios para evaluar el nivel de madurez de las ramas de la IA.

Introduction

In connection with the digital transformations taking place in modern realities, the emergence and application of new technologies tends to increase. All spheres of business and public life are introduced by smart systems that can operate effectively in a dynamically changing world. The digital economy is the basis of the entire system of government, economy, new business models and basis of the fourth industrial revolution. AI technology has been researched for over half a century. In the course of the development of this field of science, interest in such a promising area of IT field varied depending on scientific achievements and the development of applied areas of AI application. Over the past 10 years, there have been many important advances in improving the components of this technology, and IT market has identified new possible uses for AI. Business entities need to use this tool to maintain competitiveness and develop their subsystems, which prompts states to join the technological race in order to stimulate the economy, strengthen their geopolitical positions and improve the living standards of the population (Dadashev & Ustinova, 2019). This opinion is shared by the leaders of states, as well as the heads of the largest corporations. The purpose of this study is to analyze the areas of effective application of AI methods and tools, as well as to assess the potential for introducing AI into the business sphere.

Literature Review

Currently, AI is a general term that combines many more specific concepts, such as computer vision, neural networks and machine learning. This is the so-called "AI in a narrow sense", which is defined through the description of the use cases of technology, which include the use of large amounts of data for the analysis, modeling and forecasting of events. AI in the broadest sense (strong AI) is a "super machine" that is able to independently develop and make decisions without being guided by the models and sets of rules that are previously provided to it for processing. The term AI as a tracing paper from English does not satisfy the experts: many of them talk about inaccurate translation, which distorts the essence of the technology. Instead, a whole set of terms is proposed: broader - robotic intelligence, inhuman intelligence; or more tool-focused - neural network, (deep) machine learning. In any case, the emphasis is shifting from the human and the analogue of human intelligence. Experts explain the term through tools that work autonomously and not always in the image and likeness of a person. We can even say that it is precisely other forms, different from human thinking that will lead to the success of AI (Sokolova & Galdin, 2018).

Within the framework of the research carried out in the article, the concept of AI is defined in its broadest sense - as a set of technologies for processing various types of data and information, in particular, capable of interpreting such data, extracting knowledge and using it to achieve certain goals. Machine learning, in turn, is defined as a class of AI methods, which are characterized by the performance of specific tasks by computer systems by correlating them with previously performed tasks of a similar type without using explicitly established instructions. AI is already creating additional sources for the

growth of business value. AI leaders are scaling up their investments and devising large-scale strategies for implementation. The assessment of the size of AI market in the Russian Federation varies greatly depending on the research methodology. We consider in more detail the criteria for assessing the level of maturity of AI industries (Table 1).

Table 1.
Criteria for assessing the level of maturity of AI industries.

Rating element	Criterion	Legacy (1 point)	AI Ready (2 points)	AI Native (3 points)
	Software and architecture. Availability of specialized industry solutions based on AI	Individual solutions	Solutions for 1-10% of industry processes	Solutions for > 10% of the industry's processes
	Data. Data availability and usability for the development of industry solutions	Data is poorly available and mostly not used	Data is available and used for 1-10% of industry processes	Data is available and used for > 10% of industry processes
	Hardware. Percentage of large and midsize companies in the industry using Iaas / PaaS / SaaS cloud services	Mainly on-premise, individual companies use IaaS / PaaS / SaaS elements	Major industry players use onpremise / IaaS as well as PaaS / SaaS elements	Major industry players use PaaS / SaaS as well as IaaS elements
Foundation of AI	Regulation. Existence of incentive industry regulation	Has little impact on the industry	Removes major barriers to the use of AI	Stimulates the development of new applications for AI
	Personnel and qualifications. Percentage of d-people from the total number of employees in the industry (from the number of the central office)	<1%	1-10%	>10%
	Popularization. Level of awareness of companies about industry solutions in the field of AI	< 10%	10-50%	>50%
Industry indicators	Investments. Percentage of investment in the development of AI from all investments in the industry, including intracorporate	<1%	1-10%	>10%

According to the results of the research "Current trends in the market of AI and machine learning" at the end of 2017, AI segment in Russia was limited to 700 million rubles. AI market is expected to grow to 28 billion rubles by 2021. According to the forecasts of the authors of the study, its growth will be stimulated by the financial sector, retail trade and industry. According to the results of the research "Digital Economy: Global Trends and Practice of Russian Business" conducted by the Higher School of Economics, digital technologies came out on top in terms of the greatest impact on business: IoT and industrial automation (60%), digital design and modeling (58%), virtualization technologies, remote access, remote office, etc. (57%), mobile technologies and cross-channel communications (55%). Analyzing the data obtained by American and British financial analysts, we can draw obvious conclusions that the rapid development of robotics using AI technologies will lead to another leap in productivity. According to experts, this figure will grow by 30% in the whole world, accompanied by a decrease in labor costs in the range of 20-33%. Naturally, first of all, the so-called "disruptive innovations" will affect the most developed countries, which will lead to a technological reboot of several key industries at once (Mustafina, 2019).

Research Materials and Methods

The research used the methods of quantitative and qualitative expert interviews. In addition, an analysis of the secondary data was carried out. Research experts - Russian and international leaders and leading specialists in the field of AI involved in the implementation of related projects in various segments (industrial production, retail, etc.).

Recently, there has been an impressive leap forward in the development and especially the application of AI based on the use of neural networks. Great results have been obtained in solving problems such as speech, image and face recognition. These technologies are based on a rather crude copying of the work of the human brain and do not always give the expected results. The challenge for science is to understand how AI works. Technologies often start working before our understanding of all the details of their work. Without this understanding, all sorts of incidents inevitably arise. The main problem in AI theory is to understand why neural networks work, despite the fact that, from the point of view of classical mathematics, the task of constructing neural networks is incorrect, because the number of observations (training examples) is several orders of magnitude less than the number of determined parameters, but, nevertheless, in practice, the network works. We do not yet have a theoretical understanding of why the network works. Although it should not stop us to introduce these technologies. The main challenge for scientists is to learn as soon as possible how AI technology works. To raise AI to a new level of development and obtain predictable and reliable results, it is necessary to build a new or significantly modify the existing theory of AI (Efimova, 2020).

Analyzing the potential of AI, researchers began to look for new areas of its application, primarily in conjunction with improving business processes. The use of AI in this area makes it possible to make business processes flexible and adaptive, abandon traditional pipelines and move on to the idea of integrating advanced AI systems and people. This approach allows radically changing the interaction of a machine and a person and forming integrated teams of robots and people. Such teams are able to quickly process large amounts of data during production operations, assimilate new information and adapt

to continuously changing conditions. These AI capabilities allow companies to reengineer their business processes, significantly increase their productivity and reduce costs. Thus, one of the main directions of development and implementation of AI in industry is the reengineering of business processes. Another area is to supplement and expand human capabilities, when machines do what they can best (performing repetitive, monotonous tasks with processing enormous amounts of data), and people do what they do best (working with ambiguous information, inference in difficult cases, decision-making in conditions with a high level of uncertainty, creativity, etc.). This direction is usually called the third wave of business transformation (Kryukova & Mikhalenko, 2017).

Statistics show that in the period 2016-2019 revenues of the world market for AI increased by 350%, from 3221.8 to $ 11283.76 million (Figure 1). By 2025, revenues are expected to rise to $ 89847.26 million.
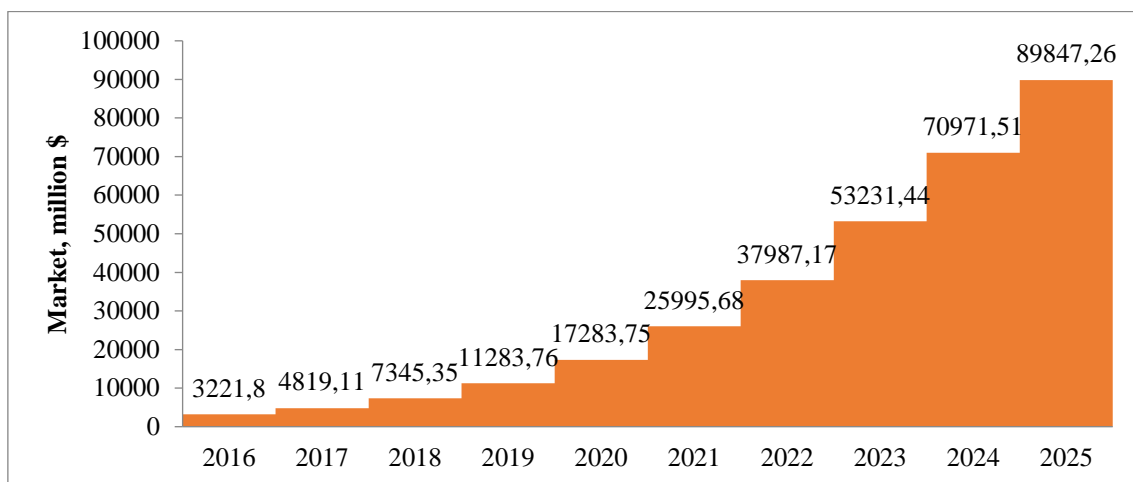

Figure 1. Revenues from the global market of AI from 2016 to 2025, million $

The impact of AI on world GDP is due to increased labor productivity, personalization, reduced time consumption and improved quality of products, works and services. Global labor productivity growth is expected to account for 55% of the cumulative impact of AI on global GDP over 2017-2030. We consider the use of AI in various sectors of the economy (Petrov, 2019).

Marketing and advertising. The introduction of AI in the field of marketing and advertising affects the increase in business profitability, significant improvement in targeting and increase in customer focus. At the same time, these benefits from AI can be used by companies from any sphere: banking, metallurgy, transport. The growing introduction of Big Data technology into the advertising market requires both advertisers and agencies to apply AI technologies to effectively analyze user data in order to obtain accurate knowledge about the audience and customer preferences. At the same time, AI allows not only to obtain complete information about users, but also to predict their behavior in the future. AI in ads is used for targeting. This is typical not only for banks, but for all digital marketing. Banks have information about transactions and this gives an advantage (Trofimov, 2019).

Retail. AI in retail is finding ever more widespread use: it is not only improving communication with customers, but also pricing optimization, working with inventory,

making decisions about the time and format of promotions and sales. According to experts, today any large retail company uses AI. This is due to the amount of data that can be analyzed in real time. In addition, the benefits are immediately noticeable through the use of process automation tools. There are main tools: automatic (smart) cash registers and recommendation services. Stores provide ordering of products based on the analysis of consumer activity. Consumers are offered discounts on goods according to their shopping basket, promotions and special offers are formed.

Banking. This sector of the economy is noted by all experts as the most promising for the development of AI. This can be explained by the fact that banks have a large amount of data that can be analyzed. The use of AI in the banking sector can be divided into two types: solving the internal tasks of the bank as an organization and customer service. To improve efficiency and simplify internal processes, decision-making automation tools and tools that increase the number of decisions are used (for example, various scoring options). Robots are also often used to automate internal processes. They help improve the efficiency of basic routine procedures. Machine intelligence is applicable for scoring, quick decision-making, risk assessment when issuing a loan and when analyzing a borrower's solvency. Scoring is also used to work with clients - these are numerous tools that allow identifying creditworthy citizens, and the formation of individual proposals for deposits and tariffs. Another tool is face recognition technology that can be used to identify customers. The potential of this technology also improves safety.

Telecommunications. Telecommunications companies, like banks, have an extensive database of their subscribers. Therefore, one of the first areas of application of AI in telecommunications was marketing, in particular, solutions for retaining customers and increasing their loyalty. Today, telecommunications companies use chat bots to answer customer questions, predictive analytics to form a tariff grid and calculate the likelihood of subscribers using certain services. Companies use machine learning and behavioral analysis based on machine learning to calculate fraudulent calls. AI allows predicting the load of network resources and optimize their distribution in accordance with forecasts.

Industry. The heavy industry sector has great potential in the implementation of AI, primarily through rapid prototyping or dynamic resource allocation - equipment modification. For manufacturing companies, the main advantage of AI is the reduction in the number of errors in work related to the human factor, reduction in the number of manual work processes and predictive analytics. A joint study by Tsifra and the Russian Union of Industrialists and Entrepreneurs reflects the upward trend in demand for AI technologies from industrialists. According to the study, AI is used in industry to increase the service life of industrial equipment and improve the efficiency of its maintenance is 44%. In the Russian industry, AI technologies are used in production (metallurgy, chemistry, petrochemistry, oil refining and oil production) - 22%, in the electric power industry - 11%. The remaining 23% are research papers from universities exploring the application of AI methods in new areas for the industrial sector. The experts interviewed for this study are also optimistic in their forecasts of the effectiveness of AI implementation in industry and note the advantage of large databases for work that stimulate the development of AI. The data is used to train AI systems, for forecasting and for the development of recommender systems, which are then used to optimize production

and administrative processes. AI helps to work with a large number of factors, analyze the influence of each and draw conclusions.

The most common elements of AI in industry are automated tools and cognitive assistants. Also, digital twins are often used systems that, based on machine learning, help optimize organizational processes. These technologies are gradually replacing workers who perform typical tasks, which in turn lead to cost savings.

The results of various studies carried out in Russia and abroad show a number of common problems faced by organizations implementing AI technologies. Most experts share the opinion that this is a fundamentally new phenomenon that is becoming a challenge not only for a group of professionals, but for the entire society. According to analytical companies SAS and Deloitte, the main difficulties in the development of AI are (Shchurina & Danilov, 2019):

- changing the list of professions and human skills in demand;
- regulatory and legal risks;
- ethical issues.
- international research draws attention to several blocks of barriers to the introduction and use of AI. Pioneer organizations identify among the main barriers to the adoption of AI technologies;
- lack of support from management;
- unclear business case.

The latter challenge was most often mentioned by Russian experts during in-depth interviews. The high cost of introducing technologies and establishing the stages of its functioning is a significant barrier to the use of AI. The economic benefit cannot always be demonstrated in the short term, which may be the reason for the closure of individual projects. AI has a more promising development when interacting with other technologies that are gaining popularity in 2019. Successful AI integration with other technologies starts with data. Organizations that have invested in identifying, aggregating, standardizing, and labeling data will be well positioned to combine AI with analytics, IoT and other technologies. To successfully connect and organize teams, DevOps techniques can be used, which put development teams and operations teams in a feedback loop for ongoing collaboration and interactive changes to new products. At the same time, it is necessary to create new roles for employees as translators and links between different groups. Models also need regular testing, updating and replacement (Ilin et al., 2017).

DevOps enables software deployments that are stable, fast and reliable, including through continuous testing, to avoid the delays and quality issues inherent in the classic design model. DevOps culture can evolve in companies either in an evolutionary way, when employees understand that processes are emerging that can be automated or in order to achieve new business goals. When a company needs to put new processes on track, it always needs specialists who can implement and develop the right tools. There are several benefits to the business moving to DevOps:

- faster time to market (faster cycle times and faster deployment);
- improved quality (increased availability, fewer disruptions, etc.);

- increase in organizational efficiency (more time is spent on activities associated with an increase in the value of the product in comparison with losses or in the amount of functionality transferred to the customer).

Results

Today in Russia, as in the whole world, interest in AI is huge: leading countries of the world are developing strategies for the development of AI, technology is discussed at all possible levels, from scientific conferences to social networks. At the same time, there is currently no generally accepted understanding and unified definition of what AI is. As a result, the attitude to technology on the part of society and industry is still ambiguous: questions remain regarding the safety of using technology, its impact on social well-being and human rights (in particular, right to privacy). Business and government agencies in Russia have already come to understand the benefits that the introduction of AI technology brings, but most business representatives do not yet fully understand how exactly the technology should be applied in order to achieve the results they need. The situation is gradually changing with the start of discussion of this topic at the highest government levels, as well as with the emergence of various successful cases of using AI.

Technology development leaders are USA, China, Japan. The participants in this study rank Russia among the countries with a high potential for the introduction of AI. The main types of application of AI technology in Russia, identified in the course of the study, generally coincide with global trends. In Russian companies, these are:

- agents (automated support services for banks, medical and telecommunications institutions, chat bots of client services);
- algorithms that optimize decision-making process are used in all areas: from industry (recommendation systems for making technological decisions, improving production safety) to retail (logistics tasks, studying customer behavior) and banks (forming individual proposals, improving targeting);
- automation of production processes in companies with a wide profile, "smart" devices (image recognition systems).

Conclusions

According to experts, the leaders in the implementation and use of AI in the Russian market are industrial enterprises, banks, telecommunications companies and retail. Industrial enterprises are actively introducing tools for automating internal and production processes. Recommender services are used at all stages of the production process for monitoring current processes and for predicting future events. The banking industry uses various scoring tools to automate routine functions, streamline and speed up decision-making processes. Banks use the accumulated knowledge about their customers and develop recommendation services on this basis. For identification and security purposes, image recognition technologies (biometrics, face recognition) are used. Telecommunications companies use chat bots to answer customer questions, predictive analytics to form a tariff grid and calculate the likelihood of subscribers using certain services. Companies use machine learning and behavioral analysis based on machine learning to calculate fraudulent calls. AI allows predicting the load of network resources and optimize their distribution in accordance with forecasts.

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