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ENGLISH READER IN ARTIFICIAL INTELLIGENCE

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В последние годы искусственный интеллект (ИИ) активно развивается, проникая во все сферы человеческой деятельности, революционизируя их и принося значительный прогресс в решение многочисленных проблем. Издание содержит тексты на английском языке, дающие представление об основных направлениях ИИ, а также упражнения различных форматов, аппендиксы и словарь для отработки вокабуляра по данной тематике.

Данная хрестоматия предназначена для студентов, изучающих английский язык на факультете ВМК МГУ им М. В. Ломоносова, а также на IT-факультетах других вузов.

Ключевые слова: искусственный интеллект, кибербезопасность, нейронные сети, большие данные

English Reader in Artificial Intelligence = Хрестоматия по искусственному интеллекту на английском языке : Textbook / E. K. Belikova, I. S. Gudilina, M. A. Kruglova, L. B. Saratovskaya, A. V. Yampol'skaya. — Moscow : Moscow University Press, 2024. — 171, [1] p. — (Library of the Faculty of Computational Mathematics and Cybernetics of Lomonosov Moscow State University). — Text English, Russian. — Electronic edition of network distribution.

In recent years, artificial intelligence (AI) has been actively developing, penetrating into all spheres of human activity, revolutionizing them and bringing significant progress to solving numerous problems. The publication contains texts in English that give an idea of AI key areas, as well as exercises in various formats, appendixes and a dictionary for practicing vocabulary on this topic.

This Textbook is intended for students studying English at the Lomonosov Moscow State University CMC Faculty, as well as at the IT departments of other universities.

Keywords: artificial intelligence, cybersecurity, neural networks, big data

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Предисловие

Настоящее издание “English Reader in AI” является результатом работы группы преподавателей кафедры английского языка факультета ВМК МГУ им. М. В. Ломоносова. Кафедра английского языка ВМК всегда старалась идти в ногу с рабочими программами и курсами различных подразделений и лабораторий факультета и создала немало учебно-методических пособий, помогающих нашим студентам овладевать профессиональными компетенциями.

Вычислительная техника стремительно развивается, возникают новые области компьютерных наук, давая жизнь новым областям образования. В последние годы одним из ключевых направлений развития РФ становится искусственный интеллект, влияющий на многочисленные области жизни и науки, в том числе и на образование. Совершенствование системы подготовки кадров в области Искусственного интеллекта — одно из приоритетных направлений и задач Указа Президента РФ по стратегии ускоренного развития ИИ в нашей стране. Многие российские компании, вузы и научно-исследовательские институты начинают активно развивать ИИ — технологии. В ряде городов открываются международные конференции и выставки по ИИ и анализу больших данных. Стоит отметить крупнейшую конференцию об инновационных технологиях в ИИ, прошедшую в Технопарке Сколково в ноябре 2023 года. В этом же году открылась первая всероссийская школа по искусственному интеллекту и большим данным в Национальном центре физики и математики в Сарове (Нижегородская область), являющимся филиалом МГУ. Здесь студенты и молодые ученые могут прослушать лекции ведущих специалистов в сфере искусственного интеллекта и кибербезопасности.

Актуальность учебного пособия “Reader in AI” связана с новыми курсами и семинарами по ИИ на нашем факультете. Пособие представляет собой тематически обусловленный сборник материалов по ИИ и упражнений к ним на английском языке. В соответствии с программой практического семинара по ИИ на 4 курсе бакалавриата, данное пособие включает оригинальные аутентичные материалы, взятые из книг и работ ведущих зарубежных ученых. Основными темами статей сборника являются: история ИИ, представление ИИ как междисциплинарной науки; экспертные системы, системы, основанные на знаниях; принципы построения и методы автоматических рассуждений; нейронные сети — их возможности, структуры, решаемые с их помощью задач; машинное обучение; автоматическая обработка текстов; системы машинного перевода.

Организация материала внутри каждого раздела имеет целью:

– развитие навыка чтения и понимания научной статьи на английском языке как единого смыслового целого;

– выделение и анализ всего объема информации с опорой на основные положения и моменты;

– пополнение терминологического и словарного запаса;

– работа над синтаксическими структурами и лексическими единицами текстов.

Набор практических упражнений, прилагаемых к статьям и текстам пособия, нацелен не только на понимание английской статьи, закрепление лексики и терминологии по ИИ, но и имеет дискуссионный и творческий характер (развернутые ответы на вопросы, изложение прочитанного на английском языке, обсуждение содержания предложенных тем и т. д.). Методика работы с упражнениями одновременно закладывает основу для развития навыков письменной речи, перевода с русского языка на английский, умения составления аннотаций и рефератов.

Пособие “English Reader in AI” рассчитано на студентов и магистров факультета ВМК разного уровня языковой подготовки. Оно может быть использовано как для работы в аудитории, так и для самостоятельной работы on-line.

Овладение языковой компетенцией является неотделимой составляющей профессиональной подготовки будущих IT специалистов. Оно расширяет возможности их кадрового роста в приоритетных отраслях РФ и многостороннего сотрудничества с международными и российскими государственными институтами и компаниями.

В связи с ограниченными размерами пособия “English Reader in AI” авторы не смогли охватить больший объем тем по искусственному интеллекту, а также вынуждены были значительно сокращать многие материалы, взятые из обширных трудов таких известных специалистов, как С. Рассел и П. Норвиг («Искусственный интеллект: современный подход», новое 4 издание, более 1200 стр.). Однако, авторы считают, что представленный комплекс текстов и разнообразных упражнений к ним будет способствовать повышению эффективности процесса обучения как в области ИИ, так и научного английского языка в целом.

Авторы выражают благодарность всем сотрудникам факультета ВМК, проявившим интерес и участвующим в обсуждении издания данного пособия. Авторы особенно признательны Коруховой Ю. С., доценту кафедры АЯ, давшей ряд важных советов и рекомендаций по его составлению. Отдельная благодарность — заведующему кафедрой ММП Воронцову К. В. и доценту кафедры ММП Гурову С. И. за составление словаря, включающего специальную лексику и вошедшего в приложение к учебному пособию.

От авторов

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Instead of Introduction. Short History of Artificial Intelligence

Since ancient and medieval times, scientists have been fascinated with the idea of creating intelligent machines. The seeds of artificial intelligence (AI) were planted by Greek, Indian, Chinese and later European philosophers who used structural methods of mathematical logic.

There have been many bright minds in artificial intelligence history. Spanish philosopher Ramon Llull (1232–1316), known for writing a logic system, developed a system for the production of knowledge by logical operations. His work had great influence on "universal genius" Gottfried Leibniz who in the 17th century redeveloped Llull's ideas and envisioned universal language of reasoning. After Leibniz English materialist Thomas Hobbes began to create the physical symbol system hypothesis and French philosopher Rene Descartes attempted to describe the whole process of human thinking as the mechanical manipulation of symbols.

By the 19th century, the ideas about artificial humans and thinking machines were also put forward in fiction by Johann Goethe's Faust, Mary Shelley's Frankenstein and Karel Capek who suggested a term "robot", which in Czech means "worker". There were also Samuel Butler's speculation "Darwin among the Machines", Edgar Allan Poe's "Maize's" and Roger Bacon's "Maazel's Chess Player".

In the 20th century, with the appearance of digital computers the study of mathematical logic provided the essential breakthrough and made artificial intelligence seem plausible. The foundations had been set by such works as Irish mathematician George Bool's "The Laws of Thought" (1854) and Austrian logician Ludwig Wittgenstein's "Begriffsschritt". Basing on their systems English philosopher Bertrand Russell and logician Alfred Whitehead presented a formal treatment of the mathematical deductions in their masterpiece "Principia Mathematica" (1913). Inspired by Russell, German scientist David Hilbert challenged mathematicians to answer the fundamental question: "Can all of mathematical reasoning be formalized?"

In 1928 Hungarian-born American mathematician John von Neumann suggested minimax game theorem, which is still used in game playing programs. In 1948 American mathematician Norbert Wiener in his book "Cybernetics" became concerned with the common factors of automatic machines, organizations control and communication in living organisms.

The book laid the theoretical foundations for servomechanisms and had a substantial impact on public thought in years ahead.

A significant role in the idea of creating an artificial electronic brain belongs to British techno-visionary Alan Turing whose computation theory showed that any computation form could be described digitally. In 1950 Alan Turing published in journal MIND a landmark paper "Computing Machinery and Intelligence" in which he speculated about the possibility of creating machines that could think. To prove an operational definition of intelligence he devised his famous Turing Test. In the simplified version of the problem Turing proposed that if a machine could carry on a conversation (over a teleprinter) that was indistinguishable from a conversation with a human being, then it was reasonable to say that the machine was "thinking". Turing's test was the first serious proposal in the philosophy of artificial intelligence. It allowed him to answer all the most common objections to the proposition and argue convincingly that a "thinking machine" was at least plausible.

Turing's test inspired a handful of scientists to discuss the possibility of creating thinking machines. Some of them recognized that a machine that could manipulate numbers could also manipulate logical symbols. The manipulation of symbols could be the essence of human thought.

Scientists from different fields began to look for the ways of making an artificial electronic brain. The first working AI programs were written in 1951 on Mark 1 machine in the University of Manchester. There were also publications of Shannon's paper on chess, followed by Dietrich Prinz. Christopher Strachey wrote a checkers program. Another checkers program by Arthur Samuel eventually achieved sufficient skill to challenge respectable checker masters.

The statement of the philosophical position when a system composed of matter could have the properties of mind was called later "Strong AI" by John Searle from Berkley University. It was opposed to so-called "Soft computing" technique when machines cannot do anything on their own and the human interference was heavily involved.

The term "artificial intelligence (AI)" was coined by John McCarthy in 1956 at Dartmouth summer conference. According to McCarthy "AI was the science and engineering of making intelligent machines, especially intelligent computer programs". The term "artificial" was included in his definition because AI was studying and constructing man made intelligence. It was also related to the task of using computers to understand human intelligence. In 1958 McCarthy invented artificial language LISP (LIST + Processing) and computational linguist Margaret Master-

man at Cambridge University designed semantic network for machine translation.

There were successful programs and new directions in the 1950s and 1960s. To achieve the goal, they preceded step-by-step method as if searching through backtracking whenever they reached the dead end. In the paradigm called "reasoning as search" researchers would reduce the search space by using heuristics or "rules of thumb", eliminating those paths that were unlikely to lead to the solution.

"Logic Theorist" written by Cliff Shaw in 1956 and future Nobel Laureate Herbert Simon was engineered to perform automated reasoning and was described as the first artificial intelligence program. Simon and Shaw together with Allen Newell tried to capture a general version of the algorithm in a program called the "General Problem Solver". Their "Logic Theory Machine" successfully proved 38 from 52 Russell and Whitehead's theorems. Simon and Shaw also invented the AI language IPL-11and in the same year theoretical linguist Noam Chomsky wrote "Syntactic Structures" for language processing.

A founder of the first AI Laboratory in Massachusetts Institute of Technology(MIT) Marvin Minsky used semantic nets in 1968 and created a neural net machine SNARC (Special Numerical Association of Response Codes) which made a great contribution from the point of view of information processing. Later he published the paper "The Society of Mind" in which he described the human mind as a collection of cooperating agents. Minsky's knowledge representation formalisms using frames were another contribution during that period.

An important goal of AI research was to make computers communicate in natural languages. Terry Winograd from MIT developed an early computer robot arm SHRDLU that could carry out instructions typed in English and moved the arm based on those instructions. Natural language processing gave machines the ability to read and understand the language that humans speak. Barbara Grosz at SRI (Nonprofit Scientific Research Institute) established a Natural Language processing model. American AI theorist Roger Schank at Stanford University and Australian journalist Bill Woods also defined and described conceptual models for natural language understanding. The interactive program that carried on a dialogue in English ELIZA was developed by Joseph Weizenbaum at MIT.

Programming in Logic language PROLOG that supported logic programs was invented in 1972. Programming languages Python and Java offered various supporting packages to the machine learners. One of the successful programs to use "Semantic networks" was written by Toss

Quillian. A conceptive semantic network was represented as nodes and relations among concepts as links between the nodes.

The first generations of AI researchers raised their expectations impossibly high: "Within ten years a digital computer will discover and prove an important new mathematical theorem and will be the world's chess champion" — wrote H. A. Simon and Allen Newell in 1958. "Within twenty years machines will be capable of doing any work a man can do" — predicted H. A. Simon in 1965. "Within a generation ... the problem of creating artificial intelligence will be substantially solved" — Marvin Minsky added in 1967. In 1970 he foretold in Life Magazine "From three to eight years we will have a machine with the general intelligence of an average human being". Scientists of that period of time seemed to fail to appreciate the difficulty of the problems they faced. AI has been proven to be much more difficult than early pioneers believed. Many important artificial intelligence applications like vision or natural language required enormous amounts of information and knowledge about the world. No one at that time could build a database so large and no one knew how much information a program might learn.

Knowledge-based systems and knowledge engineering became a major focus of AI research mainstream in the 1980s. The MOLGEN (Molecular Generation Expert System) program was demonstrated at Stanford University as an object-oriented representation of knowledge. A form of interactive computer software program called "expert systems" came from the knowledge they contained. A computer scientist and researcher in AI Douglas Lenat from Stanford University started a long-term AI project Cyc with the aim to assemble a comprehensive information and knowledge by creating a massive database.

Different practice problems were tried to be solved in the modern period of AI. To solve such practical problems researchers had to be engaged also in theoretical work on AI including heuristics search, uncertainty modeling, machinery and various reasoning problems. New AI ideas were explored in logic programming, commonsense reasoning and many other areas.

Chess playing programs, Deep Thought and DEEP Blue were created at Carnegie Mellon University and defeated world chess masters. Their applications were only expected to become more plentiful.

Although the field of artificial intelligence research was founded as an academic discipline the US Department of Defense started backing several programs in order to stay ahead of the Soviet technology. MIT

received a $2.2 million grant from the newly created Advanced Research Projects Agency in the US Department of Defense (later known as DARPA). The money was used to fund project MAC which subsumed the "AI Group" founded by McCarthy and Minsky five years earlier. The similar grant was given to Newell and Simon's program at Carnegie Mellon University (CMU) and to the Stanford AI Project (founded by John McCarthy in 1963). These four institutions including AI laboratory in Edinburgh University were the main centers of AI research for a number of years.

In the history of artificial intelligence there have been different periods. The business community's fascination with AI rose and fell in the 1980s in the classic pattern of an economic bubble. Since its release, AI developments have been making different waves across the globe. After the recovery from periods of the "AI winter", which was coined to be analogous to the idea of a nuclear winter to indicate a time of serious setback for funding and research interest in AI, it is witnessed that AI began to contribute to significant advances in many scientific fields and social impacts. This was mainly due to the birth of deep learning methods.

The development of metal-oxide-semiconductor (MOS) and very-large-scale integration (VLSI) enabled the development of practical Artificial Neural Network technology (ANN). A landmark publication in the field was of a book "Analog VISI (Modeling) Implementation of Neural System" by Carver A. Mead and Mohammed Ismail in 1989. Neural networks became to be widely used with the back-propagation algorithms. They became commercially successful in the 1990s, when they began to be used as the driving programs like optical character and speech recognition.

With the creation of intelligent agents AI reached some incredible landmarks in the 1990s and the 21st century. Public and companies alike came to realize that, given the correct guidance, AI recent developments could produce massive and positive changes in virtually every aspect of human life. Over the past few decades, several computer systems have been built that can diagnose diseases, plan the synthesis of complex organic chemical compounds, solve differential equations in symbolic form, analyze electronic circuits, understand human speech and natural language text, or write computer programs to meet formal specifications.

Unit 1

Artificial Intelligence as Interdisciplinary Field of Science

Words and phrases

To become ubiquitous — распространиться
High-latency satellite links — спутниковые каналы с высокой латентностью
Hazardous chemical spills — области опасных химических веществ
Apps — приложения, программы
Follow-ups — последующие действия
Augmented reality — расширенная/дополненная реальность
Road freight — грузовой транспорт
To mitigate — смягчать
Efficacy — эффективность/действенность
Scalable — масштабируемый
Conservationists — защитники природы
Decimate — снижать, уничтожать

Through its whole history AI increasingly became integrated with other fields and was closely related with computer science, mathematics, philosophy, statistics, cognitive psychology, neuroscience, linguistics and other sciences. This integration was driven by the need to address complex problems that required knowledge and expertise from different fields of multidisciplinary spheres. They include such fields as engineering disciplines, physics, chemistry, biology and social sciences. As AI systems became more sophisticated and integrated into human daily lives AI began to be also related and has also brought improvements to finance, economics, document classification, logistics, medical diagnosis and pharmacology.

Industry and business platforms were embedded into smart business operations with the help of AI. Artificial intelligence, the internet of things, digital twins, robotics and additive manufacturing (AM) are paving the way to new solutions for designing, producing and supplying products and services. AI could help these areas improve and streamline the processes, whether for productivity or for production.

Though some forms of computer vision have been in use in manufacturing for decades, recent advances in machine learning and image

processing have enabled new manufacturing cases. Accessible computer vision that AI technology used in manufacturing has revolutionized the automation of supply chain and safety management. It is experiencing a paradigm shift where the digital and physical sides of processes have to be properly combined to produce a new generation of products. No longer limited to structured, repetitive tasks, AI-assisted computer vision platforms are capable of functioning in increasingly complex environment. In conjunction with operators, they lead to improved efficiency, better data and fewer errors.

AI and Everyday Users

AI-based custom software appears in a widening range of Smartphones and tablet apps designed for everyday users. Currently available apps that use the power of AI to deliver their services include Google Assistant, Microsoft Pix and Socratic. Google Assistant allows users to check appointments, search the web, play music, and send messages hands-free. Socratic is an AI-based tutoring app that explains how to solve mathematical problems by analyzing images of equations. Microsoft Pix, another popular machine learning tool, uses recent AI development to select the best three shots out of ten frames captured. The app then automatically deletes the other shots to optimize users' photographing skills and save space in their Smartphone storage.

AI is revolutionizing how we create content. Their rise is undeniable — a recent Gartner study indicates that by 2025, over 30% of all marketing content will be augmented by AI-driven tools.

Whether you need catchy ad copy, blog posts, or engaging social media captions, AI text generators can streamline your process and produce surprising results for digital marketing. These tools offer a wealth of benefits. They save time, combat writer's block, spark creativity, and even help overcome language barriers. When used responsibly, AI text generators can be game-changers for your brand. If you haven't explored their potential, you're seriously missing out!

ChatGPT, by OpenAI, first made waves in late 2022, quickly gaining popularity, and for good reason. It comes in a free version and a paid subscription (ChatGPT Plus, $20/month). With ChatGPT, you can get ideas, summarize your research, and beat writer's block. It can also help with social media posts, product descriptions, and customer service chatbots (especially on Plus).

Russia did not take it long to create a rival the Open AI's AI innovation and brought forward GigaChat, an AI-powered technology introduced by

Sberbank, a Russian lender. Recently, the company successfully unveiled GigaChat, its recently developed chatbot as a rival of ChatGPT. As per the organization, the ability to hold a fluent and intelligent conversation in Russian is the most significant differentiating feature in comparison to the rest of the global neural networks. After the Western nations decreased their export to Russia post the Ukraine crisis, the Sberbank has been increasingly investing in the field of tech. This is Russia's technique to become self-sufficient in the near and far future to decrease the reliance on imports. Reportedly, Sberbank's GigaChat has developed a multimodal tool that is expected to add audio, video, and many more capabilities in the coming future.

AI and Robotics

The field of robotics is closely related to AI. Recent AI developments have made it more accessible than ever to deploy image analysis tools. The innovations have been quickly expanding the role of robotics and making remarkable impacts in humanity's collective advancement. Intelligence is required for robots to be able to handle such tasks as object manipulation and navigation, mapping and motion planning.

There are more and more areas which humans leave to robots such as Universe System, exploring planets, satellites, defusing bombs and drones, studying volcanoes, using high-latency links, operating unmanned underwater vehicles on ocean floors.

The most popular robot application of AI is the driverless cars, driverless trains and ships. In 1995 the WAMP (Windows, Apache, Mysql and PHP) NET car drove an entire 158 km racing track without any help from human intelligence. After that self-driving vehicles powered by AI began to gain rapid popularity. These vehicles came equipped with the internet of things — paired sensors, geo-analytical capabilities, and connectivity platforms for Big Data.

Tech billionaire Elon Musk built his automatic electric car company Tesla around the promise that it would represent the future of driving — a phrase on the automaker's website. Much of that project was centered on Autopilot, a control system of features that could steer, brake and accelerate the electric vehicles on highways without human drivers.

Besides Elon Musk many specialists became confident that self-driving vehicles would replace e-commerce and business road fright. In 2011 a widely respected technologist Jaron Lanier wrote about the impact of AI on the job market. He predicted that in the not-too-far future it would be inconceivable to put a person behind a wheel of a truck or a cab. The

driverless cars will help to decrease the climate change and potentially destabilize the world natural ecosystems. They will improve time and energy management by optimizing future vehicles' fuel consumption; improve time and road safety alike.

Beyond our planet, artificial intelligence also relies on combined sensor and map data to track various parameters. Right now, various space robots are working on the International Space Station providing science with insight into the atmosphere, landscape and conditions of the universe. As in the case of ground vehicles, artificial intelligence is also used to navigate spacecraft, probes, and even Mars rovers. According to experts, the control technology for these devices is very similar to the systems that ensure the movement of ground vehicles in unmanned mode.

Many robotics startups are now embracing AI to develop and automate new AI systems. Firms like Olis Robotics have been driving innovation through the use of plug-and-play controls fitted with AI-powered software. Recently, new AI agents developed by Open AI were able to learn to use tools in an experiment based on multi-gent competition. This signifies a remarkable step forward the development of valuable and autonomous artificial intelligence trends.

The automatic vehicle control system began to develop also in the Russian Federation. In Russia the permission to operate it in test mode has been already passed at the legislative level.

One of the memorable new products of the AI in the RF is drones that not only fly, but also walk and include picking up the phone. This is the first time the device has been equipped with such a function.

Transmission for intelligent digital mesh was established between human and robot devices in 5G Technology. With time, it is expected that development in artificial intelligence may create robots that can operate somewhat independently from humans and human knowledge. Some companies (e.g., American technological company NVIDIA) have been able to make robots that perform tasks in the real world by learning from human actions without being deliberately taught to do so. Robots can watch how tasks get done and then reenact these actions. Vast self-learning AI is the development of machine learning algorithms through modification of SOINN (self-organizing incremental neural network). Bot program called AlphaGo has taught advanced strategies for playing game "Go" by itself, requiring no human training.

Unmanned vehicles and facial recognition systems, as well as Russian voice assistants even surpass their foreign counterparts in "emotional intelligence". Yandex was one of the first in Russia to develop unmanned

vehicles and today is implementing useful AI solutions for business. Yandex has its own developments that compete with Google and Amazon products. Among them is Yandex Speech Kit — a speech recognition and synthesis service in several languages (voice station "Alice").

What is important — Yandex brought the technology to the masses — today every company can implement it into its IT infrastructure. SpeechKit allows to communicate with customers without the participation of operator. A robot will sign up the client for the service, find out if the buyer is satisfied with the service, and make a series of cold calls. The system recognizes speech, builds communication according to a script and transmits data to managers. The consulting agency Brand Finance also included Russian company SBER in the top 3 strongest brands in the world. One of the reasons for the high rating is success in the development of innovation.

AI and Medicine

Advanced methods recently developed in AI computation and data science have contributed to many major breakthroughs in medicine and healthcare. The latest developments of artificial intelligence in medicine are enabling improvements in accurate diagnoses, clinical decision-making and optimal patient care. It's still difficult for machines to identify rare diseases due to image shortages. But it has been challenging for AI to learn to interpret correctly diagnostic results under human supervision. AI tools are used to overcome several challenges and speed up more accurate diagnostics in radiology. Recent developments in AI have allowed for the augmentation of AI training by computer-generated X-rays to create a larger database. Through this database, neural networks are trained to identify rare conditions.

It was reported that recurrent neural networks were already able to decode speech from a sensor implanted in a human brain and transform the cortical signals into a synthetic voice for clinical assessment and treatment. This technology is helpful for patients who suffer from neurological paralysis because of stroke, traumatic brain injury, and neurodegenerative diseases. Over the past decade, AI has been useful for solving problems in basic and clinical cancer research, where solutions to such problems had been thought to be impossible. Current AI computation and data science have made significant advances in medical research toward surgery and oncology. The latest achievements in Computer-aided surgery can guide surgeons to perform accurately on patients over the areas of interest which even experienced surgeons sometimes fail to detect.

The integration of new medical knowledge and smart computer algorithms is making significant progress toward personalized and precision medicine. The personalized medical approach allows medical doctors to predict more accurately which treatment and prevention strategies will be effective for which groups of people. It contrasts with the one-size-fits-all approach, in which disease treatment and prevention strategies are developed for the average people, with less consideration for the differences between individuals. Recent developments in artificial intelligence have proven instrumental in the production of COVID-19 vaccines and identification of viral components. About 16% of Russian medical organizations are already implementing AI into their work.

AI and Cybersecurity

AI is often considered to be a powerful computational tool that can be applied to many complex problems which have not been successfully addressed so far. Cybersecurity is another increasingly hot topic as businesses, companies and remote employees move their operations online. General intelligence technology can eliminate the need for human operators to perform manual processes and speed up the processing of deposits, payments and transactions. Artificial intelligence is hugely scalable, and can rapidly analyze and process vast amounts of data to secure digital systems and protect customers' financial investments and assets. AI can rapidly and accurately identify corporate policy violations and duplicate expenses.

In spite of a lot of benefits of AI there is a risk of information manipulation and cyberattacks. The use of AI systems involves processing and storing large amounts of data, which can raise not only privacy but security concerns. There is always a risk of information manipulation and cyber-attacks. There are many violations with credit cards and insurance documents. Cybercriminals are increasingly launching attacks on both specialized companies and banks and their clients. Modern engineering advances may allow hackers to steal money from banks and individuals copying documents and using flawless imitations of human sounding speech voices. Personal information may be compromised and become a prey of swingers.

Fortunately, the latest AI developments in model network behavior have proven useful in banking fraud and threat detection events. Cybersecurity maintains optimal situational control, improves incident detection and identifies risks. The parent company of Google Alphabet in-

troduced the cybersecurity intelligence platform Chronicle to streamline and improve cybersecurity measures. Banking apps across the globe now offer new AI chatbot support. Cybersecurity apps can connect financial accounts to Facebook Messenger, enabling users to make cancelations via the popular messaging platform.

AI and Education

Another area where artificial intelligence is making noticeable changes is education. Education is among pillars of modern society. According to experts, artificial intelligence is already a powerful tool for solving a number of pressing problems that exist in the practice of accelerating educational progress and training highly qualified specialists. AI technologies offer various capabilities for personalized learning, automation of routine tasks and analysis of large volumes of data. One of the key ways artificial intelligence will impact education is through the application of greater levels of individualized learning. Some schools are using AI systems to monitor student progress and alert teachers when there might be an issue with student performance. In schools and universities grading work and tests for large lecture courses can be tedious work taking up a significant time of the teachers. It is now possible for intelligent machine tutors to use automated grading for nearly all kinds of multiple choices. There are many projects already in work that use computer intelligence to help both teachers and students alike get more out of the educational programs. Some educational programs based on artificial intelligence already exist and can teach students fundamentals. E-learning and other online teaching and training systems may be improved by interactive e-teacher distant education or educational interactive programs for computer-aided instruction SCHOLAR developed by Jane Carbinell, language model RUGPT3 and many others. IT company Intellias, together with Alphary, has developed a set of intelligent applications for learning foreign languages. The applications are based on data mining, machine learning, corpus statistics and semantic analysis.

With the rapid pace of technological advancement, educational tutoring systems may not be a pipe dream. Still, it is necessary to add that despite the important advances in education, AI tutorial systems can perform only auxiliary functions and so far, humanoid robots cannot fully replace human teachers. There are many fields where automated machines cannot do what human teachers can, let alone such problems as motivation emotions, human interactions and relationships.

When and How Well Might AI Machine Outcome Humans?

Is it possible and necessary to build a machine able of consciousness and self-awareness of Homo Sapiens? More than fifty countries around the world have approved national development strategies. As interdisciplinary research, AI has brought along great significant challenges. Major advances were significantly demonstrated in a lot of business operations, machine learning, casebased reasoning, multi-agent planning, scheduling, natural language understanding and translation, computer vision, virtual reality and other areas. Planet research, smart sustainability, and innovation management also offer some interesting challenges.

The idea that machines could contain brains just as human bodies did inspired not only scientists but fiction writers and film makers. Isaac Asimov proposed the Robot series and published the first Robot science fiction "The Caves of Steel". In "Back to Methuselah" dramatist Bernard Shaw put questions about the validity of thinking machines that acted like humans. There was also Arthur Clarke's "The Sentinel", on which Stanley Kubrick's film "A Space" is based; Super-intelligent computer HAL 9000 in 2001; A Space Odyssey, C3PO and R2D2 in Star Wars, tricorders, borgs, holograms and smart computers in Star Wars. The film "Her" explores the theme of human emotions, consciousness and interaction with artificial intelligence. Similar scenarios were occasionally raised in press, video games, television and Hollywood movies. Some of them involved science fiction stories, in which machines and robots became particularly intelligent, went out of the people's control and destroyed the human race.

The majority of modern scientific technologists in artificial intelligence still state that the humanity so far has no grounds to apprehend AI technology and despite the important advances AI systems now are far from being comparable to human intelligence. A famous AI popularizer Ray Kurzweil predicted that desktop computers might have reached the same processing power as human brains have by year 2029, and that only by 2045 AI might have reached the point where it would be able to improve itself. Another problem which is often being considered by AI specialists all over the world is a more careful consideration of ethical global impact of AI on humanity. The idea of building "Friendly AI" behaving with common ethical principles and regulations of the human society has been brought up at peer-reviewed academic conferences, workshops and roundtables organized by various technological companies including Google, Deep Mind, Meta, and IBM jointly with the Machine

Intelligence Research Institute, Special Interest Groups on Artificial Intelligence (SIGAI) and National Science Foundation, etc. "Artificial Intelligence Ethics Forum: Generation GPT. Red Lines" took place at the RF TASS press center in 2023.

In this regard, it is necessary to mention the UNESCO conference "Beijing Consensus on Artificial Intelligence and Education" in 2019, within the framework of which UNESCO prepared the publication "Artificial Intelligence Technologies in Education: Prospects and Consequences". The main idea of the publication is the need to remember about humanity and adhere to the principles of ethics and transparency of AI. Since our world is one and indivisible, AI should be aimed at eliminating existing inequalities to a variety of educational and cultural forms. The humane AI for everyone must be of special importance.

The biggest challenges for the future of AI lie ahead. Multidisciplinary AI research and machine learning techniques without "borders" may help in elaborating of general solvers. From deep fakes to biased hiring algorithms, the AI field has struggled to accommodate a rapid growth and an increasing complexity of needed solutions. Rather than just predicting or making decisions, AI might be developed to find new patterns in complex systems which will facilitate scientific discoveries and enrich the humanity. Scientists believe that in the future, large and small AI models will collaborate and then create a complete intelligent ecosystem. The development of supercomputers is gaining momentum, providing more and more powerful and energy-efficient models. The rise of quantum computers and quantum-like algorithms could further expand the hardware and algorithmic toolbox for AI.

Notes:

CEO — Chief Executive Officer, Managing director.
NLP — Natural language processing.
AlphaGo — Was created by Google DeepMind.
Fintech — I refers to firms using new technologies, big data, etc.
Blockchain — a distributed ledger with growing lists of records (blocks) that are securely linked together via cryptographic hashes.
Metal-oxide-semiconductor — CAD| CAM solutions for the Mould and Die industries.
Rules of thumb — an informed piece of practical advice.
Apps — mobile apps, web applications software designed to run on smartphones and other mobile devices.

VISI — a graphical user interface-based operating environment program by Visicorp's for IBM PC.

VLSI — very large-scale integrated circuit by combining millions or billions MOS transistors onto a single chip.

Exercises:

1. Give Russian equivalents to the following words and phrases:

A. To put forward; to envision; to speculate about; to lay the theoretical foundations for; to have an impact on; techno-visionary; to capture the essence; a landmark paper; to search through backtracking; heuristics search; commonsense reasoning; to subsume; economic bubble; setback; to make social impacts; back-propagation algorithms; to pave the way; assemble information; reasoning problems; plug-and-play controls; high-latency links.

B. To adopt chatbot support; to pass a permission; at the legislative level; to select the best shots; one-size-fits-all approach; swindlers; to protect investments and assets; to enhance threat detection; fraud detection; to be customized to the needs; to become ubiquitous; to pepper popular movies; plug-and-play control; tethered robots; high-latency satellite; banking apps; follow-ups; augmented reality; road freight; mitigate; takeaway; AI blockchain; to be embedded with; digital twins.

2. Translate the extracts from the texts into Russian:

1. In the 20th century, with the appearance of digital computers the study of mathematical logic provided the essential breakthrough and made artificial intelligence seem plausible.

2. In 1948 American mathematician Norbert Wiener in his book "Cybernetics" became concerned with the common factors of control and communication in living organisms, automatic machines, and organizations. The book laid the theoretical foundations for servomechanisms and had a substantial impact on public thought in years ahead.

3. Basing on the works of George Bool and German logician Ludwig Frege philosophers Bertrand Russell and Alfred Whitehead presented a formal treatment of the mathematical deductions in their masterpiece "Principia Mathematica" (1913).

4. Inspired by Russell, German scientist David Hilbert challenged mathematicians to answer the fundamental question: "Can all of mathematical reasoning be formalized?"

5. A significant role in the idea of creating an artificial electronic brain belongs to British techno-visionary Alan Turing whose computation theory showed that any computation form could be described digitally.

6. There were some successful programs and new directions in the 1950s and 1960s. To achieve the goal, they proceeded step-by-step towards it as if searching through backtracking whenever they reached the dead end. In the paradigm called "reasoning as search" researchers would reduce the search space by using heuristics or "rules of thumb", eliminating those paths that were unlikely to lead to a solution.

7. The business community's fascination with AI rose and fell in the 1980s in the classic pattern of an economic bubble.

8. With the creation of intelligent agents AI reached some incredible landmarks in the 1990s and the 21st century. Over the few decades, several computer systems have been built that can diagnose diseases, plan the synthesis of complex organic chemical compounds, solve differential equations in symbolic form, analyze electronic circuits, understand limited amounts of human speech and natural language text, or write computer programs to meet formal specifications.

9. Professionals in industries and business would do well to monitor future computer vision trends. Artificial intelligence, the internet of things, digital twins, robotics and additive manufacturing (AM) are paving the way to new solutions for designing, producing and supplying products and services.

10. Recent AI developments in deep learning have made it accessible than ever to deploy image analysis tools. The innovations have been quickly expanding the role of robotics and making remarkable impacts on humanity's collective advancement.

11. Firms like Olis Robotics have been driving innovation through the use of plug-and-play controls fitted with AI-powered software. They can use robotics to service satellites using highlatency links, operate unmanned underwater vehicles on ocean floors.

12. Recently, new AI agents developed by Open AI were able to learn to use tools in an experiment based on multi-gent competition.

13. Machine learning has proven useful in fraud detection efforts. It can rapidly and accurately identify corporate policy violations and duplicate expenses.

14. The precision or personalized medicine approach allow medical doctors to predict more accurately which treatment and prevention strategies will be effective for which groups of people. It contrasts with the one-size-fits-all approach, in which disease treatment and prevention

strategies are developed for the average people, with less consideration for the differences between individuals.

15. There are also many violations with credit cards and insurance papers. Cybersecurity improves incident detection, identifies risks, and maintains optimal situational control. Banking apps across the globe now offer new AI chatbot support.

16. The majority of modern scientific specialists in artificial intelligence state that the humanity so far has no grounds to apprehend AI technology and despite the important advances AI systems are still far from being comparable to human intelligence.

3. Give English equivalents to the following words and phrases:

Выдвигать; размышлять о; представлять себе картину; заложить теоретические основы; оказать влияние на; техно-провидец; уловить суть; экономический пузырь; неудача; оказывать общественное воздействие; проложить путь; на законодательном уровне; масштабируемый; защитить инвестиции и активы; обнаружение угроз и мошенничества; несбыточная мечта; выдвинуть серьезные проблемы; цифровые двойники; мошенники; столпы (опоры).

4. Answer the following questions:

1. Would you call the main figures in the history of AI?
2. What is the difference between Intelligence and AI?
3. What are the most important events in the AI history from your point of view?
4. What is AI technique? Which machine learning technique will you choose as an appropriate one for your problems and theme?
5. What is the difference between strong AI and weak AI?
6. What are the major benefits of AI technology?
7. How are AI systems integrated into human daily lives?
8. What do you think of the AI role in education?
9. How do AI technologies contribute to medicine? What are the most remarkable and favorable AI achievements in health care?
10. How does AI help in FinTech and banking?
11. Will you give examples of bot programs, please?
12. Have you read any science fiction books or stories about robots?
13. Have you seen any Hollywood movies devoted to robots?
14. Why do some specialists bring up ethical problems around AI? What do you think of “friendly AI”?
15. Is AI friend or enemy of cybersecurity?

16. Do you agree with Ray Kurzweil prediction about AI future?
17. How far is AI from reaching human-level intelligence?

5. Translate from Russian into English:

Перспективы развития искусственного интеллекта

«Что было бы, если бы вам уже удалось достичь своей цели?» Этот вопрос в области искусственного интеллекта может вызвать у исследователей ИИ большое замешательство. Искусственный интеллект демонстрирует замечательные достижения, так, о чем же беспокоиться?

Интеллектуальные компьютеры, безусловно, являются более мощными, но будет ли эта мощь использоваться во благо или во зло? Те, кто посвящают свою жизнь разработкам в области искусственного интеллекта, ответственны за то, чтобы влияние их работы было во благо. Кажется, вполне вероятным, что крупномасштабный успех в создании искусственного интеллекта повлияет на существование большинства представителей рода человеческого. Достижение в искусственном интеллекте окажет влияние на повседневную жизнь всех слоев населения во всем мире. Вполне можно представить себе, что действительно полезные персональные ассистенты для офиса или дома окажут большое положительное воздействие на повышение качества повседневной жизни. Изменится сам характер нашей работы и развлечений, также, как и наши представления об интеллекте, сознании и будущей судьбе человечества.

Однако, технологические возможности, открывающиеся на этом уровне, могут быть также применены для создания автономного оружия, появление которого многие считают нежелательным. На этом уровне системы искусственного интеллекта могут создать более непосредственную угрозу самоопределению, свободе и даже выживанию людей. По этим причинам нельзя рассматривать исследования в области искусственного интеллекта в отрыве от их этических последствий.

Каким мы видим будущее? Авторы научно-фантастических романов чаще публикуют пессимистические, а не оптимистические сценарии грядущего, по-видимому, потому что это позволяет сочинять более увлекательные сюжеты. Хотя создается впечатление, что искусственный интеллект пока развивается по такому же принципу, как и другие революционные технологии, отрицательные послед-

ствия, внедрения которых перевешиваются положительными результатами.

Даже первые успехи в области искусственного интеллекта повлияли на то, как осуществляется разработка программного обеспечения. Благодаря искусственному интеллекту удалось создать принципиально новые приложения, такие как системы распознавания речи, интеллектуальные системы наружного наблюдения, роботы и машины поиска.

За свою короткую историю искусственный интеллект добился существенного прогресса, но последнее утверждение из эссе Алана Тьюринга *Computing Machinery and Intelligence* продолжает оставаться неоспоримым и в наши дни. Мы способны заглянуть вперед лишь на очень короткое расстояние, но все равно можем увидеть, как много еще предстоит сделать.

(*С. Рассел, П. Норвиг «Искусственный интеллект. Современный подход». Диалектика. 2022*)

История развития искусственного интеллекта в России

«Официальная» история искусственного интеллекта в России началась в январе 2019 года, когда президент страны Владимир Путин дал поручение правительству разработать подходы к национальной стратегии развития искусственного интеллекта (ИИ) и представить соответствующие предложения. В середине октября президент Путин подписал указ, которым утвердил стратегию развития ИИ в стране до 2030 года. Согласно документу, Россия должна занять одну из ведущих позиций в мире в этой сфере, так как лидер в области ИИ станет, по мнению российского президента, «властелином мира».

Затраты развитых стран, особенно США, Китая, а также Евросоюза, на технологии искусственного интеллекта растут ударными темпами. Между тем, вплоть до последнего времени Россия оставалась едва ли не последней из крупных стран, не имеющих собственной стратегии развития технологий ИИ. Ситуация начала меняться лишь в конце 2019 года, когда была утверждена «Национальная стратегия развития искусственного интеллекта на период до 2030 года».

Национальная стратегия определяет две ключевые точки развития ИИ в России — 2024 и 2030 годы. Предполагается, что к первой дате страна значительно улучшит позиции в этой сфере, а к 2030 году ликвидирует отставание от развитых стран и добьется мирового лидерства в отдельных направлениях, связанных с ИИ. Внедрять тех-

нологии ИИ российские власти планируют в том числе через государственные национальные проекты. К приоритетам развития ИИ в России относится:

– Ускорение технологического развития РФ за счет увеличения количества организаций, осуществляющих технологические инновации, до 50% от их общего числа;

– Обеспечение ускоренного внедрения цифровых технологий в экономику и социальную сферу;

– Создание в базовых отраслях экономики, прежде всего в обрабатывающей промышленности и агропромышленном комплексе, высокопроизводительного экспортно-ориентированного сектора, развивающегося на основе современных технологий и обеспеченного высококвалифицированными кадрами.

Стратегия также обозначает ряд задач, которые необходимо решить для успешного развития технологий ИИ в России, в числе которых:

– Создание высокопроизводительных рабочих мест;

– Обеспечение конкурентоспособных условий труда для специалистов в сфере ИИ;

– Привлечение специалистов из-за рубежа;

– Поддержка экспорта продуктов и услуг, созданных с использованием ИИ;

– Создание стимулов для развития корпоративной науки и исследований;

– Формирование комплексной системы безопасности при создании, развитии, внедрении и использовании технологий ИИ.

Между тем искусственный интеллект уже сейчас используется в России при решении самых разных задач. Например, Сбербанк применяет его при выдаче кредитов, Яндекс — в развитии беспилотного транспорта и в голосовом помощнике «Алиса», Mail.ru — в коммуникациях, Ростех — в сфере производства, а МВД — при распознавании лиц для обеспечения безопасности на улицах Москвы.

ИИ все чаще используется в производственных системах предприятий и основных бизнес-процессах. Ожидается, что к 2024 году в разработку технологий и процессов ИИ будут внедрять 75% предприятий, а 86% предприятий перейдут на ИИ к 2025 году. Судя по опыту Huawei, основанному на более чем 600 проектах, использование ИИ в производственных системах принесет промышленникам огромную пользу.

Huawei применяет ИИ ко всем своим основным бизнес-процессам. ИИ применялся более чем в 200 сценариях, таких как продажи, НИОКР, производство, поставка и доставка, и создал более 10 000 цифровых сотрудников для Huawei.

В Шэньчжэне было разработано решение для систематического управления дорожным движением на базе искусственного интеллекта, основанное на обратной связи в режиме реального времени о дорожных условиях и на опыте экспертов. Загруженность дорог уменьшилась на 8%, а средняя скорость транспортных средств увеличилась на 6,21%.

ИИ также оптимизирует процессы и способствует инновациям. Например, благодаря синергии между облаком, 5G, искусственным интеллектом и периферийными вычислениями беспилотные летательные аппараты могут интеллектуально проверять электросети, шахты, порты и другие объекты инфраструктуры, которые являются жизненно важными для города, что приводит к 80-кратному повышению эффективности их работы.

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Тенденции ИИ в России:

Развитие облачных технологий и больших данных (Big Data), которые являются основой для работы современных алгоритмов ИИ.

Применение ИИ в различных отраслях экономики, таких как промышленность, здравоохранение, финансы, транспорт и сельское хозяйство.

Развитие робототехники и беспилотных транспортных средств, оснащенных системами ИИ.

Создание отечественных аналогов зарубежных технологий ИИ, таких как голосовые помощники, системы машинного перевода и рекомендательные системы.

Обучение специалистов в области ИИ и создание образовательных программ по искусственному интеллекту в вузах страны.

Сотрудничество с международными партнерами и участие в глобальных исследовательских проектах по ИИ.

В целом, эволюция ИИ в России характеризуется активным развитием и стремлением к инновациям. В будущем ожидается дальнейшее развитие технологий искусственного интеллекта и их применение в различных сферах жизни общества.

6. Summarize the texts and develop the following subjects and express your own opinion. Here are some statements for support:

1. AI is all around us, all the time.
2. How has AI changed our life?
3. What is your opinion how AI can change the future life?

7. Develop the following ideas in writing an essay (120–150 words):

1. The development of cloud technologies and big Data, which are the basis for the operation of modern AI algorithms.

2. Creation of domestic analogues of foreign AI technologies, such as voice assistants, machine translation systems and recommendation systems.

Unit 2

AI and Culture

Words and phrases

Ubiquity	— повсеместность
Reconceptualization	— переосмысление
Reflexive approach	— рефлексивный подход, самопознание
Assumptions	— допущения
Scarce	— дефицитный
Disperse	— рассеивать
Integrity	— целостность
Entertainment industry	— индустрия развлечений
Mastering process	— процесс освоения
Screenwriting	— написание сценариев
To portray characters	— изображать персонажей
Labour market	— рынок труда
Mimic	— подражать
Sustainable materials	— устойчивые материалы
Legal frameworks	— правовая база

The increasing ubiquity of artificial intelligence and machine learning raises a broad range of questions for the future of technology and art, and for the transformations that have taken place in the nature of being and technology. In the field of artistic practice and exhibition, this has been increasingly engaged by a critically reflexive approach, seeking to question ideas around agency, autonomy, technology, identity, and the nature of creativity and meaning with newly emergent forms of networked practice.

Collaborations between artists, curators, technology and exhibition contexts are variously interrelated, and these frame different ontological questions on the nature of the work of art, the nature of consciousness, identity and technology, and the reconceptualization of creativity.

A lot of ideas and assumptions are being expressed today by scientists from various fields of knowledge regarding the future of the digital age that humanity has entered. And the conceptual challenge of interdisciplinary is becoming more and more obvious, due to the need to study a new phenomenon — digital culture, which is going through a difficult period of its formation.

On the one hand, there is a unique opportunity to comprehend the emerging phenomenon, when complex research is still scarce and interdisciplinary interpretations of digital culture are practically absent.

On the other hand, the current stage of studying digital culture is associated with huge risks: either to describe the phenomenon in a strictly rational discourse of natural science knowledge, including a technical module, or to "disperse" the object between well-known socio-humanitarian disciplines (philosophy, sociology, cultural studies, anthropology, economics, etc.) abandoning the principles of interdisciplinary thinking, focused on understanding its integrity and complexity.

New cultural practices of an informational and communicative nature are being formed, creating qualitatively changed characteristics for a developing society in digital networks, where the freedom of the individual, his cultural self-identification and the possibilities of self-realization in virtual environments are understood in a different way.

A new style of communication is being born, highlighting its features such as independence, emotional and intellectual openness, orientation towards innovation; the emergence of a new type of nonlinear, personality-centered cognition of the "world map"; the construction of fundamentally new intellectual opportunities and new structures of "smart cities"; the creation of an Internet space new ways of forming identity and individuality, leading to an increase in self-esteem and self-worth; the formation of new political and economic values: high tolerance, global orientation, social and civic responsibility, etc.

Based on the fact that digital culture is capable of cardinally influencing the meanings and values of human existence, changing the relationship between specialized and everyday levels of society's culture, making significant adjustments to the image and lifestyle, its study goes beyond purely theoretical research. Moreover, applied aspects, due to the lack of knowledge of the object itself, actualize the search for a subject suggested to us by the installation of generally recognized concepts — inter-civilizational dialogue, sustainable development, focused on the coordination of multi-vector trends in culture, technology, and economics.

A number of researchers associate the phenomenon of digital culture with traditional objects of culture and art, represented by means of information and communication technologies, including the concepts of electronic libraries, virtual museums, multimedia reconstructions of monuments, a semantic network on the Internet, etc.

Others note that this is primarily a qualitatively new socio-anthropological reality, which is nothing more than the instrumental use of

technical capabilities: a fundamentally different digital sphere of human sociocultural activity or, in other words, the cultural reality of the digital space, overgrown with new forms of communicative influence on a person.

The Internet as a global culture-transforming phenomenon represents new values, which indicates a paradigm shift in social communications. A special space is being formed to create an over-saturated information field that surrounds modern man almost everywhere. In the era of electronic transformations, people receive various types of cultural information as a new resource for activating interests and competence levels based on a wide variety of means, including electronic ones.

Symbols generated by the age of electronic communications transform the consciousness of a person in one way or another. Electronic objects surround us everywhere and make us completely dependent. Engagement in communication increases significantly now an employee feels like a "part of the corporate body" around the clock. Using a mobile phone often causes mixing of many actions and changing masks, when, for example, mobile phone owners are in touch, they simultaneously stay in two places — the physical place they occupy and in the virtual conversation space (dialog space).

Experts see the need for the development of education for the transition to digital culture, especially in the field of management. Nationwide, there is already a shortage of digital specialists, and therefore there is an increasing need to create a nationwide matrix educational environment where universities (both public and corporate) should become an experimental gaming platform for various forms of education using advanced technologies and taking into account the specifics of digital culture.

Artificial intelligence can also be used in various areas of culture, such as music, film and theatre, as well as cultural heritage. This section examines the areas of application of AI and the associated legal issues.

AI and Art

Neural style transfer and Deep Dream technologies allow you to create objects that in many cases do not differ from human creations. The generation of random images in CAN technology adds spontaneity to the creativity of artificial intelligence and allows you to take a step forward compared to deep stylization. Of course, the gap between AI and humans is narrowing. However, it seems that it will not be completely overcome in the near future, since it is the person who sets up the model, selects training examples and uses technology for creativity.

The idea that machines can be artists, or can even replace artists, as they have already replaced some professions, looks too bold so far.

Artificial intelligence presents extraordinary tools of work and a new unusual experimental field for artists in the field of visual art and the entertainment industry (game design, CGI cinema, etc.), as well as simplifies and automates routine processes. However, the more automated the process of creating works of art becomes, the higher the value of the idea behind them increases.

Now that the issue of execution, physical realization and the availability of the necessary technical skills disappears, new ideas are the main driving force in the development of art. And the generation of these ideas is the main function that artificial intelligence cannot (or cannot yet) take away from the creator.

AI in Music

AI technologies can be used in the music industry to support composition, production, analysis and live performance.

AI systems such as "Amper Music" or "OpenAI's MuseNet" can create musical compositions by learning from databases of musical styles and structures. They can also be used in music production, for example by automating the mixing and mastering process.

The issue of copyright protection of AI-generated music is similar to that of AI-generated art. In the EU and US, it has been ruled that protection is only granted to human authors (Directive 2019/790/EU; Naruto v. Slater, 2018). It is unclear who should be considered the author of AIgenerated music.

AI systems could inadvertently plagiarize musical works if they show similarities to existing pieces due to their learning processes. Developers and musicians must ensure that they do not commit copyright infringement.

AI can also be used to analyze music tracks and create personalized recommendations for users, such as through streaming services like Spotify and their AI-based recommendation algorithms.

Live Performance and Interaction

AI can also be used in live music performances, for example through AI-controlled instruments or interactive music installations where the audience can interact with AI systems.

This expands the possibilities of musicians, but also presents them with new challenges.

AI in film and theatre AI can also be used in film and theatre, for example in screenwriting, directing, acting and post-production. It makes it possible to break new ground and express oneself creatively.

Screenwriting and Directing

AI can be used to write scripts or to support directors, for example by suggesting storylines, character developments or script adaptations. One example is the AI system "Benjamin," which wrote the script for the short film "Sunspring" in 2016. AI's infiltration into the movie industry begins at the scriptwriting stage. Tools like ScriptBook use natural language processing to analyze scripts, predict box office success, and offer insights into plot and character development. For instance, 20th Century Fox employed AI to analyze the script of Logan, which helped in making informed decisions about the movie's plot and themes. Consider, in pre-production, AI has also aided in casting and location scouting. Warner Bros. partnered with Cinelytic to use AI for casting decisions, evaluating an actor's market value to predict a film's financial success. For example, let's look at location scouting. AI algorithms can sift through thousands of hours of footage to identify suitable filming locations, streamlining what was once a time-consuming process.

Acting and Character Development

AI can also be used in acting training and character development, for example by giving feedback to actors, analasing their performance or making suggestions on how to portray characters. One example is the AI system "LAIKA," which helps actors adjust their voice and body language.

Future Potential of AI in Movie Studios

Looking to the future, AI's potential in the film industry is boundless. One emerging application is in virtual filmmaking, where AI could assist in creating realistic virtual environments, reducing the need for physical sets. This technology could revolutionize the way movies are made, offering more creative freedom and reduced production costs. Another area with potential is AI-driven narrative development. AI could analyze audience preferences and societal trends to suggest storylines and genres that are likely to resonate with viewers. This predictive storytelling could lead to more successful films that are closely aligned with audience interests. AI could also enhance immersive experiences in movies, such as augmented reality (AR) and virtual reality (VR). By integrating AI with these technologies, filmmakers could create more engaging and interactive storytelling experiences.

AI in Cultural Heritage

AI can also be used in the field of cultural heritage, for example in the conservation and restoration of works of art, in the research and archiving of cultural-historical artefacts or in the education and transmission of cultural knowledge. We have summarized what there is to know about this here.

AI can be used in the conservation and restoration of artworks, for example by analyzing damage, suggesting restoration methods or reconstructing the colours and textures of artworks. One example is the AI system "Art Transfer," which digitally restores damaged paintings.

Risks and Challenges of AI in Art and Culture

Although there are many benefits to integrating AI into arts and culture, there are also risks and challenges that need to be considered. These include issues of artistic integrity and authenticity, control and surveillance, and labour market and social implications.

Opportunities for AI in art and culture

AI technologies offer a multitude of opportunities in the fields of arts and culture by promoting creativity, innovation, accessibility and efficiency. This segment explores the key opportunities and the legal issues involved.

The integration of AI into arts and culture offers enormous potential for creativity and innovation. Through the use of AI systems, artists and cultural practitioners can explore new avenues of creative expression and break down traditional barriers.

Human-machine collaboration: AI can act as a creative partner to help artists develop new ideas and realize their visions. Examples include AI-powered painting programs that mimic human painting techniques and allow the artists to express their ideas in innovative ways, or AI systems that assist in composing music or writing screenplays.

By using AI technologies, such as Generative Adversarial Networks (GANs) and Deep Learning, artists can create entirely new forms of artwork that were previously impossible. One example is the well-known AI-generated painting "Portrait of Edmond Belamy", which was auctioned at Christie's in 2018 for 432,500 US dollars.

AI is enabling the emergence of new art forms and creative experiments by integrating technologies such as virtual reality, augmented reality and interactive media. These can help create immersive and participatory experiences for audiences that push previous artistic boundaries.

In the context of AI-generated works, the issue of intellectual property rights is relevant. In some cases, courts have ruled that AI systems have no intellectual property rights. One example is US copyright law, which generally does not recognize works created by an AI without human involvement.

The use of AI in arts and culture can help increase access to creative content and promote greater diversity in artistic expression. AI can benefit both creators and audiences by enabling new ways of interaction and engagement.

AI technologies can help make arts and culture accessible to a wider audience by breaking down barriers that prevent people with disabilities or reduced mobility from participating in cultural events.

Examples include AI-powered translation tools that make cultural content accessible in different languages, or AI applications that help visually or hearing-impaired people better experience works of art or performances.

AI can help promote cultural diversity by enabling artists and cultural practitioners from different backgrounds to express their voices and perspectives. For example, AI systems can be used to identify and address patterns of discrimination or inequality in the art world, creating a more inclusive and representative cultural environment.

However, there is also a risk that AI may unintentionally reinforce discriminatory patterns or prejudices if it has been trained on biased data and prohibit discrimination and require equal treatment of all people, regardless of their background.

There have also been some court rulings in recent years in relation to access and diversity in arts and culture. One example is the Knight First Amendment Institute v. Trump case in the US, which addressed the question of whether the use of AI-powered social media bots in political communication can be considered protected expression.

The use of AI in arts and culture can help increase the efficiency of creative processes and contribute to sustainability in the sector. AI systems can help arts and culture practitioners make better use of resources and develop innovative solutions to environmental and social challenges. AI can help optimize workflows in the arts and culture sector and enable time and cost savings. Examples include AI-powered art exhibition management tools that facilitate event planning and execution, or AI systems that help analyze and market cultural content.

AI can help promote more sustainable practices in the arts and culture sector, for example by optimizing energy consumption at events and ex-

hibitions or making the transport and storage of artworks more efficient. AI can also be used to research and promote sustainable materials and techniques in art production.

However, AI systems used in creative processes can also cause errors that lead to damage or loss. This raises questions about liability, particularly in relation to whether the artist, the AI developer or the operator of an AI system can be held responsible for such damage. In many countries, liability regimes for AI systems are not yet clearly defined and there is a need for legal frameworks.

The use of AI to promote sustainability in the arts and culture sector should also be in line with national and international environmental laws and policies. Examples include the Environmental Code in Germany or the European Environmental Strategy, each of which aims to promote environmental protection and sustainable development.

Although there are many benefits to integrating AI into arts and culture, there are also risks and challenges that need to be considered. These include issues of artistic integrity and authenticity, control and surveillance, and labour market and social implications.

The use of AI in arts and culture can lead to creativity and innovation, increase access to cultural content, promote diversity and contribute to efficiency and sustainability in the sector.

At the same time, AI-generated artworks and AI-assisted creations raise questions about artistic integrity and authenticity, while the use of AI to monitor creative processes or censor artworks raises concerns about control and surveillance.

Furthermore, the impact of AI on the labour market and social conditions in the arts and culture sector may lead to job losses and social inequalities.

In conclusion, the use of AI in culture and art is an incredibly promising area that can make a significant contribution to the development of these areas. AI can help automate processes, make them more efficient and accurate, and create new opportunities for creative work and interaction between creators and viewers.

However, it must be remembered that art and culture are spheres that have their own unique character and traditions, and the participation of the human factor remains extremely important. Therefore, it is important to find a balance between using AI and preserving art and culture in their original form.

Exercises:

1. Give Russian equivalents to the following words and expressions:

The increasing ubiquity, increasingly engaged by, variously interrelated, the nature of consciousness, assumptions, to comprehend the emerging phenomenon, highlighting its features, significant adjustments to the image and lifestyle, goes beyond purely theoretical research, engagement in communication, the associated legal issues, copyright infringement, enabling the emergence, promote sustainable materials.

2. Translate the sentences into Russian:

1. The increasing ubiquity of artificial intelligence and machine learning raises a broad range of questions for the future of technology and art, and for the transformations that have taken place in the nature of being and technology.
2. A lot of ideas and assumptions are being expressed today by scientists from various fields of knowledge regarding the future of the digital age that humanity has entered.
3. A new style of communication is being born, highlighting its features such as independence, emotional and intellectual openness, orientation towards innovation.
4. AI technologies offer a multitude of opportunities in the fields of arts and culture by promoting creativity, innovation, accessibility and efficiency. This segment explores the key opportunities and the legal issues involved.
5. AI can help promote more sustainable practices in the arts and culture sector, for example by optimizing energy consumption at events and exhibitions or making the transport and storage of artworks more efficient.
6. The use of AI in arts and culture can lead to creativity and innovation, increase access to cultural content, promote diversity and contribute to efficiency and sustainability in the sector.
7. At the same time, AI-generated artworks and AI-assisted creations raise questions about artistic integrity and authenticity, while the use of AI to monitor creative processes or censor artworks raises concerns about control and surveillance.

3. Give English equivalents to the following expressions and phrases:

Инструменты управления художественными выставками на базе искусственного интеллекта, в соответствии с национальными

и международными природоохранными законами и политикой, Использование искусственного интеллекта для содействия устойчивому развитию в секторе искусства и культуры, повышают эффективность творческих процессов и способствуют устойчивому развитию сектора, примерами могут служить инструменты управления художественными выставками на базе искусственного интеллекта, которые облегчают планирование и проведение мероприятий, или системы искусственного интеллекта, которые помогают анализировать и продавать культурный контент, искусственный интеллект способствует появлению новых форм искусства и творческих экспериментов, интегрируя такие технологии, как виртуальная реальность, дополненная реальность и интерактивные медиа.

4. Answer the following questions:

1. What are collaborations between artists, curators, technology and exhibition contexts?
2. How is digital culture capable of cardinally influencing the meanings and values of human existence?
3. What kind of new style of communication is being born?
4. What electronic objects surround us everywhere?
5. How AI could help to preserve the cultural heritage?
6. What are examples that include AI-powered translation tools that make cultural content accessible in different languages?
7. What can the use of AI in arts and culture lead to?
8. How can AI be used to research and promote sustainable materials and techniques in art production?
9. What are main risks and challenges of AI in art and culture?

5. Decide whether the statements are true or false:

1. A new style of communication is being born, highlighting its features such as independence, emotional and intellectual openness.
2. Digital culture is capable of slightly influencing the meanings and values of human existence.
3. AI systems such as “Amper Music” or “OpenAI’s MuseNet” are not able to create musical compositions by learning from databases of musical styles and structures.
4. AI systems used in creative processes can also cause errors that lead to damage or loss.
5. AI-generated artworks and AI-assisted creations raise questions about artistic integrity and authenticity.

6. Although there are many benefits to integrating AI into arts and culture, there are also risks and challenges that need to be considered.

6. Translate from Russian into English:

1. В последние годы искусственный интеллект (AI) нашел применение во многих отраслях, включая культуру и искусство. Использование AI в этой сфере позволяет создавать новые удивительные произведения и делает искусство более доступным и интерактивным для публики.

2. Один из самых ярких примеров применения AI в культуре — создание искусственных интеллектуальных художников. Такие художники могут создавать уникальные произведения, используя нейронные сети, генеративные алгоритмы и другие технологии AI.

3. Как найти баланс между использованием ИИ для творчества и сохранением человеческой уникальности в искусстве и культуре? Как создать среду, где цифровизация дополняет человеческие способности, а не заменяет людей? Ответы на эти вопросы искали в ходе дискуссии.

4. Музеи и галереи не отстают от трендов и стараются по-своему адаптироваться к новой реальности: за последние пару лет мы увидели виртуальную метавыставку в Эрмитаже, VR-квест на Куликовом поле и даже Зоологический музей МГУ обзавелся цифровым двойником.

5. Проект по оцифровке «Воображаемого музея» Михаила Шемякина — еще один образец применения цифровых технологий для архивирования и систематизации в искусстве. Художник более 60 лет занимался сбором, сравнением и анализом репродукций произведений изобразительного искусства, которые он затем классифицировал по авторской методике.

6. Даже в такой тончайшей работе, как реставрация предметов искусства, нашлось место нейросетям. ИИ зачастую позволяет сделать работу мастеров по восстановлению картин более точной. Например, технология позволяет заранее определять возможные проблемы с картиной: распознает малейшие трещины, отслоение краски и изменение цветового баланса.

7. Вслед за углублением интеграции сферы искусства и ИИ многих людей волнует вопрос о том, не заменит ли ИИ труд и ценность человека в некоторых областях, как, например, в случае с появлением в настоящее время ИИ-живописи и ChatGPT. Академическое сообщество также настороженно относится к ChatGPT с момента

его появления. Многие более консервативные учебные заведения уже запретили его использование, например, Брауновский университет, Висконсинский университет в Мэдисоне и Университет Торонто в Канаде. Однако существует немало учебных заведений, которые решили приспособиться к изменениям и открыто поддерживают использование ChatGPT.

7. Summarize the text and express your own opinion. Here are some statements for support:

1. The synthesis of art and artificial intelligence is a progressive trend, but the application of artificial intelligence technologies also faces numerous new challenges and contradictions.

2. It is important to improve the new art education system and stimulate the popularity and application of artificial intelligence technologies.

8. Develop the following ideas in writing an essay (120–150 words):

1. The development of artificial intelligence technology should not be considered as a way to replace humans, but as a way to synergistically develop artificial intelligence technology and humans so that it can become an assistant for the development of creative potential.

2. In the field of art education, AI can be used as an assistant and mentor, helping students to acquire knowledge and skills in the field of art faster, as well as providing students with more individualized and diverse study areas that help them discover their potential talents faster.

Unit 3

AI and Cybersecurity

Words and phrases:

To leverage	— эффективно использовать
To resolve	— твердо решить
Baselines	— основные данные
To spur	— подталкивать, подстрекать
Fertile	— плодородный, плодовитый
Staggering	— поражающий воображение
Mitigant	— смягчающий, уменьшающий
Ransomware	— программа-вымогатель
The odds	— шансы
A zero-day attack	— атака нулевого дня
Triage	— сортировка, отбор
Holistic	— глобальный, всесторонний
A stakeholder	— акционер, вовлеченная сторона
A red team	— условный противник
To red team	— тестить на угрозу извне
A stance	— позиция, положение
Viable	— реальный, жизнеспособный
Dissemination	— рассредоточение
Fatigue	— усталость
w.r.t. (with respect to)	— относительно
To perpetuate	— увековечить, сохранить навсегда
To scrutinize	— внимательно, тщательно изучать
Differentiators	— отличительные особенности
Discrepancy	— несоответствие, расхождение
Surveillance	— слежка, наблюдение
Containment	— карантин, ограничивание
To rife with cameras	— наполнить камерами
A cutting edge	— передний край, передовой рубеж

We are living in a world where artificial intelligence is becoming increasingly integrated into various aspects of our lives. AI has the potential to revolutionize many industries, transform the way we work and live, and bring about significant advancements in technology.

Artificial intelligence can and likely will boost security efficiency, though vulnerabilities may also escalate with increasing use of AI. Thus, we need to break down the two primary ways in which these priorities are coming together: leveraging AI to enhance security (AI for security), and applying security to defend AI (Security for AI).

AI for security is an application of AI models (both discriminative and generative) to augment human cybersecurity skills and to identify and resolve security threats and vulnerabilities faster and more accurately. Security for AI involves measures and tools organizations may adopt to protect their AI models from malicious agents aiming to exploit potential security vulnerabilities.

AI for Security

For years, machine learning has played a role in security efforts such as malware recognition and differentiation. The application of machine learning to identify activity baselines and anomalies has spurred the rise of user and entity behavior analytics, which can often provide early recognition of malicious activity based on variations from observed norms in the behavior of people as well as technology assets.

Supervised machine learning has often been used to refine approaches to security analytics previously characterized by rule-based event recognition. Unsupervised machine learning approaches, meanwhile, provide greater autonomy to security data analysis.

The emergence of generative AI has introduced further opportunities to apply AI to security priorities. Security operations (SecOps) is a particularly fertile ground for innovation. Since attackers seek to evade detection, security analysts must correlate evidence of suspicious activity across a staggering volume of inputs. They must quickly prioritize identifiable threats in this data for response, since these attacks can have an impact within minutes. Security analytics and SecOps tools are purpose-built to enable security teams to detect and respond to threats with greater agility, and AI should help in this. Early applications of generative AI show promise for spending less time on data collection, correlation and triage, and focusing instead where they can be most effective. Generative AI can also be useful in finding and presenting relevant insights to less experienced analysts, helping them build expertise as they grow in the field, thus augmenting their productivity, rather than replacing them.

Applications of AI and other technological growth areas for the security industry will likely require developments in critical areas of risk management and control for all organizations using them. Namely, use of

AI in security applications could strengthen companies' cyber preparedness, as it allows advancement in mitigant techniques against threat actors, rapid analysis of vulnerabilities, an ability to simulate various scenarios involving threat actors, data integrity, security and utilization, and other applications. However, this amplifies, not replaces, the need and demand for robust risk management schemes. The absence of robust risk management may result in companies facing limitations in their ability to proactively identify, assess, and mitigate risks effectively. Therefore, entities may be ill-prepared to address the dynamic landscape of cybersecurity, even with the use of AI (and other technologies) for security.

The Pros of AI

Enhanced threat detection

Machine learning is by far the most popular field in AI. ML involves the development of algorithms and statistical models that allow computer systems to learn from experience and improve and make predictions without requiring human intervention.

If an employee mistakenly clicks on a phishing email, he can trigger a malicious download onto his system that allows threat actors to move across the victim environment and operate in stealth. For example, they might be searching for compromised passwords or open protocols to exploit and deploy ransomware, allowing them to seize critical systems as leverage against the business.

The AI will notice that the behavior of the user who clicked on that email is now out of the ordinary. Thus, AI will analyze and contextualize this behavior, whereas a static security feature (e.g., someone's credentials) couldn't.

Also, AI techniques such as machine learning and behavioral analysis can help in identifying and mitigating malware attacks. By analyzing file characteristics, network traffic and user behavior, AI can detect previously unseen malware and zero-day attacks.

Improved Incident Response

AI can assist in automating incident response processes, allowing for faster and more efficient mitigation of cyber threats. AI algorithms can analyze and prioritize alerts, investigate security incidents, and suggest appropriate response actions to security teams.

Thus, market-leading IBM Security QRadar Suite can accelerate response time with modernized security operations. It provides a unified analyst experience, leverages an open platform to connect with your ex-

isting data and security tools, and uses AI and ML for triage, enrichment and correlation including recommended responses, which can help bring investigation time from hours or days to minutes, as well as reduce risks.

AI-enabled authentication

AI can enhance authentication systems by analyzing user behavior patterns and biometric data to detect anomalies or potential unauthorized access attempts. This can strengthen security by providing additional layers of authentication and reducing reliance on traditional password-based systems.

Still, to maximize the benefits of AI in cybersecurity while mitigating potential risks, it is crucial to adopt a holistic approach that combines AI-powered solutions with human expertise, rigorous testing, continuous monitoring and collaboration across stakeholders to ensure robust security measures.

AI also has significant implications for cybersecurity, both in terms of enhancing cybersecurity defenses and creating new challenges and risks. When examining this technology, it's important to consider not only the pros, but also cons.

Security for AI

The other major aspect of the security-AI intersection is the mitigation of security exposures related to the implementation and application of AI. These include security vulnerabilities that may be incorporated in the body of both open-source and proprietary software on which AI is built, the exposure of AI/ML functionality to misuse or abuse, and the potential for adversaries to leverage AI to define and refine new types of exploits.

This area has already begun to affect the cybersecurity products and service markets, from startups to major vendors and systems integrators, the most prominent recent examples are: the Generative Red Team Challenge hosted by the AI Village at DEF CON (August, 2023), which, according to organizers, was the largest "red teaming" exercise held so far for any group of AI models including a significant presence at the 2023 RSA Conference's Innovation Sandbox and the Black Hat Startup Spotlight.

Existing approaches that have demonstrated value are getting an uplift in this new arena. MITRE Corp., for example, spearheaded an approach to threat characterization with its Adversarial Tactics, Techniques, and Common Knowledge (ATT&CK) knowledge base, which describes threat attributes in ways consumable by detection and response technologies to improve performance and foster automation.

Techniques that have been used more broadly to secure the software supply chain are also being applied to AI by those specializing in this domain.

The aim of these initiatives is not only to help increase assurance for those adopting AI, but to help make AI safer by taking more of an active stance in defending innovative technology and providing foundations for proper digital governance, auditability and controls for security, privacy, safety, and other risks. Many of these issues are in their infancy, and an increase in viable use cases will inevitably yield standards, norms, and regulation to help enable the balance of safety and security, as well as innovation and progress.

Such standards, norms, and regulation will then need to be used in the form of updated governance and risk management strategies across organizations if they are to succeed in an increasingly digital future.

Successful companies will need to maintain effective governance for AI and other technological developments, including the establishment of policies and procedures for AI usage, oversight from boards of directors, and a proactive approach to assess and mitigate risks. Furthermore, governance should include regular audits, transparency in AI decision-making, and mechanisms for adapting to changing threat landscapes, ensuring responsible and secure AI integration across the organization.

Security is a broad concept and its meaning can change depending on who you are speaking to. From state security to private enterprise and even the individual, security will continue to be a chief concern as IoT connected devices become increasingly ubiquitous.

However, it's not just the dissemination of private data that we have to worry about. Physical security still remains pivotal for the protection of confidential data, software equipment, facilities, and company assets.

Whether it is through advanced heuristics, machine learning or data analysis, artificial intelligence can offer solutions that are a less labor-intensive solution in comparison to the traditional method and can help smaller companies achieve a level of operational efficiency that is traditionally reserved for large corporations.

The Cons of AI

Even though artificial intelligence brings numerous benefits and advancements in various fields, like any technology, it also poses cybersecurity risks that need to be addressed.

Adversarial attacks

Cyber-attackers are becoming increasingly sophisticated in their methods, leveraging adversarial attacks to deceive AI systems. An adversarial attack involves adding a tiny bit of calculated noise to your input, which causes your neural network to misbehave. Adversarial attacks are inputs that trigger the model to output something undesired.

Moreover, AI-powered systems in cybersecurity are prone to generating false positives — mistakenly identifying harmless activities as malicious threats. False positives can lead to alert fatigue and divert valuable resources toward investigating nonexistent threats, potentially causing disruptions in business operations.

A financial institution deploying an AI-based fraud detection system may face challenges in fine-tuning the model to reduce false positives without compromising. Prompt injection specifically targets language models by carefully crafting inputs (prompts) that include hidden commands or subtle suggestions. These can mislead the model into generating responses that are out of context, biased, or otherwise different from what a straightforward interpretation of the prompt would suggest.

Attacks on image classifiers have been historically more popular given their widespread applications. One of the popular attacks is the Fast Gradient Sign Method (FGSM). Gradient-based attacks are white-box attacks (you need the model weights, architecture, etc.), which rely on gradient signals to work. Gradients are how you determine which direction to nudge your weights to reduce the loss value. However, instead of calculating gradient w.r.t weights, you calculate it w.r.t pixels of the image and use it to *maximize* the loss value.

AI-enabled botnets

AI can be used to create intelligent botnets capable of coordinating attacks, evading detection and adapting to changing circumstances. These botnets can launch distributed denial-of service (DDoS) attacks, perform credential stuffing or execute large-scale attacks against targeted systems.

Data poisoning

AI algorithms rely heavily on large volumes of high-quality data to train and improve their accuracy. But an attacker can inject malicious or manipulated data into the training set, which can impact the performance and behavior of the AI system. This could lead to biased or inaccurate results, making the system vulnerable or unreliable.

Backdoor attacks are a special kind of data poisoning attack where you provide data which will make the model behave in a certain way when it sees a certain (hidden) feature. The hard thing about backdoor attacks is that the ML model will work perfectly fine in all other scenarios until it sees the backdoor pixel/feature. For example, in face recognition systems, the training data could be primed in a way to detect a certain pattern which can then be used to misclassify a burglar as a security guard or employee.

Privacy concerns and breaches

AI systems often rely on large amounts of data to train and operate effectively. This raises privacy concerns, as the collection and processing of sensitive information can expose individuals or organizations to privacy breaches. Also, the models used in AI systems can be valuable intellectual property. If an attacker gains unauthorized access to these models, it can lead to intellectual property theft, unauthorized use or even malicious manipulation of the models.

Ensuring proper data governance and implementing privacy-preserving AI techniques are crucial in maintaining a balance between security and privacy.

Misuse of AI technology

AI can be misused for malicious purposes, such as automating cyberattacks or creating sophisticated phishing scams. Attackers can leverage AI to launch more targeted and efficient attacks, making it harder for traditional security measures to detect and mitigate them.

Lack of explainability

Some AI algorithms, such as deep learning neural networks, can be highly complex and difficult to interpret. This lack of explainability can make it challenging to understand how AI systems arrive at their decisions, which can hinder the ability to detect and respond to potential security threats effectively.

AI bias and ethics

AI systems are trained based on historical data, which can contain biases or reflect societal prejudices. If these biases are not adequately addressed, AI systems can perpetuate discrimination or unfair practices, leading to social and ethical concerns.

Enterprises must ensure that their systems adhere to legal requirements and ethical standards, such as privacy regulations and fairness

in decision-making. A healthcare organization, for example, employing these algorithms to analyze patient data for anomaly detection must navigate the complexities of data privacy laws and maintain strict patient confidentiality.

Lack of skilled workforce

The adoption of AI in cybersecurity requires a skilled workforce capable of developing, implementing and managing AI systems. Organizations desperately need cybersecurity professionals who understand AI technologies and can address the associated risks and challenges effectively.

As a rule, system owners and senior leaders understand threats to secure AI and their mitigations. Your data scientists and developers maintain this awareness of relevant security threats and failure modes and help risk owners to make informed decisions. The users should be provided with guidance on the unique security risks facing AI systems (for example, as part of standard InfoSec training) and train developers in secure coding techniques and secure and responsible AI practices.

Team members can also be provided with SAMM's (Software Assurance Maturity Model) self-assessment technique that helps teams learn software security best practices.

Unemployment

One significant concern is that AI and automation may lead to widespread job displacement and unemployment. As AI technology advances, there is a possibility that various roles and tasks currently performed by humans could be automated, potentially leaving many people unemployed or facing job insecurity.

To mitigate these risks, organizations and researchers need to continue to actively work on developing AI technologies with built-in security measures, such as robust authentication, encryption and anomaly detection. It's important to remember that while AI can greatly assist in cybersecurity, it is not a complete solution. Human expertise, collaboration and continuous adaptation to evolving threats will remain essential components of effective cybersecurity strategies.

Secure AI System Development

Robust cybersecurity measures are essential for protecting AI systems from being maliciously manipulated to ensure the integrity and reliability of their operations.

Recently, the UK's National Cybersecurity Centre (NCSC) together with the US's Cybersecurity and Infrastructure Security Agency (CISA) have developed guidelines for secure AI development,

These guidelines are crucial for ensuring that AI systems function as intended, are available when needed, and do not reveal sensitive data to unauthorized parties. They emphasize the importance of developing, deploying and operating AI systems in a secure and responsible manner, considering the novel security vulnerabilities unique to AI.

The guidelines are structured around four key areas within the AI system development life cycle: secure design, secure development, secure deployment, and secure operation and maintenance. Each section of the guidelines offers detailed advice and best practices for providers of AI systems, whether the systems are created from scratch or built upon existing tools and services. The guidelines are intended for a broad audience, including data scientists, developers, managers, decision-makers and risk owners, urging all stakeholders to read and apply these guidelines.

1. Secure design: The guidelines emphasize the importance of incorporating security at the earliest stages of AI development. This includes assessing potential risks and vulnerabilities specific to AI technologies. It advocates for designing AI systems that are resilient to attacks and can maintain data integrity.

2. Secure development: In the development phase, the focus is on implementing robust coding practices and safeguarding the AI supply chain. This involves scrutinizing source codes, managing dependencies and ensuring that development tools are secure. The guidelines encourage regular security audits and stress the need for transparency in AI algorithms.

3. Secure deployment: Deployment of AI systems must be done with utmost care, ensuring that the deployment environment is secure. The guidelines recommend rigorous testing procedures, including penetration testing and vulnerability scanning, to identify and address potential security issues before widespread deployment.

4. Secure operation and maintenance: Once AI systems are operational, continuous monitoring and maintenance become crucial. The guidelines suggest regular updates and patch management to mitigate emerging threats. They also recommend the implementation of incident response plans to handle any security breaches effectively.

In general, the guidelines advocate a 'secure by default' approach, closely aligned with established cybersecurity practices. The principles prioritized include taking ownership of security outcomes for customers,

embracing radical transparency and accountability, and building organizational structures that prioritize security.

Here are Some Things Powered by AI in Security:

1. Underside vehicle bomb detection

UVeye, an Israeli startup has developed an artificial intelligence and machine learning product that helps security personnel detect threats by scanning the underside of passing vehicles.

The system uses strategically angled high-resolution cameras to create a 3D image of anomalies, such as improvised explosive devices, illegal weapons, drugs, and other suspicious material. UVeye claims that the technology will work even when the vehicle is moving up to 28 mph, meaning that the technology can detect objects that would otherwise escape the human eye.

This is where the artificial intelligence and machine learning comes in. The system has access to mountains of supplied data, ensuring that it can track the characteristics of the passing vehicle with manufacturer supplied data, and compare it with the data retrieved from the passing vehicle in real time. It can detect differentiators, such as part placement and even weight discrepancies. In addition, the system utilizes audio to listen for anything out of the ordinary.

According to UVeye, the technology takes up to three seconds to determine if a material is unlawful. Ultimately, this technology is applicable to a wide array of security roles and can change the way vehicle security is approached. This technology is applicable outside of government buildings, port facilities, border crossings, airports, power plants, tourist hotspots and other critical infrastructure that might be an ideal target for an attack.

2. Infectious disease detection

AI-based technology making great strides into the medical sector and companies is developing AI-based tools that can rapidly track, analyze and diagnose infectious diseases before they spread.

In September 2018, scientists from the National Environment Agency in Singapore created an algorithm to forecast dengue outbreaks, a mosquito-borne virus that affects over 400 million individuals.

In addition, Silicon Valley-based medical startup, AIME, has also developed an AI-based platform that is capable of predicting the exact geolocation data of infectious disease outbreaks like dengue or Zika up to three months in advance.

The system predicts outbreaks by analyzing a combination of public health data, the weather, wind speed, proximity to bodies of water, and historical outbreak data. Essentially, it factors any variable that might affect the date, location, and severity of an infectious disease outbreak. This would be a particularly time-consuming effort for humans, in a situation where time is not available.

In addition to predictive countermeasures, AI-based technologies can help with decisionmaking through modeling. Traditionally, surveillance data of the outbreak is collected and public health officials consult with experts and stakeholders to design a containment and treatment program. However, this isn't always ideal as rapid decision-making is difficult to achieve with so many stakeholders involved.

Ultimately, artificial intelligence is far more capable at pattern recognition and digesting mountains of data for the most optimal health outcome — and like other industries — data in healthcare is only becoming larger, with the growth of electronic health records, as well as digital unstructured data in the form of photos, genomic information, and health professional notes.

3. Home security

Artificial intelligence is revolutionizing home security as the technology can solve one of the biggest issues faced by traditional home security solutions; human error and false alarms. One solution, Lighthouse AI, uses artificial intelligence to alert you of humans, pets and other things that would be of interest while you're away from home.

Using the Lighthouse app on a mobile device, the technology informs you of certain events, from a pet walking across your living room, or even a home intruder. The camera needs to be taught which people should be recognized as people who live in the house in order for it to function properly. Still, home security cameras have become incredibly powerful with the addition of artificial intelligence.

4. Threat screening for large events

Evolve Technology is an AI-based system that enables threat screening on a huge scale. The technology utilizes artificial intelligence and facial recognition software to analyze live footage of approaching visitors to determine if they are approved persons, such as regular visitors, VIPs, employees and other persons who should be granted entry.

If a visitor is highlighted as a non-permissible person of interest, their profile will be sent to security officers and a human expert can review

and verify the data. The technology claims to allow at least one person to be allowed entry per second. This particular technology is not designed to completely eliminate the human element of threat analysis and can be best utilized at locations such as airports, sporting events and schools. If utilized successfully, this would effectively put an end to long lines and bottlenecks.

5. Crime prevention cameras

Artificial intelligence and machine learning are adding a layer of proactive trouble detection to CCTV cameras. With the addition of artificial intelligence, CCTV cameras are now able to spot potential shoplifters and alert shopkeepers to suspicious behavior. One solution called "AI Guardman" developed by a Japanese company can scan live video streams to form estimations of "suspicious" behavior. Through artificial intelligence and machine learning, the system tracks the posture and movement of shoppers, and analyses it to match the posture and movement of confirmed shoplifters derived from previous data.

6. Military reconnaissance

The military potential for artificial intelligence is huge. There is a natural convergence between the two areas, with military hardware rife with cameras, sensors, communication networks, and data that would benefit from artificial intelligence. The capacity for humans to deal with the sheer volume of data on the modern battlefield is becoming a roadblock, affecting decision-making and the ability for information to flow down to where it is needed the most.

The technology enables unmanned vehicles to progressively learn about the world around them. Effectively, this gives military units out in the field the ability to explore potentially life-threatening locations, such as building interiors, tunnels, and caves, with a substantially reduced risk to human personnel.

In practice, the drone can be commanded to survey a target environment, and the machine learning technology onboard the drone will help it navigate without any human participation.

This is just the beginning. Decades into the future, as the technology matures, many defense experts have stated artificial intelligence will take a more active role on the battlefield both in the air and land domain. Future warfare may consist of AI-driven armored vehicle formations on land, and AI-driven pilotless aircraft in the sky.

7. Border control lie detector

Scientists from Manchester Metropolitan are working on a cutting-edge lie detector that can determine if a person is lying about who they are and why they are traveling.

Virtual border guard uses artificial intelligence to tell if a person is lying or telling the truth through imperceptible signs, such as facial micro-gestures.

In practice, travelers are interviewed by an avatar border guard which asks a series of questions about their reason for travel, how they are traveling and more. The system takes the data and creates a psychological profile for the travelers and assigns a score based on their truthfulness. The system also utilizes machine learning, ensuring that it learns new methods of deception, ensuring that critical data to the project as each person uses the system.

8. Offshore Oil & gas threat detection

Artificial intelligence-based solutions have also breached the oil and gas sector, a sector that has only fairly recently brought into the benefits of IoT connected devices and increased connectivity to the outside world. Indeed, Artificial intelligence is revolutionizing how offshore oil & gas workers maintain the security of offshore oil and gas platforms. For instance, offshore oil workers can receive recommendations on how to prevent security breaches and ensure the longevity of equipment.

In the oil and gas sector, companies offer AI-based solutions for asset performance. With AI-based predictive asset solutions, an oil & gas organization can benefit from early warning equipment and infrastructure failure, giving workers enough time to take measure and improve performance. This will help human workers cope with the enormous task of processing huge amounts of data and making safety-critical decisions in real time.

In recent years, AI has emerged as required technology for augmenting the efforts of human information security teams. Humans can no longer scale to adequately protect the dynamic enterprise attack surface. AI has the potential to revolutionize cybersecurity: it provides much needed analysis and threat identification that can be acted upon by cybersecurity professionals to reduce breach risk and improve security posture. AI can identify and prioritize risk, instantly spot any malware on a network, guide incident response, and detect intrusions before they start. but its challenges must be carefully addressed to ensure accurate and beneficial

outcomes. Overcoming the emerging challenges can allow organizations to harness the full potential of AI in protecting their digital assets and combating emerging cyberthreats. AI allows cybersecurity teams to form powerful human-machine partnerships that push the boundaries of our knowledge, enrich our lives, and drive cybersecurity in a way that seems greater than the sum of its parts.

Notes:

SecOps — Security Operations
ML — Machine Learning
IBM Security Qradar Suite — a modernized threat detection and response solution designed to unify the security analyst experience and accelerate their speed across the full incident lifecycle *Generative Red Team Challenge* (Las Vegas, August 29, 2023) — an ethical hackers' competition to test AI LLM on a testing and evaluation platform built by Scale AI.
LLM — Large Language Models
Scale AI — the data platform for AI, providing training data for leading machine learning teams
Red Teaming — a structured testing effort to find flaws and vulnerabilities in an AI system
CCTV — a closed-circuit television camera is a type of surveillance camera that transmits video signals to a specific set of monitors or video recording devices, rather than broadcasting the video over public airwaves
InfosecTraining — an online training & certification course provider

Exercises:

1. Give Russian equivalents to the following words and phrases:

Malware recognition; to identify activity baselines; to leverage AI; to augment human cybersecurity skills; to spur the rise of…; rule-based event recognition; a particularly fertile ground for innovation; to evade detection; a staggering volume of inputs; to build expertise; mitigant techniques against threat; robust risk management; to proactively identify, assess, and mitigate risks effectively; to trigger a malicious download; to deploy ransomware; on average; the odds are in favor of the attacker; pros and cons; the exposure of AI/ML functionality to misuse or abuse; the largest "red teaming" exercise.

2. Translate the extracts from the texts into Russian:

1. Artificial intelligence can and likely will boost security efficiency, though vulnerabilities may also escalate with increasing use of AI.

2. The application of machine learning to identify activity baselines and anomalies has spurred the rise of user and entity behavior analytics.

3. Since attackers seek to evade detection, security analysts must correlate evidence of suspicious activity across a staggering volume of inputs.

4. Early applications of generative AI show promise for spending less time on data collection, correlation and triage, and focusing instead where they can be most effective.

5. The use of AI in security applications could strengthen companies' cyber preparedness, as it allows advancement in mitigant techniques against threat actors, rapid analysis of vulnerabilities, an ability to simulate various scenarios involving threat actors, data integrity, security and utilization, and other applications.

6. When you compare these numbers to the 3-to-5-person team running SOCs (Security Operation Centers) today on average, the odds are naturally in favor of the attacker.

7. The market-leading IBM Security QRadar Suite provides a unified analyst experience, leverages an open platform to connect with your existing data and security tools, and uses AI and ML for triage, enrichment and correlation including recommended responses, which can help bring investigation time from hours or days to minutes, as well as reduce risks.

8. Many of the issues are in their infancy, and an increase in viable use cases will inevitably yield standards, norms, and regulation to help enable the balance of safety and security, as well as innovation and progress.

9. False positives can lead to alert fatigue and divert valuable resources toward investigating nonexistent threats, potentially causing disruptions in business operations.

10. Gradients are how you determine which direction to nudge your weights to reduce the loss value. However, instead of calculating gradient w.r.t weights, you calculate it w.r.t pixels of the image and use it to *maximize* the loss value.

3. Give English equivalents to the following words and phrases:

Способствовать значительному развитию чего-либо; плодородная почва; реагировать на атаки более гибко; усиливать(увеличивать) необходимость; действовать скрытно; команда из 3 или 5 чело-

век; ощутимая выгода; смягчить(ослабить) потенциальные риски; физическая безопасность занимает центральное место; тенденциозная, необъективная реакция; стать повсеместным; быть склонным (предрасположенным) к…; изменяющиеся обстоятельства; неверно классифицировать; подвергать атакам; оценить потенциальные риски; прозрачность ИИ алгоритмов.

4. Answer the following questions:

1. What is the principal difference between AI for security and Security for AI?
2. How does generative AI contribute to the development of cybersecurity?
3. What are the benefits the combination of AI and automation provide today's SOCs with?
4. How does IBM Security QRadar Suite help to improve cybersecurity?
5. Are there any ways to make AI technology safer?
6. How do adversarial attacks deceive AI systems?
7. What is the mechanism of gradient-based attacks?
8. What is the hard thing about backdoor attacks?
9. What are the phases of secure AI development?
10. How do AI-based technologies help with infectious disease detection?

5. Translate from Russian into English:

Темная сторона ИИ: искусственный разум может захватить контроль над подсознанием человека

Новый закон Европейского Союза об искусственном интеллекте может позволить ИИ получить доступ к нашему подсознанию.

Когда-то использование личных данных из постов миллионов пользователей Facebook и продвинутых аналитических данных для влияния на политические исходы в США и Великобритании казалось фантастикой. Но скандал с Cambridge Analytica в 2018 году показал, что это уже реальность. Этот инцидент подчеркнул новые этические вызовы, связанные с быстрым развитием технологий и машинного интеллекта.

Инициатива по защите «нейроправ», возглавляемая Фондом Neurorights, выступает за признание нового набора мер защиты от технического прогресса. Некоторые из них обсуждаются в контек-

сте Закона об Искусственном Интеллекте, который сейчас рассматривается органами ЕС. Этот закон должен регулировать, в том числе, способность ИИ влиять на наше подсознание.

Игнаси Бельтран де Эредиа, декан юридического факультета Университета Оберта де Каталунья и автор книги «Искусственный интеллект и нейроправа», опубликовал статью о вызовах, с которыми мы сталкиваемся из-за прогресса ИИ, и оценил последний законопроект ЕС с точки зрения нейронауки.

Риски предоставления ИИ доступа к нашему подсознанию

По оценкам, только 5% деятельности человеческого мозга является сознательной. Оставшиеся 95% происходят на подсознательном уровне. Бельтран де Эредиа отмечает, что мы не контролируем эту огромную нейронную активность из-за сложного взаимодействия между сознательным и подсознательным.

Однако это не означает, что людей нельзя подсознательно повлиять. «Есть два способа, которыми ИИ может это делать», — объясняет он. «Первый — сбор данных о жизни людей и создание архитектуры решений, ведущей к определенному выбору. Второй — применение приложений или устройств для создания непреодолимых импульсов для нашего подсознания, чтобы генерировать импульсивные реакции на сублиминальном уровне».

(Неясные) пределы, предложенные ЕС

Новый регламент по искусственному интеллекту, который обсуждается в ЕС, стремится предвидеть будущие риски ИИ. Нынешний законопроект запрещает такие техники, только если они предназначены для манипуляции или обмана, значительно влияют на способность человека принимать осознанные решения и причиняют серьезный вред.

«По предложению, запрет на ИИ будет применяться, когда есть серьезный вред и человек делает что-то, чего иначе не сделал бы. Но это нереалистичный стандарт», — говорит Бельтран де Эредиа. Он подчеркивает, что мы уже подвергаемся вторжению на уровне, который был немыслим всего несколько лет назад, и общественность должна получить максимальную защиту. Наше подсознание представляет нашу самую личную сферу и должно быть полностью защищено от внешнего доступа.

Мозг остается загадочным органом, и, хотя наука делает большие шаги в этой области, многое остается неизвестным о том, как его

функционирование может быть затронуто определенными стимулами. «Нам нужно осознавать риск предоставления другим людям и компаниям доступа к нашему внутреннему миру на таких глубоких уровнях», — заключает он.

6. Summarize the texts and develop the following subjects and express your own opinion:

1. AI for security vs. Security for AI.
2. Pros and cons of AI-based technology application.
3. Adversarial attacks.
4. Four stages of secure AI system development.
5. Some spheres powered by artificial intelligence in security.

7. Develop the following ideas in writing an essay (120–150 words):

1. The possible threats of built-in AI
2. Relevance of AI in Information Security

Unit 4

AI and Big Data

Words and phrases

Data-driven world — мир, управляемый данными
Insightful knowledge — глубокие познания
Parse — анализировать, разбирать
Comprehending big data — понимание больших объемов данных
Mimic human functions — имитировать функции человека
Conventional data management techniques — традиционные методы управления данными
Prevalent — превалирующий
Veracity — достоверность
Anticipating — опережающий
Meld — сливаться
Buzzword — модное словечко
Spurred by soaring global investment — стимулируемый стремительным ростом глобальных инвестиций

AI and Big Data are Driving Forces behind Industry 4.0

It's key to understanding the roles of big data and artificial intelligence in our data-driven world. Before anyone knew big data existed, it had already taken over the globe. Big data had amassed an enormous amount of stored information by the time the term was coined. If properly examined, it might provide insightful knowledge about the sector to which that particular data belonged.

The task of sorting through all of that data, parsing it (turning it into a format more easily understood by a computer), and analyzing it to enhance commercial decision-making processes was quickly found to be too much for human minds to handle. Writing algorithms with artificial intelligence would be necessary to complete the challenging task of extracting knowledge from complex data.

As businesses expand their big data and artificial intelligence capabilities in the upcoming years, data professionals and individuals with a master's in business analytics or data analytics are anticipated to be in high demand. The goal is to keep up with and use the volume of data that all our computers, mobile smartphones and tablets, and internet of things (IoT) devices are producing.

Understanding Big Data and Artificial Intelligence

Big data and artificial intelligence are powered by several technological advancements that have defined the current digital environment and *Industry 4.0*. These two developments aim to maximize the value of the substantial data generated today.

Big data is the term used to describe the processing and storing of enormous amounts of structured, semi-structured, and unstructured data that have the potential to be organized and extracted into useful information for businesses and organizations.

On the other hand, artificial intelligence uses a variety of algorithms with the goal of building machines that mimic human functions (such as learning, reasoning, and making decisions). Let's now explore these cutting-edge technologies.

What is Big Data?

The management of massive amounts of data from many sources is the focus of the field of "big data." Big data is used when the amount of data is too great for conventional data management techniques to be useful. Long ago, businesses began gathering enormous volumes of data about customers, prices, transactions, and product security. However, finally, the data volume proved too great for humans to evaluate manually. *"Big data requires a new processing mode in order to have stronger decision-making, insight, and process optimization capabilities to adapt to massive, high growth rate and diversification of information assets." Gartner*

This idea conveyed a very key significance. Big data is now valued as a resource for information. We require new processing methods in the big data era to process these information assets because the original processing method cannot handle these data in a timely or accurate manner.

Five V's of Big Data

The traits of large data are used to summarize another idea. Massive data scale, rapid data flow, a variety of data types, and low-value density were listed by McKinsey as the four characteristics of big data. That is what we typically refer to as the big data 4V characteristic. The definition of big data, which is the 5V features of big data that are reasonably prevalent in the industry, was created by IBM after adding the fifth characteristic afterward. Let's examine each of the so-called 5V traits individually.

Volume

The first V is the volume. That means in the big data era, a lot of data needs to be processed. Currently, this magnitude is frequently utilized for terabyte-scale data analytics and mining.

Variety

The second trait is referred to as multiple forms of data. Before most of the data that we could process was structured, that is, presented in two-dimensional tables. But in the age of big data, a wider range of data kinds must be processed, including structured, unstructured, and semi-structured data. Big data technology must process these data independently or perhaps together.

Value

Low data value density is the third attribute. Although there is a huge amount of data, not much of it is useful to us. The value density of these data is rather low because they are drowned in the large ocean of data. Therefore, we must filter and mine through hundreds of millions of data, but we might only find a few dozen or a few hundred useful data.

Velocity

Fast processing speed is the fourth quality. The process of processing data to produce results used to take weeks, months, or even longer, but now we need the results in a shorter amount of time, like minutes or even seconds.

Veracity

The fifth quality is connected to the third quality. Veracity asserted that the value of commercial value is high or more real, that is, the value of the mined data is very high, whether or not it directly influences our decision-making, provides us with new information or helps us improve our processes. It is, therefore, simpler.

These 5V characteristics of big data inform us that the term “big data” in use today includes both data and a number of processing methods. In order to make decisions or optimize for the work, we must quickly locate and mine the portion of data from a vast amount of data that is useful to our work. The entire procedure is known as big data.

Big Data Analytics

A challenging process of analyzing large amounts of data to find information that might assist businesses in making wise decisions about their operations, such as hidden patterns, correlations, market trends, and customer preferences, is known as big data analytics.

Organizations can analyze data sets and gain new insights using data analytics technology and processes. Basic inquiries regarding business performance and operations are addressed by business intelligence (BI) queries.

Advanced analytics, which includes aspects like predictive models, statistical algorithms, and what-if analysis powered by analytics systems, is a subset of big data analytics.

What is Artificial Intelligence?

The creation and use of computer systems that are capable of logic, reasoning, and decision-making are known as artificial intelligence (AI). This self-learning technology analyzes data and produces information more quickly than human-driven methods by using visual perception, emotion detection, and language translation.

You probably already work with AI systems on a daily basis. Artificial intelligence is used in the user interfaces of some of the biggest businesses in the world, including Amazon, Google, and Facebook. Personal assistants like Siri, Alexa, and Bixby are all powered by AI, which also enables websites to suggest goods, movies, or articles that may be of interest to you. These focused recommendations are the outcome of artificial intelligence; they are not a coincidence.

AI and Big Data Analytics

Although gathering data has long been a crucial aspect of business, modern digital tools have made it simpler than ever. It's practically difficult for anyone or a company to effectively use the data they're collecting because data sets are growing exponentially. That's why comprehending big data, and artificial intelligence is vital.

Applications with AI capabilities may quickly process any data set, whether derived from a database or gathered in real time. AI solutions are being used by businesses to boost productivity, create personalized experiences, support decision-making, and cut costs.

Analytics and automation are frequently enhanced with data and AI, assisting organizations in transforming their operations.

Analytics technologies, such as *Microsoft Azure Synapse*, assist organizations in anticipating or identifying trends that guide decisions regarding workflows, product development, and other areas. Your data will also be arranged into readable dashboard visualizations, reports, charts, and graphs.

Meanwhile, corporate processes can be automated when big data and artificial intelligence solutions are created. For instance, AI can enhance the manufacturing sector's safety checks, predictive maintenance, and inventory tracking. Any company can utilize AI to evaluate documents, conduct document searches, and handle customer service inquiries.

Due to how AI analyzes visual, textual, and auditory representations, even though it hasn't yet equaled or surpassed human intellect, technology is becoming easier to adopt and integrate into many commercial activities

While it might seem like big data and artificial intelligence have endless potential, the technology has limitations. Let's go over five areas where AI shines:

- AI may be taught to organize data, make suggestions, and aid in semantic search. These tools will enhance the user experience of your digital products by providing beneficial information that satisfies their needs. Additionally, since your application AI will keep improving its skills based on historical data, you may optimize the utility of both current and future data.
- AI can be trained to analyze, recognize, and search images using computer vision, a class of algorithms designed to comprehend and react to images and video. AI with vision training can store and caption documents and support IoT sensor arrays. Many sectors are using visual tracking to boost productivity and effectiveness.
- Customers demand current search engines' accuracy and speed, but it might be challenging to match those high standards with your own tools. With AI, you can improve the search capabilities of your digital tools and enable them to analyze webpages, photos, videos, and more to provide consumers with the exact results they're looking for.
- By turning speech to text and text to speech, AI technology is frequently used to engage customers. You can simply review recorded customer conversations with annotated transcripts for studying customer behavior or instructing personnel. You can also create speech-based assistants like Siri or Alexa in your applications.

- Natural Language Processing makes it possible to converse with our technology in entire phrases, the way people naturally converse and receive meaningful responses (NLP). You can integrate NLP into your applications or bots to better serve user demands or create customer support tools that can have voice or text conversations. These big data and artificial intelligence perks can also be used to recognize and translate languages.

Big Data vs Artificial Intelligence

At this point, big data is unquestionably here to stay, and artificial intelligence (AI) will continue to be in high demand. AI is meaningless without data, yet mastering data is impossible without AI. Therefore, data and AI are melding into a synergistic connection.

By fusing the two disciplines, we may start to recognize and forecast future trends in business, technology, commerce, entertainment, and everything in between.

Big data is the initial, unprocessed input that must be cleaned, organized, and integrated before it can be used; Artificial intelligence is the final, intelligent product of data processing. The two are hence fundamentally different.

Artificial intelligence is a type of computer that enables robots to carry out cognitive tasks, such as acting or responding to input, in a manner that is analogous to that of humans. Traditional computing apps also respond to data, but all of these activities need hand-coding. The program is unable to respond if a curveball of any kind, such as an unexpected result, is thrown. As a result, big data and artificial intelligence systems continually refine their responses and adjust their behavior to account for new information.

A machine with AI capabilities is built to analyze and interpret data, solve problems or deal with problems depending on those interpretations. With machine learning, the computer first learns how to behave or respond to a certain result and then understands to act in the same way going forward.

Big data only search for results rather than act on them. It describes incredibly vast quantities of data as well as data that can be exceedingly diverse. For example, structured data such as transactional data in a relational database that can be found in big data sets, and less structured or unstructured data such as photographs, email data, sensor data, and so on.

They differ in how they are used as well. Gaining insight is the main goal of using big data. How does Netflix come up with recommendations

for movies and TV series based on what you watch? Because it considers the purchasing patterns and preferences of other consumers and infers that you would feel the same way.

AI is about making decisions and improving upon those decisions. AI is performing jobs previously performed by humans but more quickly and with fewer mistakes, whether it is self-tuning software, self-driving automobiles, or analyzing medical samples. These are mainly the differences between big data and artificial intelligence technologies.

Big Data and AI are Still Indispensable Twins

Despite their stark differences, big data and artificial intelligence nonetheless complement one another effectively. This is so because machine learning, in particular, needs data to develop its intelligence. For example, a machine learning picture identification program studies thousands of images of an airplane to determine what makes one so it can identify them in the future.

Big data is the starting point, but in order to train the model, it must be sufficiently structured and integrated for computers to spot useful patterns in the data consistently.

Big data collects enormous volumes of data, but before anything useful can be done with it, the wheat must be separated from the chaff. The unwanted, redundant, and useless data that is used in AI and ML has already been "cleaned" and deleted. So that's the significant first step.

AI can then prosper after that. The data required to train the learning algorithms can be provided by big data. There are two sorts of data learning: routinely collected data and initial training, which acts as a kind of priming of the pump. Once they have completed their initial training, AI programs never stop learning. They keep acquiring fresh information, and as the data evolves, they adapt their course of action accordingly. Data is, therefore, initially and continuously required.

Pattern recognition is used in both computer paradigms, but they do so in distinct ways. Big data analytics uses sequential analysis to discover patterns in data that have occasionally been collected in the past, or "cold data."

Machine learning continuously gathers data and learns from it. Your self-driving car continuously gathers data, learns new skills, and improves operations. New data is constantly being received and used. This indicates that big data and artificial intelligence are in a mutual relationship.

The Future of Big Data and AI

The rapid use of the Internet of Things digitizes data across the economy, making it now possible for AI systems to process or analyze it. As a result, AI is becoming more prevalent in various industries and companies. Some industries that utilize big data and artificial intelligence can be found below:

Big data and AI in healthcare

According to *Accenture*, integrating AI into the US healthcare system may save $150 billion annually by 2026 while also improving patient outcomes. Big data and artificial intelligence are predicted to transform a range of facets of healthcare, from robotic surgery, made possible by combining diagnostic imaging and pre-op medical data, to virtual nursing assistants that assist with initial diagnosis and patient logistics.

Big Data and Artificial Intelligence in Autonomous Vehicle Development

Autonomous vehicles (AVs), which are controlled by AI, are destined to cause a significant disruption in the transportation sector. In order to successfully observe the road and operate the vehicle, AI software included in an AV computes billions of data points every second using inputs from advanced sensors, GPS, cameras, and radar systems.

While there are still challenges before complete automation, high-end vehicles can handle fundamental driving tasks with little to no human involvement, thanks to big data and artificial intelligence. Additionally, testing of automated vehicles (AVs) that, in some circumstances, may operate autonomously in all areas of driving has begun.

Big Data and Artificial Intelligence Smart Assistant Development

Digital assistants are becoming more dynamic and practical due to advances in voice recognition, predictive analytics, and natural language processing. According to experts, as consumers move away from the keyboard, voice searches will account for 50% of all Internet queries by 2023 with the development of big data and artificial intelligence technologies.

Big Data and Artificial Intelligence in Industrial Automation Systems

Industrial automation is at the forefront of the application of big data and artificial intelligence in the physical world, spurred by soaring global

investment in robots that may approach $180 billion by 2020. Advancements in both sectors are combining to produce machines that are smarter and more competent than before, with robotics serving as a machine's body and AI serving as a machine's mind. Robots may now function more freely in unstructured settings like factories or warehouses. They can work more closely with humans on assembly lines, meaning they are no longer limited to simple, repetitive jobs.

Conclusion

These days, two key areas of computer science are big data and artificial intelligence. Research in the areas of big data and artificial intelligence hasn't halted recently. Artificial intelligence and big data are inseparable. First, because big data technology makes extensive use of artificial intelligence theories and techniques, it depends on AI's progress. Second, big data technology is essential to the advancement of artificial intelligence because this field depends heavily on data. We still need to learn about new technologies because big data and artificial intelligence innovation has only just begun.

Notes:

Industry 4.0 is a so-called "Fourth Industrial Revolution" or "4IR". It is a buzzword and neologism describing rapid technological advancement in the 21st century. The term was popularized in 2016 by Klaus Schwab, the World Economic Forum founder and executive chairman, who says that the changes show a significant shift in industrial capitalism.

Accenture plc is an Irish-American professional services company based in Dublin, specializing in information technology (IT) services and consulting. A Fortune Global 500 company, it reported revenues of $64.1 billion in 2023. Accenture's current clients include 91 of the Fortune Global 100 and more than three-quarters of the Fortune Global 500. As of 2022, Accenture is considered the largest consulting firm in the world by number of employees.

Azure Synapse Analytics is a data warehousing solution, business intelligence tool, and big data analytics platform all rolled into one. It supports all major data governance frameworks, allowing you to adhere to data protection standards and avoid penalties for non-compliance.

Exercises:

1. Give Russian equivalents to the following words and phrases and explain them in your own words:

Pre-op medical data; to keep up with and use the volume of data; the wheat must be separated from the chaff; data analytics are anticipated to be in high demand; cutting-edge technologies; artificial intelligence perks; curveball of any kind; priming of the pump; cold data

2. Translate the sentences into Russian paying attention to the prefixes and suffixes:

1. They keep acquiring fresh information, and as the data evolves;
2. They adapt their course of action accordingly. Data is, therefore, initially and continuously required;
3. Robots may now function more freely in unstructured settings;
4. Artificial intelligence and big data are inseparable;
5. Innovation in the fields of Big data and artificial intelligence has only just begun;
6. Digital assistants are becoming more dynamic and practical due to advances in voice recognition, predictive analytics, and natural language processing;
7. Product development.

3. Give English equivalents to the following words and phrases:

Последовательный анализ; прогностическая аналитика; сборочные линии; стремительный рост глобальных инвестиций; низкая плотность значений данных; структурированные, частично структурированные и неструктурированные данные; обрабатывать запросы в службу поддержки клиентов; собирать сотни миллионов данных; искусственный интеллект и большие данные неразделимы; самонастраивающееся программное обеспечение; получение свежей информации; аналитика больших данных; прогностические модели; статистические алгоритмы.

4. Answer the following questions:

1. What discipline provides analysts with the power to make sense of Big data?
2. Which of the following skills and knowledge do you think a qualified data specialist especially needs: knowledge of statistics, knowledge

of marketing and advertising, skills in programming, knowledge of economics and finance, 'soft skills' like communication;

3. Could you please list some businesses that can benefit from Big Data tools to improve their overall performance?

4. Which way of decision-making do you think is more effective and why: based on human instinct, experience and experimentation or based on Big Data tools?

5. Could you please continue the list of goals a company that wants to be more competitive must have for its data collection and processing: streamlining the hiring process, increasing revenue through customer insights, …?

5. Decide whether the statements are true or false:

1. Huge collections of information from different sources can't do much on their own, but they become extremely powerful when paired with tools that leverage artificial intelligence;

2. Artificial intelligence is a subset of big data;

3. Big data is a subset of artificial intelligence;

4. Big data and artificial intelligence rely on one another for their full effectiveness and functionality;

5. Thanks to the amount of data being collected, combined with improved algorithms, AI has become more helpful and precise, allowing data analysts to process even more data that can be used for business success.

6. Translate from Russian into English:

1. Аналитика больших данных и искусственный интеллект представляют собой мощную комбинацию инструментов и технологий, которые позволяют организациям улучшать процесс принятия решений, стратегическое планирование и повседневную деятельность;

2. Сбор данных предоставляет коммерческим организациям неограниченные возможности для роста и расширения рынка;

3. Большие данные влияют на развитие ИИ в том смысле, что для функционирования Искусственного Интеллекта необходимы данные;

4. При правильном вводе данных Искусственный Интеллект может помочь аналитикам максимально эффективно использовать Большие данные. В последние десятилетия эти две технологии развивались бок о бок, помогая улучшать друг друга;

5. Аналитика больших данных может использоваться для извлечения полезной информации из наборов данных, выявления закономерностей, тенденций и других аналитических данных, которые могут быть использованы в различных контекстах;

6. Индустрия 4.0 — так называемая «Четвертая промышленная революция» или «4IR». Это модное слово и неологизм, описывающий быстрый технологический прогресс в 21 веке.

7. Summarize the text and express your own opinion. Here are some possible statements to support:

1. The two key areas of computer science are big data and artificial intelligence;

2. Industrial automation is at the forefront of the application of big data and artificial intelligence in the physical world, spurred by soaring global investment in robots;

3. Advancements in AI and Big data are combining to produce machines that are smarter and more competent than before, with robotics serving as a machine's body and AI serving as a machine's mind;

4. Research in the areas of big data and artificial intelligence hasn't halted recently;

5. Big data technology is essential to the advancement of artificial intelligence because this field depends heavily on data.

8. Develop the following ideas in writing an essay (120–150 words):

1. We still need to learn about new technologies because big data and artificial intelligence innovation has only just begun;

2. Big data technology makes extensive use of artificial intelligence theories and techniques, it depends on AI's progress.

Unit 5

Machine Learning

Words and phrases

Insight in — понимание, постижение чего-либо
Profitability — прибыльность
To detect fraud — для выявления мошенничества
Theft — кража
Refinery — переработка
Hidden layers — скрытые слои
Cumulative reward — совокупное вознаграждение
Reinforcement — укрепление
Lack of resources — нехватка ресурсов
To handle data — обрабатывать данные
Streamlining oil distribution — оптимизация/рационализация распределения нефти
Outperform — превосходить

Machine learning is based on the idea that system can learn from data, identify the patterns and make decision with minimum human intervention. This is the scientific study of algorithms and statistical models with the help of which computer systems perform a specific task without using instructions, inference and patterns. Machine learning algorithms build mathematical model based on sample data and then make the decision. Machine learning incorporates four steps, given below

– *First*, feature extraction
– *Second*, selection of corresponding machine learning algorithms
– *Third*, training and evaluation the data model's efficiency
– *Fourth*, using trained model for prediction

Machine Learning and Deep Learning

Machine learning is considered as the subset of artificial intelligence. In earlier days of AI as academic discipline, researchers were interested in having machine learn. They attempted to solve the problem with various symbolic methods as well as connectionist approach where neural network and pattern recognition are used. In the 1990s, machine learning is reorganized as a separate field. It shifted focus from symbolic approach to the methods and models of statistics and probability theory. Relation to

data mining: Both of these employ same methods often and overlap with each other. But machine learning focuses on prediction based on known properties while data mining focuses on the discovery of unknown properties. Data mining uses machine learning methods, machine learning formulated as minimization of loss function. Loss functions show the discrepancy between prediction of model and actual problem.

Relation to statistics: It is also closely related with statistics. The ideas of machine learning have had a relationship with statistics from methodological principles to theoretical tools such as the modeling paradigm.

Who's Using Machine Learning?

As the industries grow, large volumes of data have been recognized. For handling that data, machine learning technology is required. With the machine learning, organizations are able to work more efficiently. Machine learning is used in the following areas:

Financial services: In financial services, machine learning technology is used to identify the important insight in data and to prevent fraud. The insights help to identify investment opportunities or help investors to know when to trade. Data mining concepts also identify high risk profiles of clients or to pinpoint warning signs of fraud.

Health Care: This is the major area in which wearable devices and sensors are used to assess patient's health in real time. Machine learning also helps medical experts to analyze the data to identify trends. This may lead to improve diagnoses and treatment.

Government sector: Government agencies use machine learning to mine the data for insight where agencies like public safety and utilities have multiple sources of data. Sensor data analysis increases the efficiency and save money. Machine learning can also be used for security purpose i.e., help to detect fraud and to minimize the identity theft.

Retail sector: In retail sector, machine learning is used to analyze the buying history of customers. Retailers rely on machine learning to capture data, analyze and use it to personalize the shopping experience. It is also helpful to implement the marketing campaign, optimizing price, and for customer insights.

Transportation: Machine learning is used to make routes more efficient and to predict the problems to increase profitability. It can be done after analyzing the data to identify patterns and trends. Data analysis and modeling aspects are key factors to delivery companies and transportation organizations.

Oil and gas: In this sector, machine learning is used to find new energy sources and to analyze minerals in ground. It is also used to predict refinery sensor failure. Streamlining oil distribution makes it more efficient and economic.

Processes and Techniques Associated with Machine Learning:

A number of processes, techniques and methods can be applied to enhance the performance of machine learning and these are as follows:

Feature learning
Sparse dictionary learning
Anomaly detection
Decision tree
Association rules

Applications of Machine learning:

There are many applications of machine learning such as:

Adaptive websites
Bioinformatics
Brain-machine interface
Computer vision
Data quality
DNA sequence classification handwriting recognition
Machine learning control
User behavior analytics

Basically, machine learning methods are broadly categorized in two categories i.e., shallow learning and deep learning. Shallow learning basically uses neural networks with single layers or SVMs (Support Vector Machines) while deep learning uses neural network with more than one hidden layers.

Shallow Learning

Shallow learning is broadly divided into two categories:

Supervised and Unsupervised Learning. But there are also other methods of machine learning. Overview of popular methods is as follows:

– *Supervised learning:* In supervised learning, algorithm builds a mathematical model from a set of data that contains both the input and desired outputs.

These algorithms are trained using labeled examples i.e., input and desired outputs are known. In this learning, algorithm receives a set of

inputs along with corresponding correct outputs. Algorithm learns by comparing its actual output with correct outputs to find out errors. Then, model is modified accordingly. Classification, regression, prediction and gradient boosting are the example of supervised learning which use pattern to predict the values.

This learning is commonly used in those applications where historical data predicts future events. Classification and regression are the tasks that are performed by supervised learning. Some examples of supervised machine learning are Nearest neighbor, Naïve Bayes, Decision Tree, Regression Tree.

– *Unsupervised learning:* In unsupervised learning, a mathematical model is to be built from a set of data which contains only inputs. Desired output labels are not present in this type of learning. Unsupervised learning is used against that data which doesn't contain historical label. Semi-supervised learning: In some cases, input may be only partially available, or restricted to special feedback.

At that time, these algorithms are used. These are used to develop mathematical model from incomplete training data, where a portion of the sample input doesn't contain labels. This learning is useful when cost of labeling is too high to allow for fully labeled training process.

– *Reinforcement learning:* This is the area of learning concerned with how software agents take actions in an environment to maximize the cumulative reward. In this type of learning, a feedback is to be given in the form of positive or negative reinforcement in a dynamic environment. These are commonly used in autonomous vehicle or in learning to play game against human opponent. Q-learning is an example of reinforcement learning.

– *Active learning:* Desired outputs are accessed for a limited set of inputs. In this learning, the inputs are based on budget, and optimize the choice of inputs for which output will be acquired.

– *Meta learning:* Here, algorithms learn their own inductive bias based on previous experiences. Some examples of meta learning are Bagging, Boosting, Random Forest.

Deep Learning

Deep learning is a set of algorithms of machine learning which uses multiple layers that corresponds to different level of abstraction to each level. It consists of input layer, output layer and several hidden layers. It is used for voice synthesis, image processing, handwriting recognition, object detection, prediction analytics and decision making.

Deep Learning Comparison with Conventional Machine Learning Techniques

Deep learning is a new era of machine learning. Deep learning includes both supervised and unsupervised learning paradigm of machine learning. Machine learning and deep learning help in providing intelligence to the system that can make prediction for future using past data. Conventional machine learning algorithms can't learn directly from the raw data. They need careful engineering to carefully extract features from raw data and highly classified domain expertise, which are further used in internal representations to identify these feature's patterns. In deep learning, first step of machine learning procedure is not present. This step is automated in deep learning. Deep Learning can extract new features automatically from raw data.

Deep learning algorithms work more accurately on large data sets as compared to conventional machine learning algorithms. While machine learning algorithms outperform deep learning in case of small or medium size datasets.

Deep learning algorithms take less time to infer a problem as compared to conventional machine learning algorithms. Deep learning performs a high amount of matrix multiple hence it needs powerful engine preferably GPU (Graphical Processing Units) or specially designed TPU (Tensor Processing Units) while other conventional machine learning algorithms can work on low end machines.

Deep learning algorithms are difficult to impossible to interpret. Some of the machine learning algorithms like (logistics, decision tree) can be interpreted easily while some (like SVM) are almost impossible to interpret.

Training time for data to create the model is more in deep learning as compared to other machine learning algorithms.

This article examined the concepts of machine learning. Machine learning has gained a lot of attention of researchers nowadays due to its distinct features. Firstly, the article specified the points to make a good machine learning system. Followed by this, the usage and applications of machine learning have been discussed in this article. However, the road of machine learning is not as simple as it looks to be. There are some challenges in this area to get the expected results such as lack of suitable data, data bias, and lack of resources, privacy problems and evaluation problems. This paper crates a broad view for a researcher for machine learning by categorizing it into two parts, namely: shallow learning and

deep learning. Supervised and unsupervised machine learning concepts are supposed to be in the category of shallow learning as these techniques use a smaller number of hidden layers or SVMs. While deep learning is considered as a different category, because of its deep layered architecture discussed in the article.

Deep learning is a growing field in a sector of predictive analytics. This paper provides a comparative study of conventional methods of machine learning and deep learning which helps new researchers to choose which technique would be right to apply in a particular environment. Such as, if one is working on small training data set then he must use machine learning algorithms rather than deep learning while, if dataset needed to choose the features then one must use machine learning technique because in case of deep learning this feature selection procedure is automated and researchers do not have to bother about it.

Exercises:

1. Give Russian equivalents to the following words and phases:

To provide humankind intelligence; identify the patterns; a confined version; to incorporate four steps; to shift focus; is also intimated with; employs data mining methods; is also intimated with; is also closely related with; to pinpoint warning signs of fraud; to assess patient's health; to minimize the identity theft; to capture data; to predict the problems; predict refinery sensor failure; to enhance the performance; sparse dictionary learning; modified accordingly; commonly used; reinforcement learning; conventional machine learning algorithms; to infer a problem; conventional machine learning algorithms; to carefully extract features; has gained a lot of attention challenges.

2. Translate extracts from the text into Russian:

A. Machine learning has gained a lot of attention of researchers nowadays due to its distinct features. Firstly, the article specified the points to make a good machine learning system. Followed by this, the usage and applications of machine learning have been discussed in this article. However, the road of machine learning is not as simple as it looks to be. There are some challenges in this area to get the expected results such as lack of suitable data, data bias, and lack of resources, privacy problems and evaluation problems. This paper crates a broad view for a researcher for machine learning by categorizing it into two parts, namely: shallow learning and deep learning. Supervised and unsupervised machine learn-

ing concepts are supposed to be in the category of shallow learning as these techniques use a smaller number of hidden layers or SVMs. While deep learning is considered as a different category, because of its deep layered architecture discussed in the article.

B. Shallow Learning: Shallow learning is broadly divided into two categories: Supervised and Unsupervised Learning. But there are also other methods of machine learning. Overview of popular methods is as follows:

Supervised learning: In supervised learning, algorithms are trained using labeled examples i.e., input and desired outputs are known. In this learning, algorithm receives a set of inputs along with corresponding correct outputs. Algorithm learns by comparing its actual output with correct outputs to find out errors. Then, model is modified accordingly. Classification, regression, prediction and gradient boosting are the example of supervised learning which use pattern to predict the values. This learning is commonly used in those applications where historical data predicts future events. Classification and regression are the tasks that are performed by supervised learning. Some examples of supervised machine learning are Nearest neighbor, Naïve Bayes, Decision Tree, Regression Tree.

C. Machine learning is considered as the subset of artificial intelligence. In earlier days of AI as academic discipline, researchers were interested in having machine learn. They attempted to solve the problem with various symbolic methods as well as connectionist approach where neural network and pattern recognition are used. In the 1990s, Machine learning is reorganized as a separate field. It shifted focus from symbolic approach to the methods and models of statistics and probability theory. Relation to data mining: Both of these employ same methods often and overlap with each other. But machine learning focuses on prediction based on known properties while data mining focuses on the discovery of unknown properties. Data mining uses machine learning methods, machine learning also employs data mining methods; but with different goals or to improve the learner accuracy.

D. The use of artificial intelligence and machine learning techniques across all disciplines has exploded in the past few years, with the ever-growing size of data and the changing needs of higher education, such as digital education. Similarly, online educational information systems have a huge amount of data related to students in digital education. This educational data can be used with artificial intelligence and machine learning techniques to improve digital education. This study makes two main contributions. First, the study follows a repeatable and objective

process of exploring the literature. Second, the study outlines and explains the literature's themes related to the use of AI-based algorithms in digital education. The study findings present six themes related to the use of machines in digital education. The synthesized evidence in this study suggests that machine learning and deep learning algorithms are used in several themes of digital learning. These themes include using intelligent tutors, dropout predictions, performance predictions, adaptive and predictive learning and learning styles, analytics and group-based learning, and automation. artificial neural network and support vector machine algorithms appear to be utilized among all the identified themes, followed by random forest, decision tree, naive Bayes, and logistic regression algorithms.

E. In the era of data sciences, artificial intelligence is trying to provide humankind intelligence to the computer and for this machine learning and deep learning are the technologies which are helping artificial intelligence to do it. Machine learning is the branch or subset of artificial intelligence that train the machines how to learn. Deep learning is a confined version of machine learning. It helps to raise the high standards of learning environment. Machine learning and deep learning both play vital role in upgrading the computer systems to be expert systems that can take decisions and make predictions without a human intervention.

artificial intelligence is a field which helps computer systems to be intelligent and take decisions. Machine learning helps to implement artificial intelligence on the system and deep learning, helps to achieve machine learning goals on the system more systematically.

3. Give English equivalents to the following Russian words and phrases:

Выявлять закономерности; ограниченный вариант; включают четыре этапа; сместить фокус; также использует методы интеллектуального анализа данных; тесно связан с; для выявления предупреждающих признаков мошенничества; оценить состояние здоровья пациента; свести к минимуму кражу личных данных; для сбора данных; прогнозировать проблемы; прогнозировать отказ датчиков; для повышения производительности; соответствующим образом изменены; широко используемый; обучение с подкреплением знаний и навыков; традиционные алгоритмы машинного обучения; сделать вывод о проблеме; алгоритмы машинного обучения; тщательное извлечение необходимых данных; привлекло много внимания к задачам.

4. Answer the following questions:

1. What is deep learning? How does it work? Where can it be applied?
2. Why has machine learning become so popular and in what fields it may be used?
3. Enumerate applications of machine learning usage.
4. Compare deep learning with conventional machine learning techniques.

5. Translate into English:

1. Машинное обучение — практически синоним термина «искусственный интеллект», программы развития которого уже являются национальными во многих странах. Добавлять в приложения возможности машинного обучения становится все проще: многие библиотеки машинного обучения и онлайн-сервисы уже не требуют глубоких знаний в этой области.

В опубликованной работе рассматривается проблема атак на системы машинного обучения с целью добиться желаемого поведения системы или воспрепятствовать ее корректной работе. Первым шагом к противодействию такого рода угрозам, по мнению ученых, является их классификация, понимание их типов, равно как и мест приложения. Это связано с тем, что природа атак на системы машинного обучения и глубокого обучения отличается от других кибер-угроз.

Однако даже у простых в использовании систем машинного обучения есть свои проблемы. Среди них — угроза состязательных атак, которая стала одной из важных проблем приложений машинного обучения. Под этим понимаются специальные воздействия на элементы конвейера системы, запускающие необходимое злоумышленнику поведение. Таковым поведением может быть, например, неверная работа классификатора. Но существуют и атаки, которые направлены на извлечение параметров модели.

2. Машинное обучение может помочь поставщикам энергии лучше выявлять неисправные или скомпрометированные компоненты в электросетях. Об этом стало известно 28 февраля 2022 года. В исследовательском проекте под руководством Массачусетского технологического института описывается методика, позволяющая моделировать сложные взаимосвязанные системы, состоящие из множества переменных, значения которых со временем изменяются. Сопоставляя соединения в этих так называемых множественных временных рядах, «байесовская сеть» может научиться выявлять аномалии в данных.

Состояние электросети может быть составлено из множества точек данных, включая величину, частоту и угол напряжения во всей сети, а также ток. Обнаружение аномалий зависит от выявления аномальных точек данных, которые могут быть вызваны такими вещами, как обрыв кабеля или повреждение изоляции.

«В случае с электросетью люди пытались собирать данные, используя статистику, а затем определять правила обнаружения со знанием предметной области. Например, если напряжение вырастет на определенный процент, то оператор сети должен быть предупрежден. Такие системы, даже усиленные статистическим анализом данных, требуют много труда и опыта. Мы можем автоматизировать этот процесс, а также извлекать закономерности из данных, используя передовые методы машинного обучения», — пояснили эксперты.

Данный метод использует неконтролируемое обучение для определения аномальных результатов, вместо использования правил, созданных вручную. Когда исследователи проверили свою модель на двух частных наборах данных, записывающих измерения двух межсетевых соединений в США, они выявили превосходство модели над другими методами машинного обучения, основанными на нейронных сетях.

Общий метод обнаружения аномального изменения данных можно использовать даже для подачи сигнала тревоги в случае взлома энергосистемы.

«Его можно использовать для обнаружения девальвации сбоя электросети в целях кибератак. Поскольку наш метод по-существу направлен на моделирование электросети в нормальном состоянии, он может обнаруживать аномалии независимо от причины», — отметили эксперты.

3. С начала 2017 года относительно 2021-го популярность инструментов машинного обучения резко возросла. Это связано как с ростом доверия к их точности, так и со снижением затрат. Многие компании на март 2022 года используют ML для обеспечения точных прогнозов и быстрого анализа больших массивов данных. Именно на этом фоне IBM наращивает инвестиции в искусственный интеллект. Компания фокусируется на инициировании изменений через обработку естественного языка (NLP), автоматизацию и развитие доверия к искусственному интеллекту (ИИ). Кроме того, IBM продолжает внедрять в свои продукты новые способности, полученные в ходе исследований и разработок.

В IBM говорят, что следующим шагом в развитии ИИ станет то, что компания называет жидким интеллектом в связи с тем, что

технология машинного обучения на март 2022 года является узкой. Следовательно, использование обученных моделей для обновленных потребностей требует значительного времени и подготовки данных. Компании нужен ИИ, который смешивает широкий спектр информации, исследует причинно-следственные связи и самостоятельно обнаруживает модифицированный опыт.

«Данный шаг расширяет стратегию IBM в области гибридного облака и ИИ, помогая предприятиям модернизировать и преобразовывать сложные критически важные приложения на различных облаках и платформах. Компания объединяет возможности ИИ и гибридного облака, чтобы предоставить бизнесу полную аналитику», — сказал генеральный директор направления IBM AI Applications Карим Юсуф (Kareem Yusuf).

Отдел исследований и разработок IBM использует различные подходы, которые помогут создать системы ИИ, ориентированные на 2025-2035 года. Кроме того, компания разрабатывает архитектуры и устройства с огромными вычислительными возможностями, это связано с тем, что оборудование достаточно надежно и быстро, чтобы обрабатывать огромные массивы данных, которые компания производит ежедневно.

6. Summarize the main ideas of the text and express your own opinion. Here are some possible statements to support:

1. Machine learning
2. Applications of machine learning
3. Deep learning comparison with conventional machine learning techniques

7. Develop the following ideas in writing an essay (120–150 words):

1. Today, the vast majority of machine learning models are trained on static data, e.g., pictures and texts. We still have a problem with using dynamic data to “teach” machine learning algorithms. Imagine how future machine learning models will be advanced once we figure out the way to teach them through videos, sounds, and animations!

2. Another data security-related problem is fake data. This problem happens when your company is being attacked by hackers who replace your real data with fake information. Suppose you run a manufacturing company and you’re under a fake data attack. What could have happened if your real measurements had been replaced with fake ones?

Unit 6

The Rise of Expert Systems. Neural Networks

Words and phrases

Backward chaining — обратный вывод
Acute — острый
Bring in — привносить
Expertise — профессиональная компетенция, мастерство, опыт
Inference engine — механизм логического вывода
Medications — медикаментозное лечение
Intricate — запутанный
Allow for — учитывать, допускать, позволять
Present with new information — предоставлять новую информацию
Usher in an age — положить начало эре, ознаменовать начало эпохи
Overfitting — переобучение (в машинном обучении)
Versatility — многогранность
Futures — фьючерсы
Commodities — сырьевые товары
Fungible goods — взаимозаменяемые товары
Iron ore — железная руда
Capitalize on — извлекать выгоду из

What are Expert Systems and Neural Networks?

Neural networks and expert systems are two major branches of artificial intelligence (AI). Their emergence has created the potential for a new generation of computer-based applications in different areas of decision-making.

Expert System vs Neural Network

An expert system is one that consists of five technical components. Firstly, a user interface unit that the user will interact with. Secondly, there exists a working memory unit that contains known facts regarding the domain of knowledge that the system is meant to provide assistance in. Thirdly, there is a knowledge base unit that stores the expertise of specific professionals to get the job done. Fourthly, there is an inference engine that analyzes all the previous components to provide the answer that the computer is actually looking for. In general, the inference engine consists of high level if-then statements. And finally, there is an expla-

nation engine that provides the user with a full justification of why a particular answer was given.

In businesses, expert systems provide knowledge and reasoning to employees as a learning tool and utility. They fulfill specific roles that bring in the expertise needed. Such systems are considered to be a learning tool and a great asset to a company. One of the examples of expert systems could serve special software programs in many modern medical and healthcare centers that monitor patients' medications and determine if the patients are likely to have bad reactions or not. Some other instances of expert systems are MYCIN which was based on backward chaining and can identify various bacteria that could cause acute infections and DENDRAL which is used for chemical analysis to predict molecular structure.

Some of the examples of business areas where expert systems are used are business acquisitions, large loans, etc. However, because expert systems lack common sense, the full power of human knowledge is still not encapsulated within those systems. Another problem is that experts are still reluctant to share their knowledge fully in order to avoid devaluing themselves as employees.

As for neural networks (Artificial Neural Networks or ANNs), they simulate human brain by using the mathematical model of individual neurons developed in the last century. Each neuron works similarly to that in the human neural network. These systems work much differently than expert systems because they don't use any knowledge base. Instead, they are equipped with a learning algorithm and a perception structure. The latter has many input neurons, a layer of switch neurons and, finally, the output neurons. Unlike expert systems which rely on detailed computer programs to sort through stored rules and facts to conclude a decision, neural networks can be exposed to a large volume of unstructured data to recognize patterns.

When it comes to their application in knowledge management, neural networks help optimize the process for more efficient use of resources and provide even faster access to the knowledge contained in the system. The advantages of ANNs in knowledge management become very noticeable after a period of study. This type of systems is highly resistant to "bad" or inaccurate data. Everything starts over with each new application. The system also needs to be retrained for each problem that needs to be analyzed. Such a system requires a higher level of knowledge from the user, but it works much more accurately and faster. Specific applications include financial forecasting, investment and risk management.

What is a Neural Expert System & How Does it Impact Artificial Intelligence (AI)?

A neural expert system is a type of artificial intelligence (AI) technology which utilizes both expert systems and Artificial Neural Networks (ANNs) to create high-level AI applications. It combines the advanced pattern recognition capabilities of Artificial Neural Networks with the abstract reasoning capabilities of an expert system in order to achieve an accurate means of making intelligent decisions and predictions. As a result, they can be used to make complicated decisionmaking processes easier and more manageable.

Neural expert systems use various types of statistics, probability distributions, data structures, and algorithms for the purpose of creating models that represent decision-making processes. By providing insights based on these models, the technology can help users make informed decisions quickly and accurately across a variety of contexts. Not only does this accelerate the decision-making process but it also reduces errors caused by traditional manual methods involving human analysis.

The fundamental principle of NESs as well as ANNs for data analysis and modeling is the same as or similar to that of statistics, and in many aspects NESs can be treated as the nonlinear counterparts of statistical techniques.

In addition to offering insights from data models, neural expert systems also provide simulations which allow users to test possible scenarios in order to understand potential outcomes before committing any resources. This makes them particularly useful for organizations which need to assess risks or optimize resources before embarking on projects or business activities requiring large investments of time or money.

Overall, neural expert systems enhance AI by providing users with a reliable way to utilize data in order to generate quick, informed decisions while minimizing unknown risks or excessive resource usage. By combining simulated modeling with statistical pattern recognition techniques, they are able to make complex problem solving much easier while enabling users to get accurate results quicker than ever before.

Exploring the Role of a Neural Expert System in AI

As artificial intelligence (AI) continues to evolve, many systems are becoming increasingly complex. To help deal with the challenges of large and intricate AI models, Neural Expert Systems (NESs) are gaining recognition as a valuable tool in AI development. NESs operate by leveraging neural networks, advanced algorithms, and expert knowledge to

offer better solutions than traditional approaches. This type of AI-driven expert system is well suited for time-sensitive tasks and rapidly processes huge volumes of data while providing accurate outcomes. Although this concept is relatively new in the field of AI, it has already been used in a variety of real-world applications.

One significant advantage of using a NES is that decisions and problem-solving can be executed faster than ever before without any manual intervention. This helps reduce execution time for tasks such as diagnostics and custom promotion recommendations that require real-time responses for successful completion. Moreover, a NES facilitates Data Exploration by continuously monitoring existing data sets, searching for correlations between data points, and alerting experts when variations from expected outcomes arise. Everything happens without human effort or guidance.

The integration of domain expertise into such systems creates an effective environment for research collaborations between professionals in different fields such as medicine, law, finance and marketing — wherein certain medical research could only be processed by biomedical engineers or financial decisions made by accountants. In addition to being time efficient and cost-effective solutions powered by artificial intelligence; they also provide human experts with larger datasets to thoroughly test their hypotheses on various topics or formulate predictions on future trends. Finally, these Hybrid Intelligent Systems leverage their combined knowledge bases to present both businesses and consumers with intelligent choices which could lead to more desired results compared to relying solely on either computer or individual assessment alone!

By taking advantage of the ability to harness vast amounts of data with machine learning capabilities, a Neural Expert System provides an ideal platform for a wide range of predictive projects. With this system in place, information extraction can be greatly accelerated since laborious manual searches do not have to occur each time newly acquired data needs examined; consequently, ushering us into an era where intelligent Machine Assisted Learning scenarios become commonplace within all sorts of industries from financial services through farming technology!

Examining the Potential Benefits of Neural Expert Systems

Using neural networks in artificial intelligence is quickly becoming a major topic of research. Neural networks have already been used to as-

sess complex data, detect patterns and distinguish relationships between factors. This makes them extremely well-suited for AI applications, but deploying neural networks as expert systems could produce even more dramatic results. Expert systems are designed to make decisions based on a range of factors and past experience, which is also ideally suited to the capabilities of neural networks. Development of neural expert systems is becoming increasingly popular among AI researchers, leading many to ask what their potential benefits may be.

The primary benefit of developing a neural expert system is significantly enhanced performance compared to non-neural expert systems. The ability to detect subtle patterns and understand intricate relationships gives them an edge over conventional expert systems that lack this capability. Due to their being specifically trained to use certain techniques — such as predictive analytics — they can achieve these improved results quickly and accurately. Further advantages include increased flexibility, which allows for adjusting the rules in order for better decision making when presented with new circumstances; moreover, a lot less maintenance than other types of automated decision support systems since all the parameters and settings can be stored within the expert system itself; and, also, indefinite scalability since it can scale up easily when needed with additional hardware resources or computing power.

Another key advantage of incorporating neural networks into expert systems is far greater efficiency in terms of manipulation and analysis of large volumes of data. Such analysis would require considerable processing time due to its complexity and massiveness if you used regular computing procedures instead. Additionally, using neural-based approaches reduces risk when providing recommendations or decisions. Such sophisticated approaches lead towards consistency and reliability. On the contrary, other models or conventional algorithms increase the possibility for "false positives" or accuracy issues associated with data-driven decision models without proper curation.

Finally, the demand for NESs has been booming recently. There is now access to a growing body of powerful libraries featuring open-source software. It enables programmers to get started quickly while developing ideas across multiple industries such as finance, health care, retail and marketing etc. Thus, it creates potential breakthrough applications such as fraud detection mechanisms implemented in banks or accessing sub atomic particles' characteristics through cloud computing platforms used by universities etc.

What are the Potential Tradeoffs of Using Neural Expert Systems in AI?

Neural expert systems are a powerful form of artificial intelligence that utilizes machine learning techniques like deep learning and neural networks to solve complex problems. This allows AI systems to "learn" from data sets, and make decisions as if they were an expert in the field. On the other hand, these systems come with certain tradeoffs between accuracy and efficiency, robustness and scalability, environment sensitivity, and cost.

In terms of accuracy and efficiency, deep learning of NESs can achieve super-human levels of accuracy but tends to require large amounts of data for training. Therefore, such models often need significant resources for their implementation. The system also may generate suboptimal solutions due to limited training data or overfitting — resulting in a loss of accuracy when dealing with new problems or environments.

Robustness is another important tradeoff. If not properly managed, neural networks have difficulty adapting to changing input values or dynamic contexts which can cause errors. Additionally, scaling up existing models might be a challenge because the kernel size increases exponentially with each additional layer added. Increasing layers could potentially lead to excessive parametrization which affects model performance as well as results in higher costs associated with larger scale projects.

Another major challenge when using neural networks is the environment sensitivity — since some types of AI require specific infrastructure with high energy costs along with continual training datasets updates due to dynamic changes in their environmental conditions.

Overall, utilizing Neural expert systems for artificial intelligence presents several potential tradeoffs (between accuracy and efficiency; robustness and scalability; environment sensitivity and cost). That is why, to ensure success organizations should think through these issues before embarking on such a project.

How Neural Expert Systems Could Change the Future of AI

Neural expert systems are a relatively new type of artificial intelligence technology that has the potential to profoundly affect the way in which modern AI is developed. Neural expert systems address many of the difficulties with existing AI solutions, providing significant advantages over standard neural networks, including greater flexibility, scalability and more accurate decision-making.

At their most basic level, neural expert systems rely on specialized algorithms to classify and compare data. As an example, say researchers want to determine whether an audio sample contains conversation between two people or not. A traditional neural network may use sound recognition algorithms to identify keywords; however, an NES could be used to refine the classification further — for example, by measuring certain characteristics such as individual speaking patterns or tones.

Neural expert systems can also be used for a wide range of other tasks such as image processing and speech recognition. By using sophisticated pattern recognition techniques and specific problem-solving strategies derived from domain knowledge, these systems can successfully recognize patterns and images in large datasets far faster than standard AI methods. The increased speed allows the use of probabilistic models that rapidly process large amounts of unstructured data within milliseconds for *Intent detection* applications — even when faced with greater complexity than current methods.

The versatility of neural expert systems is one reason why they're becoming increasingly popular in many industries — ranging from healthcare services to financial markets and beyond. For instance, medical researchers are now leveraging advanced machine learning models powered by publicly available datasets in order to develop better diagnostics tools while financial analysts have already begun experimenting with deep learning technology to predict stock market trends with remarkable accuracy.

In addition to the likelihood that these technologies will be extensively used in business scenarios where precision over time is paramount (such as commodities futures trading), we will likely see more companies applying them more effectively across all their processes — such as marketing automation activities or customer service operations — thus creating competitive advantages for those who capitalize on these technological advancements first.

One major benefit of using an approach like this is that it avoids black box decision making which has been a main complaint from many analysts when evaluating traditional AI approaches such as deep learning networks or *reinforcement learning* agents. This reduces risk by allowing experts to customize decisions based on specific data points instead of relying solely on preprogrammed instructions determined beforehand by programmers whose understanding may be limited. Furthermore, due to its superior scalability capabilities more precisely focused strategies can be applied to larger problems faster than ever before. It leads to potential-

ly faster results with greater confidence in predictions if compared with standard machine learning alternatives.

It's clear that this groundbreaking approach presents us with exciting opportunities to develop relevant artificial intelligence -based solutions across numerous fields from medicine and finance to marketing automation. At the same time, we can be sure that algorithmic solutions are accurate without sacrificing safety or speed. Besides that, we can avoid the nuances of the "black box" that we come across in competing approaches today.

Considering the Pitfalls When Implementing Neural Expert Systems

Neural expert systems have been gaining increasing popularity in the field of artificial intelligence. This trend arises from the use of AI technologies such as neural networks and machine learning to create AI-driven decision-making systems. Neural expert systems aim to improve efficiency and accuracy in decision-making, often using deep learning approaches to better understand complex data sets and deliver predictions or actions. These systems are typically designed and implemented by expert computer scientists with advanced knowledge in Prolog, Lisp or other programming languages and a strong understanding of AI algorithms. With all their benefits, however, there are certain potential pitfalls that must be recognized when utilizing neural expert systems for artificial intelligence purposes.

Pitfalls in neural network research arise in many different forms due to various factors. The most important contribution to the many pitfalls is perhaps the nonlinear nonparametric nature of the neural network model. While this property is desirable for many real-world applications, it also brings about more opportunities to go wrong in the modeling and application process. Compared to their linear statistical counterpart, neural networks have fewer assumptions, more parameters to estimate, many more options to select in the modeling process, all of which open more possibilities for inappropriate uses and problematic applications.

The second major reason is the lack of a uniform standard in building neural network models. For example, numerous non-linear algorithms that are alternatives or variations to the basic *backpropagation* (BP) algorithm exist. These algorithms vary in efficiency and effectiveness in estimating parameters. In addition, there are different and sometimes conflicting guidelines on many factors that could affect ANN performance. The problem is that ANN models are sensitive to many of these factors.

Pitfalls are more likely to occur to unwary researchers who lack the expertise and knowledge of the various forms of abuses. They often have the inappropriate supposition that ANNs can be built with automatic software, and that users do not need to know much of the model detail. Another reason that many inappropriate uses of ANNs are published is the lack of details on several key aspects of the model-building process. Authors or researchers often do not give sufficient details, essential features, or adequate descriptions of their study methodology, which hinders easy understanding or replications for others. On the other hand, reviewers may not pay attention to these issues. The lack of transparency, thus, contributes to the errors. Let's look at some of the common pitfalls.

Overfitting is one of the most cited problems with ANNs. The topic is well discussed and every neural network researcher is perhaps aware of the danger of overfitting. Overfitting limits the generalization ability of predictive models. For neural networks, it is easy to get a good or excellent result on the in-sample data, but this by no means suggests that a good model is found. It is likely that the model memories noise or captured spurious structures, which will cause very poor performance in the out-of-sample data. Overfitting typically happens when users build too large neural networks and/or the in-sample data used to train networks are small.

Another related pitfall is to include as many input variables as possible in the model, believing or hoping that the ANN can identify the most important and relevant variables through the linking weights' adjustment during the model-building process. Including a large number of unnecessary variables not only increases the model complexity and the likelihood of overfitting, but also causes more time and effort wasted in training. Moreover, the true pattern may be masked by the irrelevant factors and their interactions.

On the other hand, underfitting occurs if a neural network model is under-specified or not trained well. With underfitting, the model does not give good fit even to the training set. While underfitting is usually not a major concern compared to overfitting, ignoring the underfitting can also cause problems in applications, especially when the training algorithm is not appropriately used to guarantee a good solution in the estimation process.

In conclusion, despite the fact that artificial intelligence applications offer many advantages, users should exercise caution when implementing neural expert systems to avoid any problems arising from poor-quality design or design flaws. The key to avoiding pitfalls in neural network research is the awareness of the potential pitfalls and their harms to the

research study. It is important to realize that there are numerous ways that ANN techniques can be misapplied and misused. Unwary investigators are more likely to incur pitfalls. Furthermore, an awareness of the problems can lead to healthy skepticism and higher standards in the interpretation of reported findings in the literature.

Research & Development Strategies for Neural Expert System Implementation

In recent decades, artificial intelligence has been a rapidly evolving and even expanding new field. Among the most prominent areas of the movement is neural expert systems, which employ powerful computer networks to process complex problems in an efficient manner. To maximize their potential, organizations should consider utilizing several strategies when implementing neural expert system technology.

First and foremost, developing a clear plan for achieving desired results is paramount to successfully introducing a neural expert system into operation. Companies must establish both short-term and long-term goals related to the specific projects they would like to accomplish using the technology. From there, organizations can prepare the necessary resources such as personnel and funds for realizing these objectives.

In parallel, further research into the technical aspects of AI can be conducted. Understanding all conceptual designs related to machine learning and deep learning agents can help specialists prepare roadmaps that explain how each feature set of a particular project should be developed within certain timelines. As part of this process, it is also important to thoroughly review any available third-party material which could assist with performance optimization or cost benefits depending on the budget allotted for a given initiative.

Apart from this analysis stage, it's also critical for organizations to explore other collaboration possibilities with other professionals in their field. Through organizations like The Neural Information Processing Systems Foundation (NIPF), businesses can connect with peers using events such as workshops while keeping up with the latest advances in AI technologies development tools such as Python libraries, TensorFlow and PyTorch. Additionally, taking part in specialized forums pertaining to automation topics may increase chances of receiving valuable support from experts that share similar objectives in various industries across multiple nations.

Neural expert systems' implementation yields optimal results if companies put together comprehensive strategies while tapping into available resources, leveraging open-source collaborations as well as staying

updated on modern best practices. Cutting-edge AI components are being released onto today's IT market ecosystem through automated cloud deployment methods enabling faster setup timeframes so organizations can reach success quicker.

Neural Expert Systems Show Promise for Transforming AI Landscape

In a field that is life with rapid advances and innovative breakthroughs, artificial intelligence stands out as one of the most rapidly advancing fields. In an effort to make AI more intelligent, experts have been working to enhance its capabilities with neural expert systems (NES). These systems have become increasingly popular due to their ability to bridge the gap between machine-learning algorithms and actual human decision-making. By leveraging artificial neural networks (ANNs), these systems are able to simulate complex reasoning processes that mimic human decision-making.

Much of the research behind NES focuses on identifying patterns in large data sets and then using them to draw accurate conclusions. For instance, by analyzing existing customer records from a retail establishment, it could be possible for a NES to identify patterns within customer preferences or habits. It might recognize which products sell well together or learn how customer behavior changes over time — both insights that could give retailers valuable feedback about how they may wish to adjust their sales strategy. The same sort of learning power can be applied across many different industries and even help to answer complex questions in science and medicine.

Perhaps the most impressive aspect of NES is the fact that it performs many tasks more quickly than traditional programming languages while also consuming less resources in terms of computer power. This makes neural expert systems well suited for fast processing environments where decisions need to be made without sacrificing speed or accuracy. Additionally, such systems can quickly adapt and alter their algorithms if new data emerges from the environment around them; no recoding is necessary since the system can self-adjust its parameters when presented with new information.

Importantly for businesses, some forms of NES are now available commercially at relatively inexpensive costs — contributing greatly towards turning AI into something accessible for companies rather than simply being of interest to academics. With access becoming easier, it's easier than ever before for companies to integrate specialized AI appli-

cations into their products and services. Reducing the analysis time leads to cost savings and at the same time distinguishes such companies from their competitors that have not implemented these technologies yet.

Therefore, it's clear that neural expert systems are continuing to transform the artificial intelligence landscape, ushering in an age where human-like decisions can achieve greater precision faster than ever before — bringing us one step closer towards truly intelligent machines capable of automating processes across countless different industries.

Summarizing the Impact of Neural Expert Systems on AI

Neural expert systems are having a huge impact on the world of artificial intelligence. NESs use artificial neural networks to process information and arrive at decisions, making them a powerful tool for machine learning. Researchers believe that NESs offer faster and more accurate processing than traditional AI methods, as well as provide advantages such as adaptive learning capabilities. By using deep neural networks combined with specific knowledge, researchers have been able to achieve better results in problems such as image recognition. Moreover, due to their ability to optimize processes over time, NESs have become an important part of developing autonomous systems like driverless cars, robotics and robotics-related applications such as facial recognition or real-time translation. In conclusion, it is evident that neural expert systems affect the research field of AI by providing individuals involved with intelligent solutions which no other method can compete with. These increased accuracy and speed in processing data certainly have the potential to revolutionize the industry and shape the future of AI for years to come.

Notes:

Intent detection is a process of understanding the user's purpose or goal when interacting with a system. It is a technology that has been around for some time but has recently become more popular as organizations look for ways to improve customer experience and engagement. Intent detection is used in a variety of applications, such as natural language processing, customer service, and marketing. Intent detection can be used to improve customer experience and engagement by understanding the user's intent. By understanding the user's intent, organizations can provide more personalized experiences and better target their marketing efforts. Additionally, intent detection can be used to improve customer service by providing more accurate and timely responses

to customer inquiries. Intent detection works by analyzing the user's input and attempting to understand the user's intent. This is done by using natural language processing (NLP) algorithms to analyze the user's input and identify patterns in the user's behavior. Once the user's intent is identified, the system can then respond accordingly.

Futures are a type of financial derivative in which you agree to buy or sell a certain asset at a certain price at a particular time in the future.

Commodities are a type of asset representing fungible goods, such as oil, iron ore, or wheat. Commodities are usually traded using futures.

Reinforcement learning (RL) is an interdisciplinary area of machine learning and optimal control concerned with how an intelligent agent ought to take actions in a dynamic environment in order to maximize the cumulative reward. Reinforcement learning is one of three basic machine learning paradigms, alongside supervised learning and unsupervised learning.

Backpropagation (in machine learning) is a gradient estimation method used to train neural network models. The gradient estimate is used by the optimization algorithm to compute the network parameter updates.

Exercises:

1. Give Russian equivalents to the following words and phrases and explain them in your own words:

Tap into available resources; leverage open-source collaborations; stay updated on modern best practices; today's IT market ecosystem; automated cloud deployment methods; yields optimal results; paramount to successfully introducing a neural expert system into operation; short-term and long-term goals; budget allotted for a given initiative; alter their algorithms; suboptimal solutions; groundbreaking approach; pertain to automation topics.

2. Translate the sentences into Russian paying attention to the prefixes and suffixes:

1. Perhaps the most impressive aspect of NES is the fact that it performs many tasks more quickly than traditional programming languages while also consuming less resources in terms of computer power;

2. Robustness is another important tradeoff;

3. This makes them particularly useful for organizations which need to assess risks or optimize resources before embarking on projects or business activities requiring large investments of time or money;

4. Thirdly, there is a knowledge base unit that stores the expertise of specific professionals to get the job done;

5. For instance, by analyzing existing customer records from a retail establishment, it could be possible for a NES to identify patterns within customer preferences or habits.

3. Give English equivalents to the following words and phrases:

Обнаруживать тонкие закономерности; относительно недорогие затраты; выявление закономерностей в больших наборах данных; хорошо подходящие для приложений искусственного интеллекта; единый стандарт построения моделей нейронных сетей; попадать в ловушки; жертвуя скоростью или точностью; интеллектуальные решения, с которыми не может конкурировать ни один другой метод; отличный результат по данным, полученным в выборке; идти в ногу с последними достижениями в области технологий искусственного интеллекта; достаточные детали; способность прогнозирующих моделей к обобщению.

4. Answer the following questions:

1. What programming languages are used to create a NES?
2. What kinds of autonomous systems using NESs do you know?
3. What are five major components of an Expert system?
4. What are the reasons for pitfalls while implementing NESs?
5. What is the difference between conventional Expert systems and NESs?
6. Is an expert system capable of recognizing patterns in a large volume of unstructured data?
7. Can NESs replace expert systems and other artificial intelligence solutions in some applications?

5. Decide whether the statements are true or false:

1. The fundamental principle of ANNs for data analysis and modeling is the same as or similar to that of statistics, and in many aspects ANNs can be treated as the nonlinear counterparts of statistical techniques.
2. Unlike expert systems which rely on detailed computer programs to sort through stored rules and facts to conclude a decision, neural networks can be exposed to a large volume of unstructured data to recognize patterns.
3. The advantages of ANNs in knowledge management become very noticeable before a period of study.

4. There are no pitfalls in implementing NESs.

5. Overfitting occurs if a neural network model is not trained well.

6. Neural expert systems are typically designed and implemented by expert computer scientists with advanced knowledge in Prolog, Lisp or other programming languages and a strong understanding of AI algorithms.

7. Unlike conventional expert systems, NESs can achieve the result with minimum of outside intervention, so that over time NESs gradually takes over the function of the human expert.

6. Translate from Russian into English:

1. Для нейронных сетей легко получить хороший или превосходный результат на данных в выборке, но это ни в коем случае не говорит о том, что найдена хорошая модель.

2. Поскольку искусственный интеллект (ИИ) продолжает развиваться, многие системы становятся все более сложными.

3. Используя глубокие нейронные сети в сочетании со специфическими знаниями, исследователи смогли добиться лучших результатов в таких задачах, как распознавание изображений.

4. Вероятно, в ближайшем будущем все больше компаний будут более эффективно применять NESs во всех своих процессах, таких как автоматизация маркетинга или обслуживание клиентов.

5. В традиционной экспертной системе, если некоторые правила удаляются из базы знаний, система выходит из строя.

6. Даже если некоторые соединения повреждены в NES, нейронная сеть все равно выдаст разумный ответ.

7. Нейронные экспертные сети ведут себя намного лучше при ошибочных или неполных вводимых данных, чем обычные экспертные системы, поскольку NESs используют все знания, содержащиеся в нейронных соединениях.

8. Наиболее важным компонентом NES является алгоритм обучения, который позволяет нам автоматически генерировать базу знаний на основе обучающих примеров.

7. Summarize the text and express your own opinion. Here are some possible statements to support:

1. NESs combine benefits of both neural networks and expert systems;

2. Neural expert systems are ushering in an age where human-like decisions are made by intelligent machines;

3. ANNs are being treated as a standard nonlinear alternative to traditional models for pattern classification, time series analysis, regression problems and future prediction;

4. Due to their ability to optimize processes over time, NESs have become an important part of developing autonomous systems like driverless cars, robotics and robotics-related applications such as facial recognition or realtime translation;

5. The increased accuracy and speed in processing data using NESs certainly have the potential to revolutionize the industry and shape the future of AI for years to come.

6. Obviously, in the nearest future, more and more companies will use NESs more effectively in all their processes, such as marketing automation or customer service operations.

8. Develop the following ideas in writing an essay (120–150 words):

1. NESs provide faster and more accurate processing than traditional AI methods.

2. Overfitting and underfitting are the two most common traps while implementing neural expert systems.

Unit 7

Logic Programming

Words and phrases

Programming paradigm — парадигма программирования
Domain — область, сфера, домен
Leave up to smb/smth — оставить кому-то/чему-то
Proper outcome — надлежащий результат
Confuse (with) — путать (с), сбивать с толку
Data-driven — основанный на данных
Connective logic — соединительная логика
Clause — предложение
Compound or nested clauses — составные или вложенные предложения
Core information — основная информация
Precise — точный
Consistent — непротиворечивый, последовательный
Meaningful — значимый, осмысленный
Logic/control plane — плоскость логики/контроля
Vertex — вершина

Most computer programming languages fall into one of several *programming paradigms*. A paradigm classifies a language based on its features and how its programs are constructed and used. Logic programming is a paradigm that uses a system of facts and rules. It is commonly used in the Artificial Intelligence and machine learning domains. This article explains the logic programming paradigm and compares it to other programming models. It also explains its benefits and use cases, and introduces the most important logic programming languages.

What is Logic Programming

Logic programming languages were originally developed in the 1960s in academia. It was originally designed to help study knowledge representation and Artificial Intelligence. Logic programming is a variation of declarative programming based on a type of formal logic called *Predicate Calculus*. Declarative languages describe what the program should do, but not how to do it. The precise algorithms and processing methods are left up to the language, which is expected to generate the proper outcome. Logic programming should not be confused with programming

logic, which is a more general study of how logical rules apply in computer programming.

Logic programs are completely data-driven and do not typically include any connective logic. Instead, the programs use a set of logical statements, which are also called *predicates*.

Statement can be classified as either facts or rules. Logical statement contains predicates.

Cat (x) cat-predicates

Cat(x)-eats mice (x) assumption

Facts are simple statements that do not contain a body clause. They express the core information about a domain. Facts can take the form x is true or x is y, where y is a statement about x. A real-world example might be "Rex is a dog". In symbolic logic, a fact only has a head named H, and is expressed as follows: H.

Rules, also known as axioms, are logical clauses. Rules describe the circumstances under which a relationship is valid. A rule contains a head and a body and takes the form x is true if y and z are true. The x is true section forms the head of the clause, while the if y and z are true portions are the body. A simple example is "x can bite if x is a dog and x is awake." A rule containing head H and body clauses B1 to Bn can be expressed symbolically using the following notation:

H :- B1,…,Bn.

In the simplest case, the head and all body components are definite clauses. This means they are atomic and do not contain any subclauses or connective components. However, negations of definite clauses are still allowed, such as "x is not y". Some implementations also permit "if and only if", or iff, clauses. Some advanced programs permit very advanced rules using compound or nested clauses. In any case, the *syntax* must be very precise and consistent to be meaningful. The following logic programming example demonstrates how predicate calculus is used. The first rule categorizes dogs as animals. It can be written as follows:

animals**(**X**)** :- dog**(**X**)**.

A subsequent statement asserts that Rex is a dog. dog**(**Rex**)**.

Armed with these predicates, the program can automatically deduce Rex is an animal without being told. The fact animal(Rex). is not required. The program can choose Rex as an example when a user is looking for either a dog or an animal. If they are searching for something that is not an animal, then the program knows Rex is not a satisfactory choice.

The Mechanics of Logic Programming Languages

Logic programming uses controlled deduction, although the methods vary between applications. A typical program includes a logic plane, consisting of logical statements, and a control plane. The control algorithm supplies problem-solving abilities.

Each application attempts to find patterns within the data. It attempts to solve the problem only with the information it has been given and has learned. At times, this information might be incomplete or contradictory. When the logic program makes a well-reasoned decision, it is said to be functioning "logically". However, its decisions are only as good as its predicates. If either the facts or the rules are incorrect, the output is usually wrong too.

Problems are often solved internally through the use of an *and-or tree*. The objective of a search is the top node, and the tree is parsed downwards for possible solutions. From each level, the different possibilities at the next lowest level are the "or" options. If two or more of these options are bound together, this represents an "and" clause. In an "and" clause, both choices must be true. If so, the set becomes one of the options for the "or" clause. Logical programs also rely on *backward reasoning*, which draws more specific conclusions from more general facts and rules. Backward reasoning allows the program to use information taken directly from the rules and inferences it has gained through deduction.

Different applications might use different algorithms in different situations, including parallel search and best-first search. A program can use several approaches when a fact or rule is not defined. If there is no rule describing the relation between x and y, then both x is y and x is not y could potentially be false in some circumstances.

A pure logic programming environment does not use control statements or connective code. The program must generate all responses based on its library of facts and axioms. Some logic languages, including ASP (Answer Set Programming) and Datalog, are purely declarative. However, Prolog allows for some procedures and control structures.

Different Programming Paradigms

Each programming paradigm groups related programming languages together. The programs are categorized according to their features and execution model. The boundaries between the paradigms are not clear cut and some languages combine features from multiple paradigms.

Computer scientists consider logic programs to be part of the declarative programming paradigm. This relatively unconventional paradigm occupies a small but important niche within programming. It can be better understood through a comparison with the more traditional programming paradigms. The following five paradigms account for most of the best-known computer programming languages.

- *Imperative Programming:* This has historically been the most important programming paradigm. An imperative program tells the system how to perform a task using step-by-step instructions. Ordered commands are used to collect information and change the system state. This model aligns with the structure of the underlying hardware, which is designed to execute machine code similarly. Core imperative concepts include the assignment of variables and the evaluation of expressions. Control structures, including loops and conditional statements, are used to direct the control flow of the program. However, the instructions are read and executed sequentially. The order of execution is deterministic given the exact same inputs.
- *Procedural programming:* This is an evolution of imperative programming that uses procedures, also known as subroutines or functions. These procedures break the main program into smaller components for easy reuse. The main program interacts with a procedure through an interface. Procedural programming imposes greater structure, organization, and modularity on a program, and allows programmers to limit the scope of variables. It also reduces code duplication, enhances maintainability and correctness, and makes programs easier to read. Procedural programming has now almost completely replaced free-form imperative programming. Some analysts consider procedural and imperative programming to be part of the same paradigm. The C programming language is a classic example of a procedural language.
- *Object-oriented programming:* The object-oriented (OOP) paradigm extends procedural programming concepts through the use of objects and classes. Classes encapsulate variables, data structures, and internal functions known as methods, to provide a cleaner interface. Object-oriented programs create and destroy objects, which are particular instances of a class. For example, in a class called `Schedule`, each `Schedule` object is an actual schedule belonging to an individual user. Each object maintains its own state and is accessed through a clearly-defined interface. C++ and Java are popular object-oriented languages.

- *Functional programming:* This is an advanced programming paradigm centered around functions, which are used differently than in other paradigms. In this model, functions are applied in a strict mathematical sense, based on *lambda calculus*. Functions handle almost all tasks, mapping or binding values to other values using expression trees. They can be assigned to variables, passed as arguments, and returned as values. However, these functions cannot cause side effects or be affected by user input. In practice, functional programs share some stylistic similarities with declarative programming. They vary widely in implementation techniques and are considered difficult to understand and master. However, they have the advantage of being easier to test due to their strict implementation. Some popular functional programming languages include Lisp, Clojure, and Haskell, but many traditional languages now include some functional programming features.
- *Declarative programming:* This paradigm includes logic programming, database query languages, and configuration management programs. These programs specify what must happen, but not how it should happen. For example, declarative language might describe the end state of the system. Implementation details are left up to the programming language. These languages are often based on logic and mathematics but do not usually use traditional control structures or data structures. Instead, they often search for results satisfying the request. Good examples include Prolog and the *Structured Query Language* (SQL).

Although all logic programming languages are part of the declarative programming paradigm, some of them incorporate imperative programming practices. For example, Prolog includes imperative programming devices, including loops, conditionals, and functions.

Specializations within the Logic Programming

Within the logic programming paradigm, there are several different specializations. Each variation has a specific focus or adds new features and attributes.

- *Higher-order Logic Programming:* The style enhances logic programming with higher-order programming logic, such as predicate variables. It allows functions, modules, and objects to serve as values. Higher-order logic programs are sometimes used to validate formal proofs or theorems in math or logic. Several Prolog extensions provide higher-order logic features.

- *Constraint Logic Programming:* This variation allows constraints to be added to a predicate. For example, a constraint can append a valid range to any value. Constraints can potentially make rules more flexible or more restrictive. The program calculates the set of solutions satisfying all constraints. Constraint logic is used to solve problems in engineering and timetable production.
- *Concurrent Logic Programming:* Concurrent logic is used in parallel computing and distributed systems. It generates a set of guarded clauses that might also have further subclauses to validate. It distributes the clauses across different processors, executing the search in a parallel and non-deterministic manner. If more than one guard satisfies the query, the system chooses one of the possibilities and investigates the subclauses. Other guards satisfying the query might be ignored.
- *Abductive Logic Programming:* This variation allows logic programming to proceed using incomplete or unknown information. The purpose of this type of search is to generate possible solutions to a problem under investigation. It is often used in fault analysis and natural language processing.
- *Inductive Logic Programming:* This model uses positive and negative examples in conjunction with its knowledge base. Programs generalize a hypothesis inductively from the set of examples. Inductive logic is often used in natural language processing and biometrics.

Why Logic Programming? Advantages and Disadvantages of its Using

Logic programming is naturally designed to answer queries. It can determine whether a query is true or false, or provide a list of choices that satisfies the query. It can also order alternatives from most to least relevant, or rank them on some other dimension. Logic programming is not typically used for tasks requiring a lot of string or mathematical processing or for lower-level system actions.

Some of the other advantages of logic programming include the following:

- It is very useful for representing knowledge. Logical relationships can easily be transferred into facts and rules for use in a logic program.
- Users do not have to be experts in traditional programming to use it. They only have to understand the logical domain and know how to add the predicates. Logic programming syntax is straightforward.

- It can be used to represent very complicated ideas and rapidly refine an existing data model.
- It is very good at pattern matching.
- It is efficient in terms of memory management and data storage.
- It allows data to be presented in several different ways.

There are also some drawbacks to logic programming. It can be challenging to translate knowledge into facts and rules, and programs can be difficult to debug and test. Unintended side effects are much more difficult to control in logic programming than they are in traditional languages. Slight changes can generate vastly different outcomes.

Use Cases for Logic Programming

Logic programming can be used in any domain where a large amount of data must be analyzed to make decisions. However, it is most commonly applied to a few subjects. Following are some places where logic programming is most likely to be found.

- *Artificial Intelligence/Machine Learning:* This is one of the main applications of logic programming. It is especially relevant because it provides a structured method of defining domain-specific knowledge. AI systems use their facts and rules to analyze new queries and statements.
- *Natural Language Processing (NLP):* NLP handles interactions between people and computers. It relies upon a system of rules to interpret and understand speech or text. NLP systems translate their insights back into a more data-friendly format. NLP systems can also generate a relevant response to user requests and feedback.
- *Database Management:* Logic programming can determine the best place in a database to store new data. It can also analyze the contents of a database and retrieve the most useful and relevant results for a query. Logic programming is frequently used with large freeform NoSQL databases. These databases do not use tables to organize and structure data and must be analyzed using other methods.
- *Predictive Analysis:* Logic programs can sort through a large amount of data, analyze results and make predictions. This is especially useful in areas such as climate forecasting, the monitoring of deep space objects, and predicting equipment failures.

Logic programming is also used in fault diagnosis, pattern matching, and mathematical proofs.

Examples of Logic Programming Languages

There are dozens of different logic programming languages. Many of these have been adapted from more generic programs for use in one specific domain. However, three widely-known languages are used across different subject areas.

- *Prolog:* This is the original logic programming language, developed at a French university in 1972. It was designed for use in Artificial Intelligence and is still the most popular logic programming language today. Prolog mainly uses the declarative programming paradigm but also incorporates imperative programming. It is designed for symbolic computation and inference manipulation. Its logical rules are expressed in terms of relations and take the form of *Horn clauses*. Queries use these relations to generate results. Prolog operates by negating the original query and trying to find information proving it false.

  In Prolog, the Horn clause is written as:

  H :- B1,...,Bn.

  - Antecedents (or left-hand side of the sentence) in the Horn Clause are called *subgoals* or *tail*.
  - The consequent (or right-hand side of the sentence) in the Horn Clause is called *goal* or *head*.
  - A Horn Clause with no tail is a *fact*. For example, rainy(seattle). does not depend on any condition.
  - A Horn Clause with a tail is a *rule*. For example, snowy(X) :- rainy(X),cold(X)..

Developers use Prolog for database search, natural language processing, expert systems, and planning operations.

- *Datalog:* Datalog is an offshoot of Prolog that uses a strict declarative model. It is often used for machine learning, data integration, and information extraction. Datalog programs are usually interpreted by another programming language. Statements can be entered without regard to order and finite-set queries are guaranteed to terminate. It imposes more rules than Prolog does for reasons of efficiency. Several open-source products are based on Datalog or include built-in Datalog interpreters.
- *Answer Set Programming (ASP):* Not to be confused with the server-side scripting language sharing the same acronym. ASP is a form of *declarative programming* designed to solve extremely difficult search-related problems.

ASP is represented as a finite set of rules in the form as shown below:

a0 ← b1, . . . , bn, not c1, . . . , ck

From the above syntax:

- a is the *head* of the rule
- The list b1, . . . , bn, not c1, . . . , ck is called the *body* of the rule

Some examples include *graph coloring* and *Hamiltonian cycles* on large data sets. It reduces search problems to stable models. These models are then used to perform the search. All ASP queries are guaranteed to resolve.

Concluding Thoughts about Logic Programming

Logic Programming is based on the declarative paradigm of computer programming. Users specify the underlying data through a symbolic system of relations, in the forms of facts and rules. Facts are simple statements, while rules indicate relationships within the domain. A logic program uses its body of predicates and the principle of deduction to answer queries about the data. It is considered the best tool for representing knowledge and logical relationships.

Logic programming is one of several programming paradigms, including imperative/procedural, object-oriented, and functional models. Several variations of logic programming also exist. It is used in Artificial Intelligence, natural language processing, database management, and predictive analysis. Some of the best-known logic programming languages include Prolog, Datalog, and Answer Set Programming.

Notes:

Programming paradigms are a way to classify programming languages based on their features. Languages can be classified into multiple paradigms.

Syntax in linguistics is the study of how words and morphemes combine to form larger units such as phrases and sentences. Central concerns of syntax include word order, grammatical relations, hierarchical sentence structure (constituency), agreement, the nature of crosslinguistic variation, and the relationship between form and meaning (semantics).

Hamiltonian Cycle or *Circuit* in a graph *G* is a cycle that visits every vertex of *G* exactly once and returns to the starting vertex.

Graph coloring (in graph theory) is a special case of graph labeling; it is an assignment of labels traditionally called "colors" to elements of a graph subject to certain constraints. In its simplest form, it is a way of coloring the vertices of a graph such that no two adjacent vertices are of the same color; this is called a vertex coloring. Similarly, an edge coloring assigns a color to each edge so that no two adjacent edges are of the same color, and a face coloring of a planar graph assigns a color to each face or region so that no two faces that share a boundary have the same color.

Exercises:

1. Give Russian equivalents to the following words and phrases and explain them in your own words:

To certain constraints; originally developed; pure logic programming environment; offshoot of Prolog; strict declarative model; finite-set queries are guaranteed to terminate; Prolog operates by negating the original query; within the domain

2. Translate the sentences into Russian paying attention to the prefixes and suffixes:

1. It was originally designed to help study knowledge representation and artificial intelligence;
2. Unintended side effects are much more difficult to control in logic programming than they are in traditional languages;
3. Programs generalize a hypothesis inductively from the set of examples;
4. It is designed for symbolic computation and inference manipulation;
5. Classes encapsulate variables, data structures, and internal functions known as methods;
6. Facts are simple statements that do not contain a body clause;
7. Logic programs are completely data-driven and do not typically include any connective logic

3. Give English equivalents to the following words and phrases:

Небольшие изменения; присвоение переменных; добавлять новые свойства и атрибуты; по соображениям эффективности; проблемы, связанные с поиском; обработка естественного языка; сводит проблемы поиска к стабильным моделям

4. Answer the following questions:

1. What programming paradigms do you know?
2. What are the major specializations within logic programming?
3. Is logic programming based on declarative or procedural representation of knowledge?
4. Which of the following programming languages are considered to be declarative: C++, Lisp, Prolog, Java, Haskell, ASP, SQL?
5. What are the main drawbacks of logic programming?
6. What fields of logic programming application do you know?
7. What are the basic benefits of using logic programming?
8. Why do we consider artificial intelligence and machine learning to be the two most relevant areas of logic programming application?

5. Decide whether the statements are true or false:

1. Functional programming helps in solving complex problems, handles symbolic computation, and also assists in code redundancy;
2. Logic programming is data-driven and assists in natural language processing;
3. Logic programs are not easy to read and debug;
4. In the case oflLogic programming the architecture of the machine can be changed without any change in the program or its fundamental codes;
5. Facts and rules are the two important building blocks of logic programs;
6. A programming language can't combine different programming paradigms;
7. All logic programming languages are part of the object-oriented programming paradigm.

6. Translate from Russian into English:

1. Логика с ограничениями используется для решения задач в области проектирования и составления расписания;
2. Точные алгоритмы и методы обработки остаются на усмотрение языка, который, как ожидается, выдаст надлежащий результат;
3. Некоторые продвинутые программы допускают очень сложные правила, использующие составные или вложенные предложения;
4. Искусственный интеллект / машинное обучение — это одно из основных применений логического программирования. Это особенно актуально, поскольку обеспечивает структурированный метод определения знаний, специфичных для предметной области;

5. Это особенно полезно в таких областях, как прогнозирование климата, мониторинг объектов дальнего космоса и прогнозирование отказов оборудования;

6. ASP — форма декларативного программирования, предназначенная для решения чрезвычайно сложных задач, связанных с поиском;

7. Prolog в основном использует парадигму декларативного программирования, но также включает в себя императивное программирование;

8. Логические программы могут сортировать большой объем данных, анализировать результаты и делать прогнозы;

9. Перевести знания в факты и правила может быть непросто, а программы могут быть трудны для отладки и тестирования;

10. Логическое программирование основано на декларативной парадигме компьютерного программирования. Пользователи определяют базовые данные с помощью символической системы отношений в форме фактов и правил.

7. Summarize the text and express your own opinion. Here are some possible statements to support:

1. A programming paradigm classifies a language based on its features and how its programs are constructed and used;

2. Logic programming is a variation of declarative programming based on a type of formal logic;

3. In logic programming problems are often solved internally through the use of an and-or tree;

4. A logic program uses its body of predicates and the principle of deduction to answer queries about the data;

5. Logic programming is considered the best tool for representing knowledge and logical relationships.

8. Develop the following ideas in writing an essay (120–150 words):

1. Almost all computer programming languages are classified under different programming paradigms;

2. Artificial intelligence is one of the main applications of logic programming.

Unit 8

The Internet of Things

Words and phrases

Emerge	— возникать
Consumers	— потребители
Attention-grabbing headlines	— заголовки, привлекающие внимание
Decision-making process	— процесс принятия решений
Embedded	— встроенный
Interoperability	— совместимость, взаимозаменяемость
Hinder	— препятствовать
Waste and tedious process	— ненужный и утомительный процесс
Infrastructure readiness	— готовность инфраструктуры
Investment incentives	— инвестиционные стимулы

The Internet of Things is an emerging topic of technical, social and economic importance. Consumer products, durable goods, cars and trucks, industrial components and facilities, sensors, and other everyday objects are combined with internet connectivity and powerful data analysis capabilities that promise to transform the way we live and work. A major shift in our daily routines can be observed along with the widespread implementation of IoT devices and technologies. IoT is everywhere, although we don't always see it or know that a device is part of it. For consumers, new IoT products like Internet-enabled devices, home automation components and power management devices drive us toward seeing "Smart home", which provides more safety and energy efficiency. Other IoT personal devices such as wearable fitness and health monitors that support the network-enabled medical devices are transforming the way healthcare services are delivered. The Internet of Things transforms physical objects into an information ecosystem shared between wearable, portable, and even implantable devices, making our life technology and data rich. The IoT technology promises to be useful for powerful data analysis capabilities and the elderly, allowing for improved levels of independence quality of life at reasonable cost. Internet of things systems such as networked vehicles, smart traffic systems, and sensors embedded in roads and bridges bring us closer to the idea of "smart cities", which help reduce congestion and energy consumption. IoT technology offers the potential to transform agriculture, industry, and energy production

and distribution is increasing availability of information along the production value chain using networked sensors. A number of companies and research organizations have provided a wide range of expectations about the potential impact of the internet of things on the internet and the economy over the next decade. Huawei expects 100 billion IoT connections by 2025 estimating the potential economic impact of the Internet of Things from $3.9 to $11 trillion annually in 2025, driven by: lower device prices, advanced cloud storage computing, higher speed and lower delivery costs. This increases the number of machines and devices connected to the Internet. Also estimated (2015) that the Internet of Things will contribute 4% — 11% of global GDP in 2025.

However, at the same time, the Internet of Things raises significant challenges that could stand in the way of realizing its potential benefits. Attention-grabbing headlines about internet device hacking, surveillance concerns, and privacy concerns have already captured the public's attention Technical challenges remain, and new political, legal and development challenges arise. This discussion is "promise versus risk" along with the flow of information through popular media and marketing can make the internet of things a complex topic to understand.

The definition of the internet of things (IoT) is not definitively limited and not currently defined, meaning that there is no general definition approved by the majority or by the global user community, and therefore the internet of things is maturing and continuing to be the newest, most popular concept in the world of information technology.

The "thing" in IoT can be any device with any type of sensor embedded with the ability to collect data and transmit it across the network without manual intervention. The technology embedded in the object helps to interact with internal states and the external environment, which in turn aids in the decision-making process.

The internet of things (IoT) is a framework in which all things have a representation and a presence on the Internet. More specifically, the internet of things aims at offering new applications and services bridging the physical and virtual worlds, in which machine-to-machine (M2M) communications represents the baseline communication that enables the interactions between things and applications in the cloud. This is defined by IEEE communication magazine. Oxford Dictionaries provides a summary definition that calls the internet as an element of IoT: "Internet of things (noun): The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data".

The internet of things creates an inclusive information system, which consists of smaller information systems; smart devices are connected to the smart home system and connected to smart city systems. In reality, the internet of things is far more complicated than that. While security considerations are not new in the IT context, the features of many IoT applications present new and unique security challenges. Facing these challenges and ensuring security in IoT products and services should be a primary priority, and users need to trust that IoT devices and related data services are protected from vulnerabilities, especially as this technology has become more pervasive and integrated in our daily lives. Poorly secured IoT devices and services can act as potential entry points for a cyberattack and expose user data to theft by leaving data flow insufficiently protected. The interconnected nature of IoT devices means that every poorly secured device connected to the internet has the potential to affect Internet security and resiliency globally. This challenge is amplified by other considerations such as the widespread deployment of homogeneous IoT devices, the ability of some devices to automatically connect to others, and the potential for deploying these devices in insecure environments.

Privacy

The full potential of the internet of things depends on strategies that respect individual privacy options across a wide range of expectations. The data flows and user privacy that IoT devices provide can open up incredible and unique value for IoT users, but concerns about privacy and potential harms may hinder the full adoption of IoT. This means that privacy rights and respect for user privacy expectations are integral to ensuring user confidence in the Internet, connected devices, and related services.

Interoperability and Standards

Interoperability is the ability to exchange information between various IoT devices and systems. This exchange of information is not based on published software and hardware. The problem of interoperability arises due to the heterogeneous nature of the technology and the various solutions used to develop IoT. With interoperability as an important issue, researchers have agreed with several solutions such as adaptive, gateway based, virtual network and service-based architecture. They are also known as approaches to dealing with interoperability. Although the methods of dealing with interoperability

relieve the possibility of interoperability which could be an area for future studies.

The use of IoT devices raises many new regulatory and legal questions in addition to amplifying existing legal issues around the Internet. The questions are wide-ranging, and the rapid rate of change in IoT technology often outpaces the adaptability of associated policies and legal and regulatory structures. With the development of the Internet of Things, many real-life problems have been solved but have also given rise to critical ethical and legal challenges such as data security, privacy protection, trust, security, and data usability. It has also been observed that the majority of IoT users support government rules and regulations regarding data protection, privacy and safety due to mistrust of IoT devices. Therefore, this issue should be taken into consideration to maintain and improve trust among people regarding the use of IoT devices and systems.

Emerging Economies and Development

The internet of things holds great promise to deliver social and economic benefits to emerging and developing economies. This includes areas such as sustainable agriculture, water quality and use, health care, manufacturing, and environmental management, among others. As such, the internet of things holds promise as a tool for achieving the United Nations Sustainable Development Goals.

Communication

The internet of things consists of many smart devices that communicate with each other. These devices enable data exchange and collection. Smart devices can have a wired or wireless connection. Typically, IoT devices connect to the Internet through the Internet Protocol (IP) stack. This combination is very complex and requires a large amount of power and memory from the connected devices. These devices can also be connected locally through NON-IP networks which consume less power and connect to the internet via smart gateway.

Device-to-Gateway Communications

Simply, this means that there is an application program running on a local gateway device which acts as an intermediary between device and cloud service and provides security and data translation. This new wave of technology will stand at the leading position for all technologies around the world, which are directed towards billions and billions of

connected smart devices that use all the data in our lives. With new wireless networks, high sensors, and superior capabilities, IoT applications promise to make our lives easier and bring enormous value. Some uses of IoT applications are found in several important areas.

Transportation/Mobility

Maintaining vehicle health: Predictive maintenance technology relies on the use of internet of things communication tools that collect data about the performance of different parts, transfer that data to the cloud in real time and assess the risk of a possible malfunction of the vehicle's hardware or software. After the information is processed, the driver is notified and informed of any service or repair necessary to avoid potential accidents. With internet of things connectivity tools, you can forget about unplanned stops or breakdowns during the ride.

Transforming the meaning of vehicle ownership: One of the most interesting future applications of the IoT in transportation is vehicle ownership. According to a recent study by Tony and James, car ownership will decrease by 80% by 2030. You can see that actually happen. City dwellers sell or never buy cars. They choose to use ride-sharing and vehicle-sharing platforms, or ride-sharing, in addition to relying on steadily improving public transportation services.

Energy

With energy consumption worldwide expected to grow by 40% over the next 25 years, the need for a smarter energy solution has reached an all-time high. Fortunately, there are some major shifts towards more efficient energy management from smart light bulbs to fully autonomous offshore oil platforms. Overall, IoT is revolutionizing nearly every part of the energy industry from generation to transmission to distribution and changing how energy companies and customers interact. It is difficult to underestimate the current impact of the Internet of Things on the energy sector. With the increasing demand for process automation and operational efficiency, more companies are exploring IoT use cases in energy management.

Energy system monitoring and maintenance: IoT can be used in the energy industry to track a number of system metrics, including overall health, performance, and efficiency. As a result, their maintenance is simplified. Whether it's a wind turbine, solar panels, or other important equipment, it can be difficult to pinpoint a problem before the system crashes. Moreover, checking for issues manually is a very wasteful and tedious process.

Smart Cities

Thanks to the power of the internet of things, entire cities are becoming digitally interconnected and thus smarter. By collecting and analyzing huge amounts of data from IoT devices across different city systems, cities improve the lives of citizens. Smart cities can make better decisions through the data they collect on infrastructure needs, transportation requirements, crime and safety. A study shows that using existing smart city applications, cities improve quality of life indicators (such as crime, traffic, and pollution) by between 10% and 30%. Internet of things technologies in everyday life as part of your home, transportation, or city, relate to a more efficient and enjoyable life experience. IoT promises a better quality of life through routine chores and increased health and wellness.

Ultimately, solutions will not be found to maximize the benefits of the IoT while minimizing the risks by engaging in a polarized discussion that pits IoT's promises against its potential risks. In a way, it will take informed participation, dialogue and collaboration across a range of stakeholders to chart the most effective way forward, and the set of IoT challenges will not be limited to industrialized countries. Developing regions will also need to respond to realize the potential benefits of the internet of things. In addition, it will need to address unique needs and challenges for implementation in less developed regions, including infrastructure readiness, market and investment incentives, technical skills requirements, and policy resources.

What are the opportunities and challenges in the development of smart and IoT based technologies?

Rapidly developing and implementation of smart and IoT technologies has created a number of potential opportunities in technological advancements for different aspects of life. However, there are also a number of issues with smart technology that should be considered when implementing it into specific areas of life, such as health care or sustainability.

One of the most important aspects of the future of IoT is its potential to change the way we live, work and campus. There are various implications of this technology, some of which have already begun to have a significant impact on our lives. Additionally, advances in biometric technology can be used to authenticate people in various areas (such as restaurants or manufacturing). Needless to say, these developments could have far-reaching implications for our day-to-day lives and how we interact with the world around us.

Exercises:

1. Give Russian equivalents to the English words and phrases:

An emerging topic; powerful data analysis capabilities; widespread implementation; ecosystem shared between wearable, portable, and even implantable devices; people with disabilities; reduce congestion and energy consumption; estimating the potential economic impact; attention-grabbing headlines; embedded with the ability to collect data; manual intervention; services bridging the physical and virtual worlds; unique security challenges; protected from vulnerabilities; this challenge is amplified; incredible and unique value; may hinder the full adoption; the internet of things holds great promise to deliver social and economic benefits; sustainable agriculture; devices enable data exchange and collection; predictive maintenance technology; malfunction of the vehicle's hardware; across a range of stakeholders; market and investment incentives; technical skills requirements.

2. Translate the extracts from the text into Russian:

1. A number of companies and research organizations have provided a wide range of expectations about the potential impact of the internet of things on the internet and the economy over the next decade. Huawei expects 100 billion IoT connections by 2025 estimating the potential economic impact of the Internet of Things from $3.9 to $11 trillion annually in 2025, driven by: Lower device prices, advanced cloud storage computing, higher speed and lower delivery costs. This increases the number of machines and devices connected to the Internet. Also estimated (2015) that the internet of things will contribute 4% — 11% of global GDP in 2025.

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The “thing” in IoT can be any device with any type of sensor embedded with the ability to collect data and transmit it across the network without manual intervention. The technology embedded in the object helps to interact with internal states and the external environment, which in turn aids in the decision-making process.

2. Interoperability is the ability to exchange information between various IoT devices and systems. This exchange of information is not based on published software and hardware. The problem of interoperability arises due to the heterogeneous nature of the technology and the various solutions used to develop IoT.

With interoperability as an important issue, researchers have agreed with several solutions such as adaptive, gateway based, virtual network and service-based architecture. They are also known as approaches to dealing with interoperability. Although the methods of dealing with interoperability relieve the possibility of interoperability which could be an area for future studies. The use of IoT devices raises many new regulatory and legal questions in addition to amplifying existing legal issues around the internet. The questions are wide-ranging, and the rapid rate of change in IoT technology often outpaces the adaptability of associated policies and legal and regulatory structures. With the development of the internet of things, many real-life problems have been solved but have also given rise to critical ethical and legal challenges such as data security, privacy protection, trust, security, and data usability. It has also been observed that the majority of IoT users support government rules and regulations regarding data protection, privacy and safety due to mistrust of IoT devices. Therefore, this issue should be taken into consideration to maintain and improve trust among people regarding the use of IoT devices and systems.

3. Thanks to the power of the Internet of Things, entire cities are becoming digitally interconnected and thus smarter. By collecting and analyzing huge amounts of data from IoT devices across different city systems, cities improve the lives of citizens. Smart cities can make better decisions through the data they collect on infrastructure needs, transportation requirements, crime and safety. A study shows that using existing smart city applications, cities improve quality of life indicators (such as crime, traffic, and pollution) by between 10% and 30%. Internet of things technologies in everyday life as part of your home, transportation, or city, relate to a more efficient and enjoyable life experience. IoT promises a better quality of life through routine chores and increased health and wellness.

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3. Give English equivalents to the Russian words and phrases:

Встроенная возможность сбора данных; ручное вмешательство; сервисы, соединяющие физические и виртуальные возможности; вновь возникающие уникальные проблемы безопасности; все заявленные программы защищены от уязвимостей; со временем эта проблема усугубляется; необходимо ценить невероятную и уникальную ценность; может препятствовать полному восстановлению такого рода программ; в настоящее время интернет вещей имеет большие перспективы для обеспечения социальных и экономических выгод любого уровня; устойчивое сельское хозяйство; современные устройства обеспечивают обмен и сбор данных; технология профилактического обслуживания; неисправность аппаратной части транспортного средства грозит большими неприятностями; по целому ряду вопросов при переговорах заинтересованных сторон; рыночные и инвестиционные стимулы; требования к техническим навыкам.

4. Answer the following questions:

Why do we speak about the Internet of Things as the emergency problem?

1. What makes the Internet of Things so powerful and helpful technology nowadays?
2. What are the most interesting implementations of the Internet of Things in the nearest future?
3. Why is the interoperability of IoT so important?

5. Translate the following texts from Russian into English:

1. Интернет вещей иногда трактуют как синоним систем smart (в переводе с англ. — умный): умные устройства, умные дома, ум-

ный город, умная среда, умные предприятия и т. д. Далее рассмотрим их подробнее.

Умные устройства могут собирать данные, отслеживать действия и настраивать опыт для нужд и желаний пользователей. Их можно носить на разных частях тела (голове, глазах, запястье, талии, руках, пальцах, ногах), либо эти устройства встраиваются в различные элементы одежды.

Умный дом — это интеграция технологий и услуг посредством домашней сети для повышения качества жизни. Решения этой категории делают жизнь владельцев дома более удобной и приятной. Некоторые из них предназначены для оказания помощи пожилым в повседневной деятельности и мониторинге здоровья. Из-за высокого рыночного потенциала все больше интеллектуальных решений для дома выходит на рынок — умное управление энергией и ресурсами в основном направлено на взаимодействие системы и деятельности человека.

Умный город — это городской регион, который имеет передовую инфраструктуру, коммуникации и жизнеспособный рынок. Это город, где информационные технологии являются основой для предоставления основных услуг жителям. Существует множество технологических платформ, включая автоматизированные сенсорные сети и центры обработки данных. Фактически городской IoT направлен на использование самых современных коммуникационных технологий с целью поддержки дополнительных услуг для администрации города и горожан. Применение парадигмы IoT к городскому контексту представляет особый интерес, поскольку она реагирует на тенденцию многих национальных правительств к внедрению информационно-коммуникационных решений в управлении государственными делами.

2. К 2030 году во всем мире будет активировано более 100 млрд умных устройств, что в 10 раз превзойдет население планеты. В каких направлениях будет развиваться интернет вещей и какие компании могут стать бенефициарами тренда?

Домовладельцы, использующие камеру видеонаблюдения для защиты семьи; фермеры, наблюдающие за посевами с помощью дронов; спортсмены, применяющие устройства для оптимизации тренировок, — все мы становимся частью системы под названием «интернет вещей» (IoT). В 2019 году рынок устройств IoT достиг отметки $742 млрд, а к 2023 году, по прогнозам аналитиков IDC, он может превысить $1 трлн.

Умный дом, умный гаджет**.** Можно выделить несколько областей, где применение IoT-устройств будет активно расти. Во-первых, это экосистема умных домохозяйств: различные датчики, лампочки, розетки, бытовая техника. Цифровые виртуальные ассистенты вроде Alexa (Amazon), Google Assistant или «Алиса» («Яндекс») становятся своеобразным проводником между сетью устройств и человеком. С помощью голосовых помощников можно управлять работой IoT-техники: включать свет, выбирать музыку, запускать кондиционер или пылесос. В 2020 году этот сегмент рынка IoT оценивался в $79 млрд, а к 2026 году вырастет до $314 млрд.

Еще одна область активного проникновения IoT — современные автоматизированные производства. Применение подключенных устройств позволяет увеличивать степень автоматизации, осуществлять удаленное управление и мониторинг.

Проанализировав временные затраты рабочих на производстве, концерн Bosch обнаружил, что рабочие тратят большое количество времени на поиск инструментов в цеху. Чтобы решить эту проблему, компания добавила к своим инструментам датчики отслеживания. Таким образом, сотрудники всегда знают, где лежит тот или иной инструмент, и не тратят время на его поиск. Это повышает производительность труда рабочих и в итоге увеличивает доходы компании. По данным Grand View Research, в 2020 году сегмент IoT-устройств для автоматизации производств оценивался в $215 млрд. К 2025 году он вырастет до $950 млрд.

3. Что произойдет, если отдельные технические устройства приобретут сетевой интерфейс? Очевидно, что результатом будет беспрецедентное количество «вещей», подключенных к сети Интернет. Менее очевиден ответ на вопрос, что это будет означать для управления Интернетом. В свете концепции Интернета вещей (Internet of Things, IoT) взаимодействующие управленческие структуры уже приспосабливаются к тому, чтобы соответствовать эволюции применений Интернета. Однако, поскольку структура управления продолжает развиваться, безопасность пользователей становится приоритетом для всех поставщиков технических и программных решений. В контексте Интернета вещей в данной статье предлагается определение цифровой безопасности, отличающееся от защиты данных, а также обсуждается то, как управление, затрагивающее различных заинтересованных лиц, может применяться для обеспечения такой безопасности. В работе также рассматриваются вопросы интеграции «старых» отраслей и трансформации управления

ими в «мульти» модель по мере того, как их продукты и услуги становятся онлайновыми. Обсуждается, как тысячи производителей, традиционно производящие не связанные между собой «вещи», адаптируются к роли стейк-холдеров Интернета и как это изменяет наше представление об управлении Интернетом. Особое внимание в статье уделено тому, как это связано с вопросами безопасности, которые становятся все более актуальными в связи с широким распространением Интернет-ориентированных физических устройств.

4. На теорию управления существенное влияние оказывают научные технологические достижения. Важным фактором современного развития управленческой деятельности выступают распределенные информационные технологии. Одним из подходов, реализующим распределенное управление, являются сетевые системы и технологии. Одной из таких технологий и систем является технология Интернет вещей. Появление этой технологии как нового этапа глобального технологического развития связано и обусловлено динамичным внедрением информационно-коммуникационных технологий во все сферы жизни общества. Эта технология проявляется прежде всего в быстрорастущей цифровой экономике, опирающейся на массовое использование технологий Интернет, достижений микроэлектроники и программной инженерии. Интернет-вещей и решения на их основе часто называют «умными» (smart). Сегодня они наиболее широко представлены в таких областях, как «умное производство», «умная энергетика», «умная агрокультура», «умная логистика», «умный транспорт», «умный дом», «умный город», «умное здравоохранение» и этот перечень, очевидно, будет только расти, охватывая все новые рыночные сегменты.

6. Summarize the main ideas of the text and express your own opinion. Here are some possible statements to support:

1. What are the pros and cons of the “smart house”?
2. Give the examples of IoT implementation.
3. Why do you think the theme of IoT is so popular nowadays?
4. Present your own view on IoT.

7. Develop the following ideas in writing an essay (120–150 words):

1. From the beginning, IoT devices have been notoriously vulnerable to cyber-attacks. There are countless examples of IoT devices being incorporated into botnets (like the infamous Mirai botnet) or being hacked

to misuse or access other parts of a network. This problem isn't going to just go away because, unfortunately, it stems from some inherent issues with IoT devices.

2. To transmit and receive data, IoT devices need a network connection. Lose the connection, and you lose the device's capabilities. While there are numerous IoT connectivity solutions, they're all best suited for different types of coverage. The solution you choose can severely limit where you can deploy. This makes coverage a constant IoT challenge.

Unit 9

AI-based Modeling: Techniques, Applications and Research Issues

Words and phrases

To envision — предполагать, предусматривать, предвидеть
Interconnectivity — взаимосвязанность
Non-linear — нелинейный
Self-awareness — самосознание
Ultimately — в конечном счете
Milestone — веха
Bandwagon — массовое движение, увлечение, побеждающая сторона
Vulnerability management — управление уязвимостями
Standpoint — точка зрения
Enormous volumes of data — огромные объемы данных

Nowadays, we live in a technological age, the Fourth Industrial Revolution, known as Industry 4.0 or 4IR, which envisions fast change in technology, industries, societal patterns, and processes because of enhanced interconnectivity and smart automation. This revolution is affecting almost every industry in every country and causing a tremendous change in a non-linear manner at an unprecedented rate, with implications for all disciplines, industries, and economies. Three key terms Automation, i.e., reducing human interaction in operations, Intelligent, i.e., ability to extract insights or usable knowledge from data, and Smart computing, i.e., self-monitoring, analyzing, and reporting, known as self-awareness, have become fundamental criteria in designing today's applications and systems in every sector of our lives since the current world is more reliant on technology than ever before. The use of modern smart technologies enables making smarter, faster decisions regarding the business process, ultimately increasing the productivity and profitability of the overall operation, where artificial intelligence is known as a leading technology in the area. The AI revolution, like earlier industrial revolutions that launched massive economic activity in manufacturing, commerce, transportation, and other areas, has the potential to lead the way of progress. As a result, the impact of AI on the fourth industrial revolution motivates us to focus briefly on "AI-based modeling" in this chapter.

Artificial intelligence is a broad field of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. In other words, we can say that it aims to make computers smart and intelligent by giving them the ability to think and learn using computer programs or machines, i.e., can think and function in the same way that people do. From a philosophical perspective, AI has the potential to help people live more meaningful lives without having to work as hard, as well as manage the massive network of interconnected individuals, businesses, states, and nations in a way that benefits everyone. Thus, the primary goal of AI is to enable computers and machines to perform cognitive functions such as problem-solving, decision making, perception, and comprehension of human communication. Therefore, AI based modeling is the key to building automated, intelligent and smart systems according to today's needs, which has emerged as the next major technological milestone, influencing the future of practically every business by making every process better, faster, and more precise.

While today's Fourth Industrial Revolution is typically focusing on technology-driven "automation, intelligent and smart systems", AI technology has become one of the core technologies to achieve the goal. However, developing an effective AI model is a challenging task due to the dynamic nature and variation in real-world problems and data. Thus, we take into account several AI categories:

The first one is "Analytical AI" with the capability of extracting insights from data to ultimately produce recommendations and thus contributing to data-driven decision-making; the Second one is "Functional AI" which is similar to analytical AI; however, instead of giving recommendations, it takes actions; the Third one is "Interactive AI" that typically allows businesses to automate communication without compromising on interactivity like smart personal assistants or chatbots; the Fourth one is "Textual AI" that covers textual analytics or natural language processing through which business can enjoy text recognition, speech-to-text conversion, machine translation, and content generation capabilities; and, finally, the Fifth one is "Visual AI" that covers computer vision or augmented reality fields, discussed briefly in "Why artificial intelligence in today's research and applications?".

We are now in the age of the 4th Industrial Revolution, referred to as Industry 4.0 which represents a new era of innovation in technology, particularly, AI-driven technology. After the Internet and mobile Internet sparked the 3rd Industrial Revolution, AI technologies, fueled by data,

are now creating an atmosphere of Industry 4.0. The term "Industry 4.0" typically refers to the present trend of leveraging modern technology to automate processes and exchange information. In a broad sense, Industry 4.0 has been defined as "A term used to describe the present trend of industrial technology automation and data exchange, which includes cyber-physical systems, the Internet of Things, cloud computing, and cognitive computing, as well as the development of the smart factory". The digital revolution to Industry 4.0 begins with data collection, followed by artificial intelligence to interpret the data. Thus, the term "Intelligence Revolution" can be considered in the context of computing and services as AI that incorporates human behavior and intelligence into machines or systems is reshaping the world.

AI is the buzzword these days as it is going to impact businesses of all shapes and sizes, across all industries. Existing products or services can be enhanced by industrial AI to make them more effective, reliable, and safe. For example, computer vision is used in the automotive industry to avoid collisions and allow vehicles to stay in their lane, making driving safer. The world's most powerful nations are hurrying to jump on the AI bandwagon and are increasing their investments in the field. Similarly, the largest and most powerful corporations are working hard to build groundbreaking AI solutions that will put them ahead of the competition. As a result, its impact may be observed in practically every area including homes, businesses, hospitals, cities, and the virtual world, as summarized in "Real-World Applications of AI".

Understanding Various Types of Artificial Intelligence

Artificial intelligence is primarily concerned with comprehending and carrying out intelligent tasks such as thinking, acquiring new abilities, and adapting to new contexts and challenges. AI is thus considered a branch of science and engineering that focuses on simulating a wide range of issues and functions in the field of human intellect. However, due to the dynamic nature and diversity of real-world situations and data, building an effective AI model is a challenging task. Thus, to solve various issues in today's Fourth Industrial Revolution, we explore various types of AI that include analytical, functional, interactive, textual, and visual, to understand the theme of the power of AI. In the following, we define the scope of each category in terms of computing and real-world services.

- Analytical AI: Analytics typically refers to the process of identifying, interpreting, and communicating meaningful patterns of data.

Thus, Analytical AI aims to discover new insights, patterns, and relationships or dependencies in data and to assist in data-driven decision-making.

Therefore, in the domain of today's business intelligence, it becomes a core part of AI that can provide insights to an enterprise and generate suggestions or recommendations through its analytical processing capability. Various machine learning and deep learning techniques can be used to build an analytical AI model to solve a particular real-world problem. For instance, to assess business risk, a data-driven analytical model can be used.

- Functional AI: Functional AI works similarly to analytical AI because it also explores massive quantities of data for patterns and dependencies. Functional AI, on the other hand, executes actions rather than makes recommendations. For instance, a functional AI model could be useful in robotics and IoT applications to take immediate actions.
- Interactive AI: Interactive AI typically enables efficient and interactive communication automation, which is well established in many aspects of our daily lives, particularly in the commercial sphere. For instance, to build chatbots and smart personal assistants an interactive AI model could be useful. While building an interactive AI model, a variety of techniques such as machine learning, frequent pattern mining, reasoning, AI heuristic search can be employed.
- Textual AI: Textual AI typically covers textual analytics or natural language processing through which businesses can enjoy text recognition, speech-to-text conversion, machine translation as well as content generation capabilities. For instance, an enterprise may use textual AI to support an internal corporate knowledge repository to provide relevant services, e.g., answering consumers' queries.
- Visual AI: Visual AI is typically capable of recognizing, classifying, and sorting items, as well as converting images and videos into insights. Thus, visual AI can be considered as a branch of computer science that trains machines to learn images and visual data in the same manner that humans do. This sort of AI is often used in fields such as computer vision and augmented reality.

Knowledge Representation, Uncertainty Reasoning, and Expert System Modeling

Knowledge representation is the study of how an intelligent agent's beliefs, intents, and judgments may be expressed appropriately for auto-

mated reasoning, and it has emerged as one of the most promising topics of artificial intelligence. Reasoning is the process of using existing knowledge to conclude, make predictions, or construct explanations.

Many types of knowledge can be used in various application domains including descriptive knowledge, structural knowledge, procedural knowledge, meta-knowledge, and heuristic knowledge. Knowledge representation is more than just storing data in a database; it also allows an intelligent machine to learn from its knowledge and experiences to act intelligently as a human. As a result, in designing an intelligent system, an effective method of knowledge representation is required. Several knowledge representation approaches exist in the fields that can be utilized to develop a knowledge-based conceptual model, including logical, semantic network, frame, and production rules, the potential knowledge representation strategies considering real-world issues.

A knowledge-based system, such as an expert system for decision-making, relies on these representations of knowledge. The inference engine and the knowledge base are two subsystems of the expert system.

The information in the knowledge base is organized according to the knowledge representation discussed above. The inference engine looks for knowledge-based information and linkages and, like a human expert, provides answers, predictions, and recommendations. Such a knowledge-based system can be found in many application areas. For instance, Goel presents an ontology-driven context-aware framework for smart traffic monitoring. Chukkapalli presents ontology-driven AI and access control systems for smart fisheries. Kiran presents enhanced security-aware technique and ontology data access control in cloud computing. Syed presents a conceptual ontology and cyber intelligence alert system for cybersecurity vulnerability management. Thus, knowledge representation and modeling are important to build AI models as well as intelligent decision-making in various application areas to solve real-world issues.

Visual Analytics, Computer Vision and Pattern Recognition

Computer vision is also a branch of AI that allows computers and systems to extract useful information from digital images, videos, and other visual inputs and act or make recommendations based on that data. From an engineering standpoint, it aims to comprehend and automate operations that the human visual system is capable of. As a result, this is concerned with the automated extraction, analysis, and comprehension of relevant information from a single image or a series of images.

In terms of technology, it entails the creation of a theoretical and algorithmic foundation for achieving autonomous visual understanding by processing an image at the pixel level. Typical tasks in the field of visual analytics and computer vision include object recognition or classification, detection, tracking, picture restoration, feature matching, image segmentation, scene reconstruction, video motion analysis, and so on.

Pattern recognition, which is the automated recognition of patterns and regularities in data, is the basis for today's computer vision algorithms. Pattern recognition often involves the categorization (supervised learning) and grouping (unsupervised learning) of patterns. Although pattern recognition has its roots in statistics and engineering, due to the greater availability of huge data and a new wealth of processing power, some recent techniques to pattern recognition include the use of machines and deep learning.

Convolutional neural networks (CNN or ConvNet) have recently demonstrated considerable promise in a variety of computer vision tasks, including classification, object detection, and scene analysis. Large datasets of thousands or millions of labeled training samples are typically used to train these algorithms. However, the lack of appropriate data limits the applications that can be developed. While enormous volumes of data can be obtained fast, supervised learning also necessitates data that has been labeled. Unfortunately, data labeling takes a long time and costs a lot of money. In this area, a lot of work has been done.

Typically, learning techniques rather than static analysis is more effective in terms of automation and intelligence in such visual analytics. In addition to standard machine learning algorithms, various deep learning techniques including generative and discriminative models can be used to build powerful visual model according to their learning capabilities from data, which could also be a significant research direction in the area. Thus, this is important to build effective visual AI models in various application areas to solve real-world issues in the current age of the Fourth Industrial Revolution or Industry 4.0, according to the goal of this chapter.

Hybrid Approach, Searching, and Optimization

A "hybrid approach" is a blend of multiple approaches or systems to design a new and superior model. As a result, a hybrid strategy integrates the necessary approaches outlined above depending on the demands. For instance, in earlier publications hybridization of machine learning and knowledge-based expert system to build an effective context-aware mod-

el for intelligent mobile services. In this hybrid context-aware model, context-aware rules are discovered using machine learning techniques, which used as the knowledge base of an expert system rather than traditional handcrafted static rules to make computing and decision-making processes more actionable and intelligent. Similarly, in another hybrid approach, the concepts of fuzzy logic, deep learning, and natural language processing were integrated to improve Twitter sentiment analysis accuracy.

Moreover, various machine learning and deep learning techniques and their hybridization can be used to solve a variety of real-world problems in many application areas such as business, finance, healthcare, smart cities, cybersecurity, etc. Thus, hybridization of multiple techniques could play a key role to build an effective AI model in the area. Moreover, many AI problems can be solved theoretically by searching through a large number of possible solutions, and the reasoning process may be reduced down to a simple search. Thus, search strategies, also known as universal problem-solving approaches in AI, can also play a significant role to solve real-world issues such as gaming, ranking webpages, video, and other content in search results, etc. due to the properties of its completeness, optimality, time complexity, and space complexity. Depending on the nature of the problems, search algorithms can be uninformed search (a.k.a. blind, brute-force) or informed search (a.k.a. heuristic search).

Uninformed search refers to a group of general-purpose search algorithms that generate search trees without relying on domain information, such as breadth-first, depth-first, uniform cost search, etc. Informed search algorithms, on the other hand, use additional or problem-specific knowledge in the search process, such as greedy search, AI search, graph search, etc. For example, when searching on Google Maps, one needs to provide information such as a position from the current location to precisely traverse the distance, time traveled and real-time traffic updates on that specific route. Informed search can solve a variety of complicated problems that cannot be handled any other way. Furthermore, evolutionary computation employs an optimization search technique, such as genetic algorithms, which has a great potential to solve real-world issues. For instance, in the domain of cybersecurity, a genetic algorithm is used for effective feature selection to detect anomalies in fog computing environment. Genetic algorithm is used for optimized feature selection to detect Android malware using machine learning techniques. With AI-powered search, the platform learns from the data to provide the most accurate and relevant search results automatically. Thus, searching

as well as optimization techniques can be used as a part of hybridization while building AI models to solve real-world problems.

Overall, potential AI techniques can play a significant role while building various AI models such as analytical, functional, interactive, textual, and visual models, depending on the nature of the problem and target application.

To summarize, AI is a relatively open topic to which academics can contribute by inventing new methods or refining existing methods to address the issues raised above and solve real-world problems in a range of application areas.

AI will be employed in any context where large amounts of data are needed to be handled fast and accurately, and cost savings are required. AI will affect the planet more than anything else in human history. One important thing is that AI-powered automation does not pose a threat to jobs in the workplace for individuals, businesses, or countries with the appropriate skills. AI-certified professionals have access to a wide range of job prospects. AI Engineer, Artificial Intelligence Programmer, AI System Developer, Data Scientist, Machine Learning Engineer, Data Analyst, AI Architect, Deep Learning Engineer, AI Software Engineer, and many other employment opportunities are available to these professionals.

Overall, AI technologies are driving a new wave of economic progress, resolving some of the world's most challenging issues and delivering solutions to some of humanity's most significant challenges. Many industries, including information technology, telecommunications, transportation, traffic management, health care, education, criminal justice, defense, banking, and agriculture, have the potential to be transformed by artificial intelligence.

Without compromising the significant characteristics that identify humankind, we can assure that AI systems are deliberate, intelligent, and flexible with adequate security. Governments and decision-makers of a country need to focus public policies that promote AI innovation while minimizing unexpected societal consequences to realize its full potential in real-world scenarios.

Exercises:

1. Give Russian equivalents to the following words and expressions:

Envisions fast change in technology; enhanced interconnectivity and smart automation; causing a tremendous change; ultimately increasing

the productivity and profitability; which has emerged as the next major technological milestone; is a blend of multiple approaches or systems; the capability of extracting insights from data; evolutionary computation employs an optimization search technique; a variety of complicated problems that cannot be handled any other way; inventing new methods or refining existing methods

2. Translate the sentences into Russian:

1. After the Internet and mobile Internet sparked the 3rd Industrial Revolution, AI technologies, fueled by data, are now creating an atmosphere of Industry 4.0.
2. The inference engine looks for knowledge-based information and linkages and, like a human expert, provides answers, predictions, and recommendations.
3. Reasoning is the process of using existing knowledge to conclude, make predictions, or construct explanations.
4. Thus, the primary goal of AI is to enable computers and machines to perform cognitive functions such as problem-solving, decision making, perception, and comprehension of human communication.
5. AI has the potential to help people live more meaningful lives without having to work as hard, as well as manage the massive network of interconnected individuals, businesses, states, and nations in a way that benefits everyone.
6. A “hybrid approach” is a blend of multiple approaches or systems to design a new and superior model.
7. Overall, AI technologies are driving a new wave of economic progress, resolving some of the world’s most challenging issues and delivering solutions to some of humanity’s most significant challenges.
8. Without compromising the significant characteristics that identify humankind, we can assure that AI systems are deliberate, intelligent, and flexible with adequate security.

3. Give English equivalents to the following expressions and phrases:

Улучшенная взаимосвязанность и интеллектуальная автоматизация; основополагающие критерии при проектировании современных приложений и систем; современный мир больше, чем когда-либо прежде, зависит от технологий; ИИ предназначен для выполнения практических функции; механизм логического вывода ищет информацию и связи, основанные на знаниях; искусственный интеллект — модное слово в наши дни; гибридная стратегия

объединяет необходимые подходы; эволюционные вычисления используют метод оптимизационного поиска; требуется экономия средств

4. Answer the following questions:

1. What does the 4th revolution affect in almost every industry in every country?
2. What are three terms indispensable from the 4th revolution?
3. What decisions is the use of modern smart technologies making smarter and faster?
4. What types of AI are mentioned in the text?
5. Give the definition of knowledge representation.
6. What is the purpose of genetic algorithm?
7. What is the definition of a "hybrid approach"?
8. What are real-world applications of AI?

5. Decide whether the statements are true or false:

1. The traditional machine learning and deep learning techniques may not be directly applicable for the expected outcome in many cases.
2. AI has acted as the driving force behind developing technologies for industrial automation, medical applications, agriculture, IoT applications, cybersecurity services, etc.
3. Developing an effective AI model is not a challenging task due to the dynamic nature and variation in real-world problems and data.
4. The largest and most powerful corporations are working hard to build groundbreaking AI solutions that will put them ahead of the competition.
5. None of the AI types has the potential to provide solutions to various real-world problems.
6. Knowledge representation and modeling are important to build AI models as well as intelligent decision-making in various application areas to solve real-world issues.

6. Translate from Russian into English:

1. Эта революция затрагивает почти каждую отрасль в каждой стране и вызывает огромные изменения нелинейным образом с беспрецедентной скоростью, что имеет последствия для всех дисциплин, отраслей промышленности и экономики.
2. Использование современных интеллектуальных технологий позволяет принимать более разумные и быстрые решения относи-

тельно бизнес-процесса, в конечном счете повышая производительность и прибыльность всей деятельности, где искусственный интеллект (ИИ) известен как ведущая технология в этой области.

3. Таким образом, моделирование на основе искусственного интеллекта является ключом к созданию автоматизированных, интеллектуальных систем в соответствии с сегодняшними потребностями, что стало следующей важной технологической вехой, влияющей на будущее практически каждого бизнеса, делая каждый процесс лучше, быстрее и точнее.

4. Таким образом, термин "интеллектуальная революция" можно рассматривать в контексте вычислительной техники и услуг, поскольку искусственный интеллект, который включает человеческое поведение и интеллект в машины или системы, изменяет мир.

5. Механизм логического вывода ищет информацию и связи, основанные на знаниях, и, подобно эксперту-человеку, предоставляет ответы, прогнозы и рекомендации.

6. Типичные задачи в области визуальной аналитики и компьютерного зрения включают распознавание или классификацию объектов, обнаружение, отслеживание, восстановление изображения, сопоставление признаков, сегментацию изображения, реконструкцию сцены, анализ движения видео и так далее.

7. Подводя итог, можно сказать, что искусственный интеллект — это относительно открытая тема, в которую ученые могут внести свой вклад, изобретая новые методы или совершенствуя существующие для решения вопросов, поднятых выше, и решения реальных проблем в целом ряде областей применения.

7. Summarize the text and express your own opinion. Here are some statements to support:

1. AI technologies are driving a new wave of economic progress, resolving some of the world's most challenging issues and delivering solutions to some of humanity's most significant challenges.

2.AI is a relatively open topic to which academics can contribute by inventing new methods or refining existing methods to address the issues raised above and solve realworld problems in a range of application areas.

3. The future prospects of AI modeling in real-world application domains are vast and there are several opportunities to work and conduct research.

8. Develop the following ideas in writing an essay (120–150 words):

1. Artificial intelligence is influencing the future of almost every sector and every person on the planet.

2. AI techniques have proven to be beneficial in a variety of applications and research fields, including business intelligence, finance, healthcare, visual recognition, smart cities, IoT, cybersecurity, and many more.

3. The future aspects of AI towards automation, intelligence, and smart computing systems, highlighting several research issues.

Unit 10

AI and Affective Intelligence

Words and phrases:

Welding	— сварка
To gear	— приспособить, направить
Consistent	— последовательный
To customize	— подгонять, переделывать
Affective	— эмоциональный, чувствительный
To endow	— наделять
A cue	— намек, сигнал
An interlocutor	— собеседник
A gaze	— взгляд, поворот головы
Off-putting	— отталкивающий, смущающий
An asset	— имущество, ценное приобретение
To infer	— делать вывод, заключение
A larynx	— гортань
Vocal folds	— голосовые связки
A windfall	— неожиданная удача, непредвиденный доход
Visceral	— внутренний, интуитивный
A spinoff	— отпочковавшаяся компания, побочный результат
A prosthesis	— протез
A genus	— вид, сорт, тип
Conformity	— послушание, подчинение
To coerce	— вынуждать, принуждать
Dwell time	— время простоя, перерыв в работе
Push-back	— ответная реакция
Concierge	— персональный ассистент, диспетчер
Panoptic	— дающий общий вид
Hard-wired	— жестко связанный, запрограммированный
Contingent	— случайный, непредвиденный
To endeavor	— прикладывать усилия, пытаться
Overarching	— всеохватывающий, комплексный
To forestall	— предвосхитить
To sidestep	— уклоняться, игнорировать

Robotics is the intersection of science, engineering and technology that produces machines, called robots, that replicate or substitute for human actions. Pop culture has always been fascinated with robots — examples include R2-D2, the Terminator and WALL-E. Each robot has a different level of autonomy. These levels range from human-controlled bots that carry out tasks to fullyautonomous bots that perform tasks without any external influences.

As technology progresses, so too does the scope of what is considered robotics. In 2005, 90 percent of all robots could be found assembling cars in automotive factories. These robots consisted mainly of mechanical arms tasked with welding or screwing on certain parts of a car. Today, we're seeing an evolved and expanded definition of robotics that includes the development, creation and use of bots that accomplish tasks like exploring the planet's harshest conditions, assisting law enforcement, streamlining surgical procedures and undertaking rescue missions.

Many aspects of robotics involve artificial intelligence; robots may be equipped with the equivalent of human senses such as vision, touch, and the ability to sense temperature. Some are even capable of simple decision-making, and current robotics research is geared toward devising robots with a degree of self-sufficiency that will permit mobility and decision-making in an unstructured environment.

Plenty of complex and sophisticated machines have failed on the market because they were not user-friendly. Any robot that will be in direct contact with people should be designed for natural, intuitive interaction. For the robotics clients, the first choice is smooth and quick performance, without overloading the system. It means that the robot should be able to provide timely responses, making sure the conversation flows smoothly, in real time, without any significant interruptions.

The robot's performance should also be consistently effective. Witnessing a robot error, permanently lowers people's trust in the robot and its reliability, even if it happens only once. Besides losing confidence in the robot, frequent errors can lead to frustration and a loss of interest in any further interactions.

So, efficient, and customizable software can help the robot achieve a human-robot interaction that feels as natural as possible. Robots designed to work with humans are bound to take human emotions into account, especially when they are directed towards the machine.

Emotional AI, also known as affective computing, is a rapidly growing field that focuses on developing machines that recognize and respond to human emotions.

Affective and emotional intelligence are often used interchangeably when discussing AI, but they refer to different things. Emotional intelligence refers to the ability of humans to understand and manage their own emotions, as well as the emotions of others.

Affective intelligence, on the other hand, refers to the ability of machines to recognize and respond to human emotions. Affective computing aims to endow machines with emotional intelligence for improving natural human-machine interaction (HMI). In the context of human-robot interaction (HRI), it is hoped that robots can be endowed with human-like capabilities of observation, interpretation, and emotion expression. This is achieved through machine learning algorithms that analyze speech, facial expressions, and other biometric data to determine a person's emotional state.

Human communication incorporates plenty of social cues — from facial expressions to body language. Detecting and reacting to such cues comes naturally to us humans. For example, we can get a good idea of how our fellow humans are feeling just by looking at their faces or listening to their voices.

On the other hand, grasping such information is quite a challenge for machines. However, combining smart computer vision — and machine learning-based algorithms can help turn robots into decent interlocutors.

Seeing Eye to Eye

Humans use eye contact to initiate and control communication. Looking at someone's eyes as they speak indicates that they have our attention and keeps the parties engaged.

Face tracking technology can help robots achieve a similar effect. Once a human face is detected, the robot can move its eyes accordingly or even approach that person in order to initiate and maintain eye contact. Such behavior helps grab people's attention, making it easier for the robot to initiate interaction.

Another step towards a more natural human-robot interaction can be achieved with *gaze tracking*. By knowing where the human is looking at, the robot can detect whether they have established eye contact. It can then use that information to start the conversation at the right time, greet the human with a friendly smile, and more.

Furthermore, gaze tracking lets the robot keep track of where the person is looking at during the conversation. This can help measure engagement, better understand people's needs, and, finally, provide more relevant information.

However, too much intense eye contact can be off-putting, even among humans. To avoid that, robots can be designed to look friendly and display human-like behavior, such as blinking, looking away occasionally, displaying specific facial expressions, and more.

Reading Human Emotions

When it comes to successful conversations, eye contact goes hand in hand with facial gestures. We raise our eyebrows when we're surprised, smile when we're happy and frown when we're angry. Such gestures are great indicators of our current mood and it's important to take them into account during the conversation. If you're wondering why, imagine someone laughing at you while you're telling them about having a really bad day.

Robots designed to work with humans are bound to face a variety of emotions, often frustration and anger. So, in order to really treat the customers well, the machines must take human emotions into account, especially when they are directed towards the machine.

Luckily, emotion estimation technology has come a long way. For example, Face Analysis developed by Visage Technologies estimates all basic human emotions — happiness, sadness, fear, surprise, anger, and disgust. Additionally, those basic emotions can be combined to detect more complex ones, such as worry or pride. In addition to emotion monitoring, Face Analysis estimates each person's age and gender as well. Combining such information can help robots interact with people in a positive and effective way.

Emotionally intelligent robots can be valuable assets in various industries. For example, they can be used as tutors for autistic children, caregivers for the elderly or mental patients in hospitals, customer service assistants in retail, and more.

Humans have a natural ability to recognize and distinguish between faces, and we rely on it heavily in our daily communication. There's a difference between how we talk to a friend and how we talk to a stranger; the information we share, the approach we take, and even our tone of voice may change depending on the person we're talking to. This helps us maintain meaningful relationships and exchange information more efficiently.

Using face recognition technology, machines can distinguish between different faces, too. While it comes naturally to us humans, it's all about math for machines. Every face has specific landmarks that can be measured, such as the distance between the eyes, the length of the jawline,

the shape of the eyebrows, and more. Together, they create a unique faceprint that can later be compared with other people until a match is found.

Face recognition gives robots a way to personalize interactions with people. It can memorize valuable information gathered during their previous interactions, such as their favorite topics or the preferred tone of communication, and use that information to personalize each interaction. For example, a robot that cares for the elderly can remind them to take their specific medicine, bring up their favorite topics when they seem sad, and more.

Everyday experiences tell us that the voice, as well as facial expressions, is an informative channel about our interlocutor emotions. We have a natural ability to infer the emotional state underlying the semantic content of what the speaker is saying. Changes in emotional states correspond to variations of organs' features, such as larynx position and vocal fold tension, thus in variations of the voice. In HRI, automatic acoustic emotion recognition (AER) has to be performed in order to allow robots to perceive human vocal affect.

As robots are becoming more capable of autonomous actions, there is a greater need to ensure that they act ethically. We want robots on highways and battlefields to act in the interests of human beings, just as good people do. But ethics is not just a matter of cold calculation, needing to take into account emotional processes such as caring and empathy. The emotional makeup of human brains makes us capable of caring about other people and understanding them empathically. So, if robots are going to be ethical in the way that people are, they need emotions.

Estimating the feasibility of making robots emotional depends on understanding what makes *people* emotional. There are currently three main theories about human emotions, based on appraisal, physiology, and social construction. The cognitive appraisal theory says that emotions are judgments about the relevance of the current situation to a person's goals. For example, if someone gives you $1 million then you will probably be happy because the money can help you to satisfy your goals of surviving, having fun, and looking after your family. Robots are already capable of doing at least a version of appraisal, for example, when a driverless car calculates the best way of getting from its current location to where it is supposed to be. If emotions were just appraisals, then robot emotions would be just around the corner.

However, human emotions also depend on physiology. Responses such as being happy to get a pile of money are tied in with physiological changes such as heartbeat, breathing rate, and levels of hormones such

as cortisol. Because robots are made of metal and plastic, it is highly unlikely that they will ever have the kinds of inputs from bodies that help to determine the experiences that people have, the feelings that are much more than mere judgments. On the theory that emotions are physiological perceptions, robots will probably never have human emotions, because they will never have human bodies. It might be possible to simulate physiological inputs, but the complexity of the signals that people get from all of their organs makes this unlikely.

The third prevalent theory of emotions is that they are social constructions, dependent on language and other cultural institutions. For example, when $1 million falls into your hands, your response will depend very much on the language with which you describe your windfall and the expectations of the culture in which you operate. If robots ever get good at language and form complex relationships with other robots and humans, then they might have emotions influenced by culture.

These three theories of emotions are complementary rather than conflicting, and the new semantic pointer theory of emotions shows how to combine them in brain mechanisms. Robots are already being built that have some of these brain mechanisms operating on neuromorphic chips, which are computer chips that mimic the brain by implementing millions of neurons. So maybe robots could get some approximation to human emotions through a combination of appraisals with respect to goals, rough physiological approximations, and linguistic/cultural sophistication, all bound together in semantic pointers. Then robots wouldn't get human emotions exactly, but maybe some approximation would perform the contributions of emotions for humans.

Which Industries are Already Using Emotion AI?

Advertising — In 2009, Rana el Kaliouby, PhD and Picard founded Affectiva, an emotion AI company based in Boston, which specializes in automotive AI and advertising research — the latter for 25 percent of the Fortune 500 companies. "Our technology captures these visceral, subconscious reactions, which we have found correlating very strongly with actual consumer behavior, like sharing the ad or actually buying the product," el Kaliouby said. In the case of advertising research, once a client has been vetted and agreed to the terms of Affectiva's use (like promising not to exploit the technology for surveillance or lie detection) the client is given access to Affectiva's technology. With a customer's consent, the technology uses the person's phone or laptop camera to capture their reactions while watching a particular advertisement.

Self-reporting — like feedback during a test group — is helpful, el Kaliouby said, but getting a moment-by-moment response allows marketers to really tell if a particular ad resonated with people or was offensive, or if it was confusing or struck a heartstring.

Call centers — Technology from Cogito, a company co-founded in 2007 by MIT Sloan alumni, helps call center agents identify the moods of customers on the phone and adjust how they handle the conversation in real time. Cogito's voice-analytics software is based on years of human behavior research to identify voice patterns.

Mental health — in December 2018 Cogito launched a spinoff called CompanionMx, and an accompanying mental health monitoring app. The Companion app listens to someone speaking into their phone, and analyzes the speaker's voice and phone use for signs of anxiety and mood changes. The app improves users' self-awareness, and can increase coping skills including steps for stress reduction. The company has worked with the Department of Veterans Affairs, the Massachusetts General Hospital, and Brigham & Women's Hospital in Boston. Another emotion AI-driven technology for mental health is a wearable device developed at the MIT Media Lab that monitors a person's heartbeat to tell whether they are experiencing something like stress, pain, or frustration. The monitor then releases a scent to help the wearer adjust to the negative emotion they're having at that moment. The BioEssence wearable detects stress or pain and releases a scent to help the wearer adjust to the negative emotion. Media Lab researchers also built an algorithm using phone data and a wearable device, that predicts varying degrees of depression.

Automotive — Hernandez, the Media Lab researcher, is currently working on a team putting emotion AI into vehicles. While much attention has been paid to safety in the environment outside of a car, inside there is a range of distractions that can impact safety. Consider a car that could tell if a driver was arguing with the passenger next to them, based on elevated blood pressure, and adjust the speed of the distracted operator. Or a sensor that signaled the steering wheel to subtly maneuver the car into the middle of the lane, after a sleep-deprived driver unknowingly is listing to the curb. Affectiva has a similar automotive AI service of its own, which monitors a driver's state and occupants' experiences to improve road safety and the occupant experience.

Assistive services — Some people with autism find it challenging to communicate emotionally. That's where emotion AI can be a sort of "assistive technology," Hernandez said. Wearable monitors can pick up on

subtleties in facial expressions or body language in someone with autism (like an elevated pulse rate) that others might not be able to see. Hernandez said there are also "communicative prostheses" that help autistic people learn how to read other's facial expressions. One example is a game in which the person uses the camera on a tablet to identify "smiley" or "frowny" faces on the people around them. "That is a way for them to engage with other people and also learn how facial expressions work," Hernandez said, adding that this video technology that measures moods in "smiley" or "frowny" faces could work for customer feedback in crowded theme parks or hospital waiting rooms, or could be used to provide anonymous feedback to upper management in a large office.

Is Emotion AI Something to Welcome or to Worry about?

Like most AI technologies, affect recognition devices promise to augment and enhance daily existence of a human. But as a far more invasive genus of surveillance capitalism, the technological adoption of emotional AI is problematized by a myriad of legal, ethical, cultural, and scientific issues.

First, is the technology's reliance on stealth data tracking, which may lead to unethical or malicious misuse. Affect tools are designed to harvest intimate data from an individual's subjective state without necessarily their awareness or permission. For example, emotion-sensing devices in the workplace may lead to bias or discrimination against a worker for their lack of 'attitudinal conformity'. In turn, affect-sensing tools may lead to emotional policing, coercing a worker to always be happy, authentic, and positive. At the same time, they diminish their ability to backstage their feelings as well as foment higher levels of anxiety, stress, and resentment. Similarly, affect tools in automobiles may lead to unfairly higher car or health insurance premiums. Concomitantly, in commercial settings, individuals may be exposed to empathic surveillance without their knowledge and depending on country, consent. For instance, AdMobilize links their AI-driven software to public transit security cameras which then monitor audience responses to interactive ads. Besides analyzing gender, age, and dwell time, the software uses facial analysis to detect micro-expressions of surprise, happiness, discontent, and neutrality. The goal of AdMobilize's affect tools is to assess ad performance and customer engagement.

Second, are cultural tensions arising from these emotional AI technologies crossing national and cultural borders. Although emotion-sensing technologies are predominantly designed in the West, they are being sold

to a global marketplace. Problematically, as these devices cross international borders, their algorithms are seldom tweaked for racial, cultural, ethnic, or gender differences. A growing body of research shows that AI models that do not allow for difference or diversity can lead to unintentional bias or false positive identification, negatively impacting a target individual. This problem is further compounded by the lack of international consensus on the values and ethics that should be encoded into intelligent machines as well as cross-cultural incongruences arising from a country's legal understanding of privacy. For instance, while facial recognition and social credit systems are banned in many Western countries, China faces far less push-back because the notion of collective security is valued more than individual privacy. Additionally, Chinese citizens are found to show greater trust in government-sponsored data collection than their Western counterparts.

Third, is the lack of industry standard. Like the hidden data-gathering activities of many smart technologies, emotional AI will be far harder to collectively regulate as it is being developed as a proprietary layer in many products. A prime example is the automotive industry. Companies, such as Ford, Porsche, Audi, Hyundai, Toyota, Honda, BMW, Volkswagen, and Jaguar, in the name of safety and comfort enhancement, are developing in-cabin concierge systems that can track and respond to the emotional states of drivers. This means that algorithmic transparency and collective standards for non-conscious biometric data collection will not occur for some time.

Fourth, existing ethical frameworks for emotional AI are often vague and inflexible. This is due to various businesses in different cultural settings having differing rationales or goals for adoption of the new technology. For example, the Japanese voice analytics company, Empath, sees the technology as a way for call centers to optimize workplace productivity by providing supervisors with a panoptic window into the subjective state of each member of their customer service team. On the other hand, Moodbeam's emotion bracelet offers companies an alternative to the far more administrative and costly worker wellness programs. As the company's promotional literature suggests, wearing the affect-sensing bracelet will enable workers to automatically share data of their subjective state with both managers and co-workers. Besides varying objectives for adoption comes the practical limitations of implementation and establishment of concrete metrics for measuring the technology's effectiveness. But ensuring the efficacy of emotional AI technology requires having full-time staff skilled in data analytics and data management. Yet

many companies are implementing emotion-recognition systems without personnel skilled in data analytics and data management experts.

Last, but not least, comes the shaky science of the emotion-recognition industry. A growing number of critics argue how emotions can be made computable when the science community cannot agree on exactly what emotions are, how they are formed or how they manifest themselves. Are emotions hard-wired into the psycho-physical makeup of an individual or socially and culturally contingent? Pushing back against these arguments are the engineers who insist emotions are computable, and that any limitations in diversity or cultural affordance will ultimately be solved by better algorithms.

As emotional AI becomes more pervasive in society, it will have profound impacts on the daily lives of citizens. Technology that endeavors to make transparent the inner recesses of a person's being raises critical questions about data privacy in public spaces, empathic monitoring and control as well as how regulatory mechanisms should best ensure the best interests of society. Thus, this essay provides an overarching framework for discussion of the social, legal, and ethical implications of emotional AI technology. The five major tensions highlighted in this article must be thoroughly addressed in order for individuals to live well and ethically in this new era of human–machine relations.

The worries about the future of humanity still remain, as robots and intelligent computers become more prominent. One of the main concerns about the possibility of fully intelligent and independent robots is that they may act only in their own interests and therefore become harmful to humans. Building robots capable of caring about us might be one way of forestalling technological disaster. Unfortunately, by that time robots will be building robots, and they may prefer to sidestep emotions in favor of their own unpredictable goals.

Notes:

R2-D2 is a fictional robot character in *the Star Wars*

Wall-E is a small animated waste-collecting robot from American animated science- fiction film

Visage Technologies is a private company (Sweden) that produces computer vision software for face tracking and *face analysis*

Affectiva (Boston) is the global leader in Artificial Emotional Intelligence

Cogito is an innovative platform that combines emotion and conversation AI to provide real-time AI-coaching and guidance for contact centers

The BioEssence wearable gadget is developed by the MIT Media Lab. It uses variations in heart rate to detect pain, stress, and aggravation

AdMobilize is an audience verification company anonymously measuring audience impressions, giving audience experience feedback on any new content or advertising.

Exercises:

1. Give Russian equivalents to the following words and phrases:

To streamline surgical procedures; current robotics research is geared toward; timely responses; to be consistently effective; to endow machines with emotional intelligence; eye to eye; too much contact can be off-putting; a caregiver; to have specific landmarks; to create a unique faceprint; to infer the emotional state; vocal fold tension; the emotional makeup of human brains; complementary theories; to vet a client; to strike a heartstring; cross-cultural incongruences.

2. Translate the extracts from the texts into Russian:

1. As technology progresses, so too does the scope of what is considered robotics.

2. These robots consisted mainly of mechanical arms tasked with welding or screwing on certain parts of a car.

3. Today, we're seeing an evolved and expanded definition of robotics that includes the development, creation and use of bots that accomplish tasks like exploring the planet's harshest conditions, assisting law enforcement, streamlining surgical procedures and undertaking rescue missions.

4. Current robotics is geared toward devising robots with a degree of self-sufficiency that will permit mobility and decision-making in an unstructured environment.

5. Affective computing aims to endow machines with emotional intelligence for improving natural human-machine interaction (HMI).

6. Emotionally intelligent robots can be valuable assets in various industries. For example, they can be used as tutors for autistic children, caregivers for the elderly or mental patients in hospitals, customer service assistants in retail.

7. In HRI, automatic acoustic emotion recognition (AER) has to be performed in order to allow robots to perceive human vocal affect.

8. The emotional makeup of human brains makes us capable of caring about other people and understanding them empathically. So, if

robots are going to be ethical in the way that people are, they need emotions.

9. The cognitive appraisal theory says that emotions are judgments about the relevance of the current situation to a person's goals.

10. Self-reporting — like feedback during a test group — is helpful, el Kaliouby said, but getting a moment-by-moment response allows marketers to really tell if a particular ad resonated with people or was offensive, or if it was confusing or struck a heartstring.

3. Give English equivalents to the following words and phrases:

Влияние извне; дать задание, поручить сварку частей машины; приводить к разочарованию; настраиваемое программное обеспечение; использовать взаимозаменяемо; наделить машины эмоциональным интеллектом; включать в себя…; слишком пристальный визуальный контакт; моргать; технология оценки эмоций; эмоции собеседника; уловить человеческие эмоции; преуспеть в какой-то области; повысить самосознание пользователя; свернуть на обочину (тротуара); вспомогательная технология.

4. Answer the following questions:

1. Why can plenty of even complex and sophisticated robots fail on the market?
2. How does emotional awareness contribute to the development of HRI?
3. What social cues does human communication incorporate?
4. What is the difference between emotional intelligence and affective intelligence?
5. How do face tracking and gaze tracking technologies complement each other?
6. What is the role of voice in detecting the emotions?
7. What can be the affective intelligence's applications?
8. What are the potential problems of emotional intelligence adoption?

5. Translate from Russian into English:

Понимает ли искусственный интеллект сарказм: ответ ученых

Да, но только те модели, которые считывают контекст.

Большие языковые модели (LLM) — это усовершенствованные алгоритмы глубокого обучения, которые могут анализировать под-

сказки на различных языках, впоследствии генерируя реалистичные ответы. Далеко за примерами ходить не нужно — ChatGPT может быстро отвечать на широкий спектр пользовательских запросов и генерировать убедительные письменные тексты для различных целей.

Ученые из Нью-Йоркского университета провели исследование, чтобы оценить эффективность двух языковых моделей, обученных распознавать сарказм у людей, сообщает TechXplore.

Некоторые ИИ-модели могут выявить сарказм.

Анализ настроений — это область исследований, которая включает в себя анализ текстов, обычно публикуемых в социальных сетях или других веб-сайтах. Это позволяет получить представление о том, как люди относятся к определенной теме. Сегодня многие компании инвестируют в эту область, поскольку это может помочь им понять, как они могут улучшить свои услуги и удовлетворить потребности клиентов.

Существует несколько моделей, которые могут обрабатывать тексты и предсказывать их основной эмоциональный тон. Однако многие обзоры и комментарии, размещенные в интернете, содержат иронию и сарказм, что может заставить моделей классифицировать их как «положительные», хотя на самом деле они выражают отрицательные эмоции, или наоборот.

Поэтому ученые пытаются разработать модели, которые смогут обнаружить сарказм в письменных текстах. Две из наиболее многообещающих моделей, названные CASCADE и RCNN-RoBERTa, были представлены в 2018 году отдельными исследовательскими группами.

Ученые провели серию тестов, направленных на оценку способности модели CASCADE и RCNN-RoBERTa обнаруживать сарказм в комментариях, размещенных на Reddit, известной онлайн-платформе, которая обычно используется для оценки контента и обсуждения различных тем. Способность этих двух моделей выявлять сарказм в выборочных текстах также сравнивалась со средней производительностью человека при выполнении той же задачи и с производительностью нескольких базовых моделей для анализа текстов.

Исследование показало, что контекстная информация, такая как встраивание личности пользователя, может значительно улучшить производительность модели.

Эти результаты будут способствовать разработке больших языковых моделей, которые лучше распознают сарказм и иронию в че-

ловеческом языке. Такие модели могут в конечном итоге оказаться ценными инструментами для быстрого анализа настроений онлайн обзоров, публикаций и другого пользовательского контента.

6. Summarize the text and express your own opinion. Here are some statements to support:

1. The progress of robotics, its potential gains and losses.
2. Computer vision- and machine learning-based algorithms and their role in the development of HRI.
3. Face recognition technology and emotional AI.
4. Prospective spheres of application for affective intelligence.
5. Quirks and perks of affective intelligence.

7. Develop the following ideas in writing an essay (120–150 words):

1. One of the most significant benefits of artificial intelligence is that it can significantly reduce errors and increase accuracy and precision. The decisions taken by AI in every step are decided by information previously gathered and a certain set of algorithms. When programmed correctly, these errors can be reduced to null.

2. On of the noted pros of AI is decision-making. AI enhances decision-making by leveraging vast data to identify patterns and trends often invisible to humans. Machine learning algorithms can analyze historical data and predict future outcomes, allowing businesses and individuals to make informed decisions quickly and accurately. AI's ability to process information at high speeds reduces the time required for decision-making, thus providing a competitive advantage in dynamic environments.

Appendix 1

Additional Vocabulary

Составители К. В. Воронцов, С. И. Гуров

ГОВОРИ ПО-РУССКИ

Краткий англо-русский Словарик терминов и аббревиатур, обычно вызывающих наибольшие трудности при переводе на русский язык у лиц, начинающих знакомиться с тематикой искусственного интеллекта (ИИ), машинного обучения (МО) распознавания образов (РО) и смежных областей.

A/B testing — A/B тестирование: статистический способ сравнения тестового (A) и контрольного (B) подходов для выявления лучшего.

Ablation — абляция: маш. обуч. удаление; метод оценки важности функции или компонента модели путем временного его удаления их из модели.

Accelerator chips (accelerators) — чипы-ускорители: аппаратные компоненты, предназначенные для ускорения наиболее трудоемких вычислений алгоритмов глубокого обучения (тензорные, графические процессоры и др.).

Accuracy — правильность: доля (TP+TN)/(TP+TN+FP+FN) правильно классифицированных объектов.

Active Learning — активное обучение: подход к машинному обучению, при котором алгоритм выбирает объект, чтобы спросить у учителя данные, на основе которых он будет далее обучаться.

AP, Average Precision — средняя точность.

ARHR, Average Reciprocal Hit-Rank — рекоменд. сист.: средний взаимный рейтинг попадания.

Assessor — оценщик: маш. обуч. эксперт, оценивающий качество ответа модели или размечающий правильный ответ на объекте.

Attention, attention mechanism, attention model — механизм внимания: модель, оценивающая важность элементов, находящихся в контексте (в окрестности) анализируемого элемента; техника, используемая в глубоких нейросетевых моделях сложно

структурированных данных (текстов, изображений, сигналов, графов).

AUC, Area Under Curve — площадь под кривой.

AUC-ROC — площадь под ROC-кривой ошибок.

Augmentation — аугментация: маш. обуч. пополнение, искусственное создание новых прецедентов как слегка измененных копий существующих.

Autoencoder — автокодировщик: модель, обучающаяся извлечению наиболее важной информации (обычно в виде числового вектора) из входных данных; состоит из кодера и декодера.

AutoML — автоматизированное машинное обучение: автоматизированный процесс для построения моделей машинного обучения (подготовка данных, настройка гиперпараметров, планирование экспериментов и др.).

Average-pooling — объединение по среднему значению: обр. изобр. замена прямоугольного блока изображения средним значением по блоку для снижения размера изображения.

Axis-aligned condition — обр. изобр. прямое условие в дереве решений, включающее только один объект.

Backpropagation — обратное распространение [ошибки]: алгоритм, реализующий обучение ИНС методом градиентного спуска.

Bagofwords — мешок слов: обр. текста представление слов во фрагменте текста, независимо от их порядка.

Baseline — базовый уровень: маш. об. общеизвестный метод, модель или программная реализация решения данной задачи.

Batch — пакет (группа, пачка, набор) данных, подающихся в модель одновременно.

Benchmark — ориентир, контрольный показатель: маш. об. методика тестирования, основанная на сравнении результатов нескольких моделей на одном или нескольких наборах данных.

BERT, Bidirectional Encoder Representations from Transformers — двунаправленный кодировщик на основе трансформера: модель контекстно-зависимого векторного представления текста, использующаяся на основе архитектуры у трансформера.

Bias — величина смещения, смещенность, предвзятость.

Bound — граница.

Breakeven point — точка баланса, (то же, что R-precision).

CAE, Contractive Auto-Encoders — сжимающие автокодировщики: алгоритмы регуляризации при построении признаков на обучающих выборках.

Case — прецедент, объект выборки.

CASE, Computer-Aided Software Engineering — набор инструментов и методов для проектирования программного обеспечения.

CD, Contrastive divergence — алгоритм обучения RBM с целью нахождения оптимальных весов матрицы связей между слоями.

CDF, Cumulative density function — функция вероятности того, что случайная величина примет значение, меньшее или равное данному значению.

CEC, Constant error carousel — карусель константной ошибки: алгоритм контролирования распространения ошибок при настройке ИНС.

Characteristic — характеристика, признак.

Children of a node — дочерние вершины, непосредственные потомки (в графах, древовидных структурах).

Cluster matching — сопоставление кластеров.

CNN, Convolution Neural Network — сверточная ИНС: архитектура ИНС, для обработки сложно структурированных данных (обычно — изображений), основанная на локальном усреднении или других способах сворачивания элементов данных по локальным окрестностям.

Coherence — однородность (элементов изображения).

Confusion matrix — матрица ошибок.

Congruencing — согласованность: обр. изобр. сравнение, совмещение изображений.

Convolution — свертка: обр. изобр. специальная операция над парой квадратных матриц A (изображение) порядка n и B (фильтр) порядка m, $n > m$.

Credit Assignment Path (CAP) — путь передачи ответственности: цепочка преобразований ответственности (credit assignment path) от входа к выходу ИНС.

Credit assignment — присвоение коэффициентов доверия (правилам экспертной системы).

Cross-entropyloss — кросс-энтропийная функция потерь, то же, что LogLoss.

Cumulative density function, CDF — функция плотности вероятности.

Data Mining — интеллектуальный анализ данных.

Dataset — выборка, набор данных.

Decision forest — решающий лес, лес решающих деревьев: маш. обуч. ансамбль решающих деревьев, полученный путем простого голосования.

Decision list — решающий список, также комитет старшинства: частный случай решающего дерева с единственной ветвью.

Decision stump — решающий пень: частный случай решающего дерева, в котором корневая вершина оказывается терминальной.

Decision table — решающая таблица, также небрежное решающее дерево (oblivious decision tree): частный случай сбалансированного решающего дерева, в котором все внутренние вершины одного уровня содержат одно и то же условие ветвления.

Decision tree — дерево принятия решений, дерево решений, решающее дерево.

Deep belief networks — глубокая сеть доверия: тип глубоких ИНС, в которых нейроны скрытых слоев только с нейронами соседнего слоя, но не друг с другом.

Deep Learning — обучение глубоких ИНС; отличается от классических методов машинного обучения (shallow learning) тем, что (а) применяется к сложно структурированным данным, (б) основная масса слоев, за исключением нескольких последних, образует обучаемую модель векторизации данных, (в) это позволяет полностью автоматизировать конструирование признаков (feature engineering) за счет конструирования архитектуры сети (architecture engineering).

Deep neural network — глубокая нейронная сеть, см. Deep Learning.

Denoising score matching — сглаживающее сопоставление баллов: стат. метод оценки плотности вероятности, основанной на добавлении шума к входным данным с последующим шумоподавлением.

Denoising — шумоподавление: маш. обуч. подход в самообучении, при котором в набор данных искусственно добавляется шум, а модель учится его устранять.

Detection — выявление: обр. изобр. обнаружение объектов на изображении.

Dictionary Learning — обучение словаря: метод анализа данных, состоящий в поиске набора базовых элементов (линейная комбинация которых составляет словарь), наилучшим образом представляющего вектор данных.

Dilated convolution — обр. изобр. расширенная свертка.

Distance — метрика, расстояние, функция расстояния.

Distillation — маш. обуч. процесс уменьшения размера модели («учитель») до модели меньшего размера («ученик»), которая максимально точно имитирует предсказания исходной модели.

Dither — обр. изобр. размывание.

DL, Deep Leaning — глубокое обучение: машинное обучение с использованием ИНС со многими скрытыми слоями.

Downsampling — субдискретизация, понижающая выборка: метод обработки данных, используемый для уменьшения степени детализации данных временных рядов.

Dropout — отсев: маш. обуч. метод регуляризации ИНС, основанный на отключении случайно выбранных нейронов во время обучения.

Edge — граница: обр. изобр. яркостный переход, контур, граница области изображения.

Embedding — встраивание, вложение: маш. об. векторное представление нечисловых данных в ИНС.

EMD, Earth Mover's Distance — (дословно: расстояние между землеройными машинами) показатель относительного сходства между двумя документами; чем оно меньше, тем более похожи документы.

End-to-end — обучение технология, при которой на вход ИНС поступают необработанные исходные изображения, а на выходе получают готовые ответы.

ERM, Empirical Risk Minimization — минимизация эмпирического риска: способ обучения, нахождения оптимальных значений параметров модели, при которых функционал средних потерь на объектах обучающей выборки, называемый эмпирическим риском, принимает наименьшее значение.

Explaining Away — эффект оправдания, редукции причины: метод настройки весов ИНС, заключающийся в выборе из множества причин способных вызвать наблюдаемое явление какой-то одной.

F1-score, Fβ — F-оценка, среднее гармоническое точности и полноты с весом точности β.

Feature cross — синтетический объект, образованный путем «пересечения» категориальных или групповых объектов.

Feature engineering — конструирование признаков: общий термин для различных методов выделения, генерации, обучения, преобразования и отбора признаков.

Feature extraction — выделение признаков из сложно-структурированных данных (изображения, тексты, сигналы, транзакции, графы и др.).

Feature generation — генерация признаков: автоматическое или полуавтоматическое порождение большого числа признаков, из которых затем придется отобрать наиболее информативные.

Feature learning — обучение признаков: построение признаков как функций с параметрами, которые оптимизируются по данным.

Feature selection — выбор информативных признаков.

Feature transformation — преобразование признаков: построение новых признаков как функций над исходными признаками.

Feature — 1) признак; 2) полезное свойство, особенность, возможность.

Few-shot learning — постановка задачи обучения классификации с учителем Zero-shot learning при небольшом числе примеров.

FFN, Feedforward Neural Network — искусственная ИНС прямого распространения, без циклических или рекурсивных связей.

Fine tuning — дообучение.

FN, False Negative — маш. об. число объектов, ошибочно отнесенных к отрицательному классу, стат. ошибка II-го рода, воен. пропуск цели.

FP, False Positive — маш. об. число объектов, ошибочно отнесенных к положительному классу, стат. ошибка I-го рода, воен. ложная тревога.

FPR, False Positive Rate — доля неверно классифицированных объектов, FP/(FP+TN).

Framework — подход, инструментарий, программная платформа, упрощающая разработку программного продукта.

Fully connected — полносвязная [ИНС].

Gain — выигрыш.

GBT, Gradient Boosted (decision) Trees — линейная композиция (взвешенное голосование) деревьев принятия решений, обучаемая методом градиентного бустинга.

Generalization ability — обобщающая способность: свойство модели машинного обучения восстанавливать общую закономерность по выборке эмпирических данных.

Generalization performance — количественная оценка обобщающей способности модели машинного обучения.

Generative AI — генеративная модель ИИ, способная создавать реалистичные (фейковые) сложно структурированные данные, в частности, тексты, изображения, аудио- или видео-контент.

GOFAI, Good Old-Fashioned Artificial Intelligence — старый добрый искусственный интеллект: классический ИИ в отличие от более современных подходов (ИНС, робототехника и др.).

Group Method of Data Handling — метод группового учета аргументов (МГУА): семейство индуктивных алгоритмов для математического моделирования мультипараметрических данных.

Hallucination — галлюцинация: маш. обуч. создание правдоподобных, но на самом деле неверных выходных данных с помощью генеративной модели ИИ.

Handcrafted features — признаки, конструируемые исследователем (см. Feature engineering).

Herd — маш. обуч. группировка данных.

Hold-out — оценка обобщающей способности, вычисляемая по экзаменационной (тестовой) выборке для модели, обученной по другой, независимой от нее обучающей выборке.

HR, Hit-Rate — рекоменд. сист. коэффициент попадания.

Hyperparameter tuning — оптимизация гиперпараметров, этап в процессе разработки моделей МО.

i. i. d., independent and identically distributed [random variables] — независимо и одинаково распределенные [случайные величины].

Independent Subspace Analysis — анализ независимых подпространств.

IoU, Intersection Over Union — пересечение над объединением: мера (|A∩B|)/(|A∪B|) совпадения (близости) множеств A и B как доля общих элементов в них, мера Жаккара (Paul Jaccard).

Items — рекоменд. сист. объекты (продукты, изделия), которые рекомендует система.

Kernel Machine — класс алгоритмов распознавания образов; к нему относится является метод опорных векторов (SVM, см.).

KSVMs, Kernel Support Vector Machines — алгоритм классификации, который стремится максимально увеличить зазор (margin) между классами путем отображения векторов входных данных в пространство более высокой размерности.

Label — метка, класс, метка класса.

LCC, Local Coordinate Coding — алгоритм локального кодирования координат.

Leave-one-out — оценка обобщающей способности, вычисляемая путем усреднения по всем объектам выборки величины потери для модели, обученной по всей выборке кроме данного объекта.

Lift — маш. об. прирост.

LogLoss, Logistic Loss — логистическая функция потерь, кросс-энтропийная функция потерь.

Loss — потеря, функция потерь: маш. об. количественная мера неточности предсказания модели на отдельном объекте.

LSTM, Long short-term memory — долгая краткосрочная память: длинная цепь элементов краткосрочной памяти, способная к обучению долговременным зависимостям, разновидность архитектуры RNN.

MAE, Mean Absolute Error — средняя абсолютная ошибка.

Manifold Tangent Classifier — классификатор на базе касательных пространств многообразий.

MAPat K, Mean Average Precision at K, map@K — усредненная средняя точность на K элементах, среднее арифметическое средней точности, принимающая значения от 0 до 1.

Margin — зазор. отступ: маш. об. расстояние между классами.

Matching — сопоставление, сравнение, напр. изображений с эталоном, с другим изображением.

Max-pooling — максимальное объединение в пул: обр. изобр. снижение размера изображения, состоящее в замене прямоугольного блока изображения максимальным значением в нем.

MCMC — методы Монте-Карло с Марковскими цепями.

Meta-learning — метаобучение: задача МО, в которой объектами являются эксперименты по применению методов машинного обучения к различным наборам данных.

Metric — критерий.

ML, Machine Learning — машинное обучение.

MLE, Maximum Likelihood Estimation — оценка максимального правдоподобия.

MNIST — открытый набор рукописных начертаний цифр от 0 до 9 (около 60 000 изображений).

Model capacity — сложность модели, число параметров, или емкость (VC-размерность) модели.

Model Evaluation Metric — метрика оценки модели, характеристика качества модели МО: например, F1-мера, AUC-ROC, среднеквадратичная ошибка (MSE), средняя абсолютная ошибка (MAE) и др.

MSE, Mean Squared Error — средняя квадратичная ошибка.

NaN-trap, NaN-ловушка — при которой во время обучения одно число модели становится NaN (NoNumber, Не Числом), что приводит к тому, что многие или все остальные числа становятся NaN.

NAS, Neural Architecture Search — поиск по нейронной архитектуре, метод автоматического проектирования архитектуры ИНС.

NCE, Noise Contrastive estimation — метод оценки параметров для моделей NLP сравнением с шумом, позволяет сократить вычислительные затраты.

nDCG, normalized Discounted Cumulative Gain — рекоменд. сист., поиск. сист. нормализованный дисконтированный суммарный выигрыш: распространенная метрика качества ранжирования.

Nearest neighbor graph — граф ближайших соседей.

N-gram — N-грамма: обр. текста упорядоченная последовательность из N слов.

NLP, Natural Language Processing — направление ИИ, связанное с обработкой естественного языка.

Non-maximum suppression — не-максимальное подавление: обр. изобр. алгоритм фильтрации, устраняющий дублирующие гипотезы определения положения объекта.

Oblique condition — линейная разделяющая поверхность: линейный классификатор, используемый в качестве условия ветвления во внутреннем узле дерева решений.

Oblivious decision tree — см. Decision table.

Occlusion — обр. изобр.: наложение одних частей сцены на другие.

Offline inference автономный вывод, при котором создается и сохраняется пакет прогнозов.

One-shot learning — вариант постановки задачи обучения классификации с учителем Zero-shot learning, когда допускается один обучающий пример.

One-vs-all — «один против всех»: метод построения классификатора в задачи со многими классами, состоящий в последовательном решении задач отделения каждого класса от остальных.

OOBevaluation, Out-Of-Bag evaluation — самостоятельная несмещенная оценка обобщающей способности: метод оценивания качества леса деревьев принятия решений.

Outlier — выброс.

Outlier detection — обнаружение объектов-выбросов, имеющих аномально большие отклонения от основной массы объектов обучающей выборки.

Overfitting — переобучение, переподгонка: маш. об. явление избыточно точной аппроксимации моделью МО объектов обучающей выборки в ущерб точности восстановления зависимости на всем пространстве объектов.

Oversampling — метод избыточной выборки: увеличение размера малочисленного класса.

Parameterized transformation — параметризованное преобразование.

Parametric mapping — параметрическое отображение: стат. метод получения информации о топологических свойствах статистических процессов на основе теории случайных полей.

Patch — «заплатка»: прогр. программное средство, используемое для устранения ошибок или изменения ПО; обр. изобр. область изображения.

PCA, Principle Component Analysis — анализ главных компонент; факторный анализ.

Perplexity — перплексия: стат. безразмерная величина, мера того, насколько хорошо распределение вероятностей предсказывает выборку.

Policy gradient — в обучении с подкреплением: градиентный метод оптимизации стратегии (обычно как параметрического вероятностного распределения на множестве действий) агента.

Policy — маш. об. стратегия.

Pooling — объединение: операция объединения или агрегирования в сверточных ИНС; реализуется как необучаемый слой нейронов и используется для уменьшения размеров входного представления сложно структурированного объекта (изображения, сигнала, текста).

PR-curve, Precision-Recall Curve — PR-кривая (в осях «точность-полнота»).

Precision — точность [поиска]: доля TP/(TP+FP) релевантных объектов среди найденных.

Precision@k — значение точности поиска (Precision), если считать найденными только первые k элементов поисковой выдачи.

Probability density function, PDF — функция плотности вероятности.

Prompt Engineering — инженерия (конструирование) подсказок: методика составления запросов к генеративной модели текста, изображений или других сложно структурированных данных.

Proposal — гипотеза: обр. изобр. выделяемая область изображения, в которой предположительно находится искомый объект.

PSD, Predictive Sparse Decomposition — прогнозирующая разреженная декомпозиция: обр. изобр. метод одновременной оптимизации функции потерь и базовых функций матрицы изображения.

Ratio matching — соответствие отношений: стат. метод оценки плотности вероятности.

RBM, Restricted Boltzmann Machine — ограниченная машина Больцмана, вид стохастической рекуррентной ИНС.

R-CNN, Region Convolution Neural Network — нейронная сеть местной свертки, одна из первых структур ИНС для нахождения объекта на изображении.

Recall — полнота [поиска]: доля TP/(TP+FN) найденных объектов среди релевантных.

Recall@k — значение полноты поиска (Recall), если считать найденными только первые k элементов поисковой выдачи.

Recurrent neural network, RNN — рекуррентная нейронная сеть: вид ИНС с циклическими связями, когда выходное значение нейрона последующего слоя может передаваться на вход нейронов предыдущих слоев.

Reinforcement Learning, RL — обучение с подкреплением.

Reject a pattern — отказ от классификации объекта, образа.

ReLU, Rectified Linear Unit выправленная линейная функция: функция активации, равная 0 для отрицательного аргумента и линейная с коэффициентом 1 для положительного.

Representation learning — обучение модели, способной генерировать по объекту его представление (как правило, векторное) и обладающее требуемыми свойствами.

Re-ranking — повторное ранжирование, заключительный этап работы рекомендательной системы, на котором производится повторное оценивание элементов каким-либо другим алгоритмом.

Reward — награда, премия в обучении с подкреплением.

Reward Signal — сигнал вознаграждения (подкрепления) нейрона в ИНС.

RMSE (RMSD), Root-Mean-Square Error (Deviation) — среднеквадратическая ошибка (отклонение), квадратный корень из среднеквадратичной ошибки прогноза.

ROC, Receiver Operating Characteristic curve — рабочая характеристика приемника: кривая ошибок., график в осях X:FPR-Y:TPR.

R-squared, R-квадрат — коэффициент детерминации, показывающий, насколько регрессионная модель лучше приближает данные по сравнению с простейшей моделью — средним арифметическим данных.

Score — оценка, сумма.

Self-supervised learning — самостоятельное обучение: постановка задачи МО, когда вместо предсказания ответов на объектах (обучения с учителем, supervised learning), модель учится предсказывать внутреннюю структуру объекта.

Semi-supervised learning — частичное обучение: постановка задачи машинного обучения, занимающая промежуточное положение между обучением с учителем (supervised learning) и обучения без учителя (unsupervised learning), когда ответы учителя имеются только на подвыборке объектов, как правило, относительно небольшой.

Sequence Data Processing — обработка последовательных данных.

Shallow Learning — поверхностное (неглубокое) обучение: классические методы МО, противопоставляемые глубоким ИНС (deep learning) и отличающиеся от них в следующих аспектах: (а) применяется к объектам с векторными признаковыми описаниями, (б) не имеют нейросетевой архитектуры, (в) а если и имеют, то число слоев не превосходит трех.

Shrinkage — усадка: маш. обуч. регуляризация в линейной модели классификации или регрессии, приводящая к сжатию вектора коэффициентов, снижает влияние мультиколлинеарности и контролирует переобучение.

Similarity function — функция близости (сходства).

Sketching — создание эскизов, предварительный анализ сходства на примерах.

Smoothed n-gram models — обр. теста сглаженные n-граммные модели.

Softmax function — функция мягкого максимума.

SOTA, State-Of-The-Art — высшее достижение, рекорд, рекордный уровень.

Sparsity — разреженность: доля элементов, равных нулю в векторе или матрице.

Spike-and-Slab regression — точечная регрессия, один из вариантов байесовской линейной регрессии.

Spiking neuron — импульсный нейрон

SPMD, Single ProgramMany Data — одна программа / много данных.

Stacked Auto-Encoders — многоуровневые автоэнкодеры: тип алгоритма глубокого обучения, состоящий из нескольких уровней разреженных автоэнкодеров (autoencoders), в которых выходы каждого уровня подключены к входам следующего уровня.

Stochastic Maximum Likelihood — алгоритм стохастической максимизации правдоподобия

Subsampling — подвыборка.

Subsumption — категоризация, отнесение к классу.

Supervised learning — обучение с учителем.

Support Vector Machine, SVM — метод (не машина!) опорных векторов.

Temperature — маш. об. гиперпараметр, который контролирует степень случайности выходных данных модели.

Tensor — тензор: маш. об. многомерные структуры данных в программах TensorFlow (векторы, матрицы и др.).

Test set — проверочная (тестовая) выборка объектов распознавания, используется только финального однократного несмещенного оценивания.

tf.Example, tf(TensorFlow) — буфер протокола для описания входных данных.

Threshold — порог.

Time-Delay Neural Network — нейронная сеть с временной задержкой.

TN, True Negative — маш. об. число объектов, правильно отнесенных к отрицательному классу; воен. правильное необнаружение.

Token — символ: маш. об. опознавательный знак, характерный объект: лекс. анализ. последовательность символов, соответствующая лексеме.

Tower — маш. об. компонент глубокой ИНС, который сам по себе является глубокой ИНС без выходного слоя.

TPR, True Positive Rate — доля TP/(TP+FN) правильно классифицированных объектов положительного класса.

TPU, Tensor Processing Unit — модуль тензорной обработки.

Training set — обучающая выборка.

Training — обучение.

Transformer — трансформер: маш. об. архитектура глубокой ИНС для анализа сложно структурированных данных (текстов, изображений, сигналов, графов), в которых каждый объект состоит из взаимосвязанных элементов.

Undersampling — метод недостаточной выборки: уменьшение мощности наиболее мощного (доминирующего) класса.

Validation set — проверочная выборка: используется для выбора лучшей модели (model selection).

Validation — проверка на проверочной выборке (validation set): несмещенная оценка качества модели на независимой выборке данных. Отличается от тестовой выборки (test set) тем, что по проверочной выборке может осуществляться выбор лучшей модели (model selection) или подбор гиперпараметров модели, в то время как тестовая выборка используется только для финального однократного несмещенного оценивания.

Variance — разброс, дисперсия.

WALS, Weighted Alternating Least Squares — взвешенный поочередный метод наименьших квадратов.

Weight decay — сокращение веса.

Word embedding — представление слова как элемента линейного векторного пространства.

Zero-shot learning — постановка задачи обучения классификации с учителем, когда в тестовой выборке могут появиться объекты новых классов, для которых в обучающей выборке не было ни одного примера.

Appendix 2

Translate into English

IT и телекоммуникации

В начале 60-х годов кибернетики предсказывали, что через 20 лет компьютеры станут умнее человека. Ожидалось, что машины с искусственным интеллектом будут строить города на Марсе и разрешать кризисы семейной жизни. Неудача первых попыток сконструировать ИИ привела к наступлению так называемой ИИ зимы. Что делать, если наши ожидания были обмануты. Вероятно, они были ложны. Компьютер никогда не сможет весело беседовать с нами на фуршетах. Но круиз-контроль в автомобилях, маршрутизация электронной почты на серверах, персонализация рекламы и новостных подборок — примеры действующего искусственного интеллекта!

Аэропорты представляют собой место, где наиболее сложно реализовать задачу распределения ресурсов. Самолеты могут задерживаться, одна проблема накладывается на другую — и вместе они составляют невообразимую мозаику. Программы компании Ascent представляют собой некоего осьминога с тысячью лап, который будет перемещать детали этой мозаики до тех пор, пока они не сложатся в осмысленную картину. Все перечисленное называют логистикой. Если с задачей справиться не удается, то приходится подключать к делу алгоритмы естественного отбора ИИ и прокручивать различные неординарные сценарии до тех пор, пока самолеты не будут заправлены и улетят по назначению.

Интуиция, казалось бы, абсолютно человеческая, а не машинная черта, но оказывается, и ее можно достаточно успешно компьютеризировать. В основе любого предвидения лежат события или наблюдения, хранящиеся в недрах нашего опыта. Хороший врач отличает аппендицит от боли в животе по десятку признаков. Если ввести его знания в компьютер, получается экспертная система — одна из тех, что успешно анализируют заболевания крови и отыскивают опухоли на рентгенограммах. Программа FocalPoint, разработанная компанией TiPath Imaging, отыскивает следы опухолей на основе пяти миллионов слайдов, которые специалисты вводят в ее память ежегодно. Она хранит в себе постоянно расширяемый всемирный опыт, поэтому есть все основания ожидать, что со временем такие программы заменят живых диагностов.

Одна из особенностей человеческого мозга состоит в умении выделять в событиях образы. Но как бы хороши мы ни были в столь трудном деле, в некоторых случаях ИИ срабатывает лучше, особенно в ситуациях мошенничества. Специальная программа Falcon, разработанная компанией NHC, создает постоянно обновляемую базу данных профилей — того, как, где и когда клиенты используют свои кредитные карточки. На основе этой базы данных программа выявляет существенные отклонения, основываясь на результатах статистического анализа и алгоритмов нейронных сетей. Примеров использования искусственного интеллекта, о котором твердили фантасты, очень много. Он вокруг нас: в индустрии, беспроводных информационных службах аэропортов, онлайновых банках занятости, в программах геологов и гидрологов, образовании, медицинских и фармакологических лабораториях.

«Россия могла бы возглавить самый правильный путь — путь познания человеческого разума. У нас существенный кадровый потенциал, серьезные теоретические и прикладные наработки — мы могли бы это сделать», — поделился основатель Российского Агентства искусственного интеллекта Денис Онацик.

(*По материалам: www. Uslugy.ru.*
Олег Лукоев. IT и телекоммуникации. 2005. № 5)

Appendix 3

A Cutting-edge AI Product

Here we present the technical report of a new AI model developers. This product is named Sora. It can create realistic and imaginative scenes from text instructions. Sora is so-to-speak "hot-off-the-press", that is why it has some limitations, though it is still rather impressive and fascinating.

SORA. Creating Video from Text. Technical report

Video generation models as world simulators

We explore large-scale training of generative models on video data. Specifically, we train text-conditional diffusion models jointly on videos and images of variable durations, resolutions and aspect ratios. We leverage a transformer architecture that operates on spacetime patches of video and image latent codes. Our largest model, Sora, is capable of generating a minute of highfidelity video. Our results suggest that scaling video generation models is a promising path towards building general purpose simulators of the physical world.

This technical report focuses on (1) our method for turning visual data of all types into a unified representation that enables large-scale training of generative models, and (2) qualitative evaluation of Sora's capabilities and limitations. Model and implementation details are not included in this report.

Much prior work has studied generative modeling of video data using a variety of methods, including recurrent networks, generative adversarial networks, autoregressive transformers, and diffusion models. These works often focus on a narrow category of visual data, on shorter videos, or on videos of a fixed size. Sora is a generalist model of visual data — it can generate videos and images spanning diverse durations, aspect ratios and resolutions, up to a full minute of highdefinition video.

Turning visual data into patches

We take inspiration from large language models which acquire generalist capabilities by training on internet-scale data. The success of the LLM paradigm is enabled in part by the use of tokens that elegantly unify

diverse modalities of text — code, math and various natural languages. In this work, we consider how generative models of visual data can inherit such benefits. Whereas LLMs have text tokens, Sora has visual *patches*. Patches have previously been shown to be an effective representation for models of visual data. We find that patches are a highly-scalable and effective representation for training generative models on diverse types of videos and images.

At a high level, we turn videos into patches by first compressing videos into a lowerdimensional latent space, and subsequently decomposing the representation into spacetime patches.

Video compression network

We train a network that reduces the dimensionality of visual data. This network takes raw video as input and outputs a latent representation that is compressed both temporally and spatially. Sora is trained on and subsequently generates videos within this compressed latent space. We also train a corresponding decoder model that maps generated latents back to pixel space.

Spacetime latent patches

Given a compressed input video, we extract a sequence of spacetime patches which act as transformer tokens. This scheme works for images too since images are just videos with a single frame. Our patch-based representation enables Sora to train on videos and images of variable resolutions, durations and aspect ratios. At inference time, we can control the size of generated videos by arranging randomly-initialized patches in an appropriately-sized grid.

Scaling transformers for video generation

Sora is a diffusion model; given input noisy patches (and conditioning information like text prompts), it's trained to predict the original "clean" patches. Importantly, Sora is a diffusion *transformer*. Transformers have demonstrated remarkable scaling properties across a variety of domains, including language modeling, computer vision, and image generation.

In this work, we find that diffusion transformers scale effectively as video models as well. Below, we show a comparison of video samples with fixed seeds and inputs as training progresses. Sample quality improves markedly as training compute increases.

Variable durations, resolutions, aspect ratios

Past approaches to image and video generation typically resize, crop or trim videos to a standard size — e.g., 4 second videos at 256×256 resolution. We find that instead training on data at its native size provides several benefits.

Sampling flexibility

Sora can sample widescreen 1920×1080p videos, vertical 1080×1920 videos and everything inbetween. This lets Sora create content for different devices directly at their native aspect ratios. It also lets us quickly prototype content at lower sizes before generating at full resolution — all with the same model.

Improved framing and composition

We empirically find that training on videos at their native aspect ratios improves composition and framing. We compare Sora against a version of our model that crops all training videos to be square, which is common practice when training generative models. The model trained on square crops (left) sometimes generates videos where the subject is only partially in view. In comparison, videos from Sora (right) have improved framing.

Language understanding

Training text-to-video generation systems requires a large ammount of videos with corresponding text captions. We apply the re-captioning technique introduced in DALL·E 3 to videos. We first train a highly descriptive captioner model and then use it to produce text captions for all videos in our training set. We find that training on highly descriptive video captions improves text fidelity as well as the overall quality of videos.

Similar to DALL·E 3, we also leverage GPT to turn short user prompts into longer detailed captions that are sent to the video model. This enables Sora to generate high quality videos that accurately follow user prompts.

Prompting with images and videos

All of the results above and in our landing page show text-to-video samples. But Sora can also be prompted with other inputs, such as pre-existing images or video. This capability enables Sora to perform a wide range of image and video editing tasks — creating perfectly looping video, animating static images, extending videos forwards or backwards in time, etc.

Animating DALL·E images

Sora is capable of generating videos provided an image and prompt as input. On the site of Open-AI company you can see example videos generated based on DALL·E 2 and DALL·E 3 images.

Extending generated videos

Sora is also capable of extending videos, either forward or backward in time. On the site of Open-AI company you can see four videos that were all extended backward in time starting from a segment of a generated video. As a result, each of the four videos starts different from the others, yet all four videos lead to the same ending.

We can use this method to extend a video both forward and backward to produce a seamless infinite loop.

Video-to-video editing

Diffusion models have enabled a plethora of methods for editing images and videos from text prompts. Below we apply one of these methods, SDEdit, to Sora. This technique enables Sora to transform the styles and environments of input videos zero-shot.

Connecting videos

We can also use Sora to gradually interpolate between two input videos, creating seamless transitions between videos with entirely different subjects and scene compositions. In the examples below, the videos in the center interpolate between the corresponding videos on the left and right.

Image generation capabilities

Sora is also capable of generating images. We do this by arranging patches of Gaussian noise in a spatial grid with a temporal extent of one frame. The model can generate images of variable sizes — up to 2048×2048 resolution.

Emerging simulation capabilities

We find that video models exhibit a number of interesting emergent capabilities when trained at scale. These capabilities enable Sora to simulate some aspects of people, animals and environments from the physical world. These properties emerge without any explicit inductive biases for 3D, objects, etc. — they are purely phenomena of scale.

– *3D consistency.* Sora can generate videos with dynamic camera motion. As the camera shifts and rotates, people and scene elements move consistently through three-dimensional space.

– *Long-range coherence and object permanence.* A significant challenge for video generation systems has been maintaining temporal consistency when sampling long videos. We find that Sora is often, though not always, able to effectively model both short- and long-range dependencies. For example, our model can persist people, animals and objects even when they are occluded or leave the frame. Likewise, it can generate multiple shots of the same character in a single sample, maintaining their appearance throughout the video.

– *Interacting with the world*. Sora can sometimes simulate actions that affect the state of the world in simple ways. For example, a painter can leave new strokes along a canvas that persist over time, or a man can eat a burger and leave bite marks.

– *Simulating digital worlds*. Sora is also able to simulate artificial processes–one example is video games. Sora can simultaneously control the player in Minecraft with a basic policy while also rendering the world and its dynamics in high fidelity. These capabilities can be elicited zero-shot by prompting Sora with captions mentioning "Minecraft."

Discussion

Sora currently exhibits numerous limitations as a simulator. For example, it does not accurately model the physics of many basic interactions, like glass shattering. Other interactions, like eating food, do not always yield correct changes in object state. We enumerate other common failure modes of the model — such as incoherencies that develop in long duration samples or spontaneous appearances of objects — in our landing page.

We believe the capabilities Sora has today demonstrated that continued scaling of video models is a promising path towards the development of capable simulators of the physical and digital world, and the objects, animals and people that live within them.

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В последние годы искусственный интеллект (ИИ) активно развивается, проникая во все сферы человеческой деятельности, революционизируя их и привнося значительный прогресс в решение многочисленных проблем. Издание содержит тексты на английском языке, дающие представление об основных направлениях ИИ, а также упражнения различных форматов, аппендиксы и словарь для отработки вокабуляра по данной тематике.

In recent years, artificial intelligence (AI) has been actively developing, penetrating into all spheres of human activity, revolutionizing them and bringing significant progress to solving numerous problems. The publication contains texts in English that give an idea of AI key areas, as well as exercises in various formats, appendixes and a dictionary for practicing vocabulary on this topic.

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