автономного реагирования для принятия мер против кибератак. Darktrace визуализирует информацию в удобном виде. Существуют и другие решения от других компаний, такие как Vectra AI, CrowdStrike и другие, которые работают по схожему принципу.

В заключение, использование искусственного интеллекта в кибербезопасности представляет собой важную часть стратегии обеспечения цифровой безопасности. Это не только улучшает способность выявления и предотвращения киберугроз, но также дает возможность строить более гибкие и адаптивные системы, способные эффективно реагировать на постоянно меняющийся характер кибератак. Развитие и интеграция искусственного интеллекта в сферу кибербезопасности становится ключевым фактором в обеспечении безопасности в цифровой эпохе.

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THE ROLE OF AI AND DEEP LEARNING IN DIGITIZING HEALTHCARE

Abstract. *The article discusses the benefits of artificial intelligence and deep learning in healthcare. Artificial intelligence (AI) and deep learning (DL) are changing healthcare in unprecedented ways, marking a pivotal shift in medical science. Their integration opens up new opportunities for innovation in the field of digitalization of healthcare.*

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РОЛЬ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И ГЛУБОКОГО ОБУЧЕНИЯ В ЦИФРОВИЗАЦИИ ЗДРАВООХРАНЕНИЯ

***Аннотация**. В статье рассматриваются преимущества искусственного интеллекта и глубокого обучения в здравоохранении. Искусственный интеллект (ИИ) и глубокое обучение (ГО) меняют здравоохранение беспрецедентным образом, знаменуя собой поворотный сдвиг в медицинской науке. Их интеграция открывает новые возможности для инноваций в области цифровизации здравоохранения.*

Artificial intelligence (AI) and deep learning (DL) represent a fundamental transformation in how healthcare systems operate and interact with patient data, diagnostic processes and treatment methodologies. The integration of artificial intelligence and distance learning is accelerating the digitalization of healthcare, leading to advances that were once considered futuristic.

Detailed Applications in Healthcare

Advanced Disease Detection and Diagnosis: AI, particularly deep learning models like Convolutional Neural Networks (CNNs), are revolutionizing medical diagnostics. These models analyze images from MRIs, CT scans, and X-rays with greater precision and speed than traditional methods. For example, AI algorithms have been developed to detect subtle signs of diseases such as cancer, enabling early intervention which is crucial for successful treatment. AI systems have also been instrumental in diagnosing neurological disorders by identifying patterns in brain imaging that might be missed by the human eye. Beyond image analysis, AI assists in interpreting complex genetic information, opening new frontiers in personalized medicine.

Advanced disease detection and diagnosis have become crucial in various fields, including bioinformatics, cancer research, Alzheimer's disease, and obstructive heart disease. Deep Learning-based methods are successfully applied in the genetic information-infused diagnosis of tuberculosis from oral swabs. For Alzheimer's disease, early detection and prediction techniques using IoT, AI, and machine learning have been explored to avoid significant loss and provide timely treatment. Deep learning techniques have been proposed for coronary artery disease (CAD) diagnostics. For example, a feature fusion model achieved 88.8% accuracy in detecting CAD using electrocardiogram (ECG) data [1]. Another study developed a DL-based model using ResNet for CAD screening, which showed fair performance in assessing obstructive CAD (ObCAD). Additionally, a CNN-based CAD detection model was developed using CT

images, achieving high accuracy and performance. The vast availability of medical data from different modalities, such as electronic health records, x-ray images, CT and MRI scans, ECG, and physical activity data from wearable sensors provides a great basis for the development of machine learning-based methods of automated diagnosis.

Personalized Medicine and Treatment: AI's role in personalized medicine is rapidly expanding. By analyzing vast amounts of patient data, including genetic information, lifestyle factors, and environmental exposures, AI algorithms can predict individual responses to various treatments. This approach is particularly transformative in oncology, where AI is used to tailor chemotherapy and radiation treatments based on the patient's unique genetic makeup. In genetic diseases, AI helps in identifying the most effective gene therapy techniques, significantly improving patient outcomes.

AI chatbots have shown potential in personalized medicine and treatment. They can assist in managing routine tasks, processing large amounts of data, and providing patient education. Continuous improvements are expected in the development of AI chatbots for medical applications, including integration with reputable sources and the development of language models with an emphasis on citation and medical applications. AI chatbots have demonstrated efficacy in promoting health behavior change, smoking cessation, treatment adherence, and reduction in substance misuse [2]. However, it is important to note that AI chatbots lack the empathy, intuition, and experience of human healthcare providers. They should be seen as supplements rather than substitutes for medical professionals.

Innovative Drug Discovery and Development: The traditional drug development process is lengthy and expensive. AI and DL are changing this by predicting the success of drug compounds early in the development phase. AI algorithms analyze complex biological and chemical data to identify potential drug candidates, reducing the time and cost associated with traditional drug discovery methods. These technologies also play a crucial role in understanding the mechanisms of diseases at a molecular level, leading to the development of more effective and targeted drugs.

Innovative drug discovery and development processes have become crucial in the pharmaceutical industry. The use of microfluidics technology has the potential to revolutionize drug development by reducing time and cost while meeting strict guidelines for good manufacturing practices. Additionally, computerized methods such as high-throughput screening and computer-based design, as well as pharmacological software, have been

employed to accelerate the drug development process. The successful discovery and development of new drugs require proper lead compound characterization and preclinical studies to ensure safety and efficacy. Furthermore, the application of artificial intelligence (AI) in drug development shows promise in identifying hit and lead compounds, validating therapeutic targets, and optimizing structural design. These innovative approaches aim to streamline the drug discovery and development process, ultimately leading to the introduction of effective and safe therapeutic substances into clinical practice.

Robotic Surgery and Clinical Assistance: The use of AI in robotic surgery exemplifies the blend of technology and human skill. These robotic systems, guided by AI algorithms, assist surgeons in performing precise and less invasive procedures. The AI systems analyze preoperative data to guide the surgeon's instruments, resulting in fewer complications and quicker recovery times. Additionally, AI assists in surgical planning and provides real-time decision support during procedures, enhancing the surgeon's capabilities.

Robotic surgery offers advantages in terms of precision and facilitation in medicine, allowing the surgeon to control the system externally. However, there is limited data on the influence of robotic assistance on experienced surgeons. In the field of bariatric surgery, a retrospective study found that robotic assistance did not significantly reduce postoperative complications, although it did reduce the length of hospital stay. In the context of spinal surgery, the use of robotic-navigated assistance was found to be highly accurate and reliable, with a low rate of abandonment once mastered [3]. Additionally, an expansion of robotic assistance has been proposed to improve accuracy in surface-dependent medical procedures, such as precise incisions or tissue removal.

Comprehensive Healthcare Management: AI is a powerful tool for managing hospital operations. It optimizes workflows, manages patient data, and forecasts patient inflow, ensuring efficient resource allocation. AI-powered predictive analytics help hospitals plan for emergencies and allocate resources more effectively. Additionally, AI technologies like chatbots and virtual assistants are transforming patient engagement by providing personalized reminders, health tips, and answering queries, which helps in maintaining treatment adherence.

Comprehensive healthcare management encompasses various strategies and approaches to ensure optimal care, resource utilization, and patient outcomes. It involves integrating both clinical and non-clinical

management methodologies. In the context of breast cancer patients, comprehensive management includes standardized treatment, long-term follow-up, and addressing concomitant diseases and health risks. Comprehensive medication management services have been shown to improve clinical outcomes and reduce healthcare utilization among older patients with cardiovascular diseases. Additionally, a comprehensive healthcare model is proposed to integrate physical, mental, spiritual, and social dimensions, different medical approaches, and different health statuses for further research. Consent management systems are also crucial in comprehensive healthcare management to ensure privacy, security, and ethical exchange of health records within healthcare ecosystems.

Remote Monitoring and Enhanced Telemedicine: The advent of AI in telemedicine has bridged the gap between patients and healthcare providers. AI-powered devices and apps monitor patient health remotely, providing real-time data to doctors. This technology is particularly beneficial for managing chronic conditions like diabetes and heart disease, where continuous monitoring is crucial. It also allows for immediate intervention in case of abnormalities, potentially saving lives.

Remote monitoring and telemedicine have shown promise in enhancing healthcare delivery. The use of telehealth coupled with remote monitoring has been explored in various fields, including cystic fibrosis (CF) care. The feasibility of telehealth, remote spirometry, remote collection of respiratory cultures, adherence monitoring, cough assessment, symptom monitoring, and activity tracking has been studied, with favorable opinions from both clinicians and patients [4]. In the context of heart failure, telemonitoring has been used to observe patients' well-being from home, allowing them to input important data through smartphone applications. Wearable sensors have also been developed for telemedicine healthcare, aiming to provide real-time physiological and biochemical information for early disease diagnosis and cost-effective treatments. In the context of surgical care, telemedicine, and clinical decision support systems have been used for remote monitoring and management, with patients expressing support for intraoperative telemedicine use. Additionally, a remote monitoring platform has been implemented for the post-operative care of patients who have undergone spine surgery, showing high adherence and patient satisfaction.

Expansive Predictive Analytics: AI’s predictive capabilities are vast, ranging from forecasting disease outbreaks to patient admission rates. These models analyze historical and real-time data to predict future healthcare

trends, aiding in public health planning and efficient management of hospital resources. AI's predictive analytics extend to personalized health risk assessments, enabling earlier interventions for chronic diseases. By analyzing patient records and demographic data, AI systems can identify patterns and risk factors, providing insights that are often overlooked in traditional analyses.

Expansive predictive analytics in medicine is a rapidly evolving field that holds great promise for improving diagnosis, treatment, and patient outcomes. Machine learning models are being developed to learn patterns in large and heterogeneous health data, leading to improved predictive modeling in cardiovascular medicine. However, there are challenges to the expanded use of predictive analytics in healthcare, including issues related to data quality, generalizability, bias, and interpretability. Despite the advancements in predictive analytics, the impact on clinical care has been limited, with few meaningful contributions to patient treatment. To unlock the potential of advanced analytics while ensuring patient safety, regulatory and professional bodies should establish standards of clinical benefit for advanced algorithms. External validation and prospective testing of these algorithms are necessary to ensure their effectiveness and reliability [5]. In summary, while there is promise in the application of predictive analytics in medicine, there are still challenges to overcome before its expansive use becomes a reality.

As AI and Deep Learning continue to advance, their integration into healthcare systems around the world promises to bring about transformative changes in patient care and medical practices. The potential of these technologies to revolutionize healthcare is immense, offering opportunities for significant improvements in treatment efficacy, patient experience, and overall health outcomes.

However, the rapid adoption of AI and DL in healthcare also brings forth significant challenges, particularly in terms of data privacy, ethical considerations, and the regulatory landscape. Issues such as biases in AI algorithms, the need for transparent and explainable AI, and concerns about data security and patient confidentiality are at the forefront of discussions among healthcare professionals, technologists, and policymakers.

Addressing these challenges requires a thoughtful and collaborative approach. Ensuring that the advancements in AI and Deep Learning are leveraged equitably and beneficially across all segments of society is imperative. This involves fostering interdisciplinary collaboration among technologists, healthcare professionals, ethicists, and policymakers. Such collaboration is essential to fully realize the potential of AI and Deep

Learning in healthcare, ensuring that its benefits are distributed fairly and ethically.

Moreover, continuous research and development in this field are vital to overcome current limitations and explore new possibilities. The integration of AI and DL in healthcare is a journey of discovery, with each advancement opening new avenues for innovation and improvement in patient care.

In summary, the integration of AI and Deep Learning into healthcare is a transformative leap forward. These technologies are not only enhancing the effectiveness, efficiency, and personalization of medical services but also fostering a deeper understanding of complex medical conditions and enabling groundbreaking medical innovations. The scope of their applications is vast and continually expanding, with significant improvements in diagnostic accuracy, treatment personalization, and healthcare operations. However, as we embrace these technological advancements, it is crucial to navigate the associated challenges thoughtfully and collaboratively, ensuring that the benefits of AI and Deep Learning in healthcare are realized responsibly and equitably.

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