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The applications of artificial intelligence in personalized medicine

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Abstract. Personalized medicine provides advanced diagnostics, customized therapies, and proactive health management, taking into account the distinct genetic and socioeconomic profiles of each patient. The rapid development of contemporary technologies, such as the combination of biology and information technology, has laid a solid foundation for the development of artificial intelligence in the field of personalized medicine. This article primarily explores the application of artificial intelligence (AI) to personalized diagnosis and treatment. Firstly, AI can use big data analysis, machine learning, and especially deep learning to quickly detect early disease indicators from massive medical data to provide patients with more accurate diagnosis and prediction. Secondly, AI can help develop a more personalized treatment plans by analyzing relevant data such as patients' genetic information, lifestyle, and social environment. This article focuses on the technical advantages and current applications of AI in personalized medicine to better understand the known challenges and future potential of the field.

Keywords: artificial intelligence, personalized medicine, personalized diagnosis, personalized treatment.

1. Introduction

Personalized medicine provides innovative diagnoses, tailored treatments, and preventive care to individual patients, considering their unique genetic and socioeconomic characteristics. The fast development of many contemporary technologies, such as the combination of biology and information technology, is making personalized medicine more widely used [1].

Artificial intelligence (AI) is turning into one of the major forces behind medicine as a symbol of modern science and technological advancement. With the utilization of huge data that has been categorized, greatly enhanced processing power and cloud storage, AI is being used to increase clinician efficiency, enhance medical error prevention and workflows in the health system, and help patients self-manage their health data [2]. Moreover, with the development of deep learning technologies represented by computer vision, natural language processing, reinforcement learning, and general methods, deep learning models have nearly achieved the same level of accuracy as doctors in a wide range of diagnostic tasks [3]. These advancements and implementations have established a strong basis for the progress of artificial intelligence in the realm of customized medicine.

This article mainly studies the application of artificial intelligence to personalized diagnosis and treatment. First, AI can rapidly identify early disease indicators from vast amounts of medical data using

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big data analysis, machine learning, and deep learning to provide patients with more precise diagnoses and predictions. Second, by examining pertinent facts including a patient's genetic makeup, way of life, and social surroundings, AI can assist in creating more individualized treatment regimens. In order to better grasp the known obstacles and promise of the subject, this article focuses on the technological benefits and present applications of artificial intelligence in customized medicine.

2. AI in personalized diagnosis

AI can use technologies such as big data analytics, machine learning, deep learning, and natural language processing (NLP) to discover and extract valuable information from medical data such as electronic health records (EHRs), internet data, and journals. This not only allows patients to receive more accurate and personalized predictions and diagnoses, but also helps doctors develop more targeted treatment plans.

2.1. Early disease detection

Early disease detection plays a vital role in the medical field, helping to control patients' conditions promptly, improve medical outcomes, and reduce treatment costs. Artificial intelligence is showing great promise in advancing early health detection. Compared to traditional manual testing, it does not rely on the doctor's experience and the testing tools are limited. Instead, AI uses vast amounts of real-time medical data and algorithms to identify subtle features and changes in early disease. As Badidi [4] claims, AI and edge computing enable distributed intelligence, quickly becoming a critical component of early health prognostics. This innovation holds promise to transform how healthcare professionals' study and foresee outbreaks of illnesses.

Artificial intelligence plays an important role in the detection and prevention of early diseases. For example, in the field of cardiology, AI can help doctors select the best type of imaging test and correctly interpret the results of the images for the doctor. Artificial intelligence and automated algorithms help analyze cardiac single-photon emission computed tomography (SPECT) and positron emission tomography (PET) data, analyze regional signals, reconstruct 3D cardiac images, and provide information such as innervation [5]. With the help of these technologies, doctors can choose treatment more quickly and accurately.AI can also be used to accurately predict the prevalence of diseases and create personalized intervention measures. Through data analysis, it can identify patterns and trends associated with disease outbreaks, significantly halting the spread of illness and saving money on medical expenses. For example, AI can be used to assess data from wearable technology, multiple sensors, and electronic health records. By merging this data with other pertinent information, like social and demographic aspects, it is possible to precisely forecast future health outcomes and create focused interventions to stop disease epidemics [4]. In addition, AI can create customized and more effective preventive plans for individuals based on their living conditions and personal medical information, which is of great significance for early disease detection and treatment.

However, AI also has limitations when it comes to early disease detection. For example, AI algorithms may exhibit bias when training on datasets with intrinsic biases, resulting in unfair results and potentially harmful effects [4]. Therefore, the selection of datasets should be considered holistically to ensure diversity and representativeness of datasets, while ensuring ethics. In addition, algorithms should be improved to improve the usefulness of AI models so that AI can have a greater impact in early disease detection.

2.2. Personalized treatment plan

Individualized treatment generally refers to the selection of the treatment that is needed, considering the clinical evaluation of the physician and the patient's individual circumstances, or the modification of the technique in real time based on the patient's response during treatment and the clinician's clinical judgment [6].

AI systems can quickly search a patient's electronic medical record as well as a variety of data sources, including the internet, educational materials, and journals, to support accurate diagnosis and treatment.

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For example, IBM's Watson uses databases, cross-correlates family history data, and synchronizes current literature to provide screening recommendations and treatment options [5]. In addition, AI uses algorithms such as SVM, random forest, and CNN to analyze large amounts of clinical data for tumor segmentation, greatly improving the accuracy and efficiency of 3D volume measurement [7]. This data-driven strategy saves time and medical resources by reducing duplication of effort and increasing treatment efficiency. AI can also be used to predict how patients respond to various forms of treatment. The technology helps improve treatment planning, maximize efficacy, reduce risk, and dynamically adjust treatment options throughout the treatment process.

The use of these AI technologies helps medical professionals identify diseases faster and provide personalized treatment plans that consider each patient's specific needs. Artificial intelligence is used to guide the diagnostic process, improve safety and efficacy, and save healthcare expenses, bringing about a change in the medical field that cannot be ignored.

3. AI in personalized treatment

In personalized treatment, AI can analyze the patient's unique data, select the most appropriate and effective drugs, optimize the treatment route based on real-time feedback, and achieve real-time monitoring and adjustment. The application of AI has greatly increased treatment efficacy and accuracy. It can also react quickly to modifications in the treatment process, which greatly increases treatment reliability, maximizes resource use, and provides patients with safer and more effective treatments.

3.1. Drug recommendations

By examining genetic differences in response to medications, pharmacogenomics, in conjunction with artificial intelligence, optimizes and generates better-focused treatments. AI algorithms will be used in future therapies to combine a patient's genetics, transcriptome, proteome, epigenetics, and lifestyle factors to provide individualized medication [7].

Nowadays, collaborative filtering, statistical learning, low-rank matrix completion, deep learning, and graph embedding techniques are among the advancements in AI medicine [8]. These advanced algorithms and models are dedicated to finding more targeted drugs for patients, which is more comprehensive and detailed than doctors. This not only saves medical time but also improves patients' treatment experience. However, although these medication recommendation algorithms can achieve high prediction accuracy, they still have several drawbacks and limitations [8].

Additionally, deep learning is essential when it comes to medication recommendations. For instance, the use of deep learning in drug recommendation leads to effective feature extraction and multi-data mode integration, notable improvements in drug response prediction and drug combination prioritization, and the revelation of intricate details via the use of prior biological knowledge from graph convolutional networks [9]. The related structure shows great potential in pharmacogenomics.

However, AI-based drug recommendations currently have limitations. For example, the use of AI to recommend drugs faces the problem of explainability. It may restrict the AI model's acceptance in real-world medical settings because it is impossible to guarantee that medical personnel comprehend and trust the AI model's decision-making process [10]. Explainability is crucial in the fields of medicine and healthcare, and systems based on machine learning and computational intelligence methods might be limited in practical application if explainability cannot be guaranteed. Therefore, in future research and development of algorithms and models, improving the interpretability of models should be one of the goals to enhance the credibility and adoption rate of artificial intelligence.

3.2. Remote monitoring

Remote patient monitoring through wearable devices and sensors is appropriate for non-invasive patient monitoring of critically ill patients, post-operative patients, chronically sick patients, and patients in remote areas [11]. The application of artificial intelligence in remote monitoring promotes the development of personalized treatment. During COVID-19, healthcare infrastructure has been overwhelmed, and healthcare workers are at high risk of transmission. Imaging technologies developed

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using machine learning and deep learning are being used to perform high-intensity and high-risk tasks for healthcare workers, screening and monitoring the health of a large number of susceptible or infected people [12]. This application not only reduces the risk of infection for medical staff but also reduces the medical burden.

In the field of personalized treatment, AI is beginning to show its advantages. To automatically monitor and manage the patient's health status, the health monitoring service (HMS) system gathers data by using smart devices and medical sensors. By evaluating past medical records and current health status, the health monitoring service system creates personalized healthcare plans in real-time and issues alerts and warnings when necessary. Then, in order to assist medical professionals in diagnosing and making decisions, the hospital system uses data from the patient record management centre and health monitoring system. [13]. This integration greatly improves the accuracy and effectiveness of personalized medicine, providing patients with better medical services.

AI devices are also used for patient self-management, which provides patients with a better medical experience. For instance, numerous researchers have created various intelligent assistants, such as chatbots and robots, that can help patients with everyday diabetes management tasks like food monitoring and insulin administration [14]. This application allows patients to monitor their physical data in real time, detect health problems promptly, and reduce the overuse of medical resources. AI is also being used to develop chatbots that gather user information and offer individualized responses and real-time support [15]. Chatbots gather information from users and offer instant assistance, enhancing patient autonomy and sparing medical professionals' time so they can concentrate on more critical tasks.

The application of AI in remote monitoring has promoted the development of personalized treatment, which not only saves medical staff's time and energy and reduces the danger of medical work, but also enables patients to self-manage their health data and obtain a better medical experience. However, privacy issues raised by remote monitoring still need to be considered. Health data must be protected from theft and modification because it directly affects people's lives and health [16]. In the future, the privacy and security of health data should be protected through methods such as user authentication, data encryption, and limited access rights to build and maintain trust.

4. Conclusion

This article explores the application of artificial intelligence in personalized medicine, focusing on analyzing its technical advantages and practical applications in personalized diagnosis and treatment. Research shows that artificial intelligence can significantly improve the accuracy and timeliness of early disease detection by extracting valuable information from large amounts of complex medical data through technologies such as big data analysis, machine learning, and deep learning. In addition, AI can also develop more personalized treatment plans based on data such as the patient's genetic information, lifestyle, and social environment. On this basis, AI can optimize drug recommendations through algorithms and models, and provide patients with more accurate drugs by considering them more comprehensively than doctors. Finally, AI can achieve remote monitoring, monitor the development trend of diseases while ensuring ethics, and help doctors and patients manage personal health data to improve treatment effects and patient experience.

However, the application of AI in the medical field still faces challenges such as data bias and privacy security, and further optimization of algorithm models and improvement of privacy protection measures are needed. There is also limitation in this paper, it only reviews the applications of artificial intelligence in personalized medicine, not in the medical field without conducting any experimental research. Future research should focus on improving the interpretability and adaptability of models, ensuring the diversity and representativeness of data, and establishing a sound privacy protection mechanism to give full play to the potential of AI in personalized medicine and promote the continuous improvement of medical standards.

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