

Applications and Challenges of Artificial Intelligence in Life Sciences

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Abstract. With the continuous development of science and technology, exploration in the field of life sciences has become increasingly profound, encompassing the understanding of human beings themselves and the exploration of disease etiology and treatment methods. Artificial intelligence is defined as the intelligence exhibited by artificially created systems. The application of artificial intelligence is quite extensive and can replace humans in various aspects of work, significantly enhancing efficiency in daily life and work. Artificial intelligence has a dual nature, as it could provide convenience to human society but could also bring about various adverse effects. This paper summarizes the current applications of artificial intelligence in the field of life sciences. By analyzing the applications of artificial intelligence in areas such as gene editing, drug development, and bioinformatics, it demonstrates the potential of artificial intelligence in the field of life sciences. At the same time, this paper also points out the ethical, technical, social, and various challenges that the application of artificial intelligence technology in the field of life sciences faces, with the aim of providing reference for research in related fields.

1 Introduction

With the advancement of technology, human understanding of life continues to deepen, and the field of life sciences has achieved a series of significant breakthroughs. As an emerging technology, artificial intelligence has provided robust support for research in the life sciences [1][2]. Although artificial intelligence itself lacks a consistent definition, it broadly refers to systems that can operate to some extent independently and can continuously optimize processes through iteration.

Artificial intelligence can be widely applied in the following areas:

Life Sciences: Artificial intelligence can assist healthcare professionals in diagnosis, analyze disease trends through big data, predict epidemics, and provide support for medical decision-making. Additionally, it can be applied to drug development, helping scientists discover new treatment methods more rapidly.

Autonomous Driving: The use of artificial intelligence in self-driving vehicles is becoming increasingly prevalent. Through deep learning and machine learning techniques, it can enhance a vehicle's perception and responsiveness, thereby improving road safety and traffic efficiency.

Energy Management: Artificial intelligence can help optimize energy production and usage through intelligent forecasting and automatic adjustments, reducing energy consumption and carbon emissions to achieve sustainability.

Financial Services: Applications of artificial intelligence in financial services include risk assessment, credit rating, and transaction prediction, assisting financial institutions in more accurately evaluating risks and identifying investment opportunities.

Education: Artificial intelligence can facilitate personalized education by tailoring teaching plans and methods based on individual students' characteristics and needs, thereby enhancing educational quality and effectiveness.

Smart Cities: Artificial intelligence can be applied to the development of smart cities, encompassing areas such as intelligent transportation, security, and environmental protection. This elevates the level of urban management intelligence and improves residents' quality of life.

2 Application of artificial intelligence in life sciences

2.1. Gene Editing

Gene editing technology refers to the artificial alteration of a specific gene in an organism to control its gene expression or function [3-4]. The implementation of modern artificial gene editing technology is based on the principle of DNA mutation. DNA, found in the chromosomes of an organism's cells, carries relevant proteins that control life processes. Currently, artificial gene editing technology primarily comprises three

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methods: gene knockout technology, gene activation technology, and gene modification technology.

Artificial intelligence technology has brought about a revolutionary impact on various industries, and gene editing technology is no exception [5-6]. The combination of gene editing technology with the powerful capabilities of artificial intelligence has opened up new possibilities and accelerated research advancements in gene editing. One of the key ways in which artificial intelligence technology influences gene editing is through its robust analytical capacity, enabling effective analysis of vast genetic data.

In the process of gene editing, scientists often require substantial data for foundational research to identify suitable inducers or enzymes for altering an organism's DNA sequence or gene expression [5]. Traditional gene editing methods relied on trial and error, typically taking several years to achieve desired results. However, with the continuous advancement of technology, the volume of data has gradually increased, and the processes have become increasingly complex, making manual data handling and analysis increasingly challenging. With the aid of artificial intelligence technology, researchers can now analyze large-scale datasets to uncover patterns and correlations that would be impossible to detect through manual examination.

For gene editing technology, the application of artificial intelligence presents an exciting prospect [7]. Scientists can leverage the advantages of artificial intelligence to provide more theoretical support and design services for gene editing. Simultaneously, the application of artificial intelligence will minimize human-induced factors that affect experimental results, thereby enhancing the efficiency of gene editing.

2.2. Drug Development

The application of artificial intelligence technology in the field of drug development can improve the efficiency of drug research. Drug design involves the integration of multiple disciplines, such as chemistry and biology, to develop new drugs that can effectively act on the human body. Traditional drug design methods are labor and resource-intensive, and their efficiency is limited [8]. By analyzing known drugs and compounds, as well as modeling and predicting drug effects, artificial intelligence technology can assist researchers in identifying new drug targets and candidate drugs.

Artificial intelligence technology is effective in extracting and mining valuable data from vast pharmacological data sets, particularly for large-scale pharmacology data [9]. Through artificial intelligence technology, it can guide pharmacological chemical synthesis, assist in multi-dimensional data description, enhance pharmacological chemical theories, and facilitate the discovery of new compounds through target prediction. This ultimately aids in drug development by predicting targets, screening drug components, identifying suitable ingredients, calculating efficacy, analyzing synthesis feasibility, and formulating optimal component ratios. This has provided substantial

assistance to pharmacological research and pharmaceutical development.

As many of these advances are based on new ways to harness the analytical power of large data, drug development has become an artificial intelligence and data science problem. This implies that pharmaceutical companies need to master data analysis capabilities. The emerging model of artificial intelligence-assisted drug development significantly enhances R&D efficiency and reduces development costs. This is expected to be the direction of development in the pharmaceutical research and development industry in the future.

2.3. Bioinformatics

Bioinformatics is an essential subfield within the life sciences, involving extensive data analysis and model construction. The application of artificial intelligence technology in bioinformatics contributes to enhance the accuracy and efficiency of data analysis [10]. Bioinformatics can be broadly understood as the organic integration of computer science and biology, constituting an interdisciplinary field that encompasses research in molecular biology, genetics, mathematics, computer science, and statistics [11]. It facilitates addressing large-scale and data-intensive biological problems from a computational perspective. It integrates technologies for collecting, storing, distributing, and analyzing biological information to support scientific research across various domains of biology. Through extensive data processing and analysis, as well as the construction and prediction of models, it addresses a range of issues in the biological sciences. The application of artificial intelligence technology injects new vitality and possibilities into this field.

Genome sequencing is a fundamental field within bioinformatics, where artificial intelligence plays a crucial role [12]. Currently, there are approximately 1,700 DNA sequence databases worldwide, with representative databases including INSD, GenBank, EMBL, BioSino, and others [13]. DNA sequence analysis primarily focuses on DNA sequence alignment and the analysis of DNA homology. A significant theme in computational biology is the comparison of sequences and the attempt to identify common segments between two sequences. Sequence alignment includes global alignment, local alignment, pairwise sequence alignment, and multiple sequence alignment. Its advantages include the identification of homologous molecular segments to determine their functions, while disadvantages include high computational costs, inapplicability to sequences without homology, a strict form-driven content approach without addressing issues of polysemy, and the neglect of inter-individual relationships.

3 Challenges of Artificial Intelligence in Life Sciences

3.1. Ethical Challenges

The application of artificial intelligence technology in the field of life sciences necessitates careful consideration of ethical issues to ensure the rationality and morality of scientific research [14]. The principles governing the application of artificial intelligence technology should also encompass the ideas of non-confrontation and non-escalation. Artificial intelligence has already become a constitutive element of human society, and we must adopt a more open-minded approach towards artificial intelligence. Intelligent means should be employed to regulate the accelerating growth of artificial intelligence [15].

The competition in artificial intelligence technology should not be limited to a singular dimension of technological competition, nor should it involve the use of technological advantages to hinder the technological development of other nations. Instead, it should be a comprehensive competition within the context of artificial intelligence technology, fostering global development and progress through healthy competition. This should include competition in social governance, where ethical reflection on human relationships in society forms an integral part of the competition.

Firstly, ethical reflection imposes higher requirements on artificial intelligence technology competition. Fairness, trustworthiness, interpretability, transparency, and security in artificial intelligence are not just ethical requirements but also represent the developmental direction of artificial intelligence technology. These are the technological high grounds that artificial intelligence technology competition should strive to secure. Technological development should serve the comprehensive development of humanity, and ethical reflection helps prevent the excessive utilitarianism.

Secondly, ethical reflection provides value guidance for the competition in artificial intelligence technology. Ethical reflection emphasizes the protection of human rights and recognizes that technological development is not the sole measure of societal progress. It should also consider diverse factors, particularly safeguarding the interests of marginalized groups, such as addressing issues like data disparities. Ethical reflection contributes to the holistic and healthy development of artificial intelligence.

3.2. Technical Challenges

Although artificial intelligence has achieved a series of important results in the field of life sciences, it still faces many technical challenges. For example, gene editing technology has off-target effects, and drug development faces safety and effectiveness issues. These technical challenges need to be overcome to ensure the safety and reliability of research results.

1. Data problem

Artificial intelligence is mainly driven by big data, so data availability, data quality and data annotation costs are major factors restricting the development of artificial intelligence. For example, some sensitive or private data may not be easy to obtain or share, some low-quality or erroneous data may affect the accuracy and reliability of the model, and some data that require manual annotation may consume a lot of time and resources. Data privacy and security issues are becoming increasingly serious [16]. How to ensure that personal information is not misused has become an urgent problem to be solved.

2. Generalization problem

It is currently difficult for artificial intelligence to achieve generalization capabilities, that is, adapting and learning new knowledge and tasks in different environments and scenarios. For example, a model trained in one domain may not run effectively in another domain, and a model trained in one language may not run effectively in another language.

3. Energy consumption problem

Artificial intelligence requires large amounts of computing resources and electricity to support model training and inference, which results in high costs and environmental impacts. For example, it is estimated that training a state-of-the-art natural language processing model GPT-3 consumes approximately \$3 million in electricity bills and generates approximately 284 tons of carbon dioxide emissions.

4. Preconception gap

There is a predetermined gap between artificial intelligence and humans, that is, there is a gap between human expectations and understanding of artificial intelligence and the actual capabilities and behaviors of artificial intelligence. For example, humans may be too trusting or distrustful of AI, or misunderstand AI's goals and intentions, leading to undesirable consequences or conflicts.

3.3. Social Challenges

The application of artificial intelligence in the field of life sciences must consider its societal impact to ensure the sustainability and social stability of scientific research [17].

The development of artificial intelligence brings about concerns regarding unemployment in various sectors. Artificial intelligence is expected to replace humans in specific types of work, such as assembly line production and automobile driving [18]. While most people hold an optimistic view of the economic impact of artificial intelligence, believing that it will not only replace existing jobs but also create new employment opportunities, similar to the transition from farming to industrial work during the era of large-scale machinery.

In the long term, artificial intelligence will be a powerful force driving societal productivity forward, generating a significant amount of new social wealth and affording humans more discretionary time [19-20]. However, concerns about job displacement due to artificial intelligence are not mere baseless fears. They

imply a deeper question: how can everyone benefit from the wealth created by artificial intelligence, rather than having some individuals gain wealth and freedom while others lose their jobs and fall into relative poverty?

4. Conclusion

Artificial intelligence has a wide range of potential applications in the field of life sciences and provides powerful support for achieving human immortality. However, the realization of human immortality still faces ethical, technical, social, and other multifaceted challenges. This article aims to provide a reference for research in related fields, with the hope of contributing to the realization of human immortality.

Despite the numerous challenges that artificial intelligence technology faces, its significant potential for development fills us with optimism about its future. The following are the prospects for the future development of artificial intelligence technology:

Broader Application Areas: With technological advancements and the expansion of application scenarios, artificial intelligence will gradually extend into more fields such as healthcare, education, finance, and others, bringing greater convenience to human life.

In conclusion, artificial intelligence technology, as one of the most cutting-edge technologies in the world today, is gradually transforming our way of life and driving social progress. Despite the current challenges, with the continuous advancement of technology and the expansion of application scenarios, we have reasons to believe that the future of artificial intelligence will bring more surprises and well-being to humanity.

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