Science and Modern Technology Journal

2023, VOL. 1, NO. 1, [13-19]

MINIREVIEW

The Future is Now: Artificial Intelligence is Transforming the Development of Biotech, Biomedicine, and Agriculture.

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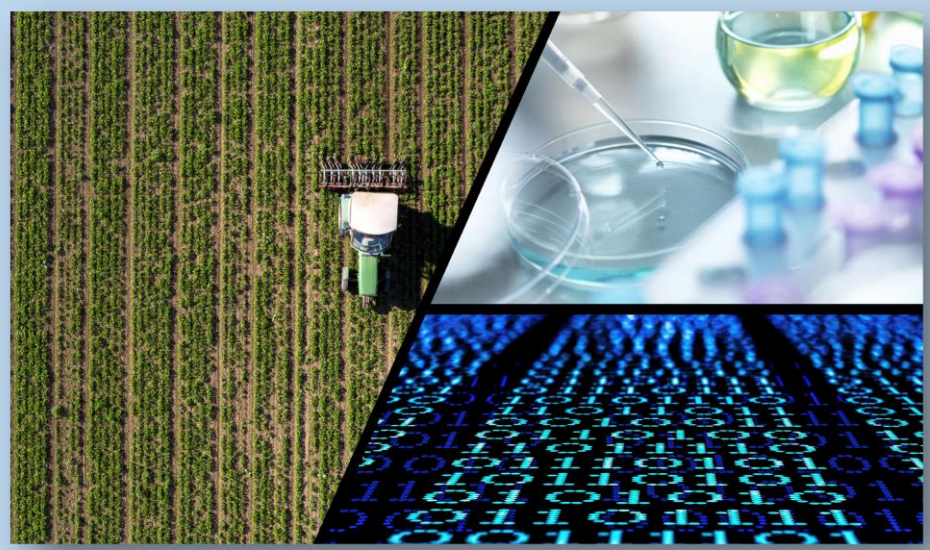
Abstract

Artificial intelligence (AI) has made significant advancements in recent years, with machine learning (ML) algorithms playing an essential role in many fields. The application of AI in biotechnology and biomedicine has shown enormous potential for enhancing research and development, diagnosis, and treatment of diseases, as well as optimizing crop yield and resource management. It has facilitated drug discovery, personalized medicine, and understanding of complex biological systems. In agriculture, AI has the potential to significantly contribute to precision farming, pest and disease control, and implementing sustainable agriculture. In conclusion, AI has a significant impact on the future of biotechnology, biomedicine, and agriculture, highlighting the importance of ongoing research and innovation in these areas. It is important to note, while AI development is essential, several relevant concerns must be addressed, including ethical considerations, privacy and data security, job displacement, potential misuse, and legal and regulatory issues.



ARTICLE HISTORY

Received 1 Feb. 2023

Revised 20 Feb. 2023

Accepted 10 Mar. 2023

Keywords

Artificial Intelligence; Machine Learning; Biotechnology; Biomedicine; Agriculture.

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1. Introduction

Artificial intelligence (AI) has emerged as a ground-breaking computational tool in various fields. It employs machine learning (ML) techniques to develop algorithms that can perform tasks that typically require human intelligence. Since the beginning of AI in the middle of the 20th century, significant advancements and milestones have been reached, especially in machine learning and deep learning (Linardatos et al. 2020; Isozaki et al. 2020; LeCun et al. 2015). These developments have made AI an essential tool across a range of fields, enabling innovative solutions and novel approaches (Gallego et al. 2021; Koski and Murphy 2021). It has transformed multiple sectors, including the economy, education, and healthcare, and resulted in enhanced efficiency, cost-effectiveness, and decision-making processes (Kazançoğlu et al. 2021). By using the power of AI, researchers and practitioners can gain new insights, simplify operations, and develop innovative solutions to address complex challenges in these fields (Okolo 2022).

In biotechnology and biomedicine, AI-driven approaches have shown incredible potential for advancing research and development, facilitating drug discovery, personalized medicine, and understanding complex biological systems and medical treatment solutions (Koski and Murphy 2021; Okolo 2022; Rajpurkar et al. 2022; Sahu et al. 2022). In agriculture, AI has contributed to optimizing and increasing crop yield, precision farming, and resource management. In agriculture, precision farming, resource management, digital soil mapping and crop yield optimization have all benefited from AI-based technologies (Mavridou et al. 2019; Hemming et al. 2020; Kamienski et al. 2019; Khaledian and Miller 2020).

AI is going to have a significant impact on shaping the future of biotechnology, biomedicine, and agriculture, which highlights the need for ongoing research and innovation in these domains. However, there are risks associated with the development of AI, including those related to ethical concerns, data security, and privacy, job displacement, malicious use, difficulties with AI decision-making, and legal and regulatory issues (Katznelson and Gerke 2021; Kazim and Koshiyama 2021; Lysaght et al. 2019; O'Sullivan et al, 2019; Steimers and Schneider 2022; Zou and Schiebinger 2021). It is essential to address these problems while implementing responsible AI.

2. Artificial intelligence and transforming the fields of biotechnology and biomedicine

Machine learning is a subfield of AI that focuses on the development of algorithms that can learn from data. In biotech and biomedicine, machine learning is being used to analyze enormous amounts of data to identify patterns and insights that help to develop new drugs and treatments (Koromina et al. 2019; Vergetis et al. 2021). AI algorithms can analyze large datasets quickly and accurately, which allows scientists to identify potential new medicines and treatments faster and more precisely than ever before. For example, in drug discovery, machine learning algorithms can analyze large databases of chemical compounds to identify the most effective molecules against a particular disease in a shorter time and at a lower cost (Carracedo-Reboredo et al. 2021; Musella et al. 2021; Rema et al. 2022). Additionally, using AI and deep learning approaches can improve the safety of patients by identifying potential side effects and drug interactions (Ploug and Holm 2020).

In the process of disease diagnosis, machine learning algorithms can evaluate medical images and patient data which assists medical doctors in prescribing treatments for diseases more precisely (Erickson et al. 2017; Giger 2018; Tchito Tchapga et al. 2021). Machine learning can also improve personalized treatment plans for each individual patient. As AI technology continues to progress, we expect even more remarkable achievements in development of more personalized medicine based on the patient's genetic background resulting in prescribing of more sustainable treatments. This could lead to better plans for disease prevention and more effective individualized treatments (Chi et al. 2022; Wongvibulsin et al. 2022; Koski and Murphy 2021). There are already many practical AI applications in biotechnology and medicine, including IBM's Watson Health (https://www.ibm.com/watson-health), which uses AI to help doctors diagnose and treat cancer, and Watson Discovery service for focusing on drug

discovery (https://www.ibm.com/cloud/watson-discovery).

3. The role of AI in agriculture and its influence on plant production

AI and machine learning plays a crucial role in agriculture by increasing crop yields, minimizing waste, and encouraging sustainable farming practices such as water resource management, soil conservation, and climate change mitigation. These goals are accomplished by optimizing irrigation systems, identifying ideal planting locations, and enabling farmers to increase their yields while reducing the negative environmental impacts. The abilities of AI in agriculture include learning, logical reasoning, perception, and decision-making (Gardiner and Krishna 2021; Gwagwa et al. 2021; Hemming et al. 2020; Kalboussi et al. 2022; Liakos et al. 2018).

A prominent application of AI in agriculture is precision agriculture, which employs sensors, drones, and other technologies to gather data on soil conditions, weather patterns, crop growth, and pest and disease management. Later, machine learning algorithms analyze this data and give farmers valuable information to optimize their farming practices. For instance, AI can assist farmers in determining the most suitable times for planting and harvesting crops, the optimal amounts of fertilizer and water to use, and the most effective strategies for pest and disease control. These have a positive financial and environmental impact. (Jawad et al. 2017; Iost Filho et al. 2019; Yin et al. 2021).

In the agricultural sector, startups like Blue River Technology are using AI to create weed-killing robots that can accurately identify and target weeds, thereby lowering the need for herbicides (https://bluerivertechnology.com/). The SoilSerdem startup is also trying to develop and offer a global soil mapping service to facilitate the decision-making process with confidence for farmers and agronomists (https://soilserdem.com/). Prospera, a different startup, uses AI to help farmers improve their fertilization and irrigation methods (https://prospera-.ag/).

4. Challenges and ethical considerations of using AI in biotech, biomedicine, and agriculture

While AI has enormous potential in biotech, biomedicine, and agriculture, some challenges and limitations must be addressed. Machine learning algorithms, which form the backbone of AI systems, require vast amounts of accurate and reliable data to learn effectively and generate precise predictions. Inadequate or low-quality data can lead to inaccurate or biased results, undermining the usefulness of the AI-driven solutions. Therefore, it is crucial to invest in data collection and curation efforts followed by creating and training appropriate AI/ML models to reach the best possible AI-based decision-making platform. Another challenge is related to the interdisciplinary nature of AI applications in biotechnology, biomedicine, and agriculture. These fields require professionals with expertise in both AI and the specific field which is under consideration. To enable experts to bridge the gap between AI and their respective fields, this calls for encouraging interdisciplinary education and collaboration. Such cooperation will make it easier to create AI solutions that are customized to the unique needs and challenges of each industry (Bar et al. 2020; Kim 2019; Koski and Murphy 2021; Lysaght et al. 2019; Suarez 2022; Wald 2020; Zou and Schiebinger 2021; Kerasidou and Kerasidou 2021; Petkovic et al. 2020; Khaledian and Miller 2020).

Ethical considerations are also essential when developing and implementing AI in biotechnology, biomedicine, and agriculture. As AI systems become more integrated into these fields, it is necessary to ensure that they are designed and used in a manner that respects privacy, promotes fairness, and avoids unintended consequences. This includes addressing potential biases in data and algorithms, ensuring transparency in AI decision-making processes, and establishing guidelines and standards for the responsible use of AI in research and applications. Therefore, by providing access to high-quality data, promoting interdisciplinary collaboration, and adhering to ethical guidelines, we can enhance the power of AI to drive innovation and improve lives in these vital fields (Baird and Schuller 2020; Chauhan and Gullapalli 2021; Dalton-Brown 2020; Ibrahim et al. 2021; Katznelson and Gerke 2021; Kazim and Koshiyama 2021).

5. Some general risks to take into account when creating and using AI

There are risks associated with the creation and application of AI technologies, all of which need to be carefully considered and managed. These include ethical questions and concerns, privacy, and data security issues, the possibility of job loss, the risk of misuse, challenges in understanding AI decision-making processes, the risk of over-reliance on AI systems, and legal and regulatory obstacles. It is necessary to address these risks through research, collaboration, and the establishment of strict guidelines and safeguards to fully utilize the potential of AI technologies while minimizing their potential negative impacts (Feijóo et al. 2020; Shiyam Sundar et al. 2021; Steimers and Schneider 2022; Tomašev et al. 2020; Wang 2019).

6. Conclusion

In conclusion, biotech, biomedicine, and agriculture all stand to benefit significantly from AI-based development. AI has already had a significant impact on these fields, from drug discovery and disease diagnosis to personalized medicine and sustainable farming methods. We can anticipate even greater benefits in the future as technology develops. However, it is crucial to ensure that AI is developed and used in an ethical and responsible manner in these fields. With the right approach, AI has the power to revolutionize biotech, biomedicine, and agriculture and make a significant impact on our planet and its inhabitants.

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