

Role of Artificial Intelligence in Biological Research: A Short Review

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Abstract:

Artificial Intelligence (AI) is simply machine learning (ML), a modern technology that handles various tasks that humans typically perform. This article aims to demonstrate the significance of AI in biological research science. Because of its ability to interpret data clearly, customize treatment strategies based on data representation, and optimize administrative processes, artificial intelligence (AI) has become increasingly important in the twenty-first century. However, some lacunae also exist due to their application in various fields, including biological research. However, this machine-learning technique enables the examination of various disease histories, the detection of diseases, etc. For research purposes, it also helps to make 3D structures of proteins, biomedical imaging, molecular formation, etc. By utilizing this AI technology, various nations improved their therapeutic techniques. As a result, the review article will help us to learn more about the application of AI technology in our educational system and research.

Introduction:


Not only in biological research but also in other fields today, scientists in different fields are involved in developing their techniques and tools using AI technology. Many industries use AI to upgrade their systems, such as healthcare, banking, gaming, robotics, virtual assistants, self-driving cars, fraud detection, and recommendation systems. In biology, scientists are dependent on AI to solve various challenging issues. Though it can be tough to understand how AI works on biological systems, it is a new idea in our modern era. A remarkable development in biological research was observed in the late 18th century and early 19th century (Figure 1) (Bhardwaj et al., 2022). It is considered the most demanding science because of its advanced technologies that save human lives, particularly by developing various health medicines. The connection between biology and computer science involves computing various biological data to solve problems and take concrete solutions. This multidisciplinary approach, known as computational biology or bioinformatics, is critical for analyzing extensive biological data, making it easy to decide on any drug discovery or advanced technologies.

About Artificial Intelligence (AI)

AI is the machine-learning process where a set of algorithms enables a computer to act as a human. It has two main subsets: machine learning and deep learning (Figure 2). Machine learning is the process where the computer can learn from data efficiently without any

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particular programming input. In machine learning (ML) algorithms are instructed in machine learning to create models using sample data so they can go on to make predictions or judgments (Camacho et al., 2018; Dawn et al., 2022; Dawn et al., 2023). A further branch of machine learning called "deep learning" uses a "neural network" to simulate how people process information and make decisions. Deep learning techniques expand upon research on artificial neurons, first proposed to simulate real biological brains in the 1940s (Ching et al., 2018; Hassoun et al., 2022).

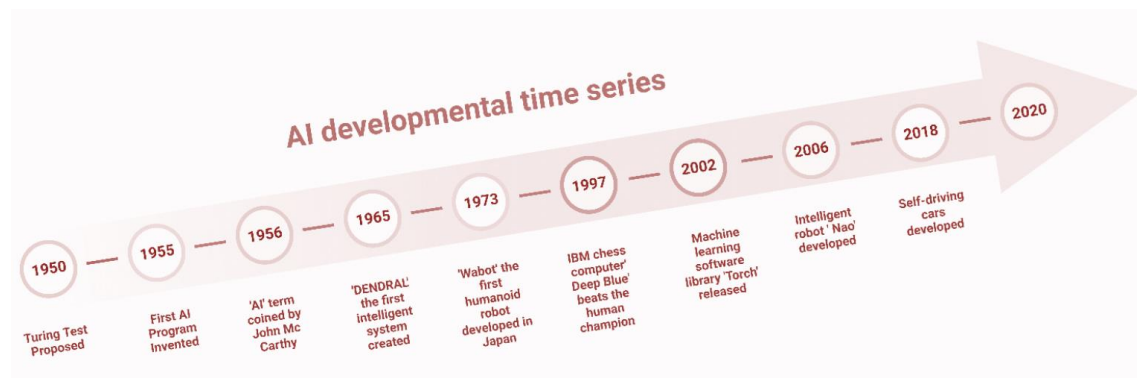


Figure 1. A sequence of events highlighting significant developments in artificial intelligence and their applications (Source: Bhardwaj et al., 2022).

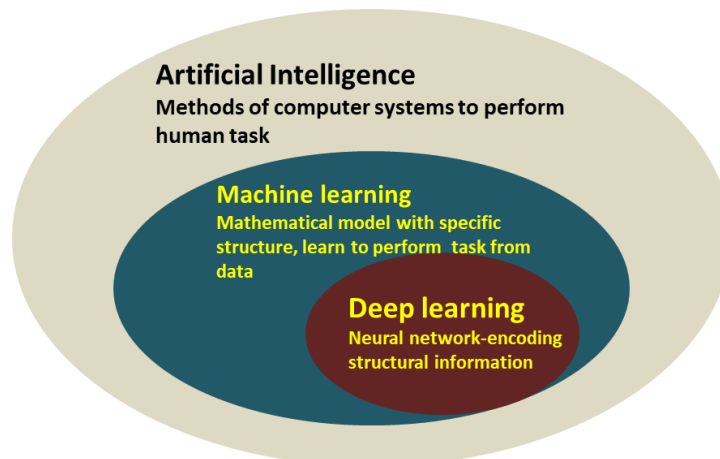


Figure 2. Structural relationship between artificial intelligence, machine learning and deep learning. (Source: <https://bitesizebio.com/64186/artificial-intelligence-in-biology/> & CRS Report R47849. Artificial Intelligence in the Biological Sciences: Uses, Safety, Security, and Oversight. November 2023. <https://crsreports.congress.gov>).

In the recent era, humans benefit differently as AI and biology work together. It gives up facilitating research and development opportunities, which can scrutinize vast biological data and detect them, further correlating with **human's** nature of work. Thus, AI may be used in various biological fields such as genetic engineering, drug design and development, protein

structure detection, critical diseases and their operation, etc., which are discussed further in this review section.

Some Applications of AI in Biological Research

Several search engine tools have observed that the number of AI search results in PubMed has increased daily, as mentioned in Figure 3.

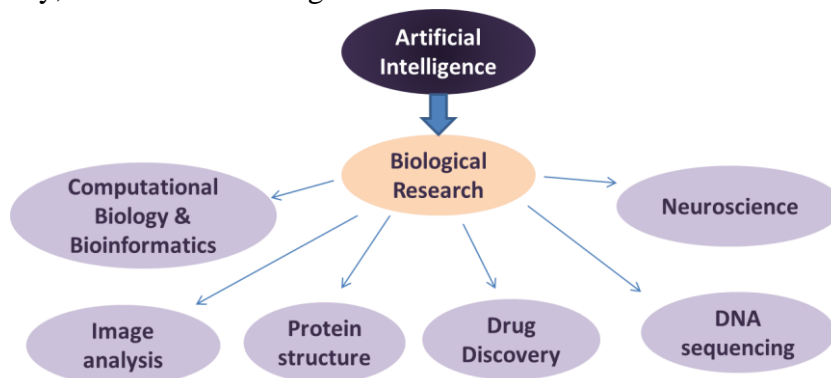


Figure 3. Some applications of AI in the field of biological research.

Application of AI in neuroscience:

Like the human brain, ML algorithms play a critical role in neuroscience. It plays a vital role in processing data in the visual cortex, neural plasticity, episodic memory etc. An important step towards understanding how the brain performs complex functions like face recognition is that artificial neural networks (ANNs) give neuroscientists ample models to explain how neural activity in different brain areas is performed (Koulakov et al., 2021). For experimental analysis, an animal given a series of stimuli and responses from different regions were recorded, which can be further used to compare the accuracy of the responses produced by various ANNs. Frequently, a neurone is modeled as a linear combination of ANN units, and the amount of variance in the neural response that the linear model explains is then determined (Savage, 2021; Richards et al., 2022; Kudithipud et al., 2022).

AI used for prediction of protein structure:

Different software tools were developed to analyze the protein structure. One of the most revolutionary protein structure detection software as a consequence of amino acid sequencing is AlphaFold. This is the leading software used for the first time to predict near-native protein folds from their genetic sequence. With the succession of AlphaFold software a few months later, the analog RoseTTAFold along with AlphaFold has contributed to their success in that anyone interested in experimenting with these programs can download them for free due to their open-source nature (Gomes et al., 2022; Jumper et al., 2021; Baek et al., 2021).

Application of AI in Drug Discovery

A simple drug is any substance used to prevent disease, treatment, or any other abnormal condition with a minimal dose. However, discovering a drug is challenging and critical to

establish and show its efficacy in a limited period; identifying the target takes a long time. Thus, AI can help smooth the drug discovery process at this time. In various aspects, AI can help a drug design a program to target the problem. In addition to its benefits, artificial intelligence poses serious data challenges, including data volume, growth, diversity, and unpredictability (Hassabis et al., 2017; Chen et al., 2018). In most cases, the main areas where AI is fruitful in drug discovery are predicting the properties of a potential compound accurately, developing new compounds by creating molecules with properties predicted for success, which could dramatically improve the discovery and development of effective new drugs, eliminate repetitive tasks when assessing a drug's effectiveness (Jumper et al., 2021; Preuer et al., 2019). Furthermore, AI-based algorithms can also be employed to identify new targets for drug development, such as the specific proteins or genetic pathways involved in diseases (Paul et al., 2021). In medical chemistry, AI is used to predict the efficacy and toxicity of potential compounds. The mode and pattern of action of a drug can be identified by AI-based analysis by ML algorithm, which could not be possible by human scientists (Blanco-González et al., 2023). Using these techniques, a bioactive compound's efficacy with a very minimal dose can be identified easily. On the other hand, AI is also used to identify a broad spectrum interaction between two drugs or multiple drugs with their trends and patterns of reaction (Blanco-González et al., 2023; You et al., 2019; Hansen et al., 2015; Gómez-Bombarelli et al., 2018). Thus, we can state that artificial intelligence (AI) is utilized in drug discovery processes such as target identification, drug molecular simulation, drug designing, and drug assumption of properties for subsequent pathway synthesis generation.

Application of AI in DNA sequencing

DNA sequencing, also known as genomic sequencing, is an experimental method scientists use to ascertain the precise nucleotide sequence of a DNA molecule. The machine methods for sequencing DNA have certain limitations and require much time. On the other hand, application AI can aid in data integration, sequencing variation, and the reduction of errors during the DNA sequencing process. This data variation aids in the discovery of customized medication to treat genetic illness (Chen et al., 2018; Qureshi et al., 2023; Vilhekar and Rawekar, 2024; Heather et al., 2016; Xu et al., 2019; Racovita and Jaramillo, 2020).

Application of AI in biological image analysis

Biological imaging is a non-invasive process where researchers can observe the biological data visually in a large section and analyze the data. Thus, the AI helps to analyze the extensive data from an image and extract the result, which can facilitate the scientist to interpret the result of their observation obtained from the bio-imaging. The fields of bio-imaging where AI technology can be beneficial are microscopy, molecular imaging, pathological imaging, optical coherence tomography, nuclear medicine, ultrasound imaging, X-ray radiography, CT-scan, magnetic resonance imaging (MRI), etc. (Xu et al., 2021; Dias and Torkamani, 2019; Carreras-Puigvert and Spjuth, 2024; Li et al., 2024; Bhardwaj et al., 2022; Maqsood et al., 2024). One of

the most essential tools in using machine learning technology in bio-imaging is "Aivia." These ML tools are used to arrange objects and pixels in an image by using deep learning technology, which can further restore the image resolution and extract essential information for speedy learning to identify any infectious diseases or conditions (Xu et al., 2021).

Application of AI in Computational Biology and Bioinformatics

Computational biology and bioinformatics are two significant fields in the biological research sector of modern science that analyze biological data using large-scale computer-generated mathematical calculations. As a result, this industry is vast in which ML algorithms using AI-based technology can be applied. The development of artificial intelligence (AI) in bioinformatics has opened up a wide range of knowledge about RNA, DNA computing, genomic sequence, gene expression regulation, and protein data processing, among other topics. Without this technology, it is challenging to conduct large-scale theoretical studies of the structures of proteins, RNA, and DNA, which makes it easier to develop new drugs and put them to use (Lai et al., 2018; Alam et al., 2024; Karim et al., 2023; Narayanan et al., 2002; Ezziane, 2006).

Conclusion:

It is evident now from AI's discoveries and applications that AI may be essential for biological and medical research. Numerous applications of machine learning in various biological fields have shown that AI is essential to overcoming the difficult task of analyzing large amounts of biological data, which is nearly impossible for researchers working by hand. However, there are some drawbacks to using AI in machine learning. Because machine learning is involved, calculations may occasionally miss the main issue, and the application will stray from its intended purpose. Applying AI to human research raises additional ethical concerns. This review paper provides information about the benefits of applying AI to our biological research system, which is essential for conducting theoretical and mathematical analyses of large amounts of data, even though it ignores some of its drawbacks. Following analysis, the data's conclusions may be applied to people to improve their quality of life.

Conflict of Interest:

The author declares no conflict of interest.

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