It is critical that the U.S. Government enacts policies that keep the United States at the forefront of the convergence of AI and biotechnology (AIxBio), while also encouraging responsible development and innovation. Recent advances in AI have spurred innovation in the field of biotechnology.

To seize on this innovation and to support policymakers around AIxBio decision-making, the National Security Commission on Emerging Biotechnology is releasing a series of white papers in January 2024 to provide an introduction to AIxBio. To address the special technical and policy considerations associated with AIxBio, these white papers will cover the landscape and basic technical concepts of AIxBio, cover the opportunities and new advances in AI and biotechnology, and explain potential risks that AI presents with respect to biosecurity.

What is AIxBio?

The use of artificial intelligence and machine learning (AI/ML) to enhance research and encourage breakthrough discoveries in all areas of biotechnology (AIxBio) has advanced over the last several decades. These tools help researchers and developers understand and interpret the genetic code, analyze images for farming and medical diagnostics, and run autonomous experimentation to increase the pace of cutting-edge research.

Large Language Model chatbots vs. Biological Design Tools

When discussing AIxBio, it is critical to understand the types of AI algorithms being considered. This paper specifically notes the difference between Large Language Model (LLM) chatbots such as ChatGPT and models that are built for use with biological information, called Biological Design Tools (BDTs).[1] There are many other types of AI models, but these white papers will focus on LLMs and BDTs to effectively compare the benefits and risks of both as they relate to biotechnology

Large Language Model (LLMs) chatbots

Inputs: Vast amounts of written material, usually from the internet
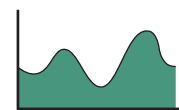
Outputs: Plain language responses

User Requirements: LLM chatbots have interfaces so any user can query the model

Biological Capabilities: Currently have varying scientific capabilities, but can be helpful in specific scenarios such as experimental troubleshooting

Biological Design Tools (BDTs)
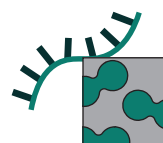
Inputs: Biological data such as genetic sequences, microscope images, or biological 3-D structures

Outputs: Predictions, simulations, or a further understanding of biological information

User Requirements: Using and developing BDTs require an understanding of biology and computer science, and BDTs are not accessible to untrained users

Biological Capabilities: BDTs can perform a wide range of biological predictive tasks because their algorithms are trained on biological data

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Why is AIxBio important?

Today, most large biotechnology companies use AI/ML in some part of their product development, and there are many start-ups dedicated to the development of AIxBio platforms for drug discovery and precision medicine, improved agricultural production, and enhanced fermentation processes. These models have already provided researchers the opportunity to accurately predict the 3-D structures of cellular components such as proteins[2] and RNA,[3] expedited the development of countermeasures for pandemics,[4] and interpreted information for precision farming practices[5] (Please see **White Paper #2** for more information on key examples of AIxBio). BDTs have already changed the way biologists perform experiments because AI models can make helpful predictions and suggestions that reduce experimentation time. The importance of AIxBio for research and innovation toward improving human and planetary health cannot be ignored.

What are the risks associated with AIxBio?

While there are a number of risks associated with AIxBio, this paper will highlight three key risks for consideration:

1) Not taking advantage of AI tools in the biotechnology discovery process: AI tools have already shown the ability to expedite biotechnology discovery. If the United States does not promote and take advantage of these technologies, the country is at risk of delaying discoveries and breakthroughs and potentially ceding ground to strategic competitors.
2) Inaccurate outputs from AI models: AI models that have errors in their algorithms or are trained on biased or incomplete datasets could produce inaccurate outputs that waste time and resources on unsuccessful biological experiments
3) Development of a harmful biological agent: AI models could assist in the creation and distribution of a harmful biological agent. For this class of risk, it is important to carefully consider who the bad actor is (amateur vs. expert), what AI model the actor is using (LLM vs. BDT), and what resources are available. Currently, there is very little quantitative study or information on the ability of any actor to create or use a harmful biological entity with the assistance of AI tools.

White Paper #3 of this series will dive into specific risks, with a focus on what is understood about using AI models to develop a harmful biological agent.

What is the future of AIxBio?

AIxBio is on the verge of a breakthrough moment where a model or suite of models revolutionizes all of biotechnology, making the research and development of drugs, foods, and the fermentation of industrial chemicals faster and more accessible to industry experts. While AIxBio tools are currently used extensively, there has not yet been a ChatGPT moment for AIxBio like there was in the field of LLMs.[6]

The United States has the potential to be at the forefront of such a breakthrough because of its advanced discoveries in computation. However, the United States must continue to encourage innovation in AIxBio and provide mechanisms for responsible development and innovation. If innovation is not promoted in the United States, other countries are prepared to move forward in realizing the potential of AIxBio, which will cause the United States to cede enormous geopolitical advantage in relation to both economic and national security gain.

Sources

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