Can artificial intelligence improve life science? As much as life science can improve AI, researchers say

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Artificial intelligence (AI) may attempt to mimic the human brain, but it has yet to fully grasp the complexity of what it means to be human.

While it may not truly understand feelings or original creativity, it can help us better understand ourselves—especially our physical bodies in health and in disease, according to a series of articles published by the journal *Quantitative Biology*.

The papers—a variety of editorials, perspectives and commentaries on AI for life science—assess the rapid development of AI and recent attention to Chat GPT and how life science researchers may be able to harness such AI tools to improve human health and understanding.

"There is no doubt that machine learning and AI have brought a new revolution in science and technology and will deliver huge unforeseeable impact to human everyday life, as well as to social relationships," said Michael Q. Zhang, the Cecil H. and Ida Green Distinguished Chair of Systems Biology Science and professor of biological sciences at the University of Texas, Dallas. He serves as co-editor-in-chief of *Quantitative Biology*. "In this context, *Quantitative Biology* could be a great platform for encouraging intellectual discussions on the topic."

Zhang said he wrote the editorial, "Dialog between artificial intelligence & natural intelligence," to prompt conversation among researchers and students. In it, he imagined a conversation between AI and natural intelligence (NI), in which the two debated their fundamental purposes and ultimate uses.

According to NI, the objective goal is survival of the population, while AI's goal should be to extend and maximize human capability—AI should complement the human brain. AI's position ultimately comes down to the idea that all disciplines require creativity, and AI is "more than happy working for science… especially in the area of generating big and longitudinal data for machine learning."

Xuegong Zhang, professor of automation at Tsinghua University and

executive editor-in-chief of *Quantitative Biology*, led the perspective study, "Building digital life systems for future biology and medicine," on fulfilling the potential of AI to creatively expand human knowledge. The team proposed the concept and framework of Digital Life Systems (dLife) as a new paradigm to comprehensively integrate AI as a means of digital investigation.

The idea is that by incorporating acquired information into system modeling, dLife can digitally twin full systems—including individual human bodies—and deliver knowledge quicker and more accurately about potential treatment benefits or side effects.

"A central step toward AI medicine is to achieve quantitative understanding of complex biological phenomena and underlying laws and to establish their mathematical and/or computational models, based on the ever-growing biological/medical data and knowledge," Xuegong Zhang said.

"Such models should mirror real life by being able to reproduce or simulate major biological processes and mechanisms in the digital space."

He noted that dLife is ambitious and will require significant collaborative research across multiple disciplines to achieve, starting with the design of a basic informatics framework to serve as dLife's operating system.

Such work depends largely on the ability of researchers to continue designing more capable AI while simultaneously making use of the available AI in their work. Gangqing Hu, assistant professor of microbiology, immunology and cell biology at West Virginia University, and his team authored a perspective, "Empowering beginners in bioinformatics with ChatGPT," on enabling early scholars to understand

how to do just that.

The researchers proposed the OPTIMAL model, which stands for Optimization of Prompts Through Iterative Mentoring and Assessment with an LLM (large language model) chatbot. OPTIMAL is an iterative model that helps beginners finetune instructions for guiding ChatGPT in generating code for bioinformatics data analysis.

They demonstrated the feasibility of the model by testing it in three case studies where students served as mentors to guide the chatbot in data analysis while also learning coding skills from the chatbot.

"While the concept of ChatGPT-aided education is relatively new, our case studies from different disciplines demonstrated ChatGPT's potential to enhance students' coding skills and critical creative thinking," Hu said. "Such benefits of practicing bioinformatics with a chatbot are likely to extend from the classroom to a lifelong learning experience, especially for beginners."

Dong Xu, the Curators' Distinguished Professor and the Paul K. and Dianne Shumaker Professor at the University of Missouri, echoed support for OPTIMAL and other potential applications of ChatGPT in advancing science in his commentary, "ChatGPT opens a new door for bioinformatics."

"The OPTIMAL model pioneered chatbot-aided bioinformatics data analysis and tutoring by employing a series of iterative steps to improve student learning outcomes," Xu said. "The strategy can probably go beyond the classroom and into a lifelong learning experience. Like many other fields, ChatGPT will also gain ground in bioinformatics, from education and literature mining to data analysis and method development."

ChatGPT is not the end game, though, according to Jianfeng Feng, dean of the Institute of Science and Technology for Brain-Inspired Intelligence at Fudan University.

In his commentary, "Simulating the whole brain as an alternative way to achieve AGI," Feng argued that the ability of ChatGPT to outperform humans in certain tasks is not surprising—after all, a simple calculator can multiply large numbers quicker than a human. However, it is not an example of artificial general intelligence (AGI), a theoretical step beyond AI that represents human abilities so well it can find a solution for any unfamiliar task.

"What is the key difference between our brain and current computers, from a mechanistic point of view?" Feng asked. "A simple answer is that our brain is a probabilistic machine: it calculates in a noisy or dynamic background. … To fully understand the dynamic operation of our brain, we should go beyond naïve static ways to analyze its dynamics, such as functional connectivity."

According to Feng, current progress in AI research is "exciting and encouraging," and there is much more to do to accurately duplicate the neurological and psychological processes of the human brain. Feng leads one research group aiming to simulate the whole human brain with 86 billion neurons simultaneously—a massive task across computer science, mathematics and biology.

"I am confident that to simulate the whole human brain at the cellular level provides us with the key to understand the complex brain spatiotemporal dynamics and subsequently achieve AGI," Feng said.

That human-AI integrative approach to advance AI abilities and human understanding simultaneously may be the optimal path for AI for life science, according to these articles.

More information: Michael Q. Zhang, Dialog between artificial intelligence & natural intelligence, *Quantitative Biology* (2023). DOI: 10.1002/qub2.5

Xuegong Zhang et al, Building digital life systems for future biology and medicine, *Quantitative Biology* (2023). DOI: 10.15302/J-QB-023-0331

Evelyn Shue et al, Empowering beginners in bioinformatics with ChatGPT, *Quantitative Biology* (2023). DOI: 10.15302/J-QB-023-0327

Dong Xu, ChatGPT opens a new door for bioinformatics, *Quantitative Biology* (2023). DOI: 10.15302/J-QB-023-0328

Jianfeng Feng, Simulating the whole brain as an alternative way to achieve AGI, *Quantitative Biology* (2023). DOI: 10.1002/qub2.6

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