The Rise of Generative Artificial Intelligence and Its Impact on Education: The Promises and Perils

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While we applaud the promise and value of generative artificial intelligence and Chat Generative Pretrained Transformer–like tools, leveraging their potential and values heavily depends on what we use them for and how, while also acknowledging and addressing their limits, limitations, and concerns.

In the past few months, we have witnessed much buzz and unprecedented interest in generative artificial intelligence (GAI), particularly GAI-driven chatbots and automated writing, drawing, painting, and coding tools. From science fiction to reality, GAI is making inroads into several areas, including education and research, transforming and revolutionizing them in unexpected ways. GAI is also changing how we interact with computers, gather information, and get work done. Notably, OpenAI's release of the conversational AI text-writing tool Chat Generative Pretrained Transformer (ChatGPT) in November 2022 created a storm in technology and business domains, opening up unforeseen opportunities, concerns, and challenges.

Implications of GAI for education are profound, as are concerns surrounding them. However, how we can—and

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should—leverage the opportunities these conversational GAI-driven tools offer and address the issues they present us satisfactorily is a moot point. Opinions and viewpoints vary widely and are changing as we try to use them in unseen ways, uncovering their merits and drawbacks, and their developers continue to improve them.

THE RISE OF GAI

Unlike traditional AI machine learning models, which recognize patterns in the training data and learn to make predictions, classify things, offer personalized recommendations, or help in decision-making, GAI can create new content quickly on the fly based on a prompt (input) from the user. For example, it can write a short essay, answer a question, generate code, synthesize a new drug, summarize text, create a new image, or synthesize music. As a result, it can support and facilitate the development of several game-changing applications and transformations in several domains. Hence, the field of GAI is generating significant interest not only from general users, educators, and researchers but also from global media and commentators.

Although the concept of GAI is not new, the emergence and convergence of several trends in recent years, including better models such as generative adversarial networks, variational autoencoders, and large language models (LLMs); availability of more training data; and higher computing capacity at relatively lower cost have productized GAI models and brought them to everyday applications, and to everyone (free for now). In effect, these chatbots have democratized GAI.

Excitement and hype in GAI are high, and over 275 big tech companies and startups are driving GAI forward. The AI arms race is on.[1,2] As a result, GAI is poised to usher in a new era of GAI-driven applications we had never envisaged possible, at least so soon.

CHATBOTS

A form of GAI, a chatbot is a conversational virtual assistant. Major tech companies have been working on LLMs that drive GAI and AI-enabled chatbots for a long time. However, only now they are advanced enough to be deployed for public use. They include ChatGPT, Bard, Language Model for Dialogue Applications (LaMDA), Sparrow, and YouChat 2.0 and their several extensions and application programming interfaces (APIs).

ChatGPT

Launched in November 2022, OpenAI's ChatGPT (https://openai.com/blog/chatgpt/) is a conversational text-writing chatbot built on its updated version of LLM GPT.[3] A transformer is a deep learning model that selectively concentrates on discrete aspects of information, differentially weighting the significance of each part of the input data. ChatGPT is essentially a user interface for the LLM GPT-3 (the third version of the GPT), which has 175 billion parameters and a massive 600 GB of data, gathered from books, newspapers, reports, research papers, and online sources in 2021. Accessible via a free, intuitive, conversational web interface, ChatGPT can create new text or an essay on the fly in response to the user's prompts or questions. As a result, ChatGPT can revolutionize everything from writing and customer service to coding.

Microsoft has integrated ChatGPT with its search engine and plans to integrate ChatGPT into its Office suite. ChatGPT also powers Microsoft Teams; developers can use it through an API. A paid tier called ChatGPT Plus is available for users who want faster response times and improved access to the tool.

Since its launch, ChatGPT has generated a tsunami of interest and become the fastest-growing app in human history, reaching an estimated 100 million active users in just two months.[4] It attracted an average of 13 million unique daily users in January of this year.[5] Yet, despite its popularity and the hype surrounding it, it has significant limitations. For example, it can even make factual errors, fabricate answers, and give invalid responses, which raise several concerns among many.

LaMDA, Bard, and Pathways Language Model

Google's LaMDA, released in May 2022, is a large natural language model trained on over 1.56 trillion words of conversation data and online pages using the transformer architecture. LaMDA has 137 billion parameters[6] and drives Google's chatbot Bard and AI search engine. Its Pathways Language Model (PaLM) is expected to be bigger than LaMDA and ChatGPT. Google shared its perspective on the growth of AI and why it was taking a careful approach to roll out PaLM.[7]

Sparrow

DeepMind's Sparrow is a chatbot trained on text data scraped from the Internet and optimized for dialogue. It is expected to be available for a private beta in 2023. It leverages reinforcement learning with human feedback and is likely to offer safer responses than its nonreinforced counterparts, with less bias and discrimination. Further, it can support its response by showing evidence from sources. However, it sometimes can make mistakes and give answers far off the topic. For a comparison between ChatGPT and Sparrow, refer to an article[8] in *The Algorithmic Bridge*.

YouChat 2.0

In February 2023, search engine startup You.com launched a new multimodal conversational AI system called YouChat 2.0, which promises to offer

a unique and interactive experience with each query.[9] Based on its blended LLM known as Chat, Apps, and Links, YouChat 2.0 can present charts, images, videos, tables, graphs, text, or code in its responses to user queries.

AI ART TOOLS

Several LLM-based tools such as DALL-E 2, Stable Diffusion, Imagen, and Parti can create images and paintings responding to the user's text prompt in natural language. In addition, Shutterstock, a popular online source of stock photos and illustrations, in partnership with OpenAI, has launched its GAI Image Tool based on DALL-E, which is accessible to its paid customers.

ADD-ONs AND EXTENSIONS

Within months of the introduction of ChatGPT, several valuable add-ons and extensions to ChatGPT, such as GraphGPT, Codex, Humata, and ChatBCG, have arrived.

GraphGPT

GraphGPT (https://github.com/varunshenoy/GraphGPT) converts unstructured natural language into a knowledge graph providing a structure and a graph visualization of entities and their relationships in a given text. The text could be a passage from a web page, book, conversation, or video transcript. GraphGPT can generate updatable, complex, directed graphs.

Codex

OpenAI's Codex is an AI-powered code writer cum editor and generates a solution code for a problem described in natural language as input. It can also explain program code, translate code between programming languages, and perform other programming-related tasks.[10] Alphacode, AI Code Reviewer, AI Data Sidekick, and Figstack are other AI tools helpful to programmers.

Humata

Humata (https://www.humata.ai/) is a chatbot that lets you upload a PDF document (up to 60 pages long) and answers your questions about the document in simple English. It can instantly turn complex articles into easily understandable summaries, generate insights, and immediately give easy-to-understand answers to questions (prompts) related to your document and cite the page for each answer.

ChatBCG

Based on bimodal conditional generation (BCG), ChatBCG-3 (https://www.chatba.com/) can create PowerPoint presentation slides in multiple layouts or themes for a given text prompt. In addition, in the future, it will likely generate slides for the provided content and data-driven charts.

BioGPT

Microsoft's BioGPT is a domain-specific chatbot based on a transformer language model tailored for answering biomedical questions.[11] It was trained using only biomedical articles from PubMed, published before 2021.

Other extensions

Several ChatGPT extensions unite ChatGPT with a search engine, allow voice prompts for ChatGTP, and integrate ChatGPT in Google Docs, Microsoft Word, WhatsApp, and the Google Chrome web browser.[12]

Chatbot: A general-purpose technology

Chatbots built on an LLM possess the characteristics that let them be a general-purpose technology, such as pervasiveness (being used or usable in many industries), inherent potential for continued improvement, and "innovational complementarities" [capacity to inspire and drive knock-on innovation (innovation that generates further innovations)].[13,14] Major technology companies are showing great interest in chatbots, driven by the competitive pressure to succeed in the era of GAI. Hence, chatbots are in a favorable position to gain widespread adoption, improve significantly, and bring about transformative changes in various industries.

CHATBOTS' LIMITATIONS AND CONCERNS

While powerful and versatile, LLM-based chatbots are still in their early stages and have several limitations. For example, there are significant concerns about the accuracy and validity of their responses and their potential for misuse and the spread of false information. Other issues include increased plagiarism, racial bias in their response, the potential for creating harmful content, and ethical concerns. Furthermore, these chatbots may aid cybercrime, fraud, and cyberattacks by creating spam messages or other means and may also face legal issues around copyright and other legal matters.

Occasionally, a chatbot's response may even contain factual errors. Chatbots can create regurgitate or create falsehoods and makeup responses. So, users have to review and assess their validity. To capture and classify the errors ChatGPT and other LLMs make, a public "error tracker" database[15] has been set up. The database is expected to help examine why these models misbehave and how people might avoid misuse.

Chatbots are like a double-edged sword. How we use them—and what for—matters. If you ask ChatGPT to create misinformation, it will. It could also instantly create fake news about anything. Some may misuse AI-generated content, claiming they had written or created it. For example, students could claim an AI-written essay that is well done and can attract a good grade as their own, even without understanding what is written, increasing incidences of AI-driven plagiarism.

Artists have launched a class action against companies that offer AI-generated art, and the legality of using data to train an AI without the consent of the people who created those data are being examined.[16,17]

Unsurprisingly, users and commentators of AI content generators fall

into three groups: passionate lovers, strong critics, and those in between who take a balanced view.

GAI AND EDUCATION

Technology will continue to be an effective tool for learning and education. We have long been using the computer for learning and doing assignments and also to help with and improve our writing. We have used spellcheckers, grammar checkers, and AI text editors like Grammarly to correct grammatical errors and improve word choice and sentence structure. Students use calculators, spreadsheets, and tools like MATLAB and Mathematica for calculation, statistical analysis, and simulation. They have been quickly consulting Wikipedia and online resources (blogs, social media, and scholarly articles) assisted by powerful search engines like Google and Google Scholar to write essays and for learning research.

So, teachers' and students' widespread use of educational software and AI tools is not new, and educational institutions have adapted to them. What is new is that we have more powerful and versatile cognitive GAI tools that can help students, teachers, and researchers with higher-level cognitive tasks.

Use of chatbots and AI tools

A ChatGPT-like chatbot is a teaching tool as well as a learning tool. For example, it can assist schoolteachers in generating sample lesson plans, learning objectives, and activities for students at a given level, which they must review and refine. It can also help teachers and students plan, generate ideas, and organize lessons. Furthermore, ChatGPT can not only create code but also debug it.

With the popularity of ChatGPT, a new term, "prompt engineering,"[18] has emerged; it refers to generating prompts or input text for a language model such as ChatGPT or any other application built using LLMs. To get a better response, prompt(s) have to be relevant, coherent, and consistent with the intended purpose of the output.[19,20] Results can be further refined iteratively (even simplified) with subsequent prompts. Additionally, if the chatbot tends to be verbose, we can ask for a summary or shorter response with an upper limit on word count.

AI tools can free up some time for teachers to connect and engage with students and help create more personal and meaningful learning opportunities, including learning new developments that are often neglected. In addition, chatbots can accelerate the learning of basic concepts.

Besides chatbots, several AI tools and applications can help in programming, debugging, and creating meaningful connections and learning experiences.[21,22]

As learners are bound to use modern AI tools, it is vital that assessment and teaching models also keep up with the trend. There is a need to change traditional assessment models to assess the process of learning, problem-solving, and critiquing rather than evaluating the end product. Humans and AI working together is the future.

However, using AI tools in education has led to concerns about increased student plagiarism, also known as "AI-giarism." To address this issue, several tools have emerged, including GPTZero (https://gptzero.me/) and OpenAI's classifier.[23] GPTZero identifies text authored by AI based on perplexity, a measure of how complex the text is, and burstiness, a measure of how uniform a text is in terms of sentence length. OpenAI's classifier rates the likelihood that a given text is AI-generated. However, these tools can still be evaded by minor edits or alterations and cannot be relied upon solely to detect AI-generated text. For more on AI-generated content detectors, stay tuned for a follow-on article in this department.

Research and development

GAI will have significant implications for research, creating both opportunities and concerns. For instance, GAI can help researchers summarize the literature, identify research gaps, understand concepts in other domains they can embrace, improve their papers, write software for analysis and simulation, and even help with designing experiments. They are likely to revolutionize research practices, accelerate innovation, make science more equitable, and increase the diversity of scientific perspectives.[24,25] However, if not used ethically and professionally, they could also harm research quality, transparency, and creativity and raise concerns about publications (which will be discussed in an upcoming *Computer* article). Several issues[24] on the implications of GAI on research and development need further discussion among stakeholders.

ADDRESSING TECH-DRIVEN EDUCATIONAL CRISIS

Education is facing a tech-driven crisis as students and teachers across the globe are beginning to embrace disruptive GAI tools such as ChatGPT. Educators need to recognize that GAI can help students to learn and write better, assist teachers, and help in research and discovery, but it can also help one to cheat. Moving forward, we must consider ways to augment learning, teaching, and research using GAI rather than curb its use. It seems futile to fight against the educational use of AI tools. Instead, we must integrate GAI's various offerings meaningfully into teaching and learning and remodel student learning objectives and assessments.

Historically, educational institutions have adapted to new technologies and new sources of information to enhance learning and teaching. They can—and should—do the same with new AI tools, supported by new safeguards and updated policies on academic integrity. In response to the emergence of new GAI tools and their potential use, several educational institutions have updated their policies

regarding student assignments, plagiarism, proper crediting of AI tool usage, and academic integrity.[26]

A LOOK AHEAD

Chatbots and other AI-supported content creators are rapidly evolving despite being in their early stages. As they evolve, they will improve sophistication, offer new features, and overcome limitations. This disruption will significantly impact the future of content creation and have a profound effect.

In the future, education at all levels will be AI-enabled, and GAI will play significant roles in all aspects of education. Educational institutions and academics will innovatively embrace new tools and technologies and address the concerns. Learners will increasingly use AI-enabled tools, even if some institutions ban them. This is an opportune time to rethink and reshape teaching, learning, writing, assessment, and research.

Like it or not, GAI will advance further and be a game changer in many ways. So, let us remain optimistic and be tuned to embrace a GAI-driven future effectively.

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