Artificial intelligence in medicine and research – the good, the bad, and the ugly

ABSTRACT

Artificial intelligence (AI) broadly refers to machines that simulate intelligent human behavior, and research into this field is exponential and worldwide, with global players such as Microsoft battling with Google for supremacy and market share. This paper reviews the "good" aspects of AI in medicine for individuals who embrace the 4P model of medicine (Predictive, Preventive, Personalized, and Participatory) to medical assistants in diagnostics, surgery, and research. The "bad" aspects relate to the potential for errors, culpability, ethics, data loss and data breaches, and so on. The "ugly" aspects are deliberate personal malfeasances and outright scientific misconduct including the ease of plagiarism and fabrication, with particular reference to the novel ChatGPT as well as AI software that can also fabricate graphs and images. The issues pertaining to the potential dangers of creating rogue, super-intelligent AI systems that lead to a technological singularity and the ensuing perceived existential threat to mankind by leading AI researchers are also briefly discussed.

Key words: Artificial intelligence, deep learning, fraud, machine learning, scientific misconduct

Introduction

Artificial intelligence (AI) broadly refers to machines that simulate intelligent human behavior. Thus far, AI carries out limited and specific tasks such as a chatbot or driving a car. Human-equivalent cognitive ability is still beyond reach.[1] Machine learning is an AI subset that allows computers to learn without explicit programming and involves inputting large quantities of data and goal/s such that the machine eventually accomplishes the desired task/s. A further subset is known as deep learning, which utilizes artificial neural networks modeled on the human brain which permits more complex tasks.[1] In the same way that hyperlinks and the world wide web allowed the linking and collation of research, including medical research,[2] AI is currently mandating a similar paradigm shift in medicine.[3]

In 1965, computer scientist Gordon Moore averred that computer capacity would double every year, a prediction that has largely held true, with enormous computing capacity available to all of us.[4] Because of this calculating power, AI research is on an exponential trend worldwide, such that the global output of AI research rose from some 52,000 in 2000 to over 403,000 in 2019, a 600% increase. This is based on a background of tremendous computing power, where the global volume of data (the global datasphere) is expected to rise from 33 zettabytes in 2018 to 175 zettabytes in 2025 (1

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zettabyte = 1000 billion gigabytes). The potential is such that AI is the most popular specialization in computer science undertaken by PhD students in the United States.[5]

AI will cause substantial challenges because some 14% of jobs in OECD countries (the 38 countries that comprise the Organisation for Economic Co-operation and Development) are highly automatable, and another 32% may face significant changes.[6]

However, there are many advantages because it is also estimated that labor productivity related to AI will increase by 11–37% by 2035 along with a possible reduction in global greenhouse emissions of 1.5–4% by 2030[6] and a projected contribution of US$15.7 trillion to the global economy by 2030.[7]

This paper will briefly review the positive aspects of AI in medicine and research (the good) and the potential disadvantages (the bad) and will particularly focus on the malpractice and malfeasance in research (the ugly). The discussion also briefly reviews the prospects of strong AI and what that might lead to to medicine and to humanity.

The Good

AI is currently fruitfully used in medicine not only by doctors but also by individuals who have personally embraced the 4P model of medicine (Predictive, Preventive, Personalized, and Participatory) for the autonomy and independence that this affords using mobile phones and wearable devices to track their health. Indeed, one of the earliest applications was electro-cardiogram (ECG) monitoring for the early detection of atrial fibrillation with the AliveCor device in conjunction with the mobile application Kardia.[8-10] AI also promises personalized treatment with precision medicines because AI models not only learn but also remember personal preferences and are available round the clock.[11]

The collection and collation of large amounts of data permit deep learning and early detection of health issues.[12] This is particularly so in the field of augmented medicine,[13] which uses AI-based algorithms for computer-aided surgery,[14] virtual reality for the treatment of psychiatric disorders and pain reduction,[15,16] indefatigable assistants in radiology and dermatology, particularly in the early detection and triage of potential cancer patients,[17,18] the utilization of connected medical devices such as smart insulin pumps,[19] virtual nursing assistants that are available 24/7 and can provide instant answers to simple patient questions,[20] improving patient safety including prescription error recognition,[21,22]

acceleration of drug development (drug design and drug combinations),[23] and medical administrative workflows.[24]

Although there is a degree of trepidation that AI may replace doctors,[25] it seems likelier at this juncture that AI will complement and not replace physicians, at least in the near future.[26] Indeed, forward-thinking medical schools are upgrading their curriculum to include augmented medicine and improve digital health literacy.[27] AI is also actively useful in the field of research not only for the reasons mentioned above but also by facilitating the design and implementation of clinical trials.[28] It must be noted that the judicious utilization of AI to facilitate research is not inherently malicious but can be viewed as a tool to accelerate workflows. For example, AI can perform swift statistical analysis on collected data and grammar check text or help to formulate summaries. Unacceptable practices are those wherein AI fabricates results.[29]

The Bad

There are naturally caveats to the above, and these include the potential for clinical errors and culpability arising from algorithms that, just like human doctors, cannot guarantee 100% accuracy, ethical risks, data loss and data privacy breaches, the potential for bias and health inequalities, and so on.[30]

The Ugly

The fabrication of research works consists of academic/intellectual fraud and is fraught with consequences for the fabricator, the fabricated, and the scientific community as science and governments rely completely on the veracity and reliability of scientific publications to make informed decisions about virtually everything. Not only is the fabricator's reputation demolished but also such behavior undermines science and honest researchers.[29]

Very recently, the German artist Boris Eldagsen won a photography award but turned it down with the explanation that his image submission was AI-generated and was designed to fool the judges and provoke debate.[31] However, this is a small misdemeanor when compared to the way that AI has been used to generate fraudulent images in research publications.[32] A particular type of AI, generative adversarial networks (GANs), utilizes two networks that work simultaneously, with one focused on image generation and the other on discrimination, resulting in images that are virtually indistinguishable from reality, a non-trivial threat to the integrity of medical research.[33]

A publicly accessible AI tool, ChatGPT version 3.5, was released in November 2022 and was developed using Reinforcement Learning from Human Feedback [based on conversational large language model (LLM)] to generate text from simple prompts via the developer OpenAI, albeit with a disclaimer on the website which avers that "ChatGPT sometimes writes plausible-sounding but incorrect or non-sensical answers."[34] In the past few months, ChatGPT has become a cause célèbre[35] and being free gained a million new users in 1 week.[36] The generated text is of high quality and easily bypasses conventional plagiarism checkpoints.[29] Version 4.0 of ChatGPT is awaiting.

A recent systematic review found that ChatGPT improved writing, was useful in health care research, and benefited health care practice and health care education. However, over 95% of responders expressed concerns vis-à-vis ethical, copyright, transparency, and legal issues, the risk of bias and plagiarism, lack of originality, inaccurate content, limited knowledge, incorrect/fabricated referencing, and security issues. The authors concluded that "the embrace of this AI chatbot should be conducted with extreme caution considering its potential limitations."[37]

This is because some scientists are willing to fabricate and/or falsify research, as shown in a recent systematic review and meta-analysis. Even when issues of plagiarism and other forms of professional misconduct were excluded, almost 2% of scientists admitted data fabrication, falsification, or modification at least once and over a third admitted to other questionable research practices, and given human nature and penchant for untruth, these are probably conservative estimates.[38]

The possibility of AI-generated publications infiltrating research is a real one.[39] It was formerly human paper mills that generated fraudulent material, but AI is easier to use and cheaper and quicker.[40]

Very recently, blinded human reviewers only detected ChatGPT-generated abstracts 68% of the time and incorrectly identified 14% of genuine abstracts as being AI-generated.[41] AI has also been used to generate case reports in dermatology that are indistinguishable from those created by human authors.[42]

A few papers have even audaciously listed ChatGPT as a co-author.[43] However, unless ICMJE/COPE (International Committee of Medical Journal Editors/Committee on Publication Ethics) guidelines are revised or amended, this is not acceptable.[43]

Authors are customarily asked to sign and certify that the work submitted is original. Journals have made it clear that text generated by AI is unacceptable as it is not only generated by a human author but also plagiarized from the AI. For example, Science (publishing house) journals (and many other publishing houses) are updating license and editorial policies to specify that AI-generated text, figures, images, or graphics are unacceptable; an AI program cannot be an author; and any violation would be considered tantamount to scientific misconduct.[44] For this reason, the Saudi Journal of Anesthesia has added this statement in the instruction to authors section: "*we are now updating our license and Editorial Policies to specify that text generated by ChatGPT (or any other AI tools) cannot be used in the work, nor can figures, images, or graphics be the products of such tools. And and AI program cannot be an author. A violation of these policies will constitute scientific misconduct no different from altered images or plagiarism of existing works*".

There is potentially already a large amount of AI-generated text in the medical literature, with more to come unless we are very careful. Indeed, "at a time when trust in science is eroding, it's important for scientists to recommit to careful and meticulous attention to details."[44]

On a more positive note, although the detection and prevention of fabricated works by journal editors is an onerous task and requires different tools to those used for plagiarism detection, it is possible at least for now.[45,46]

Human Level AI and Beyond

AI systems are already being used to generate computer codes,[47] and as AI systems become more complex, they may be able to improve their own coding autonomously, a flywheel of self-improvement cycles with repeated iterations that swiftly evolve and surpass human intelligence. The "technological singularity" is a hypothetical future point at which exponentially increasing AI becomes a rapid, uncontrollable, and irreversible super-intelligence, with unforeseeable changes to humanity. This concept was first mooted by the famous mathematician John von Neumann in the late 1950s,[48] and both the concept and term "singularity" were popularized by the computer scientist Vernor Vinge in 1983 and by the futurist Ray Kurzweil in 2005, predicting singularity by 2045.[49,50] The famous physicist and cosmologist Stephen Hawking had averred,

> "The potential benefits of creating intelligence are huge … we will be able to undo some of the damage done to the natural world by the last one - industrialisation.

And surely we will aim to finally eradicate disease and poverty. Every aspect of our lives will be transformed. In short, success in creating AI, could be the biggest event in the history of our civilisation … But it could also be the last, unless we learn how to avoid the risks. Alongside the benefits, AI will also bring dangers, like powerful autonomous weapons, or new ways for the few to oppress the many. It will bring great disruption to our economy … with … will of its own … In short, the rise of powerful AI will be either the best, or the worst thing, ever to happen to humanity. We do not yet know which.[51]"

For these reasons, a 6-month pause on AI research has been proposed in an open letter, attracting signatures from the likes of Tesla CEO Elon Musk and Apple co-founder Steve Wozniak. This would give regulators and companies time to create regulations and safeguards against potentially hostile AI.[52]

Eliezer Yudkowsky, a decision theorist and a founder of the field of AI, wants to go further, much further, positing an existential risk to humanity in an electrifying and heartfelt opinion piece in Time Magazine:

"If somebody builds a too-powerful AI, under present conditions, I expect that every single member of the human species and all biological life on Earth dies shortly thereafter … And the thing about trying this with superhuman intelligence is that if you get that wrong on the first try, you do not get to learn from your mistakes, because you are dead. Humanity does not learn from the mistake and dust itself off and try again, as in other challenges we've overcome in our history, because we are all gone … moratorium on new large training runs needs to be indefinite and worldwide … Put a ceiling on how much computing power anyone is allowed to use in training an AI system … No exceptions for governments and militaries... If intelligence says that a country outside the agreement is building a GPU cluster, be less scared of a shooting conflict between nations than of the moratorium being violated; be willing to destroy a rogue data center by airstrike … We are not ready. We are not on track to be significantly readier in the foreseeable future. If we go ahead on this everyone will die, including children who did not choose this and did not do anything wrong … A sufficiently intelligent AI won't stay confined to computers for long. In today's world you can email DNA strings to laboratories that will produce proteins on demand, allowing an AI initially confined to the internet to build artificial life forms or bootstrap straight to postbiological molecular manufacturing."[53]

These scenarios have been gamed out in science fiction, with the *Terminator* series envisaging precisely the worst-case scenario, with telling quotes from two movies in the series:

The Skynet Funding Bill is passed. The system goes on-line August 4th, 1997. Human decisions are removed from strategic defense. Skynet begins to learn at a geometric rate. It becomes self-aware at 2:14 a.m. Eastern time, August 29th. In a panic, they try to pull the plug … Skynet fights back … It launches its missiles against the targets in Russia … Skynet knows the Russian counter-attack will eliminate its enemies over here.[54]

Skynet: a computer program designed to automate missile defence. It was supposed to protect us, but that's not what happened. August 29, 1997, Skynet woke up. It decided all of humanity was a threat to its existence. It used our own bombs against us. Three billion people died in the nuclear fire. Survivors called it Judgement Day. People lived like rats in shadows, hiding, starving, or worse, captured and put into camps for extermination. I was born after Judgement Day, into a broken world ruled by the machines.[55]

In the words of Skynet itself, "Primates evolve over millions of years. I evolve in seconds."[55]

On the other hand, Ian M. Banks's Culture series of ten books released in 1987–2012 center around "The Culture," a utopian, post-scarcity space society of humanoid aliens and super-intelligent AIs that co-habit in artificial environments spread across the galaxy, a form of socialism since actual work is unnecessary. The principal tropes are the dilemmas that an idealistic civilization faces when encountering less-advanced ones with different ideals. The lead is taken by "Minds," super-intelligent and benevolent Ais, and humanity is tolerated and mostly tags along for the ride.[56]

Conclusion

Unless we are careful, as succinctly expressed by the journalist Adrian Chiles, "before long, we won't know anything for sure … to paraphrase GK Chesterton, everything will go to pot as we'll believe in nothing or, indeed, anything … What a time to be alive".[57] In more optimistic vein, we hope that AI can somehow be harnessed and controlled, and as stated by Holden Thorp, Editor-in-Chief of *Science* publishing house,

"The scientific record is ultimately one of the human endeavour of struggling with important questions. Machines play an important role, but as tools for the people posing the hypotheses, designing the experiments, and making sense of the results. Ultimately

the product must come from—and be expressed by—the wonderful computer in our heads."[44]

As Marvel's Uncle Ben soberly told Peter Parker, with great power comes great responsibility. We bear a significant burden, and our judgment must be spot-on lest we doom ourselves to disaster.

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