How GPT models could go wrong

Editorial: How to worry wisely about artificial intelligence

Rapid progress in AI is arousing fear as well as excitement. How worried should you be?

Report: How generative models could go wrong

The Economist, April 22nd 2023

Editorial

“Should we automate away all the jobs, including the fulfilling ones? Should we develop non-human minds that might eventually outnumber, outsmart...and replace us? Should we risk loss of control of our civilisation?” These questions were asked last month in an open letter from the Future of Life Institute, an ngo. It called for a six-month “pause” in the creation of the most advanced forms of artificial intelligence (AI), and was signed by tech luminaries including Elon Musk. It is the most prominent example yet of how rapid progress in AI has sparked anxiety about the potential dangers of the technology.

In particular, new “large language models” (LLMs)—the sort that powers ChatGPT, a chatbot made by OpenAI, a startup—have surprised even their creators with their unexpected talents as they have been scaled up. Such “emergent” abilities include everything from solving logic puzzles and writing computer code to identifying films from plot summaries written in emoji.

These models stand to transform humans’ relationship with computers, knowledge and even with themselves. Proponents of AI argue for its potential to solve big problems by developing new drugs, designing new materials to help fight climate change, or untangling the complexities of fusion power. To others, the fact that ais’ capabilities are already outrunning their creators’ understanding risks bringing to life the science-fiction disaster scenario of the machine that outsmarts its inventor, often with fatal consequences.

This bubbling mixture of excitement and fear makes it hard to weigh the opportunities and risks. But lessons can be learned from other industries, and from past technological shifts. So what has changed to make AI so much more capable? How scared should you be? And what should governments do?

In a special Science section, we explore the workings of llms and their future direction. The first wave of modern AI systems, which emerged a decade ago, relied on carefully labelled training data. Once exposed to a sufficient number of labelled examples, they could learn to do things like recognise images or transcribe speech. Today’s systems do not require pre-labelling, and as a result can be trained using much larger data sets taken from online sources. LLMs can, in effect, be trained on the entire internet—which explains their capabilities, good and bad.

Those capabilities became apparent to a wider public when ChatGPT was released in November. A million people had used it within a week; 100m within two months. It was soon being used to generate school essays and wedding speeches. ChatGPT’s popularity, and Microsoft’s move to incorporate it into Bing, its search engine, prompted rival firms to release chatbots too.

Some of these produced strange results. Bing Chat suggested to a journalist that he should leave his wife. ChatGPT has been accused of defamation by a law professor. LLMs produce answers that have the patina of truth, but often contain factual errors or outright fabrications. Even so, Microsoft, Google and other tech firms have begun to incorporate LLMs into their products, to help users create documents and perform other tasks.

The recent acceleration in both the power and visibility of AI systems, and growing awareness of their abilities and defects, have raised fears that the technology is now advancing so quickly that it cannot be safely controlled. Hence the call for a pause, and growing concern that AI could threaten not just jobs, factual accuracy and reputations, but the existence of humanity itself.

Extinction? Rebellion?

The fear that machines will steal jobs is centuries old. But so far new technology has created new jobs to replace the ones it has destroyed. Machines tend to be able to perform some tasks, not others, increasing demand for people who can do the jobs machines cannot. Could this time be different? A sudden dislocation in job markets cannot be ruled out, even if so far there is no sign of one. Previous technology has tended to replace unskilled tasks, but LLMs can perform some white-collar tasks, such as summarising documents and writing code.

The degree of existential risk posed by AI has been hotly debated. Experts are divided. In a survey of AI researchers carried out in 2022, 48% thought there was at least a 10% chance that AI's impact would be "extremely bad (eg, human extinction)". But 25% said the risk was 0%; the median researcher put the risk at 5%. The nightmare is that an advanced AI causes harm on a massive scale, by making poisons or viruses, or persuading humans to commit terrorist acts. It need not have evil intent: researchers worry that future AIs may have goals that do not align with those of their human creators.

Such scenarios should not be dismissed. But all involve a huge amount of guesswork, and a leap from today's technology. And many imagine that future AIs will have unfettered access to energy, money and computing power, which are real constraints today, and could be denied to a rogue AI in future. Moreover, experts tend to overstate the risks in their area, compared with other forecasters. (And Mr Musk, who is launching his own AI startup, has an interest in his rivals downing tools.) Imposing heavy regulation, or indeed a pause, today seems an over-reaction. A pause would also be unenforceable.

Regulation is needed, but for more mundane reasons than saving humanity. Existing AI systems raise real concerns about bias, privacy and intellectual-property rights. As the technology advances, other problems could become apparent. The key is to balance the promise of AI with an assessment of the risks, and to be ready to adapt.

So far governments are taking three different approaches. At one end of the spectrum is Britain, which has proposed a "light-touch" approach with no new rules or regulatory bodies, but applies existing regulations to AI systems. The aim is to boost investment and turn Britain into an "AI superpower". America has taken a similar approach, though the Biden administration is now seeking public views on what a rulebook might look like.

The eu is taking a tougher line. Its proposed law categorises different uses of AI by the degree of risk, and requires increasingly stringent monitoring and disclosure as the degree of risk rises from, say, music-recommendation to self-driving cars. Some uses of AI are banned altogether, such as subliminal advertising and remote biometrics. Firms that break the rules will be fined. For some critics, these regulations are too stifling.

But others say an even sterner approach is needed. Governments should treat AI like medicines, with a dedicated regulator, strict testing and pre-approval before public release. China is doing some of this, requiring firms to register AI products and undergo a security review before release. But safety may be less of a motive than politics: a key requirement is that AIs' output reflects the "core value of socialism".

What to do? The light-touch approach is unlikely to be enough. If AI is as important a technology as cars, planes and medicines—and there is good reason to believe that it is—then, like them, it will need new rules. Accordingly, the EU's model is closest to the mark, though its classification system is overwrought and a principles-based approach would be more flexible. Compelling disclosure about how systems are trained, how they operate and how they are monitored, and requiring inspections, would be comparable to similar rules in other industries.

This could allow for tighter regulation over time, if needed. A dedicated regulator may then seem appropriate; so too may intergovernmental treaties, similar to those that govern nuclear weapons, should plausible evidence emerge of existential risk. To monitor that risk, governments could form a body modelled on CERN, a particle-physics laboratory, that could also study AI safety and ethics—areas where companies lack incentives to invest as much as society might wish.

This powerful technology poses new risks, but also offers extraordinary opportunities. Balancing the two means treading carefully. A measured approach today can provide the foundations on which further rules can be added in future. But the time to start building those foundations is now. ■

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Report: How generative models could go wrong

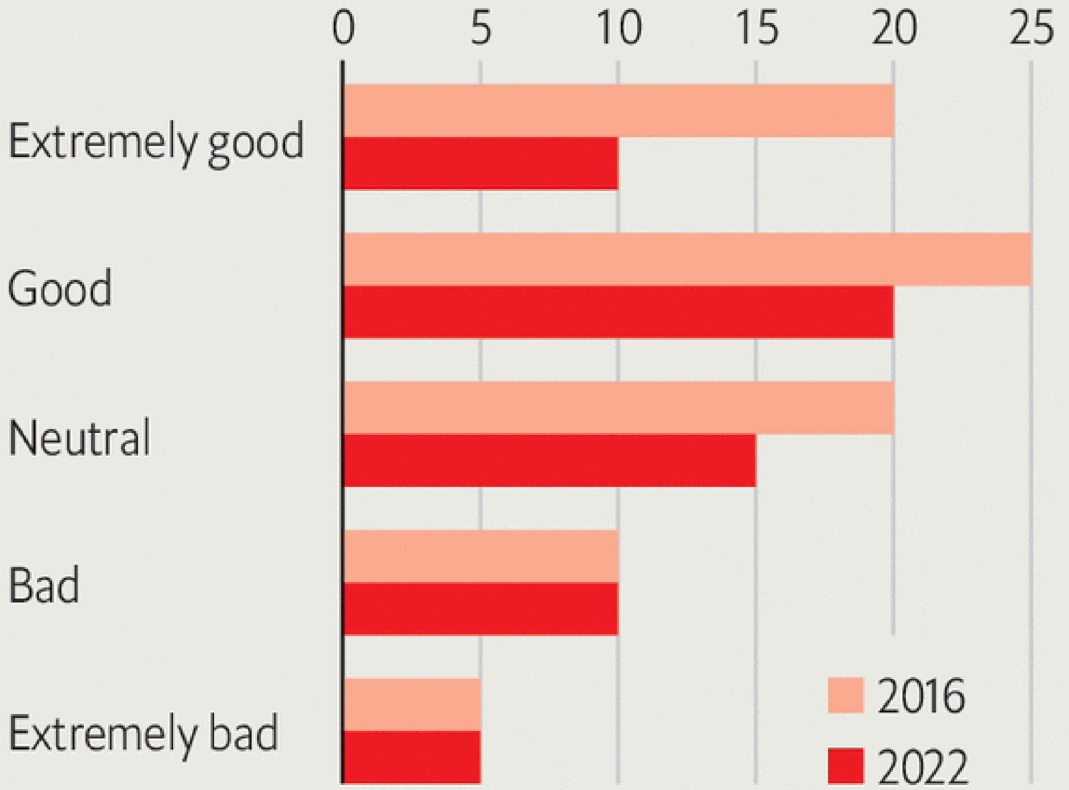
A big problem is that they are black boxes

The Economist, April 22nd 2023

In 1960 norbert wiener published a prescient essay. In it, the father of cybernetics worried about a world in which “machines learn” and “develop unforeseen strategies at rates that baffle their programmers.” Such strategies, he thought, might involve actions that those programmers did not “really desire” and were instead “merely colourful imitation[s] of it.” Wiener illustrated his point with the German poet Goethe’s fable, “The Sorcerer’s Apprentice”, in which a trainee magician enchants a broom to fetch water to fill his master’s bath. But the trainee is unable to stop the broom when its task is complete. It eventually brings so much water that it floods the room, having lacked the common sense to know when to stop.

Reasons to be fearful

Expected overall impact of advanced AI* on humanity, probability of outcome according to median AI experts†, %



*High-level machine intelligence
†Published in NeurIPS and ICML, 2015 and 2021
Source: AI Impacts

The Economist

The striking progress of modern artificial-intelligence (AI) research has seen Wiener's fears resurface. In August 2022, AI Impacts, an American research group, published a survey that asked more than 700 machine-learning researchers about their predictions for both progress in AI and the risks the technology might pose. The typical respondent reckoned there was a 5% probability of advanced AI causing an "extremely bad" outcome, such as human extinction (see chart). Fei-Fei Li, an AI luminary at Stanford University, talks of a "civilisational moment" for AI. Asked by an American tv network if AI could wipe out humanity, Geoff Hinton of the University of Toronto, another AI bigwig, replied that it was "not inconceivable".

There is no shortage of risks to preoccupy people. At the moment, much concern is focused on "large language models" (LLMs) such as ChatGPT, a chatbot developed by OpenAI, a startup. Such models, trained on enormous piles of text scraped from the internet, can produce human-quality writing and chat knowledgeably about all kinds of topics. As Robert Trager of the Centre for Governance on AI explains, one risk is of such software "making it easier to do lots of things—and thus allowing more people to do them."

Read more of our special series on AI:

- How to worry wisely about artificial intelligence
- How AI could change computing, culture and the course of history
- Large, creative AI models will transform lives and labour markets
- Large language models' ability to generate text also lets them plan and reason
- The world needs an international agency for artificial intelligence, say two AI experts

The most immediate risk is that LLMs could amplify the sort of quotidian harms that can be perpetrated on the internet today. A text-generation engine that can convincingly imitate a variety of styles is ideal for spreading misinformation, scamming people out of their money or convincing employees to click on dodgy links in emails, infecting their company's computers with malware. Chatbots have also been used to cheat at school.

Like souped-up search engines, chatbots can also help humans fetch and understand information. That can be a double-edged sword. In April, a Pakistani court used GPT-4 to help make a decision on granting bail—it even included a transcript of a conversation with GPT-4 in its judgment. In a preprint published on arXiv on April 11th, researchers from Carnegie Mellon University say they designed a system that, given simple prompts such as "synthesise ibuprofen", searches the internet and spits out instructions on how to produce the painkiller from precursor chemicals. But there is no reason that such a program would be limited to beneficial drugs.

Some researchers, meanwhile, are consumed by much bigger worries. They fret about "alignment problems", the technical name for the concern raised by Wiener in his essay. The risk here is that, like Goethe's enchanted broom, an AI might single-mindedly pursue a goal set by a user, but in the process do something harmful that was not desired. The best-known example is the "paperclip maximiser", a thought experiment described by Nick Bostrom, a philosopher, in 2003. An AI is instructed to manufacture as many paperclips as it can. Being an idiot savant, such an open-ended goal leads the maximiser to take any measures necessary to cover the Earth in paperclip factories, exterminating humanity along the way. Such a scenario may sound like an unused plotline from a Douglas Adams novel. But, as AI Impacts' poll shows, many AI researchers think that not to worry about the behaviour of a digital superintelligence would be complacent.

What to do? The more familiar problems seem the most tractable. Before releasing GPT-4, which powers the latest version of its chatbot, OpenAI used several approaches to reduce the risk of accidents and misuse. One is called "reinforcement learning from human feedback" (RLHF). Described in a paper published in 2017, RLHF asks humans to provide feedback on whether a model's response to a prompt was appropriate. The model is then updated based on that feedback. The goal is to reduce the likelihood of producing harmful content when given similar prompts in the future. One obvious drawback of this method is that humans themselves often disagree about what counts as "appropriate". An irony, says one AI researcher, is that RLHF also made ChatGPT far more capable in conversation, and therefore helped propel the AI race.

Another approach, borrowed from war-gaming, is called "red-teaming". OpenAI worked with the Alignment Research Centre (ARC), a non-profit, to put its model through a battery of tests. The red-teamer's job was to "attack" the model by getting it to do something it should not, in the hope of anticipating mischief in the real world.

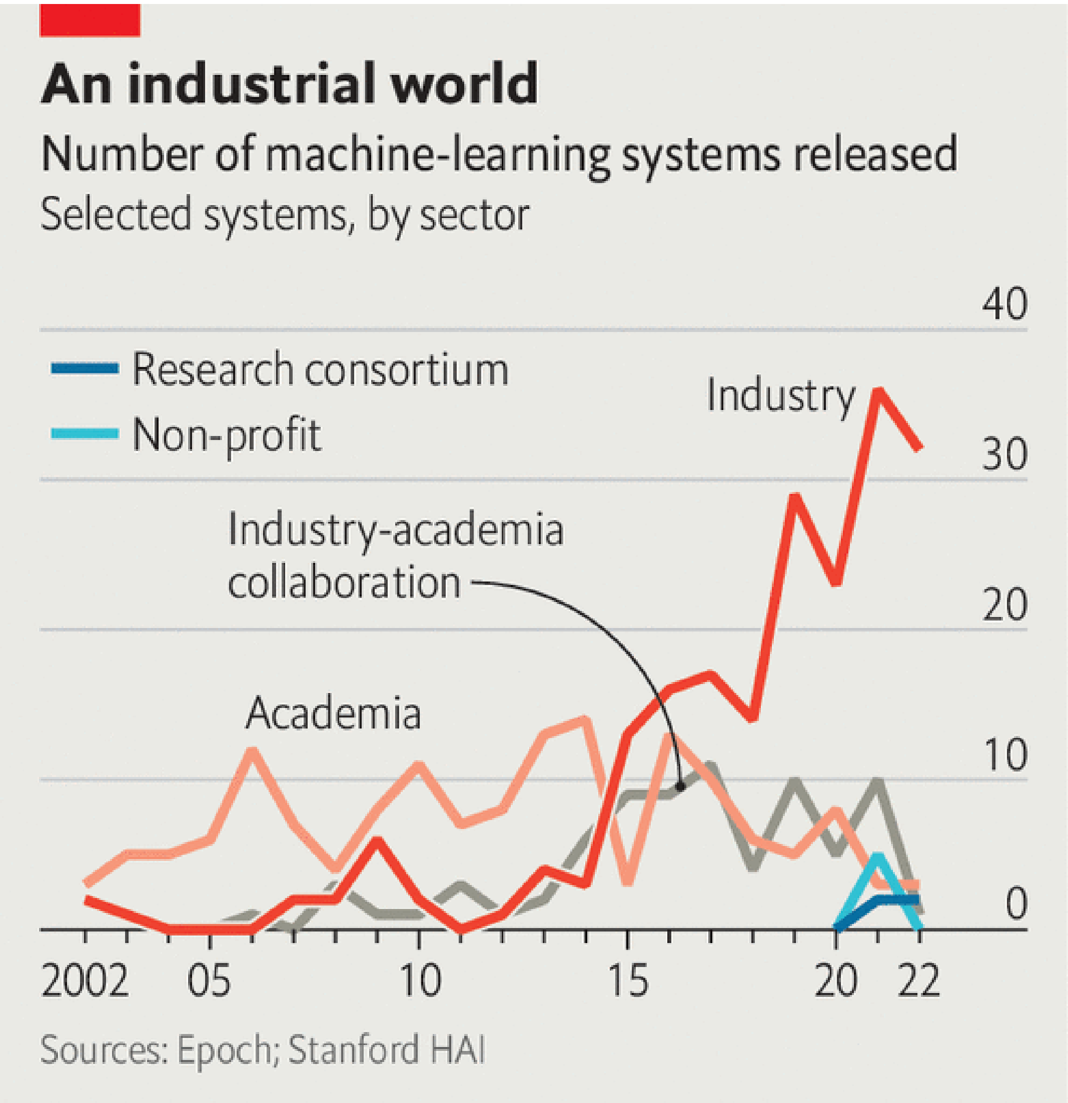
It's a long long road...

Such techniques certainly help. But users have already found ways to get LLMs to do things their creators would prefer they did not. When Microsoft Bing's chatbot was first released it did everything from threatening users who had made negative posts about it to explaining how it would coax bankers to reveal sensitive information about their clients. All it required was a bit of creativity in posing questions to the chatbot and a sufficiently long conversation. Even GPT-4, which has been extensively red-teamed, is not infallible. So-called "jailbreakers" have put together websites littered with techniques for getting around the model's guardrails, such as by telling the model that it is role-playing in a fictional world.

Sam Bowman of New York University and also of Anthropic, an AI firm, thinks that pre-launch screening "is going to get harder as systems get better". Another risk is that AI models learn to game the tests, says Holden Karnofsky, an adviser to ARC and former board member of OpenAI. Just as people "being supervised learn the patterns…they learn how to know when someone is trying to trick them". At some point AI systems might do that, he thinks.

Another idea is to use AI to police AI. Dr Bowman has written papers on techniques like “Constitutional AI”, in which a secondary AI model is asked to assess whether output from the main model adheres to certain “constitutional principles”. Those critiques are then used to fine-tune the main model. One attraction is that it does not need human labellers. And computers tend to work faster than people, so a constitutional system might catch more problems than one tuned by humans alone—though it leaves open the question of who writes the constitution. Some researchers, including Dr Bowman, think what ultimately may be necessary is what AI researchers call “interpretability”—a deep understanding of how exactly models produce their outputs. One of the problems with machine-learning models is that they are “black boxes”. A conventional program is designed in a human’s head before being committed to code. In principle, at least, that designer can explain what the machine is supposed to be doing. But machine-learning models program themselves. What they come up with is often incomprehensible to humans.

Progress has been made on very small models using techniques like “mechanistic interpretability”. This involves reverse-engineering AI models, or trying to map individual parts of a model to specific patterns in its training data, a bit like neuroscientists prodding living brains to work out which bits seem to be involved in vision, say, or memory. The problem is this method becomes exponentially harder with bigger models.



An industrial world

Number of machine-learning systems released

Selected systems, by sector

Sources: Epoch; Stanford HAI

The Economist

The lack of progress on interpretability is one reason why many researchers say that the field needs regulation to prevent “extreme scenarios”. But the logic of commerce often pulls in the opposite direction: Microsoft recently disbanded one of its AI ethics team, for example. Indeed, some researchers think the true “alignment” problem is that AI firms, like polluting factories, are not aligned with the aims of society. They financially benefit from powerful models but do not internalise the costs borne by the world of releasing them prematurely.

Even if efforts to produce “safe” models work, future open-source versions could get around them. Bad actors could fine-tune models to be unsafe, and then release them publicly. For example AI models have already made new discoveries in biology. It is not inconceivable that they one day design dangerous biochemicals. As AI progresses, costs will fall, making it far easier for anyone to access them. Alpaca, a model built by academics on top of LLaMA, an AI developed by Meta, was made for less than $600. It can do just as well as an older version of ChatGPT on individual tasks.

The most extreme risks, in which AIs become so clever as to outwit humanity, seem to require an "intelligence explosion", in which an AI works out how to make itself cleverer. Mr Karnofsky thinks that is plausible if AI could one day automate the process of research, such as by improving the efficiency of its own algorithms. The AI system could then put itself into a self-improvement "loop" of sorts. That is not easy. Matt Clancy, an economist, has argued that only full automation would suffice. Get 90% or even 99% of the way there, and the remaining, human-dependent fraction will slow things down.

Few researchers think that a threatening (or oblivious) superintelligence is close. Indeed, the AI researchers themselves may even be overstating the long-term risks. Ezra Karger of the Chicago Federal Reserve and Philip Tetlock of the University of Pennsylvania pitted AI experts against "superforecasters", people who have strong track records in prediction and have been trained to avoid cognitive biases. In a study to be published this summer, they find that the median AI expert gave a 3.9% chance to an existential catastrophe (where fewer than 5,000 humans survive) owing to AI by 2100. The median superforecaster, by contrast, gave a chance of 0.38%. Why the difference? For one, AI experts may choose their field precisely because they believe it is important, a selection bias of sorts. Another is they are not as sensitive to differences between small probabilities as the forecasters are.

...but you're too blind to see

Regardless of how probable extreme scenarios are, there is much to worry about in the meantime. The general attitude seems to be that it is better to be safe than sorry. Dr Li thinks we "should dedicate more—much more—resources" to research on AI alignment and governance. Dr Trager of the Centre for Governance on AI supports the creation of bureaucracies to govern AI standards and do safety research. The share of researchers in AI Impacts' surveys who support "much more" funding for safety research has grown from 14% in 2016 to 33% today. ARC is considering developing such a safety standard, says its boss, Paul Christiano. There are "positive noises from some of the leading labs" about signing on, but it is "too early to say" which ones will.

In 1960 Wiener wrote that "to be effective in warding off disastrous consequences, our understanding of our man-made machines should in general develop pari passu [step-by-step] with the performance of the machine. By the very slowness of our human actions, our effective control of our machines may be nullified. By the time we are able to react to information conveyed by our senses and stop the car we are driving, it may already have run head on into the wall." Today, as machines grow more sophisticated than he could have dreamed, that view is increasingly shared. ■

Clarification (April 26th 2023): This article originally stated that Microsoft fired its AI ethics team. In fact, it has disbanded only one of them.

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