

News in focus



Engineers work on NASA's Clipper spacecraft, which will set off for Jupiter's moon Europa this year.

THE SCIENCE EVENTS TO WATCH FOR IN 2024

Advanced AI tools, Moon missions and ultrafast supercomputers are among the developments set to shape research this year.

By Miryam Naddaf

AI advances

The rise of ChatGPT had a profound effect on science last year. The chatbot's creator, OpenAI in San Francisco, California, is expected to release GPT-5, the next generation of the artificial intelligence (AI) model that underpins ChatGPT, late this year. GPT-5 is likely to showcase more advanced capabilities than its predecessor, GPT-4. Scientists are also watching the roll-out of Gemini, Google's GPT-4 competitor. The large language model

can process several types of input, including text, computer code, images, audio and video.

A new version of Google DeepMind's AI tool AlphaFold, which researchers have used to predict the 3D shapes of proteins with high accuracy, is also due to be released this year. The AI will be capable of modelling interactions between proteins, nucleic acids and other molecules with atomic precision, which could open up new possibilities in drug design and discovery.

Big questions loom on the regulatory front. The United Nations High-Level Advisory Body

on Artificial Intelligence will share its final report in mid-2024, laying down guidelines for the international regulation of AI.

Aiming for the stars

The Vera C. Rubin Observatory in Chile is scheduled to begin operating some of its instruments towards the end of the year, ahead of its planned decade-long survey of the Southern Hemisphere's entire sky. With the observatory's 8.4-metre telescope and giant 3,200-megapixel camera, scientists are hoping to discover many transient phenomena and near-Earth asteroids.



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Also in Chile, the Simons Observatory in the Atacama Desert will be complete in mid-2024. This next-generation cosmology experiment will look for signatures of primordial gravitational waves – the afterglow of the Big Bang – in the cosmic microwave background. Its telescopes will be equipped with as many as 50,000 light-collecting detectors, 10 times more than similar projects currently under way.

Astronomers continue to worry that new ground-based telescope data could be rendered unusable because of an increasing number of bright satellite constellations polluting the night sky with light.

Weaponized mosquitoes

The World Mosquito Program is due to start producing disease-fighting mosquitoes at a factory in Brazil. The mosquitoes are infected with a bacterial strain that prevents them from transmitting pathogenic viruses, and could protect up to 70 million people from diseases such as dengue and Zika. The non-profit organization will produce up to five billion infected mosquitoes per year over the next decade.

Beyond the pandemic

As the world moves past the emergency phase of the COVID-19 pandemic, the US government is funding trials of three next-generation vaccines, two of which are intranasal vaccines that aim to prevent infection by generating immunity in airway tissues. The third, an mRNA vaccine, boosts antibody levels and T-cell responses, promising to provide long-lasting immunity against a broad range of SARS-CoV-2 variants.

Meanwhile, the World Health Organization (WHO) is due to unveil the final draft of its pandemic treaty during the 77th World Health

Assembly in May. The accord seeks to better equip governments worldwide to prevent and manage future pandemics. The 194 WHO member states will decide on the terms of the accord, including whether any of its provisions will be legally binding. At the centre of negotiations is ensuring equitable access to the tools, including vaccines, data and expertise, that are needed to prevent pandemics.

Moon missions

For the first time since the 1970s, NASA is launching a crewed lunar mission. Artemis II could launch as soon as November, and will

carry four astronauts – three men and one woman – aboard the Orion spacecraft for a ten-day fly-by around the Moon. Artemis II will lay the groundwork for the subsequent Artemis III mission, which will land the first woman and next man on the Moon. China is also preparing to launch its Chang'e-6 lunar sample-return mission in 2024. If successful, the mission will be the first to collect samples from the far side of the Moon.

Missions to explore moons in the outer Solar System include NASA's Clipper craft, which will set off for Jupiter's moon Europa in October. Its objective is to determine whether the moon's underground ocean could harbour life. Japan's Martian Moons eXploration mission, also planned for this year, will visit Mars's moons, Phobos and Deimos. It will land on Phobos and collect samples for return to Earth in 2029.

Illuminating dark matter

Results of an experiment to detect dark-matter particles known as axions will see light in 2024. Axions are thought to be emitted by the Sun and converted into light, but the particles have not yet been observed experimentally because this would require sensitive detection tools and a very strong magnetic field. The experiment BabyIAXO at the German Electron Synchrotron in Hamburg is using a solar telescope made of a 10-metre-long magnet and ultra-sensitive noise-free X-ray detectors to track the centre of the Sun for 12 hours per day, to capture the conversion of axions into photons.

And this could be the year that scientists nail down the mass of the neutrino – the most mysterious particle in the standard model of particle physics. Results of the Karlsruhe Tritium Neutrino experiment in 2022 showed that neutrinos have a maximum mass of



The UN plastics treaty aims to establish a global agreement to eliminate plastic pollution.

RUBIN OBS/NSF/AURA

LUIS ACOSTA/AFP VIA GETTY

0.8 electronvolts. Researchers will finish collecting data in 2024 and are expected to make a definite measurement of the tiny particles.

Consciousness debate: round two

This year could bring insights into the neural basis of consciousness. A project that is testing two theories of consciousness through a series of adversarial experiments is expected to release the results of its second stage by the end of the year. In the first round, neither theory aligned completely with observed brain-imaging data, settling a 25-year bet in favour of philosophy over neuroscience. The second round could move neuroscience closer to deciphering the secrets of the subjective experience.

Saving the planet

In the second half of 2024, the International Court of Justice in The Hague, the Netherlands, could give an opinion on nations' legal obligations to combat climate change, and could rule on legal consequences for those deemed to be damaging the climate. Although the ruling will not be legally binding, the court's clout could push countries to strengthen their climate goals and can be cited in domestic legal cases.

Ongoing negotiations for the UN plastics

treaty, which seeks to establish a binding international agreement to eliminate plastic pollution, will wrap up. Since the 1950s, the world has produced 10 billion tonnes of plastic, of which more than 7 billion tonnes is now waste – much of it polluting oceans and harming wildlife. But there is growing concern among researchers that the UN negotiations, which started in 2022, are advancing too slowly and will not accomplish the intended goals.

Super-fast supercomputers

This year, researchers will switch on Jupiter, Europe's first exascale supercomputer. The gigantic machine can perform one quintillion (one billion billion) computations each second. Researchers will use the machine to create 'digital twin' models of the human heart and brain for medical purposes, and to run high-resolution simulations of Earth's climate.

Researchers in the United States will install two further exascale machines: Aurora at Argonne National Laboratory in Lemont, Illinois, and El Capitan at Lawrence Livermore National Laboratory in Livermore, California. Scientists will use Aurora to create maps of the brain's neural circuits, and El Capitan to simulate the effects of nuclear-weapons explosions.

the model from nearly 0% to nearly 100%. But this trend was less extreme if the number of correctly predicted digits in the answer was considered instead. The researchers also found that they could dampen the curve by giving the models many more test questions – in this case, the smaller models answered correctly some of the time.

“The models are making improvements but they're not approaching consciousness yet.”

Next, the researchers looked at the performance of Google's LaMDA language model on several tasks. The ones for which it showed a sudden jump in apparent intelligence, such as detecting irony or translating proverbs, were often multiple-choice tasks, with answers scored discretely as right or wrong. When, instead, the researchers examined the probabilities that the models placed on each answer – a continuous metric – signs of emergence disappeared.

Finally, the researchers turned to computer vision, a field in which there are fewer claims of emergence. They trained models to compress and then reconstruct images. By setting a strict threshold for correctness, they could induce apparent emergence. “They were creative in the way that they designed their investigation,” says Yejin Choi, a computer scientist at the University of Washington in Seattle.

Nothing ruled out

Study co-author Sanmi Koyejo, a computer scientist at Stanford University in Palo Alto, California, says that it wasn't unreasonable for people to accept the idea of emergence, given that some systems exhibit abrupt “phase changes”. He also notes that the study can't completely rule out emergence in large language models – let alone in future systems – but adds that “scientific study to date strongly suggests most aspects of language models are indeed predictable”.

Raji is happy to see the AI community pay more attention to benchmarking, rather than to developing neural-network architectures. She'd like researchers to go even further and ask how well the tasks relate to real-world deployment. For example, does acing the LSAT exam for aspiring lawyers, as GPT-4 has done, mean that a model can act as a paralegal?

The work also has implications for AI safety and policy. “The AGI crowd has been leveraging the emerging-capabilities claim,” Raji says. Unwarranted fear could lead to stifling regulations or divert attention from other risks. “The models are making improvements, and those improvements are useful,” she says. “But they're not approaching consciousness yet.”

WILL SUPERINTELLIGENT AI SNEAK UP ON US? STUDY SUGGESTS NOT

Improvements in the performance of tools such as ChatGPT are more predictable than they seem.

By Matthew Hutson

Will an artificial intelligence (AI) superintelligence appear suddenly, or will scientists see it coming, and have a chance to warn the world? That's a question that has received a lot of attention, with the rise of large language models, such as that behind ChatGPT, which have achieved vast new abilities as their size has grown. Some findings point to 'emergence', a phenomenon in which AI models gain intelligence in a sharp and unpredictable way. But a study presented last November at the NeurIPS 2023 machine-learning conference in New Orleans, Louisiana, calls these cases mirages – artefacts arising from how the systems are tested – and suggests that innovative abilities instead build more gradually (see go.nature.com/4aj5pum).

“I think they did a good job of saying ‘nothing magical has happened’,” says Deborah Raji, a

computer scientist at the Mozilla Foundation in San Francisco, California. It's “a really good, solid, measurement-based critique”.

Bigger is better

Large language models are typically trained using huge amounts of text, or other information, which they use to generate realistic answers by predicting what comes next. Typically, the bigger the model is – some have more than one hundred billion tunable parameters – the better it performs. Some researchers suspect that these tools will eventually achieve artificial general intelligence (AGI), matching and even exceeding humans on most tasks.

The new research tested claims of emergence in several ways. In one approach, the scientists compared the abilities of four sizes of the GPT-3 model, developed by OpenAI in San Francisco, to add up four-digit numbers. Looking at absolute accuracy, performance differed between the third and fourth size of