Matsoso. "But eventually, over time, I think there was what I would call the voice of reason."

The details of how exactly the system will work have yet to be hashed out. But the accord states that there must be provisions for the "rapid and timely" sharing of information, and that manufacturers participating in the agreement must make at least 20% of the vaccines, drugs and diagnostics that they produce available to the WHO during a pandemic.

A spokesperson for the Geneva-based International Federation of Pharmaceutical Manufacturers and Associations says that it's important that the agreement is translated into a "practical plan" that incentivizes pharmaceutical companies of all sizes to invest in research on pathogens. "Innovation is not guaranteed. It requires the right environment to thrive."

The draft agreement will be presented at the World Health Assembly in May and will need to be ratified by member states if adopted – a process that could take months or years.

Technology exchange

As well as promoting equitable access to health products, the treaty states that nations should "promote and otherwise facilitate or incentivize" the exchange of technology and know-how to enable manufacturers in low-income countries to produce their own drugs and vaccines. "That should help poorer regions like Africa to become more self-sufficient in the face of a pandemic," says Gostin.

It also stipulates that governments attach conditions to research into drugs and vaccines that they fund – either at universities or companies – to "promote timely and equitable access" during pandemics. Such conditions could include allowing other companies to manufacture the products, affordable pricing policies and the publication of relevant clinical-trial protocols and results.

"Concretely, this means that, when the next pandemic hits and a life-saving medicine developed thanks to taxpayer funding is unaffordable or unavailable, a government will be able to intervene for the benefit of its citizens and people in need around the world," says Childs. By contrast, during the COVID-19 pandemic, she adds, governments did not always have a say in how knowledge was shared, even when they had funded the research.

"One of the greatest benefits that can be shared is the data and the scientific activity around the data," says Guy Cochrane, head of the European Nucleotide Archive at the European Molecular Biology Laboratory in Hinxton, UK.

No US presence

The pandemic treaty will be weaker without buy-in from the United States, given its dominance as a producer of drugs, vaccines and diagnostics, says Gostin. "There is no sugar-coating it. The absence of the US leaves a gaping hole," he says.

But Gostin thinks that the country's "destructive" behaviour since Trump became president was key to the treaty eventually being agreed. "This is the world reacting to Donald Trump, determined to show that multilateralism and global solidarity still are important, as well as the rule of law," he says.

Pathogen data produced in the United States "are typically freely and openly shared", says Cochrane. "I hope that this approach continues."

Before the United States exited the process, US scientists "brought enormous expertise to the negotiations", says Matsoso. But "we still have experts in different parts of the world who can work towards making sure we achieve our goals", she says. "In this gloomy political environment, this gives us hope."

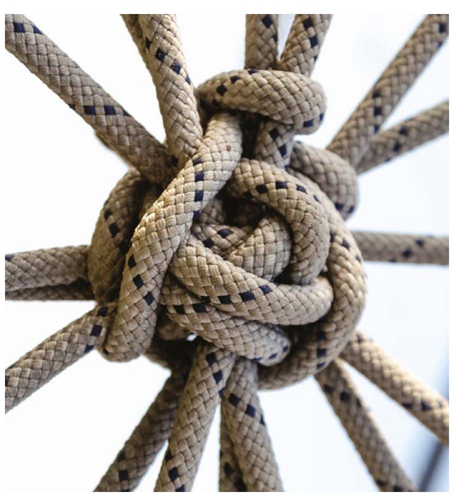
QUANTUM COMPUTER UNTANGLES THE MATHEMATICS OF KNOTS

Algorithms for studying knots and other topological objects could have a quantum advantage.

By Davide Castelvecchi

Are quantum computers worth the billions that are being invested in them? The answer is probably many years away. However, the machines could prove to be particularly suited to solving problems in mathematics – especially in topology, the branch of maths that studies shapes.

In a preprint posted on arXiv in March[1], researchers at Quantinuum, a company in Cambridge, UK, report using their quantum machine H2-2 to distinguish between different types of knot on the basis of topological properties, and show that the method could be faster than those that run on ordinary, or 'classical', computers. Quantinuum chief product officer Ilyas Khan says that Helios, a quantum computer that the company expects to release later this year, could get much closer to beating classical supercomputers at analysing fiendishly complicated knots.



A knot's pattern of crossing threads.

ILIE LUPESCU/500PX VIA GETTY

Although other groups have already made similar claims of 'quantum advantage', typically for ad hoc calculations that have no practical use, classical algorithms tend to catch up eventually. But theoretical results[2,3] indicate that for some topology problems, quantum algorithms could be faster than any possible classical counterpart. This is owing to mysterious connections between topology and quantum physics. "That these things are related is mind-blowing, I think," says Konstantinos Meichanetzidis, a Quantinuum researcher who led the work behind the preprint.

Knotty problems

In that work, Meichanetzidis and his colleagues used a quantum computer to calculate knot 'invariants' – numbers that describe particular types of knot. The invariants they looked at were devised by mathematician Vaughan Jones.

Knot invariants are typically calculated from patterns of crossings – how the threads in a knot cross over each other when it is flattened on a surface – but depend only on the knot's topological type. In other words, the same knot can be flattened in two distinct ways, with vastly different crossing patterns, but the knot invariant will still be the same. If two crossing patterns have different knot invariants, it means that they come from knots that are topologically distinct. (However, the converse is not always true: in rare cases, two topologically different knots can give the same invariant.)

Meichanetzidis's team implemented a quantum algorithm for calculating the invariants of knots, proposed[4] by Jones and computer scientists Dorit Aharonov and

Zeph Landau. The algorithm is a series of quantum operations corresponding to the crossings of a flattened knot. The researchers used it to calculate Jones invariants for knots with up to 104 crossings on Quantinuum's H2-2 quantum computer. This is still well within the scope of classical computing, but the firm's machines should eventually be able to handle 3,000 crossings or so, at which point even the fastest classical supercomputers will run out of steam, says Meichanetzidis.

Mathematically, the theoretical equivalence between knot crossings and quantum algorithms has been known for decades, but only now has the team been able to fully put it into practice, says Aharonov, who is at the Hebrew University of Jerusalem. "I expected that the transition between the languages would be much less efficient," she adds.

Meichanetzidis and his colleagues also showed that their technique can be used to check that the quantum computer is working correctly – by comparing the numbers for two different ways of flattening the same knot. This addresses a notorious problem for quantum computing: quantum advantage means that one day, classical computers will not be able to cross-check the results of quantum computations. Quantinuum's idea of using topological equivalence between knots to get the quantum computer to check its own results is "really fascinating", says Aharonov.

Exploring topology

Meichanetzidis says that the techniques could be generalized to calculate even more powerful topological invariants for knots, known as Khovanov homology. In an arXiv preprint posted in January[2], researchers describe a quantum algorithm for doing just that – at least at a theoretical level. "We don't fully prove exponential speed-up, but we give strong evidence for it," says Alexander Schmidhuber, a theoretical physicist at the Massachusetts Institute of Technology in Cambridge, who led the work.

Schmidhuber thinks that more problems in topology will turn out to be amenable to quantum computing. He and others have worked towards quantum speed-up of homology – a technique in topology for counting how many holes of any given dimension a space contains, which can also be applied to the analysis of complex data sets. In a paper published in November[3], researchers suggested that homology calculations are quantum-mechanical in nature. This means that quantum calculations for homology could have the same inherent quantum advantage that researchers think will apply to problems in physics and chemistry.

"Why is topology so inherent to quantum computation? I think this is a very deep question," says Aharonov. The answer, she adds, could be linked to the fact that in quantum physics, many particles can share a collective 'entangled' state, and there are quantum states that maintain their quantum information even if they change at a local level. Having properties that don't change when an object undergoes a local deformation is "very much the essence of topology", she says.

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2. Schmidhuber, A., Reilly, M., Zanardi, P., Lloyd, S. & Lauda, A. Preprint at arXiv https://doi.org/10.48550/arXiv.2501.12378 (2025).
3. Crichigno, M. & Kohler, T. *Nature Commun.* **15**, 9846 (2024).
4. Aharonov, D., Jones, V. & Landau, Z. *Algorithmica* **55**, 395–421 (2009).

SAFETY TRIAL WILL TEST PIG LIVERS FOR HUMANS

Four people with liver failure will be connected to an external organ from genetically modified pigs.

By Rachel Fieldhouse

The first trial to test whether genetically modified pig livers can be used safely to treat people with organ failure has been approved by the US Food and Drug Administration (FDA). As part of the trial, people with severe liver failure who are ineligible to receive a human organ will be temporarily connected to an external pig liver that will filter their blood.

The trial is a huge step forward for the field of xenotransplantation – the use of animal organs in people – and for people with a serious form of liver failure that has a mortality rate of about 50%, says Wayne Hawthorne, a transplant surgeon at the University of Sydney, Australia. This shows that decades of research have been worthwhile, he adds.

"The trial is a huge step forward for the use of animal organs in people."

A clinically dead man in the United States was the first person to be connected to a pig liver outside their body, in late 2023. About half a dozen people in the United States and China have received other organs from genome-edited pigs. These surgeries were approved for terminally ill people on compassionate grounds, and most did not survive beyond a few months.

Four individuals will be included in the initial phase of the trial of the pig liver, due to begin later this year, according to the companies running the trial: eGenesis, a bioengineering firm based in Cambridge, Massachusetts, and OrganOx, a biotechnology company based in Oxford, UK. eGenesis and OrganOx were both also involved in the 2023 surgery. The trial will include people aged 18–70 years old who have acute-on-chronic liver failure, a sudden worsening of chronic liver disease, and hepatic encephalopathy, a brain disorder caused by impaired liver function. Over a 2-week period, participants will be connected to the pig liver for 72 hours; their blood will be sent through the organ to remove harmful waste products that build up during liver failure. Participants will then be monitored for a year for safety and changes in liver function. The organs have been genetically modified to make them more compatible with humans.

Hawthorne, who is a former president of the International Xenotransplant Association, says the pig liver will act as a bridging graft to keep people with severe liver failure alive, and hopefully to give their livers time to regain some function.

Safety review

eGenesis says that a monitoring committee will review safety data for the first two participants, before the second two receive treatment. Then another safety review will decide whether the trial should be expanded to up to 20 individuals.

Hawthorne says that the treatment could eventually be given to people dying from liver failure, as they wait for a conventional transplant or to become well enough to receive one.

Another company, United Therapeutics in Silver Spring, Maryland, received FDA approval earlier this year for a trial testing the safety of transplanting pig kidneys into people with end-stage kidney disease. That trial will also start later this year, with an initial cohort of six participants.

But research teams are likely to face challenges as they test the long-term viability of such treatments, including possible organ rejection and the risk of infections.