government officials to help address Chile's socio-economic issues.

"It's not about 30 pesos; it's about 30 years," says Carolina Rojas, a geographer at the Pontifical Catholic University of Chile in Santiago, who supports the protesters. Government policies have widened the socio-economic gap among Chileans since 1990, when the country emerged from a brutal dictatorship. One per cent of the wealthiest people in the country earn 33% of the nation's income, whereas nearly 70% of Chilean workers earn $500 or less per month. Rojas's mother, a retired elementary-school teacher, receives a monthly pension of $150, Rojas says.

Since late October, several universities have temporarily closed their doors in response to safety concerns and an eight-day government-imposed curfew — as well as to allow students to participate in the protests. The turmoil has also led to a change in venue for a global climate summit scheduled for 2–13 December from Santiago to Madrid, Spain. "Mentally, it's really difficult to work these days," says Jaque.

Most worrying for everyone, including researchers, is the escalating violence. In its most recent count, released on 6 November, Chile's National Institute of Human Rights reported that more than 1,700 civilians had been taken to hospital after being injured in the demonstrations. And more than 1,000 members of the security forces across the country have been injured, according to the police.

The violence hasn't stopped the protests, but many people are frightened. "I think we're all fearful," says Facundo Gómez, an astrophysicist at the University of La Serena, which cancelled classes on 21 October and has yet to restart them. On 28 October, Gómez and his colleagues posted a letter online protesting against the 22 October detention of three students from their institution.

Finding a way forward

Chilean President Sebastián Piñera reversed the metro-fare increase soon after the initial riots. But protesters are demanding broader, deeper changes to the country's economic and political system. Many are even pushing for a new constitution to replace the current one, which was instituted during the dictatorship.

So far, the only attempt by lawmakers to start a dialogue with citizens has been a series of meetings with researchers set up by the science and technology commission in Chile's Senate. From late October, around 50 scientists spoke to senators on the commission about how to address socio-economic problems.

They agreed that change will require input from a cross-section of society, but that the scientific community needs to do its part. Some researchers say that reforming how science is funded could help. One nascent idea includes changing how scientists are evaluated for government funding so as to prioritize research that might improve the country at a national or local level, says Claudio Gutiérrez, a computer scientist at the University of Chile in Santiago who has participated in the protests. This would encourage more researchers to work on projects that benefit Chileans, such as solving the country's current water crisis or studying the poorest populations near big cities in order to help them, he says.

Others, such as Cecilia Hidalgo, a biochemist at the University of Chile and president of the Chilean Academy of Science, view the moment as an opportunity to increase federal research spending and bolster science in the country. As of 2017, the latest year for which data are available, Chile spent roughly 0.4% of its gross domestic product on science and technology, compared with an average of 0.6% for countries in Latin America and the Caribbean.

But some point out that this might benefit only scientists. "To increase the budget for what?" Gutiérrez asks. "So that the country's 10 or 15 major research centres keep publishing, making agreements with international agencies and the rest of the country remains the same?"

Rojas thinks that the protests will permanently change Chile, although she can't say how. It's imperative that the scientific community decides how best to participate in the country's future, she says. "We can't let [Chile] fall apart," Rojas adds. "That might mean postponing research projects or publications. But it seems to me that the country is more worthwhile."

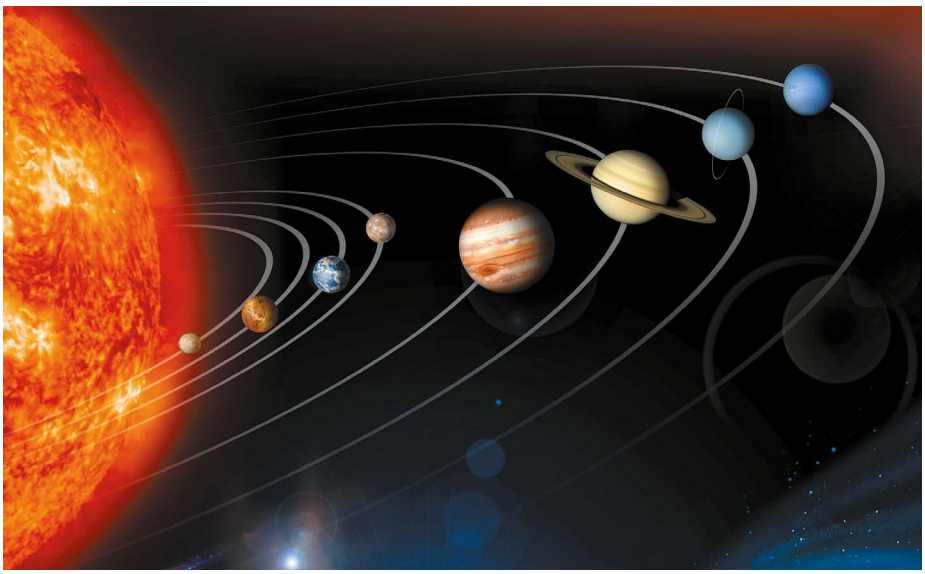
AI COPERNICUS 'DISCOVERS' THAT EARTH ORBITS THE SUN

Neural network that teaches itself the laws of physics could help to solve quantum-mechanics mysteries.

By Davide Castelvecchi

Astronomers took centuries to figure it out. But now, a machine-learning algorithm inspired by the brain has worked out that it should place the Sun at the centre of the Solar System, on the basis of how movements of the Sun and Mars appear from Earth. The feat is one the first tests of a technique that researchers hope they can use to discover new laws of physics, and perhaps to reformulate quantum mechanics, by finding patterns in large data sets. The results are due to appear in *Physical Review Letters* (R. Iten *et al. Phys. Rev. Lett.*; in the press).

Physicist Renato Renner at the Swiss Federal Institute of Technology (ETH) in Zurich and his collaborators wanted to design an algorithm that could distil large data sets down into a few basic formulae, mimicking how physicists come



NASA/JPL/SPL

Physicists have designed an AI that realizes the Sun must be at the centre of the Solar System.

up with concise equations such as $E = mc^2$. To do this, they had to design a new type of neural network, a machine-learning system inspired by the structure of the brain.

Conventional neural networks learn to recognize objects — such as images or sounds — by training on huge data sets. They discover general features — for example, 'four legs' and 'pointy ears' might be used to identify cats. They then encode those features in mathematical 'nodes', the artificial equivalent of neurons. But rather than condensing that information into a few easily interpretable rules, as physicists do, neural networks are something of a black box, spreading their acquired knowledge across thousands or even millions of nodes in ways that are unpredictable and difficult to interpret.

So Renner's team designed a kind of 'lobotomized' neural network: two sub-networks that were connected to each other through only a handful of links. The first sub-network would learn from the data, as in a typical neural network, and the second would use that 'experience' to make and test new predictions. Because few links connected the two sides, the first network was forced to pass information to the other in a condensed format. Renner likens it to how an adviser might pass on their acquired knowledge to a student.

Planet positioning

The team gave the network simulated data about the movements of Mars and the Sun in the sky, as seen from Earth. From this point of view, Mars's orbit of the Sun appears erratic; for example, it periodically goes 'retrograde', reversing its course. For centuries, astronomers thought that Earth was at the centre of the Universe, and explained Mars's motion by suggesting that planets moved in small circles, called epicycles, in the celestial sphere. But in the sixteenth century, Nicolaus Copernicus found that the movements could be predicted with a much simpler system if both Earth and the planets were orbiting the Sun.

The team's neural network came up with Copernicus-style formulae for Mars's trajectory, rediscovering "one of the most important shifts of paradigms in the history of science", says Mario Krenn, a physicist at the University of Toronto in Canada, who works on applying artificial intelligence (AI) to scientific discovery.

Renner stresses that although the algorithm derived the formulae, a human eye is needed to interpret the equations and understand how they relate to the movement of planets around the Sun.

This work is important because it is able to single out the crucial parameters that describe a physical system, says roboticist Hod Lipson at Columbia University in New York City. "I think that these kinds of techniques are our only hope of understanding and keeping pace with increasingly complex phenomena, in physics and beyond," he says.

Renner and his team want to develop AI technologies that could help physicists to solve apparent contradictions in quantum mechanics. The theory seems to produce conflicting predictions about the outcome of an experiment and how it is seen by an observer who is subject to its laws (D. Frauchiger and R. Renner *Nature Commun.* **9**, 3711; 2018).

"It's possible that the current way [quantum mechanics is] formulated is in some way just a historical artefact," says Renner. He adds that a computer could potentially come up with a formulation that is free of such contradictions, but the team's latest techniques are not yet sophisticated enough to do so. To move towards that goal, he and his collaborators are trying to develop a version of their neural network that can not only learn from experimental data, but also propose entirely new experiments to test its hypotheses.

ACADEMICS IN SOUTH KOREA CAUGHT NAMING KIDS AS CO-AUTHORS

The practice was probably used to improve the children's chances of securing a university place.

KIM HONG-JI AUN/REUTERS

Dozens of papers with child authors who did not contribute to the work have been identified.

By Mark Zastrow

The number of South Korean academics accused of naming children as co-authors on research manuscripts — even though the children did not contribute to the research — continues to grow. An education ministry report released last month details 11 university academics who named high-school- or middle-school-aged children on papers that the children allegedly did not contribute to. Nine of these are newly identified, bringing the total number accused to 17, and the total number of papers affected to 24, since the practice was exposed in late 2017.

Five of the nine newly identified academics named their own children on papers, said the report. One named a child of an acquaintance, and the others had no special relationship to the children. It is thought that in some cases, the children were named on papers to boost their chances of winning university places, for which competition in the country is fierce. The papers the ministry has identified as problematic stretch back at least as far as 2007.

The report's release comes amid intense national scrutiny of the way children of South Korea's wealthy, well-connected 'elite' get accepted to university. Unjustified authorship is considered research misconduct in South Korea.

The report follows an announcement by the education ministry in May, in which it said that it had found nine university academics who gave unjustified co-authorship to children. One of those, the ministry has now told *Nature*,