MACHINE LEARNING & AI

AI's current hype and hysteria could set the technology back by decades

Most discussions about artificial intelligence (AI) are characterised by hyperbole and hysteria. Though some of the world's most prominent and successful thinkers regularly forecast that AI will either solve all our problems or destroy us or our society, and the press frequently report on how AI will threaten jobs and raise inequality, there's actually very little evidence to support these ideas. What's more, this could actually end up turning people against AI research, bringing significant progress in the technology to a halt.

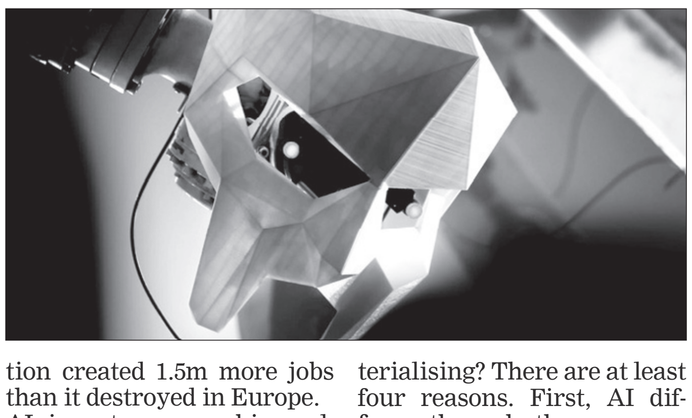
The hyperbole around AI largely stems from its promotion by tech-evangelists and self-interested investors. Google CEO Sundar Pichai declared AI to be "probably the most important thing humanity has ever worked on." Given the importance of AI to Google's business model, he would say that.

Some even argue that AI is a solution to humanity's fundamental problems, including death, and that we will eventually merge with machines to become an unstoppable force. The inventor and writer Ray Kurzweil has famously argued this "Singularity" will occur by as soon as 2045.

The hysteria around AI comes from similar sources. The likes of physicist Stephen Hawking and billionaire tech entrepreneur Elon Musk warned that AI poses an existential threat to humanity. If AI doesn't destroy us, the doomsayers argue, then it may at least cause mass unemployment through job automation.

The reality of AI is currently very different, particularly when you look at the threat of automation. Back in 2013, researchers estimated that, in the following ten to 20 years, 47% of jobs in the US could be automated. Six years later, instead of a trend towards mass joblessness, we're in fact seeing US unemployment at a historic low.

Even more job losses have been threatened for the EU. But past evidence indicates otherwise, given that between 1999 and 2010, automation created 1.5m more jobs than it destroyed in Europe.



AI is not even making advanced economies more productive. For example, in the ten years following the financial crisis, labour productivity in the UK grew at its slowest average rate since 1761. Evidence shows that even global superstar firms, including firms who are among the top investors in AI and whose business models depends on it such as Google, Facebook and Amazon, have not become more productive. This contradicts claims that AI will inevitably enhance productivity.

So why are the society-transforming effects of AI not materialising? There are at least four reasons. First, AI diffuses through the economy much more slowly than most people think. This is because most current AI is based on learning from large amounts of data and it is especially difficult for most firms to generate enough data to make the algorithms efficient or simply to afford to hire data analysts. A manifestation of the slow diffusion of AI is the growing use of "pseudo-AI" where a firm appears to use an online AI bot to interact with customers but which is in fact a human operating behind the scenes.

The second reason is AI innovation is getting harder. Machine learning techniques that have driven recent advances may have already produced their most easily reached achievements and now seem to be experiencing diminishing returns. The exponentially increasing power of computer hardware, as described by Moore's Law, may also be coming to an end.

Related to this is the fact that most AI applications just aren't that innovative, with AI mostly used to fine-tune and disrupt existing products rather than introduce radically new products. For example, Carlsberg is investing in AI to help it improve the quality of its beer. But it is still beer. Heka is a US company producing a bed with in-built AI to help people sleep better. But it is still a bed.

Third, the slow growth of consumer demand in most Western countries makes it unprofitable for most businesses to invest in AI. Yet this kind of limit to demand is almost never considered when the impacts of AI are discussed, partly because academic models of how automation will affect the economy are focused on the labour market and/or the supply side of the economy.

Fourth, AI is essentially not really being developed for general application. AI innovation is overwhelmingly in visual systems, ultimately aimed for use in driverless cars. Yet such cars are most notable for their absence from our roads, and technical limits mean they are likely to remain so for a long time.

New thinking needed

Of course, AI's small impact in the recent past doesn't rule out larger impacts in the future. Unexpected progress in AI could still lead to a "robocalypse." But it will have to come from a different kind of AI. What we currently call "AI"—big data and machine learning—is not really intelligent. It is essentially correlation analysis, looking for patterns in data. Machine learning generates predictions, not explanations. In contrast, human brains are storytelling devices generating explanations.

As a result of the hype and hysteria, many governments are scrambling to produce national AI strategies. International organisations are rushing to be seen to take action, holding conferences and publishing flagship reports on the future of work. For example the United Nations University Centre for Policy Research claims that AI is "transforming the geopolitical order" and, even more incredibly, that "a shift in the balance of power between intelligent machines and humans is already visible."

This "unhinged" debate about the current and near-future state of AI threatens both an AI arms race and stifling regulations.

This could lead to inappropriate controls and moreover loss of public trust in AI research. It could even hasten another AI-winter—as occurred in the 1980s – in which interest and funding disappear for years or even decades after a period of disappointment. All at a time when the world needs more, not less, technological innovation.

PLANTS & ANIMALS

New protein found in strongest spider web material

A team of researchers affiliated with several institutions in the U.S. and Slovenia has found a previously unknown protein in the strongest known spider web material. In their paper published in the journal Communications Biology, the group describes their study of Darwin's bark spider silk and the glands that produce it.

Humans have been impressed by the silk made from spiders for thousands of years—so much so that a lot of effort has been put into harvesting it from spiders for use in making clothing—and in reproducing it in a lab to create new strong materials. In this new effort, the researchers focused their efforts on Darwin's bark spiders, their silk-producing glands and the silk that is produced.

Darwin's bark spiders are a type of orb spider, which means they make their spider webs in the shape of a spoked wheel. They make the largest known orb webs of any spider, which they spin above the surfaces of streams. Prior research has shown that the spider actually makes seven different kinds of silk for use in different parts of its web. One of those silk types, called dragline, is used to build the spokes that give the wheel its strength. Prior research has shown it to be the strongest spider silk in existence. In this new effort, the researchers took a closer look at the dragline silk and the gland that produces it.

The researchers found two familiar types of spindroins—types of repetitive proteins—called MaSp1 and MaSp2, which are found in many spider silks. But in the dragline from Darwin's bark spiders, they found another spindroin, which they named MaSp4a. Study of this protein revealed that contained high quantities of an amino acid called proline, which prior research has shown is generally associated with elasticity. The protein also had less of some of the other components found in MaSp1 and MaSp2, which made it quite unique.

The researchers also found that the gland that produces the silk—the ampullae—is longer than in other spiders, perhaps providing another clue to the strength of the silk that is produced.

ECOLOGY

28 days later, French deep-sea divers back from the depths

After 28 days below the sea at a crushing depth of 120 metres, a team of four researchers emerged into the sunshine at the French Mediterranean port of Marseille on Sunday.

The team, led by marine naturalist and underwater photographer Laurent Ballesta, celebrated with family and friends Sunday evening after a three-day period spent in a decompression chamber.

This was not quite Jules Verne's "20,000 Leagues under the Sea" and the canary-yellow capsule in which they made their descent was not quite a submarine.

But the diving bell that was their home for four weeks allowed them to spend up to eight hours a day at 120 metres (395 feet) below the sea without having to worry about getting the bends when they resurfaced.

Ballesta described the marine wildlife and the "rock cathedrals of the underwater cliffs" that they had witnessed, as he and his colleagues celebrated the end of the expedition with champagne. And reunited with his wife and two-month-old daughter, he admitted, tears in his eyes: "I underestimated the return to land. It's more moving than expected."

Ballesta has brought back film footage and thousands of images taken during his time in that inhospitable region: the weight of the water at that depth is 13 times that on the surface. 'Exploring another world'

"We all live on the same planet, but there are several worlds, and we have had the honour of exploring another world," said Ballesta.

"At almost every dive, we were able to film or photograph a species that had never been observed living in its environment."

The other members of the team were marine biologist Antonin Guilbert, diving instructor and lighting specialist Thibault Rauby, and diver and cameraman Yannick Gentil. Every day, the seel capsule, which measures one square metre, was lowered from a barge into the gloom of the "twilight" or mesophotic zone, where only one percent of the sun's rays penetrate.

After each deep-sea dive, the divers returned to the chamber, in which the pressure was set at 13 times the pressure of the atmosphere.

When they were brought back to the surface at the end of every day, their capsule was connected to two other chambers—one acting as a bathroom and the other as a kitchen with a small table and an airlock through which to receive food.

The research station was towed by barge along the coast between Marseille and Monaco over the course of the month, with their three-day stint at the end the only time they entered a decompression chamber.

During their four weeks under water, the team also carried out experiments commissioned by researchers and laboratories and universities.

But the combination of the cold and the pressure made working so deep difficult and dangerous, said Ballesta. He and colleague Thibault Ribault were still suffering from frostbite on their fingers Sunday. The Planet Mediterranean team stayed in regular contact with the outside world with video blogs and televised news conferences.

They are planning an exhibition of the photos taken during their expedition and also a documentary for release next year.

NANOPHYSICS

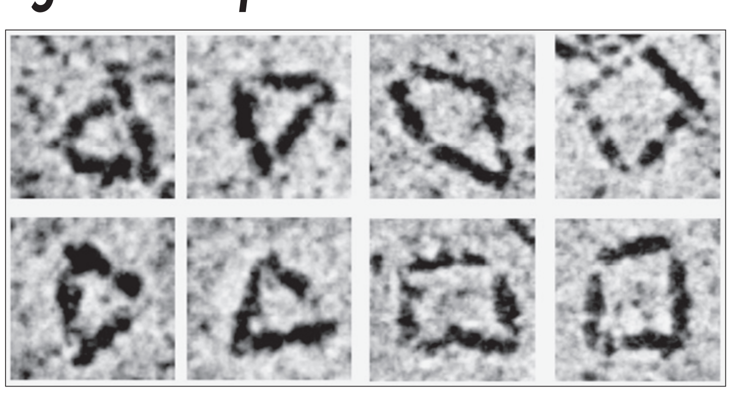
Engineers find new way to create single-chain protein nanostructures

The ancient art of paper folding known as origami is used to make intricate birds or other shapes. Inspired by the work of DNA origami, in which nanostructures are made from folding DNA, a team of engineers at the McKelvey School of Engineering at Washington University in St. Louis has found a new way to create single-chain protein nanostructures by using synthetic biology and protein-assembly techniques.

The team created nanostructures—in the shapes of triangles and squares—using stable protein building blocks. These protein nanostructures can endure high temperatures and harsh chemical conditions, both of which are not possible with DNA-based nanostructures. In the future, these protein nanostructures could be used to improve sensing capabilities, speeding chemical reactions, in drug delivery and other applications.

When trying to create protein nanostructures suited for particular applications, researchers typically make modifications to existing protein structures, such as virus particles. However, the shapes of nanostructures that can be made using this approach are limited to what nature provides. Now, Fuzhong Zhang, associate professor of energy, environmental & chemical engineering, and members of his lab have developed a bottom-up approach to build 2-D nanostructures, essentially starting from scratch.

"Building something that nature has not offered is more exciting," Zhang said. "We took individually folded proteins and used them as building blocks, then assembled them together piece by piece so that we can create tailored nanostructures."



Using synthetic biology approaches, Zhang's team first biosynthesized rod-shaped protein building blocks, similar in shape to a pencil but only 12 nanometers long.

Then, they connected these building blocks together through reactive protein domains that were genetically fused to the ends of each of the rods, forming triangles with three rods and squares with four rods. These reactive protein domains are known as split inteins, which are not new to Zhang's lab—they are the same tools that his group uses to make high-strength synthetic spider silk and synthetic replicas of the adhesive mussel foot proteins.

In both cases, these split intein groups enable the production of large proteins that make the synthetic spider silk tougher and stronger and the mussel foot proteins stickier. In this case, they enable the construction of novel nanostructures.

Zhang's team worked with Rohit Pappu, the Edwin H. Murty Professor of Engineering, professor of biomedical engineering and an expert in the biophysics of intrinsically disordered proteins, phase transitions and protein folding. Both Zhang and Pappu are members of the university's Center for Science & Engineering of Living Systems (CSELS).

"Professor Pappu's lab, specifically former postdoctoral fellow Jeong-Mo Choi, helped us understand how the protein sequence at the connections determines the flexibility of these nanostructures and helped us to predict protein sequences to better control the flexibility and geometry of nanostructures," Zhang said. "The collaboration between my synthetic biology lab and Professor Pappu's biophysical modeling lab has proven very productive."

The collaboration simplified a very complex process.

"Once we understood the design strategy, the work is fairly straightforward and quite fun to do," Zhang said. "We just controlled the different functional groups, then they controlled the shapes."

Due to the versatile functionality of proteins, these nanostructures potentially could be used as scaffolds to assemble various nanomaterials. To test this idea, the team assembled 1-nanometer gold nanoparticles precisely at the vertices of the triangle. Using a state-of-the-art electron microscope in the university's Institute of Materials Science & Engineering, both the protein triangles and the gold nanoparticles assembled to the vertices of the triangles were visible.

To test the stability of these protein nanostructures, the team exposed them to high temperatures, up to 98 degrees Celsius, to chemicals such as guanidium hydrochloride, and to organic solvents such as acetone. While these conditions generally destroy protein structures, the structures from Zhang's lab stayed intact. This ultra-stability could enable more nanoscale applications that are difficult or not possible using nanostructures made from DNA or other proteins, Zhang said.

Next, the team is working with Srikanth Singamaneni, professor of mechanical engineering & materials science and a member of CSELS, to use these protein nanostructures to develop improved plasmonic sensors.

"Exploiting the interplay between highly stable structural building blocks and intrinsically disordered or flexible regions provides a novel route to designing nanostructures with customizable features for a variety of applications in synthetic biology and biomedical sciences," Pappu said. "This is one of the major thrusts of our center as reflected by the synergies among three different labs that are part of the center."

OPTICS & PHOTONICS

Shaping light with a Smartlens

Camera performance on mobile devices has proven to be one of the features that most end-users aim for. The importance of optical image quality improvement, and the trend to have thinner and thinner smartphones have pushed manufactures to increase the number of cameras in order to provide phones with better zoom, low-light exposure high quality photography, and portrait settings, to name a few. But adding additional lenses to a miniaturized optical configuration and driving light focusing with an electronic device is not as easy as it seems, particularly at small scales or in confined spaces.

The integration of an adjustable-dynamic zoom lens in a millimeter-thick cell phone, in a miniaturized microscope, or at the remote end of a medical endoscope requires complex lenses that can handle the full optical spectrum and be reshaped electrically within milliseconds. Until now, a class of soft materials known as liquid crystal spatial light modulators have been the tool of choice for high-resolution light shaping, but their implementation has proven to have limits in terms of performance, bulkiness and cost.

In a study recently published in Nature Photonics, the outcome of a close collaboration between Pascal Berto, Chang Liu and Gilles Tessier from Institut de la Vision; and Laurent Philippet, Johann Osmond, Adeel Afridi, Marc Montagut, and Bernat Molero, led by ICREA Prof. at ICFO Romain Quidant, the researchers demonstrate an adjustable technique to manipulate light without any mechanical movement.

In this approach, coined Smartlens, a current is passed through a well-optimized micrometer-scale resistor, and the heating locally changes the optical properties of the transparent polymer plate holding the resistor. In much the same way as a mirage bends light passing through hot air to create illusions of distant lakes, this microscale hot region is able to deviate light.

Within milliseconds, a simple slab of polymer can be turned into a lens and back: small, micrometer-scale Smartlenses heat up and cool down quickly and with minimal power consumption. They can even be fabricated in arrays, and the authors show that several objects located at very different distances can be brought into focus within the same image by activating the Smartlenses located in front of each of them, even if the scene is in colours.

By modelling the diffusion of heat and the propagation of light and using algorithms inspired by the laws of natural selection the authors show they can go way beyond simple lenses: a properly engineered resistor can shape light with a very high level of control and achieve a wide variety of optical functions. For instance, if the right resistor is imprinted on it, a piece of polymer could be activated or deactivated at will to generate a given "freeform" and correct specific defects in our eyesight, or the aberrations of an optical instrument. As Prof. Romain Quidant points out, "remarkably, the Smartlens technology is cost effective and scalable, and has proven to have the potential to be applied to high-end technological systems as well as simple end-user-oriented imaging devices." The results of this study open a new window for the development of low-cost dynamically tuneable devices that could have a high impact on current existing optical systems.