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ARTIFICIAL NEURONS QUANTUM WITH PHOTONIC CIRCUITS

In recent years, artificial intelligence has become ubiquitous with applications such as speech interpretation, image recognition, medical diagnosis and many more. At the same time, quantum technology has been proven capable of computational power well beyond the reach of even the world's largest supercomputer. Physicists at the University of Vienna have now demonstrated a new device, called quantum memristor which may allow to combine these two worlds, thus unlocking unprecedented capabilities. The experiment, carried out in collaboration with the National Research Council (CNR) and the Politecnico di Milano in Italy has been realized on an integrated quantum processor operating on single photons.

At the heart of all artificial intelligence applications are mathematical models called neural networks. These models are inspired by the biological structure of the human brain, made of interconnected nodes. Just like our brain learns by constantly rearranging the connections between neurons, neural networks can be mathematically trained by tuning their internal structure until they become capable of human-level tasks: recognizing our face, interpreting medical images for diagnosis, even driving our cars. Having integrated devices capable of performing the computations involved in neural networks quickly and efficiently has thus become a major research focus, both academic and industrial.

One of the major game changers in the field was the discovery of the memristor, made in 2008. This device changes its resistance depending on a memory of the past current, hence the name memory-resistor, or memristor. Immediately after its discovery, scientists realized that (among many other applications) the peculiar behavior of memristors was surprisingly similar to that of neural synapses. The memristor has thus become a fundamental building block of neuromorphic architectures.

A group of experimental physicists from the University of Vienna, the National Research Council (CNR) and the Politecnico di Milano led by Prof. Philip Walther and Dr. Roberto Osellame, have demonstrated that it is possible to engineer a device that has the same behavior as a memristor while acting on quantum states and being able to encode and transmit quantum information. In other words, a quantum memristor. Realizing such device is challenging because the dynamics of a

memristor tends to contradict the typical quantum behavior.

By using single photons i.e. single quantum particles of lights and exploiting their unique ability to propagate simultaneously in a superposition of two or more paths, the physicists have overcome the challenge. In their experiment, single photons propagate along waveguides laser-written on a glass substrate and are guided on a superposition of several paths. One of these paths is used to measure the flux of photons going through the device and this quantity through a complex electronic feedback scheme, modulates the transmission on the other output, thus achieving the desired memristive behavior. Besides demonstrating the quantum memristor, the researchers have provided simulations showing that optical networks with quantum memristor can be used to learn on both classical and quantum tasks, hinting at the fact that the quantum memristor may be the missing link between artificial intelligence and quantum computing.

Unlocking the full potential of quantum resources within artificial intelligence is one of the greatest challenges of the current research in quantum physics and computer science. The group of Philip Walther of the University of Vienna has also recently demonstrated that robots can learn faster when using quantum resources and borrowing schemes from quantum computation. This new achievement represents one more step towards a future where quantum artificial intelligence become reality.

G.AAKASH

I B.Sc. (Information Technology)

SECURING DATA TRANSFERS WITH RELATIVITY

To counter hacking, researchers have developed a new system based on the concept of 'zero-knowledge proofs', the security of which is based on the physical principle of relativity: information cannot travel faster than the speed of light. Thus, one of the fundamental principles of modern physics allows for secure data transfer.

The volume of data transferred is constantly increasing but the absolute security of these exchanges cannot be guaranteed, as shown by cases of hacking frequently reported in the news. To counter hacking, a team from the University of Geneva (UNIGE), Switzerland, has developed a new system based

on the concept of "zero-knowledge proofs," the security of which is based on the physical principle of relativity: information cannot travel faster than the speed of light. Thus, one of the fundamental principles of modern physics allows for secure data transfer. This system allows users to identify themselves in complete confidentiality without disclosing any personal information, promising applications in the field of cryptocurrencies and blockchain. These results can be read in the journal Nature.

When a person so called 'prover' wants to confirm their identity, for example when they want to withdraw money from an ATM, they must provide their personal data to the verifier, in our example the bank which processes this information (e.g. the identification number and the pin code). As long as only the prover and the verifier know this data, confidentiality is guaranteed. If others get hold of this information, for example by hacking into the bank's server, security is compromised.

Zero-Knowledge Proof as a Solution

To counter this problem, the prover should ideally be able to confirm their identity, without revealing any information at all about their personal data. But is this even possible? Surprisingly the answer is yes, via the concept of a zero-knowledge proof. "Imagine I want to prove a mathematical theorem to a colleague. If I show them the steps of the proof, they will be convinced, but then have access to all the information and could easily reproduce the proof," explains Nicolas Brunner, a professor in the Department of Applied Physics at the UNIGE Faculty of Science. "On the contrary, with a zero-knowledge proof, I will be able to convince them that I know the proof, without giving away any information about it, thus preventing any possible data recovery."

The principle of zero-knowledge proof, invented in the mid-1980s, has been put into practice in recent years, notably for cryptocurrencies. However, these implementations suffer from a weakness, as they are based on a mathematical assumption (that a specific encoding function is difficult to decode). If this assumption is disproved, security is compromised because the data would become accessible. Today, the Geneva team is demonstrating a radically different system in practice: a relativistic zero-knowledge proof. Security is based here on a physics concept, the principle of relativity, rather than on a mathematical hypothesis. The principle of relativity that information does not travel faster than light is a pillar of modern physics, unlikely to be ever challenged.

K.SUDHIR

I B.Sc. (Information Technology)

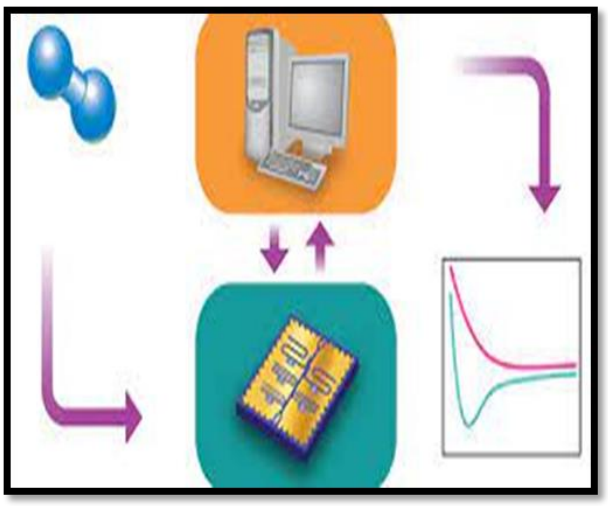
QUANTUM COMPUTER THAT CALCULATES MOLECULAR ENERGY

Quantum computers are getting bigger, but there are still few practical ways to take

advantage of their extra computing power. To get over this hurdle, researchers are designing algorithms to ease the transition from classical to quantum computers. In a new study in Nature, researchers unveil an algorithm that reduces the statistical errors, or noise, produced by quantum bits, or qubits, in crunching chemistry equations.

Developed by Columbia chemistry professor David Reichman and **postdoc Joonho Lee** with researchers at Google Quantum AI, the algorithm uses up to 16 qubits on Sycamore, Google's 53-qubit computer, to calculate ground state energy, the lowest energy state of a molecule. "These are the largest quantum chemistry calculations that have ever been done on a real quantum device," Reichman said.

The ability to accurately calculate ground state energy which will enable chemists to develop new materials, said Lee, who is also a visiting researcher at Google Quantum AI. The algorithm could be used to design materials to speed up nitrogen fixation for farming and hydrolysis for making clean energy, among other sustainability goals, he said.



The algorithm uses a quantum Monte Carlo, a system of methods for calculating probabilities when there are a large number of random, unknown variables at play, like in a game of roulette. Here, the researchers used their algorithm to determine the ground state energy of three molecules: heliocide (H4), using eight qubits for the calculation molecular nitrogen (N2), using 12 qubits and solid diamond, using 16 qubits.

Ground state energy is influenced by variables such as the number of electrons in a molecule, the direction in which they spin and the paths they take as they orbit a nucleus. This electronic energy is encoded in the Schrodinger equation. Solving the equation on a classical computer becomes exponentially harder as molecules get bigger, although methods for estimating the solution have made the process easier. How quantum computers might circumvent the exponential scaling problem has been an open question in the field.

In principle, quantum computers should be able to handle exponentially larger and more

complex calculations, like those needed to solve the Schrodinger equation, because the qubits that make them up take advantage of quantum states. Unlike binary digits, or bits, made up of ones and zeros, qubits can exist in two states simultaneously. Qubits, however, are fragile and error-prone: the more qubits used, the less accurate the final answer. Lee's algorithm harnesses the combined power of classical and quantum computers to solve chemistry equations more efficiently while minimizing the quantum computer's mistakes.

A classical computer can handle most of Lee's quantum Monte Carlo simulation. Sycamore jumps in for the last, most computationally complex step: the calculation of the overlap between a trial wave function a guess at the mathematical description of the ground state energy that can be implemented by the quantum computer -- and a sample wave function, which is part of the Monte Carlo's statistical process. This overlap provides a set of constraints, known as the boundary condition, to the Monte Carlo sampling, which ensures the statistical efficiency of the calculation.

The prior record for solving ground state energy used 12 qubits and a method called the variational quantum eigensolver, or VQE. But VQE ignored the effects of interacting electrons, an important variable in calculating ground state energy that Lee's quantum Monte Carlo algorithm now includes. Adding virtual correlation techniques from classic computers could help chemists tackle even larger molecules, Lee said.

The hybrid classical-quantum calculations in this new work were found to be as accurate as some of the best classical methods. This suggests that problems could be solved more accurately and/or quickly with a quantum computer than without a key milestone for quantum computing. Lee and his colleagues will continue to tweak their algorithm to make it more efficient, while engineers work to build better quantum hardware.

"The feasibility of solving larger and more challenging chemical problems will only increase with time," Lee said. "This gives us hope that quantum technologies that are being developed will be practically useful."

B. THARANIKA

II B.Sc. (Information Technology)

NEW CLOUD-BASED PLATFORM OPENS GENOMICS DATA TO ALL

Harnessing the power of genomics to find risk factors for major diseases or search for relatives relies on the costly and time-consuming ability to analyze huge numbers of genomes. A team co-led by Johns Hopkins, a University computer scientist has levelled the playing field by creating a cloud-based platform that grants genomics researchers easy

access to one of the world's largest genomics databases.

Known as Anvil (Genomic Data Science Analysis, Visualization, and Informatics Lab-space), the new platform gives any researcher with an Internet connection access to thousands of analysis tools, patient records, and more than 300,000 genomes. The work, a project of the National Human Genome Institute (NHGRI), appears today in Cell Genomics.

"Anvil is inverting the model of genomics data sharing, offering unprecedented new opportunities for science by connecting researchers and datasets in new ways and promising to enable exciting new discoveries," said project co-leader Michael Schatz, Bloomberg Distinguished Professor of Computer Science and Biology at Johns Hopkins.

Typically, genomic analysis starts with researchers downloading massive amounts of data from centralized warehouses to their own data centers, a process that is not only time-consuming, inefficient, and expensive, but also makes collaborating with researchers at other institutions difficult.

" Anvil will be transformative for institutions of all sizes, especially smaller institutions that don't have the resources to build their own data centers. It is our hope that Anvil levels the playing field, so that everyone has equal access to make discoveries," Schatz said.

Genetic risk factors for ailments such as cancer or cardiovascular disease are often very subtle, requiring researchers to analyse thousands of patients' genomes to discover new associations. The raw data for a single human genome comprises about 40GB, so downloading thousands of genomes can take takes several days to several weeks: A single genome requires about 10 DVDs worth of data, so transferring thousands means moving "tens of thousands of DVDs worth of data," Schatz said.

In addition, many studies require integrating data collected at multiple institutions, which means each institution must download its own copy while ensuring that patient-data security is maintained. This challenge is expected to become even greater in the future, as researchers embark on ever-larger studies requiring the analysis of hundreds of thousands to millions of genomes at once.

"Connecting to Anvil remotely eliminates the need for these massive downloads and saves on the overhead," Schatz says. "Instead of painfully moving data to researchers, we allow researchers to effortlessly move to the data in the cloud. It also makes sharing datasets much easier so that data can be connected in new ways to find new associations, and it simplifies a lot of computing issues, like providing strong encryption and privacy for patient datasets."

Anvil also provides researchers with several major analysis tools, including Galaxy, developed in part at Johns Hopkins, along with other popular tools such as R/Bioconductor, Jupyter notebooks, WDLs, Gen3, and Dockstore to support both interactive analysis and large-scale batch computing. Collectively, these tools allow researchers to tackle even the largest studies without having to build out their own computing environments.

Researchers from all over the world currently use the platform to study a variety of genetic diseases, including autism spectrum disorders, cardiovascular disease, and epilepsy. Schatz's team, part of the Telomere-to-Telomere Consortium, used it to reanalyse thousands of human genomes with the new reference genome to discover more than 1 million new variants.

The Anvil team includes researchers from Johns Hopkins University, the Broad Institute of MIT and Harvard, Harvard University, Vanderbilt University, the University of Chicago, Oregon Health and Sciences University, Yale University School of Medicine, the University of California, Santa Cruz, Roswell Park Comprehensive Cancer Institute, the Pennsylvania State University, the City University of New York, the Carnegie Institute, and Washington University in St. Louis.

G. CHANTHRU

II B.Sc. (Computer Technology)

ARTIFICIAL INTELLIGENCE TUTORING OUTPERFORMS EXPERT INSTRUCTORS IN NEUROSURGICAL TRAINING

The COVID-19 pandemic has presented both challenges and opportunities for medical training. Remote learning technology has become increasingly important in several fields. A new study finds that in a remote environment, an artificial intelligence (AI) tutoring system can outperform expert human instructors.

The Neurosurgical Simulation and Artificial Intelligence Learning Centre at The Neuro (Montreal Neurological Institute-Hospital) recruited seventy medical students to perform virtual brain tumour removals on a neurosurgical simulator. Students were randomly assigned to receive instruction and feedback by either an AI tutor or a remote

expert instructor with a third control group receiving no instruction.

An AI-powered tutor called the Virtual Operative Assistant (VOA) used a machine learning algorithm to teach safe and efficient surgical technique and provided personalized feedback, while a deep learning Intelligent Continuous Expertise Monitoring System (ICEMS) and a panel of experts assessed student performance. In the other group, remote instructors watched a live feed of the surgical simulations and provided feedback based on the student's performance.

The researchers found that students who received VOA instruction and feedback learned surgical skills 2.6 times faster and achieved 36 per cent better performance compared to those who received instruction and feedback from remote instructors. And while researchers expected students instructed by VOA to experience greater stress and negative emotion, they found no significant difference between the two groups.

Surgical skill plays an important role in patient outcomes both during and after brain surgery. VOA may be an effective way to increase neurosurgeon performance, improving patient safety while reducing the burden on human instructors. "Artificially intelligent tutors like the VOA may become a valuable tool in the training of the next generation of neurosurgeons," says Dr. Rolando Del Maestro, the study's senior author. "The VOA significantly improved expertise while fostering an excellent learning environment. Ongoing studies are assessing how in-person instructors and AI-powered intelligent tutors can most effectively be used together to improve the mastery of neurosurgical skills."

"Intelligent tutoring systems can use a variety of simulation platforms to provide almost unlimited chances for repetitive practice without the constraints imposed by the availability of supervision," says Ali Fazlollahi, the study's first author. "With continued research, increased development, and dissemination of intelligent tutoring systems, we can be better prepared for ever-evolving future challenges."

This study, published in the Journal of the American Medical Association (JAMA Network Open) on 22 February, 2022, was funded by the Franco Di Giovanni Foundation, the Royal College of Physicians and Surgeons of Canada, and the Brain Tumour Foundation of Canada Tumour Research Grant along with The Neuro. Cognitive assessment was led by

Dr. Jason Harley at McGill University's Department of Surgery.

A. K. SUJA

II B.Sc. (Information Technology)

SYSTEM RECOGNIZES HAND GESTURES TO EXPAND COMPUTER INPUT ON A KEYBOARD

The prototype called Typealike, works through a regular laptop webcam with a simple affixed mirror. The program recognizes the user's hands beside or near the keyboard and prompts operations based on different hand positions. A user could, for example, place their right hand with the thumb pointing up beside the keyboard, and the program would recognize this as a signal to increase the volume. Different gestures and different combinations of gestures can be programmed to carry out a wide range of operations.

The innovation in the field of human-computer interaction aims to make user experience faster and smoother with less need for keyboard shortcuts or working with a mouse and trackpad. "It started with a simple idea about new ways to use a webcam," said Nalin Chhibber, a recent master's graduate from the University of Waterloo's Cheriton School of Computer Science. "The webcam is pointed at your face, but the most interaction happening on a computer is around your hands. So we thought, what could we do if the webcam could pick up hand gestures?"

The initial insight led to the development of a small mechanical attachment that redirects the webcam downwards towards the hands. The team then created a software program capable of understanding distinct hand gestures in variable conditions and for different users. The team used machine learning techniques to train the Typealike program. "It's a neural network, so you need to show the algorithm examples of what you're trying to detect," said Fabrice Matulic, senior researcher at Preferred Networks Inc. and a former postdoctoral researcher at Waterloo. "Some people will make gestures a little bit differently, and hands vary in size, so you have to collect a lot of data from different people with different lighting conditions."

The team recorded a database of hand gestures with dozens of research volunteers. They also had the volunteers do tests and surveys to help the team understand how to make the program as functional and versatile as

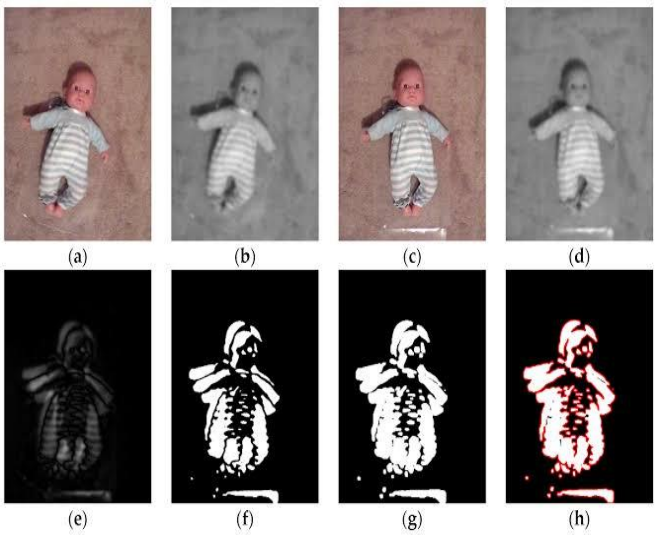
possible. "We're always setting out to make things people can easily use," said Daniel Vogel, an Associate Professor of Computer Science at Waterloo. "People look at something like Typealike, or other new tech in the field of human-computer interaction, and they say it just makes sense. That's what we want. We want to make technology that's intuitive and straightforward, but sometimes to do that takes a lot of complex research and sophisticated software."

The researchers say there are further applications for the Typealike program in virtual reality where it could eliminate the need for hand-held controllers.

S.P. VISHVA
III B.Sc. (Information Technology)

BABY DETECTOR SOFTWARE EMBEDDED IN DIGITAL CAMERA RIVALS ECG

Man faces is now common with adults, but this is the first time that researchers have developed software to reliably detect a premature baby's face and skin when covered in tubes, clothing, and undergoing phototherapy. Engineering researchers and a neonatal critical care specialist from UniSA remotely monitored heart and respiratory rates of seven infants in the Neonatal Intensive Care Unit (NICU) at Flinders Medical Centre in Adelaide, using a digital camera.



"Babies in neonatal intensive care can be extra difficult for computers to recognise because their faces and bodies are obscured by tubes and other medical equipment," says UniSA Professor Javaan Chahl, one of the lead researchers. "Many premature babies are being treated with phototherapy for jaundice, so they are under bright blue lights, which also makes it challenging for computer vision systems."

The 'baby detector' was developed using a dataset of videos of babies in NICU to reliably detect their skin tone and faces. Gram (ECG) and in some cases appeared to outperform the conventional electrodes, endorsing the value of non-contact monitoring of pre-term babies in intensive care. The study is part of an ongoing UniSA project to replace contact-based electrical sensors with non-contact video cameras, avoiding skin tearing

and potential infections that adhesive pads can cause to babies' fragile skin.

Infants were filmed with high-resolution cameras at close range and vital physiological data extracted using advanced signal processing techniques that can detect subtle colour changes from heartbeats and body movements not visible to the human eye. UniSA neonatal critical care specialist Kim Gibson says using neural networks to detect the faces of babies is a significant breakthrough for non-contact monitoring.

"In the NICU setting it is very challenging to record clear videos of premature babies. There are many obstructions, and the lighting can also vary, so getting accurate results can be difficult. However, the detection model has performed beyond our expectations. "Worldwide, more than 10 per cent of babies are born prematurely and due to their vulnerability, their vital signs need to be monitored continuously. Traditionally, this has been done with adhesive electrodes placed on the skin that can be problematic and we believe non-contact monitoring is the way forward," Gibson says.

S.BHARATH

III B.Sc. (Information Technology)

A ROBOT AND SOFTWARE MAKE IT EASIER TO CREATE ADVANCED MATERIALS

Researchers who want to explore large libraries of polymers, including plastics and fibers, for chemical and biological applications such as drugs and regenerative medicine through tissue engineering. While a human researcher may be able to make a few polymers a day, the new automated system featuring custom software and a liquid-handling robot can create up to 384 different polymers at once, a huge increase over current methods.

Synthetic polymers are widely used in advanced materials with special properties and their continued development is crucial to new technologies, according to a study in the journal Advanced Intelligent Systems. Such technologies include diagnostics, medical devices, electronics, sensors, robots and lighting. "Typically, researchers synthesize polymers in highly controlled environments, limiting the development of large libraries of complex materials," said senior author Adam J. Gormley, an assistant professor in the Department of Biomedical Engineering in the School of Engineering at Rutgers University-New Brunswick. "By automating polymer synthesis and using a robotic platform, it is now possible to rapidly create a multitude of unique materials."

Robotics has automated many ways to make materials as well as discover and develop drugs. But synthesizing polymers remains challenging because most chemical reactions are extremely sensitive to oxygen and can't be done without removing it during production. The Gormley lab's open-air robotics platform carries out polymer synthesis reactions that tolerate oxygen. The group developed custom software that allows a liquid handling robot to interpret polymer designs made on a computer and carry out every step of the chemical reaction. One benefit: the new automated system makes it easier for non-experts to create polymers.

K. GOWTHAM

III B.Sc. (Computer Technology)

IOT CONNECTIVITY -5G, WI-FI 6, LPWAN AND SATELLITES

The main challenge that IoT networks have had to overcome in recent years is wireless data rates. As these technologies improve, so too will the aspects of IoT technology, including sensors, edge computing, wearables, smart homes and more. Recently, more infrastructure has been developed for newer connectivity types that make IoT solutions more feasible. These are connectivity technologies like 5G, Wi-Fi 6, LPWAN, and satellites.

5G: Advanced Mobile Networks

In many IoT technology solutions, connectivity infrastructure needs to be set up before an array of edge devices, sensors, or other devices can be maintained. However, mobile networks like LTE can be a potential alternative for certain situations such as outdoor settings. However, 4G LTE is limited by bandwidth. 5G networks however are much faster and can support data processing needed for IoT networks much more efficiently.

WI-FI 6

For indoor settings, Wi-Fi operating in the 6 GHz band increases the bandwidth potential of IoT technology greatly. The faster that a network of devices can communicate, the more reliable that the system will be. As a bonus, Wi-Fi 6 can be

used in households, meaning that this can offer great benefits for smart home IoT networks.

LPWAN

Low-Power Wide-Area Network connectivity is an emerging technology that is effective for connecting devices with low-bandwidth usage with low bit rates over larger areas. This makes it a good choice for IoT devices that communicate with one another on a machine-to-machine basis. LPWANs are more energy efficient, making them more cost-effective. If you need to use a large number of devices over a large area, LPWAN technology is a good choice.

SATELLITE

In some cases, IoT technology can be powered by satellites for geographically separated networks. Powered by Globalstar satellites, Traksat's satellite-powered IoT devices enable humanitarian staff to report emergency incidents to immediately request assistance. GPS information is immediately recorded and sent to a headquarters for rescue preparations.

J SUBHA SHREE

I B.Sc. (Information Technology)

MOBILE COMMUNICATIONS BEYOND 5G

Researchers have revealed a new beam-steering antenna that increases the efficiency of data transmission and opens up frequencies for mobile communications that are inaccessible to currently used technologies. The technology has demonstrated vast improvements in data transmission efficiency at frequencies ranging across the millimeter wave spectrum, specifically those identified for 5G (mmWave) and 6G, where high efficiency is currently only achievable using slow, mechanically steered antenna solutions.

Birmingham scientists have revealed a new beam-steering antenna that increases the efficiency of data transmission for 'beyond 5G' and opens up a range of frequencies for mobile communications that are inaccessible to currently used technologies. Devised by researchers from the University of Birmingham's School of Engineering, the technology has demonstrated vast improvements in data transmission efficiency

at frequencies ranging across the millimetre wave spectrum, specifically those identified for 5G (mmWave) and 6G, where high efficiency is currently only achievable using slow, mechanically steered antenna solutions. For 5G mmWave applications, prototypes of the beam-steering antenna at 26 GHz have shown unprecedented data transmission efficiency.

The device is fully compatible with existing 5G specifications that are currently used by mobile communications networks. Moreover, the new technology does not require the complex and inefficient feeding networks required for commonly deployed antenna systems, instead using a low complexity system which improves performance and is simple to fabricate. The beam-steering antenna was developed by Dr James Churm, Dr Muhammad Rabbani, and Professor Alexandros Feresidis, Head of the Metamaterials Engineering Laboratory, as a solution for fixed, base station antenna, for which current technology shows reduced efficiency at higher frequencies, limiting the use of these frequencies for long-distance transmission.

Around the size of an iPhone, the technology uses a metamaterial, made from a metal sheet with an array of regularly spaced holes that are micrometres in diameter. An actuator controls the height of a cavity within the metamaterial, delivery micrometre movements, and, according to its position, the antenna will control the deflection of the team of a radio wave effectively 'concentrating' the beam into a highly directive signal, and then redirecting this energy as desired whilst also increasing the efficiency of transmission. The team is now developing and testing prototypes at higher frequencies and in applications that take it beyond 5G mobile communications. Dr Churm commented: "Although we developed the technology for use in 5G, our current models show that our beam steering technology may be capable of 94% efficiency at 300 GHz. The technology can also be adapted for use in vehicle-to-vehicle, vehicle-to-infrastructure, vehicular radar, and satellite communications, making it good for next generation use in automotive, radar, space and defence applications."

University of Birmingham Enterprise has filed a patent application for this next generation beam-steering antenna technology, and is seeking industry partners for collaboration, product development or licensing. The efficiency and other aspects of the underpinning technology have been subjected to the peer review process, published in respected journals, and presented at academic conferences.

Dr Churm added, "We are assembling a further body of work for publication and presentation that will demonstrate a level of efficiency that has not yet been reported for transmission of radio waves at these challenging frequencies. The simplicity of the design and the low cost of the elements are

advantageous for early adoption by industry, and the compact electronics configuration make it easy to deploy where there are space constraints. We are confident that the beam-steering antenna is good for a wide range of 5G and 6G applications as well as satellite and the Internet of Things."

G MOWNIKA

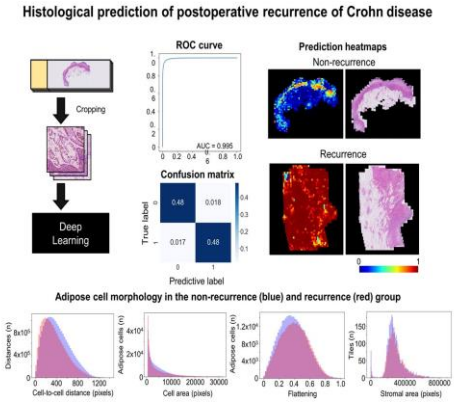
I B.Sc. (Computer Technology)

ARTIFICIAL INTELLIGENCE MODEL CAN SUCCESSFULLY PREDICT THE REOCCURRENCE OF CROHN'S DISEASE

Many people end up needing surgery to treat their Crohn's disease. Even after a successful operation, recurrence is common. Now, researchers are reporting that their AI tool is highly accurate at predicting the postoperative recurrence of Crohn's disease.

Using an Artificial Intelligence (AI) tool that simulates how humans visualize and is trained to identify and categorize pictures, researchers created a model that predicts the postoperative recurrence of Crohn's disease with high accuracy by evaluating histological images. The AI tool also identified previously unknown differences in adipose cells and substantial disparities in the degree of mast cell infiltration in the subserosa, or outer lining of the gut, when comparing individuals with and without disease recurrence.

The 10-year rate of postoperative symptomatic recurrence of Crohn's disease, a chronic inflammatory gastrointestinal illness, is believed to be 40%. Although there are scoring methods to measure Crohn's disease activity and the existence of postoperative recurrence, no scoring system has been devised to predict whether Crohn's disease will return.



"Most of the analysis of histopathological images using AI in the past have targeted malignant tumors," explained lead investigators Takahiro Matsui, MD, Ph.D., and Eiichi Morii, MD, Ph.D., Department of Pathology, Osaka University Graduate School of Medicine, Osaka, Japan.

The research involved 68 Crohn's disease patients who underwent bowel resection between January 2007 and July 2018. They were divided into two groups based on whether or not they had postoperative disease recurrence within two years after surgery. Each group was divided into two subgroups, one for

training and the other for validation of an AI model. Whole slide pictures of surgical specimens were cropped into tile images for training, labeled for the presence or absence of postsurgical recurrence, and then processed using EfficientNet-b5, a commercially available AI model built to perform image classification. When the model was tested with unlabelled photographs, the findings indicated that the deep learning model accurately classified the unlabelled images according to the presence or absence of disease occurrence.

Following that, prediction heat maps were created to identify areas and histological features from which the machine learning algorithm could accurately predict recurrence. All layers of the intestinal wall were shown in the photos. The heatmaps revealed that the machine learning algorithm correctly predicted the subserosal adipose tissue layer. However, the model was less precise in other regions, such as the mucosal and proper muscular layers. Images with the greatest accurate predictions were taken from the non-recurrence and recurrence test datasets. The photos with the greatest predictive results all had adipose tissue.

Because the machine learning model achieved accurate predictions from images of subserosal tissue, the investigators hypothesized that subserosal adipose cell morphologies differed between the recurrence and the non-recurrence groups. Adipose cells in the recurrence group had a significantly smaller cell size, higher flattening, and smaller center-to-center cell distance values than those in the non recurrence group.

"These features, defined as 'adipocyte shrinkage,' are important histological characteristics associated with Crohn's disease recurrence," said Dr. Matsui and Dr. Morii.

The investigators also hypothesized that the differences in adipocyte morphology between the two groups were associated with some degree or type of inflammatory condition in the tissue. They found that the recurrence group had a significantly higher number of mast cells infiltrating the subserosal adipose tissue, indicating that the cells are associated with the recurrence of Crohn's disease and the "adipocyte shrinkage" phenomenon.

K. GOWTHAM

III B.Sc. (Computer Technology)

FUNDAMENTAL BUILDING BLOCKS FOR FAULT-TOLERANT QUANTUM COMPUTING

Due to high-quality fabrication, errors during processing and storage of information have become a rarity in modern computers. However, for critical applications, where even single errors can have serious effects, error

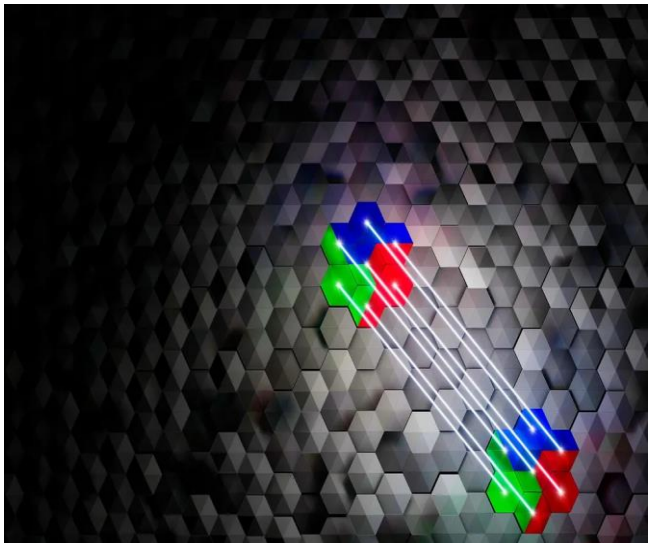
correction mechanisms based on the redundancy of the processed data are still used.

Quantum computers are inherently much more susceptible to disturbances and therefore error correction mechanisms will almost certainly always be required. Otherwise, errors would propagate uncontrolled in the system and information would be lost. Because the fundamental laws of quantum mechanics forbid copying quantum information, redundancy can be achieved by distributing logical quantum information into an entangled state of several physical systems, for example, multiple individual atoms.

The research team, led by Thomas Monz of the Department of Experimental Physics at the University of Innsbruck and Markus Müller of RWTH Aachen University and Forschungszentrum Jülich in Germany, has now succeeded for the first time in realizing a set of computational operations on two logical quantum bits that can be used to implement any possible operation. “For a real-world quantum computer, we need a universal set of gates with which we can program all algorithms,” explains Lukas Postler, an experimental physicist from Innsbruck.

The team of researchers implemented this universal gate set on an ion trap quantum computer featuring 16 trapped atoms. The quantum information was stored in two logical quantum bits, each distributed over seven atoms.

It has been possible to implement two computational gates on these fault-tolerant quantum bits, which are necessary for a universal set of gates: a computational operation on two quantum bits (a CNOT gate) and a logical T gate, which is particularly difficult to implement on fault-tolerant quantum bits.



“T gates are very fundamental operations,” explains theoretical physicist Markus Müller. “They are particularly interesting because quantum algorithms without T gates can be simulated relatively easily on classical computers, negating any possible speed-up. This is no longer possible for algorithms with T gates.” The physicists demonstrated the T-gate by preparing a special state in a logical quantum bit and teleporting it to another quantum bit via an entangled gate operation.

G. GOWRI

III B.Sc. (Computer Technology)

COMPUTER RIDDLES

1. What did the computer do at lunchtime?
2. What do you get if you stuff your computer's disk drive with herbs?
3. Why is a Computer so smart?
4. What did the dentist say to the computer?
5. What did the computer eat on the moon?

ANSWER:

1. It had a byte
2. A thyme Machine
3. Its listen to its motherboard
4. This won't hurt a byte
5. Space Bars

J. KAVIYA SREE

I B.Sc. (Information Technology)

TCS INTERVIEW QUESTIONS

1. An exam was conducted and the following was analysed. 4 men were able to check some exam papers in 8 days working 5 hours regularly. What is the total number of hours taken by 2 men in 20 days to check double the number of exam papers?

   Answer: 8 hours

2. The numbers from 101 to 150 are writtenas,
   101102103104105…14614714814915
   0. What will be the remainder when this total number is divided by 3?

   Answer: 2

3. If the alphabets are written in the sequence of a, bb, ccc, dddd, eeeee, ffffff, …. What will be the 120^{th} letter?

   Answer: o

4. There is a tank whose 1/7 th part is filled with fuel. If 22 litres of fuel is poured into the tank, the indicator rises to 1/5 th mark of the tank. So what is the total capacity of the tank?

   Answer: 385

5. How many prime numbers lie between 3 and 100 (excluding the values) that satisfies the condition: In the given figure, find the ratio of area of the square to area of the triangle:

a) 3:2 b) 2:3 c) 2:1 d) 1:2

Answer:2:1

M.HEMASRI
III B.Sc. (Information Technology)

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COMPUTER SCIENCE GENERAL KNOWLEDGE QUESTIONS

1. What does XML stand for?
   1) Example Markup Language
   2) Extensible Markup Language
   3) X Markup Language
   4) Extra Modern Link
2. Which is not a type of secondary memory?
   1) Solid State Drive
   2) Hard Disk
   3) Random Access Memory (RAM)
   4) USB Pen Drive
3. IPv6 protocol defines an IP address of
   1) 32 bit
   2) 64 bit
   3) 128 bit
   4) 256 bit
4. A social network can be represented as
   1) Graph
   2) Tree
   3) Star
   4) Ring
5. Who among the following is known as the father of computer?
   1) Charles Babbage
   2) Tim Berners Lee
   3) Philip Don Estridge
   4) James Gosling
6. Which of the following keyboard shortcuts displays the start menu in the Windows Operating Systems?
   1) Ctrl + Z
   2) Alt + Spacebar
   3) Ctrl + Esc
   4) Alt + Enter
7. A system program designed to aid the programmer in finding and correcting errors or bugs is known as
   1) Evaluator
   2) Debugger
   3) Quarantiner
   4) Corrector
8. Microsoft Excel is a
   1) MS office package
   2) Electronic Spreadsheet
   3) Graphic package
   4) Financial planning package
9. Which memory is both static and non-volatile?
   1) CACHE
   2) ROM
   3) BIOS
   4) RAM

10. Blowfish is a type of

1) Symmetric Encryption Algorithm

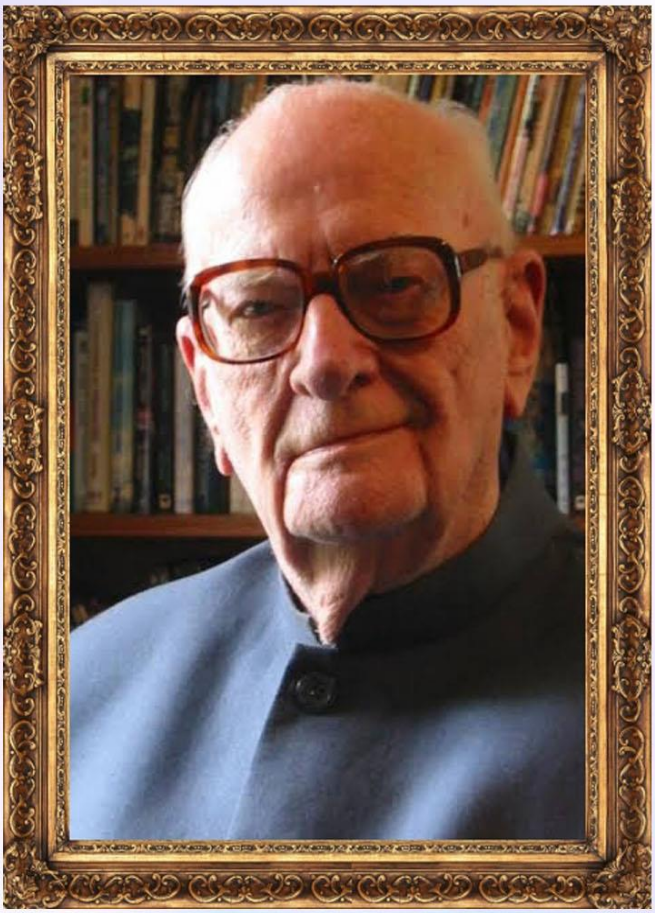
2) Hashing Algorithm

3) Digital Signature Algorithm

4) Asymmetric Encryption Algorithm

N.R.SHARMILA

III B.Sc. (Information Technology)



ANY SUFFICIENTLY ADVANCED TECHNOLOGY IS INDISTINGUISHABLE FROM MAGIC

- ARTHUR C CLARKE