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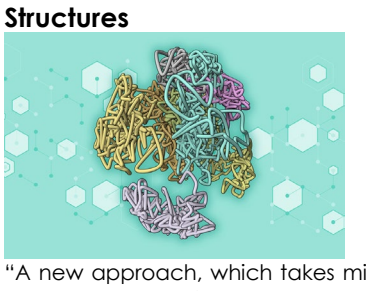
3D GENOMIC STRUCTURES & AI

With Generative AI, MIT Chemists Quickly Calculate 3D Genomic Structures



"A new approach, which takes minutes rather than days, predicts how a specific DNA sequence will arrange itself in the cell nucleus.

Every cell in your body contains the same genetic sequence, yet each cell expresses only a subset of those genes. These cell-specific gene expression patterns, which ensure that a brain cell is different from a skin cell, are partly determined by the three-dimensional structure of the genetic material, which controls the accessibility of each gene.

MIT chemists have now come up with a new way to determine those 3D genome structures, using generative artificial intelligence. Their technique can predict thousands of structures in just minutes, making it much speedier than existing experimental methods for analyzing the structures.

Using this technique, researchers could more easily study how the 3D organization of the genome affects individual cells' gene expression patterns and functions.

"Our goal was to try to predict the three-dimensional genome structure from the underlying DNA sequence," says Bin Zhang, an associate professor of chemistry and the senior author of the study. "Now that we can do that, which puts this technique on par with the cutting-edge experimental techniques, it can really open up a lot of interesting opportunities."

Source: MIT (31 Jan 2025)

AI

How China Created AI Model Deepseek and Shocked the World

"Chinese technology start-up DeepSeek has taken the tech world by storm with the release of two large language models (LLMs) that rival the performance of the dominant tools developed by US tech giants — but built with a fraction of the cost and computing power.

On 20 January, the Hangzhou-based company released DeepSeek-R1, a partly open-source 'reasoning' model that can solve some scientific problems at a similar standard to o1, OpenAI's most advanced LLM, which the company, based in San Francisco, California, unveiled late last year. And earlier this week, DeepSeek launched another model, called Janus-Pro-7B, which can generate images from text prompts much like OpenAI's DALL-E 3 and Stable Diffusion, made by Stability AI in London.

If DeepSeek-R1's performance surprised many people outside of China, researchers inside the country say the start-up's success is to be expected and fits with the government's ambition to be a global leader in artificial intelligence (AI).

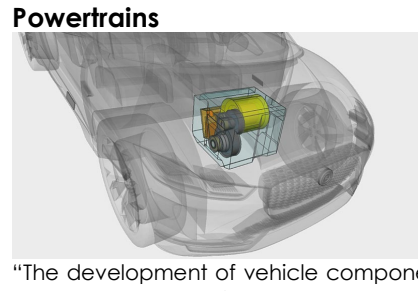
It was inevitable that a company such as DeepSeek would emerge in China, given the huge venture-capital investment in firms developing LLMs and the many people who hold doctorates in science, technology, engineering or mathematics fields, including AI, says Yunji Chen, a computer scientist working on AI chips at the Institute of Computing Technology of the Chinese Academy of Sciences in Beijing. "If there was no DeepSeek, there would be some other Chinese LLM that could do great things."

In fact, there are. On 29 January, tech behemoth Alibaba released its most advanced LLM so far, Qwen2.5-Max, which the company says outperforms DeepSeek's V3, another LLM that the firm released in December. And last week, Moonshot AI and ByteDance released new reasoning models, Kimi 1.5 and 1.5-pro, which the companies claim can outperform o1 on some benchmark tests."

Source: Nature (30 Jan 2025)

AI & POWERTRAINS

E-Mobility: TU Graz AI System Accelerates the Development of Powertrains



"The development of vehicle components is a lengthy and therefore very costly process. Researchers at Graz University of Technology (TU Graz) have developed a method that can shorten the development phase of the powertrain of battery electric vehicles by several months. A team led by Martin Hofstetter from the Institute of Automotive Engineering is combining simulation models of components with evolutionary optimisation algorithms. This AI system automatically optimises the entire powertrain – from the power electronics to the electric machine through to the transmission – in line with the manufacturer's technical requirements, taking into account targets such as production costs, efficiency and package space requirements in the vehicle. The OPED (Optimisation of Electric Drives) software solution was developed at TU Graz and is the result of almost ten years of research. It is already being used successfully by a renowned Austrian automotive supplier.

The starting point for automatic optimisation is the input of the technical requirements that the powertrain must fulfil: these include the power output, the minimum service life, the maximum speed to be achieved and the maximum space available in the vehicle. "Electric drives consist of a large number of components that can be designed very differently in order to fulfil the desired requirements," explains Martin Hofstetter. "If I make a small change to the electric machine, it has an effect on the transmission and the power electronics. So it's extremely complex to make optimal decisions." An additional difficulty is that there is no one perfect solution for a powertrain, as the priorities of the manufacturers also play a role. These could be production costs, the weight and volume of the powertrain or energy efficiency."

Source: Tugraz (30 Jan 2025)

ARCHITECTURE

Playful Pedagogy: 4 Projects Using Topography to Redefine Children's Learning Environments in China

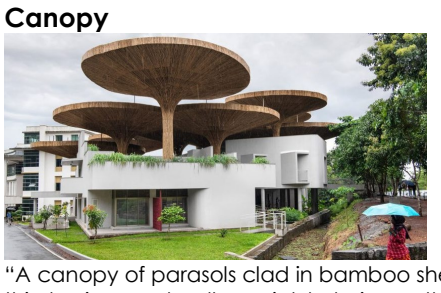
"Educational architecture globally is undergoing a significant transformation, moving away from static, rigid designs toward more dynamic, interactive, and nature-driven environments. As cities become denser and land availability diminishes, architects are reimagining schools not just as places for learning but as ecosystems where children can grow holistically. A key element in this shift is the integration of landscape and topographical design, which allows schools to transcend traditional boundaries, combining education with play, exploration, and connection to nature. These designs aim to create engaging spaces that challenge children to interact with their environment physically and emotionally, fostering creativity, independence, and well-being. By layering natural elements such as mounds, gardens, terraces, and play structures into architectural plans, educational spaces are being reshaped into vibrant, multi-dimensional landscapes that encourage movement, imagination, and discovery.

This collection highlights projects completed in China by architects like MAD Architects, 11ARCHITECTURE, waa, and Yijing Architectural Design, who are redefining how children experience schools in urban environments. Despite their diverse approaches, these projects share key principles: leveraging verticality to maximize land use, blurring the boundaries between indoor and outdoor spaces, and creating playful, child-centered environments that connect students with nature. From the flowing rooftop playgrounds of YueCheng Courtyard Kindergarten in Beijing to the thematic topographies of Xinsha Primary School in Shenzhen, these designs reflect a commitment to integrating architecture and landscape as tools for learning and exploration."

Source: Archdaily (2 Feb 2025)

ARCHITECTURE

The Purple Ink Studio Covers Tapmi Centre in India with Bamboo Parasol Canopy



"A canopy of parasols clad in bamboo shelters this business school's social hub in southwest India, which local practice The Purple Ink Studio has designed to challenge conventional academic buildings.

The Purple Ink Studio's extension of the Tapmi Center business faculty is located on a prominent corner site on the T A Pai Management Institute campus in the town of Manipal, Karnataka, set against a backdrop of lush forested valleys.

It consists of two white buildings arranged in wings, which provide classrooms, administration space, workshops and a small cafeteria. Sitting at the heart of these structures is a "porous" sunken amphitheatre called Angala.

This communal hub was built to address the town's lack of space for its 30,000-strong student community to socialise and gather and is designed to be accessible from the road below, through a series of ramps and staircases."

BATTERY

Recycling Lithium-Ion Batteries Cuts Emissions and Strengthens Supply Chain

"Recycling lithium-ion batteries to recover their critical metals has significantly lower environmental impacts than mining virgin metals, according to a new Stanford University lifecycle analysis published in Nature Communications. On a large scale, recycling could also help relieve the long-term supply insecurity – physically and geopolitically – of critical battery minerals.

Lithium-ion battery recyclers source materials from two main streams: defective scrap material from battery manufacturers, and so-called "dead" batteries, mostly collected from workplaces. The recycling process extracts lithium, nickel, cobalt, copper, manganese, and aluminum from these sources.

The study quantified the environmental footprint of this recycling process, and found it emits less than half the greenhouse gases (GHGs) of conventional mining and refinement of these metals and uses about one-fourth of the water and energy of mining new metals. The environmental benefits are even greater for the scrap stream, which comprised about 90% of the recycled supply studied, coming in at: 19% of the GHG emissions of mining and processing, 12% of the water use, and 11% of the energy use. While it was not specifically measured, reduced energy use also correlates with less air pollutants like soot and sulfur.

"This study tells us that we can design the future of battery recycling to optimize the environmental benefits. We can write the script," said William Tarpeh (BS '12), assistant

DESIGN

Spout Home Appliance Transforms Air Into "Pure Drinking Water"

"California company Spout has launched a countertop kitchen gadget that transforms humidity from the air into drinking water, drawing on technology used by NASA.

The atmospheric water generator is around the size of a large coffee machine and can produce 7.5 litres of water per day.

This is achieved using a rotating desiccant wheel, also used in dehumidifiers, which removes water molecules from the air as it flows through the wheel's honeycomb structure.

"The ceramic honeycomb is a marvel of molecular engineering," Spout CEO and co-founder Reuben Vollmer told Dezeen.

"Utilizing zeolites, a material with microscopic pores, it acts like a sponge, attracting and trapping water molecules from the air."

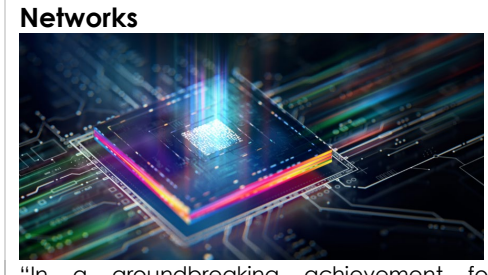
"As it rotates, the honeycomb moves into a heated section, where the bonds holding the water are gently released, turning the captured vapor into liquid water through condensation."

The device is 38 centimetres tall and was designed to be placed on kitchen countertops. In average conditions, it can fill a 500-millilitre bottle in about an hour and a half, and produce up to 7.5 litres of water per day – enough to meet the daily needs of a family of three.

Spout's Los Angeles-based parent company hopes that the appliance will reduce the use

QUANTUM NETWORKS

A New Register with Thousands of Entangled Nuclei to Scale Quantum Networks



"In a groundbreaking achievement for quantum technologies, researchers at the Cavendish Laboratory, University of Cambridge, have created a functional quantum register using the atoms inside a semiconductor quantum dot.

Published in Nature Physics, the work demonstrates the introduction of a new type of optically connected qubits—a critical advance in the development of quantum networks, where stable, scalable, and versatile quantum nodes are essential.

Quantum dots are nanoscale objects with unique optical and electronic properties that come from quantum mechanical effects. These systems are already used in technologies like display screens and medical imaging, and their adoption in quantum communication has been mostly due to their ability to operate as bright single-photon sources. However, effective quantum networks need more than just single-photon emission; they also require stable qubits that can interact with the photons and store quantum information locally. The new research builds on the inherent spins of the atoms forming the quantum dots as a functioning many-body quantum register to store information over extended periods.

A many-body system refers to a collection of interacting particles—here, the nuclear spins inside the quantum dot—whose collective behaviour gives rise to new, emergent properties that are not present in individual

professor of chemical engineering in the School of Engineering and the study's senior author."

Source: Eurekalert! (31 Jan 2025)

of plastic bottles. Americans buy about 50 billion water bottles per year and plastic waste generation in the US is projected to surpass 140 million metric tons by 2060.

"At its core, it provides water independence, ensuring families always have access to a safe, endless supply of pure water without relying on plastic bottles or inconsistent municipal sources," Vollmer said."

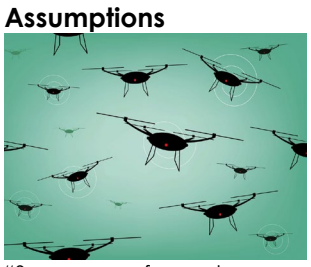
Source: Dezeen (22 Jan 2025)

components. By using these collective states, the researchers created a robust and scalable quantum register."

Source: Cambridge (28 Jan 2025)

ROBOTICS

Just How Many Robots Can One Person Control at Once? A DARPA Project Overturns Longstanding Assumptions



"Swarms of autonomous robots are increasingly being tested and deployed in complex missions, yet a certain level of human oversight during these missions is still required. Which means a major question remains: How many robots—and how complex a mission—can a single human manage before becoming overwhelmed?

In a study funded by the U.S. Defense Advanced Research Projects Agency (DARPA), experts show that humans can single-handedly and effectively manage a heterogenous swarm of more than 100 autonomous ground and aerial vehicles, while feeling overwhelmed only for brief periods of time during an overall small portion of the mission. For instance, in a particularly challenging, multiday experiment in an urban setting, human controllers were overloaded with the workload only 3 percent of the time. The results were published 19 November in IEEE Transactions on Field Robotics.

Julie A. Adams, the associate director of research at Oregon State University's Collaborative Robotics and Intelligent Systems Institute, has been studying human interactions with robots and other complex systems, such as aircraft cockpits and nuclear power-plant control rooms, for 35 years. She notes that robot swarms can be used to support missions where work may be particularly dangerous and hazardous for humans, such as monitoring wildfires.

"Swarms can be used to provide persistent coverage of an area, such as monitoring for new fires or looters in the recently burned areas of Los Angeles," Adams says. "The information can be used to direct limited assets, such as firefighting units or water tankers to new fires and hotspots, or to locations at which fires were thought to have been extinguished.""

Source: IEEE Spectrum (26 Jan 2025)

ROBOTICS

Robots Get Smarter to Work in Sewers

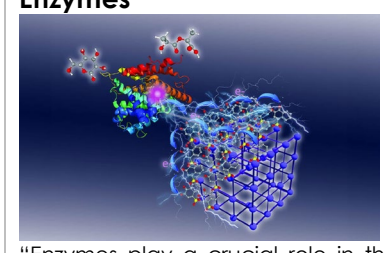
"The ambitious project PIPEON* will develop new robotic and AI-based technologies for mapping, monitoring, and maintaining Europe's sewer networks using autonomous "thinking" robots and AI-based modelling and analysis tools.

The development and application of such new technologies would have major societal, environmental and economic impact. Instead of repairing in-sewer defects and removing blockages after streets and homes have been flooded with sewage, defects can be quickly identified and repaired and blockages removed when they are still small. Early, preventative repair and maintenance actions will limit the frequency and volume of sewage spills from sewer overflows into rivers, a key target of the new Urban Wastewater Treatment Directive, which has been recently approved by the European Commission."

Source: Eurekalert! (31 Jan 2025)

SENSORS

Improving the Performance of Biosensors: Developing New Materials for Effectively Harnessing the Power of Enzymes



"Enzymes play a crucial role in the chemical reactions occurring in the human body and nature. However, enabling effective and efficient electron transfer between enzymes and electrodes remains a significant challenge in utilizing enzymes for electronic devices such as sensors, especially with conventional technologies.

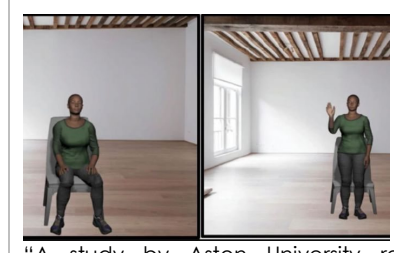
Recently, the research team solved this problem by using a special material called metal-organic frameworks (MOFs). MOFs are a combination of metal and organic linkers that form a porous crystalline structure and are commonly used in gas adsorption/separation and other fields. In general, MOFs are inherently redox-inactive and exhibit poor electrical conductivity; therefore, the researchers modified the MOF structure using materials that facilitate electron conduction and enable specific redox reactions (such materials are called redox mediators). The modified material acts as a "wire," allowing efficient electron exchange between the enzyme and electrode. Furthermore, the design of the MOFs allowed easy access to the buried active sites of enzymes. Another important aspect was engineering an appropriate nanoscale structure and implementing an effective immobilization strategy to retain the enzyme on the electrode surface. This approach helps to prevent enzyme leaching, which can lead to inaccurate measurements.

This innovative strategy enables highly efficient and stable long-term measurements of the enzyme-based biosensor. This achievement has potential future applications in various fields, such as disease diagnosis, environmental monitoring, and sustainable energy technology. The research team believes that their research will not only contribute to scientific advancement but also improve the lives of people."

Source: Tsukuba (17 Jan 2025)

VR

Study Using Virtual Breathing Coach Indicates It Is as Effective as A Human Trainer



"A study by Aston University researchers suggests that a computer-generated breathing coach could be as effective as sessions with a human trainer.

A breathwork trainer guides individuals through various breathing techniques to improve their physical, mental, and emotional wellbeing. However, a new research paper indicates that individuals would be as comfortable being guided by an on-screen virtual reality (VR) coach as by a trained professional.

The Covid-19 pandemic affected a huge number of people worldwide not just because of respiratory infections but also by causing long-term anxiety and depression. While there are several medications for treating both the physiological and psychological effects, one of the simplest and most widely used treatments is the use of breathing exercises. However, the services of trained coaches often have to be paid for and individuals may have to pay for and find the time to travel to appointments.

The researchers wanted to investigate both the perception of the virtual coach and evaluate its usability as an alternative to training provided by a human. They developed an online system where a virtual coach guides the user's breathing through a set of established exercises that can be done at home. The VR instructor which appears on screen was given a human appearance and voice and displayed breathing movements of the chest and head. It guided the users through a breathing cycle of inhale, hold breath, exhale and hold breath.

Twenty volunteers took part and were given a questionnaire afterwards. The results showed that around 73% found the virtual version likeable and trustworthy, 76% found it easy to use and 60% were interested in using it in the future."

Source: ScienceDaily (30 Jan 2025)