SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

AERODYNAMICS
Physicists Find a Way to Set a New Marathon Record

"Results from wind-tunnel experiments could help athletes run the fastest marathon ever1.

In 2019, Kenyan long-distance runner Eliud Kipchoge became the first person to complete a marathon in less than two hours. That feat was made possible in part by drafting — a strategy in which air resistance is reduced by positioning other athletes, called pacers, around the main runner.

Massimo Marro and his colleagues at the Central School of Lyon in France mounted a group of mannequins in a wind tunnel to study the aerodynamics of a runner surrounded by pacers in various formations. The researchers identified three swordfish-shaped arrangements of seven pacers that lowered the air resistance on the designated runner by about 60% compared with a solo runner. They estimate that this improvement would shave roughly four minutes off of a marathon time.

The team says that these results could be refined by using simulations to explore the factors that reduce air resistance for the main runner."

Source: Nature (15 Aug 2023)

AI
## AI Models Are Powerful, But Are They Biologically Plausible?
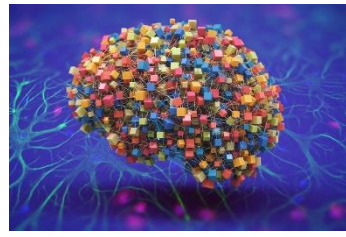
About six years ago, scientists discovered a new type of more powerful neural network model known as a transformer. These models can achieve unprecedented performance, such as by generating text from prompts with near-human-like accuracy. A transformer underlies AI systems such as ChatGPT and Bard, for example. While incredibly effective, transformers are also mysterious: Unlike with other brain-inspired neural network models, it hasn't been clear how to build them using biological components.

Now, researchers from MIT, the MIT-IBM Watson AI Lab, and Harvard Medical School have produced a hypothesis that may explain how a transformer could be built using biological elements in the brain. They suggest that a biological network composed of neurons and other brain cells called astrocytes could perform the same core computation as a transformer."

Source: MIT (15 Aug 2023)

AI
How Old Are You, really? AI Can Tell Your True Age by Looking at Your Chest
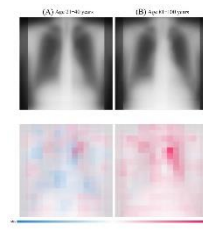

"What if "looking your age" refers not to your face, but to your chest? Osaka Metropolitan University scientists have developed an advanced artificial intelligence (AI) model that utilises chest radiographs to accurately estimate a patient's chronological age. More importantly, when there is a disparity, it can signal a correlation with chronic disease. These findings mark a leap in medical imaging, paving the way for improved early disease detection and intervention. The results are set to be published in The Lancet Healthy Longevity.

The research team, led by graduate student Yasuhito Mitsuyama and Dr. Daiju Ueda from the Department of Diagnostic and Interventional Radiology at the Graduate School of Medicine, Osaka Metropolitan University, first constructed a deep learning-based AI model to estimate age from chest radiographs of healthy individuals. They then applied the model to radiographs of patients with known diseases to analyse the relationship between AI-estimated age and each disease. Given that AI trained on a single dataset is prone to overfitting, the researchers collected data from multiple institutions."

Source: OMU (14 Aug 2023)

APPLIED BIOLOGICAL SCIENCES
Silk-Protein-Based Gradient Hydrogels with Multimode Reprogrammable Shape Changes for Biointegrated Devices
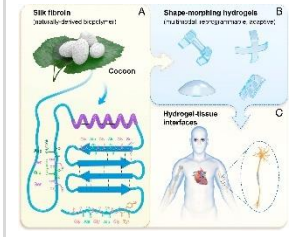
"Biocompatible and morphable hydrogels capable of multimode reprogrammable, and adaptive shape changes are potentially useful for diverse biomedical applications. However, existing morphable systems often rely on complicated structural designs involving cumbersome and energy-intensive fabrication processes. Here, we report a simple electric-field-activated protein network migration strategy to reversibly program silk-protein hydrogels with controllable and reprogrammable complex shape transformations. The application of a low electric field enables the convergence of net negatively charged protein cross-linking networks toward the anode (isoelectric point plane) due to the pH gradient generated in the process, facilitating the formation of a gradient network structure and systems suitable for three-dimensional shape change. These tuneable protein networks can be reprogrammed or permanently fixed by control of the polymorphic transitions. We show that these morphing hydrogels are capable of conformally interfacing with biological tissues by programming the shape changes and a bimorph structure consisting of aligned carbon nanotube multilayers and the silk hydrogels was assembled to illustrate utility as an implantable bioelectronic device for localised low-voltage electrical stimulation of the sciatic nerve in a rabbit."

Source: PNAS (7 Aug 2023)

EDUCATION & SOCIETY
"Microcosms of Empire" in the Colonial Grand Hotel

"In colonial India and Southeast Asia, Palladian façades, modern plumbing, and a six-foot Sikh doorman were just some features Western tourists could expect at European style "grand hotels." In the late nineteenth and early twentieth centuries, such "hotels were a fixture of colonial urban life," reports historian Maurizio Peleggi, who argues that these sites operated as "microcosms of empire."

By studying luxury establishments such as Colombo's Galle Face Hotel and Singapore's Raffles Hotel, which are still in business today, he examines how "hotels were traversed by the same tensions and ambivalences that destabilised the colonial project."

The architecture and infrastructure of these European hotels were marked by imperial tastes. For example, the Raffles Hotel has a "Palm Court" that separates its main building and suite wing—a landscaping choice that Peleggi links to British colonials' public garden obsession."

Source: JSTOR (14 Aug 2023)

MATERIALS
Clever Coating Turns Lampshades into Indoor Air Purifiers

"Indoor air pollution may have met its match. Today, scientists will report that they have designed catalyst-coated lampshades that transform indoor air pollutants into harmless compounds. The lampshades work with halogen and incandescent light bulbs, and the team is extending the technology so it will also be compatible with LEDs.

The lampshades target volatile organic compounds (VOCs), which account for most indoor airborne pollutants, according to Hyoung-il Kim, Ph.D., the project's principal investigator. These compounds include acetaldehyde and formaldehyde and are released by paints, cleaners, air fresheners, plastics, furniture, cooking and other sources."

Source: ACS (16 Aug 2023)

ROBOTICS
Nature-Inspired Pressure Sensing Technology Aims to Transform Healthcare and Surgical Robots


"Researchers at the National University of Singapore (NUS) have developed a novel aero-elastic pressure sensor, called 'eAir.' This technology can be applied to minimally invasive surgeries and implantable sensors by directly addressing the challenges associated with existing pressure sensors.

The eAir sensor promises increased precision and reliability across medical applications. It can potentially transform laparoscopic surgeries by enabling tactile feedback for surgeons, allowing more precise manipulation of patient tissues. In addition, the sensor can improve patient experiences by offering a less invasive means of monitoring intracranial pressure (ICP), a key health metric for individuals with neurological conditions."

Source: NUS (18 Aug 2023)

ROBOTICS
Robotic Exoskeletons and Neurorehabilitation for Acquired Brain Injury: Determining the Potential for Recovery of Overground Walking
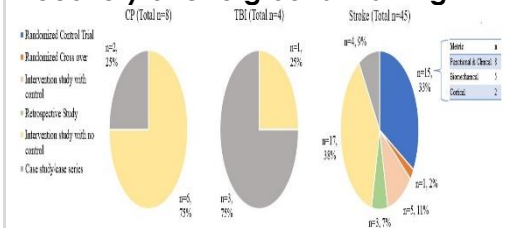

"A team of New Jersey researchers reviewed the evidence for the impact of robotic exoskeleton devices on recovery of ambulation among individuals with acquired brain injury, laying out a systematic framework for the evaluation of such devices that is needed for rigorous research studies. The open access article, "Lower extremity robotic exoskeleton devices for overground ambulation recovery in acquired brain injury – A review" (doi: 10.3389/fnbot.2023/1014616), was published May 25, 2023, in Frontiers in Neurorobotics."

Source: Kessler foundation (14 Aug 2023)

QUANTUM INFORMATION PROCESSING
Mollow Triplets Under Few-Photon Excitation
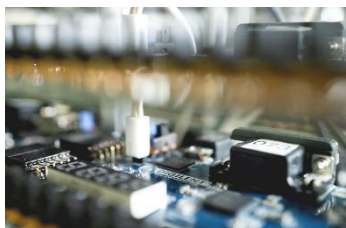
"Resonant excitation is an essential tool in the development of semiconductor quantum dots (QDs) for quantum information processing. One central challenge is to enable transparent access to the QD signal without post-selection information loss. A viable path is through cavity enhancement, which has successfully lifted the resonantly scattered field strength over the laser background under weak excitation. Here, we extend this success to the saturation regime using a QD-micropillar device with a Purcell factor of 10.9 and ultra-low background cavity reflectivity of just 0.0089±0.0001. We achieve a signal to background ratio of 55 and overall system responsivity of 3.01±0.08%, i.e., we detect on average 0.03 resonantly scattered single photons for every incident laser photon. Raising the excitation to the few-photon level, the QD response is brought into saturation where we observe Mollow triplets as well as the associated cascaded single photon emissions, without resorting to any laser background rejection technique. Our work offers a perspective on a QD cavity interface that is not restricted by the laser background."

Source: Optica (15 Aug 2023)

SUPERCONDUCTOR
LK-99 Isn't A Superconductor — How Science Sleuths Solved the Mystery

"Researchers seem to have solved the puzzle of LK-99. Scientific detective work has unearthed evidence that the material is not a superconductor and clarified its actual properties.

The conclusion dashes hopes that LK-99 — a compound of copper, lead, phosphorus, and oxygen — would prove to be the first superconductor that works at room temperature and ambient pressure. Instead, studies have shown that impurities in the material — in particular, copper sulphide — were responsible for sharp drops in its electrical resistivity and a display of partial levitation over a magnet, properties similar to those exhibited by superconductors.

"I think things are pretty decisively settled at this point," says Inna Vishik, a condensed-matter experimentalist at the University of California, Davis."

Source: Nature (16 Aug 2023)

WATER PURIFICATION
## Cleaning Water With 'Smart Rust' And Magnets
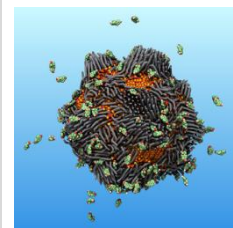
"Pouring flecks of rust into water usually makes it dirtier. But researchers have developed special iron oxide nanoparticles they call "smart rust" that actually makes it cleaner. Smart rust can attract many substances, including oil, nano- and microplastics, as well as the herbicide glyphosate, depending on the particles' coating. And because the nanoparticles are magnetic, they can easily be removed from water with a magnet along with the pollutants. Now, the team is reporting that they've tweaked the particles to trap oestrogen hormones that are potentially harmful to aquatic life.

The researchers will present their results today at the fall meeting of the American Chemical Society (ACS). ACS Fall 2023 is a hybrid meeting being held virtually and in-person Aug. 13–17, and features about 12,000 presentations on a wide range of science topics."

Source: ACS (16 Aug 2023)

WIRELESS COMMUNICATION
Age of Loop for Wireless Networked Control System in the Finite Blocklength Regime: Average, Variance and Outage Probability
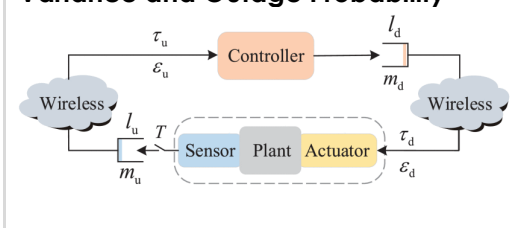
"Age of information (AoI) is an effective measure of the information freshness for wireless networked control systems (WNCSs). However, the AoI performance for a closed loop of WNCS with two-way delays has remained unexplored, especially in the finite blocklength (FBL) regime. In this paper, we investigate the peak age of loop (PAoL) performances, including the average, variance, and outage probability of PAoL, for WNCSs with FBL over fading channels. Their closed-form expressions are respectively derived regarding the blocklength and the maximum number of allowable transmissions. We prove that the average PAoL is less than the sum of the average peak AoI in uplink (UL) and downlink (DL) due to the coupling between UL and DL. We also show that there is a tradeoff between the average PAoL and the variance/outage probability of PAoL. Based on the comprehensive performance analysis, we study a PAoL-oriented communication and control co-design with an adaptation scheme for transmission power, blocklength and the maximum number of allowable transmissions. Simulation results verify the correctness of the analytical results and show that the proposed PAoL-oriented scheme significantly outperforms the UL only and DL only optimisation schemes, with an up to 8-fold reduction in the average control cost."

Source: IEEE (Aug 2023)