NUS RESEARCH in brief

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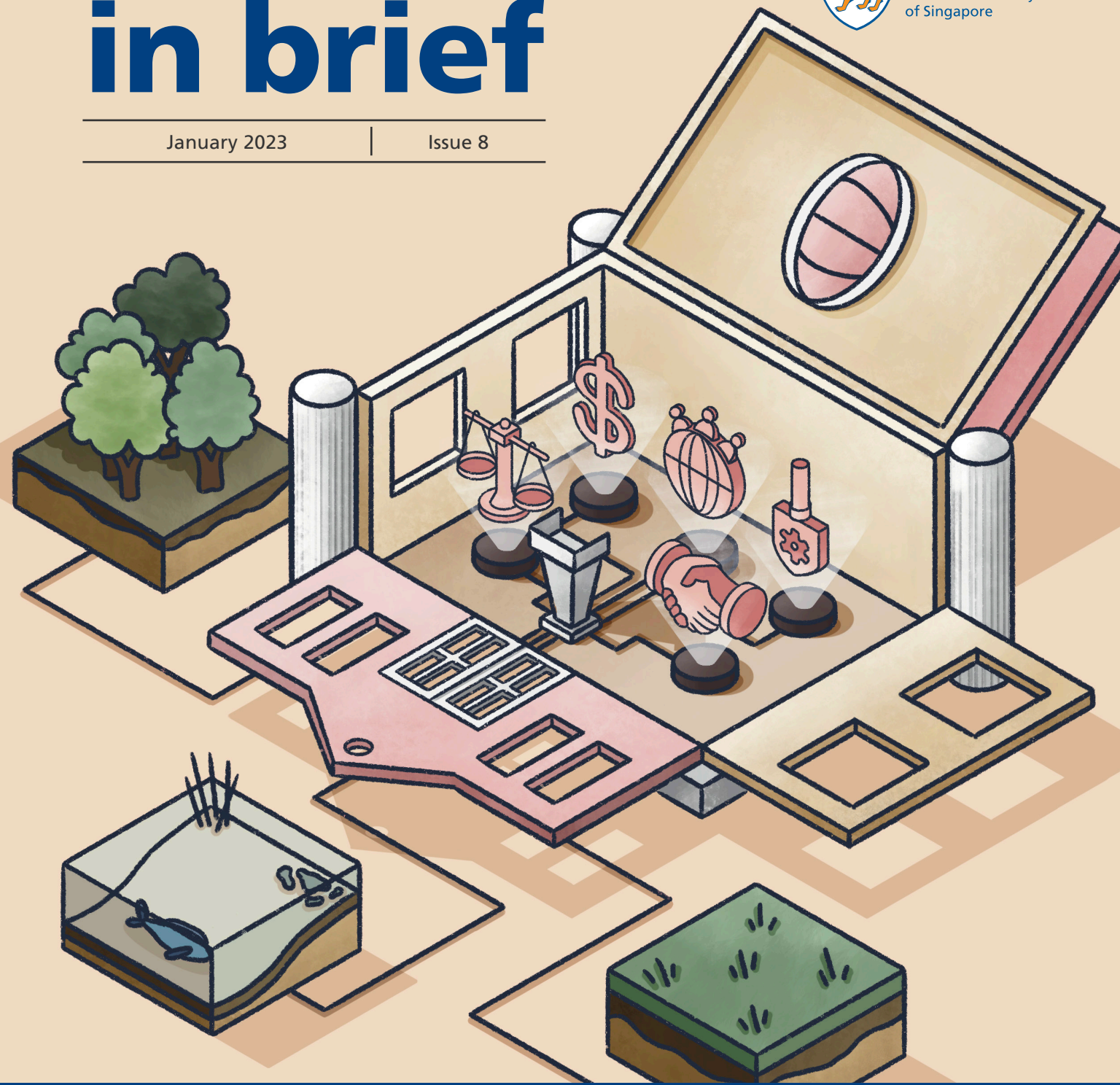
NUS National University of Singapore



COVER STORY
Addressing Global Challenges Through Interdisciplinary Research

NEW INITIATIVES
New Centre for Music and Health established at Yong Siew Toh Conservatory of Music

FEATURE ARTICLE
Bridging the Gap between Constraint Satisfaction Problems and Data Stream Models

From the Deputy President

Today, societies around the world are faced with increasingly common challenges, from ageing populations and economic downturns, to the growing burden of climate change.

To address these challenges, researchers across various fields are coming together, taking data-driven approaches, and applying artificial intelligence-based tools to develop solutions that instil resilience and promote well-being in the population.

At NUS, we encourage problem-driven interdisciplinary research that can be applied to the understanding of factors that shape the well-being of a nation, including cultural influences, population growth, and urbanisation.

Climate change is a problem that is inextricably linked to society, through its influence on politics, the economy and the environment. Mitigating the impacts of climate change requires knowledge, skills and insights from different disciplines, and can only be met by a concerted collaborative effort.

Leading such a programme is Prof David Taylor from NUS Geography. His team were awarded the Social Science Research Thematic Grant in 2022 to conduct research in the area of climate resilience, and build optimal arrangements for governing Nature-based Carbon Sinks (NCS). This work will promote inclusive, adaptive, and fair governance across spatial and administrative scales, investigate successful examples of NCS governance in Southeast Asia and assess potential transferability to other regions.

Promoting the well-being of vulnerable population groups, is another key goal of the social sciences research conducted at NUS. Now, through a first-of-its-kind research centre, the Centre for Music and Health (CMH), evidence-based music programmes and research will assess the use of music to promote social engagement, mental health, student well-being, and improved quality of life for ageing populations

Over the years, many of our social science and humanities researchers have been recognised for contributions to their field. I would like to extend my congratulations to Prof James D. Sidaway from NUS Geography, who was awarded the Royal Geographical Society 2022 Busk Medal, and Distinguished Prof Henry Yeung, also from NUS Geography, who was awarded the prestigious 2022 Sir Peter Hall Award.

Many additional research programmes are underway at NUS, and it is an exciting time to see how data-driven approaches will be adopted within these programmes, to allow a better understanding of societal issues, and create solutions that benefit the nation and its citizens.

Professor Chen Tsuhan
Deputy President (Research & Technology)

12,011*
Research publications

Our researchers collaborated with

3788 institutes & universities

from

175 countries

5
Research Centres of Excellence#

4
Corporate Laboratories#

35
Research Institutes & Centres#

17
Schools & Faculties#

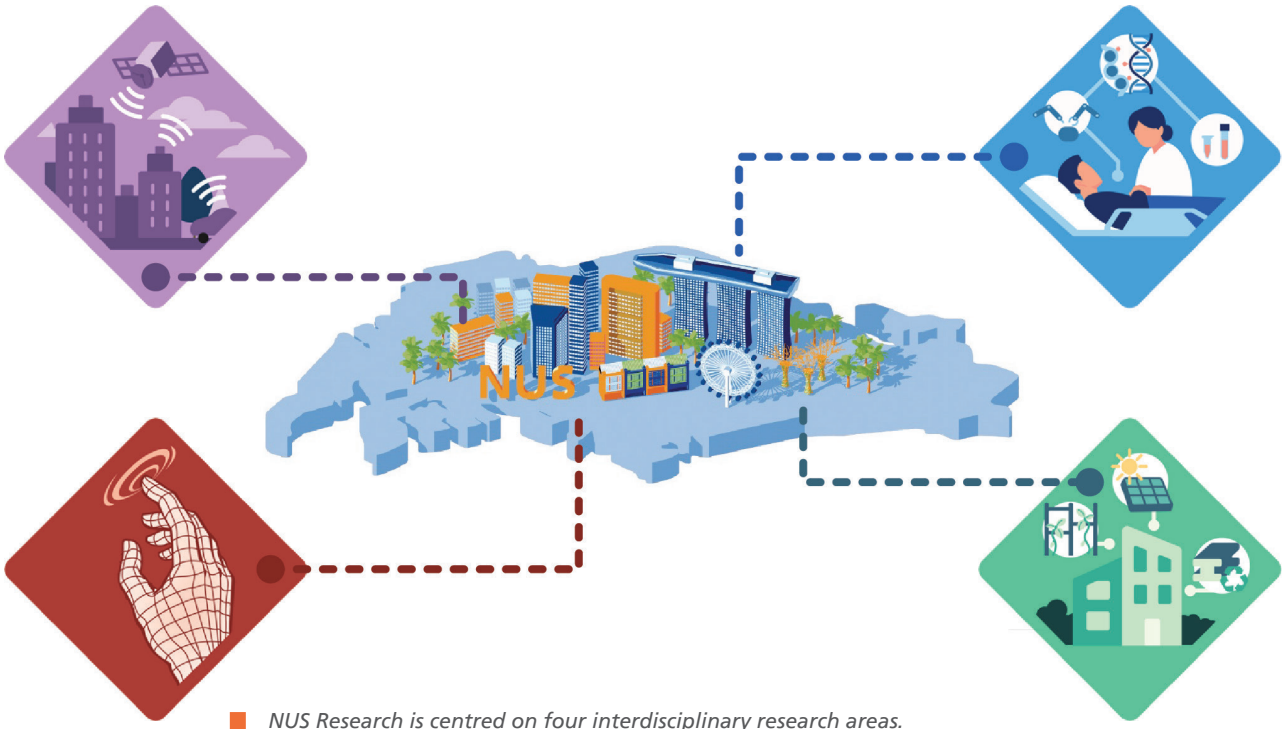
NUS Research in Numbers

$956.3m^

Total research funds awarded by external sources in 2021

$760m	$787m	$845m
FY2019	FY2020	FY2021

Research revenue 3-year moving average



NUS Research is centred on four interdisciplinary research areas. These are health innovation, materials research, smart nation and sustainability.

875
Patent applications

124
Patents granted

398
Invention disclosures

112
Technology licences executed

Our researchers work to innovate and develop solutions that meet the present and emerging needs of Singapore, Asia, and the world.

*Data extracted from the Scopus database 9 Nov 2022. Figure represents articles, reviews, conference papers, books, and book chapters for calendar year 2021. #Accurate as of Nov 2022. ^Based on FY2021. All other data based on Calendar Year 2021.

Addressing global challenges through interdisciplinary research

From climate change to social inequality and food insecurity, the world's biggest challenges are inherently multifaceted. They require solutions borne from the convergence of varied ideas and perspectives, so it is no surprise that interdisciplinary, data-driven approaches are transforming how researchers understand these complex issues.

Interdisciplinarity is not a new concept. It has enabled the emergence of many niche fields in recent decades, especially those addressing challenges in healthcare and well-being. Synthetic biology, for example, integrates engineering principles with molecular biology and sees specific functions or abilities engineered into biological systems. Similarly, the field of mechanobiology melds cell biology with biophysics and engineering, to understand how living systems interact with the physical environments in which they exist. Our understanding of cancer and ageing have been redefined by these fields.

Of course, an issue like ageing is far greater than the biological or engineering processes at play. It impacts both individuals and populations as a whole and although it continues to be understood primarily as a public health or medical challenge, many solutions have been trialled through public policy and social initiatives.

Finding solutions hidden in data

In recent years, the call has gone out to further interdisciplinary collaboration in many fields. One common thread that runs through each collaborative effort is data, and the use of computational approaches to understand challenges empirically. In the emerging interdisciplinary research area of Computational Social Science, computer science and statistics are used to address challenges traditionally within the realm of the social sciences. Novel computational methods can measure human behaviour with precision. Researchers from NUS Information Systems and Analytics, for example, are using large-scale demographic, behavioural and network data to investigate human activity and relationships.

Here, digital data generated by e-commerce or social media platforms can be exploited to glean novel insights into individual and collective human behaviour (e.g., spread of online content, causal impact of recommendations, video and ad effectiveness). The methodology behind such work has now advanced to the point that researchers can employ novel field experiments at larger scales, with longer time horizons, and greater complexity and realism than was possible in a laboratory setting, whilst still allowing for inference of causality.

Despite the fact that complex real-world problems may be solved through the insights of multiple disciplines, integrating the data attained from different sources, and processed in unique ways, remains a challenging endeavour. In projects that involve the physical, human, and social sciences, data may not always be immediately compatible.

Interdisciplinarity in climate change mitigation

One of the most pressing global challenges today is climate change. Solutions to mitigate its impact are being pursued in multiple disciplines, primarily within STEM based fields. For example, the development of alternative green energies seeks to reduce the world's reliance on fossil fuels, the engineering of coastal protection mechanisms aims to protect cities against sea level rise, and the identification of nature-based climate solutions strives, amongst other goals, to reduce the environmental and economical burden of carbon emissions. In each case, their successful adoption within society requires policy and behavioural shifts at all levels, from individual to community and from local to global.

The social sciences are also playing a key role in the successful implementation of climate change mitigation strategies. For example, Professor David Taylor from NUS Geography has embarked on an interdisciplinary programme focused on the area of climate change mitigation, specifically in the governance of nature-based carbon sinks (NCS). Funded under the Social Science Research Thematic Grant from Singapore's Social Science Research Council, this multi-million-dollar project will bring together collaborators with expertise in geography, forestry, economics, and law.

NCS, a form of nature-based solution to climate change, are defined by the United Nations Framework Convention on Climate Change as ecosystems that absorb and store (or sequestrate) more carbon than they release. At present, most climate change mitigation efforts focus on cutting emissions of greenhouse gases, notably carbon dioxide. Engineers and scientists are also working on ways to boost the efficacy of NCS, and to better understand the science behind carbon sequestration.

NCS have great potential in carbon sequestration and climate change mitigation in Southeast Asia, a region rich in carbon sequestration potential. However, there is a risk that this potential will not be realised because of the multiple anthropogenic threats, including deforestation, wildfires, pollution, and urbanisation, faced by NCS in the region. Further, the ability of some NCS, notably rainforests, to sequester carbon appears to be on the decline, in part because of climate change. There are also many unresolved governance challenges surrounding NCS, hindering their potential for enhanced carbon sequestration.

Much of what is currently known about NCS globally is derived from remotely sensed data, field and laboratory measurements of carbon dioxide fluxes and computer-based models. Although useful, the value of NCS' contribution to the mitigation of climate change is heavily reduced by the lack of consideration regarding their governance within a context of rapidly changing social-ecological conditions and competing demands and dependencies on the same natural resources.

Prof Taylor and collaborating researchers are prioritising the development of equitable, holistic and adaptive climate governance strategies in order to ensure the long-term sequestration of carbon in NCS and without jeopardising the success of other key policies, notably those aimed at achieving the UN Sustainable Development Goals.

This means deploying empirical studies to understand the social realities in decision-making, and how this knowledge becomes formally embedded into legislation aimed at enhancing carbon sequestration. Who is included and excluded from conservation and sustainable development activities is another important consideration, especially in Southeast Asia, where overlapping forms of resource organisation involving kinship/patrimonial ties, state and customary laws, private sector interests and civil society activities frequently converge within the same NCS.

Such theoretically-informed, evidence-based research outcomes will provide a roadmap for Singapore to enhance the governance of NCS, and at the Southeast Asia level, support ongoing efforts to develop low-carbon initiatives with social, economic and environmental benefits.

Data-driven approaches that capitalise on advances in computing and AI will continue to provide new avenues from which to answer questions in the humanities and social sciences. Likewise, public policy and governance considerations, and an understanding of societal impacts of technology implementation and the behavioural shifts at play, are crucial to the successful adoption of new technological innovations.

With the world facing existential challenges on multiple fronts, it is critical now more than ever, to engage in problem-driven interdisciplinary research.

About the cover

Interdisciplinary research approaches are being pursued that integrate legal, economic, political and cultural dimensions, together with low-carbon techonologies, to determine the optimal arrangements for governing Nature-based Carbon Sinks (NCS).

Cover art by Koh Pei Wen

New Centre for Music and Health established at Yong Siew Toh Conservatory of Music

Mental, emotional and social well-being are increasingly prominent topics in public awareness today, thrown into relief by recent trends such as student mental health issues and loneliness among elders. Alongside existing medical interventions, music is leading the way internationally as an alternative holistic approach to supporting health and well-being. This has been recognised at numerous levels, from the World Health Organisation to ongoing community engagement initiatives across Singapore.

To further the use of music to improve lives in Singapore and the region, NUS Yong Siew Toh Conservatory of Music (YST) is establishing a new Centre for Music and Health (CMH). The CMH will be the first of its kind in Singapore and Southeast Asia to develop evidence-based music programmes to support health and well-being, as well as research methods to inform and evaluate the efficacy of such programmes.

Drawing on NUS' strong research capabilities and YST's position as one of Asia's top conservatories, CMH aims to become a leading centre for music and health in the region. It will investigate interdisciplinary practices and spearhead new musical interventions, deploying them in health and well-being settings. It also seeks to be a platform for community engagement, involving NUS students and partner organisations. With funded research projects and further recruitment already underway, the Centre is well-positioned to house a vibrant spectrum of activities and gearing up for more. The Centre will be helmed by Dr Kat Agres, Assistant Professor in Music Cognition at YST.

NUS to lead S$15 million research project to improve the credibility of nature-based carbon projects in Southeast Asia

A new S$15 million research project, the Carbon Market Integrity Research and Development Programme Singapore, or Carbon Integrity SG was launched recently at the United Nations 27th Conference of the Parties. It is a five-year research effort that supports establishing and monitoring of high-quality nature-based carbon projects across Southeast Asia, and will be led by NUS Centre for Nature-based Climate Solutions (CNCS). The new programme will build on earlier research done at CNCS, which leverages satellite data and existing datasets to map out where nature-based projects in Southeast Asia can be developed as potential sources of high-quality carbon credits. It will also develop and improve internationally-recognised standards and methodologies to ensure the credibility and integrity of the global carbon marketplace, ensuring a stable supply of high-quality, nature-based carbon offset credits from the Southeast Asian region to meet global market demands. This effort will contribute to the realisation of Singapore's ambition to be a global hub for climate-related services.

Integrated community platform to tackle municipal issues piloted in Toa Payoh East

To facilitate community-led solutions to tackle municipal issues, the Municipal Services Office (MSO) and NUS Centre for Sustainable Asian Cities have worked with Toa Payoh East Constituency Office to launch the Dragon Heart Community Platform. This initiative arises from an ongoing research collaboration on fostering positive social norms and values, and facilitating community-led solutions in Singapore's high-density housing environment.

Supported by various government organisations, this initiative seeks to understand the perceptions of residents on the role of the community in addressing municipal issues and how the Government can better engage residents to foster positive social norms and facilitate community-led solutions.

The Dragon Heart Community Platform takes a three-pronged approach: (1) Dragon Idea Bank, an informative website with resources, ideas, toolkits and case studies to facilitate co-solutioning; (2) Dragon Chat, a chatgroup for residents to collect feedbacks, contribute ideas and coordinate meetups; and (3) Dragon Carts, mobile carts as a conducive space for community collaboration.

Keppel Infrastructure and NUS collaborate to jumpstart sustainable environmental technology solutions

NUS researchers have been awarded S$13 million in research funding to develop cutting-edge technologies and systems to boost maritime operations in Singapore. The Centre of Excellence in Modelling and Simulation for Next Generation Ports (C4NGP) received S$10 million in funding from the Singapore Maritime Institute (SMI), to develop advanced modelling, simulation and optimisation capabilities for next-generation ports and maritime systems. Two NUS research teams were also awarded research grants by SMI and Maritime and Port Authority of Singapore. One team was awarded S$1.18 million to use artificial intelligence to estimate fuel consumption and emission from ships. Another team received S$1.43 million to develop an AI tool to estimate and classify vessel risk.

NUS and NRF launch National Synchrotron Programme and International Synchrotron Access initiative

NUS and the National Research Foundation, Singapore (NRF) have launched the National Synchrotron Programme (NSP) to promote and anchor synchrotron research in the country. Hosted by NUS, the S$16 million NSP will coordinate resources for synchrotron research locally at the Singapore Synchrotron Light Source (SSLS), which is based at NUS' Kent Ridge campus, and overseas through the International Synchrotron Access (ISA) initiative. Under the ISA initiative, a five-year collaboration agreement was signed between NUS and the Australian Nuclear Science and Technology Organisation (ANSTO) that allows Singapore researchers to use ANSTO's synchrotron facilities in Melbourne, Australia.

New NUS Research Centre on Sustainable Urban Farming seeks high-tech solutions to boost Singapore's food security

Against a backdrop of climate change, population increase and food-chain disruptions, Singapore faces an uphill task in ensuring an adequate supply of food for the coming decades. In response to the need for indoor urban farming solutions, the NUS Research Centre on Sustainable Urban Farming (SUrF) was established to develop novel science- and technology-based solutions to make food production more efficient and sustainable in the country. Led by Professor Prakash Kumar from NUS Biological Science, multidisciplinary research at SUrF will focus on three stages of food production – pre-production, production, and post-production, with the aim to maximise agricultural productivity and quality, improve shelf-life, and minimise food wastage.

Awards

NUS geographer conferred prestigious Royal Geographical Society (with IBG) award

Professor James D. Sidaway, a political geographer from the NUS Faculty of Arts and Social Sciences, has been conferred the prestigious Royal Geographical Society 2022 Busk Medal. The Busk medal is awarded for conservation research or for fieldwork abroad in geography or in a geographical aspect of an allied science. It is one among several top accolades in the medals category. Prof Sidaway is an exceptional geographer whose research over several decades has broken new ground in political geography, geopolitics and critical area studies.

NUS geographer Prof Henry Yeung clinches prestigious global award for lifetime contributions to research

Distinguished Professor Henry Yeung from NUS FASS has been awarded the prestigious 2022 Sir Peter Hall Award for Lifetime Contribution to the Field by the influential Regional Studies Association (RSA). The annual RSA awards recognise research works that have made an original and outstanding contribution to the analysis of regions and regional issues. Prof Yeung is one of the world's leading academic experts in global production networks, global value chains, and East Asian firms and developmental states in the global economy.

Four outstanding young NUS scientists lauded in MIT Technology Review "Innovators under 35"

Four NUS scientists have been lauded in the 2022 edition of MIT Technology Review's "Innovators under 35" list for making game-changing advances in Science and Technology. Each year, MIT Technology Review recognises the best young talents in the Asia-Pacific region who have made important discoveries in diverse technical fields such as biotech, artificial intelligence, materials science, energy, computing, and quantum technology.

Pioneer

Asst Prof Hou Yi

Asst Prof Hou Yi from NUS Chemical and Biomolecular Engineering set a new efficiency record in the field of perovskite/organic tandem solar cells with a power conversion efficiency of 23.6%, a significant improvement from the 20% reported by other similar studies.

Pioneer

Asst Prof Steven Touzard

Asst Prof Steven Touzard from NUS Materials Science and Engineering is recognised for his work in quantum technologies, from pioneering experiments in quantum error correction to working on novel proposals for quantum networks at present.

Inventor

Asst Prof Liu Yuxin

Asst Prof Liu Yuxin from NUS Biomedical Engineering developed the first implanted electronic device with Young's modulus comparable to nervous tissues and addressed the problem of foreign body reaction and implant rejection.

Inventor

Asst Prof Lum Yanwei

Asst Prof Lum Yanwei from NUS Chemical and Biomolecular Engineering developed a suite of novel techniques to label atoms in a reaction mixture based on their origin, to yield entirely new insights into catalytic mechanisms.

NUS University Awards

NUS celebrated the accomplishments of eight outstanding members of the NUS community who have scaled new peaks of excellence and set new benchmarks in education, research and service in 2022. The annual NUS University Awards recognises educators, researchers and professionals for their exceptional contributions to the University, Singapore and the global community.

University Research Recognition Award

Prof Chua Tat Seng

Kwan Im Thong Hood Cho Temple Chair Professor, NUS Computer Science

Well-known for his work in multimedia information retrieval and social media analytics, he is a pioneer for neural and explainable recommendation as well as causal reasoning framework towards robust Artificial Intelligence.

Prof Liu Bin

Senior Vice Provost (Faculty and Institutional Development)

Distinguished Professor

A world-renowned researcher in the field of organic functional materials, she is known for her prolific work on polymer chemistry and applications of organic nanomaterials in medicine, environmental monitoring, and energy systems.

Young Researcher Award

A/Prof John Ho

iHealthtech

NUS Electrical & Computer Engineering

A rising star in the field of bioelectronics, he is internationally known for his work on developing wireless medical devices that monitor and intervene in medical conditions occurring in the body.

A/Prof Jessica Pan

NUS Economics

An empirical labour economist whose recent work focuses on gender differences in labour market and educational outcomes, the labour market effects of immigration, and the economics of higher education.

A/Prof Lu Jiong

NUS Chemistry

Institute for Functional Intelligent Materials

Known for his creative works involving large-scale synthesis of atomically precise single-atom catalysts, he is spearheading critical technologies for many industrial applications related to sustainable chemical and energy transformations.

More than 30 NUS scientists among world's most highly cited researchers

34 NUS researchers are among the world's most highly cited, according on the Highly Cited Researchers 2022 List published by data analytics firm Clarivate. The list is drawn from highly cited papers that rank in the top 1 per cent by citations for field and publication year in the Web of Science citation index over the past decade.

Chemistry

Professor
CHEN Xiaoyuan, Shawn *
Dept of Diagnostic Radiology, YLLSoM | Dept of ChBE, CDE

Professor
LIN Zhiqun
Dept of ChBE, CDE

Professor
LIU Xiaogang
Dept of Chemistry, FoS

Professor
JIANG Donglin
Dept of Chemistry, FoS

Professor
LIU Bin
NUS Centre for Hydrogen Innovations | Dept of ChBE, CDE

Associate Professor
XIE Jianping
Dept of ChBE, CDE

Computer Science

Dr
TAN Jen Hong
NUS Institute of Systems Science

Professor
ZHANG Rui
Dept of ECE, CDE

Economics & Business

Dr
SU Bin
NUS Energy Studies Institute; NUS Centre for Maritime Studies; Dept of ISEM, CDE

Professor
Jochen WIRTZ
Dept of Marketing, NUS Business School

Neuroscience & Behaviour

Associate Professor
Thomas YEO Boon Thye
Dept of ECE, CDE
Centre for Sleep and Cognition
Centre for Translational MR Research
NUS N.1 Institute for Health

Clinical Medicine

Professor
Carolyn LAM
Duke-NUS Medical School

Engineering

Professor
GE Shuzhi Sam
Dept of ECE, CDE

Microbiology

Professor
WANG Lin-Fa
Duke-NUS Medical School

Cross-Field

Emeritus Professor
ANG Beng Wah
NUS Energy Studies Institute; NUS Centre for Maritime Studies; Dept of ISEM, CDE

Associate Professor
Goki EDA
Dept of Chemistry, FoS; Dept of Physics, FoS

Assistant Professor
Shirin KALIMUDDIN
Duke-NUS Medical School

Professor
Jenny LOW
Duke-NUS Medical School

Dr
Muthu Kumaraswamy SHANMUGAM
Dept of Pharmacology, YLLSoM

Associate Professor
Wilson TAM
Alice Lee Centre for Nursing Studies, YLLSoM | NUS Lloyd's Register Foundation IPUR

Professor
Guilermo BAZAN
Institute for Functional Intelligent Materials; NUS Chemistry, FOS

Professor
Derek John HAUSENLOY
Duke-NUS Medical School

Research Assistant Professor
Alan Prem KUMAR
Dept of Pharmacology, YLLSoM; CSI Singapore

Professor
Barbaros ÖZYILMAZ
Dept of MSE, CDE; Dept of Physics, FoS; NUS Centre for Advanced 2D Materials

Assistant Professor
SING Swee Leong
Dept of Mechanical Engineering, CDE

Associate Professor
YAN Ning
Dept of ChBE, CDE | NUS Centre for Hydrogen Innovations

Professor
Antonio BERTOLETTI
Duke-NUS Medical School

Assistant Professor
Cyrus HO
Dept of Psychol Med, YLLSoM

Associate Professor
Sibudjing KAWI
Dept of ChBE, CDE; NUS Centre for Hydrogen Innovations

Professor
Seeram RAMAKRISHNA
Dept of Mechanical Engineering, CDE; NUS Centre for Nanotechnology and Sustainability

* Also listed under Materials Science

** Also listed under Physics

Physics

Professor
Antonio Helio CASTRO NETO
Institute for Functional Intelligent Materials; Centre for Advanced 2D Materials; Dept of Physics, FoS; Dept of MSE, CDE

Associate Professor
QIU Cheng Wei
Dept of ECE, CDE

Materials Science

Professor Sir
Konstantin NOVOSELOV **
NUS Institute for Functional Intelligent Materials; Dept of MSE, CDE

Professor
John WANG
Dept of MSE, CDE

Psychiatry and Psychology

Associate Professor
Roger HO Chun-Man
Dept of Psychol Med, YLLSoM

NRF Investigatorship (NRFI) - Class of 2023

Three NUS researchers were awarded the prestigious NRF Investigatorship grant. The NRF Investigatorship provides opportunities for scientists and researchers to pursue ground-breaking, high-risk research. It is designed to support Principal Investigators with a strong track record of research achievements, and are identifed as leaders in their respective field(s) of research.

Prof CHEN Wei

NUS Chemistry and Physics

Interface Engineered 2D Materials for Neuromorphic Computing

Prof Chen's project aims to develop artificial synaptic devices using one atomic thick two-dimensional (2D) materials, which would possess superior electrostatics and efficient charge transport. Integrating 2D materials in neuromorphic devices will allow for the desired low power consumption, low noise and conductance drift, high device reliability, and high computing density. Such devices have potential applications in edge computing and intelligent vision sensing, and would be a promising and energy-efficient solution to alleviate the existing computing bottleneck and support the world's growing reliance on smart, IoT-based, and data-centered technologies.

Prof Praveen LINGA

NUS Chemical and Biomolecular Engineering

Solidified Natural Gas (SNG) Storage Technology

With the NRF Investigatorship, Prof Linga aims to develop a novel and sustainable technology based on gas hydrates for long-term storage of natural gas. Solidified natural gas is more convenient and safer to store and transport, making it a more economical alternative to compressed and liquified natural gas storage. The technology developed by Prof Linga is also sustainable as water is the primary component used in the formation of solid natural gas pellets. This project has a significant societal impact in ensuring long-term energy security and resilience across the world.

Assoc Prof ZHAO Dan

NUS Chemical and Biomolecular Engineering

In-Situ Investigation of Soft Porous Materials for Gas Adsorption and Separation

This project will focus on the design and synthesis of soft porous metal-organic frameworks (MOFs), and covalent organic frameworks (COFs), for more efficient adsorbents in separation engineering. Assoc Prof Zhao will study the interactions between gases (carbon dioxide and acetylene) and soft porous materials (MOFs and COFs), to identify the most efficient separation process. Findings from this project will see energy-efficient gas separation technologies being developed and deployed in the industry, contributing significantly to reducing the carbon footprint of the petrochemical and chemical industries.

Social Science and Humanities Research (SSHR) Fellowship Awardees

Three NUS social science and humanities researchers were awarded the Social Science and Humanities Research (SSHR) Fellowship in 2022. The SSHR Fellowship aims to support talented Singapore social science and humanities researchers in the early stages of their academic careers and in building their expertise.

Asst Prof Cynthia SIEW

NUS Psychology

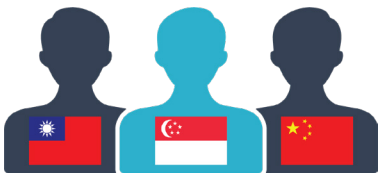
Measuring the Singaporean Mental Lexicon: Lexical-semantic norms for Singapore English words

This project seeks to map Singapore's first cognitive language network of Singaporean mental lexicon. By collecting data with the semantic properties of words from the Singaporean population and using advanced network science methods, Asst Prof Siew hopes to create a Singaporean network model to preserve cultural heritage, build Singapore-tailored robust AI, and optimise digital text analysis for Singapore's national security and interest.

Asst Prof KUNG Chien Wen

NUS History

Sinospheric Subjects: Chinese Singaporeans, China, and Taiwan, 1976-1990



This project explores how Singapore's domestic Chinese agenda from around 1976 to 1990 shaped and was shaped by social and cultural ties between ordinary Chinese Singaporeans and China and Taiwan. Focusing on Chinese Singaporeans within the Sinosphere, his research seeks to help the public better understand this generation of Chinese Singaporeans and how their memories and experiences in relation to the histories of China and Taiwan continue to inform their identities and affinities today.

Asst Prof Joelle FONG

NUS Lee Kuan Yuan School of Public Policy

Advancing Financial Literacy in Singapore

This project uses rigorous econometric methods and new data to provide useful insights into how financial literacy, investor knowledge, longevity awareness, and other literacy dimensions may influence retirement financial behaviour. Findings from this research will contribute to a better understanding of the role of financial literacy in economic decision-making among Singaporeans, and produce critical policy implications to enhance financial education programmes in Singapore.

A class of meditative practices that produces different effects from mindfulness-related meditation

Mindfulness studies have long dominated our understanding of the neurobiology of meditation. A recent study led by Assoc Prof Maria Kozhevnikov from NUS Psychology has discovered a different class of meditative practices that seeks to employ and regulate the state of stress that an individual experiences – rather than to reduce it – to achieve an even more heightened state of focus and attention. The researchers collected and compared electrocardiographic and electroencephalographic data of the practitioners as they performed different meditative practices. They found that mindfulness-related practices, led to relaxation, alertness and monitoring of thoughts while the practice of self-visualisation as a deity allowed practitioners to achieve the state of brain stimulation that led to significant enhancement of their attentional resources. The result demonstrated that these meditative practices can be seen as methods for transcending the normal limitations of the human condition, specifically attaining higher levels of performance and cognitive capacities than are ordinarily available.

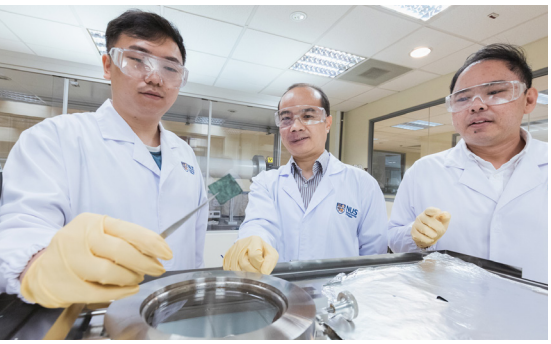
NUS-led study finds extreme debtors may be exposed to debt accumulation due to inflated sense of self-control

A first-of-its-kind study led by Assoc Prof Jia Lile from NUS Psychology found that extreme debtors have a low capacity to regulate their behaviour but hold an illusory perception of high capacity, which may expose them to further debt accumulation.

The study is conducted in collaboration with the Singapore University of Social Sciences with the support of Credit Counselling Singapore. Using a series of tests, the researchers compare the self-control profile of 1,442 extreme debtors in Singapore with those of two control groups.

Exploratory analysis and confirmatory analysis comparing test results of extreme debtors with those of control groups confirmed the notion of inflated assessment of self-control among extreme debtors.

The findings from the study have important implications for policymakers and other relevant support organisations in designing intervention programmes to help debtors improve self-control behaviour.



Revolutionary technique to generate hydrogen more efficiently from water

NUS researchers have found that light can trigger a new mechanism in a catalytic material used extensively in water electrolysis, where water is broken down into hydrogen gas and oxygen gas. A more energy-efficient method of obtaining hydrogen, this finding can potentially open up new and more effective industrial methods of producing hydrogen.

Solar forecasting to boost reliability, resilience of Singapore's power grid

Researchers at the NUS Solar Energy Research Institute of Singapore have developed an unprecedented solar forecast model that generates constant solar irradiance forecasts at regular intervals – up to one hour ahead. Their model combines data from real-time irradiance sensors, solar forecasting techniques such as satellite imagery and machine learning algorithms. The Energy Market Authority will incorporate the model's forecasts by 2023 allowing pre-emptive adjustments to power plant energy supply and storage, to better manage the reliability and resilience of Singapore's power grid.

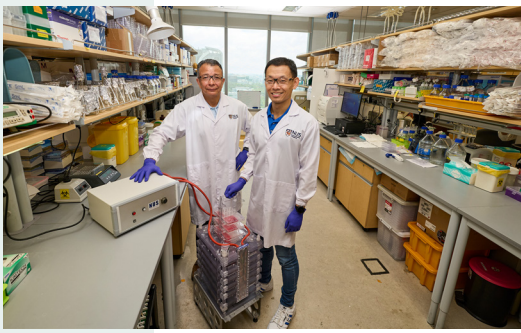
(Photo: SERIS)

New mapping tool for high-quality nature-based carbon credits

An interactive mapping dashboard, Carbon Prospecting Dashboard, was jointly developed by the NUS Centre for Nature-based Climate Solutions (CNCS) and ST Engineering Geo-Insights. This pioneering dashboard enables users to identify high-quality nature-based carbon credits, calculate their estimated yield and financial return on investment, and conserve key biodiversity areas. With deforestation being a major contributor to greenhouse gas emissions, this dashboard supports the efforts of governments, businesses and society in preserving carbon-rich, natural ecosystems, thereby addressing dual global crises – climate change and biodiversity loss.

NUS scientists develop novel technique to grow meat in the lab

Cultured meat is a sustainable alternative to animal farming. However, current methods of producing cultured meat involve using other animal products. Now, a multidisciplinary research team at NUS have described an unconventional method, using magnetic pulses to stimulate the growth of cell-based meat. This technique simplifies the production process of cell-based meat by reducing reliance on animal products. A patent has also been filed for this novel technology and the team is in the process to commercialise the technology.

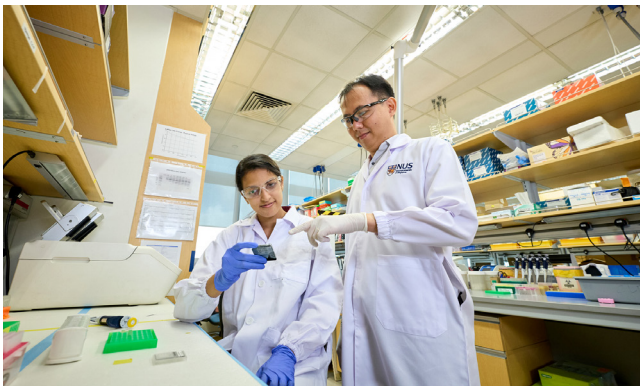


A new cancer testing method to make regular monitoring affordable

Current cancer diagnostic methods can suffer from a lack of sensitivity or from being too expensive to be used for regular screening.

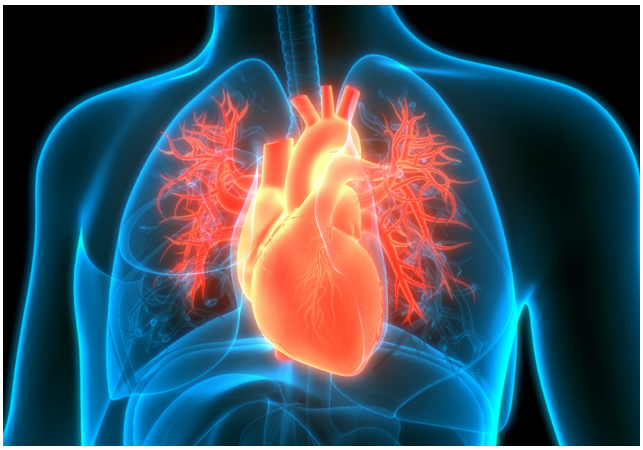
Led by Asst Prof Cheow Lih Feng, a team of NUS researchers discovered a novel low-cost, non-invasive method of testing for cancers. Called the Heatrich-BS assay, this new test sequences heated clinical samples in order to isolate cancer-specific signatures found in a patient's blood.

Asst Prof Cheow and his team are now exploring ways to commercialise their assay by partnering with pharmaceutical and biotechnology companies.



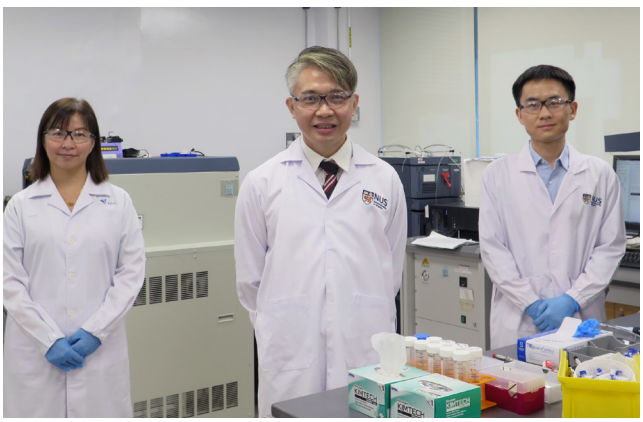
Laying the molecular foundation of mechanobiological signalling in the heart

A research team from NUS Mechanobiology Institute (MBI) together with clinical researchers from the Cardiovascular Research Institute under National University Health System adopted an interdisciplinary approach to study the molecular responses of cardiac muscle cells to biochemical and mechanical signals. They discovered how BNIP-2, a signalling scaffold protein, responds to mechanical signals, such as the contraction of cardiac muscle cells, to activate biochemical signals that control cell differentiation. Results from the study represent a first step in understanding the integrative work of mechanical and biochemical signals in controlling cardiac muscle differentiation and will help reveal the underpinnings of cardiac ageing.

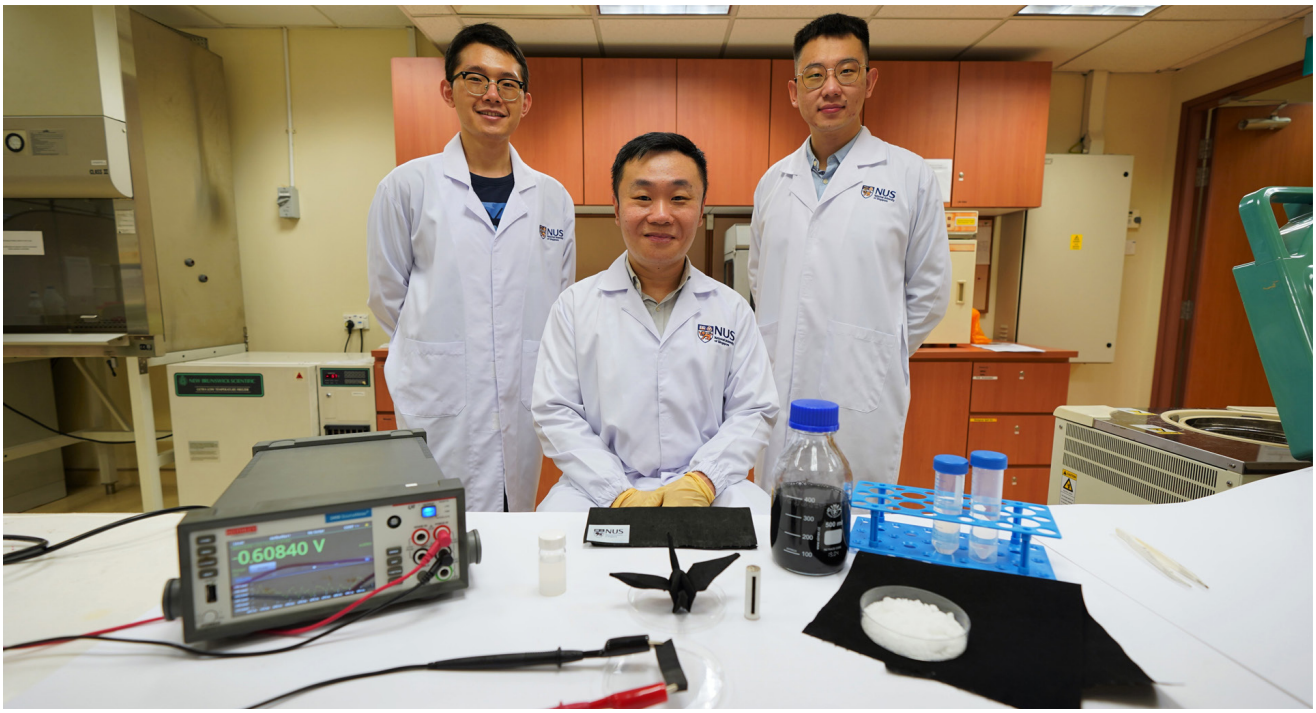


Three new biomarkers identified to detect consumption of emerging synthetic cannabinoid

The abuse of new psychoactive substances, particularly synthetic cannabinoids, poses a significant risk to public health. One of these is OXIZID, an emerging subclass of synthetic cannabinoids unregulated by existing laws due to its unique molecular scaffold. A research team led by Prof Eric Chan from NUS Pharmacy has collaborated with the Analytical Toxicology Laboratory of Singapore's Health Sciences Authority (HSA) to investigate key metabolic properties and identify urinary biomarkers of four OXIZID analogues. The team successfully identified biomarkers and translated their findings into routine testing to monitor for OXIZID consumption.



NUS researchers invent self-charging, ultra-thin device that generates electricity from air moisture



A team of researchers from NUS College of Design and Engineering has developed a new moisture-driven electricity generation (MEG) device made of a thin layer of fabric - about 0.3 millimetres (mm) in thickness - sea salt, carbon ink, and a special water-absorbing gel.

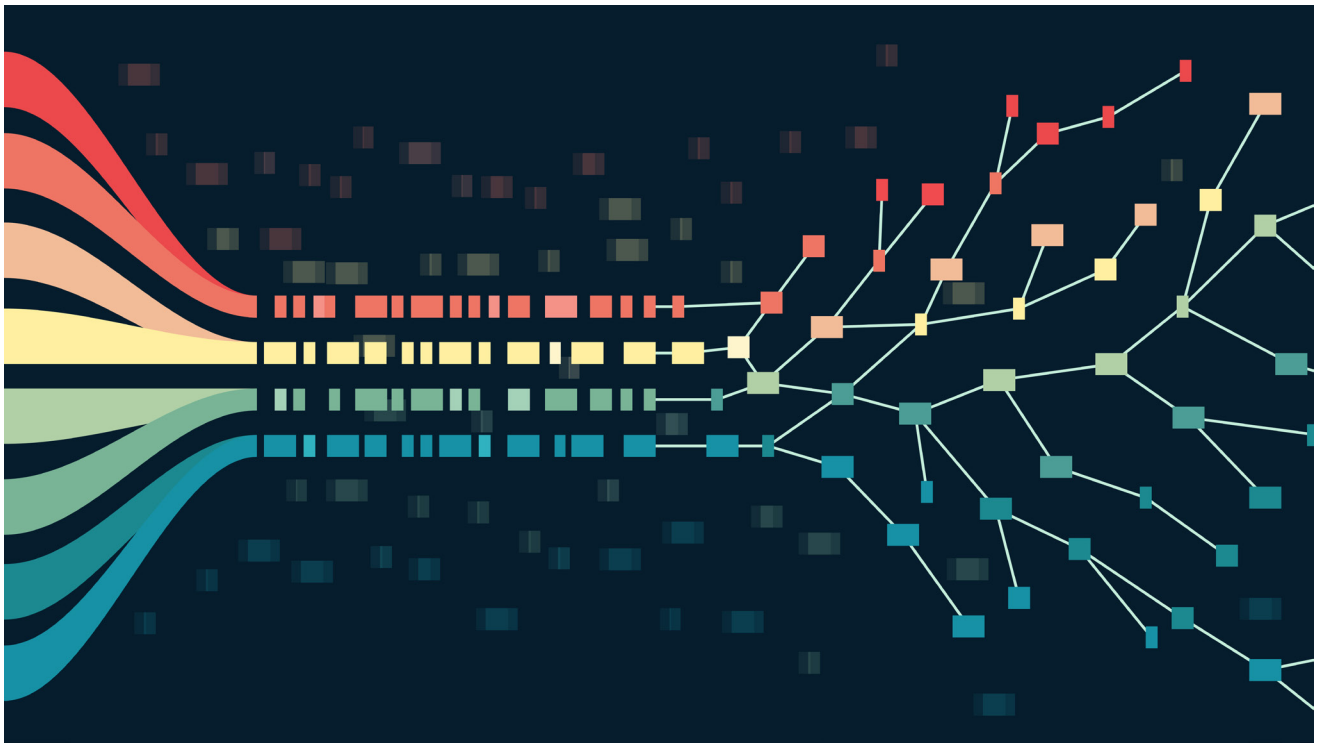
MEG devices exploit the ability of different materials to generate electricity from their interaction with moisture in the air. Such devices have potential use in a wide range of real-world applications, including self-powered devices such as wearable electronics, and information storage devices.

However, the electricity generated by conventional MEG devices is insufficient to power electrical devices due to several challenges in their design, including water saturation of the device when exposed to ambient humidity and unsatisfactory electrical performance.

To overcome these challenges, the team devised a novel MEG device that contains two regions of different properties. This allows a difference in water content to be perpetually maintained across the regions, with electrical output being generated for hundreds of hours.

Due to its ease of scalability and the commercial availability of the raw materials, the MEG device has immediate applications such as a portable power source for mobile electronics powered directly by ambient humidity.

The researchers have filed a patent for the technology and are planning to explore potential commercialisation strategies for real-world applications.



Bridging the gap between constraint satisfaction problems and data stream models

The world is becoming increasingly automated, with artificial intelligence (AI)-based technology enabling machines that can simulate human thinking and behaviour. They now power many services in our daily lives, from recommendations on Netflix, and virtual personal assistants such as Siri, to language translation programs such as Google Translate.

These machines learn from data via what are known as machine learning algorithms. That is, they are not explicitly programmed.

A subset of AI, machine learning algorithms are often based on probabilistic inference, which is the ability to calculate the probabilities of specific events occurring with only partial information. For example, what is the average airfare given the intended duration of travel and preference for a beach destination?

Despite its central role in machine learning, probabilistic inference remains a basic computational challenge. Events are typically complex and can depend on many variables. Using the same example, an estimation of average airfares would normally also factor in various flight routes, airlines, and dates of travel. This complexity poses a fundamental computational problem issue in performing inference.

One way to address the inference problem is via model counting, where the goal is to determine the number of system states (models) that correspond to a particular event. An event is typically described as a set of constraints to be satisfied. For example, how many different available flights allow you to fly from Singapore to your favourite holiday destination, subject to constraints like arrival time and budget?

An award-winning approach to a complex problem

Asst Prof Arnab Bhattacharyya and Asst Prof Kuldeep S. Meel have brought a fresh perspective to the study of model counting.

In research published in 2021, the pair examined the connection between model counting and data streaming. In the framework of data streaming, data is arriving continuously from many data sources, typically sent in small batches, and the goal of the streaming algorithm is to reliably maintain some statistics about the stream. For example, a streaming algorithm could be asked to keep track of how many distinct flights there are in a stream of flight routes. The objectives in model counting and data streaming are quite different. For model counting, the goal is to efficiently perform computations given explicit constraints, while the data streaming model focuses on reducing memory usage while processing the stream.

Often work at the intersection of fields is a fertile background for major breakthroughs

Over the past two decades, researchers from the model counting and data streaming communities have developed algorithmic frameworks separately, independent of developments in the other fields. However, Bhattacharyya and Meel's research uncovered a simple yet surprising connection between the two communities. Using the above example, they found that in order to count the number of flight routes that satisfy particular constraints, they can implicitly generate a stream of possible routes and then deploy a streaming algorithm on this (fictional) stream. Their work implies that the core technique employed in the algorithmic frameworks in model counting and data streaming is in fact, the same.

Owing to this significant discovery, their work was recognised in several achievements, including Best of PODS 21, SIGMOD Research Highlight Award, and the CACM Research Highlight Award.

"It's a tremendous gratification to see our work recognised by the broader community. The award has given us the confidence and motivation to plunge deeper into related questions and to investigate how we can make our work more practical," said Bhattacharyya.

The research was co-authored by Prof Pavan Aduri of Iowa State University as well as Prof N.V. Vinodchandran from the University of Nebraska-Lincoln.

"We are incredibly excited about this discovery and the recognition it has received. It opens up new avenues for research and collaboration between the model counting and data streaming communities, and we can't wait to see where it takes us," added Meel.

Pavan, A., Vinodchandran, N. V., Bhattacharya, A., & Meel, K. S. (2021). Model counting meets f0 estimation. In *Proceedings of the 40th ACM SIGMOD-SIGACT-SIGAI Symposium on Principles of Database Systems* (pp. 299-311).

Kuldeep S. Meel is an NUS Presidential Young Professor at the School of Computing, National University of Singapore. His research interests lie at the intersection of artificial intelligence and formal methods, where he hopes to advance artificial intelligence techniques to enable computing to deal with increasingly uncertain real-world environments. He is a recipient of an NRF Fellowship for AI (2019), ACP 2022 Early Career Researcher Award, and was named AI's 10 to Watch by IEEE Intelligent Systems in 2020.

Arnab Bhattacharya is an Assistant Professor at the School of Computing, National University of Singapore. His research focuses on theoretical computer science and the foundations of data science. Specifically, he is interested in algorithms for problems involving high-dimensional data, statistics, coding theory, and complexity theory. Bhattacharya is the recipient of an NRF Fellowship for AI (2019) and an Amazon Research Award (2018).

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