NUS RESEARCH in brief

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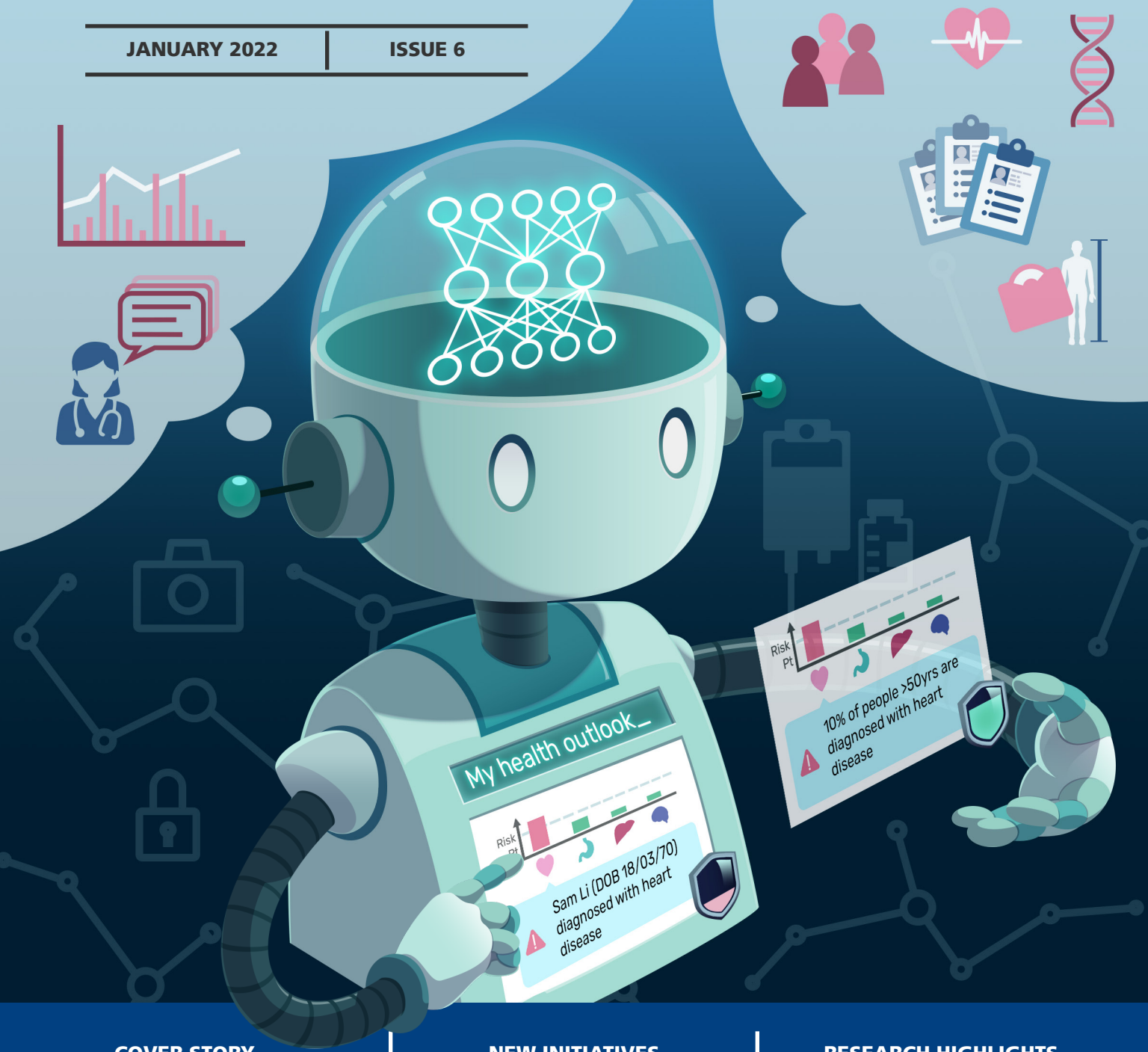
NUS National University of Singapore



COVER STORY
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NEW INITIATIVES
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From the Deputy President

Against a backdrop of climate change, an aging population, and an ongoing pandemic, Singapore continues to position itself as an innovation-driven, knowledge-based economy. This requires a research community that lends its collective knowledge to proposing innovative, yet accessible solutions to society's needs. At NUS we contribute to this effort by encouraging problem-driven research within interdisciplinary domains that are both globally relevant, and of strategic importance to the country.

In the area of **Health Innovation**, our researchers bring cutting edge technologies to medical interventions, diagnostics and treatments. Recent examples include smart bandages that provide data on chronic wounds, and smart sutures that detect complications in deep surgical wounds. Interdisciplinary collaborations within this research domain are also enabling social initiatives aimed at improving the wellbeing of Singapore's aging population.

Another area with exciting developments is **Materials Research**, which brings modern tools such as artificial intelligence to traditional materials science, and applies engineering principles towards technology development and application. In October 2021, a new Research Centre of Excellence, the Institute for Functional Intelligent Materials (I-FIM), was launched. This institute, which is supported by the Ministry of Education and hosted at NUS, will enable researchers to use machine learning and robotics to design materials with properties that can dynamically change in response to environmental stimuli. These materials are therefore functional and intelligent.

Our **Smart Nation** research continues to progress with the launch of the Cisco-NUS Accelerated Digital Economy Corporate Laboratory, which is supported by the National Research Foundation. It will focus on five strategic research areas aimed at boosting Singapore's digital economy. These are Artificial Intelligence, Healthcare, Cybersecurity, Urban Infrastructure and Future Work Force, and Productivity.

Finally, our focus on **Sustainability and Urban Solutions** has received a significant boost with the establishment of the Sustainable and Green Finance Institute (SG-FIN), a new research institute supported by the Monetary Authority of Singapore. SG-FIN aims to shape sustainability outcomes and policymaking across financial sectors. In addition, eight teams led by NUS researchers were recently awarded funding under the Low-Carbon Energy Research Funding Initiative (LCER FI) to develop cutting-edge low-carbon energy technology solutions to curb climate change. These projects will lead to innovative approaches for carbon capture, storage and utilisation.

The impact our researchers make continues to resonate around the world. In 2021 several NUS researchers were recognised for their contributions to their respective fields and I would like to congratulate all who were awarded recently. In particular, I would like to recognise Prof Brenda Yeoh, who was awarded the Vautrin Lud Prize in Geography; Prof Liu Bin, who received the Kabiller Young Investigator Award; and Prof Ivy Ng, Prof Linfa Wang, Assoc Prof Too Heng-Phon and Asst Prof Yvonne Gao, who were recognised at the President's Science and Technology Awards 2021; for their contributions to the advancement of science and technology in Singapore.

Professor Chen Tsuhan
Deputy President (Research & Technology)

NUS Research in Numbers

11,580
Research publications

Our researchers collaborated with

3537 institutes & universities from **166** countries

5
Research Centres of Excellence^

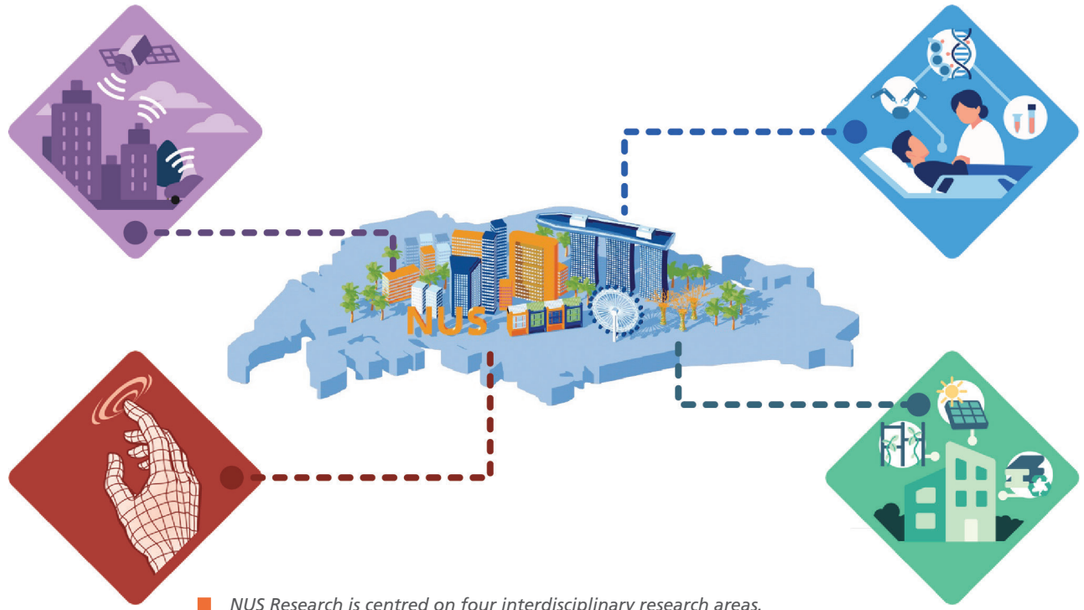
4
Corporate Laboratories^

33
Research Institutes & Centres^

17
Schools & Faculties^

$821.1m*
Total research funds awarded by external sources

$336.15m*	$273.53m*	$211.38m*
From industry and other government sources (local and overseas)	Awarded by the National Research Foundation	Total awarded by the Ministry of Education



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

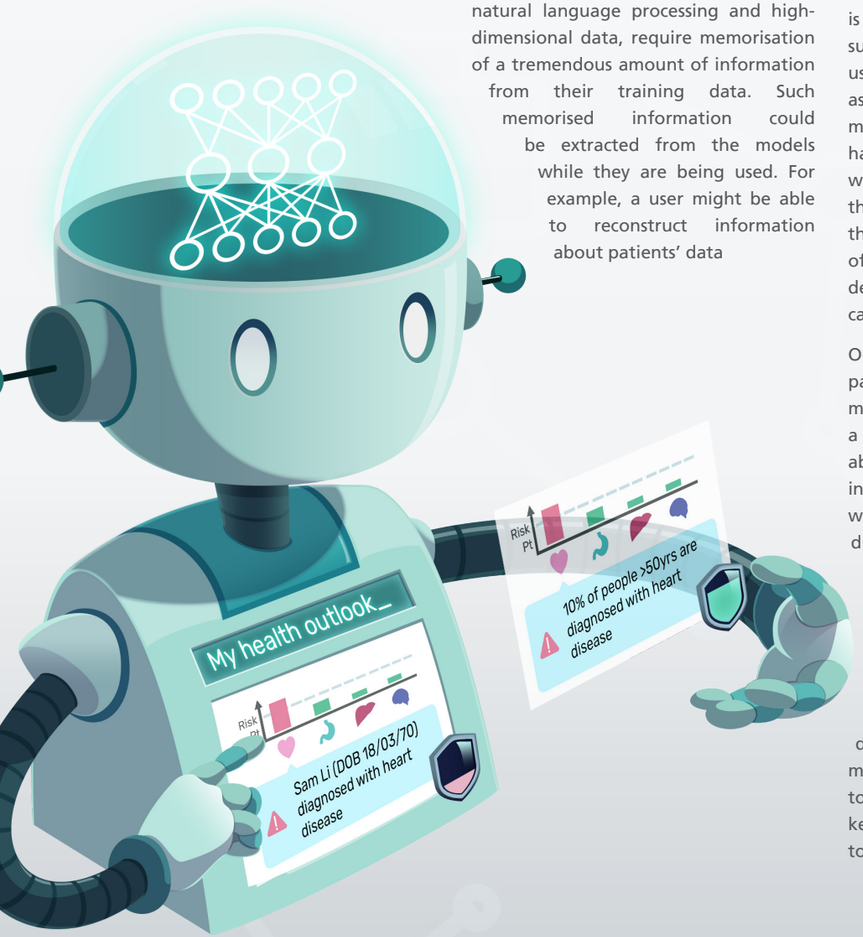
764	167	439	130
Patent applications	Patents granted	Invention disclosures	Technology licences executed

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

*Based on FY2020. ^Accurate as of January 2022. All other data based on Calendar Year 2020.

Privacy risks in machine learning and auditing with NUS' ML Privacy Meter

Machine learning plays a central role in automated decision-making technologies, which are emerging across a range of industries, including in healthcare, finance, education, as well as smart city, and smartphone platforms. However, data used to train these high-performance machine learning models typically contain sensitive personal information. With a significant amount of data required to train each machine learning algorithm, privacy and confidentiality concerns are of growing importance.



Privacy risks in machine learning

Various aspects of the data lifecycle in a machine learning pipeline, such as collection of data, model training, and model deployment, could cause privacy risks. Current privacy regulations are primarily concerned with the risks related to data collection. However, vulnerabilities in other aspects of machine learning must be considered as well.

Many machine learning algorithms, such as the deep neural networks in advanced AI, and large models used in natural language processing and high-dimensional data, require memorisation of a tremendous amount of information from their training data. Such memorised information could be extracted from the models while they are being used. For example, a user might be able to reconstruct information about patients' data that was used to train the models. This is a serious threat, because security mechanisms such as access control (which are useful during the data collection phase) cannot prevent the leakage of such information.

Protecting confidentiality and differential privacy

Data "confidentiality" must be protected against entities who should not have direct access to the data. Confidentiality becomes an issue when data computation, like model training, is performed on an untrusted platform such as the cloud. In this case, we can use cryptographic technologies (such as homomorphic encryption, secure multi-party computation, and trusted hardware) for blind computation, where the computer can neither see the data nor the intermediate steps of the computation. However, the output of such computation (the "models") is designed for a wide range of users, which can cause a new privacy issue.

Our research[1, 2, 3] shows that model parameters and predictions made by machine learning models can reveal a significant amount of information about their training data. For example, in a language model, a user can infer which sentences were most likely used during the training. This violates data privacy, and may harm the individuals who contribute the training data – especially if the data contains personal information.

To ensure models do not contain excess information from the training data, complementary privacy protection methods are needed. Information related to "individual" data records should be kept hidden, while information related to patterns identified from "group" data records is allowed to be learned and shared by the model. This method, known as differential privacy, preserves individual privacy while enabling machine learning (extracting useful pattern from training data for prediction) to be achieved.

Using this method, two machine learning models that are trained on two disctinct data sets (differing only in one individual data record) are almost indistinguishable. This allows accurate data training at a population level while creating inaccuracies at an individual level, thereby reducing its value should an attacker attempt to extract information.

Satisfying both confidentiality and differential privacy provides considerable data protection in many practical scenarios. To widely adopt such an approach, several questions must be addressed: how can privacy risks be quantified; and how can privacy be protected while respecting expectations from machine learning algorithms (like prediction accuracy, algorithmic fairness, transparency, and scalability)?

Auditing data privacy in machine learning

We can measure privacy risks of a machine learning algorithm as the amount of information that an adversary can possibly infer about each training data record, by observing the model.

We quantify this risk through modeling of the adversary and measuring the success of "membership inference attacks". This allows us to predict whether an adversary can identify a particular data record that was used during the training. This approach is being used in academia and industry as the systematic methodology for "auditing data privacy for machine learning".

Guidelines by the European Commission and the White House call for protection of personal data during all the phases of deploying AI systems and require systems to be resistant to such attacks. Recent reports published by the Information Commissioner's Office (ICO) also highlight privacy risks such as vulnerabilities to membership inference as a privacy violation and potential threat to a model's training data. ICO recommends organisations to identify these threats and take measures to minimise the risk.

At NUS, we have designed state of the art algorithms for membership inference, and developed an open source tool, ML Privacy Meter[4]. This tool quantifies how much information the models leak about each individual record in their training set and produces reports about which data points are vulnerable and how much the total privacy risk is. The tool is also being used in academia and in industry.

Auditing privacy allows data protection policies to be proactive and effective. A "privacy meter" must be applied for auditing the privacy risks of a machine learning algorithm quantitatively. The complementing element is having "provable guarantees" for data privacy, to make sure all the risks within the assumed threat model are sufficiently mitigated[5].

For Singapore to be a trusted hub for AI and Machine Learning based technologies, it is imperative that we pioneer the foundational technologies for large-scale computations with robust data protection mechanisms. In our "data privacy and trustworthy machine learning" lab at NUS, we are taking significant steps towards this goal.

ABOUT THE AUTHOR

Reza Shokri is a NUS Presidential Young Professor, leading a research lab on data privacy and trustworthy machine learning in NUS Computer Science. He is a recipient of the IEEE Security and Privacy Test-of-Time Award 2021, for his paper on quantifying location privacy. He also received the Caspar Bowden Award for Outstanding Research in Privacy Enhancing Technologies in 2018, for his work on analyzing the privacy risks of machine learning algorithms. Beyond these achievements, he is also awarded the NUS Early Career Research Award 2019, VMWare Early Career Faculty Award 2021, Meta (Facebook) Faculty Research Award 2021, and Intel Faculty Research Award (Private AI Collaborative Research Institute) 2021, for his work on analyzing and mitigating the privacy risks of machine learning algorithms.

References:

[1] Reza Shokri, Marco Stronati, Congzheng Song, and Vitaly Shmatikov, Membership Inference Attacks against Machine Learning Models, IEEE Symposium on Security and Privacy (S&P) — Oakland, 2017.

[2] Milad Nasr, Reza Shokri, and Amir Houmansadr, Comprehensive Privacy Analysis of Deep Learning: Passive and Active White-box Inference Attacks against Centralized and Federated Learning, IEEE Symposium on Security and Privacy (S&P) — Oakland, 2019

[3] Jiayuan Ye, Aadyaa Maddi, Sasi Kumar Murakonda, and Reza Shokri, Enhanced Membership Inference Attacks against Machine Learning Models, 2021

[4] http://privacy-meter.com/

[5] Rishav Chourasia*, Jiayuan Ye*, and Reza Shokri, Differential Privacy Dynamics of Langevin Diffusion and Noisy Gradient Descent, Conference on Neural Information Processing Systems (NeurIPS), Spotlight presentation, 2021

A quantum leap for materials science: NUS launches world's first research institute for intelligent materials

The Institute for Functional Intelligent Materials (I-FIM) is the world's first institute that is dedicated to the design, synthesis, and application of functional intelligent materials and NUS' newest Research Centre of Excellence (RCE).

Most materials, like steel, have fixed properties. I-FIM intends to create intelligent and adaptive materials with properties that can dynamically change according to the environment – crucial for artificial organs, smart membranes, smart batteries, and many others. This is done by turning traditional research approach of trial and error into an interdisciplinary method that leverages on modern tools – from machine learning to artificial intelligence – to unlock new smart materials, explained Professor Chen Tsuhan, Deputy President (Research and Technology) at NUS.

"We don't want to be slaves to the existing materials. We want to be able to create our own materials with pre-determined common properties for given applications," said Professor Sir Konstantin Novoselov, Nobel-Prize-winning materials scientist and director of I-FIM. With Prof Novoselov and Professor Antonio Castro Neto at the helm, I-FIM joins five other RCEs in Singapore that are geared towards advancing research excellence on a national level.

I-FIM is on a mission to grow its multidisciplinary panel of experts across machine learning, mathematics, material science, physics, chemistry, and biology, to achieve a quantum leap breakthrough.

Beyond the science, the team at the Institute is also developing new materials that could revolutionise many technologies – making them greener, more affordable, and smarter to solve real-life problems that could impact the world.

New Cisco-NUS Corporate Lab to accelerate Singapore's digital transformation

NUS and global technology leader Cisco launched a Corporate Laboratory to boost innovation and research in key technology areas, including artificial intelligence (AI), healthcare, urban infrastructure and cybersecurity. These capabilities are crucial in driving Singapore's knowledge-based, innovation-driven digital economy. Based at NUS' Kent Ridge campus, the Cisco-NUS Accelerated Digital Economy Corporate Laboratory was established with an investment of S$54 million over five years, and is supported by the National Research Foundation Singapore (NRF Singapore). The Corp Lab will be helmed by Associate Professor Biplab Sikdar from NUS Electrical and Computer Engineering, and Mr Jeremy Lim, Manager of the Cisco Singapore Co-Innovation Center.

The Lab will take a multi-sectoral and multi-disciplinary approach to accelerate Singapore's Digital Economy transformation by developing solutions to automate and scale business operations; developing intelligent infrastructure for healthcare; building and operationalising secure and resilient next-generation infrastructure for Internet of Things and enterprise environments; and harnessing technology to augment and drive productivity of a future-ready professional workforce.

NUS to establish Sustainable and Green Finance Institute to drive green finance education and research

NUS will be establishing a new research institute to develop deep research and capabilities in the area of green finance and sustainability focusing on Asia by the end of the year. The Sustainable and Green Finance Institute (SGFIN) will provide thought leadership and shape sustainability outcomes and policy-making across the real economy and financial sectors.

SGFIN is supported by the Monetary Authority of Singapore (MAS) and will be helmed by NUS Business School faculty members Professor Sumit Agarwal as the Institute's Managing Director, Associate Professor Johan Sulaeman as its Director and Associate Professor Zhang Weina as its Deputy Director.

SGFIN plans to embark on academic and applied research in providing relevant financial solutions and frameworks to address pressing climate and social challenges faced by the world and particularly the region.

Singapore's Quantum Engineering Programme teams up with Amazon Web Services to boost the development of quantum technologies

NUS has signed a Memorandum of Understanding (MoU) with Amazon Web Services (AWS) for a collaboration to boost the development of quantum communication and computing technologies, and explore potential industry applications of quantum capabilities.

Under the MoU, AWS will support Quantum Engineering Programme (QEP) in the development of quantum computing research and projects, and connect to the National Quantum-Safe Network for quantum communications. Both areas include the identification of use cases and development of applications that could support future commercialisation of Singapore-designed quantum computing and communication technologies, and the joint organisation of academic, scientific, and public outreach activities like seminars, workshops, festivals, and conferences.

NUS East Asian Institute establishes Korea Centre in Singapore

The East Asian Institute (EAI) at the NUS has established the Korea Centre to spearhead research on governance, peace and development in the Korean Peninsula. The first of its kind in Southeast Asia, the new Centre seeks to contribute to understanding and interaction between the two Koreas (North and South Korea) and ASEAN countries.

Headed by Dr Lam Peng Er, the Centre is welcomed by the embassies to Singapore of the Republic of Korea and the Democratic People's Republic of Korea, with support from the Korea Foundation. Its vision is to become a leading knowledge hub in the Asia Pacific outside of the Korean Peninsula, focusing on contemporary Korean politics, economy, society and international relations, as well as North-South interaction in the Korean Peninsula.

New partnership between QEP and Thales to spur innovation in quantum security and quantum sensors

NUS and Thales have inked a Memorandum of Understanding (MoU) to mark the start of a two-year partnership to jointly develop and test quantum technologies for commercial applications.

Under the MoU, Singapore's Quantum Engineering Programme (QEP) and Thales aim to advance quantum technologies and prepare industry players for their arrival. The partnership will see industry and academic experts develop capabilities to test and evaluate interdisciplinary quantum security technologies; explore potential research collaboration opportunities in the fields of new materials and design for quantum sensing; and develop devices that tap on quantum physics for higher performance, which is an area of focus under Singapore's Research, Innovation and Enterprise 2025 Plan (RIE2025).

NUS scientists conferred national honours for research excellence

Top researchers in NUS have been recognised for their contributions to the advancement of science and technology in Singapore, and the world.

President's Science and Technology Medal (PSTM)

Prof Ivy Ng

Prof Ng, a member of the Duke-NUS Governing Board, clinical professor at Duke-NUS and NUS Medicine as well as Group CEO of SingHealth, was conferred the PSTM for her outstanding leadership in the development of academic medicine in Singapore, nurturing clinical research talent, and for pushing the boundaries of medicine to improve health and healthcare delivery. She has also been a tireless advocate for biomedical research, innovation and education.

President's Technology Award (PTA)

Assoc Prof Too Heng-Phon

Assoc Prof Too from NUS Medicine received the PTA for his groundbreaking work in developing an accurate and versatile method to detect microRNA (miRNA) biomarkers, leading to the clinical implementation of blood tests for early detection of diseases such as cancer. Assoc Prof Too is also the scientific Co-founder, Chief Scientific Advisor and Non-executive Chairman of MiRXES, a Singapore-headquartered biotechnology company that has licensed and commercialised his miRNA detection technology.

President's Science Award (PSA)

Prof Wang Linfa

Prof Wang from Duke-NUS' Programme in Emerging Infectious Diseases was awarded the PSA for his breakthrough research and contributions to the field of bat biology and emerging viral transmission. His work will help to better predict, prevent and control future viral spill, and has implications for other conditions including cancer, inflammation, and ageing-related diseases. Prof Wang has contributed significantly to Singapore's response to the COVID-19 pandemic, including the development of a novel rapid serological test kit - cPass™.

Young Scientist Award (YSA)

Asst Prof Yvonne Gao

Asst Prof Gao from NUS Physics and CQT was presented with the YSA for her work on developing the key hardware building blocks – such as novel device architectures – for quantum computers. Her research is critical for up-scaling quantum devices while effectively preserving their performance. Her PhD work has also resulted in two patents which have been licensed in a Yale spin-off based in the United States. Asst Prof Gao also mentors the next generation of young scientists through public talks, popular science writing and school outreach activities.

32 NUS scientists among the world's most highly cited researchers

32 NUS researchers have been placed among some of the world's most highly cited researchers, according to the Highly Cited Researchers 2021 List published by data analytics firm Clarivate.

Chemistry

Professor
JIANG Donglin
Dept of Chemistry, FoS

Professor
LIU Xiaogang
Dept of Chemistry, FoS

Computer Science

Dr
TAN Jen Hong
NUS Institute of Systems Science

Professor
ZHANG Rui
Dept of ECE, CDE

Economics & Business

Professor
ANG Beng Wah
NUS Energy Studies Institute
Dept of ISEM, CDE

Dr
SU Bin
NUS Energy Studies Institute
Dept of ISEM, CDE

Neuroscience & Behaviour

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

Clinical Medicine

Professor
WONG Tien Yin
Duke-NUS Medical School
Dept of Ophth, YLLSoM

Engineering

Professor
GE Shuzhi Sam
Dept of ECE, CDE

Pharmacology & Toxicology

Associate Professor
Gautam SETHI
Dept of Pharmacology, YLLSoM

Cross-Field

Professor
Antonio BERTOLETTI
Duke-NUS Medical School

Professor
CHEN Wei
Dept of Chemistry, FoS
Dept of Physics, FoS

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

Professor
Derek John HAUSENLOY
Duke-NUS Medical School

Assistant Professor
Cyrus HO
Dept of Psychol Med, YLLSoM

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

Associate Professor
Sibudjing KAWI
Dept of ChBE, CDE

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

Professor
LIM Chwee Teck
Dept of BME, CDE
Institute for Health Innovation & Technology
Mechanobiology Institute, NUS

Professor
LIU Bin
Dept of ChBE, CDE

Professor
LOH Kian Ping
Dept of Chemistry, FoS

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

Professor
Seeram RAMAKRISHNA
Dept of ME, CDE

Dr
Muthu Kumaraswamy SHANMUGAM
Dept of Pharmacology, YLLSoM

Assistant Professor
Benjamin TEE
Dept of MSE, CDE
Dept of ECE, CDE

Professor
WANG Linfa
Duke-NUS Medical School

Associate Professor
XIE Jianping
Dept of ChBE, CDE

Physics

Professor
Antonio Helio CASTRO NETO
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
Guillermo C. BAZAN
Dept of Chemistry, FoS

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

Professor
John WANG
Dept of MSE, CDE

Prof Barry Halliwell honoured as a 2021 Citation Laureate

Professor Barry Halliwell, Senior Advisor (Academic Appointments and Research Excellence), NUS Office of the Senior Deputy President and Provost, has been conferred Citation Laureate for 2021. The distinction is awarded by information and insights company Clarivate to researchers whose work has been deemed to be of "Nobel Class" as they are among the most highly cited and influential, even transformative, in their fields. Citation Laureate candidates are selected from authors of the 0.01 per cent of some 52 million articles and proceedings that have been cited 2,000 times or more. Prof Halliwell is one of 16 scientists around the world listed in the Hall of Citation Laureates this year.

NUS scientists honoured as influential young innovators in Asia Pacifc

Five young researchers from NUS who have made great achievements in their respective fields have been identified as among the most influential innovators in Asia Pacific who are younger than 35.

Recognised in the 2021 MIT Technology Review Innovators Under 35 Asia Pacific List, these honourees were selected by judges, based on criteria such as: impact, ingenuity, daring, timeliness, entrepreneurial accomplishments, and communication skills.

Pioneer

Dr Agata Blasiak

Dr Agata Blasiak was instrumental in the development of an artificial intelligence (AI) platform CURATE.AI to assist doctors in Singapore to optimise the dose of chemotherapy drugs.

Asst Prof Tan Yu Jun

Asst Prof Tan Yu Jun from NUS Mechanical Engineering developed a new and unique fluoropolymer that has very high dielectric permittivity with good elastic properties, and several other innovative materials.

Visionary

Asst Prof Koh Ming Joo

Asst Prof Koh Ming Joo from NUS Chemistry has successfully developed realistic and less costly catalyst systems. His sustainable approach will significantly enhance the way many important molecules are prepared in terms of cost savings, as well as the amount of waste generated.

Asst Prof Jonathan Scarlett

Asst Prof Jonathan Scarlett from NUS Computer Science and NUS Mathematics has spent years in better understanding the mathematical algorithms and theory behind group testing. His work provided new precise characterisations of the performance bounds for algorithms and impossibility results.

Asst Prof Shin Sunmi

Asst Prof Shin Sunmi from NUS Mechanical Engineering devised a series of novel setups that demonstrated the capability to enhance and directly measure the coherent thermal emission from nanoscale emitters with exceedingly low emitting power from cryogenic to room temperature.

NUS geographer Brenda Yeoh awarded the prestigious 'Nobel Prize for Geography'

Professor Brenda Yeoh from NUS Geography, Faculty of Arts and Social Sciences has been awarded the international Vautrin Lud Prize 2021 in Geography and the first Singaporean to receive this accolade. Modelled after the Nobel Prize, it is awarded to geographers for outstanding achievements in the field. She has deep expertise working on a wide range of migration research in Asia, including key themes such as cosmopolitanism and highly skilled talent migration.

Prof Liu Bin bags Kabiller Young Investigator's Award

Professor Liu Bin, NUS Senior Vice Provost and Head of NUS Chemical and Biomolecular Engineering has bagged the Kabiller Young Investigator's Award in Nanoscience and Nanomedicine.

Prof Liu was recognised for her research in finding practical solutions for disease diagnosis and treatment through multidisciplinary collaborative projects, such as the development of brain tumor-specific imaging agents for tumor identification and image-guided surgery.

Smart sutures to monitor deep surgical wounds

Monitoring surgical wounds after an operation is an important step to prevent infection, wound separation and other complications.

To detect wound complications as soon as they occur, a team of researchers, led by Assistant Professor John Ho from the NUS Electrical and Computer Engineering as well as the NUS Institute for Health Innovation & Technology, has invented a smart suture that is battery-free and can wirelessly sense and transmit information from deep surgical sites.

NUS researchers develop world's first smart bandage that detects multiple biomarkers for onsite chronic wound monitoring

A research team led by Professor Lim Chwee Teck from NUS Biomedical Engineering and Institute for Health Innovation & Technology (iHealthtech), in collaboration with clinical partners from Singapore General Hospital, has developed a smart wearable sensor that can conduct real-time, point-of-care assessment of chronic wounds wirelessly via an app. The novel sensor technology can detect key factors including inflammatory factors specific to chronic wounds within 15 minutes, hence enabling fast and accurate wound assessment.

Together, but still apart

Social distancing measures brought about by the ongoing COVID-19 pandemic have exacerbated social isolation, especially among the elderly. Now, researchers from NUS Yong Loo Lin School of Medicine and Faculty of Arts and Social Sciences, have studied factors associated with social isolation in a cohort of 16,943 community-dwelling seniors. The results of this study have been described, and published in Gerontology on 16 June 2021.

Fine aerosols emitted during talking and singing may play a crucial role in COVID-19 transmission: Singapore study

A new study led by researchers from NUS and conducted at the National Centre for Infectious Diseases (NCID), revealed that severe acute respiratory syndrome coronavirus (SARS-CoV-2) particles can be aerosolised by an infected person during talking and singing. The researchers concluded that fine respiratory aerosols may play a significant role in SARS-CoV-2 transmission, especially in an indoor environment, and hence, should be taken into consideration when planning infection prevention measures.

NUS researchers develop brain-inspired memory device that can revolutionise semiconductor design

NUS physicists have collaborated with an international team of researchers to develop a novel molecular memristor, or an electronic memory device, that has exceptional memory reconfigurability.

Unlike hard-wired standard circuits, the molecular device can be reconfigured using voltage to embed different computational tasks. The energy-efficient new technology, which is capable of enhanced computational power and speed, can potentially be used in edge computing, as well as handheld devices and applications with limited power resource.

Associate Professor Ariando from the NUS Physics said: "This work is a significant breakthrough in our quest to design low-energy computing. The idea of using multiple switching in a single element draws inspiration from how the brain works and fundamentally reimagines the design strategy of a logic circuit."

Building on their research, the team used the molecular memory devices to run programs for different real-world computational tasks. As a proof of concept, the team demonstrated that their technology could perform complex computations in a single step, and could be reprogrammed to perform another task in the next instant. An individual molecular memory device could perform the same computational functions as thousands of transistors, making the technology a more powerful and energy-efficient memory option. The team in the midst of building new electronic devices incorporating their innovation, and working with collaborators to conduct simulation and benchmarking relating to existing technologies.

NUS Centre on AI Technology for Humankind launches manifesto on building a human-centred digital society

The Centre on AI Technology for Humankind (AiTH) at the NUS Business School has rolled out recommendations on how society and organisations should approach artificial intelligence (AI) in ways that truly promote human interests and well-being.

"Most of us interact with AI systems on a daily basis, even if we do not realise it. Many of these systems are focused on promoting human performance with the narrowly defined goal to increase efficiency, and hence productivity. But to make our tech efforts sustainable and build a truly humane and creative society, we need to focus on developing tech that optimises and enriches a variety of experiences that make us uniquely human. Our recommendations guide both individuals and organisations in their AI approach," said Professor David De Cremer, Founding Director of AiTH.

Integrated decision making for smart cities

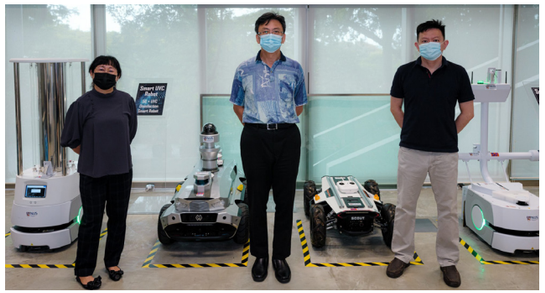
NUS is collaborating with the French National Centre for Scientific Research (CNRS), the Agency for Science, Technology and Research (A*STAR), and Nanyang Technological University in a new S$56 million hybrid artificial intelligence programme to develop solutions that support the creation of smart cities.

The five-year DesCartes Programme, which is funded by the National Research Foundation, Singapore (NRF), aims to enhance real-time decision-making in urban-critical systems, with a focus on individuals and society at large. The DesCartes Programme will ride on the strong AI research collaborations between Singapore and France. It will focus on four areas – data and its applications; verifiable and explicable AI; natural language processing; and human-machine/AI interaction.

New NUS Centre for 5G Digital Building Technology to augment digital capability of Singapore's built environment industry

In a boost to Singapore's future-built environment landscape, the NUS Built Environment has established a new research centre to augment the digital capability of Singapore's construction industry, accelerate 5G training and promote the adoption of 5G technologies in Smart Facilities Management (FM).

The Centre for 5G Digital Building Technology aims to play an important role in Singapore's digital research transformation as the nation pushes to offer nation-wide 5G coverage by 2025. Specifically, it has set its sights to be a leading centre in digital building technology through high impact research, broad-based education, and implementing best practices. It will harness 5G connectivity, cloud-based digital twin and robotics for Smart FM and Built Environment industry applications and seek to transform the way people design, deliver and manage Singapore's built environment.



Solutions to meet food demands of the future

At NUS, research groups have been working on solutions to tackle the impending food security crisis. Three teams recently secured funding from the Singapore Food Agency (SFA) for their work focusing on sustainable urban food production. These projects aim to increase the productivity of local food producers while balancing key factors like cost-effectiveness, sustainability, and climate resilience. Additionally, the groups aim to develop local agri-tech R&D ecosystem, and sustainable urban food solutions to support Singapore's "30 by 30" goal for food security.

New technology to boost energy efficiency of District Cooling Systems

This Thermal Energy Storage (TES) technology solution, jointly designed and developed by NUS and Keppel DHCS Pte Ltd (KDHCS), uses a new Phase-Change Material (PCM) that can store and release cold energy as it changes between liquid and solid states. The stored cold energy is gradually released in a district cooling plant to mitigate cooling peak loads in commercial buildings. This new invention has demonstrated that it could improve the energy carrying capacity by up to three times as compared to a conventional chilled water storage system, and yield more than 10% in cost savings annually.

Climate change increases fluvial sediment in the high mountains of Asia

High Mountain Asia (HMA), which refers to the Tibetan Plateau and the surrounding high Asian mountains, is home to the world's third-largest ice reservoir and the origin of many of Asia's large rivers. In fact, these rivers are crucial lifelines for a third of the world's population. The rivers in HMA are experiencing increased runoff and sediment fluxes from amplified climate change, glacier melt and permafrost thaw. To examine the impact of these phenomena on HMA, Professor Lu Xixi and Dr Dongfeng Li from NUS Geography, Faculty of Arts and Social Sciences led an international team of researchers to conduct a new analysis of observations of headwater rivers in the area.

Accelerating decarbonisation: Eight NUS projects to pioneer low-carbon energy technologies

From novel processes to produce hydrogen to innovative ways to capture, use and store carbon dioxide, eight teams led by NUS researchers have recently been awarded funding under the Low-Carbon Energy Research Funding Initiative (LCERFI) to develop cutting-edge low-carbon energy technology solutions. They are among the 12 projects – selected from more than 50 research proposals – to receive a total of S$55 million in research grants from the Singapore Government.

Office of the Deputy President (Research & Technology)

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