VISION
To be among the world’s best in science education and research

MISSION
To provide quality education, foster the spirit of enterprise and conduct leading-edge research to advance knowledge in Science and Technology for the benefit of Singapore and the global community

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FACULTY OF SCIENCE
ANNUAL REPORT 2018

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DEAN’S MESSAGE

2018 was another exciting year for the Faculty of Science. We continued to forge ahead with quality education and cutting-edge research centred on natural and mathematical sciences. We also leveraged on our strengths in fundamental sciences to extend into interdisciplinary and applied areas. We constantly redesign and enhance our curriculum to provide students with both depth and breadth of scientific knowledge as well as transferrable skill sets. The quality of our education and the interesting array of courses have drawn many highly talented students to the Faculty. We focus on fundamental research with impactful innovations. We have secured multiple high-value grants and achieved significant breakthroughs in a number of areas this year. Our research achievements are well-recognised internationally; our professors have received awards for the advances they made to fundamental sciences. Increasingly, we also pursue interdisciplinary and multidisciplinary research to work on novel problems that bring science from bench to table, thereby creating impact to society and industry.

Transformative Education

In addition to strengthening our curriculum to provide depth in discipline knowledge and breadth in foundational knowledge, we have focused on integrating knowledge acquisition and skills development, facilitating learning opportunities outside students’ majors, and inculcating the mindset for lifelong learning. We are offering new modules in computational thinking skills, applied projects for more students, and internships under the Cooperative Education Programme for Data Science and Analytics students. These and other efforts help students gain industry experience and apply their knowledge to develop practical solutions to authentic problems. New and expanded Summer Programmes – Global Science Summer Programme and the NUS-Hokkaido University Summer Programme: Agri-Science in Japan and Singapore – offer students additional opportunities to learn under experts in the field and to experience learning in different environments. Another highlight is the Concurrent Degree Programme with the University of Melbourne (UoM), which we offered this year. This programme allows students to receive both NUS’ Bachelor of Science in Life Sciences and UoM’s Doctor of Veterinary Medicine.

Global Science Summer Programme
The Faculty has worked hard over the past year to prepare a suite of Continuing Education and Training (CET) modules for adult learners that can lead to certificates, graduate diplomas and Master degrees on specialised themes relevant to skills development. We have obtained approval for over 50 SkillsFuture Singapore-funded credit courses with many more courses pending approval. These CET courses in data science and analytics, food science and technology, pharmaceutical science, forensic science, and others, will help graduates to be up-to-date with the latest scientific developments and acquire new skills for emerging industries.

Transformative Research

In terms of research, we have worked hard to gain breakthroughs in many areas of fundamental research while building and integrating strengths in niche areas like data science and analytics, materials science, healthcare sciences, sustainability sciences, and food science and technology. In this report, apart from achievements in fundamental research, we highlight various translational research achievements that have significantly impacted materials science, healthcare and food science industries. We have also continued to facilitate interdisciplinary, multidisciplinary and multi-institutional research where the Faculty plays a central role to tackle interesting scientific problems. The launch of the Applied Materials-NUS Advanced Materials Corporate Lab which brings together experts in chemistry, materials science and microelectronics engineering, is one example of such collaboration. Another example is the South Java Deep Sea Expedition jointly undertaken by researchers in the Lee Kong Chian Natural History Museum and Indonesian researchers.

2019 and beyond

While we remain steadfast in our core mission in education and research, we are aware of the current rapid pace of change in science and technology. Both faculty and students are facing uncertain times ahead, but we can face the future from a position of strength. We have talented staff and students and the resources to continue building on what we have achieved so far. Going forward, we need to be flexible and innovative in our response and to challenge the status quo. We also need to stay locally relevant and globally engaged. We will help to shape the future by creating international impact with fundamental research. At the same time, we will make direct contributions to Singapore with quality education and translational research. With the dedication of all stakeholders – staff, students, donors and partners – we are confident that these goals are within our reach.
YEAR IN REVIEW

We affirmed our standing as a faculty at the forefront of transformative science education and cutting-edge research. The year’s milestones included the launch of several academic programmes, new exchange programmes and Continuing Education and Training courses for adult learners. The Applied Materials-NUS Advanced Materials Corporate Lab was established to develop groundbreaking materials engineering for the next generation of semiconductor manufacturing.

**New Academic Programmes**

**Computational Thinking courses**

In line with NUS’ initiative to introduce computational skills in the undergraduate curriculum, we offer two higher-order modules - COS2000 Computational Thinking for Scientists and CM3267 Computational Thinking and Programming in Chemistry, in Academic Year 2017/2018 and 2018/2019, respectively. The former is customised for NUS Science students, while the latter is an elective option for Chemistry, and Food Science and Technology majors to apply computational thinking skills to discipline-specific content [see pgs 26 and 30].

**Forensic Science Minor revision**

The programme, which covers concepts and principles in the application of scientific techniques to forensic investigations and the criminal justice system, has been revised. Students now have more elective options. This includes five new interdisciplinary modules to broaden their exposure to specialised forensic science fields, more existing discipline-based science modules relevant to the forensic science curriculum, as well as Undergraduate Research Opportunities Programme in Science projects related to forensic science offered by our departments.

**Expanded scope of internships**

We have incorporated more applied learning which aligns with NUS’ experiential learning outcomes. Data Science and Analytics students from the 2017 cohort can opt for credit-bearing internships under the Cooperative Education Programme. Like Chemistry and Life Sciences majors, the Food Science and Technology programme has introduced the Applied Project module [see pg 13], enabling students to undertake internship projects in applied contexts as an alternative to the traditional Honours project.
To support Singapore’s lifelong learning movement and NUS initiatives in this direction, we are offering a range of SkillsFuture Singapore-funded, credit-bearing courses in data science and analytics, food science and technology, pharmaceutical science, forensic science, and others, to adult learners. We now offer Graduate Certificate, Graduate Diploma and M.Sc. programmes in Food Science, Food Nutrition, and Pharmaceutical Process and Technology to suit individual learners’ needs. We will continually expand and refine these offerings by developing theme-based, skills-oriented and industry-relevant science courses. This will meet the learning needs of the workforce and STEM [Science, Technology, Engineering and Mathematics]-related sectors.

The first cohort from the Master of Science in Chemistry for Environment and Energy programme graduated in July. The one-year programme offers an integrated and comprehensive study on the latest energy and environmental technologies [see pg 26].

NUS-Hokkaido University Summer Programme: Agri-Science in Japan and Singapore

Given Singapore’s focus on food security, NUS and Hokkaido University jointly designed a new four-week summer programme for students from both universities on parallel and comparative studies of agricultural advances in Singapore and Japan. Through classroom learning, field studies and site visits, students gained understanding of agriscience, agritechnology and agronomy in improving field crop selection and production, and soil improvement and management. Students spent about a week each in Singapore and Sapporo, and two days at Malaysia’s Sime Darby Plantation Bhd for an overview of upstream and downstream plantation operations, agritechnology and biodiesel.

Global Science Summer Programme [GSSP]

The inaugural GSSP from 16 to 27 July was opened to NUS and overseas students from universities worldwide. Students took one or a feasible combination of two modules in Data Analytics and / or Forensic Science. The programme blends practice-based learning in cutting-edge scientific topics with a cultural immersion programme offering exposure to Singapore’s multicultural society.
First South Java Deep Sea Biodiversity Expedition

Scientists from the Lee Kong Chian Natural History Museum, Tropical Marine Science Institute, and the Research Centre for Oceanography, Indonesian Institute of Sciences, embarked on a 14-day expedition on 23 March of the unexplored deep seas off the southern coast of West Java. They collected some 800 species from over 200 families of sponges, jellyfish, molluscs, starfish, urchins, worms, crabs, prawns and fish. The expedition ties in with RISING50, a celebration of 50 years of diplomatic ties between Singapore and Indonesia [see pg 34].

Inaugural Data Science Conference and Workshop

On 31 May, the Data Analytics Consulting Centre organised a conference which featured leading data science experts from the public sector, multinational corporations and a startup. The event gave an overview of Singapore’s data science and analytics landscape, and the importance of academia-industry collaborations in achieving Singapore’s Smart Nation vision. The conference was paired with a workshop on 1 June, which included case studies on practical applications of data analytics concepts to solve business issues.

Events

- 93 participants
- More than 12,000 marine creatures collected

Key Initiative

Applied Materials-NUS Advanced Materials Corporate Lab

The Faculties of Science and Engineering, NUS are partnering Applied Materials Inc., to establish the lab to develop new semiconductor processes, chemistry and materials that enable the next generation of semiconductor manufacturing. This university-industry collaboration will design, synthesise and test new materials as well as processing techniques for atomic layer deposition and etching for advanced semiconductor manufacturing [see pg 20].
Prof Hervé This public lecture

On 28 June, Prof Hervé THIS, a world-renowned French chemist and a father of molecular gastronomy, spoke on "Molecular Gastronomy and the Future of Food". To demonstrate the chemistry of food, he cooked the dish "Dirac", named after the famous physicist, to illustrate how chemistry, physics and biology research can create novel food tastes and flavours. This event was part of the Master in Science Communication programme’s 10th anniversary celebration.

Events

30th Science Research Congress and Science Research Programme

The Congress, organised by the Faculty and Ministry of Education, was held on 26 May to showcase the research findings of students mentored by NUS faculty and staff from research institutions. Students from 15 junior colleges and Integrated Programme schools participated. 16 of the projects received four Gold, two Silver, five Bronze and five Merit awards, as well as one Special award, at the Singapore Science and Engineering Fair 2018.

Events

Pack-A-Meal

On 11 December 2017, the NUS Science Volunteer Corps [subsidiary of NUS Students’ Science Club] collaborated with the Kraft-Heinz Company and international relief organisation Rise Against Hunger to host the first event of its kind in Singapore. Some 200 students, staff and alumni sorted and packaged rice, grain and dried vegetables into food packets for malnourished families and orphanages in Cambodia and the Philippines. Each packet provided food for up to six people.
New joint educational programmes
NUS’ Food Science and Technology programme, together with NUS [Suzhou] Research Institute [NUSRI], signed 3+1+1 joint educational programme agreements with two universities in China - College of Food Science, South China Agricultural University and School of Food and Biological Engineering, Jiangsu University. The five-year agreements take effect from 9 July and 14 June respectively. Selected Year 3 students from the Chinese universities will spend one bridging year, their 4th year, at NUSRI before applying for NUS’ Master of Science [M.Sc.] in Food Science and Human Nutrition programme.

The Department of Mathematics signed a 3+2 joint educational programme agreement with School of Mathematics, Tianjin University [TJU] for five years, from 3 April. Selected Year 3 students from TJU will continue their studies at NUS for two years in Mathematics, Statistics, Quantitative Finance, or Data Science and Analytics. Upon fulfilling programme requirements, students will receive a Graduation Diploma and a Bachelor of Science from TJU, as well as an M.Sc. from NUS.

New International Residential Summer Course
The Department of Biological Sciences signed a three-year Summer Course Agreement with the Department of Chemistry, School of Pharmaceutical Sciences, Zhejiang University as well as School of Pharmacy, Huazhong University of Science and Technology, from 30 April, 4 May and 7 May respectively. The three-week intensive, research-led course will expose participants to wide-ranging modern biological knowledge and techniques used in research laboratories and industries [see pg 22].

New Student Exchange Programme partnership
The Department of Pharmacy established a three-year Student Exchange Programme agreement for undergraduates and postgraduates with College of Medicine and Health, University College Cork with effect from 16 March. This exchange allows students from both universities to gain real-world research and technical experience [see pgs 12 and 28].
GROOMING FUTURE-PROOF GRADUATES

Our Transformative Science Education equips students to be future-proof through specialised domain expertise and transferable skills. Our flexible curriculum also gives students myriad choices to enrich their learning experiences.

Pioneer batch: New programmes

We enlarged our network of overseas partners and increased our suite of Study Abroad Programmes [SAP]. This opens the door to a global learning experience, exposing students to different cultures and academic environments, and broadening their intellectual and global outlook.

Fresh Life Sciences graduate NG Sing Yin was the first student to take up the Life Sciences Doctor of Veterinary Medicine Concurrent Degree Programme with the University of Melbourne. She said, “The programme, which includes post-mortem dissections and live animal handling sessions, is a fulfilling step towards realising my dream to be a veterinarian.”

With support from the Marine Science Research and Development Programme Overseas Programme Award, Theodora LEE, Environmental Studies [Biology] Year 4, undertook marine science research at University of the Ryukyus. She said, “The marine diversity in Okinawa is amazing. I did a comparative study on changes to coral diversity in Nakagusuku Bay with data collected 40 years ago, sampled different sites for coral cover and identified over 1,200 coral colonies with photo guides.”

Jonathan YEO, a fresh Physics graduate, took on an Overseas Summer Undergraduate Research Opportunities Programme in Science at Chang Gung University. He said, “I gained exposure in medical physics topics and research on proton therapy and medical imaging, which are not covered in Singapore.”

Stephanie ER, Pharmacy Year 4, is undertaking a semester-long Final Year Project under a new Student Exchange Programme at University College Cork [see pgs 11 and 28]. She said, “Through my journey of self-discovery in Ireland, I faced up to challenges, pushed boundaries and gained new perspectives.”
Experiential learning

Our enhanced Undergraduate Professional Internship Programme [UPIP] and Applied Project module [see pg 7] provide Year 2 to Honours year students the option to take up multiple internships in diverse industries. These complementary programmes provide structured experiential training to prepare students for the workplace of the future.

Germaine SIT, Food Science and Technology [FST] Year 4, undertook the inaugural FST Applied Project module introduced in Academic Year 2018/2019. She said, “Interning in Chr. Hansen, a global bioscience company, allowed me to follow through a product life cycle - from conception, to trials, production at the pilot plant, and microbiological testing of the finished product.”

Summer programmes

Summer programmes enrich students’ learning experiences without disrupting their academic schedules.

Genevieve TANG, Life Sciences Year 4, embarked on the Yale Summer Session where she read a module on Global Environmental Governance. She said, “It was an invaluable opportunity to learn about protocol, treaties and agreements related to global environmental issues from the perspective of political scientists. These insights will be useful when I delve deeper into a possible career in environmental conservation.”

Holistic global education

The NUS Overseas Colleges [NOC] Programme is a unique immersive means to gain international entrepreneurial exposure.

Jessica Kartika GUNAWAN, Statistics Year 4, participated in the NOC Shanghai programme and undertook an exchange at Fudan University. As part of the NOC module, she validated the idea of localised anonymous chatrooms to encourage social interactions amongst the Chinese community. She also interned at a business advisory firm Sapience Partners, where she acquired managerial skills. She said, “Chinese entrepreneurs are daring and nimble in navigating the business landscape. My experience has stretched my personal and professional abilities to a new level.”

Applied Mathematics Masters student CHEONG Yu Jia read the French Double Degree Programme at the prestigious École Polytechnique. She said, “The programme has very rigorous mathematical foundations and ethics. Working alongside brilliant students helped me to discover my potential.”

Amelia GUNAWAN, Chemistry Year 3, went on the Nanotechnology Study Trip, organised with La Trobe University, to Tokyo. Through study tours to The University of Tokyo, International Centre for Materials Nanoarchitectonics, Japan and industrial visits to Nano-Star Pte Ltd and NMT Pharmaceuticals Pte Ltd in Singapore, projects and industry seminars, she said, “I gained insights into the nanoscience business and cultural linkages with Japan. Participating in the Nanotech Exhibition and Conference, one of the biggest events of its kind, was a unique experience.”
Department engagement activities

The Departments of Biological Sciences, Chemistry, Mathematics, Physics, and Statistics and Applied Probability, as well as the Food Science and Technology, and Data Science and Analytics programmes, each hosted a half-day visit from 18 to 28 April to encourage prospective students, who received admission offers, to study Science at NUS [see pg 26]. The departments customised their programmes to provide information on our Science courses, other learning opportunities and the career prospects of science graduates. The programme included talks, laboratory visits, hands-on activities and meetings with faculty members and students.

Creative and Heuristic Applications of Science [CHAOS]

The theme for CHAOS 2018 was “Cyclones”, a timely response to the increasing occurrence of this phenomenon over the last 10 years. Participants integrated and applied scientific knowledge and ideas to address this real-life issue. Out of 34 teams from 19 schools, six teams were selected to present their research findings at the finals on 23 May. CHAOS, a joint initiative by the Faculty and MOE, is a multidisciplinary science competition for secondary school students.

Young Educators in Science [YES] programmes

The Mathematics Focus Group of the YES initiative held three workshop sessions - on 28 May, 2 to 4 July and 11 July - for Chinese Development Assistance Council students, Science Summer Camp and Pioneer Junior College students, respectively. The events generated interest in mathematics through Graph Theory, Game Theory and Topology activities. YES, the Physics Department and Victoria Concert Hall also brought astronomy and astrophysics to 80 concertgoers on 16 June. The audience was treated to musical pieces from “The Planets” by composer Gustav HOLST and a tour of the night skies at a planetarium dome. The YES initiative trains our undergraduates in science communication skills.

Attracting Young Talent

The Faculty, together with the Ministry of Education [MOE] and other partners, runs pre-undergraduate research programmes, competitions, workshops, school visits, talks as well as our flagship Faculty Open House. These programmes promote public awareness in science education and encourage students to read Science at NUS.

Nearly 200 student participants

Young Educators in Science [YES] programmes

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**Visit by Innova Junior College**
On 8 January, the Faculty hosted a visit for Innova Junior College [IJC]. Prof TAN Meng Chwan, Assistant Dean [Outreach and Admissions], shared on the Faculty’s Transformative Science Education, and Kenneth LEE, a Science Student Ambassador and IJC alumnus, spoke of his overseas educational experience. Dr Emelyn TAN covered the Chemistry undergraduate programme and Prof TAN Zhi Kuang delivered a MasterClass on new semiconductor materials and their applications.

**Science Demonstration Laboratory [SDL] workshops**
Students and educators from 70 institutions and 20 countries around the world engaged in a wide variety of science demonstrations and experiments conducted in a hands-on, minds-on setting. These activities aim to illuminate scientific ideas and concepts in a lighthearted and meaningful way. SDL conducts workshops for visitors to excite them about science.

**Physics Enrichment Camp**
Students from 32 secondary schools and 14 junior colleges attended the event from 5 to 8 June, which featured live demonstrations, talks, hands-on activities and a quiz for participants to solve physics problems. The event was jointly organised by the Physics Department and the NUS Physics Society, and sponsored by MOE [see pg 31].
CELEBRATING STUDENT ACHIEVEMENTS

Our students achieve excellence beyond the classroom in areas ranging from sports to community service. They contribute in meaningful ways to the NUS community and society at large.

NUS’ inaugural Animal Day on 24 August, initiated by avid animal lover Nur Fatimah FARZANAH Bte Jalaludin, Life Sciences Year 2, encouraged the NUS community to interact with shelter animals and find homes for them. The event drew some 450 participants and raised over $1,400 for the Animal Lovers League [ALL]. At ALL, Farzanah cleans shelter grounds, treats sick animals and organises adoption drives.

In June, seven Science students were part of the NUS Dragon Boat team who emerged top in all three categories they participated in - 200m, 500m and 2km - in the World University Dragonboat Invitational Race 2018 at Weinan, China. It was the first time that the women’s team participated, competing against 22 teams from nine countries.

Michelle KO, Life Sciences Year 3, believes in giving back to the community. During NUS Day of Service 2017, she led a project to help migrant workers at the Mandai Westlite Dormitory. This project also raised funds for The Straits Times School Pocket Money Fund Fold-A-Heart project. As Chairperson of NUS Students’ Community Service Club’s MINDSville@Napiri programme, she organises enrichment activities to improve the quality of life of intellectually disabled people. She also cares for patients with life-limiting diseases as Chairperson of the NUS Volunteer Action Committee’s HCA Home Hospice Project.
Food Science and Technology Ph.D. student CHUA Jian Yong co-founded Singapore Food Tech Pte Ltd in March 2018 to commercialise his research finding - an award-winning fermentation technology that can biotransform soy whey, a waste byproduct from tofu manufacturing, into Sachi, a first-of-its-kind alcoholic beverage. A patent has been filed for this technology.

Max TAN, Chemistry Year 4, is a head mentor for the Special Programme in Science [SPS]. He coordinates SPS courses and grooms SPS mentors and students. Under his guidance, a group of SPS students won Gold in the International Natural Sciences Tournament in India in 2017. As the President of the only American Chemical Society [ACS] Student Chapter in Singapore, Max grew the interest group into a leading chapter in Southeast Asia. He was the only student outside the Americas to receive the ACS Student Leadership Award 2018.
At NUS Science

SERVING SOCIETY

Our students contribute to numerous meaningful causes, where they give back to society and make a difference to disadvantaged communities.

Project La Lumiere

Project La Lumiere was organised by the NUS Science Computer-Based Learning Centre with a Vietnam social enterprise Youth Employment and Society Development. From 15 to 27 December 2017, this Overseas Community Service Project sought to improve English literacy of children in Ha Giang province. The volunteers also constructed a library and recreation room in the local school. A mural to promote responsible tourism was designed by the 13 volunteers and children, and painted on the community house walls.

Project Sunbeam 2018

From 24 March to 14 April, 21 Science students participated in this volunteer programme jointly organised by the NUS Science Volunteer Corps, Sunbeam Friends Club and Singapore Children’s Society. The event comprised indoor and outdoor interactive activities and monthly informal workshops on science enrichment for primary school children from low-income families.

Project Angel XXI: Stringing Lives, Shaping Hope

Between 24 May and 6 June, 14 Science student volunteers worked with the Thai Youth Community Foundation to bring clean drinking water to a Ban Huay Tong rural hill tribe in Chiang Mai. The volunteers provided funds and efforts to build a water filter for the school, conducted lessons in basic conversational English, as well as science experiments using household materials to show a water filtration system. The expedition concluded with a mini carnival for students to revise what they learnt in an interactive and fun way.

RAG [Receive and Give] and FLAG 2018

More than $17,470 raised

This year, more than 375 Science students participated in Flag Day on 6 August. The proceeds raised will go towards our beneficiary, the Lions Befriender Service Association (Singapore), which cares for seniors. The Science RAG team clinched the Silver award for their performance.

ALIVE! [Appreciating Lives, Initiating Volunteerism Everyday!] 2018

On 7 June, 50 Science student volunteers hosted seniors from the Caregiving Welfare Association and children from the Young Women’s Christian Association and Fei Yue Family Service Centre. The activities, like station games and photo frame customisation, encouraged the beneficiaries to help each other.

Around 100 beneficiaries

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VALEDICTORIANS
CLASS OF 2018

STRETCH YOUR BOUNDARIES “Keep challenging ourselves - we may achieve things that are otherwise impossible. Never give up - we will overcome problems through perseverance.” » Gregory ANG, Honours [Highest Distinction] with a Double Degree in Statistics and Economics

TAKE CHARGE OF YOUR FUTURE “Believe in yourself and be responsible for your own choices. We are the creators of our futures. Live your passion without regret.” » Dr TENG Dan, Ph.D. in Mathematics

LEARN FOR LIFE “The scroll we receive today signifies that the learning baton is now in our hands. The degree scrolls will serve as a reminder to keep up the enthusiasm for learning and to be as creative as you can in the lifelong learning endeavour.” » Dr LIM Xin Xiang, Ph.D. in Biological Sciences

FULFIL YOUR DREAMS “Our experiences, good and bad, and our skills, make us equal to the dreams we can now choose.” » CAO Xujun, Honours [Highest Distinction] in Chemistry

SEEK FRESH PERSPECTIVES “We have learnt to be observant of small details which could lead to big discoveries. Asking questions and seeking reasons, as well as developing curiosity, allow us to add fresh perspectives at work.” » Gina NG, Honours [Highest Distinction] with a Double Degree in Life Sciences and Business Administration

IMPACT LIVES “Today we set sail for uncharted waters. We will wield technology to be trailblazers in our paths, to seek the best outcomes that our patients and our communities deserve.” » Elston FOO, Honours [Highest Distinction] in Pharmacy

STRIVE TOWARDS YOUR GOALS “No matter how many ups and downs we encounter, there is no real failure as we will eventually achieve our goals if we work hard, persevere and trust our capabilities.” » Dr Raditya Weda BOMANTARA, Ph.D. in Physics
LEADING TRANSLATIONAL RESEARCH

The Faculty conducts research to advance knowledge, industry and society. Our researchers continue to win competitive public sector grants and collaborate with universities worldwide, government agencies and industry to develop high-value, high-impact partnerships to translate scientific innovations into solutions.

Establishing the Applied Materials-NUS Advanced Materials Corporate Lab
Researchers from the Faculties of Science and Engineering, NUS are partnering Applied Materials Inc., to establish the Applied Materials-NUS Advanced Materials Corporate Lab to develop new semiconductor processes, chemistry and materials to enable the next generation of semiconductor manufacturing. This university-industry collaboration will design, synthesise and test new materials as well as processing techniques for atomic layer deposition and etching for advanced semiconductor manufacturing [see pg 9].

Building up Data Science and Analytics capabilities
The Faculty is collaborating with the Singapore Institute of Manufacturing Technology [SIMTech] to stimulate Data Science and Analytics research for Industry 4.0. SIMTech and industrial partners will jointly provide industry perspectives to the research directions of selected Ph.D. students under the NUS Industry-Relevant Ph.D. scholarship programme, in collaboration with NUS academic supervisors, and seek to translate or deploy the research results.
Developing high performance lithium-oxygen batteries

The Surface and Interface research group led by Prof CHEN Wei from the Departments of Chemistry and Physics, is employing interface and defect engineering approaches to control the properties of the reaction products produced during the lithium-oxygen battery discharge process. This is important to develop lithium-oxygen batteries which have potentially two to three times’ higher energy densities compared to commonly available lithium-ion batteries. This work is supported by a grant from the Ministry of Education.

Advancing sustainable palm oil production

The research group led by Prof XU Jian, Department of Biological Sciences, is studying the developmental traits of plant roots to improve water absorption and develop better plant defence against pathogens, supported by a gift from the Kewalram Chanrai Group [see pg 39]. Soil water inadequacy and plant pathogens are two major causes of yield loss in oil palm and other plantation crops. This research will advance the framework for marker-assisted breeding of drought-tolerant and pathogen-resistant oil palm varieties for sustainable crop production amidst climate change.

Transforming organic waste for sustainable food production

The Evolutionary Biology research group led by Prof Rudolf MEIER, Department of Biological Sciences, is partnering Temasek Foundation Ecosperity CLG Ltd to use black soldier flies to recycle food waste. This produces feed and fertiliser, and avoids costly waste incineration. The larvae of the black soldier fly feast on discarded food and are efficient food waste recyclers. In the process, the larvae themselves become nutritious animal food [see pg 23].

Developing food products with better texture and flavour

The research groups led by Prof HUANG Dejian and Prof LIU Shao Quan, Food Science and Technology programme, Department of Chemistry, are partnering Kikkoman Singapore R&D Laboratory Pte Ltd to gain deeper insights into the effects of commercial enzyme preparations on the physical, nutritional and flavour qualities of fruit-based items. Using enzymes to transform the food molecules, this project will develop new tomato- and tropical fruit-based products and beverages with improved texture and flavour.

Discovering plant-based ingredients to support cell growth

The Pharmaceutical Science research group led by Prof Rachel EE, Department of Pharmacy, is partnering Roquette Asia Pacific Pte Ltd to curate their diverse library of plant-based materials for their potential in supporting cell growth for tissue engineering applications. The extracellular matrix in our tissues entraps growth factors which are important for regulating various cell behaviours. Emerging studies show that plants may provide a huge reservoir of biocompatible ingredients that can fulfil these functions provided by the extracellular matrix.

Developing high performance lithium-oxygen batteries

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Department of BIOLOGICAL SCIENCES

EXECUTIVE SUMMARY

The Department of Biological Sciences (DBS) continues to raise the bar in providing excellent educational and research opportunities for students, preparing them to be future-proof. Through collaborative partnerships with international academic communities and industries, we seek to push scientific frontiers to improve lives.

We continued to secure major competitive grants, like a shared infrastructure grant from the National Research Foundation Singapore (NRF), which expands our Protein and Proteomics Centre into a national facility for Mass Spectrometry (MS) applications. SingMass, a national MS resource, will provide professional services in molecular analysis, MS training courses and collaborative research opportunities to health and biomedical science researchers.

DBS’ Centre for BioImaging Sciences, together with the Institute of Medical Biology, Singapore Centre for Environmental Life Sciences Engineering, Mechanobiology Institute, and SingHealth Advanced Bioimaging, successfully applied for another shared infrastructure support grant from NRF which will provide funds over the next five years to establish a Singapore-wide imaging facility network, SingaScope. This serves as a one-stop platform for access to advanced microscopes, acquisition of new instruments, training and the exchange of expertise with international counterparts.

EDUCATIONAL MILESTONES

Two new programmes for Life Sciences Majors were launched in 2018. The Concurrent Degree Programme with The University of Melbourne (UoMelb) allows students to receive both NUS Bachelor of Science in Life Sciences and UoMelb’s Doctor of Veterinary Medicine within 5.5 years. The Joint Degree Programme in Life Sciences with the University of Dundee (UoD) includes a 1.5 year Honours research component in drug discovery and design at UoD. The Applied Internship Honours option offers placement opportunities locally and overseas. New elective modules in the Minor in Forensic Science hosted at DBS were offered by our faculty members and industry practitioners to keep pace with forensic science developments for the criminal justice system [see pg 7].

KEY EVENTS

International Residential Summer Course
The Department organised its inaugural summer course in July to train 50 international students from Zhejiang University and Huazhong University of Science and Technology [see pg 11].

World Seagrass Conference and 13th International Seagrass Biology Workshop
The conference and workshop were held in Singapore from 11 to 17 June, to discuss changes in seagrass science communication, conservation and how old paradigms can be refreshed to address key challenges facing seagrass habitats in the future.
**RESEARCH ACHIEVEMENTS**

**Contributing to the NEWater success story**

Prof [GONG Zhiyuan](#) has contributed significantly to the national NEWater project between 1999 and 2003. This work was recognised by a recent award-winning television documentary “Blueprint for Survival: NEWater” by *Channel NewsAsia*. Prof Gong’s research team, including Scientific Managers [YAN Tie](#) and [TONG Yan](#), used small aquarium fish, Medaka, to conduct health effect tests on the recycled water. The team has carried out basic biological tests for multi-generations, including carcinogenic and estrogenic effects, and found no adverse health effects of NEWater. These tests provide crucial scientific data for government decision-making.

**Recycling organic waste for sustainable food production**

Singapore’s challenges in food waste and food security can be addressed through a food recycling system using bioconversion of black soldier flies [BSFs] that yields feed for egg / fish production and fertilisers for vertical farming, while avoiding costly waste incineration. The project’s first phase concentrates on “domesticating” BSFs for food recycling via artificial selection and genomics. The second phase focuses on recycling a large proportion of NUS’ daily food waste using BSFs. The multidisciplinary team comprises Prof [Roman CARRASCO](#) [economic modelling], Prof [Rudolf MEIER](#) [genomics, artificial selection], Prof [Nalini PUNIAMOORTHY](#) [reproductive biology], Prof [Abel TABLADA](#) [facility design] and Prof [Hugh TAN](#) [plant production]. This project is supported by NUS and Temasek Foundation Ecosperity CLG Ltd [see page 21].

**Improving plant adaptation to heat through stomata**

With global warming threatening agriculture, developing plants that can maintain yields in the changing climate is a pressing need. Stomata, plants’ surface pores which govern carbon and water exchange, are crucial for plant fitness. A detailed understanding of how they respond to the environment benefits agriculture and urban farming. A team led by Prof [LAU On Sun](#) has uncovered the regulatory mechanism of how plants can modulate stomatal numbers in response to high temperatures. The findings could help pinpoint genes for breeding or genetic manipulation to improve thermo-tolerance in important plant species. This work was published in *Current Biology* [April 2018].

**AWARDS AND ACCOLADES**

On 30 June, Xiamen University presented Emeritus Professor [HEW Choy Leong](#) two distinguished awards for his lifelong contributions towards life sciences. Graduate student [JEON Ah Jung](#) was an invited panellist with four other senior education leaders for a Times Higher Education Teaching Excellence Summit at the University of Glasgow. She was the only student invited from Universitas 21 for her pedagogical research and experience as an international student and teacher in higher education. The speakers included luminaries in evidence-based teaching like Nobel Laureate in Physics Prof [Carl E WIEMAN](#).
At NUS Science

Department of MATHEMATICS

In Academic Year 2017/2018, we extended the Master of Science in Quantitative Finance programme to Shanghai, China, together with the School of Mathematical Sciences at Shanghai Jiao Tong University. The programme will strengthen research and post-graduate educational collaboration between the two universities. We also structured a graduate certificate in Data Mining and Interpretation with the Department of Statistics and Applied Probability [see pg 32].

The Department of Mathematics continues to make significant progress in its core mission of delivering quality education and research. Faculty members continued to engage in cutting-edge fundamental and interdisciplinary research, receiving recognition nationally and internationally. According to Quacquarelli Symonds World University Rankings 2018, Mathematics at NUS is ranked 13th in the world and top in Asia.

Edward J. Nutter, Chair

Since Academic Year 2014/2015, we initiated various programmes in honour of our past academic leaders: Sir Alexander Oppenheim [Head, 1931 to 1959]; Prof Peng Tsu Ann [Head, 1982 to 1996]; and Prof Louis Chen Hsiao-Yun [Head, 1996 to 2000]. These programmes are the Oppenheim Lectures, Peng Tsu Ann Assistant Professorship, and Louis Chen Hsiao-Yun Best Dissertation Prize, respectively.

Provost’s Chair Professor TOH Kim Chuan was named a SIAM Fellow for his contributions to the development of algorithms and software for conic programming. Prof Toh, Prof SUN Defeng and their former graduate student Dr YANG Liuqin won the triennial Beale–Orchard-Hays Prize for Excellence in Computational Mathematical Programming. Adjunct Prof YU Chien Siang received the Hall of Fame Award in Singapore’s inaugural Cybersecurity Awards for his contributions to the cybersecurity ecosystem. University Professor CHONG Chi Tat was conferred the University Outstanding Service Award for his significant contributions in education, research and administration in NUS and beyond. Prof Toh received the NUS Research Recognition Award for his research in, and contributions to the theory, practice and application of convex optimisation [see pgs 36 and 37].

Past Oppenheim Lectures’ speakers
Understanding polynomial chaos and scaling limits
Many disordered systems arise as a result of perturbing an underlying pure model with disorder. Prof SUN Rongfeng’s team found a novel criterion to determine whether a given disordered system is disorder-relevant, as when small disorder perturbation changes the qualitative behaviour of the model on large space-time scales. New models that have been incorporated into this framework include the disordered pinning model, the long-range directed polymer model in dimension 1+1, and random field perturbation of the critical two-dimensional Ising model.

Deciding parity games in quasipolynomial time
Parity games are certain infinite duration games played on finite directed graphs. An open question is the computational complexity to determine the winner of a parity game. On a finite directed graph with \(n\) nodes, the earlier best-known complexity bound was approximately \(n^{o(\sqrt{n})}\) time. Prof Frank STEPHAN’s team reduced this complexity to slightly less than \(O(\log(n))\), thereby providing a quasipolynomial time algorithm for the problem.

Uncovering jumps in equity index returns during financial crises
Through Bayesian analysis, Prof Steven KOU’s team found that a simple affine jump diffusion model with both stochastic volatility and double exponential jumps fits both the Standard & Poor’s 500 and the NASDAQ 100 daily returns from 1980 to 2013 well. The model outperformed existing ones during the 2008 financial crisis and is at least comparable before the crisis. On the basis of the model and the datasets, they also found that during the crisis, negative jump rates increased significantly, although there was little change in the average negative jump size.

OUTREACH
We have been running a learning journey outreach programme since 2015 that introduces prospective students to NUS’ Mathematics course, and creates awareness of the relevance and applications of mathematics. In Academic Year 2017/2018, we also organised a successful Data Science and Analytics Day, where speakers shared with junior college students and the public on the fascinating role of mathematics in modern topics such as Reinforcement Learning and AlphaGo, an artificial intelligence brain.
We continued to strengthen our undergraduates’ learning experience with new skills such as computational thinking and its applications to analytical chemistry [see pg 7]. We actively participate in the NUS Lifelong Learners programme, a university-wide initiative to offer lifelong learning courses for our alumni. In addition, we offer many interesting modules for alumni working in the chemical industry.

The Department of Chemistry remains top in Asia and seventh in the world based on the Quacquarelli Symonds World University Rankings 2018. In the past year, we published over 400 papers and secured $10 million in research funding. Our staff continued to receive international research awards. Our first cohort of Master of Science in Environment and Energy students graduated in July [see pg 8].

**Chemistry Alumni Study Award**
At an award appreciation lunch on 17 January, the first batch of 13 Chemistry Alumni Study Awards was disbursed to encourage students who do well in their studies despite financial constraints.

**Department engagement days**
93 prospective students and their parents attended a half-day Chemistry engagement programme on 24 April comprising a curriculum talk, tours of the teaching and research laboratories, inquiry-based experiments and an optional campus bus tour. The Food Science and Technology programme conducted a programme introduction and student engagement session [see pg 14].

**13th Singapore National Crystal Growing Challenge**
The finale on 26 May drew 109 teams from 47 schools. They competed in three categories, showcasing their crystals which they have grown since October 2017.

**International Chemistry Olympiad [IChO]**
The IChO, held from 19 to 29 July in Slovakia and Prague, Czech Republic, commemorated its 50th anniversary. The Singapore team clinched two Gold medals and two Silver medals, ranking sixth amongst 76 participating countries. Marvin Dragon CHOO attained fifth position amongst 300 delegates.
No cardiovascular disease risk through egg consumption
The consumption of eggs, a breakfast staple, has risen steadily over the years in Singapore. However, egg consumption is generally discouraged due to the high cholesterol content in egg yolks. Prof KIM Jung Eun from the Food Science and Technology programme and her Honours student Dr WANG Min Xian demonstrated that consuming more than four whole eggs per week does not increase blood total cholesterol concentration and blood pressure in middle-aged and older adults. The findings address the long-standing misperception on the impact of eggs on cardiovascular disease risks. Whole eggs can be a nutritious food source due to their high content of unsaturated fat, high quality protein, and certain vitamins and minerals.

Combating tuberculosis through the study of fatty molecules
Tuberculosis [TB], a disease caused by Mycobacterium tuberculosis, is the leading cause of death from a single infectious agent. It is very hard to treat because the mycobacterial species possess an outer membrane lipid bilayer protecting the bacterium from external insults. A team led by Prof CHNG Shu Sin and his Ph.D. student Dr XU Zhujun recently developed elegant biochemical assays to characterise the function of the membrane protein MmpL3 as a lipid transporter, which is critical for outer membrane assembly and small molecule inhibition. This finding has significant impact on current and future anti-TB drug discovery efforts.

Controlling electrons in graphene by strain induced pseudomagnetism
Prof LOH Kian Ping, a graphene research pioneer, and his team achieved the breakthrough of producing a large area pseudomagnetic field on graphene with controllable spatial distribution and amplitude. This has important implications for a new way of quantum confining electrons on graphene, which could translate to achieving valleytronics. Prior to this work, experimentalists faced challenges implementing theoretical predictions on how to generate wide area pseudomagnetism by straining graphene.

Awards and accolades
Prof Richard WONG was awarded the 2018 Fukui Medal by the Asia-Pacific Association of Theoretical and Computational Chemists. Prof LIU Xiaogang was appointed as Provost’s Chair in the Faculty of Science [see pgs 36 and 37].

Max TAN, President of the American Chemical Society [ACS] NUS Student Chapter, received the ACS Student Leadership Award 2018 in the United States on 19 January, which recognises emerging leaders with notable work in chemistry-based activities. Max is also a Special Programme in Science mentor who coached the NUS team to win the 8th International Natural Sciences Tournament in India [see pg 17].
With the Alice Lee Centre for Nursing Studies, we are spearheading a national initiative, the Collaborative Prescribing Programme [CPP]. This intensive 13-week programme for senior pharmacists and advanced practice nurses in hospitals trains them to prescribe certain classes of medications, as part of Singapore’s National Healthcare Strategy for integrative and quality healthcare. The CPP provides additional skills and certification for experienced healthcare workers. The first batch completed the programme on 2 July.

**EDUCATIONAL MILESTONES**

We signed a Memorandum of Understanding with the Norwegian University of Science and Technology and University College Cork [UCC] for a semester-long Student Exchange Programme. This extends our students’ overseas exchange experience to include Final Year Projects. The first student, Stephanie ER, left for UCC on 2 July [see pgs 11 and 12].

**STUDENT ACHIEVEMENTS**

CHONG Jin Jian [Class of 2018] received the Outstanding Undergraduate Researcher Prize for his final-year project on “Inhaled protein powders: Designing “plug-and-play” powder formulation platforms for proteins and peptides”. This project was supervised by Prof Rachel EE and collaborators at the Institute of Chemical and Engineering Sciences [ICES], a research institute under the Agency for Science, Technology and Research [A*STAR] [see pg 17].

Four students [Angeline LAI, Benjamin CHENG, HO Xin Ni and Ivan KOH] participated in an inaugural 11-month internship programme in partnership with GSK Consumer Healthcare. This programme provides insights into the operations of a major pharmaceutical company, coupled with project-based training in regulatory affairs, medical affairs, innovations and research.

Relevance. Future-Readiness. Globalisation. Innovation. These describe what we are and our aspirations.
Reasearch AchiEvements

Fighting pulmonary diseases with nature’s resources

Chronic obstructive pulmonary disease is an increasingly prevalent lung inflammatory disease associated with high mortality. Prof LIN Haishu and his postdoctoral fellow Dr Samuel YEO have identified a compound, isorhapontigenin, found in grapes as a promising anti-inflammatory agent. The molecule’s benefits include anti-inflammatory properties through a corticosteroid-independent mechanism, upregulation of antioxidant genes and very good absorption upon oral administration. This work was carried out with Imperial College London and highlighted as Editor’s Choice in the British Journal of Pharmacology [2017].

Using biomimicry for targeted drug delivery in cancer

The targeted delivery of drugs to tissues is crucial in the treatment of pathological conditions. The last few decades saw the development of engineered nanomaterials as drug delivery systems [DDS], with approximately 250 nanomedicines currently approved or in various stages of [pre]clinical evaluation. However, these nanoparticles have weak specific tissue targeting properties and non-optimal local drug delivery, limiting their therapeutic outcomes. Prof Giorgia PASTORIN and her team have developed the next generation of DDS, called nano Cell Vesicle Technologies, which are designed on biomimicry principles - using the body’s own immune defences against tumours. This advances the field of personalised nanomedicine.

other significant initiatives

On 13 April, we cohosted a symposium on "Innovation at the Heart of Discovery" with the German Academic Exchange Service. The symposium was opened by Mr Knut ZUCHAN, Head of Science and Technology, German Embassy Singapore. The keynote speakers were Dr Peter NAGLER, Executive Director, ICES, A*STAR, who spoke about creating value in industry through innovation, and Prof Freddy BOEY, Senior Vice President, NUS, who shared his experiences from research to innovation.

With the NUS Development Office, we hosted an NUS Greater Good Series on 4 April. Alumni and stakeholders gained up-to-date information on “Transforming the Pharmacy Landscape”.

The Ministry of Health’s Chief Pharmacist, Prof Lita CHEW, spoke on the healthcare landscape, and current and future challenges. Ms Joyce LIM, Head of Marketing and Market Access, Johnson & Johnson Pte Ltd, shared her working experience in the pharmaceutical industry. Prof Alexandre CHAN discussed how his clinical research impacts the lives of cancer patients.

A workshop on “Pharmacogenomics: Clinical Implementation Strategies And Pharmacists’ Roles” was conducted from 26 to 27 February with Prof Christina AQUILANTE, University of Colorado Skaggs School of Pharmacy and Pharmaceutical Sciences as the guest speaker. The fundamentals and clinical applications of pharmacogenomics [PGx], educational strategies and cost-effectiveness of PGx implementation were discussed, with relevant case studies.
At NUS Science

In line with NUS’ initiative to introduce computational skills in the undergraduate curriculum, we introduced COS2000 Computational Thinking for Scientists, which provides rigorous understanding of computational thinking processes, coupled with essential technical knowledge. The module covers topics of problem abstraction from the real world, degrees of approximation estimation, formulation of solutions and critical interpretation of results. It also highlights scientific computational issues, like accuracy and convergence of numerical results [see pg 7].

Department of PHYSICS

AWARDS AND ACCOLADES

Three professors were conferred Emeritus Professorships from 2016 to 2018, namely, Prof OH Choo Hiap [2016], Prof Bernard TAN Tiong Gie [2017] and Prof LIM Hock [2018] [see pg 37].

EXECUTIVE SUMMARY

The Department of Physics covers physics as a fundamental discipline, to understand nature through mathematics and concepts such as space, time, energy, force, particles, and fields. Our key research focus areas include: physics of nanoscience; condensed matter and advanced materials; biological physics; physics of nonlinear and complex systems; atomic and molecular physics; computational and theoretical physics; quantum information; and graphene and two-dimensional materials. Faculty members made several research breakthroughs and serve as editors or members of editorial boards of top scientific journals. We are strongly associated with the Centre for Quantum Technologies (CQT) and Centre for Advanced 2D Materials through joint appointments.

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**RESEARCH ACHIEVEMENTS**

**Harnessing time crystals for quantum computing**
In a new study, Dr. Raditya Weda BOMANTARA and Prof. GONG Jiangbin have theoretically demonstrated that different edge modes of a topological time crystal can be braided, or the location of two edge modes exchanged with an additional quantum phase. This approach can be extended to manipulate quantum information by braiding multiple topological edge modes, hence enabling universal and robust quantum computation.

**Building better atomic clocks using lutetium**
A CQT team led by Prof. Murray BARRETT has singled out an untried atom, lutetium, that could provide higher-performance atomic clocks. Atomic clocks have set the global standard for measuring time for over half a century. Lutetium has lowest sensitivity to temperature of any current clock candidate, as reported in *Nature Communications* [25 April]. Its properties may help to set new records in clock accuracy. The CQT team are working towards a multi-ion clock for improved stability.

**Track-walking molecular motors**
Molecular cargo transportation is a vital undertaking in every cell of the human body. Nature transports intracellular cargo using bipedal molecular motors that walk along a mesh of molecular filaments, called cytoskeletons. Presently, most artificial nanowalkers must damage the traversed part of the track when they proceed in a given direction. Prof. WANG Zhisong and his research team have developed new self-directed molecular motors that use nanomechanical effects to generate direction and intramotor coordination. These biomimetic bipeds made of engineered DNA molecules can adapt their shape to their environment. This enables the nanowalker to move forward by optical driving or autonomously feeding on chemical fuels. This potentially opens up new nanoscale applications.

**KEY EVENTS**

The Physics Enrichment Camp 2018 drew over 660 students from 32 secondary schools and 14 junior colleges. Jointly organised by the Physics Department and the NUS Physics Society, and sponsored by the Ministry of Education, the camp was held over two days for secondary and junior college students [see pg 15]. We also organised summer camps from 6 to 9 July for Indian and international high school students who were here.
We identified about 30 data analytics and statistics courses for the L3 programme, to be offered over the next two years. We structured two graduate certificates - Quality Assurance and Yield Optimisation, and Data Mining and Interpretation - the latter jointly with the Department of Mathematics [see pg 24]. We also developed new modules on data analytics and the use of probability and statistics to advance forensic science and data science education. The Forensic Science Minor was comprehensively reviewed, to include a module on the articulation of probability and statistics in court [see pg 7].

The Department of Statistics and Applied Probability will contribute data analytics and statistics modules in support of NUS’ Lifelong Learners (L3) programme in continuing education. The new Data Analytics Consulting Centre was set up in July to help businesses unlock value from Big Data. We also conducted the inaugural Global Science Summer Programme and Data Science conference [see pgs 8 and 9].

We were placed 11th in the world and top in Asia, in the Quacquarelli Symonds World University Rankings 2018 for Statistics and Operational Research. Our faculty members contributed impactful research in text mining, high-dimensional statistics and customer analytics, serve as associate editors of top statistical journals, and continue to win prestigious research awards.

The department’s Data Analytics Consulting Centre hosted the inaugural conference on Data Science in Singapore on 31 May, which gave an overview of Singapore’s data science and analytics landscape, and the importance of academia-industry collaborations in achieving Singapore’s Smart Nation vision [see pg 9].

At the 5th Institute of Mathematical Statistics Asia Pacific Rim Meeting held from 26 to 29 June, two Plenary Lectures were given by world-renowned scientists in probability and statistics. The lecture in probability was presented by Prof Louis CHEN, NUS, on the Stein’s Method. The lecture in statistics was presented by Prof Bin YU, University of California, Berkeley, on the Principles of Data Science. Leading specialists also gave 16 Distinguished Lectures.

At the Faculty’s inaugural Global Science Summer Programme in July, Prof Carol HARGREAVES and Dr Vilneswaran GOPAL developed and taught modules in introductory data science and data analytics for customer insights. Attendees learnt to apply statistical analysis, computer programming and visualisation to deliver business value.
Unlocking the power of web text data
The growing usage of internet and social media applications has created vast amounts of data. Businesses and organisations need to be able to analyse and make sense of voluminous data to remain competitive. Web text data provides important information for content analysis. Prof CHEN Ying’s team developed the Regularised Text Logistic regression model, which can identify and extract informative textual data of interest automatically from internet content.

Comparing high-dimensional data efficiently
Multivariate analysis of variance [MANOVA] is a commonly used statistical method in data analysis to determine differences in the means of different data groups. However, it is not suitable for analysing high-dimensional data - in a traditional MANOVA, the dimension is assumed to be fixed and has to be much smaller than the number of observations. Prof ZHANG Jin-Ting and his Ph.D. students developed a new high-dimensional MANOVA method, which can be used to test and compare high-dimensional data efficiently.

Understanding user behaviour for freemiums
Freemium refers to a business strategy where basic products or services are provided free to users, while more advanced features or functionalities have to be purchased. Prof LI Jialiang and his Ph.D. student Dr CHEN Dacheng developed a better way to analyse user behaviour for freemiums, particularly for the online gaming industry. By gaining insights into consumers’ willingness to pay for products and services, businesses can refine their consumer marketing strategies.

Prof CHEN Ying was appointed an advisory board member of the Institute of Statistical Mathematics. Prof Sanjay CHAUDHURI received the Young Statistical Scientist Award in Theoretical Statistics and Probability, awarded by the Indian International Statistical Association.
On 18 December 2017, we launched our second temporary exhibition - Christmas Island Red. Christmas Island is biogeographically unique, with at least 200 species of animals found only on the island and nowhere else. The exhibition displayed a range of specimens collected from expeditions over the years, and included seven talks to raise public awareness of Christmas Island’s rich biodiversity and history. The exhibition has drawn about 30,000 visitors so far.

For a second consecutive year, we held our Marine Open House on 10 March in collaboration with St John’s Island National Marine Laboratory. Over 600 visitors learnt more about marine biodiversity through complimentary tours and public talks. We also conducted over 700 programmes for 17,000 participants from 108 schools.

Research staff published 77 peer-refereed papers, most of them indexed in the Web of Science, and 42 other publications including general articles, local technical papers, books, chapters, etc.

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The Lee Kong Chian Natural History Museum [LKCNHM] is a world-class leader in Southeast Asian biodiversity research, tertiary education and outreach.

The highlight was the first deep-sea exploration of the West Java Seas in the Indian Ocean undertaken with the Research Centre for Oceanography of the Indonesian Institute of Sciences in late March. More than 12,000 deep-sea marine creatures were uncovered during the expedition, which spanned 2,200 kilometres from Muara Baru to Cilacap in Southern Java. Some 800 species from over 200 families of marine creatures were collected, of which over 40 species are new species and new records for Indonesia. The expedition results will be shared with the world at a workshop in Indonesia in 2020 [see pg 9].

We were involved in an initiative by the Sarawak Forestry Corporation - RIMBA-Sarawak [Research for Intensified Management of Bio-Rich Areas of Sarawak], documenting Sarawak’s rich biodiversity and utilising the data to improve wildlife conservation management. 4,700 specimens were collected from the Lanjak Entimau Wildlife Sanctuary, where an endemic palm-sized Jerusalem / King cricket was recorded as a rediscovery.

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At NUS Science

MAKING A MARK

Our alumni make impactful contributions in diverse professions and sectors. Many of them are leaders and game-changers in their respective fields.

Dr Alaric Koh [Chemistry 2006] is the Acting Deputy Laboratory Director with the Health Sciences Authority [HSA]’s Forensic Chemistry and Physics Laboratory. He applies science to criminalistics investigations, playing a crucial role in the criminal justice system as a scientific expert witness. He has handled high-profile cases such as the Shangri-La and the Khoo Tech Puat Hospital shooting incidents. Alaric represents HSA at international expert working groups and lectures on forensic science to law enforcement and judicial agencies, and at NUS.

Ms Irene Quay [Pharmacy 1997] is the Head of Pharmacy at KK Women’s and Children’s Hospital and Assistant Director [Allied Health Office], overseeing clinical governance and accreditation of advanced practice allied health professionals. She is also the President of the Pharmaceutical Society of Singapore and serves on several national advisory committees such as the National Pharmacy and Therapeutics Committee. As a new nominated Member of Parliament, Irene plans to champion empowerment of healthcare professionals and support for working mothers. She has received multiple awards, including the National Day Commendation Medal [2016] and the PS21 ExCEL Innovation Champion Gold Award [2016], amongst others.

Leading primatologist Dr Andie Ang [Life Sciences 2008] is Chairperson of the Raffles’ Banded Langur Working Group. She heads a joint project between Singapore and Malaysia to implement the first regional action plan to save the endangered leaf-eating monkey from extinction, supported by the Wildlife Reserves Singapore Conservation Fund. Andie is a recipient of the Prestige Singapore 40 Under 40 2017 award and one of Singapore Tatler’s Generation T listers 2018. She was also appointed as President of the Jane Goodall Institute [Singapore] in May 2018.

Dr Lee Kean Loon [Physics 2007] is a Software Developer at CGG Services [Singapore] Pte Ltd, a leader in cutting-edge geoscience technologies. Kean Loon maintains the software used by geophysicists to efficiently produce and analyse extremely precise data and images of the Earth’s subsurface. This supports the company’s geological and geophysical capabilities, to deliver solutions for clients from the global oil and gas industry.

Dr Matt Zhang [Quantitative Finance 2008] is Vice President at GIC Pte Ltd, Singapore’s sovereign wealth fund. He is responsible for risk management and performance assessment of GIC’s total portfolio which covers multiple asset classes in public and private markets globally, including equities, bonds and real estate. By supporting GIC’s mandate of achieving good long-term returns above global inflation, Matt contributes towards the better management of Singapore’s reserves.
RECOGNISING EXCELLENCE

Our faculty members are widely recognised by their peers for their research achievements and enjoy high international standing. Our reputation for excellence was reinforced with various prestigious awards for our faculty members’ exceptional contributions to science and research.

2018 Fukui Medal
Prof Richard WONG, Department of Chemistry, was awarded the 2018 Fukui Medal for his outstanding contributions to the application of computational chemistry to physical organic chemistry. The Fukui Medal is awarded to outstanding theoretical / computational chemists by the Asia-Pacific Association of Theoretical and Computational Chemists [see pg 27].

2018 Beale–Orchard-Hays Prize
Provost’s Chair Prof TOH Kim Chuan, Department of Mathematics [together with his coworkers], was awarded the Beale–Orchard-Hays Prize by the Mathematical Optimisation Society for Excellence in Computational Mathematical Programming based on their paper on SDPNAL+, which describes a new method for semidefinite programming with non-negative constraints. Prof Toh was also elected as a Fellow of the Society for Industrial and Applied Mathematics for his contributions to the development of algorithms and software for semidefinite programming and, more generally, conic programming. This year, he also received the NUS Research Recognition Award [see pg 24].

Fellow of the American College of Clinical Pharmacy
Prof LEE Yu-Chia, Joyce, Department of Pharmacy, was elected as a Fellow of the American College of Clinical Pharmacy. The Fellowship recognises distinction in practice and the science of clinical pharmacy.
Commendation Medal
Dr NG Kah Loon, Department of Mathematics, was awarded the medal in the National Day Awards 2018 for his outstanding contributions to education and service. This award is given by the Prime Minister’s Office of Singapore.

Singapore National Academy of Science Fellowships
Prof Artur EKERT, Department of Physics, Prof GAN Wee Tech, Department of Mathematics, and Prof XU Guo Qin, Department of Chemistry, were conferred the Singapore National Academy of Science Fellowships. Prof Ekert is an expert on information processing in quantum-mechanical systems and quantum cryptography. Prof Gan has resolved several outstanding problems in the Langlands programme and the theory of theta correspondence, and contributed to the Gan-Gross-Prasad conjecture for classical groups. Prof Xu has deep mechanistic understanding in molecular binding on semiconductor surfaces, and demonstrated leadership in deepening China-Singapore bilateral relations through the NUS [Suzhou] Research Institute.

Emeritus Professorship
Prof LIM Hoch, Department of Physics, was conferred Emeritus Professorship in recognition of his stellar and sustained contributions in distinguished scholarship and service to the university. He was instrumental in the setting up of the Centre for Remote Imaging, Sensing and Processing, Temasek Laboratories, and the Singapore Nuclear Research and Safety Initiative at NUS [see pg 30].

Provost’s Chair Professorship
Prof LIU Xiaogang, Department of Chemistry, was appointed Provost’s Chair Professor. He has made significant advances in the understanding of, and the optical manipulation of photon conversion in nanosized particles [see pg 27].
DARING TO DREAM

Some of our alumni have ventured into the unknown by starting their own businesses. Through hard work and determination, they overcame challenges and translated their dreams into products and services that benefit society.

AGplus Technologies Pte Ltd
Chemistry alumnus Dr LIU Hongjun, who founded AGplus Technologies in 2012, started by collaborating with Mercy Relief to provide water services to disaster- and poverty-stricken areas. Hongjun invented and commercialised three water technologies, including the world’s first antimicrobial ceramic membrane which turns contaminated water into clean drinking water. He has received 31 international patents and numerous awards including the World Future Foundation prize. His company reports yearly revenues of $2 million.

Clean Shaven Apps Pte Ltd
Life Sciences alumnus Mr MUH Hon Cheng, who co-founded Clean Shaven Apps in 2015, made Singapore proud by winning the coveted global Apple Design Award 2017 for Elk, a currency converter mobile application [app] - a first in Asia Pacific. That year, he was also named one of Apple Singapore’s Red Dot Heroes. He created some of Singapore’s most popular apps, like SG Buses and SG NextBus, which boast more than four million downloads locally. He plans to make his apps more accessible through multiple mobile platforms.

Botbot.AI
In 2017, Mr WONG Hong Ting [Quantitative Finance] and Mr Elvin LI [Computational Biology] co-founded Botbot.AI, an enterprise productivity solution that automates repetitive and menial workflows. Using conversational interfaces that harness artificial intelligence [AI], machine learning and natural language processing, Botbot.AI is optimised for local languages and popular platforms in the region. Having succeeded in the human resources field, Botbot.AI is now introducing more pretrained chatbots to boost human resource productivity. It was the top winner at the HR Tech Asia Summit Startup Competition 2018.

BioMind™
Physics and Applied Mathematics alumnus Mr Joe WU co-founded BioMind™ in 2017, which deploys AI in healthcare. BioMind™ is the world’s first CE-certified “AI doctor” that can analyse medical images and diagnose various neurological conditions within seconds. By empowering medical professionals with next-generation diagnostic tools, patients everywhere can benefit from fast and accurate diagnoses, better treatment outcomes, lower costs and greater access to quality healthcare. Joe plans to deploy BioMind™ to over 1,000 hospitals around the world by 2020. Joe was also an advisor for the AI Singapore national programme in 2017.
At NUS Science

REALISING DREAMS

The generous support of our benefactors has far-reaching impact. It helps students to fully benefit from the university experience and supports research that addresses real-life problems.

Louis Chen Science Merit Scholarship
During his 43 years with NUS, Emeritus Professor Louis CHEN made significant contributions in distinguished scholarship and service to the university. He laid the foundations critical to the development of the Departments of Mathematics, and Statistics and Applied Probability. He also built the Institute for Mathematical Sciences into a respected mathematical research institute. The Louis Chen Science Merit Scholarship was established in July in recognition of Prof Chen’s achievements.

Science research
The Kewalram Chanrai Group made an expendable gift pledge, of which $500,000 was received in July. This supports the university’s palm oil research project, with a focus on identifying secondary metabolites that effectively contribute to defending against Ganoderma disease. The oil palm is a key source of edible oil. The research is headed by Prof XU Jian from the Department of Biological Sciences [see pg 21].

The Science Student Fund was established in 2008 to enable financially disadvantaged students to enjoy the full benefits of NUS Science’s education without financial worries.

“I am very thankful for the bursary which enables me to stay on campus and experience an exciting student life. I am also motivated to excel in my studies and to give back to the student community.”
- TAY Wei David, Chemistry Year 1

“The bursary makes it possible for financially disadvantaged students to complete a university education. It also lightened the strain from my parents’ medical bills.”
- LEUNG Jia Nuo, Chemistry Year 4

The Science Student Overseas Exposure Fund was set up in 2006 to enable financially disadvantaged students to participate in overseas programmes.

“I went on a language immersion programme at Juntendo University. I never took part in overseas exchange programmes due to financial constraints. I am thankful for the generous support which made my trip possible.”
- Gladys LOI, Life Sciences Year 4

Please contact Ms YONG Lai Cheng at sciylc@nus.edu.sg if you wish to make a donation.
Building Research Capabilities

This chart shows the funding sources for Ph.D. students enrolled in our programmes over the past four years. A typical Ph.D. scholarship lasts four years. This chart provides a snapshot of the funding support for students with us in the review year. While the Ministry of Education still provides the bulk of support for our Ph.D. students, the Faculty has started to diversify the sources of funding through research grants and partnerships with industry and government agencies.

644 Ph.D. students enrolled

This chart shows the funding sources for research grants which our researchers have won over the past five years. As research projects typically run for three to five years, the research grant income gives a snapshot of the research intensity at the Faculty. While the public sector grant agencies together remain as the largest grantor for our research programmes, the Faculty has been developing funded partnerships with companies and statutory boards. These will increase the impact of our research work on industry and society.

$329 million in research income

Note:
- Industry includes funding from licensing agreements.
* Percentages of allocation may not add up to 100% due to rounding errors.
At NUS Science

FACTS AND FIGURES


4909 UNDERGRADUATE STUDENTS

34 UNDERGRADUATE PROGRAMMES

16 MINOR PROGRAMMES

6 FRENCH DOUBLE DEGREE PROGRAMMES^*

4 CONCURRENT DEGREE PROGRAMMES*^*

1185 POSTGRADUATE STUDENTS

18 M.SC. / PHARM. D. PROGRAMMES

6 PH.D. PROGRAMMES

5 JOINT PH.D. PROGRAMMES

2 JOINT M.SC. PROGRAMMES

183 B.SC. [ PHARMACY ] & B.SC. [ PHARMACY ] [ HONS ] GRADUATES

29 B.ENV. STUDIES [ HONS ] IN ENVIRONMENTAL BIOLOGY GRADUATES

GRADUATING CLASS OF 2018 UNDERGRADUATE STUDIES
B.SC., B.SC. [ HONS ]

- Applied Mathematics 108
- Chemistry 191
- Computational Biology 7
- Food Science and Technology 34
- Life Sciences 450
- Mathematics 28
- Physics 66
- Quantitative Finance 25
- Statistics 168

Total 1077

^ Refers to B.Sc. [Hons] & M.Sc. from NUS and Diplôme d’Ingénieur from French Grandes Écoles

* Includes B.Sc. [Hons] & M.Sc.
At NUS Science

RESEARCH OUTPUT AND RECOGNITION

ASIA FIRST
Chemistry
Environmental Sciences
Mathematics
Pharmacy & Pharmacology
Statistics & Operational Research

GLOBAL TOP TWENTY
Chemistry
Environmental Sciences
Materials Science*
Mathematics
Pharmacy & Pharmacology
Statistics & Operational Research

^ Research subject ranking
Source: QS World University Rankings by Subject 2018
# Includes contributions from materials physics and materials chemistry

1466
Research articles published
[Source: Web of Science]

81791
Citations received
[Source: Web of Science]

19
New patent families filed

47
Research collaborations with industry

17
Research collaborations with statutory boards

GRADUATING CLASS OF 2018
GRADUATE COURSEWORK PROGRAMMES

M.SC. in Applied Physics 13
M.SC. in Chemistry 22
M.SC. in Chemistry for Energy and Environment 23
M.SC. in Mathematics 19
M.SC. in Pharmaceutical Sciences and Technology 11
M.SC. in Physics 6
M.SC. in Quantitative Finance 50
M.SC. in Statistics 98
Doctor of Pharmacy 14

GRADUATING CLASS OF 2018
GRADUATE RESEARCH PROGRAMMES

Biological Sciences 51 4
Chemistry 43 8
Mathematics 17 4
Pharmacy 15 2
Physics 24 7
Statistics and Applied Probability 7 6