As the 6th most international university* in the world, NUS has a total of 17 faculties and schools, 11 overseas colleges, 30 university-level research institutes and centres, with more than 40,000 students from over 100 countries.

**Century-Old Institution**

Founded in 1905, the National University of Singapore (NUS) is the oldest higher education institution in Singapore.

**Top Research University**

NUS is consistently ranked as one of the top 20 universities in the world and is ranked 1st in the Asia-Pacific region by QS World University Rankings 2021.

**A Cultural Melting Pot**

As the 6th most international university* in the world, NUS has a total of 17 faculties and schools, 11 overseas colleges, 30 university-level research institutes and centres, with more than 40,000 students from over 100 countries.

*Cited from Times Higher Education The World’s Most International Universities 2021
SCHOOL OF COMPUTING

Department of Computer Science
Department of Information Systems & Analytics

186 Academic & Teaching Staff
222 Research Staff
111 Admin & Technical Staff

4261 Undergraduates
948 Graduate students
598 Masters students, 350 PhD students
TOP ASIAN UNIVERSITY FOR COMPUTING

1st in Asia
8th in the world

Computer Science 2021
1 PROGRAMME STRUCTURE
PROGRAMME HIGHLIGHTS

WIDE RANGE
of subjects offered across 4 clusters with 16 topics in total to build your knowledge in high-demand IT fields

NUS ACCOUNT
exclusively created for you with access to NUS learning platforms such as LumiNUS, Zoom & Microsoft Teams in the course of Summer Workshop

SYNCHRONOUS LEARNING
via Zoom with real-time social interaction for discussion, feedback, sharing and insights

PROJECT COMPETITION
at the end of the workshop to showcase your computing skills through intensive hands-on project supervised by our esteemed professors

WIDE RANGE

LECTURE RECORDINGS
will be provided to offer flexibility to review lecture materials and consolidate knowledge gained in class

CERTIFICATE
greatly advantageous for future career and further studies

BECOME ELIGIBLE
to apply for the SoC NGNE Programme which offers a chance for early admission to the Master of Computing programme

INTERNSHIP
opportunities available to participants of the Summer Workshop on a competitive basis
INTENSIVE LEARNING

- Introductory Lectures: 30h (6 hours for each topic)*
- Advanced Seminars: 10h
- Project Work: 82h
- Research Seminars: 8h

Total workload hours: 130

*Except for the topic Embedded System and Deep Learning which will have 12 hours of introductory lectures as it is further divided into 2 sub-topics: 1. Embedded System 2. Deep Learning, with 6 hours of introductory lectures for each sub-topic.
Students will be provided with an NUS account which can be used to access NUS learning platforms including LumiNUS, Zoom and Microsoft Teams.

Lectures will be taught via synchronous video conferencing using Zoom where students can enjoy real-time interaction with professors.

Lecture recordings will be provided to offer flexibility to review lecture materials and consolidate knowledge gained in classes.

Interactive tools such as Zoom Breakout Rooms, Poll Everywhere, discussion forums, interactive coding, live demo may be utilised in the courses to maximise student engagement.

Professors and teaching assistants will provide project consultations via remote screen sharing. Microsoft Teams may also be used to aid in communication.
Enroll in **1 CLUSTER** out of 4 available clusters

Attend lectures of all **5 TOPICS** in your cluster to acquire **BROAD-BASED KNOWLEDGE** across the field

Strengthen knowledge acquired by completing assignments and quizzes

**Programme Phases** (FULLY ONLINE!)

"**BREADTH-TAKING**"

8 May - 5 June 2021

"**DEPTH-DIVING**"

12 July - 28 July 2021

- Narrow down to **1 TOPIC** for further exploration
- **ADVANCED SEMINARS** digging deeper into your topic
- **PROJECT DEVELOPMENT** under supervision of topic professor
- **SHOWCASE** and project competition
Feb - Apr

APPLICATION + CONFIRM CLUSTER
Submit application online before **9 April**.
If you are given an offer, pay total programme fee of **SGD1,950** to secure a place in the workshop.
Thereafter, you will be assigned to a cluster.

May

"BREADTH-TAKING" PHASE
Attend introductory lectures (conducted on weekends) of all the topics in your cluster online via Zoom from **8 May to 5 June**.
Retain knowledge and boost your confidence by completing assignments and practice quizzes.

June

CONFIRM PROJECT TOPIC
Students are to submit project topic preference by **10 June**.
Final project topic will be announced by **11 June**.

July

"DEPTH-DIVING" PHASE
Starting from 12 July, attend advanced seminar in your topic.
Final project topic will be announced by **28 July**.

28 July

FINAL SHOWCASE!
Showcase your project to peers after weeks of intensive construction and refinement!
2 CLUSTERS & TOPICS
CLUSTER 1: ALGORITHM, CLOUD & SECURITY

Non-Invasive Pre-Natal Testing by Cell-Free DNA Screening
WONG Lim Soon
Ken SUNG

Cloud Computing with Big Data
TEO Yong Meng

Simulation - Allowing "What if" Scenarios
Gary TAN

DOTA Defense of the Ancients
Hugh ANDERSON

Mining Communities in Big-Data with Algorithms and Computational Thinking
LEONG Hon Wai
Non-Invasive Pre-Natal Testing by Cell-Free DNA Screening

Cluster: Algorithm, Cloud & Security

This workshop explores the application of computer science and bioinformatics techniques in non-invasive pre-natal testing (NIPT). Cell-free DNA (cfDNA) screening is an emerging NIPT approach for identifying and detecting abnormalities in the genome of a fetus from a pregnant woman’s blood sample. It involves two steps. The first step is extracting and sequencing cell-free DNAs from a pregnant woman’s blood. Only a small fraction (circa 5%) of these cell-free DNAs are fetal DNAs. While a normal clinical genome is sequenced at 30x coverage, NIPT sequencing is done at 5x coverage for cost effectiveness. This translates to an ultra-low circa 0.1x coverage the fetal genome (i.e. 300x lower than that of a clinical genome). Moreover, sequencing reads this fetal genome is buried in over 20x noise from the maternal genome. The second step - which is also the theme of this workshop - infers the genomic information of the fetus by means of bioinformatics analysis, in face of the challenges of ultra-low coverage and high noise.

Learning objective: Students attending this workshop will be introduced to
1. DNA sequencing and read mapping, with an emphasis on computational methods and tools for read mapping;
2. NIPT by cfDNA screening, with an emphasis on appreciating complications and noise in the ultra-low-covering sequencing data; and
3. Statistical modeling and analysis, which takes genetic features into consideration.
Cloud Computing with Big Data

Cluster: Algorithm, Cloud & Security

This is a project-based course to expose students to both the theory and practice of cloud computing. The learning objectives include understanding of key principles of cloud computing concepts, models, technologies and its application for big data. The course is divided into two parts: two 3-hr lecture that introduces basic cloud computing concepts, modules and technologies, and a project to develop web-based big data cloud applications augmented with four 2-hr project related lectures.

I. Topics include: principles of cloud computing – what and why, key business drivers, basic concepts and terminology, technical and non-technical challenges; fundamental concepts and models – cloud characteristics, cloud service (delivery) models, reference architecture, cloud deployment models; technologies behind cloud computing – resource hosting, main components in a datacenter, virtualization, multitenancy; cloud architecture – how to organize (partition) resources, how to operate/manage resources to meet certain objectives, cloud bursting; cloud applications and paradigms – cloud applications, challenges in developing applications, application development models – IaaS (Infrastructure as a Service), PaaS (Platform as a Service) and SaaS (Software as a Service), MapReduce programming model.

II. Cloud-based Big Data Projects - The learning outcome of the team-project is to design a big data application and to develop its implementation on a public cloud. A hackathon-like approach will be adopted to allow students to suggest ideas and form teams based on individual interests and skills. Four 2-hr lectures cover programming PaaS and SaaS IBM cloud services and pattern-based approach to design and implement big data applications. Students learn by examples with hands-on laboratories. For data, students can tap on the rich Singapore Smart Nation Open Government Data repositories among others.
Simulation - Allowing "What if" Scenarios

Cluster: Algorithm, Cloud & Security

This workshop aims to provide students with a working knowledge of modelling and simulation. Students will learn how to apply simulation techniques to model, simulate and study systems. It covers techniques in simulation model design, input modelling, model execution and model analysis. There will also be an introduction to parallel and distributed simulation. Students will have hands-on experience using a simulation package to gain a better understanding of how simulation is applied in the real world.

The objectives of this workshop are:

- Understand how computer simulation can be used to model complex systems and solve decision problems.
- Learn to use simulation software, such as Arena, to run simulation projects from start to finish.
- Learn how to incorporate statistical methods when designing a simulation.
- Learn how to interpret and validate the results obtained from simulations.
- Communicate insights obtained from the simulation analysis to the lay audience.
DOTA Defense of the Ancients

Cluster: Algorithm, Cloud & Security

No - not DOTA, and not DOTA 2. This workshop is all about computer security. We are building a brave new world, where computer systems intrude everywhere, in your home, at your work, in your pockets. Many systems are based on truly ancient technology. We will look at how to defend our ancient systems, providing practical guidance as to how to make you, your organization, and even your country safer.

DOTA will cover topics such as: attack surfaces for Windows and UNIX based systems, Android, GSM, SCADA/PLCs networking hardware, remote car controllers; injections, cross-site scripting, overflows, classic attacks, cryptography, PKI; defenses: software techniques, design approaches, configurations, IDS.
Mining Communities in Big-Data with Algorithms and Computational Thinking

Cluster: Algorithm, Cloud & Security

This course will teach students how to use algorithms and computational thinking for community detection in large graphs built from big-data, and to use them to gain insights and solve real world problems. Computational thinking is about applying powerful ideas in computer science (problem formulation, abstraction, decomposition, pattern recognition, and algorithm design) to formulate and tackle real world problems.

Students will apply what they learn to a mini-project where they do knowledge discovery from big data in the real world. They work in teams, they choose their own topics, find appropriate datasets from the real world, and they learn to model their datasets using graphs, and then use algorithms to identify communities in these graphs. Then they apply ideas in CT knowledge to analyze the communities identified in the search of new knowledge or insights about the communities. For example, the communities can provide give new insights to how the individual nodes interact, the role of certain nodes in the communities (the driver nodes, the hubs and authorities in the graph), can also help to condense large graphs into communities, and can help in visualization of these large graphs which is helpful in many other big-data analytics tasks.
CLUSTER 2: ANALYTICS & IOT

Big Data Analytics and Visualization
Danny POO

Web Mining
LEK Hsiang Hui

Data Story App Development with R
LIU Qizhang

Artificial Intelligence of Things
TAN Wee Kek

AI/ML for Financial Services
Anand BHOJAN
Big Data Analytics and Visualization

Cluster: Analytics & IoT

The “Big Data” phenomenon has come about with the increased production, storage and availability of digital data. Organizations are now grappling with the problem on how to use these data effectively for the benefits of the business. Big Data Analytics is the practice of using digital data for understanding insights from data. To unlock the potential contained within the Big Data requires the application of techniques to explore and convey the key insights. Data is the oil, and data visualization is the engine that facilitates its true value. This course discusses the art and science of data visualization, methods for visualizing data and a methodology for visualizing data for effective and efficient communication of data in business. Participants will be able to create their own stunning and effective visualizations based on real data.

Learning Objectives and Outcomes

1. Understand what big data is and how Big Data Analytics can help organizations achieve a competitive advantage.
2. Appreciate the benefits and insights that Big Data Analytics bring to the organizations.
3. Learn how to use methods and methodology to produce effective and efficient data visualizations.
Web Mining

Cluster: Analytics & IoT

With the increased adoption of digital solutions, huge amount of data is generated on the web. While this data is readily available on web pages or found in web applications, most of the emphasis in the data analytics world focus more on the predictive modeling aspects and assumes that the data can be easily downloaded from data repositories such as Kaggle. However, this limits the number of AI applications that can be built.

This course addresses both the manual mining of web content and predictive modeling of the data. Specifically, students will be taught various systematic techniques on how to mine web content, and how to process the data such as applying predictive modeling and building recommender systems.
We are now at the era of big data. Data and algorithms dominate the day. Competitive advantage, for more and more enterprises, is obtained via data analytics and idea sharing in the current fast-paced, data-intensive, and open-source business environment. The capability of understanding data, digging out valuable insights from data, and thus making right managerial decisions accordingly has gradually become an essential skill that business graduates must master in order to excel in their career.

This course prepares students with fundamental knowledge of using R, a powerful complete analytical environment, to organize, visualize, and analyze data. It is, however, not a programming course. It will focus on case studies that will train students how to summarise and present findings in a structured, meaningful, and convincing way. At the end of the course, students should be ready to develop an app to tell data story for a given business case.
Artificial Intelligence of Things

Cluster: Analytics & IoT; AI & FinTech

Artificial Intelligence of Things (AIoT) lies at the intersection of Artificial Intelligence (AI) technologies and Internet of Things (IoT) infrastructure. AIoT aims to achieve smart IoT operations that optimise human-machine interaction, and data management and analytics.

More specifically, IoT is set to disrupt the way we live and work. Smart homes that are filled with connected devices are loaded with endless possibilities to make our lives easier, more convenient, and more comfortable. Industry 4.0, which is powered by Industrial IoT (IIoT), promises to turn smart manufacturing and smart factory into a reality.

IoT devices are expected to generate a huge volume of data. AI techniques such as machine learning and deep learning can help individuals and organisations alike to realise unprecedented business values from these data.

In this course, you will learn how to work with single-board microcontrollers and computers in conjunction with various connected devices such as sensors, actuators, smartphones, smartwatches, Bluetooth Low Energy beacons, and other interesting hardware to build various smart home and industry scenarios. You will also learn how to integrate a real-time data pipeline for visualising and analysing the data that are collected by these devices to create a smart AIoT system.
AI/ML for Financial Services

Cluster: Analytics & IoT; AI & FinTech

In this course, students will be introduced to financial services, trading and the importance of AI/ML in the fintech industry with a set of case studies. Students will learn fundamental concepts of AI/ML, including supervised/unsupervised learning, bias-variance tradeoff, principal component analysis and neural networks. The students will get hands-on experience in obtaining financial data via Quandl, or Yahoo Finance and understanding financial data and structure the data in a way that is amenable to ML algorithms. Students will be equipped with skills to implement machine learning algorithms to extract key features from financial datasets. Students will also be trained to develop fintech web applications using modern web application frameworks reactJS, python-flask and basic DB.

Learning Outcomes:
- Understand and appreciate the growing importance of AI/ML in the Financial Industry.
- Understand and distinguish between supervised machine learning (ML), unsupervised ML, deep learning and artificial intelligence.
- Understanding statistical and mathematical models and their limitations.
- Understand Financial datasets and prepare the data for ML using Python libraries.
- Build and apply appropriate AI/ML models and data processing techniques using Python libraries for business decisions in financial settings.
- Use reactJS, python-flask, basic DB operations (CURD) to build fintech web applications.
CLUSTER 3: AI & FINTECH

Embedded System and Deep Learning
SOO Yuen Jien
Colin TAN

Visual Computing
Terence SIM

Artificial Intelligence of Things
TAN Wee Kek

AI/ML for Financial Services
Anand BHOJAN
Embedded System and Deep Learning

Cluster: AI & FinTech

This module covers two threads: Embedded system and Deep learning.

Embedded system thread will cover basic hardware / low level software interaction. You will learn how to interface with useful peripherals, e.g. sensors, actuators etc.

In the Deep Learning section you will begin by looking at the fundamentals of statistical models like regression models, Bayesian classifiers, Decision Trees and Support Vector Machines. From there you will explore classical neural network learning algorithms gradient descent and unsupervised methods, before delving into contemporary deep learning methods like Convolutional Neural Networks, Recurrent Neural Networks, Long Short Term Memories, Generative Adversarial Networks and Autoencoders. You will take a hands-on approach and will learn to identify key features of the problem at hand, and choose appropriate deep learning architectures and strategies to solve those problems.

To bridge between the hardware and the deep learning back-end, you will learn about how to efficiently transfer data over Message Queueing Telemetry Transport (MQTT), RESTful APIs, and learn to store and manage that data using both SQL and NoSQL databases. Lastly you will learn to secure your communications by generating and signing cryptographic keys and certificates.

You will apply the ideas learned in an intensive 2-3 person teams to design and build a hardware + software system. The system is freeform and open ended, but should include hardware interfacing and deep learning. For example, a "home security" system that uses movement sensors and deep learning to understand the typical movement of the occupants. Any out of ordinary movements will trigger an alert.
Visual Computing

Cluster: AI & FinTech; AI & Media

Visual Computing concerns the analysis and synthesis of images and videos. Understanding images is an AI problem, and the field has grown substantially because of the confluence of big data, powerful hardware, and machine learning. Applications are everywhere: face detection in digital cameras, optical character recognition for text translation, diet apps in smartphones, etc.

In this course, you will learn the basics of visual computing, including: image processing & synthesis, object recognition. You will learn through lectures and hands-on sessions, culminating in a final group project.

At the end of the course, you will:

- Understand the basics of visual computing
- Use Python and OpenCV to perform image processing and analysis
- Complete a non-trivial but interesting image analysis project
Artificial Intelligence of Things

*Cluster: Analytics & IoT; AI & FinTech*

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- Understand and distinguish between supervised machine learning (ML), unsupervised ML, deep learning and artificial intelligence.
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- Build and apply appropriate AI/ML models and data processing techniques using Python libraries for business decisions in financial settings.
- Use reactJS, python-flask, basic DB operations (CURD) to build fintech web applications.
CLUSTER 4: AI & MEDIA

Real-Time Graphics Rendering
LOW Kok Lim

Introduction to 2D Game Development
Kelvin SUNG

Visual Computing
Terence SIM

Make Good Products Great Again!
LU Weiquan

Video Streaming with DASH Development
Roger ZIMMERMANN
Real-Time Graphics Rendering

Cluster: AI & Media

Real-time graphics is at the heart of all 3D interactive computer applications, such as 3D games, VR, 3D modelling, and data visualization.

Recent rendering techniques have been heavily exploiting the powerful graphics hardware to achieve unprecedented performance and effects.

In this course, students study the modern real-time rendering pipeline. It introduces modern and traditional real-time rendering techniques, and students learn to write shaders to implement these techniques for the GPU.

The syllabus includes multiple-pass rendering, shading & reflection models, procedural texture-mapping & shading, lights & shadows, non-photorealistic rendering, deferred shading, post-rendering processing, etc.
Introduction to 2D Game Development

Cluster: AI & Media

Examinates the fundamental issues in designing and developing computer video games; creative and artistic elements, story narration, software architecture, interaction model, mathematic, physics, special effects, and in-game AI logic.

Experiences elements in game design: world setting, game play, and interface; and experiences implementing games: conceptualization, prototyping, and play testing.

Learning Objectives

- Critically examine video games
- Understand the structure of games
- Design, prototype, test and implement a game from scratch
- Understand and extend techniques commonly used in games
- Work in groups, present and reflect on extended project
Visual Computing

Cluster: AI & FinTech; AI & Media

Visual Computing concerns the analysis and synthesis of images and videos. Understanding images is an AI problem, and the field has grown substantially because of the confluence of big data, powerful hardware, and machine learning. Applications are everywhere: face detection in digital cameras, optical character recognition for text translation, diet apps in smartphones, etc.

In this course, you will learn the basics of visual computing, including: image processing & synthesis, object recognition. You will learn through lectures and hands-on sessions, culminating in a final group project.

At the end of the course, you will:
- Understand the basics of visual computing
- Use Python and OpenCV to perform image processing and analysis
- Complete a non-trivial but interesting image analysis project
Make Good Products Great Again!

Cluster: AI & Media

Have you ever wondered why some products are such a joy to use, while others are just horrible user experiences? Have you wondered why some systems have similar specifications (CPU, RAM, Storage etc), yet each system can feel so different when you use it? Have you wondered why some devices “just work”, while others are just frustratingly difficult? In other words, what is good design, and what is bad design, and how do you design great products? Hint: it has nothing to do with money!

This workshop will teach you how to design IT products using a User-Centered, Design Thinking framework, combined with AGILE Rapid Prototyping methodology. You will learn to analyze existing products and decide which parts of the product has good design, and which parts are bad. You will then start to design your own Web/Mobile/AVR products, starting with design prototypes, and ending with a final, well designed and demonstratable prototype.

By the end of this course, students should be able to:
1. Analyze any product (using Usability Goals) to determine how well (or badly) it is designed.
2. Improve any product (using Design Principles).
3. Defend their design decisions using UX Design theory and heuristics.
4. Develop extremely well-designed products that enable users to simply “pick-up-and-use” without the need for users to learn the interfaces.
Video Streaming with DASH Development

Cluster: AI & Media

Who doesn't like TikTok, Youku, YouTube, Hulu, etc.! These video services are some of the most popular applications on the web today. Fun fact: video traffic now makes up the majority of Internet traffic (about 80%, according to Cisco). Would you like to know how the video streaming in these applications works? Then this module is for you! In this course you will learn how modern video streaming systems work and even build your own.

This course will teach the underlying technologies and components of video streaming systems that use the modern DASH industry standard (Dynamic Adaptive Streaming over HTTP) and Apple's HLS (HTTP Live Streaming). Students will learn both in theory and in a practical, hands-on project about video encoding, different video representations, segmentation of long videos, how to prepare videos for streaming on a server, how to customize their own video player and how to experiment with different dynamic network adaptation schemes that will result in a smooth playback for the user.

Students will learn a number of different industry-leading technologies such as the DASH playlist format (XML), working with Linux and the Apache web server software, understanding issues about video coding (H.264 and H.265), streaming file formats and the dash.js video player. The students will then combine these various technologies and get a hands-on experience with actually building their own DASH streaming system in a team project.

The course will also teach the fundamental technologies as a basis for the project. At the end of the course, the students will have the knowledge to integrate industry-standard video streaming into their own applications and projects. They will also learn about the latest trends and technologies, such as 360-degree video streaming and low latency live streaming, as used by Twitch.tv and Facebook.
APPLICATION
APPLICATION

Apply online via: https://app.comp.nus.edu.sg/app/appln/

**Deadline: 9 April 2021**
Application may be closed earlier if all vacancies are filled before the deadline.

**Notified within 2 weeks**
Students will be contacted within 2 weeks after completing the application process.

**Open to Year 2 & above**
Open to Year 2 and above undergraduates majoring in Computer Science, Software Engineering, Electronics, Information Systems and Management, Internet of Things, Statistics, Automation, Life Sciences and other related disciplines (you may enquire).

**Apply early to secure cluster**
Some popular topics may be oversubscribed - we advise that you apply early for the best chance at getting your topic of choice.
REQUIRED DOCUMENTS

01 TRANSCRIPT
- In English
- Chinese transcripts acceptable for students from China

02 ENGLISH QUALIFICATIONS
- For non-English medium universities
- Either one of the following: CET4, CET6, TOEFL or IELTS

03 AWARDS/ACHIEVEMENTS
- Optional - you can provide certificates of award or achievement that may support your application
PROGRAMME FEE

- There is no application fee.

- Programme fee is only payable after receiving offer letter/email from the organiser.

- Once you have received an offer email, you may log in to the application system to make payment of SGD1,950 before the deadline stated in your offer email.

- To have assurance that you will have the best chance at getting your preferred cluster, you should make payment as soon as possible upon receiving offer.

Programme Fee: SGD1,950

Accepted Payment Methods:

- Visa
- Mastercard
- American Express
- PayNow
- Alipay
CONTACT US

Contact

Official Website
https://sws.comp.nus.edu.sg/

Official Email
sws@comp.nus.edu.sg

Other Useful Links

Summer Workshop Online Application Portal
https://app.comp.nus.edu.sg/app/appln/

NUS SoC NGNE Programme
https://www.comp.nus.edu.sg/~ngne/

NUS SoC Graduate Programme
https://www.comp.nus.edu.sg/programmes/#graduate
THANK YOU!

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