Welcome!

CS Curriculum

(Seth Gilbert)
University Life

- classes
- socializing
- extracurriculars
University Life

- Classes
- Socializing
- Extracurriculars
“What should I do now?”
Information on these slides is simplified for this presentation and should not be treated as official degree requirements.

Students should *always* refer to the official SoC Website and NUS Bulletin for complete up-to-date information.

Please check with the SoC Undergraduate Office to clarify any requirements that are unclear.
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Focus today: BComp(CS) degree requirements.

Other programs (Turing, DDP, etc.) are similar.
# BComp(CS) Degree Requirements

*Special programmes and double degree programs are slightly different.

<table>
<thead>
<tr>
<th>CS Program Requirements</th>
<th>SoC Common Core</th>
<th>Unrestricted Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 units</td>
<td>40 units</td>
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</table>

CS Goals

Strong technical foundations.

Excellent problem solving skills.

Broad knowledge of the field.

In-depth knowledge of (at least) one specialized area.

Good communication and teamwork skills.
BComp(CS) Degree Requirements

CS Program Requirements

80 units

36 units (9 courses)
CS Foundations

32 units (~7 courses)
Breadth & Depth

12 units (3 courses)
Industrial Experience

16 units
Math & Sci

University Requirements

36 units (9 courses)

32 units (~7 courses)

12 units (3 courses)

Unrestricted Electives

40 units

CS Foundations

Algorithms and Theory
- What do you want to do?
- How do you do it efficiently?

Programming and Software Engineering
- How do you translate your idea into code?
- How do you build it?
- How do you work on a team?

Computer Systems
- How does a computer work?
- What is really happening underneath the abstractions?
- How does a network work?

AI & ML
- How do we design intelligent systems?
- Big data
- How do computers learn?
CS Foundations

Areas not covered in the CS Foundations:
- Security
- Databases
- Media
- Computational Biology

Algorithms and Theory
- What do you want to do?
- How do you do it efficiently?

Programming and Software Engineering
- How do you translate your idea into code?
- How do you build it?
- How do you work on a team?

Computer Systems
- How does a computer work?
- What is really happening underneath the abstractions?
- How does a network work?

AI & ML
- How do we design intelligent systems?

Big data
- How do computers learn?
CS Foundations

- The Beginning
- Algorithms and Theory
- Programming and Software Engineering
- Computer Systems
- AI & ML
<table>
<thead>
<tr>
<th>The Beginning</th>
<th>Algorithms and Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS1101s</td>
<td></td>
</tr>
<tr>
<td>Programming</td>
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</tr>
<tr>
<td>Methodology</td>
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<td>CS1231s</td>
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<tr>
<td>Discrete</td>
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<td>AI &amp; ML</td>
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CS Foundations

The Beginning

- CS1101s Programming Methodology
- CS1231s Discrete Structures

Algorithms and Theory

- CS2040S Data Structures & Algorithms
- CS3230 Design & Analysis of Algorithms

Programming and Software Engineering

Computer Systems

AI & ML
CS Foundations

The Beginning
- CS1101s Programming Methodology
- CS1231s Discrete Structures

Programming and Software Engineering
- CS2030S Programming Methodology II
- CS2103T Software Engineering

Computer Systems
- CS2100 Computer Organization
- CS2106 Intro to Operating Systems

Algorithms and Theory
- CS2040S Data Structures & Algorithms
- CS3230 Design & Analysis of Algorithms

AI & ML
- CS2101 Effective Communication
# CS Foundations

## The Beginning
- CS1101s Programming Methodology
- CS1231s Discrete Structures

## Algorithms and Theory
- CS2040S Data Structures & Algorithms
- CS3230 Design & Analysis of Algorithms

## Programming and Software Engineering
- CS2030S Programming Methodology II
- CS2103T Software Engineering
- CS2101T Effective Communication

## Computer Systems
- CS2100 Computer Organization
- CS2106 Intro to Operating Systems

## AI & ML
- CS2109S Intro to AI and Machine Learning
The Beginning

Semester 1

- CS1101s Programming Methodology
- CS1231s Discrete Structures

Semesters 2 & 3

- Algorithms and Theory
  - CS2040S Data Structures & Algorithms
  - CS3230 Design & Analysis of Algorithms

- Programming and Software Engineering
  - CS2030S Programming Methodology II
  - CS2103T Software Engineering

- Computer Systems
  - CS2100 Computer Organization

- AI & ML
  - CS2109S Intro to AI and Machine Learning

Semesters 3 & 4

- CS2109S Intro to AI and Machine Learning

Semester 1

Semesters 2 & 3

Semesters 3 & 4
Semester 1

Programming Methodology
S1101s

Discrete Structures
S1231s

Semesters 2 & 3

Algorithms and Theory
CS2040S Data Structures & Algorithms

Programming and Software Engineering
CS2030S Programming Methodology II

Computer Systems
CS2100 Computer Organization

AI & ML

Semesters 3 & 4

Algorithms and Theory
CS3230 Design & Analysis of Algorithms

Programming and Software Engineering
CS2103T Software Engineering

Computer Systems
CS2106 Intro to Operating Systems

AI & ML
CS2109S Intro to AI and Machine Learning

Year 3

Industry Experience

Semester abroad / exchange / NOC / SEP
BComp(CS) Degree Requirements

CS Program Requirements

80 units

- 40 units
- 36 units (9 courses)
- 32 units (~7 courses)
- 12 units (3 courses)

Unrestricted Electives

Breadth & Depth

1. Complete 12 units at level 4000 or above.

2. Satisfy a focus area:
   Complete 3 “primary” courses in an area (at least one level 4000).

3. Get industrial experience:
   Complete 3 month (6 unit) or 6 month (12 unit) industrial experience.
10 Focus Areas

1. Algorithms and Theory
2. Artificial Intelligence
3. Computer Graphics and Games
4. Computer Security
5. Database Systems
6. Multimedia Information Retrieval
7. Networking and Distributed Systems
8. Parallel Computing
9. Programming Languages
10. Software Engineering
Algorithms & Theory

CS3230
Design and Analysis of Algorithms

CS4231
Parallel and Distributed Algorithms

CS3236
Introduction to Information Theory

CS3231
Theory of Computation

CS3234
Optimisation Algorithms
Artificial Intelligence

- CS2109S Intro to AI and Machine Learning
- CS3263 Foundations of Artificial Intelligence
- CS3264 Foundations of Machine Learning
- CS4243 Computer Vision and Pattern Recognition
- CS4244 Knowledge Representation and Reasoning
- CS4246 AI Planning and Decision Making
- CS4248 Natural Language Processing
Computer Security

- CS2107 Introduction to Information Security
- CS3235 Computer Security
- CS4236 Cryptography Theory and Practice
- CS4238 Computer Security Practice
- CS4239 Software Security
Database Systems

- CS2102: Database Systems
- CS3223: Database Systems Implementation
- CS4221: Database Applications Design and Tuning
- CS4224: Distributed Databases
- CS4225: Big Data Systems for Data Science
AI

MA1521 Calculus
MA2001 Linear Algebra
ST2334 Probability and Statistics

CS1231S Discrete Structure
CS2040S Data Structures & Algorithms
CS2109S Intro to AI and ML

CS3263 Foundations of AI
CS3264 Foundations of ML

CS4246 AI Planning & …
CS4278 Intelligent Robots
CS5339 Theory & Alg. For ML
Warning: Check Prerequisites

Example: Artificial Intelligence
Warning: Check Prerequisites

Example: Computer Graphics & Games
Focus area electives

Each focus area has a set of “electives” for students who want to learn more about the area.
Breadth & Depth

1. Complete 12 units at level 4000 or above.

2. Satisfy a focus area:
   Complete 3 “primary” courses in an area (at least one level 4000).

3. Get industrial experience:
   Complete 3 month (6 unit) or 6 month (12 unit) industrial experience.
Industrial Experience

“Complete 3 month (6 unit) or 6 month (12 unit) industrial experience.”

ATAP
Advanced Technology Attachment Program

IIC
Industry Internship Program

SIP
Student Internship Program

CVWO
Computing Voluntary Welfare Organization

NOC
NUS Overseas College

Students with CAP of 4.00 or higher may replace Industry Experience with a dissertation (Final Year Project: CP4101).

Students who aim for Honours (Highest Distinction) must pass the programme’s dissertation course (i.e. CP4101).
BComp(CS) Degree Requirements

CS Program Requirements

80 units

36 units (9 courses)
CS Foundations

32 units (~7 courses)
Breadth & Depth

12 units (3 courses)
Industrial Experience

16 units
Math

BComp(CS) Degree Requirements

36 units (9 courses)

32 units (~7 courses)

12 units (3 courses)

Math courses

MA1521 Calculus for Computing

MA1522 Linear Algebra

ST2334 Probability & Statistics
## BComp(CS) Degree Requirements

*Special programmes and double degree programs are slightly different.*

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BComp(CS) Degree Requirements

Unrestricted Electives: 40 units

SoC Common Core:
- 24 units (6 courses)
  - University Pillars
  - Interdisciplinary/Cross-Disciplinary Courses
- 12 units (3 courses)

Restrictions:
- 4 units (1 course)
  - Ethics: IS1108 Digital Ethics and Privacy
BComp(CS) Degree Requirements

https://www.nus.edu.sg/registrar/academic-information-policies/undergraduate-students/general-education/for-students-admitted-from-AY2021-22
BComp(CS) Degree Requirements

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BComp(CS) Degree Requirements

Data Literacy:
- Preregistered: GEA1000
- Other options: DSA1101, STA1131
- Can drop GEA1000 and apply for other options

University Pillars

Cultures & Connections
Critique & Expression
Data Literacy
Digital Literacy
Singapore Studies
Communities & Engagement

ES2660 Communicating in the Information Age
CS1101S Programming Methodology

https://www.nus.edu.sg/registrar/academic-information-policies/undergraduate-students/general-education/for-students-admitted-from-AY2021-22
Data Literacy

GEA1000: Quantitative Reasoning
- Intro to statistics
- Data analysis
- Data analysis project

ST1131: Introduction to Statistics and Statistical Computing
- Statistics
- R programming
- Data analysis

DSA1101: Introduction to Data Science
- Basic probability and statistics
- Data manipulation
- Data analysis

Broader
Less mathematical
Less programming

Targeted at DSA students
Fewer seats available
More overlap with CS courses
Data Literacy

GEA1000: Quantitative Reasoning
• Intro to statistics
• Data analysis
• Data analysis project

ST1131: Introduction to Statistics and Statistical Computing
• Statistics
• R programming
• Data analysis

DSA1101: Introduction to Data Science
• Basic probability and statistics
• Data manipulation
• Data analysis

Computational/programming centered
Mathematically rigorous
Good preparation for CS courses in AI/ML
Interdisciplinary / Cross-disciplinary courses

• Choose three courses from the specified course lists.
• At least two must be interdisciplinary.

Interdisciplinary = integrates more than one discipline

Cross-disciplinary = a field different from CS that has interesting connections to CS.
BComp(CS) Degree Requirements

Examples: Interdisciplinary courses

• IS1128 IT, Management and Organisation
• IS2238 Economics of IT and AI
• HSH1000 The Human Condition
• HSI2001 Scientific Inquiry & Health: Good Science, Bad Science
• HSI2011 The World of Quantum
• DTK1234 Design Thinking
• EG2501 Liveable Cities
• IE2141 Systems Thinking and Dynamics
• PF1101 Fundamentals of Project Management
BComp(CS) Degree Requirements

Examples: Cross-disciplinary courses

- DAO2703 Operations and Technology Management
- EL1101E The Nature of Language
- SPH2002 Public Health and Epidemiology
- NUR1113A Healthy Ageing and Well-being
- EG2201A User-Centred Collaborative Design
- EG2310 Fundamentals of Systems Design
- Any Chemistry, Physics, or Biological Sciences (PC, CM, or LSM coded)
BComp(CS) Degree Requirements

**Unrestricted Electives**
40 units

**SoC Common Core**
40 units

- **Unrestricted Electives**
  - 4 units (1 course)
  - Ethics: IS1108 Digital Ethics and Privacy

- **SoC Common Core**
  - 24 units (6 courses)
  - University Pillars

- **Interdisciplinary/Cross-Disciplinary courses**
  - 12 units (3 courses)
  - Interdisciplinary/Cross-Disciplinary courses
### BComp(CS) Degree Requirements

*Special programmes and double degree programs are slightly different.*

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Some options:

• Second major in mathematics.
• Second major in statistics.
• Minor in mathematics.
• Minor in statistics.
• Minor in financial mathematics.
• Minor in life sciences.
• Minor in geographic information systems.

• Minor in interactive media development.
• Minor in management.
• Minor in management of technology.
• Minor in entrepreneurship.

And many more...

40 units of Unrestricted Electives are useful here...
How should I plan my time?
Year 1: The Basic Foundation

- **CS1101s**: Programming Methodology
- **CS2040s**: Data Structures & Algorithms
- **IS1108**: Privacy/Ethics in Computing
- **CS2030s**: Programming Methodology II
- **CS1231s**: Discrete Structures
- **CS2100**: Computer Organization

**How to think computationally.**
**How to solve computational problems.**
**How to program.**
**How does a computer work.**
**Basic computing math.**
**Ethical/legal/social issues.**

- Data Literacy course
- University Pillar or Interdisciplinary
- Math
- Math
## Year 2: The CS Core

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>CS2103T</td>
<td>Software Engineering</td>
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<tr>
<td>CS2106</td>
<td>Intro. to Operating Systems</td>
</tr>
<tr>
<td>CS2101</td>
<td>Communication</td>
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<tr>
<td>ES2660</td>
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<td>CS2109S</td>
<td>Intro to AI and Machine Learning</td>
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How to deal with complex systems. How to deal with complex software. How to solve hard problems. Advanced algorithmic techniques. Begin to specialize. Develop software skills.

[Sample Diagram]

- University Pillar or Interdisciplinary
- Math
- University Pillar or Interdisciplinary
Year 3: The Practical Year

Apply knowledge to projects. Learn practical skills on internships or NOC. Drill deeper into focus area.

- Focus Area Primary
- Industrial Experience
- Breadth & Depth
- University Pillar or Interdisciplinary
- Elective
- Elective
- Math
Year 4: Choose Your Own Adventure

- Focus Area Primary
- Breadth & Depth

Study advanced courses.
Do research.
Work on projects.
Broaden your knowledge.

- Breadth & Depth
- Breadth & Depth

- Breadth & Depth
- Elective
- Elective
- Elective

Sample
What if I can’t take XXX in Year 1?

Example: Student cannot take CS1231S in Semester 1
- Semester 1: MA1100
- Semester 2: CS1231S
- Semester 3: CS2040S
- Semester 4: CS2103T

It’s okay!

As long as CS Foundations are *mostly* finished by the end of Year 2, you are on track!
What should I do during the summer?
What should I do during the summer?

- Orbital
- CVWO
- Internship
- Summer School
- Research
- Independent project
- Etc.
Research at SOC

Lots of exciting research happening in Computer Science!

Examples:

• SINGA: platform for deep learning.
• Self-driving car(t)s.
• Drones.
• Singapore Cyber-security Consortium
• Cryptocurrencies.
• Cancer data analysis.
• SeSaMe: Sensor-enhanced Social Media.
• TSUNAMi: Trustworthy Systems from UN-trusted component AMalgamations
Undergraduate Research at SOC

You can be part of it...

Error Correction of Reads in DNA Fragment Assembly
By Zheng Jia

Algorithm for Peptide Sequencing via Tandem Mass Spectrometry
By Ye Nan

A Repetition-Based Framework for Lyric Alignment in Popular Songs
By Luong Minh Thang

Secure and Lightweight Acknowledgment for Peer-to-Peer Overlay Networks
By Lim Chee Liang

Recognition of Polyadenylation Sites from Genomic Arabidopsis Sequences
By Koh Chuan Hock

Directed Novelty and Redundancy in Information Retrieval
By Joseph Tan Kai Huang

Simplified Muscle Dynamics For Real-Time Skin Deformation
By Lee Keng Siang
Turing Programme
Turing Programme:

- Take CS2309: Research Methodology.
- Do a UROP (Undergraduate Research Opportunity Project)
- Do an FYP (Final Year Project)

Similar requirements, with additional research.
Why?

• You are interested in research!
• You may want to pursue a career in research (either industrial or academic).
• “Honors” program for our most successful students.
• Networking opportunities.
• Mentor in research.

By invitation only.
Based on recommendation from CS2309 instructor or UROP advisor.
The NUS Computer Science Research Week is an event that brings together the best researchers in computer science from academia and industry. The event includes a series of research and tutorial talks, by renowned computer scientists from around the world. The event will be held from January 4 through January 6, 2023.

Registration
The event is free of charge. However, please register to help with the organization (to cater for coffee and lunch).

Speakers

Anastasia Borisyuk
Imperial College London

Sibyen Capkun
ETH Zurich

Volkan Cemier
EPFL

Flarcd Doshi-Velez
Harvard

Ammi Karpas
Yale

Negas Nyamw
EPFL

Swetha Kopparty
University of Toronto

Kasper Green Larsen
Aarhus University

Michael Swift
University of Wisconsin-Madison

Vinod Vaikuntam
MIT
A few words of advice… from your seniors…

Notes to CS Freshman from the Future
Slides from this talk

Welcome!