Quick Guide for SEAS CS Students

This Quick Guide is for SEAS students thinking of majoring or minoring in Computer Science. It explains how the program is structured, what courses to take, and when to take them.

The Computer Science Major at Columbia for SEAS

The Undergraduate program consists of a minimum of 63 or 65 points and includes the following: ENGI E1006 which is a prerequisite to the CS major, the CS Core consisting of 7-8 classes (24-26 points), 7 track courses (21 points), and 15 points of general technical electives.

Note: All courses toward the CS major must be taken for a letter grade. A maximum of one course worth no more than 4 points passed with a grade of D may be counted towards the major. Any course exceptions to the noted requirements toward the CS major, as well as all thesis, projects, special topics, and general technical electives must be approved by the faculty advisor in writing prior to enrolling in these courses.

Graduates of the Computer Science program can step into career positions in industry or government, or continue their education in graduate or professional degree programs in a wide range of disciplines.

Getting started

Take Intro to Computing for Engineers and Applied Scientists (ENGI E1006) during your first year. Take the introductory sequence in Computer Science (W1004/W1007, W3134/W3137, W3157, and W3203) in your first two years. This will enable you to complete most of the CS core and to start your upper-level CS track during your junior year, which will provide you with a broad choice of electives in your chosen track. The first three courses (W1004/W1007, W3134/W3137, W3157) should be taken in that order. W3203 can be taken anytime after W1004 or concurrently with W1007.

Take Intro to Computer Science and Programming in Java (W1004) or Honors Intro to Computer Science (W1007) in your first year if possible. This course introduces you to basic computer science concepts and problem-solving techniques using Java.

Advanced Placement Credit

The department grants 3 points for a score of 4 or 5 on the AP Computer Science A exam along with exemption from COMS W1004 Introduction to Computer Science and Programming in Java. However, we recommend that you take COMS W1004 before taking COMS W3134/W3137 Data Structures.

Faculty advisor

Every Computer Science major is assigned a faculty advisor who is a leading computer science researcher. You should meet with your advisor at least once a semester to discuss your progress in the Computer Science program.
http://www.cs.columbia.edu/education/undergraduate/advisors/

(Contact the course instructor if you have questions about a given course.)

Additional questions about the CS Department, major, etc can be sent to advising@cs.columbia.edu.

CS core curriculum (24-26 points)

The core of the major consists of 7 or 8 courses plus one prerequisite course (listed above) for a total of 8 or 9 courses. These courses provide the foundation for the specializations and advanced courses. Beginning with the class of 2023 the CS Core requirements will change as noted below. Note: ENGI W1006 is a prerequisite for the major.

The following are required courses toward the CS Core for the class of 2022 and earlier:
1. Intro to CS and Programming in Java (COMS W1004, 3pts) or Honors Intro to CS (COMS W1007, 3pts)
2. Data Structures in Java (COMS W3134, 3pts) or Honors Data Structures and Algorithms (COMS W3137, 4pts)
3. Advanced Programming (COMS W3157, 4pts)
4. Discrete Mathematics (COMS W3203, 3pts)
5. Linear Algebra (MATH 2010, APMA 3101, or APMA 2101, 3pts)
6. Computer Science Theory (COMS W3261, 3pts)
7. Fundamentals of Computer Systems (CSEE W3827, 3pts)
8. Probability and Statistics (STAT 4001 or IEOR 4150, 3pts)

The following are required courses toward the CS Core for the class of 2023 and beyond:
1. Intro to CS and Programming in Java (COMS W1004, 3ps) or Honors Intro to CS (COMS W1007, 3ps)
2. Data Structures in Java (COMS W3134, 3ps) or Honors Data Structures and Algorithms (COMS W3137, 4pts)
3. Advanced Programming (COMS W3157, 4pts)
4. Discrete Mathematics (COMS W3203, 3pts until Fall 2019, 4ps from Spring 2020)
5. Computational Linear Algebra (COMS 3251, 4pts, Recommended) or Linear Algebra (MATH 2010, APMA 3101, or APMA 2101, 3pts)
6. Computer Science Theory (COMS 3261, 3pts)
7. Fundamentals of Computer Systems (CSEE 3827, 3pts)

Tracks Coursework (~21 points)

The upper-level curriculum in Computer Science is organized into tracks of electives that allow you to select one of five major areas of Computer Science for study in greater depth. Each track consists of at least 21 points. In your second year you might want to discuss which track you should take with your advisor.

General Technical Electives (15 points)

In addition to the fulfilling the track requirements, 15 points of advisor approved general technical electives at the 3000 level or above are required. These general technical electives should be in mathematics, science, engineering or closely related disciplines. All GTE coursework must be approved by your CS faculty advisor prior to enrolling in them in order to ensure they fulfill the CS Major requirement.

The courses and requirements for each track are spelled out in detail in the [SEAS Bulletin](#).

In order to provide students with as large a variety of elective courses as possible, some electives are only offered every other year. Therefore, a student who begins taking track courses as a first semester junior has a full range of choices. If a student delays taking track courses until the second semester of the junior year, the range of choices is narrowed. Waiting to take track courses until the first semester of the senior year will conceivably delay graduation.

Foundations of Computer Science track

This track is for students interested in algorithms, computational complexity, and other areas of theoretical computer science.

- Two required courses
    - CSOR W4231 Analysis of Algorithms
    - COMS W4236 Introduction to Computational Complexity
- Five elective courses from this list
    - COMS W4203 Graph Theory
    - COMS W4252 Introduction to Computational Learning Theory
    - COMS W4261 Introduction to Cryptography
    - COMS E6232 Analysis of Algorithms II
    - COMS E6253 Advanced Topics in Computational Learning Theory
    - COMS E6261 Advanced Cryptography
    - Math 3020 Number Theory and Cryptography
    - Math 3025 Making, Breaking Codes
    - Math 4032 Fourier Analysis
    - Math 4041 Introduction to Modern Algebra I
    - Math 4042 Introduction to Modern Algebra II
    - Math 4061 Introduction to Modern Analysis 1
    - Math 4155 Probability Theory
    - Math 6238x. Enumerative Combinatorics
    - APMA 4300 Numerical Methods
    - CSPH 4801 Mathematical Logic 1
    - CSPH 4802 Mathematical Logic 11: incompleteness
    - PHIL 4431 Set Theory
    - IEOR E4407 Game Theoretic Models of Operation
    - IEOR E6400 Scheduling: Deterministic Models
    - IEOR E6603 Combinatorial Optimization
    - IEOR E6606 Advanced Topics in Network Flows
    - IEOR E6608 Integer Programming
    - IEOR E6610 Approximation Algorithms
    - IEOR E6613 Optimization I (4.5 points)
    - IEOR E6614 Optimization II (4.5 points)
    - IEOR E6711 Stochastic Models I
    - IEOR E6712 Stochastic Models II
    - EEORE6616 Convex Optimization
    - ELEN E6717 Information Theory
    - ELEN E6718 Algebraic Coding Theory
    - ELEN E6970 Resource Allocation and Networking Games
    - COMS W3902 Undergraduate Thesis (advisor approval required)
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)

Note: No more than 6 units of project/thesis courses (e.g. COMS W3902, COMS W3998, COMS W4901, COMS E6901) can count towards the major.

Note #2: Students who declared their Computer Science major prior to Fall 2016 may also count COMS 4241, COMS 4205, COMS 4281, COMS 4444, COMS 4771, and COMS 4772 as elective courses.

Software Systems Track

The software systems track is for students interested in the implementation of software systems.

- Three required courses
    - COMS W4115 Programming Languages and Translators
    - COMS W4118 Operating Systems
    - CSEE W4119 Computer Networks
- Any four courses from this list
    - Any COMS W41xx course
    - Any COMS W48xx course
    - COMS W3107 Clean Object-Oriented Design
    - COMS BC3930 Creative Embedded Systems
    - COMS W4444 Programming and Problem Solving
    - COMS W3902 Undergraduate Thesis – counts as two courses (advisor approval required; maybe repeated for credit)
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)
    - Any COMS E61xx course (advisor approval required)
    - Any COMS E68xx course (advisor approval required)

Note: No more than 6 pts of project/thesis courses (ex. COMS W3902, W3998, W4901, E6901) can count towards major.

Digital Systems Track

The digital systems track is for students interested in working at the interface of hardware and software. Subjects include digital design, computer architecture (both sequential and parallel) and embedded systems.

- One required course
    - CSEE4824 Computer Architecture
- At least one course from this list
    - EECS 4340 Computer Hardware Design
    - CSEE 4823 Advanced Logic Design
    - CSEE 4840 Embedded Systems
- At least one course from this list
    - COMS W4130 Parallel Programming
    - COMS W4115 Programming Languages and Translators
    - COMS W4118 Operating Systems
- Up to four courses from this list
    - Any COMS/CSEE W41xx
    - Any COMS/CSEE W48xx
    - CSEE E6824 Parallel Computer Architecture (advisor approval required)
    - CSEE E6847 Distributed Embedded Systems (advisor approval required)
    - COMS E6861 CAD of Digital Systems (advisor approval required)
    - CSEE W4868 (formerly E6868) System-on-Chip Platforms (advisor approval required)
    - COMS BC3930 Creative Embedded Systems
    - COMS W3902 Undergraduate Thesis (advisor approval required; may be repeated for credit)
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)

Note: No more than 6 pts of project/thesis courses (ex. COMS W3902, W3998, W4901, E6901) can count towards major.

Intelligent Systems Track

This track is for students interested in machine learning, robots, and systems capable of exhibiting ''human-like'' intelligence.

- At least three courses from this list
    - COMS W4701 Artificial Intelligence
    - COMS W4705 Natural Language Processing
    - COMS W4706 Spoken Language Processing
    - COMS W4731 Computer Vision
    - COMS W4733 Computational Aspects of Robotics
    - COMS W4771 Machine Learning
- Up to four courses from this list
    - COMS W4165 Computational Techniques in Pixel Processing
    - COMS W4252 Introduction to Computational Learning Theory
    - COMS W47xx (any course, if not used as a required course)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)
    - COMS E67xx (any course)
- Up to two courses from this list
    - COMS W3902 Undergraduate Thesis (advisor approval required; may be repeated for credit)
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
- Up to one course from this list
    - COMS W4111 Introduction to Databases
    - COMS W4160 Computer Graphics
    - COMS W4170 User Interface Design
    - COMS W4999 Computing and the Humanities

Note: No more than 6 pts of project/thesis courses (ex. COMS W3902, W3998, W4901, E6901) can count towards major.

Applications Track

This track is for students interested in interactive multimedia applications for the Internet and wireless networks.

- Two required courses
    - COMS W4111 Introduction to Databases
    - COMS W4170 User Interface Design
- Any five elective courses from this list
    - Any COMS W41xx course
    - Any COMS W47xx course
    - COMS W3107 Clean Object-Oriented Design
    - COMS BC3420 Privacy in a Networked World
    - COMS BC3430 Computational Sound
    - COMS BC3930 Creative Embedded Systems
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)
    - COMS W3902 Undergraduate Thesis – Can count as two courses (advisor approval required)
    - Any COMS E69xx course (advisor approval required)

Note: No more than 6 pts of project/thesis courses (ex. COMS W3902, W3998, W4901, E6901) can count towards major.

Vision, Graphics, Interaction, and Robotics Track

This track is for students interested in vision, graphics, and advanced forms of human-computer interaction.

- At least two courses from this list
    - COMS W4731 Computer Vision
    - COMS W4160 Computer Graphics
    - COMS W4167 Computer Animation
- Up to five elective courses from this list
    - COMS W4160, W4731, or W4167 (whichever is not taken as two courses above)
    - COMS W4162 Advanced Computer Graphics
    - COMS W4165 Computational Techniques in Pixel Processing
    - COMS W4170 User Interface Design
    - COMS W4172 3D User Interfaces and Augmented Reality
    - COMS W4701 Artificial Intelligence
    - COMS W4732 Computer Vision II: Learning
    - COMS W4733 Computational Aspects of Robotics
    - COMS W4735 Visual Interfaces to Computers
    - COMS W4771 Machine Learning
    - COMS W4995 Special Topics in Computer Science (Video Game Technology and Design)
    - COMS W4995/E6998 Topics in Computer Science (advisor approval required)
    - Any COMS BC3xxx course (advisor approval required)
    - COMS W3998/W4901 Projects in Computer Science (advisor approval required)
    - COMS W3902 Undergraduate Thesis – Can count as two courses (advisor approval required)
    - Any COMS E69xx course (advisor approval required)

Note: No more than 6 units of project/thesis courses (e.g. COMS W3902, COMS W3998, COMS W4901, COMS E6901) can count towards the major. The required track courses should be taken as early as possible starting in the junior year.

Advanced Track

An advanced version of each track is available for qualified students who would like extra opportunities for advanced learning. It comprises accelerated versions of the other six tracks. Entry is only by collective faculty invitation, extended to students who have already completed the core courses and the required courses for one of those tracks.

- Required Track Courses
    - A student designates one of the six other track areas and completes the set of required track courses for that track, prior to entry into the Advanced Track. There are two or three courses, depending on the designated area.
- Electives
    - At least 6 points of 4000-level lecture courses from the menu for the designated track, plus 6 points of 6000-level courses in the designated track area.
- Thesis
    - There is a required 6-point thesis.
- Invitation
    - Only the top 20 percent of computer science majors in course performance in computer science courses will be considered for invitation during the junior year. A student in the advanced track who does not maintain this status may be required to return to his/her previously selected track area.

Scheduling your CS courses

The list below is a suggested path to a BS major. It's not cast in stone and taking courses earlier than shown offers many advantages. Taking courses more than one semester later than suggested may foreclose some options.

- First Year
    - Fall or Spring: COMS E1006 (Intro to Computing for EAS).
    - Fall or Spring: COMS W1004 (Intro to CS) or COMS W1007 (Honors Intro to CS).
- Sophomore Year
    - Fall: COMS W3134 (Data Structures) or COMS W3137 (Honors Data Structures) and COMS W3203 (Discrete Math).
    - Spring: COMS W3157 (Advanced Programming) and CSEE W3827 (Fundamentals of Computer Systems).
- Junior Year
    - Fall: MATH 2010 (Linear Algebra), COMS W3261 (CS Theory), STAT 4001, and one track course.
    - Spring: two track courses and two general technical electives.
- Senior Year
    - Fall: two track courses and two general technical electives.
    - Spring: two track courses and one general technical elective.

The Computer Science Minor:

The Computer Science Department offers a minor in Computer Science for SEAS students consisting of 7 courses from the following list. Students who pass the Computer Science Advanced Placement Exam, either A or AB, with a 4 or 5 will receive 3 credits and exemption from COMS W1004.

The following are required courses for the CS concentration for the class of 2022 and earlier:

1. Intro to CS and Programming in Java (COMS W1004, 3pts) or Honors Intro to CS (COMS W1007, 3pts)
2. Data Structures (COMS W3134, 3pts) or Honors Data Structures and Algorithms (COMS W3137, 4pts)
3. Advanced Programming (COMS W3157, 4pts)
4. Discrete Mathematics (COMS W3203, 3pts until Fall 2019, 4pts from Spring 2020)
5. Computer Science Theory (COMS W3261, 3pts)
6. Fundamentals of Computer Systems (CSEE W3827, 3pts) or a 4000-level COMS technical elective (3pts)
7. 1 course from the following: Linear Algebra (MATH 2010, APMA 3101, APMA 2101) or Prob/Stats (STAT 4001, IEOR 4150)

The following are required courses for the CS concentration for the class of 2023 and beyond:

1. Intro to CS and Programming in Java (COMS W1004, 3pts) or Honors Intro to CS (COMS W1007, 3pts)
2. Data Structures (COMS W3134, 3pts) or Honors Data Structures and Algorithms (COMS W3137, 4pts)
3. Advanced Programming (COMS W3157, 4pts)
4. Discrete Mathematics (COMS W3203, 4pts)
5. Computer Science Theory (COMS W3261, 3pts)
6. Fundamentals of Computer Systems (CSEE W3827, 3pts) or a 4000-level COMS technical elective (3pts)
7. 1 course from the following: Computational Linear Algebra (COMS 3251, 4pts, Recommended), Linear Algebra (MATH 2010, APMA 3101, APMA 2101) or Prob/Stats (STAT 4001, IEOR 4150)