QuickGuide for SEAS CS Students (New Requirements Beginning Fall 2012)

This QuickGuide 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

Computer Science majors in SEAS at Columbia study an integrated curriculum consisting of a broad core of 8 foundational courses and an upper-level track of 7 advanced courses chosen from one of six elective tracks. In addition there is a Computing for Engineers and Applied Scientists pre-requisite, a 3-semester calculus requirement, and 5 general technical electives required for a total of 74 or 75 points. Upper-level students in Computer Science may assist faculty members in research projects. 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 EAS (ENGI E1006) during your first year. Try to take the introductory sequence of courses in Computer Science (COMS W1004-W3134 or W1007-W3137, W3203, and W3157) in your first two years. This will enable you to complete most of the CS core and to start your upper-level CS track in your junior year, which will provide you with a broad choice of electives in your chosen track.

Chose an introductory sequence that suits your background. If you have no experience programming in Java take COMS W1004-COMS W3134. If you took AP CS in Java in high school or have equivalent Java programming experience, take the honors introductory sequence COMS W1007-COMS W3137.

Take Discrete Math (W3203) concurrently with your data structures course (W3134 or W3137) during your second year.

Then take Advanced Programming (W3157). Advanced Programming teaches C, C++, Internet programming, and Unix utilities. It assumes you already have a programming background in Java

CS core curriculum

The core of the Computer Science curriculum for SEAS CS majors is built with the following eight courses. These courses provide the foundation for the tracks and the advanced courses. *Note: ENGI W1006 is a prerequisite for the major.*

1. Intro to CS and Programming in Java (COMS W1004) or Honors Intro to CS (COMS W1007)
2. Data Structures in Java (COMS W3134) or Honors Data Structures and Algorithms (COMS W3137)
3. Advanced Programming (COMS W3157)
4. Discrete Mathematics (COMS W3203)
5. Computational Linear Algebra (COMS W3251)
6. Computer Science Theory (COMS W3261)
7. Fundamentals of Computer Systems (CSEE W3827)
8. Probability and Statistics (SIEO W4150 or SIEO W3600)

Tracks + General Technical Electives

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. 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.

Foundations of Computer Science track

This track is for students interested in algorithms, computational complexity, scientific computing, and security.

- Three required courses
    - CSOR W4231 Analysis of Algorithms, I
    - COMS W4236 Introduction to Computational Complexity
    - COMS W4241 Numerical Algorithms and Complexity
- Any four elective courses from this list
    - COMS W4203 Graph Theory
    - COMS W4205 Combinatorial Theory
    - COMS W4252 Introduction to Computational Learning Theory
    - COMS W4261 Introduction to Cryptography
    - COMS W4281 Introduction to Quantum Computing
    - COMS W4444 Programming and Problem Solving
    - COMS W4771 Machine Learning
    - COMS W4772 (E6772) Advanced Machine Learning
    - COMS W4995 Math Foundations of Machine Learning
    - COMS E6232 Analysis of Algorithms II
    - COMS E6261 Advanced Cryptography
    - COMS E6717 Information Theory
    - COMS E6998 Approximation Algorithms
    - COMS W3902 Undergraduate Thesis (with advisor approval; may be repeated for credit)
    - COMS W3998 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS E6901 Projects in Computer Science (with advisor approval; may be repeated for credit)

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

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 W4444 Programming and Problem Solving
    - COMS W4995-W4996 Special projects in computer science, I and II
    - COMS W3902 Undergraduate Thesis - counts as two courses (With advisor approval; maybe repeated for credit)
    - COMS W3998 Projects in Computer Science (with advisor approval; maybe repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; maybe repeated for credit)
    - COMS E6901 Projects in Computer Science (with advisor approval; maybe repeated for credit)
    - Any COMS E61xx course with advisor approval
    - Any COMS E68xx course with advisor approval

    Note: No more than 6 units of project/thesis courses (COMS W3902, COMS W3998, COMS W4901, COMS E6901) can count towards the 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 (with advisor approval)
    - CSEE E6847 Distributed Embedded Systems (with advisor approval)
    - COMS E6861 CAD of Digital Systems (with advisor approval)
    - CSEE E6868 System-on-Chip Platforms (with advisor approval)
    - COMS W3902 Undergraduate Thesis (with advisor approval; may be repeated for credit)
    - COMS W3998 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS E6901 Projects in Computer Science (with advisor approval; may be repeated for credit

        Note: No more than 6 units of project/thesis courses (COMS W3902, COMS W3998, COMS W4901, COMS E6901) can count towards the 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 W40xx (any course, with advisor approval)
    - 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 Special Topics in Computer Science I (with advisor approval; may be repeated)
    - COMS W4996 Special Topics in Computer Science II (with advisor approval; may be repeated)
    - COMS E67xx (any course)
    - COMS E6998 Topics in Comp Science I (with advisor approval)
    - COMS E6999 Topics in Comp Science II (with advisor approval)
- Up to two courses from this list
    - COMS W3902 Undergraduate Thesis (with advisor approval; may be repeated for credit)
    - COMS W3998 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; may be repeated for credit)

- - COMS E6901 Projects in Computer Science (with advisor approval; may be repeated for credit)
- 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 units of project/thesis courses (COMS W3902, COMS W3998, COMS W4901, COMS E6901) can count towards the major.

Applications Track

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

- Two required courses
    - COMS W4115 Programming Languages and Translators
    - COMS W4170 User Interface Design
- Any five elective courses from this list
    - Any COMS W41xx course
    - Any COMS W47xx course
    - COMS W4995-W4996 Special Topics in Computer Science I and II
    - COMS W3902 Undergraduate Thesis – Can count as two courses (with advisor approval)
    - COMS W3998 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS E6901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - Any COMS E69xx course with advisor approval

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

Vision and Graphics 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 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 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-W4996 Special Projects in Computer Science, I and II
    - COMS W3902 Undergraduate Thesis – Can count as two courses (with advisor approval)
    - COMS W3998 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS W4901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - COMS E6901 Projects in Computer Science (with advisor approval; may be repeated for credit)
    - Any COMS E691x course with advisor approval

Note: No more than 6 units of project/thesis courses (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.

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.

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.

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.

- Freshman Year
  - 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: COMS W3251 (Computational Linear Algebra), COMS W3261 (Computer Science Theory), IEOR W4150 or SIEO W3600 (Probability and Statistics) 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.

1. Introduction to CS (W1004) or Honors Introduction to CS (W1007)

2. Data Structures in Java (W3134) or Honors Data Structures and Algorithms (W3137)
3. Advanced Programming (W3157)
4. Discrete Mathematics (W3203)
5. Computer Science Theory (W3261)
6. Fundamentals of Computer Systems (CSEE W3827) or a 4000-level COMS technical elective (3 points)
7. 1 course from the following: Computational Linear Algebra (W3251), or Prob/Stats (SIEO W4150 or SIEO W3600), or Scientific Computation (W3210)

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.

Questions?

Contact the course instructor if you have questions about a given course. If you have any questions, please send an email to advising@cs.columbia.edu.