Quick Guide for CC, GS, and Barnard CS Students

This Quick Guide is for Columbia College, General Studies, and Barnard students thinking of majoring or concentrating in Computer Science. It explains how the program is structured, what courses to take and when.

The Computer Science Major at Columbia College, General Studies, and Barnard

Computer Science majors study an integrated curriculum consisting of a broad core of 7 foundational courses, and an upper-level track of 5 or 6 advanced courses chosen from one of six elective tracks for a total of 40-47 points (22-26 points for CS core, 3 points Calculus II or III, and 15-18 points for track electives). 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.

Calculus Requirement

Calculus II or Calculus III is required for the major. Note that Calculus III does NOT depend on Calculus II. You can take either Calculus II or III, but we recommend Calculus III, which covers topics that are more relevant for upper-level Computer Science courses.

If you have received equivalent credits for Calculus I & II already (through AP Calculus exam for example), you are not required to take any more Calculus courses. But we recommend taking one more semester of Calculus, either Math UN1201 Calculus III or APAM E2000 Multivariate Calculus for Engineers and Scientists. APAM E2000 covers relevant topics from Calculus III and IV.

Getting started

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 any time 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 1st year if possible. These courses introduce you to basic computer science concepts and problem-solving techniques using Java.

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.

Pre-Introductory Courses

COMS W1004 is the first course in the Computer Science major curriculum, and it does not require any previous computing experience. Before taking COMS W1004, however, students have an option to start with one of the pre-introductory courses: ENGI E1006 or COMS W1002.

ENGI E1006 Introduction to Computing for Engineers and Applied Scientists is a general introduction to computing for STEM students. ENGI E1006 is in fact a required course for all SEAS CS majors. COMS W1002 Computing In Context is a course primarily intended for humanities majors, but it also serves as a pre-introductory course for CS majors. ENGI E1006 and COMS W1002 do not count towards Computer Science major.

CS core curriculum for Columbia College, General Studies, and Barnard

The core of the Computer Science curriculum for CS majors is built with the following seven courses. These courses provide the foundation for the tracks and the advanced courses.

Though not required, Intro to Comp for Eng/App (ENGI E1006) is also recommended for BA majors.

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 (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)
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 toward the CS Core 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)
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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)
7. Computational Linear Algebra (COMS 3251, 4pts)

Tracks

The upper-level curriculum in Computer Science is organized into tracks of electives which allow you to select one of five major areas of Computer Science for study in greater depth. A track consists of 15-18 points encompassing two or three required courses, one breadth course, and one or two elective courses for a total of 5-6 courses. In your second year you might want to discuss which track you should take with your advisor.

For courses marked with "advisor approval required", students must obtain their CS faculty advisor's approval before taking the course in order to count the course towards the major.

Foundations of Computer Science Track

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

- Two required courses
  - CSOR W4231 Analysis of Algorithms
  - COMS W4236 Introduction to Computational Complexity
- One breadth course
  - Any COMS 3000- or 4000-level course of at least 3 points except those courses in the CS core or in the required or elective courses for this track
- Two 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 V3020 Number Theory and Cryptography
  - Math V3025 Making, Breaking Codes
  - Math W4032 Fourier Analysis
  - Math W4041 Introduction to Modern Algebra I
  - Math W4042 Introduction to Modern Algebra II
  - Math W4061 Introduction to Modern Analysis 1
  - Math W4155 Probability Theory
  - Math G6238x. Enumerative Combinatorics
  - APMA 4300 Numerical Methods
  - CSPH G4801 Mathematical Logic 1
  - CSPH G4802 Mathematical Logic 11: incompleteness
  - PHIL G4431 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)

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
- One breadth course
    - Any COMS 3000- or 4000-level course of at least 3 points except those courses in the CS core or in the required or elective courses for this track
- One elective course 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 (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)
    - Any COMS E61xx course (advisor approval required)
    - Any COMS E68xx course (advisor approval required)

Intelligent Systems Track

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

- Any two required 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
- One breadth course
    - Any COMS 3000- or 4000-level course of at least 3 points except those courses in the CS core or in the required or elective courses for this track
- Two elective course from this list
    - COMS W3902 Undergraduate thesis (advisor approval required)
    - 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 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 E67xx (any course)

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
- One breadth course
    - Any COMS 3000- or 4000-level course of at least 3 points except those courses in the CS core or in the required or elective courses for this track
- Two 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 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)
    - Any COMS E69xx course (advisor approval required)

Vision, Graphics, Interaction, and Robotics Track

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

- Any two courses from
    - COMS W4160 Computer Graphics
    - COMS W4731 Computer Vision
    - COMS W4167 Computer Animation
- One breadth course
    - Any COMS 3000- or 4000-level course of at least 3 points except those courses in the CS core or in the required or elective courses for this track
- Two elective courses from this list
    - COMS W4162 Advanced Computer Graphics
    - COMS W4165 Computational Techniques in Pixel Processing
    - COMS W4167 Computer Animation
    - COMS W4170 User Interface Design
    - COMS W4172 3D User Interfaces
    - 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 I (Video Game Technology and Design)
    - 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)
    - Any COMS E69xx course (advisor approval required)

Combination Track

This track is for students who wish to combine computer science with another discipline in the arts, humanities, social or natural sciences. A coherent selection of six upper-level courses is required: three from computer science and three from another discipline.

The courses should be planned with and approved by the student's CS faculty advisor by September 30th of the junior year. The six courses are typically 4000-level elective courses that would count towards the individual majors. Moreover, the six courses should have a common theme. The combination track is not available to those students who pursue double majors.

For a Concentration or Minor in Computer Science

The Computer Science Department offers a concentration/minor in Computer Science consisting of the following seven courses with a total of 23-25 points.

Though not required, Intro to Comp for Eng/App (ENGI E1006) is also recommended.

The following are required courses for the CS concentration/minor 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/minor 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. Computational Linear Algebra (COMS 3251, 4pts)

Double-counting CS requirements with another major/minor/concentration

If you are a CC or GS student, you may double-count the following CS requirements with another major, minor, or concentration:

- Any calculus courses (including Honors Math A and B)
- COMS W1004 Introduction to CS and Programming in Java
- Linear Algebra courses (COMS 3251, MATH 2010)

If you are a BC student and your major requires more than 40 credits, you may double-count up to two courses if they are required for both major and minor. Exception should be discussed with the Barnard CS department chair.

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 /

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.