COMPUTER SCIENCE

http://www.cs.barnard.edu

Departmental Office: 504 Milstein Center; 212-853-0305

Director: Dr. Rebecca Wright, chair-cs@barnard.edu

Barnard’s computer science community is growing. The number of Computer Science majors at Barnard has doubled over the last several years. Barnard’s Computer Science program offers meaningful computing education and experiences to all Barnard students and partners with Columbia’s Computer Science department to offer a major in Computer Science. The program aims to expand students’ use and understanding of computation and data analysis across disciplines; offer students opportunities to think critically about the social implications of technology, including how to harness it for social good; promote curricular and pedagogical advances in computer science and its multidisciplinary applications; and provide new models for engaging students and enhancing diversity in computing.

Program Director: Rebecca Wright

Professor: Rebecca Wright (Druckenmiller Professor of Computer Science)

Assistant Professors: Emily Black, Brian Plancher, Mark Santolucito, Corey Toler-Franklin

Visiting Associate Professor: Smaranda Muresan

Faculty Fellows: Antonio Moretti (Roman Family Teaching and Research Fellow), Lisa Soros (Roman Family Teaching and Research Fellow)

For a list of other officers of the University offering courses in Computer Science, please see the Columbia Computer Science department website below:

https://www.cs.columbia.edu/people/faculty/

As of Fall 2023, there is a new "trackless" version of the Computer Science curriculum. Barnard students who declared the major before Fall 2023 will still follow the older, track-based CS curriculum, though we can allow the new version as an exception.

Requirements for Students Declaring the Major in Fall 2023 or after (p. 1):

PREREQUISITE
MATH UN1101 CALCULUS I

MATH REQUIREMENTS

A. CALCULUS III / MULTIVARIABLE CALCULUS (select one of the following)
   MATH UN1201 CALCULUS III
   MATH UN1205 ACCELERATED MULTIVARIABLE CALC
   APMA E2000 MULTV. CALC. FOR ENGI # APP SCI

B. LINEAR ALGEBRA (select one of the following)
   COMS W3251 COMPUTATIONAL LINEAR ALGEBRA
   APMA E3101 APPLIED MATH I: LINEAR ALGEBRA
   APMA E2101 INTRO TO APPLIED MATHEMATICS
   MATH UN2010 LINEAR ALGEBRA
   MATH UN2015 Linear Algebra and Probability

C. PROBABILITY (select one of the following)

STAT UN1201 CALC-BASED INTRO TO STATISTICS
STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS
IEOR E3658 PROBABILITY FOR ENGINEERS
MATH UN2015 Linear Algebra and Probability

** MATH UN2015 can double count for Linear Algebra and Probability requirements. This is the ONLY instance a course can double count.

CS CORE (6 required courses)

COMS W1004 Introduction to Computer Science and Programming in Java
COMS W3134 Data Structures in Java
COMS W3157 ADVANCED PROGRAMMING
COMS W3203 DISCRETE MATHEMATICS
COMS W3261 COMPUTER SCIENCE THEORY
CSEE W3827 FUNDAMENTALS OF COMPUTER SYSTS

AREA FOUNDATION COURSES (AFC)
Select 3 courses from the following list:

COMS W4111 INTRODUCTION TO DATABASES
COMS W4113 FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115 PROGRAMMING LANG # TRANSLATORS
COMS W4118 OPERATING SYSTEMS I
CSEE W4119 COMPUTER NETWORKS
COMS W4152 Engineering Software-as-a-Service
COMS W4156 ADVANCED SOFTWARE ENGINEERING
COMS W4160 COMPUTER GRAPHICS
COMS W4167 COMPUTER ANIMATION
COMS W4170 USER INTERFACE DESIGN
COMS W4181 SECURITY I
CSOR W4231 ANALYSIS OF ALGORITHMS I
COMS W4236 INTRO-COMPUTATIONAL COMPLEXITY
COMS W4701 ARTIFICIAL INTELLIGENCE
COMS W4705 NATURAL LANGUAGE PROCESSING
COMS W4731 Computer Vision I: First Principles
COMS W4733 COMPUTATIONAL ASPECTS OF ROBOTICS
CBMF W4761 COMPUTATIONAL GENOMICS
COMS W4771 MACHINE LEARNING
CSEE W4824 COMPUTER ARCHITECTURE
CSEE W4868 SYSTEM-ON-CHIP PLATFORMS

CS ELECTIVES

3 courses from COMS/CSXX/XXCS that are at the 3000 level or higher and are at least 3-point courses

Requirements for Students who Declared the Major Prior to the Fall of 2023 (p. 1):

See below for the track-based curriculum.

Barnard College Computer Science Courses
COMS BC1016 Introduction to Computational Thinking and Data Science. 3.00 points.

This course and its co-requisite lab course will introduce students to the methods and tools used in data science to obtain insights from data. Students will learn how to analyze data arising from real-world phenomena while mastering critical concepts and skills in computer programming and statistical inference. The course will involve hands-on analysis of real-world datasets, including economic data, document collections, geographical data, and social networks. The course is ideal for students looking to increase their digital literacy and expand their use and understanding of computation and data analysis across disciplines. No prior programming or college-level math background is required.

Fall 2023: COMS BC1016

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 1016</td>
<td>001/00542</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Lisa Soros</td>
<td>3.00</td>
<td>40/42</td>
</tr>
<tr>
<td>COMS 1016</td>
<td>002/00543</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>Antonio Moretti</td>
<td>3.00</td>
<td>38/42</td>
</tr>
<tr>
<td>COMS 1016</td>
<td>002/00545</td>
<td>T Th 11:10am - 12:25pm</td>
<td>Emily Black</td>
<td>3.00</td>
<td>40/42</td>
</tr>
</tbody>
</table>

COMS BC1017 Introduction to Computational Thinking and Data Science - Lab. 1.00 point.

This is the co-requisite lab to COMS BC 1016 (Introduction to Computational Thinking and Data Science) This course will introduce students to the methods and tools used in data science to obtain insights from data. Students will learn how to analyze data arising from real-world phenomena while mastering critical concepts and skills in computer programming and statistical inference. The course will involve hands-on analysis of real-world datasets, including economic data, document collections, geographical data, and social networks. This class is ideal for students looking to increase their digital literacy and expand their use and understanding of computation and data analysis across disciplines. No prior programming or math background is required.

Spring 2024: COMS BC1016

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 1016</td>
<td>001/00255</td>
<td>T Th 10:10am - 11:25am</td>
<td>Emily Black</td>
<td>3.00</td>
<td>43/42</td>
</tr>
<tr>
<td>COMS 1016</td>
<td>002/00256</td>
<td>T Th 11:40am - 12:55pm</td>
<td>Emily Black</td>
<td>3.00</td>
<td>40/42</td>
</tr>
</tbody>
</table>

COMS BC3099 INDEPENDENT STUDY. 1.00-4.00 points.

Course can be taken for 1-4 points.

Fall 2023: COMS BC3099

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 3099</td>
<td>001/00775</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Lisa Soros</td>
<td>1.00</td>
<td>1/5</td>
</tr>
<tr>
<td>COMS 3099</td>
<td>002/00776</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>Antonio Moretti</td>
<td>1.00</td>
<td>1/5</td>
</tr>
<tr>
<td>COMS 3099</td>
<td>003/00780</td>
<td>T 4:10pm - 7:00pm</td>
<td>Rebecca Wright</td>
<td>1.00</td>
<td>3/5</td>
</tr>
<tr>
<td>COMS 3099</td>
<td>005/00786</td>
<td>T 4:10pm - 7:00pm</td>
<td>Lisa Soros</td>
<td>1.00</td>
<td>3/5</td>
</tr>
<tr>
<td>COMS 3099</td>
<td>006/00793</td>
<td>T 4:10pm - 7:00pm</td>
<td>Paul Blaer</td>
<td>1.00</td>
<td>1/5</td>
</tr>
</tbody>
</table>

Spring 2024: COMS BC3099

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 3099</td>
<td>001/00850</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Emily Black</td>
<td>3.00</td>
<td>40/42</td>
</tr>
<tr>
<td>COMS 3099</td>
<td>004/00857</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Brian Plancher</td>
<td>1.00</td>
<td>4/5</td>
</tr>
</tbody>
</table>

COMS BC3162 DEVELOPING ACCESSIBLE USER INTERFACES. 3.00 points.

Introduction to access technology and the development of accessible systems. In this course, students build and evaluate various access technologies. Topics include: text-to-speech, speech recognition, screen readers, screen magnification, alternative input, tactile displays, and web transformation. This course teaches students to understand user interfaces of today's user interface technology and serve as a guide for building the user interfaces of the future.

Spring 2024: COMS BC3162

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 3162</td>
<td>001/00257</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Emily Black</td>
<td>3.00</td>
<td>36/35</td>
</tr>
<tr>
<td>COMS 3162</td>
<td>002/00256</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>Antonio Moretti</td>
<td>3.00</td>
<td>36/35</td>
</tr>
<tr>
<td>COMS 3162</td>
<td>003/00256</td>
<td>W 11:00am - 12:50pm</td>
<td>Emily Black</td>
<td>1.00</td>
<td>15/25</td>
</tr>
<tr>
<td>COMS 3162</td>
<td>004/00256</td>
<td>W 2:10pm - 4:00pm</td>
<td>Emily Black</td>
<td>1.00</td>
<td>20/25</td>
</tr>
</tbody>
</table>
COMS BC3364 Introduction to Contextual Design for Technology. 3 points.
Introduces methods and tools used in Contextual Inquiry (CI) specifically the early stages of software design focused on meeting user needs. Key concepts include user research, contextual design, design thinking, ideation, iterative design, prototyping, and design documentation. Projects utilize software tools used in the industry.

COMS BC3420 PRIVACY IN A NETWORKED WORLD. 4.00 points.
The ubiquity of computers and networks in business, government, recreation, and almost all aspects of daily life has led to a proliferation of online sensitive data: data that, if used improperly, can harm the data subjects. As a result, concern about the use, ownership, control, privacy, and accuracy of these data has become a top priority. This seminar course focuses on both the technical challenges of handling sensitive data, the privacy implications of various technologies, and the policy and legal issues facing data subjects, data owners, and data users.

COMS BC3430 Computational Sound. 3.00 points.
In this course, we explore the variety of roles that computation can play in the analysis, creation, and performance of music. We start with the fundamentals of sound in the digital domain, covering issues of representation and audio synthesis. We then move through various synthesis techniques including the additive, subtractive, frequency modulation (FM), and amplitude modulation (AM) synthesis. After covering some core DSP techniques, we put these concepts into performatve practice by exploring "live coding". In the space of live coding, we examine various programming language designs to understand how various domain specific languages (DSLs) support live coding. For the third module, we turn our focus to automated composition and analysis, addressing challenges in music information retrieval, generative art, and autonomous improvisation systems. All the while, we continue to develop our fluency in live coding by putting new topics to practice.

COMS BC3930 Creative Embedded Systems. 3.00 points.
Ubiquitous computing is creating new canvases and opportunities for creative ideas. This class explores the use of microprocessors, distributed sensor networks, IoT, and intermedia systems for the purposes of creative expression. The course is delivered in a mixed lecture and lab format that introduces the fundamental concepts and theory behind embedded systems as well as issues particular to their creative employment. The key objective of the course is for students to conceive of and implement creative uses of computation.
COMS W1003 INTRO-COMPUT SCI/PROGRAM IN C. 3.00 points.
COMS W1004 Introduction to Computer Science and Programming in Java. 3 points.
Lect: 3.

A general introduction to computer science for science and engineering students interested in majoring in computer science or engineering. Covers fundamental concepts of computer science, algorithmic problem-solving capabilities, and introductory Java programming skills. Assumes no prior programming background. Columbia University students may receive credit for only one of the following two courses: 1004 or 1005.

Fall 2023: COMS W1004

Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 1004  001/11546  M W 2:40pm - 3:55pm  309 Havemeyer Hall  Paul Blaer  3  290/320

COMS 1004  002/11547  M W 6:40pm - 6:55pm  417 International Affairs Bldg  Paul Blaer  3  249/398

Spring 2024: COMS W1004

Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 1004  001/11451  T Th 11:40am - 12:55pm  417 International Affairs Bldg  Adam Cannon  3  127/398

COMS 1004  002/12052  T Th 1:10pm - 2:25pm  417 International Affairs Bldg  Adam Cannon  3  121/398

COMS W1005 Introduction to Computer Science and Programming in MATLAB. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

A general introduction to computer science concepts, algorithmic problem-solving capabilities, and programming skills in MATLAB. Assumes no prior programming background. Columbia University students may receive credit for only one of the following two courses: W1004 or W1005.

COMS W1007 Honors Introduction to Computer Science. 3 points.
Lect: 3.

Prerequisites: AP Computer Science with a grade of 4 or 5 or similar experience.
An honors-level introduction to computer science, intended primarily for students considering a major in computer science. Computer science as a science of abstraction. Creating models for reasoning about and solving problems. The basic elements of computers and computer programs. Implementing abstractions using data structures and algorithms. Taught in Java.

COMS W1011 INTERMED COMPUTER PROGRAMMING. 3.00 points.
COMS W1012 COMPUTING IN CONTEXT REC. 0.00 points.

Fall 2023: COMS W1012

Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 1012  001/11548  Th 7:10pm - 8:00pm  825 Seeley W. Mudd Building  Adam Cannon  0.00  40/40

COMS 1012  002/11198  F 10:10am - 10:50am  825 Seeley W. Mudd Building  Adam Cannon  0.00  23/40

COMS 1012  003/11199  F 11:00am - 11:50am  825 Seeley W. Mudd Building  Adam Cannon  0.00  23/40

COMS 1012  004/11200  F 2:00pm - 2:50pm  825 Seeley W. Mudd Building  Adam Cannon  0.00  34/40

COMS 1012  005/11201  F 9:00am - 9:40am  825 Seeley W. Mudd Building  Adam Cannon  0.00  22/30

COMS 1012  006/11202  F 1:00pm - 1:50pm  825 Seeley W. Mudd Building  Adam Cannon, Mark Santolucito  0.00  17/30

COMS 1012  007/11203  Th 7:10pm - 8:00pm  327 Seeley W. Mudd Building  Adam Cannon  0.00  10/30

COMS 1012  008/11204  F 1:00pm - 1:50pm  337 Seeley W. Mudd Building  Adam Cannon  0.00  3/30

COMS 1012  009/11205  Th 7:10pm - 8:00pm  306 Uris Hall  Adam Cannon  0.00  15/20

COMS 1012  010/11206  F 11:00am - 11:50am  337 Seeley W. Mudd Building  Adam Cannon  0.00  7/20
COMS W1103 HONORS INTRO COMPUTER SCIENCE. 3.00 points.

COMS W1404 EMERGING SCHOLARS PROG SEMINAR. 1.00 point.
Pass/Fail only.

Prerequisites: the instructor’s permission. Corequisites: COMS W1002 or COMS W1004 or COMS W1007
Corequisites: COMS W1004, COMS W1007, COMS W1002
Prerequisites: the instructors permission. Corequisites: COMS W1002 or COMS W1004 or COMS W1007 Corequisites: COMS W1004, COMS W1007, COMS W1002 Peer-led weekly seminar intended for first and second year undergraduates considering a major in Computer Science. Pass/fail only. May not be used towards satisfying the major or SEAS credit requirements

COMS W3011 INTERMED COMPUTER PROGRAMMING. 3.00 points.

COMS W3101 Programming Languages. 1 point.
Lect: 1.

Prerequisites: Fluency in at least one programming language. Introduction to a programming language. Each section is devoted to a specific language. Intended only for those who are already fluent in at least one programming language. Sections may meet for one hour per week for the whole term, for three hours per week for the first third of the term, or for two hours per week for the first six weeks. May be repeated for credit if different languages are involved.

COMS W3102 DEVELOPMENT TECHNOLOGY. 1.00-2.00 points.

Prerequisites: Fluency in at least one programming language.
Prerequisites: Fluency in at least one programming language.
Introduction to software development tools and environments. Each section devoted to a specific tool or environment. One-point sections meet for two hours each week for half a semester, and two point sections include an additional two-hour lab

COMS W3107 Clean Object-Oriented Design. 3.00 points.

Prerequisites: Intro to Computer Science/Programming in Java (COMS W1004) or instructor’s permission. May not take for credit if already received credit for COMS W1007.

Prerequisites: see notes re: points
A course in designing, documenting, coding, and testing robust computer software, according to object-oriented design patterns and clean coding practices. Taught in Java. Object-oriented design principles include: use cases; CRC; UML; javadoc; patterns (adapter, builder, command, composite, decorator, facade, factory, iterator, lazy evaluation, observer, singleton, strategy, template, visitor); design by contract; loop invariants; interfaces and inheritance hierarchies; anonymous classes and null objects; graphical widgets; events and listeners; Java’s Object class; generic types; reflection; timers, threads, and locks
COMS W3123 ASSEMBLY LANG AND COMPUT LOGIC. 3.00 points.

COMS W3132 Intermediate Computing in Python. 4.00 points.
Essential data structures and algorithms in Python with practical software development skills, applications in a variety of areas including biology, natural language processing, data science and others

Spring 2024: COMS W3132
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3132 001/15110 F 1:10pm - 3:40pm 413 Kent Hall Jan Janak 4.00 63/60

COMS W3134 Data Structures in Java. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W1004) or knowledge of Java.
Data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection.
Storage management. Rudiments of the analysis of algorithms. Taught in Java. Note: Due to significant overlap, students may receive credit for only one of the following three courses: COMS W3134, COMS W3136, COMS W3137.

Fall 2023: COMS W3134
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3134 001/11208 M W 4:10pm - 5:25pm 301 Uris Hall Brian Borowski 3 225/250
COMS 3134 002/11209 M W 5:40pm - 6:55pm 301 Uris Hall Brian Borowski 3 100/250

Spring 2024: COMS W3134
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3134 001/12067 M W 4:10pm - 5:25pm 301 Uris Hall Brian Borowski 3 242/250
COMS 3134 002/12068 M W 5:40pm - 6:55pm 301 Uris Hall Brian Borowski 3 152/250

COMS W3136 ESSENTIAL DATA STRUCTURES. 4.00 points.
Prerequisites: (COMS W1004) or (COMS W1005) or (COMS W1007) or (ENGI E1006)
Prerequisites: (COMS W1004) or (COMS W1005) or (COMS W1007) or (ENGI E1006) A second programming course intended for nonmajors with at least one semester of introductory programming experience.
Basic elements of programming in C and C, array-based data structures, heaps, linked lists, C programming in UNIX environment, object-oriented programming in C, trees, graphs, generic programming, hash tables. Due to significant overlap, students may only receive credit for either COMS W3134, W3136, or W3137

Fall 2023: COMS W3136
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3136 001/11210 T Th 5:40pm - 6:55pm 401 Computer Science Bldg Timothy Paine 4.00 25/65

COMS W3137 HONORS DATA STRUCTURES # ALGOL. 4.00 points.
Prerequisites: (COMS W1004) or (COMS W1007)
Corequisites: COMS W3203
Prerequisites: (COMS W1004) or (COMS W1007) Corequisites: COMS W3203 An honors introduction to data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection. Storage management. Design and analysis of algorithms. Taught in Java. Note: Due to significant overlap, students may receive credit for only one of the following three courses: COMS W3134, W3136, or W3137

COMS W3157 ADVANCED PROGRAMMING. 4.00 points.
Lect. 4.

Prerequisites: (COMS W3134) or (COMS W3137)
Prerequisites: (COMS W3134) or (COMS W3137) C programming language and Unix systems programming. Also covers Git, Make, TCP/IP networking basics, C fundamentals

Fall 2023: COMS W3157
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3157 001/11211 T Th 2:40pm - 3:55pm 301 Pupin Laboratories Jae Lee 4.00 240/272
COMS 3157 002/11212 T Th 5:40pm - 6:55pm 301 Pupin Laboratories Jae Lee 4.00 214/272

Spring 2024: COMS W3157
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3157 001/12069 T Th 4:10pm - 5:25pm 417 International Affairs Bldg Jae Lee 4.00 311/398

COMS W3202 FINITE MATHEMATICS. 3.00 points.

COMS W3203 DISCRETE MATHEMATICS. 4.00 points.
Lect. 3.

Prerequisites: Any introductory course in computer programming.
Prerequisites: Any introductory course in computer programming. Logic and formal proofs, sequences and summation, mathematical induction, binomial coefficients, elements of finite probability, recurrence relations, equivalence relations and partial orderings, and topics in graph theory (including isomorphism, traversability, planarity, and colorings)

Fall 2023: COMS W3203
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3203 001/11213 M W 2:40pm - 3:55pm 301 Pupin Laboratories Tony Dear 4.00 119/180
COMS 3203 002/11214 M W 4:10pm - 5:25pm 428 Pupin Laboratories Tony Dear 4.00 81/180

Spring 2024: COMS W3203
Course Number Section/Call Number Times/Location Instructor Points Enrollment
COMS 3203 001/12070 T Th 10:10am - 11:25am 301 Uris Hall Ansaf Salleb Aoussi 4.00 219/200
COMS 3203 002/12071 T Th 11:40am - 12:55pm 301 Uris Hall Ansaf Salleb Aoussi 4.00 212/200
COMS W3210 Scientific Computation. 3 points.
CC/GS: Partial Fulfillment of Science Requirement


COMS W3251 COMPUTATIONAL LINEAR ALGEBRA. 4.00 points.

COMS W3261 COMPUTER SCIENCE THEORY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3203)
Corequisites: COMS W3134, COMS W3136, COMS W3137
Prerequisites: (COMS W3203)
Corequisites: COMS W3134, COMS W3136, COMS W3137
Regular languages: deterministic and non-deterministic finite automata, regular expressions. Context-free languages: context-free grammars, push-down automata. Turing machines, the Chomsky hierarchy, and the Church-Turing thesis.
Introduction to Complexity Theory and NP-Completeness

COMS W3410 COMPUTERS AND SOCIETY. 3.00 points.
Lect: 3.

Suitable for nonmajors

COMS W3902 UNDERGRADUATE THESIS. 0.00-6.00 points.
Prerequisites: Agreement by a faculty member to serve as thesis adviser. Agreement by a faculty member to serve as thesis adviser. An independent theoretical or experimental investigation by an undergraduate major of an appropriate problem in computer science carried out under the supervision of a faculty member. A formal written report is mandatory and an oral presentation may also be required. May be taken over more than one term, in which case the grade is deferred until all 6 points have been completed. Consult the department for section assignment

COMS W3995 Special Topics in Computer Science. 3 points.
Lect: 3.

Prerequisites: the instructor's permission. Consult the department for section assignment. Special topics arranged as the need and availability arise. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit.

COMS W3998 UNDERGRAD PROJECTS IN COMP SCI. 1.00-3.00 points.
Prerequisites: Approval by a faculty member who agrees to supervise the work.
Prerequisites: Approval by a faculty member who agrees to supervise the work. Independent project involving laboratory work, computer programming, analytical investigation, or engineering design. May be repeated for credit, but not for a total of more than 3 points of degree credit. Consult the department for section assignment

COMS W3999 FIELDWORK. 1.00 point.
Prerequisites: Obtained internship and approval from faculty advisor. May be repeated for credit, but no more than 3 total points may be used toward the 128-credit degree requirement. Only for SEAS computer science undergraduate students who include relevant off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. May not be used as a technical or non-technical elective. May not be taken for pass/fail credit or audited

COMS W4111 INTRODUCTION TO DATABASES. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: COMS W3134, COMS W3136, or COMS W3137; or the instructor’s permission.

Prerequisites: (COMS W3134) or (COMS W3136) or (COMS W3137) or The fundamentals of database design and application development using databases: entity-relationship modeling, logical design of relational databases, relational data definition and manipulation languages, SQL, XML, query processing, physical database tuning, transaction processing, security. Programming projects are required
COMS W4112 DATABASE SYSTEM IMPLEMENTATION. 3.00 points.  
Lect: 2.5.

Prerequisites: (COMS W4111) and fluency in Java or C++. CSEE W3827 is recommended.

The principles and practice of building large-scale database management systems. Storage methods and indexing, query processing and optimization, materialized views, transaction processing and recovery, object-relational databases, parallel and distributed databases, performance considerations. Programming projects are required.

COMS W4113 FUND-LARGE-SCALE DIST SYSTEMS. 3.00 points.  
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3157 or COMS W4118 or CSEE W4119) Design and implementation of large-scale distributed and cloud systems. Teaches abstractions, design and implementation techniques that enable the building of fast, scalable, fault-tolerant distributed systems. Topics include distributed communication models (e.g., sockets, remote procedure calls, distributed shared memory), distributed synchronization (clock synchronization, logical clocks, distributed mutex), distributed file systems, replication, consistency models, fault tolerance, distributed transactions, agreement and commitment, Paxos-based consensus, MapReduce infrastructures, scalable distributed databases. Combines concepts and algorithms with descriptions of real-world implementations at Google, Facebook, Yahoo, Microsoft, LinkedIn, etc.

COMS W4115 PROGRAMMING LANG # TRANSLATORS. 3.00 points.  
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3261) or (CSEE W3827) or equivalent, or the instructors permission. Principles of parallel software design. Topics include task and data decomposition, load-balancing, reasoning about correctness, determinacy, safety, and deadlock-freedom. Application of techniques through semester-long design project implementing performant, parallel application in a modern parallel programming language.

COMS W4118 OPERATING SYSTEMS I. 3.00 points.  
Lect: 3.

Prerequisites: (CSEE W3827) and knowledge of C and programming tools as covered in COMS W3136, W3157, or W3101, or the instructor's permission. Design and implementation of operating systems. Topics include process management, process synchronization and interprocess communication, memory management, virtual memory, interrupt handling, processor scheduling, device management, I/O, and file systems. Case study of the UNIX operating system. A programming project is required.

COMS W4119 COMPUTER NETWORKS. 3.00 points.  
Introduction to computer networks and the technical foundations of the internet, including applications, protocols, local area networks, algorithms for routing and congestion control, security, elementary performance evaluation. Several written and programming assignments required.

COMS W4121 COMPUTER SYSTEMS FOR DATA SCIENCE. 3.00 points.  
Prerequisites: background in Computer System Organization and good working knowledge of C/C++ Corequisites: CSOR W4246,STAT GU4203 An introduction to computer architecture and distributed systems with an emphasis on warehouse scale computing systems. Topics will include fundamental tradeoffs in computer systems, hardware and software techniques for exploiting instruction-level parallelism, data-level parallelism and task level parallelism, scheduling, caching, prefetching, network and memory architecture, latency and throughput optimizations, specialization, and an introduction to programming data center computers.

COMS W4130 Principles and Practice of Parallel Programming. 3 points.  
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3137 or COMS W3136 and experience in Java) and basic understanding of analysis of algorithms. Principles of parallel software design. Topics include task and data decomposition, load-balancing, reasoning about correctness, determinacy, safety, and deadlock-freedom. Application of techniques through semester-long design project implementing performant, parallel application in a modern parallel programming language.
COMS W4152 Engineering Software-as-a-Service. 3.00 points.
Modern software engineering concepts and practices including topics such as Software-as-a-Service, Service-oriented Architecture, Agile Development, Behavior-driven Development, Ruby on Rails, and Dev/ops

COMS W4156 ADVANCED SOFTWARE ENGINEERING. 3.00 points.
Lect: 3.

Prerequisites: (COMS W3157) or equivalent.
Prerequisites: (COMS W3157) or equivalent. Software lifecycle using frameworks, libraries and services. Major emphasis on software testing. Centers on a team project

COMS W4160 COMPUTER GRAPHICS. 3.00 points.
Lect: 3.

Prerequisites: (COMS W3134) or (COMS W3136) or (COMS W3137) COMS W4156 is recommended. Strong programming background and some mathematical familiarity including linear algebra is required.

COMS W4162 Advanced Computer Graphics. 3 points.
Lect: 3.

Prerequisites: (COMS W4160) or equivalent, or the instructor’s permission.

COMS W4165 COMPUT TECHNIQUES-PIXEL PROCESS. 3.00 points.
An intensive introduction to image processing - digital filtering theory, image enhancement, image reconstruction, antialiasing, warping, and the state of the art in special effects. Topics from the basis of high-quality rendering in computer graphics and of low-level processing for computer vision, remote sensing, and medical imaging. Emphasizes computational techniques for implementing useful image-processing functions

COMS W4167 COMPUTER ANIMATION. 3.00 points.
Lect: 3.

Prerequisites: Multivariable calculus, linear algebra, C++ programming proficiency. COMS W4156 recommended.

Theory and practice of physics-based animation algorithms, including animated clothing, hair, smoke, water, collisions, impact, and kitchen sinks. Topics covered: Integration of ordinary differential equations, formulation of physical models, treatment of discontinuities including collisions/contact, animation control, constrained Lagrangian Mechanics, friction/dissipation, continuum mechanics, finite elements, rigid bodies, thin shells, discretization of Navier-Stokes equations. General education requirement: quantitative and deductive reasoning (QUA).
COMS W4170 USER INTERFACE DESIGN. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137)
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137)
Introduction to the theory and practice of computer user interface design, emphasizing the software design of graphical user interfaces. Topics include basic interaction devices and techniques, human factors, interaction styles, dialogue design, and software infrastructure. Design and programming projects are required

Fall 2023: COMS W4170
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4170       | 001/11225            | T Th 1:10pm - 2:25pm 428 Pupin Laboratories | Brian Smith | 3.00   | 147/140    |
COMS 4170       | V01/18565            |                    | Brian Smith | 3.00   | 8/99       |

Spring 2024: COMS W4170
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4170       | 001/12081            | M W 1:10pm - 2:25pm 417 International Affairs Bldg | Lydia Chilton | 3.00   | 422/398    |
COMS 4170       | V01/15381            |                    | Lydia Chilton | 3.00   | 20/20      |

COMS W4172 3D UI AND AUGMENTED REALITY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W4160) or (COMS W4170) or the instructor's permission.
Prerequisites: (COMS W4160) or (COMS W4170) or the instructors permission. Design, development, and evaluation of 3D user interfaces. Interaction techniques and metaphors, from desktop to immersive. Selection and manipulation. Travel and navigation. Symbolic, menu, gestural, and multimodal interaction. Dialogue design. 3D software support. 3D interaction devices and displays. Virtual and augmented reality. Tangible user interfaces. Review of relevant 3D math

Spring 2024: COMS W4172
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4172       | 001/12082            | T Th 1:10pm - 2:25pm 227 Seeley W. Mudd Building | Steven Feiner | 3.00   | 40/45      |

COMS W4181 SECURITY I. 3.00 points.
Not offered during 2023-2024 academic year.

Prerequisites: COMS W3157 or equivalent.
Introduction to security. Threat models. Operating system security features. Vulnerabilities and tools. Firewalls, virtual private networks, viruses. Mobile and app security. Usable security. Note: May not earn credit for both W4181 and W4180 or W4187

Fall 2023: COMS W4181
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4181       | 001/11226            | M W 1:10pm - 2:25pm 461 Computer Science Bldg | Suman Jana | 3.00   | 38/60      |

COMS W4182 SECURITY II. 3.00 points.
Not offered during 2023-2024 academic year.

Prerequisites: COMS W4181, COMS W4118, COMS W4119
Advanced security. Centralized, distributed, and cloud system security. Cryptographic protocol design choices. Hardware and software security techniques. Security testing and fuzzing. Blockchain. Human security issues. Note: May not earn credit for both W4182 and W4180 or W4187

Spring 2024: COMS W4182
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4182       | 001/12083            | F 1:10pm - 3:40pm 1127 Seeley W. Mudd Building | John Koh | 3.00   | 25/40      |
COMS 4182       | V01/15421            |                    | John Koh | 3.00   | 2/99       |

COMS W4186 MALWARE ANALYSIS#REVERSE ENGINEERING. 3.00 points.
Not offered during 2023-2024 academic year.

Prerequisites: COMS W3157 or equivalent. COMS W3827 Hands-on analysis of malware. How hackers package and hide malware and viruses to evade analysis. Disassemblers, debuggers, and other tools for reverse engineering. Deep study of Windows Internals and x86 assembly

Fall 2023: COMS W4186
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4186       | 001/11227            | Th 4:10pm - 6:40pm 825 Seeley W. Mudd Building | Michael Sikorski | 3.00 | 28/40      |

COMS W4203 Graph Theory. 3 points.
Lect: 3.

Prerequisites: (COMS W3203)
General introduction to graph theory. Isomorphism testing, algebraic specification, symmetries, spanning trees, traversability, planarity, drawings on higher-order surfaces, colorings, extremal graphs, random graphs, graphical measurement, directed graphs, Burnside-Polya counting, voltage graph theory.

Spring 2024: COMS W4203
Course Number  | Section/Call Number  | Times/Location      | Instructor     | Points | Enrollment |
----------------|----------------------|--------------------|----------------|--------|------------|
COMS 4203       | 001/20497            | W 7:00pm - 9:30pm 451 Computer Science Bldg | Yihao Zhang | 3     | 23/60      |

COMS W4205 Combinatorial Theory. 3 points.
Lect: 3.Not offered during 2023-2024 academic year.

Prerequisites: (COMS W3203) and course in calculus. Sequences and recursions, calculus of finite differences and sums, elementary number theory, permutation group structures, binomial coefficients, Stirling numbers, harmonic numbers, generating functions.
### COMS W4223 Networks, Crowds, and the Web. 3.00 points.
This class introduces fundamental ideas and algorithms on networks of information collected by online services. It covers properties pervasive in large networks, dynamics of individuals that lead to large collective phenomena, mechanisms underlying the web economy, and results and tools informing societal impact of algorithms on privacy, polarization and discrimination.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4223</td>
<td>001/15083</td>
<td>T Th 4:10pm - 5:25pm</td>
<td>Augustin Chaintreau</td>
<td>3.00</td>
<td>78/110</td>
</tr>
<tr>
<td></td>
<td>001/18856</td>
<td>833 Seeley W. Mudd Building</td>
<td>Augustin Chaintreau</td>
<td>3.00</td>
<td>14/99</td>
</tr>
</tbody>
</table>

### COMS W4231 ANALYSIS OF ALGORITHMS I. 3.00 points.
COMS W4232 Advanced Algorithms. 3.00 points.
Prerequisite: Analysis of Algorithms (COMS W4231).

Prerequisites: see notes re: points. Introduces classic and modern algorithmic ideas that are central to many areas of Computer Science. The focus is on most powerful paradigms and techniques of how to design algorithms, and how to measure their efficiency. The intent is to be broad, covering a diversity of algorithmic techniques, rather than be deep. The covered topics have all been implemented and are widely used in industry. Topics include: hashing, sketching/streaming, nearest neighbor search, graph algorithms, spectral graph theory, linear programming, models for large-scale computation, and other related topics.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4232</td>
<td>001/12084</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Alexandr Andoni</td>
<td>3.00</td>
<td>47/100</td>
</tr>
<tr>
<td></td>
<td>001/15422</td>
<td>633 Seeley W. Mudd Building</td>
<td>Alexandr Andoni</td>
<td>3.00</td>
<td>2/99</td>
</tr>
</tbody>
</table>

### COMS W4236 INTRO-COMPUTATIONAL COMPLEXITY. 3.00 points.
Lect: 3.

Prerequisites: (COMS W3261)
Prerequisites: (COMS W3261) Develops a quantitative theory of the computational difficulty of problems in terms of the resources (e.g. time, space) needed to solve them. Classification of problems into complexity classes, reductions, and completeness. Power and limitations of different modes of computation such as nondeterminism, randomization, interaction, and parallelism.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4236</td>
<td>001/11228</td>
<td>M W 1:10pm - 2:25pm</td>
<td>Henry Yuen</td>
<td>3.00</td>
<td>24/55</td>
</tr>
<tr>
<td></td>
<td>001/17093</td>
<td>524 Seeley W. Mudd Building</td>
<td>Henry Yuen</td>
<td>3.00</td>
<td>3/99</td>
</tr>
</tbody>
</table>

### COMS W4241 Numerical Algorithms and Complexity. 3 points.
Lect: 3.

Prerequisites: Knowledge of a programming language. Some knowledge of scientific computation is desirable.
Modern theory and practice of computation on digital computers. Introduction to concepts of computational complexity. Design and analysis of numerical algorithms. Applications to computational finance, computational science, and computational engineering.

### COMS W4242 NUMRCL ALGORITHMS-COMPLEXITY II. 3.00 points.
COMS W4252 INTRO-COMPUTATIONAL LEARN THRY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (CSOR W2431) or (COMS W4236) or COMS W3203 and the instructor's permission, or COMS W3261 and the instructor's permission. Possibilities and limitations of performing learning by computational agents. Topics include computational models of learning, polynomial time learnability, learning from examples and learning from queries to oracles. Computational and statistical limitations of learning. Applications to Boolean functions, geometric functions, automata.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4252</td>
<td>001/11229</td>
<td>M W 8:40am - 9:55am</td>
<td>Rocco Servedio</td>
<td>3.00</td>
<td>51/100</td>
</tr>
<tr>
<td></td>
<td>V01/17095</td>
<td>428 Pupin Laboratories</td>
<td>Rocco Servedio</td>
<td>3.00</td>
<td>11/99</td>
</tr>
</tbody>
</table>

### COMS W4261 INTRO TO CRYPTOGRAPHY. 3.00 points.
Lect: 2.5.

Prerequisites: Comfort with basic discrete math and probability.
Recommended: COMS W3261 or CSOR W4231.
Prerequisites: Comfort with basic discrete math and probability.
Recommended: COMS W3261 or CSOR W4231. An introduction to modern cryptography, focusing on the complexity-theoretic foundations of secure computation and communication in adversarial environments; a rigorous approach, based on precise definitions and provably secure protocols. Topics include private and public key encryption schemes, digital signatures, authentication, pseudorandom generators and functions, one-way functions, trapdoor functions, number theory and computational hardness, identification and zero knowledge protocols.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4261</td>
<td>001/11230</td>
<td>T Th 10:10am - 11:25am</td>
<td>Tal Malkin</td>
<td>3.00</td>
<td>74/105</td>
</tr>
<tr>
<td></td>
<td>001/18295</td>
<td>142 Uris Hall</td>
<td>Tal Malkin</td>
<td>3.00</td>
<td>5/99</td>
</tr>
</tbody>
</table>
COMS W4281 INTRO TO QUANTUM COMPUTING. 3.00 points.
Lect: 3.
Prerequisites: Knowledge of linear algebra. Prior knowledge of quantum mechanics is not required although helpful.

COMS W4419 INTERNET TECHNOLOGY, ECONOMICS, AND POLICY. 3.00 points.
Not offered during 2023-2024 academic year.
Technology, economic and policy aspects of the Internet. Summarizes how the Internet works technically, including protocols, standards, radio spectrum, global infrastructure and interconnection. Micro-economics with a focus on media and telecommunication economic concerns, including competition and monopolies, platforms, and behavioral economics. US constitution, freedom of speech, administrative procedures act and regulatory process, universal service, role of FCC. Not a substitute for CSEE4119. Suitable for non-majors. May not be used as a track elective for the computer science major.

COMS W4444 PROGRAMMING # PROBLEM SOLVING. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (CSEE W3827)
Hands-on introduction to solving open-ended computational problems. Emphasis on creativity, cooperation, and collaboration. Projects spanning a variety of areas within computer science, typically requiring the development of computer programs. Generalization of solutions to broader problems, and specialization of complex problems to make them manageable. Team-oriented projects, student presentations, and in-class participation required

COMS W4460 PRIN-INNOVATN/ENTREPRENEURSHIP. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or the instructor’s permission.
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or the instructor’s permission. Team project centered course focused on principles of planning, creating, and growing a technology venture. Topics include: identifying and analyzing opportunities created by technology paradigm shifts, designing innovative products, protecting intellectual property, engineering innovative business models

COMS W4560 INTRO-COMP APPL-HLTH CRE/BIOMD. 3.00 points.
Lect: 3.
Prerequisites: Experience with computers and a passing familiarity with medicine and biology. Undergraduates in their senior or junior years may take this course only if they have adequate background in mathematics and receive the instructor’s permission.
Undergraduates in their senior or junior years may take this course only if they have adequate background in mathematics and receive permission from the instructor. An overview of the field of biomedical informatics, combining perspectives from medicine, computer science, and social science. Use of computers and information in healthcare and the biomedical sciences, covering specific applications and general methods, current issues, capabilities and limitations of biomedical informatics. Biomedical Informatics studies the organization of medical information, the effective management of information using computer technology, and the impact of such technology on medical research, education, and patient care. The field explores techniques for assessing current information practices, determining the information needs of healthcare providers and patients, developing interventions using computer technology, and evaluating the impact of those interventions
COMS W4701 ARTIFICIAL INTELLIGENCE. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and any course on probability. Prior knowledge of Python is recommended.
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and any course on probability. Prior knowledge of Python is recommended.
Provides a broad understanding of the basic techniques for building intelligent computer systems. Topics include state-space problem representations, problem reduction and and-or graphs, game playing and heuristic search, predicate calculus, and resolution theorem proving. AI systems and languages for knowledge representation, machine learning and concept formation and other topics such as natural language processing may be included as time permits.

COMS W4702 Language Processing. 3.00 points.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or the instructor's permission.
Computational approaches to speech generation and understanding. Topics include speech recognition and understanding, speech analysis for computational linguistics research, and speech synthesis. Speech applications including dialogue systems, data mining, summarization, and translation. Exercises involve data analysis and building a small text-to-speech system.

COMS W4725 Knowledge representation and reasoning. 3 points.
Lect: 3. Not offered during 2023-2024 academic year.

Prerequisites: (COMS W4701)
General aspects of knowledge representation (KR). The two fundamental paradigms (semantic networks and frames) and illustrative systems. Topics include hybrid systems, time, action/plans, defaults, abduction, and case-based reasoning. Throughout the course particular attention is paid to design trade-offs between language expressiveness and reasoning complexity, and issues relating to the use of KR systems in larger applications.

COMS W4731 Computer Vision I: First Principles. 3.00 points.
Lect: 3.

Prerequisites: Fundamentals of calculus, linear algebra, and C programming. Students without any of these prerequisites are advised to contact the instructor prior to taking the course.
Introductory course in computer vision. Topics include image formation and optics, image sensing, binary images, image processing and filtering, edge extraction and boundary detection, region growing and segmentation, pattern classification methods, brightness and reflectance, shape from shading and photometric stereo, texture, binocular stereo, optical flow and motion, 2D and 3D object representation, object recognition, vision systems and applications.

COMS W4732 Computer Vision II: Learning. 3.00 points.
Advanced course in computer vision. Topics include convolutional networks and back-propagation, object and action recognition, self-supervised and few-shot learning, image synthesis and generative models, object tracking, vision and language, vision and audio, 3D representations, interpretability, and bias, ethics, and media deception.
COMS W4733 COMPUTATIONAL ASPECTS OF ROBOTICS. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136COMS W3137)
Introduction to fundamental problems and algorithms in robotics. Topics
include configuration spaces, motion and sensor models, search and
sampling-based planning, state estimation, localization and mapping,
perception, and learning

Spring 2024: COMS W4733

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4733</td>
<td>001/14014</td>
<td>F 1:10pm - 3:40pm</td>
<td>Tony Dear</td>
<td>3.00</td>
<td>19/164</td>
</tr>
<tr>
<td>COMS 4733</td>
<td>V01/18546</td>
<td></td>
<td>Tony Dear</td>
<td>3.00</td>
<td>6/99</td>
</tr>
</tbody>
</table>

COMS W4735 VISUAL INTERFACES TO COMPUTERS. 3.00 points.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137)
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) Visual input as data and for control of computer systems. Survey and analysis
of architecture, algorithms, and underlying assumptions of commercial
and research systems that recognize and interpret human gestures,
analyze imagery such as fingerprint or iris patterns, generate natural
language descriptions of medical or map imagery. Explores foundations
in human psychophysics, cognitive science, and artificial intelligence

COMS W4737 Biometrics. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: a background at the sophomore level in computer science,
engineering, or like discipline.
In this course, we will explore the latest advances in biometrics as well
as the machine learning techniques behind them. Students will learn
how these technologies work and how they are sometimes defeated.
Grading will be based on homework assignments and a final project.
There will be no midterm or final exam. This course shares lectures with
COMS E6737. Students taking COMS E6737 are required to complete
additional homework problems and undertake a more rigorous final
project. Students will only be allowed to earn credit for COMS W4737 or
COMS E6737 and not both.

COMS W4762 Machine Learning for Functional Genomics. 3 points.
Prerequisites: Proficiency in a high-level programming language (Python/
R/Julia). An introductory machine learning class (such as COMS 4771
Machine Learning) will be helpful but is not required.

Prerequisites: see notes re: points
This course will introduce modern probabilistic machine learning
methods using applications in data analysis tasks from functional
genomics, where massively-parallel sequencing is used to measure the
state of cells: e.g. what genes are being expressed, what regions of DNA
("chromatin") are active ("open") or bound by specific proteins.

COMS W4771 MACHINE LEARNING. 3.00 points.
Lect: 3.

Prerequisites: Any introductory course in linear algebra and any
introductory course in statistics are both required. Highly recommended:
COMS W4701 or knowledge of Artificial Intelligence.
Prerequisites: Any introductory course in linear algebra and any
introductory course in statistics are both required. Highly recommended:
COMS W4701 or knowledge of Artificial Intelligence. Topics from
generative and discriminative machine learning including least squares
methods, support vector machines, kernel methods, neural networks,
Gaussian distributions, linear classification, linear regression, maximum
likelihood, exponential family distributions, Bayesian networks, Bayesian
inference, mixture models, the EM algorithm, graphical models and
hidden Markov models. Algorithms implemented in MATLAB

Lect: 3.

Prerequisites: (COMS W4771) or instructor's permission; knowledge of
linear algebra & introductory probability or statistics is required.
An exploration of advanced machine learning tools for perception and
behavior learning. How can machines perceive, learn from, and classify
human activity computationally? Topics include appearance-based
models, principal and independent components analysis, dimensionality
reduction, kernel methods, manifold learning, latent models, regression,
classification, Bayesian methods, maximum entropy methods, real-time
tracking, extended Kalman filters, time series prediction, hidden Markov
models, factorial HMMs, input-output HMMs, Markov random fields,
variational methods, dynamic Bayesian networks, and Gaussian/Dirichlet
processes. Links to cognitive science.
COMS W4773 Machine Learning Theory. 3 points.
Prerequisites: Machine Learning (COMS W4771). Background in probability and statistics, linear algebra, and multivariate calculus. Ability to program in a high-level language, and familiarity with basic algorithm design and coding principles.

Prerequisites: see notes re: points
Core topics from unsupervised learning such as clustering, dimensionality reduction and density estimation will be studied in detail. Topics in clustering: k-means clustering, hierarchical clustering, spectral clustering, clustering with various forms of feedback, good initialization techniques and convergence analysis of various clustering procedures. Topics in dimensionality reduction: linear techniques such as PCA, ICA, Factor Analysis, Random Projections, non-linear techniques such as LLE, IsoMap, Laplacian Eigenmaps, TSNE, and study of embeddings of general metric spaces, what sorts of theoretical guarantees can one provide about such techniques. Miscellaneous topics: design and analysis of data structures for fast Nearest Neighbor search such as Cover Trees and LSH. Algorithms will be implemented in either Matlab or Python.

COMS W4774 Unsupervised Learning. 3.00 points.
Prerequisites: Solid background in multivariate calculus, linear algebra, basic probability, and algorithms.

Prerequisites: see notes re: points
Core topics from unsupervised learning such as clustering, dimensionality reduction and density estimation will be studied in detail. Topics in clustering: k-means clustering, hierarchical clustering, spectral clustering, clustering with various forms of feedback, good initialization techniques and convergence analysis of various clustering procedures. Topics in dimensionality reduction: linear techniques such as PCA, ICA, Factor Analysis, Random Projections, non-linear techniques such as LLE, IsoMap, Laplacian Eigenmaps, TSNE, and study of embeddings of general metric spaces, what sorts of theoretical guarantees can one provide about such techniques. Miscellaneous topics: design and analysis of data structures for fast Nearest Neighbor search such as Cover Trees and LSH. Algorithms will be implemented in either Matlab or Python.

COMS W4775 Causal Inference. 3.00 points.
Prerequisites: Discrete Math, Calculus, Statistics (basic probability, modeling, experimental design), some programming experience.

Prerequisites: see notes re: points
Causal Inference theory and applications. The theoretical topics include the 3-layer causal hierarchy, causal bayesian networks, structural learning, the identification problem and the do-calculus, linear identifiability, bounding, and counterfactual analysis. The applied part includes intersection with statistics, the empirical-data sciences (social and health), and AI and ML.

Fall 2023: COMS W4775

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4775</td>
<td>001/11242</td>
<td>M W 4:10pm - 5:25pm</td>
<td>Elias</td>
<td>3.00</td>
<td>35/60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750 Schapiro Cepser</td>
<td>Bareinboim</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
COMS W4910 CURRICULAR PRACTICAL TRAINING. 1.00 point.
COMS W4995 TOPICS IN COMPUTER SCIENCE. 3.00 points.
Lect: 3.

Prerequisites: Instructor’s permission.
Selected topics in computer science. Content and prerequisites vary between sections and semesters. May be repeated for credit. Check “topics course” webpage on the department website for more information on each section.

Fall 2023: COMS W4995

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4995</td>
<td>001/11243</td>
<td>M W 5:40 - 6:55pm 633 Seeley W. Mudd Building</td>
<td>Stephen Edwards</td>
<td>3.00</td>
<td>57/70</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>002/11244</td>
<td>F 10:10am - 12:40pm 608 Schermerhorn Hall</td>
<td>Bjane Stroustrup</td>
<td>3.00</td>
<td>32/33</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>003/11245</td>
<td>Th 4:10pm - 6:40pm 1127 Seeley W. Mudd Building</td>
<td>Homayoon Beigi</td>
<td>3.00</td>
<td>9/60</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>004/11246</td>
<td>T Th 5:40pm - 6:55pm 1024 Seeley W. Mudd Building</td>
<td>Yongwhan Lim</td>
<td>3.00</td>
<td>29/50</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>005/11247</td>
<td>M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building</td>
<td>Yongwhan Lim</td>
<td>3.00</td>
<td>18/200</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>006/11248</td>
<td>M W 11:40am - 12:55pm 415 Schapiro Ceper</td>
<td>Michelle Levine</td>
<td>3.00</td>
<td>23/40</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>007/11249</td>
<td>T Th 4:10pm - 5:25pm 461 Computer Science Bldg</td>
<td>Hugh Thomas</td>
<td>3.00</td>
<td>76/80</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>008/11250</td>
<td>T 4:10pm - 6:40pm 644 Seeley W. Mudd Building</td>
<td>Paul Blaer, Jason Cahill</td>
<td>3.00</td>
<td>38/40</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>009/11251</td>
<td>F 1:10pm - 3:40pm 601 Fairchild Life Sciences Bldg</td>
<td>Nakul Verma</td>
<td>3.00</td>
<td>40/75</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>010/11252</td>
<td>M W 2:40pm - 3:55pm 461 Computer Science Bldg</td>
<td>Richard Zemel</td>
<td>3.00</td>
<td>99/100</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>011/11253</td>
<td>T Th 2:40pm - 3:55pm 428 Pupin Laboratories</td>
<td>Peter Belhumeur</td>
<td>3.00</td>
<td>103/120</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>013/20652</td>
<td>T 1:10pm - 3:40pm 545 Seeley W. Mudd Building</td>
<td>Gary Zamchick</td>
<td>3.00</td>
<td>28/40</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>014/20725</td>
<td>F 2:00pm - 4:00pm 253 Engineering Terrace</td>
<td>Shalmali Joshi</td>
<td>3.00</td>
<td>10/20</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>020/12881</td>
<td>T 4:10pm - 6:40pm 833 Seeley W. Mudd Building</td>
<td>Vijay Pappu</td>
<td>3.00</td>
<td>129/120</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>021/12882</td>
<td>Th 7:00pm - 9:30pm 417 International Affairs Bldg</td>
<td>Vijay Pappu</td>
<td>3.00</td>
<td>119/120</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>030/16892</td>
<td>M 7:00pm - 9:30pm 833 Seeley W. Mudd Building</td>
<td>Andi Cupallari</td>
<td>3.00</td>
<td>62/120</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>031/16893</td>
<td>M 7:00pm - 9:30pm 501 Northwest Corner</td>
<td>Andrei Simion</td>
<td>3.00</td>
<td>130/160</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>01/17101</td>
<td>Stephen Edwards</td>
<td>3.00</td>
<td>2/99</td>
<td></td>
</tr>
<tr>
<td>COMS 4995</td>
<td>013/17106</td>
<td>Homayoon Beigi</td>
<td>3.00</td>
<td>3/99</td>
<td></td>
</tr>
<tr>
<td>COMS 4995</td>
<td>015/17507</td>
<td>Yongwhan Lim</td>
<td>3.00</td>
<td>1/99</td>
<td></td>
</tr>
<tr>
<td>COMS 4995</td>
<td>018/17104</td>
<td>Richard Zemel</td>
<td>3.00</td>
<td>18/20</td>
<td></td>
</tr>
<tr>
<td>COMS 4995</td>
<td>020/17099</td>
<td>Vijay Pappu</td>
<td>3.00</td>
<td>17/99</td>
<td></td>
</tr>
</tbody>
</table>

Spring 2024: COMS W4995

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS 4995</td>
<td>001/12095</td>
<td>T Th 8:40am - 9:55am 1024 Seeley W. Mudd Building</td>
<td>Andrew Blumberg</td>
<td>3.00</td>
<td>29/40</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>002/12096</td>
<td>M W 6:40pm - 6:55pm 1024 Seeley W. Mudd Building</td>
<td>Yongwhan Lim</td>
<td>3.00</td>
<td>11/50</td>
</tr>
<tr>
<td>COMS 4995</td>
<td>003/12098</td>
<td>T 4:10pm - 6:40pm 1024 Seeley W. Mudd Building</td>
<td>Christian</td>
<td>3.00</td>
<td>34/40</td>
</tr>
</tbody>
</table>

COMS W4996 Special topics in computer science, II. 3 points.
Lect: 3. Not offered during 2023-2024 academic year.

Prerequisites: Instructor’s permission.
A continuation of COMS W4995 when the special topic extends over two terms.