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.

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

<table>
<thead>
<tr>
<th>PREREQUISITE</th>
<th>MATH UN1101</th>
<th>CALCULUS I</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH REQUIREMENTS</td>
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<tr>
<td>A. CALCULUS III / MULTIVARIABLE CALCULUS (select one of the following)</td>
<td>MATH UN1201</td>
<td>CALCULUS III</td>
</tr>
<tr>
<td></td>
<td>MATH UN1205</td>
<td>ACCELERATED MULTIVARIABLE CALC</td>
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<tr>
<td></td>
<td>APMA E2000</td>
<td>MULTV. CALC. FOR ENGI # APP SCI</td>
</tr>
<tr>
<td>B. LINEAR ALGEBRA (select one of the following)</td>
<td>COMS W3251</td>
<td>COMPUTATIONAL LINEAR ALGEBRA</td>
</tr>
<tr>
<td></td>
<td>APMA E3101</td>
<td>APPLIED MATH I: LINEAR ALGEBRA</td>
</tr>
<tr>
<td></td>
<td>APMA E2101</td>
<td>INTRO TO APPLIED MATHEMATICS</td>
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<tr>
<td></td>
<td>MATH UN2010</td>
<td>LINEAR ALGEBRA</td>
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<tr>
<td></td>
<td>MATH UN2015</td>
<td>Linear Algebra and Probability</td>
</tr>
<tr>
<td>C. PROBABILITY (select one of the following)</td>
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</tbody>
</table>

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

See below for the track-based curriculum.
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.

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.

COMS BC3099 INDEPENDENT STUDY. 1.00-4.00 points.
Course can be taken for 1-4 points.
Independent Study. Instructor permission required

COMS BC3159 Parallel Optimization for Robotics. 3.00 points.
Many stages of state-of-the-art robotics pipelines rely on the solutions of underlying optimization algorithms. Unfortunately, many of these approaches rely on simplifications and conservative approximations in order to reduce their computational complexity and support online operation. At the same time, parallelism has been used to significantly increase the throughput of computationally expensive algorithms across the field of computer science. And, with the widespread adoption of parallel computing platforms such as GPUs, it is natural to consider whether these architectures can benefit robotics researchers interested in solving computationally constrained problems online. This course will provide students with an introduction to both parallel programming on CPUs and GPUs as well as optimization algorithms for robotics applications. It will then dive into the intersection of those fields through case studies of recent state-of-the-art research and culminate in a team-based final project.

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 the deep inner workings of today's user interface technology and serve as a guide for building the user interfaces of the future.

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.

Fall 2024: COMS BC3420
<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 3420</td>
<td>001/00246</td>
<td>W 4:10pm - 6:00pm 111 Milstein Center</td>
<td>Rebecca Wright</td>
<td>4.00</td>
<td>0/24</td>
</tr>
</tbody>
</table>

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 performative practice by exploring "live coding". In the space of live coding, we examine various programming languages designed 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.

Spring 2024: COMS BC3430
<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>
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<tbody>
<tr>
<td>COMS 3430</td>
<td>001/00263</td>
<td>T Th 1:10pm - 2:25pm 307 Milbank Hall</td>
<td>Mark Santolucito</td>
<td>3.00</td>
<td>32/35</td>
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</table>

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 intermediate 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 conceiving and implement creative uses of computation.

Spring 2024: COMS BC3930
<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>
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<td>001/00264</td>
<td>T Th 2:40pm - 3:55pm 516 Milstein Center</td>
<td>Mark Santolucito</td>
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Fall 2024: COMS BC3930
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<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<td>Mark Santolucito</td>
<td>3.00</td>
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COMS BC3997 NEW DIRECTIONS IN COMPUTING. 1.00-3.00 points.
This is an undergraduate seminar for special topics in computing arranged as the need and availability arises. Topics are usually offered on a one-time basis. Participation requires permission of the instructor. Since the content of this course changes each time it is offered, it may be repeated for credit.

Spring 2024: COMS BC3997
<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>
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<tr>
<td>COMS 3997</td>
<td>001/00558</td>
<td>M 6:10pm - 8:00pm 10917 Milstein Center</td>
<td>Brian Plancher</td>
<td>1.00</td>
<td>0/16</td>
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<tr>
<td>COMS 3997</td>
<td>002/00559</td>
<td>M W 2:40pm - 3:55pm 805 Altschul Hall</td>
<td>Lisa Soros</td>
<td>1.00</td>
<td>37/35</td>
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<tr>
<td>COMS 3997</td>
<td>003/00560</td>
<td>M W 11:40am - 12:55pm 203 Diana Center</td>
<td>Corey Toler Franklin</td>
<td>1.00</td>
<td>23/40</td>
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<tr>
<td>COMS 3997</td>
<td>004/00561</td>
<td>M W 10:10am - 11:25am 202 Milbank Hall</td>
<td>Smaranda Muresan</td>
<td>1.00</td>
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Fall 2024: COMS BC3997
<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>
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</thead>
<tbody>
<tr>
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<td>3/15/35</td>
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<tr>
<td>COMS 3997</td>
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<td>1/45</td>
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<tr>
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<td>T Th 1:10pm - 2:25pm 207 Milbank Hall</td>
<td>Smaranda Muresan</td>
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<td>0/24</td>
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</table>

Columbia College Computer Science Courses

COMS W1001 Introduction to Information Science. 3 points.
Lect: 3.
Basic introduction to concepts and skills in Information Sciences: human-computer interfaces, representing information digitally, organizing and searching information on the internet, principles of algorithmic problem solving, introduction to database concepts, and introduction to programming in Python.

COMS W1002 COMPUTING IN CONTEXT. 4.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Introduction to elementary computing concepts and Python programming with domain-specific applications. Shared CS concepts and Python programming lectures with track-specific sections. Track themes will vary but may include computing for the social sciences, computing for economics and finance, digital humanities, and more. Intended for nonmajors. Students may only receive credit for one of ENGI E1006 or COMS W1002.

Fall 2024: COMS W1002
<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 1002</td>
<td>001/11915</td>
<td>T Th 1:10pm - 2:25pm Room TBA</td>
<td>Adam Cannon</td>
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<tr>
<td>COMS 1002</td>
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<td>COMS 1002</td>
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<td>COMS 1002</td>
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<td>T Th 2:40pm - 3:55pm Room TBA</td>
<td>Adam Cannon</td>
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<td>21/40</td>
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</table>
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.

Spring 2024: COMS W1004

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<tr>
<td>COMS 1004</td>
<td>001/11451</td>
<td>T Th 11:40am - 12:55pm 417 International Affairs Bldg</td>
<td>Adam Cannon</td>
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Fall 2024: COMS W1004

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<td>Paul Blaer</td>
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<td>M W 5:40pm - 6:55pm Room TBA</td>
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<td>3</td>
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</table>

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 W1011 INTERMED COMPUTER PROGRAMMING. 3.00 points.

COMS W1012 COMPUTING IN CONTEXT REC. 0.00 points.

Fall 2024: COMS W1012

<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>
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<td>COMS 1012</td>
<td>010/11930</td>
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<td>Adam Cannon</td>
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<td>0/30</td>
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<tr>
<td>COMS 1012</td>
<td>011/11931</td>
<td>F 11:00am - 11:50am Room TBA</td>
<td>Adam Cannon</td>
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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
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. 1.00 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. 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.

Spring 2024: COMS W3102

<table>
<thead>
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<th>Course Number</th>
<th>Section/Call Number</th>
<th>Time/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<td>COMS 3102</td>
<td>001/12065</td>
<td>F 6:10pm - 8:00pm 451 Computer Science Bldg</td>
<td>Shaib Ahamed</td>
<td>1.00-2.00</td>
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Fall 2024: COMS W3102

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<th>Section/Call Number</th>
<th>Time/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<tr>
<td>COMS 3102</td>
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<td>Shaib Ahamed</td>
<td>1.00-2.00</td>
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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.
COMS W3157 ADVANCED PROGRAMMING. 4.00 points.
Lect: 4.
Prerequisites: (COMS W3134) or (COMS W3137)
C programming language and Unix systems programming. Also covers
Git, Make, TCP/IP networking basics, C fundamentals
Spring 2024: COMS W3157
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<th>Enrollment</th>
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<tr>
<td>COMS 3157</td>
<td>001/12069</td>
<td>T Th 4:10pm - 5:25pm 417 International Affairs Bldg</td>
<td>Jae Lee</td>
<td>4.00</td>
<td>295/398</td>
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</table>

COMS W3202 FINITE MATHEMATICS. 3.00 points.
COMS W3203 DISCRETE MATHEMATICS. 4.00 points.
Lect: 3.
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)
Spring 2024: COMS W3203
<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>
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<tbody>
<tr>
<td>COMS 3203</td>
<td>001/12070</td>
<td>T Th 10:10am - 11:25am 301 Uris Hall</td>
<td>Ansaf Salleb-Aouissi</td>
<td>4.00</td>
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<tr>
<td>COMS 3203</td>
<td>002/12071</td>
<td>T Th 11:40am - 12:55pm 301 Uris Hall</td>
<td>Ansaf Salleb-Aouissi</td>
<td>4.00</td>
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COMS W3210 Scientific Computation. 3 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: two terms of calculus.
Introduction to computation on digital computers. Design and analysis
of numerical algorithms. Numerical solution of equations, integration,
recurrences, chaos, differential equations. Introduction to Monte
Carlo methods. Properties of floating point arithmetic. Applications to
weather prediction, computational finance, computational science, and
computational engineering.

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
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
Spring 2024: COMS W3261
<table>
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<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<tr>
<td>COMS 3261</td>
<td>001/12072</td>
<td>M W 2:40pm - 3:55pm 417 International Affairs Bldg</td>
<td>Josh Alman</td>
<td>3.00</td>
<td>130/150</td>
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<tr>
<td>COMS 3261</td>
<td>022/12073</td>
<td>T Th 11:40am - 12:55pm 501 Northwest Corner</td>
<td>Yannakakis</td>
<td>3.00</td>
<td>152/160</td>
</tr>
</tbody>
</table>

COMS W3410 COMPUTERS AND SOCIETY. 3.00 points.
Lect: 3.
Broader impact of computers. Social networks and privacy. Employment,
intellectual property, and the media. Science and engineering ethics.
Suitable for nonmajors
Fall 2024: COMS W3410
<table>
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<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<tr>
<td>COMS 3410</td>
<td>001/11936</td>
<td>T Th 8:40am - 9:55am Room TBA</td>
<td>Tal Malkin</td>
<td>3.00</td>
<td>105/105</td>
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<tr>
<td>COMS 3410</td>
<td>002/11937</td>
<td>T Th 10:10am - 11:25am Room TBA</td>
<td>Tal Malkin</td>
<td>3.00</td>
<td>105/105</td>
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</table>

COMS W3902 UNDERGRADUATE THESIS. 0.00-6.00 points.
Prerequisites: 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 COMPUTER SCIENCE. 1.00-3.00 points.
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. Consult the department for section assignment
COMS W3999 FIELDWORK. 1.00 point.
May be repeated for credit, but no more than 3 total points may be used toward the 128-credit degree requirement. 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.

Spring 2024: COMS W4111
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<th>Course Number</th>
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<tr>
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<td>Kenneth Ross</td>
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<td>COMS 4111</td>
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<td>F 10:10am - 12:40pm</td>
<td>Donald Ferguson</td>
<td>3.00</td>
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<td>COMS 4111</td>
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<td>Donald Ferguson</td>
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Fall 2024: COMS W4111
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<th>Course Number</th>
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<td>COMS 4111</td>
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<td>Luis Gravano</td>
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<tr>
<td>COMS 4111</td>
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<td>COMS 4111</td>
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<td>F 10:10am - 12:40pm</td>
<td>Donald Ferguson</td>
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</table>

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.

Fall 2024: COMS W4113
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<tr>
<td>COMS 4113</td>
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<td>F 10:10am - 12:40pm</td>
<td>Roxana Geambasu</td>
<td>3.00</td>
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COMS W4115 PROGRAMMING LANG # TRANSLATORS. 3.00 points.
Lect: 3.
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3261) and (CSEE W3827) or equivalent, or the instructor’s permission.
Modern programming languages and compiler design. Imperative, object-oriented, declarative, functional, and scripting languages. Language syntax, control structures, data types, procedures and parameters, binding, scope, run-time organization, and exception handling. Implementation of language translation tools including compilers and interpreters. Lexical, syntactic and semantic analysis; code generation; introduction to code optimization. Teams implement a language and its compiler.

Spring 2024: COMS W4115
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<th>Course Number</th>
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<td>M W 4:10pm - 5:25pm</td>
<td>Ronghui Gu</td>
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Fall 2024: COMS W4115
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<tr>
<td>COMS 4115</td>
<td>001/11943</td>
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<td>Baishakhi Ray</td>
<td>3.00</td>
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</table>
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, W3137, 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.

Spring 2024: COMS W4118

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<th>Course Number</th>
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<tr>
<td>COMS 4118</td>
<td>001/12079</td>
<td>T Th 4:10pm - 5:25pm</td>
<td>Kostis Kaffes</td>
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<td>COMS 4118</td>
<td>V01/18798</td>
<td>501 Northwest Corner</td>
<td>Kostis Kaffes</td>
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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 W4137 From Algorithmic Thinking to Development. 3.00 points.
Algorithmic problem-solving and coding skills needed to devise solutions to interview questions for software engineering positions. Solutions are implemented in Python, Java, C, and C. Approaches include brute-force, hashing, sorting, transform-and-conquer, greedy, and dynamic programming. Focus on experimentation and team work.

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 W4153 Cloud Computing. 3.00 points.
Software engineering skills necessary for developing cloud computing and software-as-a-service applications, covering topics such as service-oriented architectures, message-driven applications, and platform integration. Includes theoretical study, practical application, and collaborative project work.

Fall 2024: COMS W4153

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<td>COMS 4153</td>
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<td>F 1:10pm - 3:40pm</td>
<td>Donald Ferguson</td>
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COMS W4156 ADVANCED SOFTWARE ENGINEERING. 3.00 points.
Lect: 3.
Prerequisites: (COMS W3157) or equivalent.
Software lifecycle using frameworks, libraries and services. Major emphasis on software testing. Centers on a team project

Fall 2024: COMS W4156

<table>
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<th>Course Number</th>
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<tr>
<td>COMS 4156</td>
<td>001/11945</td>
<td>T Th 10:10am - 11:25am</td>
<td>Gail Kaiser</td>
<td>3.00</td>
<td>47/120</td>
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</table>

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.
Introduction to computer graphics. Topics include 3D viewing and projections, geometric modeling using spline curves, graphics systems such as OpenGL, lighting and shading, and global illumination. Significant implementation is required: the final project involves writing an interactive 3D video game in OpenGL

Spring 2024: COMS W4160

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<th>Course Number</th>
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<th>Enrollment</th>
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<tr>
<td>COMS 4160</td>
<td>001/13865</td>
<td>T Th 7:10pm - 8:25pm</td>
<td>Hadi Fadaifard</td>
<td>3.00</td>
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COMS W4162 Advanced Computer Graphics. 3 points.
Lect: 3.
Prerequisites: (COMS W4160) or equivalent, or the instructor’s permission.
A second course in computer graphics covering more advanced topics including image and signal processing, geometric modeling with meshes, advanced image synthesis including ray tracing and global illumination, and other topics as time permits. Emphasis will be placed both on implementation of systems and important mathematical and geometric concepts such as Fourier analysis, mesh algorithms and subdivision, and Monte Carlo sampling for rendering. Note: Course will be taught every two years.

COMS W4165 COMPUTE 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) 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

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.
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

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

Prerequisites: COMS W3157 or equivalent. Introduction to security. Threat modeling, 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

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

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

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.
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.
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.

Spring 2024: COMS W4223
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 4223    001/15083  T Th 4:10pm - 5:25pm  833 Seeley W. Mudd Building  Augustin Chaintreau  3.00  69/110
COMS 4223    V01/18856  Augustin Chaintreau  3.00  14/99

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.

Spring 2024: COMS W4232
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 4232    001/12084  M W 2:40pm - 3:55pm  633 Seeley W. Mudd Building  Alexandr Andoni  3.00  43/100
COMS 4232    V01/15422  Alexandr Andoni  3.00  2/99

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

Fall 2024: COMS W4236
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
COMS 4236    001/11948  M W 8:40am - 9:55am  Room TBA  Xi Chen  3.00  30/50

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 W4231) or (COMS W4236) 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.

COMS W4261 INTRO TO CRYPTOGRAPHY. 3.00 points.
Lect: 2.5.
Prerequisites: Comfort with basic discrete math and probability. Recommended: COMS W261 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.

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. Microeconomics 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.
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 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. 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 W4705 NATURAL LANGUAGE PROCESSING. 3.00 points.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or the instructor's permission.
Computational approaches to natural language generation and understanding. Recommended preparation: some previous or concurrent exposure to AI or Machine Learning. Topics include information extraction, summarization, machine translation, dialogue systems, and emotional speech. Particular attention is given to robust techniques that can handle understanding and generation for the large amounts of text on the Web or in other large corpora. Programming exercises in several of these areas
COMS W4706 Spoken Language Processing. 3 points.
CC/GS: Partial Fulfillment of Science Requirement

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 W4721 MACHINE LEARNING FOR DATA SCI. 3.00 points.
Spring 2024: COMS W4721

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<tr>
<td>COMS 4721</td>
<td>001/12843</td>
<td>F 1:10pm - 3:40pm</td>
<td>Nakul Verma, Robert Kramer</td>
<td>3.00</td>
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<td></td>
<td>Nakul Verma</td>
<td>3.00</td>
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</table>

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

Spring 2024: COMS W4731

<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>
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<tr>
<td>COMS 4731</td>
<td>001/11965</td>
<td>M W 10:10am - 11:25am</td>
<td>Shree Nayar</td>
<td>3.00</td>
<td>110/100</td>
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<td>461 Computer Science Bldg</td>
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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

Spring 2024: COMS W4732

<table>
<thead>
<tr>
<th>Course Number</th>
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<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<td>COMS 4732</td>
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<td>Carl Vondrick</td>
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<td>COMS 4732</td>
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<td>Carl Vondrick</td>
<td>3.00</td>
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</table>

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>
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<th>Instructor</th>
<th>Points</th>
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<tr>
<td>COMS 4733</td>
<td>001/14014</td>
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<td>Tony Dear</td>
<td>3.00</td>
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<td>COMS 4733</td>
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<td>Tony Dear</td>
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</table>

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

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.
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.

COMS W4772 ADVANCED MACHINE LEARNING. 3.00 points.
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.

COMS W4776 Machine Learning for Data Science. 3 points.
Lect.: 3
Prerequisites: (STAT GU4001 or IENG E4150) and linear algebra.
Introduction to machine learning, emphasis on data science. Topics include least square methods, Gaussian distributions, linear classification, linear regression, maximum likelihood, exponential family distributions, Bayesian networks, Bayesian inference, mixture models, the EM algorithm, graphical models, hidden Markov models, support vector machines kernel methods. Emphasizes methods and problems relevant to big data. Students may not receive credit for both COMS W4771 and W4776.

COMS W4824 COMPUTER ARCHITECTURE. 3.00 points.

COMS W4835 COMPUTER ORGANIZATION II. 3.00 points.
COMS W4901 Projects in Computer Science. 1-3 points.
Prerequisites: Approval by a faculty member who agrees to supervise the work.
A second-level 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 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.

### 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>
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| COMS 4995     | 001/12095           | T Th 8:40am - 9:55am  
1024 Seeley W. Mudd Building | Andrew Blumberg | 3.00 | 26/40 |
| COMS 4995     | 002/12096           | M W 6:40pm - 6:55pm  
1024 Seeley W. Mudd Building | Yongwan Lim | 3.00 | 11/50 |
| COMS 4995     | 003/12098           | Th 4:10pm - 6:40pm  
1127 Seeley W. Mudd Building | Christian Swinehart | 3.00 | 33/40 |
| COMS 4995     | 004/12099           | T Th 5:40pm - 6:55pm  
451 Computer Science Bldg | Austin Reiter | 3.00 | 95/110 |
| COMS 4995     | 005/12101           | F 10:10am - 12:40pm  
1127 Seeley W. Mudd Building | Michelle Levine | 3.00 | 24/40 |
| COMS 4995     | 006/12102           | T 1:10pm - 3:40pm  
1127 Seeley W. Mudd Building | Gary Zamchick | 3.00 | 39/40 |
| COMS 4995     | 008/12104           | W 4:10pm - 6:40pm  
451 Computer Science Bldg | Jae Lee, Hans Montero | 3.00 | 74/110 |
| COMS 4995     | 030/12956           | T 7:00pm - 9:30pm  
413 Kent Hall | Adam Kelleher | 3.00 | 63/70 |
| COMS 4995     | 032/12965           | W 4:10pm - 6:40pm  
329 Pupin Laboratories | Vijay Pappu | 3.00 | 101/100 |
| COMS 4995     | 031/18718           | T 7:00pm - 9:30pm  
413 Kent Hall | Andrew Blumberg | 3.00 | 0/99 |
| COMS 4995     | V01/15425           | M W 1:10pm - 2:25pm  
Room TBA | Stephen Edwards | 3.00 | 30/70 |
| COMS 4995     | V08/16721           | W 4:10pm - 6:40pm  
Room TBA | Jae Lee, Hans Montero | 3.00 | 0/110 |
| COMS 4995     | V32/20861           | T Th 4:10pm - 5:25pm  
Room TBA | Hugh Thomas | 3.00 | 0/99 |
| COMS 4995     | 030/13530           | M 7:00pm - 9:30pm  
Room TBA | Michelle Levine | 3.00 | 3/40 |
| COMS 4995     | 031/13532           | W 7:00pm - 9:30pm  
Room TBA | Homayoon Beigi | 3.00 | 14/60 |
| COMS 4995     | 032/13534           | T Th 4:10pm - 5:25pm  
Room TBA | Hugh Thomas | 3.00 | 0/100 |
| COMS 4995     | 033/13535           | W 7:00pm - 9:30pm  
Room TBA | Andi Cupallari | 3.00 | 14/120 |
| COMS 4995     | 034/13536           | T Th 4:10pm - 6:40pm  
Room TBA | Andi Cupallari | 3.00 | 21/170 |

### Fall 2024: COMS W4995

<table>
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<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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| COMS 4995     | 001/11960           | T 4:10pm - 6:40pm  
Room TBA | Paul Blaer,  
Jason Cahill | 3.00 | 63/70 |
| COMS 4995     | 002/11961           | F 10:10am - 12:40pm  
Room TBA | Bjarni Stroustrup | 3.00 | 0/33 |
| COMS 4995     | 003/11962           | M W 1:10pm - 2:25pm  
Room TBA | Stephen Edwards | 3.00 | 0/100 |
| COMS 4995     | 004/11963           | W 4:10pm - 6:40pm  
Room TBA | Jae Lee, Hans Montero | 3.00 | 0/110 |
| COMS 4995     | 005/11964           | T Th 2:40pm - 3:55pm  
Room TBA | Peter Belhumeur | 3.00 | 53/125 |
| COMS 4995     | 006/11965           | T Th 4:10pm - 6:55pm  
Room TBA | Itsk Pe'er | 3.00 | 1/40 |
| COMS 4995     | 007/11966           | T Th 5:40pm - 6:55pm  
Room TBA | Yongwan Lim | 3.00 | 1/100 |
| COMS 4995     | 008/11967           | T 1:10pm - 3:40pm  
Room TBA | Gary Zamchick | 3.00 | 44/40 |
| COMS 4995     | 009/11968           | W 10:10am - 12:40pm  
Room TBA | Michelle Levine | 3.00 | 3/40 |
| COMS 4995     | 010/11969           | Th 4:10pm - 6:40pm  
Room TBA | Homayoon Beigi | 3.00 | 14/60 |
| COMS 4995     | 011/13628           | T Th 4:10pm - 5:25pm  
Room TBA | Hugh Thomas | 3.00 | 0/100 |
| COMS 4995     | 012/15929           | W 7:00pm - 9:30pm  
Room TBA | Yihao Zhang | 3.00 | 0/50 |
| COMS 4995     | 030/13530           | M 7:00pm - 9:30pm  
Room TBA | Andi Cupallari | 3.00 | 14/120 |
| COMS 4995     | 031/13532           | W 7:00pm - 9:30pm  
Room TBA | Andi Cupallari | 3.00 | 21/170 |
| COMS 4995     | 032/13534           | T 4:10pm - 6:40pm  
Room TBA | Yiwen Pan | 3.00 | 12/120 |

## 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.