Computer Science

Subject: Computer Science

Computer Science 1

Great Ideas in Computer Science (119953)

Henry Leitner

2016 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

An introduction to the most important discoveries and intellectual paradigms in computer science, designed for students with little or no previous background. Explores problem-solving using high and low-level programming languages; presents an integrated view of computer systems, from switching circuits up through compilers and GUI design. Examines theoretical and practical limitations related to unsolvable and intractable computational problems, and the social and ethical dilemmas presented by such issues as software unreliability and invasions of privacy.

Course Notes: May not be taken for credit after completing Computer Science 50. This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.

Additional Course Attributes:

Attribute	Value(s)
FAS: General Education	Empirical and Mathematical Reasoning
FAS: Course Level	Primarily for Undergraduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 20

Discrete Mathematics for Computer Science (128073)

Harry Lewis

2016 Spring (4 Credits) **Schedule:** MWF 1000 AM - 1059 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Widely applicable mathematical tools for computer science, including topics from logic, set theory, combinatorics, number theory, probability theory, and graph theory. Practice in reasoning formally and proving theorems.

Course Notes: Covers material used in Computer Science 121 and Computer Science 124. This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Final Assessment Category	Three-hour Exam
FAS: Course Level	Primarily for Undergraduate Students
FAS: Core Curriculum	Quantitative Reasoning
FAS: General Education	Empirical and Mathematical Reasoning

Computer Science 50

Introduction to Computer Science I (152514)

David J. Malan

2015 Fall (4 Credits) **Schedule:** MW 0100 PM - 0159 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Introduction to the intellectual enterprises of computer science and the art of programming. This course teaches students how to think algorithmically and solve problems efficiently. Topics include abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Languages include C, PHP, and JavaScript plus SQL, CSS, and HTML. Problem sets inspired by real-world domains of biology, cryptography, finance, forensics, and gaming. Designed for concentrators and non-concentrators alike, with or without prior programming experience. 72% of CS50 students have never taken CS before.

Class Notes: This course ordinarily meets in Sanders Theatre on Mondays and Wednesdays from 1pm until 2pm, but students may simultaneously enroll in another course that meets at the same time. To do so, enroll in the other course via my.harvard.edu, and then email enrollment@fas.harvard.edu to have CS50 added to your study card as well. Undergraduates, GSAS students, and cross-registered students may take CS50 either Satisfactory/Unsatisfactory (SAT/UNS) or for a letter grade. When taken for a letter grade, CS50 meets the General Education requirement for undergraduates for Empirical and Mathematical Reasoning. See cs50.harvard.edu for FAQs.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
FAS: Core Curriculum	Quantitative Reasoning
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: General Education	Empirical and Mathematical Reasoning

Computer Science 51

Introduction to Computer Science II (112960)

Stuart Shieber

2016 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Abstraction and design in computation. Topics include functional and object-oriented styles of programming, software engineering in the small, and models of computation. Our main goal is to understand how to design large programs to make them readable, maintainable, elegant, and efficient.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
FAS: Final Assessment Category	Three-hour Exam
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 61

Systems Programming and Machine Organization (123623)

Margo Seltzer

2015 Fall (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Fundamentals of computer systems programming, machine organization, and performance tuning. This course provides a solid background in systems programming and a deep understanding of low-level machine organization and design. Topics include C and assembly language programming, program optimization, memory hierarchy and caching, virtual memory and dynamic memory management, concurrency, threads, and synchronization.

Recommended Prep: CS50 or some experience programming in C.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 91R

Supervised Reading and Research (113257)

Harry Lewis

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Supervised individual study of advanced topics in computer science. A student wishing to enroll in Computer Science 91r must be accepted by a faculty member who will supervise the course work. A form available from the Student Affairs Office, Pierce Hall 110, must be filled out and signed by the student and faculty supervisor. Students writing theses may enroll in this course while conducting thesis research and writing.

Course Notes: At most two terms of Computer Science 91r may be taken for academic credit. May not be taken Pass/Fail. Students wishing more information about the range of suitable projects or faculty supervisors should consult the Director of Undergraduate Studies.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Undergraduate Students

Computer Science 91R

Supervised Reading and Research (113257)

Harry Lewis

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Supervised individual study of advanced topics in computer science. A student wishing to enroll in Computer

Science 91r must be accepted by a faculty member who will supervise the course work. A form available from the Student Affairs Office, Pierce Hall 110, must be filled out and signed by the student and faculty supervisor. Students writing theses may enroll in this course while conducting thesis research and writing.

Course Notes: At most two terms of Computer Science 91r may be taken for academic credit. May not be taken Pass/Fail. Students wishing more information about the range of suitable projects or faculty supervisors should consult the Director of Undergraduate Studies.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Undergraduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 105

Privacy and Technology (125407)

James Waldo

2015 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

What is privacy, and how is it affected by recent developments in technology? This course critically examines popular concepts of privacy and uses a rigorous analysis of technologies to understand the policy and ethical issues at play. Case studies: database anonymity, research ethics, wiretapping, surveillance, and others. Course relies on some technical material, but is open and accessible to all students, especially those with interest in economics, engineering, political science, computer science, sociology, biology, law, government, philosophy.

Course Notes: This course, when taken for a letter grade, meets the General Education requirement for Culture and Belief.

Additional Course Attributes:

Attribute	Value(s)
FAS: Core Curriculum	Social Analysis
FAS: General Education	Culture and Belief
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 108

Intelligent Systems: Design and Ethical Challenges (160419)

Barbara Grosz

2015 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** 20

For centuries, people have imagined smart machines in fictional stories. Computer systems now communicate in speech and text, learn, negotiate, and work in teams (with people and other systems). These intelligent-systems capabilities raise questions about the impact of such systems on people and societies. This course introduces the basic techniques of AI in the context of (science) fiction imaginings and ethical challenges. It examines the roles of design and of policy in reducing potential negative consequences. The course presumes a basic programming ability, but is accessible to concentrators in the humanities and social sciences as well as science and engineering.

Recommended Prep: CS50 or equivalent.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 109

Data Science (109899)

Hanspeter Pfister

Joseph Blitzstein

Verena Kaynig-Fittkau

2015 Fall (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Learning from data in order to gain useful predictions and insights. This course introduces methods for five key facets of an investigation: data wrangling, cleaning, and sampling to get a suitable data set; data management to be able to access big data quickly and reliably; exploratory data analysis to generate hypotheses and intuition; prediction based on statistical methods such as regression and classification; and communication of results through visualization, stories, and interpretable summaries. Built around three modules: prediction and elections, recommendation and business analytics, and clustering and text analysis.

Course Notes: Only one of CS 109, AC 209, or Stat 121 can be taken for credit.

Recommended Prep: Programming knowledge at the level of CS 50 or above, and statistics knowledge at the level of Stat 100 or above (Stat 110 recommended).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 121

Introduction to the Theory of Computation (119064)

Harry Lewis

2015 Fall (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

General introduction to the theory of computation, teaching how to reason precisely about computation and prove mathematical theorems about its capabilities and limitations. Finite automata, Turing machines, formal languages, computability, uncomputability, computational complexity, and the P vs. NP question.

Course Notes: Students may not receive credit for both CS 121 and CS 125.

Recommended Prep: experience in formal mathematics at the level of Computer Science 20.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students

All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 124

Data Structures and Algorithms (115384)

Michael Mitzenmacher

2016 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Design and analysis of efficient algorithms and data structures. Algorithm design methods, graph algorithms, approximation algorithms, and randomized algorithms are covered.

Course Notes: Starting in the spring of 2013, Computer Science 124 will assume background from Computer Science 20. Students will not receive credit for both CS 124 and CS 125.

Recommended Prep: Computer Science 50 or equivalent; Computer Science 51 is helpful. Some exposure to discrete applied mathematics, such as Applied Mathematics 106 or 107 or Computer Science 121 or Statistics 110, is also helpful.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
FAS: Final Assessment Category	Three-hour Exam
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 125

Algorithms and Complexity (156210)

Michael Mitzenmacher

2015 Fall (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

An accelerated introduction to theoretical computer science for students with strong mathematical preparation, to be taken in place of both Computer Science 121 and 124. Algorithm design methods, including graph algorithms, approximation algorithms, and randomized algorithms. Models of computation, computability theory, and computational complexity, including the P vs. NP question.

Course Notes: Students may not receive credit for both CS 125 and either CS 121 or CS 124.

Recommended Prep: Comfort with reading and writing mathematical proofs, at the level of Math 25 or 55 (which may be taken concurrently).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 127 Section: 1

Cryptography (109566)

Boaz Barak

2016 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Cryptography is as old as human communication itself, but has undergone a revolution in the last few decades. It is now about much more than "secret writing" and includes seemingly paradoxical notions such as communicating securely without a shared secret, and computing on encrypted data. In this challenging but rewarding course we will start from the basics of private and public key cryptography and go all the way up to advanced notions such as fully homomorphic encryption and software obfuscation. This is a proof-based course that will be best appreciated by mathematically mature students.

Recommended Prep: Comfort with mathematical proofs at the level of CS121, CS124 or similar. Please contact the instructor if you're unsure if your background is sufficient.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 134

Networks (160409)

Yaron Singer

Benjamin Golub

2015 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Networks—of social relationships, economic interdependencies, and digital interactions—are critical in shaping our lives. This course introduces models and algorithms that help us understand networks. Fundamental concepts from applied mathematics, microeconomics, and computer science will be presented through the lens of network science, in order to equip students to usefully analyze the "big data" generated by online networks. Applications discussed include the viral spread of ideas, maximizing influence, and the contagion of economic downturns. Concepts and tools covered include game theory, graph theory, data mining, and machine learning.

Course Notes: Computer Science 134 is also offered as Economics 1034. Students may not take both for credit.

Class Notes: Course Link http://networksatharvard.com/

Recommended Prep: Linear Algebra, Calculus, probability (either their courses or their equivalents): AM 21a, AM 21b, Statistics 110.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 136

Economics and Computation (128164)

David Parkes

2016 Spring (4 Credits) **Schedule:** MW 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

The interplay between economic thinking and computational thinking as it relates to electronic commerce, social networks, collective intelligence and networked systems. Topics covered include: game theory, peer production, reputation and recommender systems, prediction markets, crowd sourcing, network influence and dynamics, auctions and mechanisms, privacy and security, matching and allocation problems, computational social choice and behavioral game theory. Emphasis will be given to core methodologies, with students engaged in theoretical, computational and empirical exercises.

Course Notes: Formerly Computer Science 186

Recommended Prep: Applied Math 21b, Computer Science 51 or equivalent, Statistics 110, and one of Computer Science 181, Computer Science 182, Economics 1011a, Economics 1052, or Economics 1056.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 141

Computing Hardware (113856)

David Brooks

2015 Fall (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Introduction to the design, structure, and operation of digital computers; logic circuits and digital electronics; computer arithmetic; computer architecture; and machine language programming. Consideration of the design interactions between hardware and software systems.

Recommended Prep: Programming experience required.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 144R

Networks Design Projects (112630)

H. Kung

2015 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Networking has evolved to a new era of supporting large-scale distributed computing for big data. These new networks are software defined in the sense that they can be dynamically programmed to meet various communications needs in computing. In CS 144r/244r, students will obtain the knowledge and experience necessary not only to understand this momentous technological shift in networking, but also to be able to play a part themselves. To this end, the course will not only teach the fundamental concepts necessary to understand this emerging field of software-defined networking, but also real world applications of the technologies such as next-generation ultra-dense 5G cellular networks, as well as their connection with complementary topics such as machine learning. The class will be organized into the following eight modules: A View of the Future: The Promise of Next Generation Networking; Basic Network Design and Protocols; Datacenter Design and Networking; Software Defined Networking; Cross-Disciplinary Applications of Next Generation Networking: Machine Learning, Distributed Computing, and Consumer Applications; Wireless Networking: 5G Networks and Millimeter Wave Communication; Connecting the Internet of Things; Next Generation Networking Enabled Infrastructure: Network Function Virtualization. Students will gain mastery of the subject through lectures, programming assignments, discussion of the latest networking literature, and a final project. Students will have wide latitude in designing and implementing a final project they are passionate about. Industry partners will support the course and provide resources for the final projects.

Course Notes: Preference given to upper-class undergraduates or graduate students in computer science or in business.

Recommended Prep: Programming experience (CS 50 should be fine) and interest in the subject matter. Importantly, CS 143 is NOT a prerequisite. Labs and extra support will provide intensive preparation in the first weeks of the semester to help students quickly obtain the networking background necessary to excel in the course.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 148

Design of VLSI Circuits and Systems (110990)

Gu-Yeon Wei

2016 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** 16

Presentation of concepts and techniques for the design and fabrication of VLSI systems and digital MOS integrated circuits. Topics include: basic semiconductor theory; MOS transistors and digital MOS circuits design; synchronous machines, clocking, and timing issues; high-level description and modeling of VLSI systems; synthesis and place and route design flows; and testing of VLSI circuits and systems. Various CAD tools for design, simulation, and verification are extensively used.

Course Notes: Offered in alternate years.

Recommended Prep: Computer Science 141 or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	For Undergraduate and Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 152

Programming Languages (119629)

Stephen Chong

2016 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Comprehensive introduction to the principal features and overall design of both traditional and modern programming languages, including syntax, formal semantics, abstraction mechanisms, modularity, type systems, naming, polymorphism, closures, continuations, and concurrency. Provides the intellectual tools needed to design, evaluate, choose, and use programming languages.

Recommended Prep: Computer Science 51; Computer Science 121 is recommended. Students must have good programming skills, be very comfortable with recursion, proofs, basic mathematical ideas and notations, including sets, relations, functions, and induction.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Final Assessment Category	Three-hour Exam
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 153

Compilers (131493)

Jean-Baptiste Tristan

2015 Fall (4 Credits) **Schedule:** TF 1000 AM - 1129 AM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Implementation of efficient interpreters and compilers for programming languages. Associated algorithms and pragmatic issues. Emphasizes practical applications including those outside of programming languages proper. Also shows relationships to programming-language theory and design. Participants build a working compiler including lexical analysis, parsing, type checking, code generation, and register allocation. Exposure to run-time issues and optimization.

Class Notes: For more course information, see http://sites.fas.harvard.edu/~lib153/.

Recommended Prep: Computer Science 51 or 61.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 161

Operating Systems (113847)

Margo Seltzer

James Mickens

2016 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

The fundamental principles of resource management and abstraction in modern operating systems. Control abstractions: threads, processes, scheduling, synchronization. Storage abstractions: dynamic memory allocation, virtual memory, file system design. Communication abstractions: interprocess communication, networking. Case studies. Design and implementation of parts of a multiuser multitasking virtual-memory operating system.

Recommended Prep: Computer Science 61.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 165

Data Systems (119249)

Stratos Idreos

2015 Fall (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

We are in the big data era and data systems sit in the critical path of everything we do, i.e., in businesses, in sciences, as well as in everyday life. This course will be a comprehensive introduction to modern data systems. The primary focus of the course will be on modern trends that are shaping the data management industry right now such as column-store and hybrid systems, shared nothing architectures, cache conscious algorithms, hardware/software codesign, main memory systems, adaptive indexing, stream processing, scientific data management, and key value stores. We will also study the history of data systems and traditional and seminal concepts and ideas such as the relational model, row-store database systems, optimization, indexing, concurrency control, recovery and SQL in order to understand both how data systems have evolved over the years and why, as well as how these concepts apply today and how data systems might evolve in the future.

Recommended Prep: Computer Science 51 and Computer Science 61.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 171

Visualization (124364)

Hanspeter Pfister

2016 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

An introduction to key design principles and techniques for visualizing data. Covers design practices, data and image models, visual perception, interaction principles, visualization tools, and applications. Introduces programming of web-based interactive visualizations.

Course Notes: This course, when taken for a letter grade, meets the General Education

requirement for Empirical and Mathematical Reasoning.

Recommended Prep: Students are expected to have basic programming experience (e.g., Computer Science 50).

Additional Course Attributes:

Attribute	Value(s)
FAS: Core Curriculum	Quantitative Reasoning
FAS: Course Level	For Undergraduate and Graduate Students
FAS: General Education	Empirical and Mathematical Reasoning
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 175

Computer Graphics (113410)

Steven Gortler

2015 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

This course covers the fundamentals of 3D computer graphics using a modern shader-based version of OpenGL. Main topics include: geometric coordinate systems and transformations, keyframe animation and interpolation, camera simulation, triangle rasterization, material simulation, texture mapping, image sampling and color theory. The course also touches on ray tracing, geometric modeling and simulation-based animation.

Recommended Prep: Computer Science 51 or 61, Applied Mathematics 21b or Mathematics 21b.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 179

Design of Useful and Usable Interactive Systems (123971)

Krzysztof Gajos

2016 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

The course covers skills and techniques necessary to design innovative interactive products that are useful, usable and that address important needs of people other than yourself. You will learn how to uncover needs that your customers cannot even articulate. You will also learn a range of design principles, effective creativity-related practices, and techniques for rapidly creating and evaluating product prototypes. You will also have several opportunities to formally communicate your design ideas to a variety of audiences. You will complete two large team-based design projects.

Recommended Prep: CS 50 or web programming experience.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 181

Machine Learning (148156)

Finale Doshi-Velez

2016 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Introduction to machine learning, providing a probabilistic view on artificial intelligence and reasoning under uncertainty. Topics include: supervised learning, ensemble methods and boosting, neural networks, support vector machines, kernel methods, clustering and unsupervised learning, maximum likelihood, graphical models, hidden Markov models, inference methods, and computational learning theory. Students should feel comfortable with multivariate calculus, linear algebra, probability theory, and complexity theory. Students will be required to produce non-trivial programs in Python.

Recommended Prep: Computer Science 51, Computer Science 121, Statistics 110, Math 21a and 21b (or equivalent).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 182

Artificial Intelligence (110661)

Alexander Rush

2015 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Introduction to AI focused on problems in reasoning about action and rational decision making, covering search, knowledge representation and planning. Search: heuristics, informed search and optimization; constraint satisfaction; game playing. Knowledge representation: logics, efficient logical inference, reasoning about categories. Planning: action representations and planning algorithms, hierarchical task networks, sequential decision making. Applications to multi-agent systems, robotics and natural-language processing. Discussion of relevant work in philosophy, economics, and decision theory.

Course Notes: Formerly Intelligent Machines: Reasoning, Actions, and Plans

Recommended Prep: Computer Science 51; Computer Science 121 (may be taken concurrently).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 189

Autonomous Robot Systems (127551)

Radhika Nagpal

2016 Spring (4 Credits) **Schedule:** F 0100 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** 20

Building autonomous robotic systems requires understanding how to make robots that observe, reason, and act. Each component uses many engineering principles: how to fuse, multiple, noisy sensors; how to balance short-term versus long-term goals; how to control one's actions and how to coordinate with others. This year theme will be "Robots Roam the Halls", where we will focus on kinect-based robots that move in the SEAS buildings, to do applications like navigating, map building, and interacting with people. The class format will have a mixed lecture and lab format, and have a final project component.

Course Notes: Preference will be given to students with experience in AI (e.g. CS181 or CS182 and/or robotics ES159).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	For Undergraduate and Graduate Students

Computer Science 205

Computing Foundations for Computational Science (128104)

Thouis Jones

2015 Fall (4 Credits) **Schedule:** MWF 1100 AM - 1159 AM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

An applications course highlighting the use of computers in solving scientific problems. Students will be exposed to fundamental computer science concepts such as computer architectures, data structures, algorithms, and parallel computing. Fundamentals of scientific computing including abstract thinking, algorithmic development, and assessment of computational approaches. Students will learn to use open source tools and libraries and apply them to data analysis, modeling, and visualization of real scientific problems. Emphasizes parallel programming and "parallel thinking."

Recommended Prep: Students are expected to have programming experience (e.g., CS50/51, fluent in Python, C/C++, or similar). Course will be taught primarily in Python.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 207

Systems Development for Computational Science (128105)

Pavlos Protopapas

Rahul Dave

2016 Spring (4 Credits) **Schedule:** MW 0230 PM - 0459 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This is a project-based course emphasizing designing, building, testing, maintaining and modifying software for

scientific computing. Students will work in groups on a number of projects, ranging from small data-transformation utilities to large-scale systems. Students will learn to use a variety of tools and languages, as well as various techniques for organizing teams. Most important, students will learn to fit tools and approaches to the problem being solved.

Recommended Prep: Students are expected to have basic programming experience (Computer Science 50).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 221

Computational Complexity (111993)

Leslie Valiant

2016 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

A quantitative theory of the resources needed for computing and the impediments to efficient computation. The models of computation considered include ones that are finite or infinite, deterministic, randomized, quantum or nondeterministic, discrete or algebraic, sequential or parallel.

Recommended Prep: Computer Science 121 or equivalent.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 229R

Information Theory in Computer Science (120237)

Madhu Sudan

2016 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

This advanced graduate course will introduce students to tools from Information Theory that have seen applications in Computer Science: List of topics include:

1) Basic tools of Information Theory2) Distribution Testing3) Moser's algorithmic LLL4) Communication Complexity 5) Parallel repetition and Direct Product Theorems5) Polar Codes and Capacity

Course will be run in seminar style with students presenting half the lectures.

The following courses illustrate some of the topics that we will cover:
http://www.cs.cmu.edu/~venkatg/teaching/ITCS-spr2013/

https://catalyst.uw.edu/workspace/anuprao/15415/86593

http://ttic.uchicago.edu/~madhurt/courses/infotheory2014/index.html

http://www.cs.princeton.edu/~mbraverm/pmwiki/uploads/COS597F-info.pdf

Recommended Prep: Computer Science 221 or the equivalent.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 229R

Algorithms for Big Data (120237)

Jelani Nelson

2015 Fall (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

This course will cover rigorous methods, based on solid theoretical foundations, for processing massive amounts of data. Topics discussed will include streaming and sketching algorithms, dimensionality reduction, and external memory algorithms, to name a few.

Recommended Prep: Mathematical maturity and comfort with algorithms (e.g. CS 124), discrete probability, and linear algebra.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 234R

Topics on Computation in Networks and Crowds (109667)

Nicole Immorlica

2016 Spring (4 Credits) **Schedule:** F 0900 AM - 1159 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Topics on the design and analysis of algorithms, processes, and systems related to crowds and social networks. Readings in AI, theoretical CS, machine learning, social science theory, economic theory, and operations research.

Recommended Prep: Mathematics 21b, Applied Mathematics 21b, or equivalent; Computer Science 124, and 181 or 182, or equivalents; or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 236R

Topics at the Interface between Computer Science and Economics (116531)

Yiling Chen

2016 Spring (4 Credits) **Schedule:** MW 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** 20

Interplay between computation and economics. Topics in electronic commerce, computational social choice, computational mechanism design, peer production, prediction markets and reputation systems. Readings in AI, theoretical CS, multi-agent systems, economic theory, and operations research.

Recommended Prep: Mathematics 21b, Applied Mathematics 21b, or equivalent; Economics 1011a, or equivalent; or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 242

Computing at Scale (160624)

H. Kung

2016 Spring (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Scaling computation over parallel and distributed computing systems is a rapidly advancing area of research receiving high levels of interest from both academia and industry. The objective can be for high---performance computing and energy---efficient computing ("green" data center servers as well as small embedded devices). In this course, students will learn principled methods of mapping prototypical computations used in machine learning, the Internet of Things, and scientific computing onto parallel and distributed compute nodes of various forms. These techniques will lay the foundation for future computational libraries and packages for both high---performance computing and energy---efficient devices. To master the subject, students will need to appreciate the close interactions between computational algorithms, software abstractions, and computer organizations. After having successfully taken this course, students will acquire an integrated understanding of these issues. The class will be organized into the following modules: Big picture: use of parallel and distributed computing to achieve high performance and energy efficiency; End---to---end example 1: mapping nearest neighbor computation onto parallel computing units in the forms of CPU, GPU, ASIC and FPGA; Communication and I/O: latency hiding with prediction, computational intensity, lower bounds; Computer architectures and implications to computing: multi---cores, CPU, GPU, clusters, accelerators, and virtualization; End---to---end example 2: mapping convolutional neural networks onto parallel computing units in the forms of CPU, GPU, ASIC, FPGA and clusters; Great inner loops and parallelization for feature extraction, data clustering and dimension reduction: PCA, random projection, clustering (K---means, GMM---EM), sparse coding (K---SVD), compressive sensing, FFT, etc.; Software abstractions and programming models: MapReduce (PageRank, etc.), GraphX/Apache Spark, OpenCL and TensorFlow; Advanced topics: autotuning and neuromorphic spike---based computing. Students will learn the subject through lectures/quizzes, programming assignments, labs, research paper presentations, and a final project. Students will have latitude in choosing a final project they are passionate about. They will formulate their projects early in the course, so there will be sufficient time for discussion and iterations with the teaching staff, as well as for system design and implementation. Industry partners will support the course by giving guest lectures and providing resources. The course will use server clusters at Harvard as well as external resources in the cloud. In addition, labs will have access to state---of---the---art IoT devices and 3D cameras for data acquisition. Students will use open source tools and libraries and apply them to data analysis, modeling, and visualization problems.

Recommended Prep: (1) programming experience (Python, MatLab or C/C++ should be fine); (2) basic knowledge in systems and machine organization; (3) familiarity in data structures and algorithms; and (4) maturity in mathematics (e.g., undergraduate linear algebra and statistics). For students with strong interest in the subject matter and related research topics, one of these four

requirements may be waived. Labs and extra support will provide preparation in the first weeks of the semester to help students quickly obtain the background necessary to excel in the course.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 244R

Networks Design Projects (112631)

H. Kung

2015 Fall (4 Credits) **Schedule:** MW 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

The contents and course requirements are similar to those of Computer Science 144r, with the exception that students enrolled in Computer Science 244r are expected to do substantial system implementation and perform graduate-level work.

Course Notes: Preference given to upper-class undergraduates or graduate students in computer science or in business who are proficient in computer programming or in business software.

Recommended Prep: Programming experience (CS 50 should be fine) and interest in the subject matter. Importantly, CS 143 is NOT a prerequisite. Labs and extra support will provide intensive preparation in the first weeks of the semester to help students quickly obtain the networking background necessary to excel in the course.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 247R

Advanced Topics in Computer Architecture (128149)

David Brooks

2016 Spring (4 Credits) **Schedule:** TR 1000 AM - 1129 AM

Instructor Permissions: None **Enrollment Cap:** n/a

Seminar course exploring recent research in computer architecture. Topics vary from year to year and will include subjects such as multi-core architectures, energy-efficient computing, reliable computing, and the interactions of these issues with system software. Students read and present research papers, undertake a research project.

Recommended Prep: Computer Science 146 or 246 or permission of the instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 248

Advanced Design of VLSI Circuits and Systems (121984)

Gu-Yeon Wei

2016 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** 16

The contents and course requirements are similar to those of Computer Science 148, with the exception that students enrolled in Computer Science 248 are expected to do a substantial design project and paper discussions on advanced topics.

Course Notes: Offered in alternate years.

Recommended Prep: Computer Science 141 or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 252R

Advanced Topics in Programming Languages (114807)

Stephen Chong

2015 Fall (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Seminar course exploring recent research in programming languages. Topics vary from year to year. Students read and present research papers, undertake a research project.

Recommended Prep: Computer Science 152 or permission of the instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 262

Introduction to Distributed Computing (122813)

James Waldo

2016 Spring (4 Credits) **Schedule:** MW 1130 AM - 1259 PM

Instructor Permissions: None **Enrollment Cap:** n/a

An examination of the special problems associated with distributed computing such as partial failure, lack of global knowledge, asynchrony and coordination of time, and protocols that function in the face of these problems. Emphasis on both the theory that grounds thinking about these systems and in the ways to design and build such systems.

Recommended Prep: Computer Science 161 or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 263

Systems Security (160579)

James Mickens

2015 Fall (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

This course explores practical attacks on modern computer systems, explaining how those attacks can be mitigated using careful system design and the judicious application of cryptography. The course discusses topics like buffer overflows, web security, information flow control, and anonymous communication mechanisms such as Tor. The course includes several small projects which give students hands-on experience with various offensive and defensive techniques; the final, larger project is open-ended and driven by student interests.

Recommended Prep: Computer Science 161 (Operating Systems)

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 265

Big Data Systems (113660)

Stratos Idreos

2016 Spring (4 Credits) **Schedule:** WF 0400 PM - 0529 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Big data is everywhere. A fundamental goal across numerous modern businesses and sciences is to be able to exploit as many machines as possible, to consume as much information as possible and as fast as possible. The big challenge is "how to turn data into useful knowledge". This is far from a simple task and a moving target as both the underlying hardware and our ability to collect data evolve. In this class, we will discuss how to design data systems and algorithms that can "scale up" and "scale out". Scale up refers to the ability to use a single machine to all its potential, i.e., to exploit properly the memory hierarchy and the multiple CPU and GPU cores. Scale out refers to the ability to use more than 1 machines (typically 100s or 1000s) effectively. This is a research oriented class. Every week we will read two modern research papers; one from the scale up area and one from the scale out area. We will use examples from several areas, including relational systems and distributed databases, graph processing systems (i.e., for social networks), key value stores, noSQL and newSQL systems as well as mobile computing. Each student will work on a semester long data systems research project (in groups of 2-4 students) which can be in any of the above areas and will be based on an open research problem.

Recommended Prep: CS 165 or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 278

Rendering and Image Processing in Computer Graphics (116856)

Steven Gortler

2016 Spring (4 Credits) **Schedule:** TR 0100 PM - 0229 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Advanced course in computer graphics focusing on image rendering and processing. Topics include: light transport, efficient rendering, image based rendering, texture processing, interactive image processing.

Class Notes:

Instructor to be determined

Recommended Prep: Computer Science 175 or permission of instructor.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 281

Advanced Machine Learning (107677)

Finale Doshi-Velez

2015 Fall (4 Credits) **Schedule:** MW 0900 AM - 1029 AM

Instructor Permissions: Instructor **Enrollment Cap:** 60

Advanced statistical machine learning and probabilistic data analysis. Topics include: Markov chain Monte Carlo, variational inference, Bayesian nonparametrics, text topic modeling, unsupervised learning, dimensionality reduction and visualization. Requires a major final project.

Class Notes:

Instructor to be determined

Recommended Prep: Students should feel comfortable with basic linear algebra and probability theory. Students will be expected to implement algorithms in a programming language such as Matlab, Python or R.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 283

Computer Vision (113944)

Todd Zickler

2015 Fall (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Vision as an ill-posed inverse problem: image formation, two-dimensional signal processing; feature analysis; image segmentation; color, texture, and shading; multiple-view geometry; object and scene recognition; and applications.

Course Notes: Offered jointly with the Design School as SCI-06275.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 284

Optimization Algorithms for Robotics (160954)

Scott Kuindersma

2016 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Computational methods have revolutionized the way we control the motions of complex, nonlinear, and underactuated robots. In this course, we study a variety of optimization algorithms for designing and stabilizing trajectories for walking, manipulating, and flying systems. Topics will include optimal control (HJB and Pontryagin's minimum principle), nonlinear optimization, trajectory planning (shooting and direct methods) and stabilization, model-predictive control, legged systems (classical models, humanoids, centriodal dynamics), convex methods for control and stability analysis, and optimization through frictional contact. Students will gain practical experience implementing modern algorithms to control a variety of simulated systems using the Drake software toolbox.*

*http://drake.mit.edu

Recommended Prep: Linear algebra and calculus. Prior exposure to robotics and dynamics is helpful, but not required. Students will be expected to complete programming problems in MATLAB.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 287

Statistical Natural Language Processing (112867)

Alexander Rush

2016 Spring (4 Credits) **Schedule:** TR 0230 PM - 0359 PM

Instructor Permissions: None **Enrollment Cap:** n/a

Focuses on statistical and machine learning approaches to natural language processing. Methods include log-linear models, hidden Markov models and conditional random fields, expectation maximization, and neural networks. Natural language topics include language modelling, tagging and information extraction, syntactic parsing, and machine translation. As part of the course, students will also undertake a final research project.

Recommended Prep: CS 181 required, CS 187 or Linguistics 116 recommended.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 289

Biologically-inspired Multi-agent Systems (120238)

Radhika Nagpal

2016 Spring (4 Credits) **Schedule:** TR 1130 AM - 1259 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Surveys biologically-inspired approaches to designing distributed systems. Focus is on algorithms, analysis, and programming paradigms. Topics: swarm intelligence, amorphous computing, immune-inspired systems, synthetic biology. Discussion of research papers and a research project required.

Course Notes: Geared toward graduate students of all levels as well as advanced undergraduates. Preference given to graduate students or upper-level concentrators.

Recommended Prep: Experience with algorithms (e.g. Computer Science 124) and programming (e.g. Computer Science 51).

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 299R

Special Topics in Computer Science (114035)

David Parkes

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Supervision of experimental or theoretical research on acceptable computer science problems and supervision of reading on topics not covered by regular courses of instruction.

Course Notes: Open to graduate students and AB/SM candidates only. Students must arrange such work with a member of the School of Engineering and Applied Sciences. This course is graded and is ordinarily taken with the approval of the Committee on Higher Degrees. Applicants must file a project sheet before study cards are filed. Project sheets may be obtained from the Academic Office, Pierce Hall 110.

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 299R

Special Topics in Computer Science (114035)

David Parkes

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Supervision of experimental or theoretical research on acceptable computer science problems and supervision of reading on topics not covered by regular courses of instruction.

Course Notes: Open to graduate students and AB/SM candidates only. Students must arrange such work with a member of the School of Engineering and Applied Sciences. This course is graded and is ordinarily taken with the approval of the Committee on Higher Degrees. Applicants must file a project sheet before study cards are filed. Project sheets may be obtained from the Academic Office, Pierce Hall 110.

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 304

Statistical Machine Learning (108374)

Ryan Adams

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 304

Statistical Machine Learning (108374)

Ryan Adams

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 306

Readable, Extensible, High-Performance Software Systems (109278)

Eddie Kohler

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 306

Readable, Extensible, High-Performance Software Systems (109278)

Eddie Kohler

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 308

Biologically-Inspired Multi-Agent Systems, Distributed Systems, and Computational Biology (119252)

Radhika Nagpal

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 308

Biologically-Inspired Multi-Agent Systems, Distributed Systems, and Computational Biology (119252)

Radhika Nagpal

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 310

Computational Mechanism Design, Electronic Marketplaces, and Multi-Agent Systems (116301)

David Parkes

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 310

Computational Mechanism Design, Electronic Marketplaces, and Multi-Agent Systems (116301)

David Parkes

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 312

Collaborative Systems, AI Planning, and Natural Language Processing (143299)

Barbara Grosz

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 312

Collaborative Systems, AI Planning, and Natural Language Processing (143299)

Barbara Grosz

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 314

Visual Computing (124155)

Hanspeter Pfister

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 314

Visual Computing (124155)

Hanspeter Pfister

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 316

Social Computing: Computation and Economics (125388)

Yiling Chen

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 316

Social Computing: Computation and Economics (125388)

Yiling Chen

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 320

Data Systems Design (156744)

Stratos Idreos

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 320

Data Systems Design (156744)

Stratos Idreos

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 322

Databases, Operating System, and Software Design (113643)

Margo Seltzer

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 322

Databases, Operating System, and Software Design (113643)

Margo Seltzer

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 324

Human-Computer Communication through Natural, Graphical, and Artificial Languages (111666)

Stuart Shieber

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 324

Human-Computer Communication through Natural, Graphical, and Artificial Languages (111666)

Stuart Shieber

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 326

Intelligent Interactive Systems and Human-Computer (126331)

Krzysztof Gajos

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 326

Intelligent Interactive Systems and Human-Computer (126331)

Krzysztof Gajos

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 327

Tools for Reliable Meaningful Efficient Communication (160962)

Madhu Sudan

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 327

Tools for Reliable Meaningful Efficient Communication (160962)

Madhu Sudan

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 328

Mathematical Logic, Theory of Computation (133437)

Harry Lewis

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 328

Mathematical Logic, Theory of Computation (133437)

Harry Lewis

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 344

Computer Architecture: Modeling and Design (116858)

David Brooks

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 344

Computer Architecture: Modeling and Design (116858)

David Brooks

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 346

High-Performance Computer Systems (117841)

Michael Smith

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 346

High-Performance Computer Systems (117841)

Michael Smith

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 348

Computer Vision (120091)

Todd Zickler

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 348

Computer Vision (120091)

Todd Zickler

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 352

Cryptography: Unbreakable Codes and Financial Cryptography (111744)

Michael Rabin

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 352

Cryptography: Unbreakable Codes and Financial Cryptography (111744)

Michael Rabin

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 356

Computational Complexity, Parallel Computation, Computational Learning, Neural Computation (113027)

Leslie Valiant

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 356

Computational Complexity, Parallel Computation, Computational Learning, Neural Computation (113027)

Leslie Valiant

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 358

Computational Complexity, Cryptography, and Pseudorandomness (115136)

Salil Vadhan

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 358

Computational Complexity, Cryptography, and Pseudorandomness (115136)

Salil Vadhan

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 360

On-line Algorithms and Randomized Algorithms (109883)

Michael Mitzenmacher

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 360

On-line Algorithms and Randomized Algorithms (109883)

Michael Mitzenmacher

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 362

Software Systems: Security, Performance, and Robustness (160959)

James Mickens

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 362

Software Systems: Security, Performance, and Robustness (160959)

James Mickens

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 364

Programming Languages and Security (126329)

Stephen Chong

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 364

Programming Languages and Security (126329)

Stephen Chong

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 365

SEAS Teaching Practicum (125374)

John Girash

2016 Spring (4 Credits) **Schedule:** F 0200 PM - 0359 PM

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Gain effective skills for teaching applied sciences. Topics: presentation and communication, grading and giving feedback on assignments, cognition and learning, classroom practice and student interactions. Seminar style with an emphasis on observation, practice, feedback, discussion, and reflection.

Class Notes:

John A. Girash 6894

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 376

Computer Graphics (121071)

Steven Gortler

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 376

Computer Graphics (121071)

Steven Gortler

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 378

Sketching Algorithms for Massive Data (110261)

Jelani Nelson

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 378

Sketching Algorithms for Massive Data (110261)

Jelani Nelson

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 380

Algorithms for Social Data (110263)

Yaron Singer

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: None **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 380

Algorithms for Social Data (110263)

Yaron Singer

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 382

Natural Language Understanding and Generation (160961)

Alexander Rush

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 382

Natural Language Understanding and Generation (160961)

Alexander Rush

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Primarily for Graduate Students

Computer Science 384

Advanced Control, Estimation, and Analysis of Robots and Dynamical Systems (160963)

Scott Kuindersma

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 384

Advanced Control, Estimation, and Analysis of Robots and Dynamical Systems (160963)

Scott Kuindersma

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Graduate Course
All: Cross Reg Availability	Available for Harvard Cross Registration

Computer Science 386

Machine Learning (160970)

Finale Doshi-Velez

2015 Fall (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
All: Cross Reg Availability	Available for Harvard Cross Registration
FAS: Course Level	Graduate Course

Computer Science 386

Machine Learning (160970)

Finale Doshi-Velez

2016 Spring (4 Credits) **Schedule:** TBD

Instructor Permissions: Instructor **Enrollment Cap:** n/a

Additional Course Attributes:

Attribute	Value(s)
FAS: Course Level	Primarily for Graduate Students
All: Cross Reg Availability	Available for Harvard Cross Registration