COMPUTER SCIENCE

http://www.uvm.edu/~cemcs/cs/

OVERVIEW

The Department of Computer Science offers three graduate programs through the Graduate College: an Accelerated Master's Program (AMP) that enables strong undergraduate students to complete computer science Bachelor's and Master's degrees in 5 years; a Master's Program (M.S.) in computer science with course work-only, project, and thesis options; and an interdisciplinary Ph.D. program that offers study in both traditional and cross-disciplinary areas of computing. The Department also participates in the Transdisciplinary Certificate of Graduate Study in Complex Systems, and the Master's and Ph.D. degrees in Complex Systems & Data Science.

DEGREES

- Computer Science AMP (http://catalogue.uvm.edu/graduate/computerscience/computerscienceamp/)
- Computer Science M.S. (http://catalogue.uvm.edu/graduate/computerscience/computersciencecms/)
- Computer Science Ph.D. (http://catalogue.uvm.edu/graduate/computerscience/computersciencephd/)

FACULTY

Bagrow, James; Assistant Professor, Department of Mathematics and Statistics; PHD, Clarkson University
Beckage, Brian; Professor, Department of Plant Biology; PHD, Duke University
Bongard, Joshua C.; Professor, Department of Computer Science; PHD, University of Zurich
Cheney, Nicholas A.; Research Assistant Professor, Department of Computer Science; PHD, Cornell University
Clemins, Patrick J.; Assistant Professor, Department of Computer Science; PHD, Marquette University
Cockrell, R. Chase; Assistant Professor, Department of Surgery; PHD, Iowa State University
Danforth, Chris; Associate Professor, Department of Mathematics and Statistics; PHD, University of Maryland College Park
Darais, David; Assistant Professor, Department of Computer Science; PHD, University of Maryland
Dodds, Peter Sheridan; Professor, Department of Mathematics and Statistics; PHD, Massachusetts Institute of Technology
Eppstein, Margaret Jean; Professor Emerita, Department of Computer Science; PHD, University of Vermont
Hébert-Dufresne, Laurent; Assistant Professor, Department of Computer Science; PHD, Université Laval, Québec, Canada
Hibbeler, Jason P.; Professor of the Practice, Department of Computer Science; PHD, University of Illinois at Urbana-Champaign
Hines, Paul D.; Associate Professor, Department of Electrical and Biomedical Engineering; PHD, Carnegie Mellon University
Lee, Byung S.; Professor, Department of Computer Science; PHD, Stanford University
Li, Dawei; Assistant Professor, Department of Microbiology and Molecular Genetics; PHD, Shanghai Jiao Tong University
Ling, Alan Chi; Associate Professor, Department of Computer Science; PHD, University of Waterloo
Near, Joseph P.; Assistant Professor, Department of Computer Science; PHD, Massachusetts Institute of Technology
Pinder, George Francis; Professor, Department of Civil and Environmental Engineering; PHD, University of Illinois Urbana-Champaign
Radermacher, Michael; Professor Emeritus, Department of Molecular Physiology and Biophysics; PHD, Technical University of Munich
Rizzo, Donna Marie; Professor, Department of Civil and Environmental Engineering; PHD, University of Vermont
Skalka, Christian Edward; Associate Professor, Department of Computer Science; PHD, Johns Hopkins University
Yu, Jun; Professor, Department of Mathematics and Statistics; PHD, University of Washington Seattle
Zia, Asim; Professor, Department of Community Development and Applied Economics; PHD, Georgia Institute of Technology
P Practitioner-based appointment.

Courses

CS 201. QR: Operating Systems. 0 or 3 Credits.
Supervisory and control software for multiprogrammed computer systems. Processes, threads, synchronization, interprocess communication, scheduling, memory management, resource allocation, performance evaluation, secondary storage, case studies. Prerequisites: CS 120 and CS 121.

CS 202. Compiler Construction. 3 Credits.
Covers the design and construction of compilers and translation of high-level programming languages to assembly language. Topics include code representation, register allocation, optimization, static analysis, mutable data, garbage collection, and compilation of higher-order language features. Prerequisites: CS 124, CS 125.

CS 204. QR: Database Systems. 3 Credits.
Techniques for processing very large collections of data. Secondary storage. Database design and management. Query languages and optimization. Database recovery. Prerequisite: CS 124.

CS 205. QR: Software Engineering. 3 Credits.
Treatment of software engineering problems and principles, with a focus on iterative software development. A significant part of the course is devoted to two multi-week team projects. Prerequisite: CS 120.

CS 206. QR: Evolutionary Robotics. 3 Credits.
Exploration of the automated design of autonomous machines using evolutionary algorithms. Coursework involves reading of research papers, programming assignments and a final project. Prerequisites: Junior standing and programming experience, or Instructor permission.
CS 211. Data Privacy. 3 Credits.
Explores the research field of data privacy, including privacy attacks on anonymized data, and formal approaches like k-Anonymity and differential privacy. Applies the theory of data privacy to real problems in programming projects. Prerequisites: CS 124, CS 125.

CS 222. QR: Computer Architecture. 3 Credits.
Architecture of computing systems. Control unit logic, input/output processors and devices, asynchronous processing, concurrency, parallelism, and memory hierarchies. Prerequisite: CS 121.

CS 224. QR: Algorithm Design & Analysis. 3 Credits.
Comprehensive study of algorithms including greedy algorithms, divide and conquer, dynamic programming, graph algorithms and network flow. Computational intractability. Approximation, local search and randomization. Prerequisite: CS 124. Pre/co-requisites: Recommended: CS 125; STAT 143, STAT 151, or CS 128.

CS 225. QR: Programming Languages. 3 Credits.
The principles of programming language design and fundamental implementation concepts. Syntax, semantics, and static program analysis for various paradigms. Programming language metatheory, including confluence and type safety. Stack-based implementation and memory management issues. Prerequisites: CS 124, CS 125.

CS 226. QR: Software Verification. 3 Credits.
Principles and practice of software specification and verification. Design of algorithms which are verified correct using interactive or automated, software-based tools. Emphasis on the design space for software specification, and the spectrum of verification goals ranging from shallow to deep verification. Includes a course project. Prerequisites: CS 124, CS 125.

CS 228. QR: Human-Computer Interaction. 3 Credits.
The design, implementation, and evaluation of user interfaces for computers and other complex, electronic equipment. Includes a significant project. Pre/co-requisites: Programming experience and Junior standing or Instructor permission.

CS 237. QR: Intro to Numerical Analysis. 3 Credits.
Error analysis, root-finding, interpolation, least squares, quadrature, linear equations, numerical solution of ordinary differential equations. Prerequisites: Math 121; MATH 122 or MATH 124 or MATH 271; CS 020 or CS 021. Cross-listed with: MATH 237.

CS 243. QR: Theory of Computation. 3 Credits.
Reducibility and decidability, recursion theory, time and space complexity, P, NP, NP-completeness, PSPACE, PSPACE-completeness, L and NL, advanced topics in computability and complexity. Prerequisites: CS 124 and CS 125.

CS 253. QR: Reinforcement Learning. 3 Credits.
Students will program agents that learn to optimize a reward function using Reinforcement Learning; Markov Decision Processes with discrete states, Value Iteration, Policy Iteration, Q-learning and SARSA, methods for value function approximation in complex domains using linear and non-linear methods. Prerequisites: CS 064 or MATH 052; STAT 151 or STAT 251; CS 110. Pre/Co-requisites: MATH 122 or MATH 124; CS 125.

CS 254. QR: Machine Learning. 3 Credits.
Introduction to machine learning algorithms, theory, and implementation, including supervised and unsupervised learning; topics typically include linear and logistic regression, learning theory, support vector machines, decision trees, backpropagation artificial neural networks, and an introduction to deep learning. Includes a team-based project. Prerequisites: STAT 151 or STAT 251; MATH 122 or MATH 124.

CS 265. QR: Computer Networks. 3 Credits.
Introduction to the theoretical and pragmatic principles and practices of computer networking. Topics include: the Internet; wired and wireless communications protocols; network security protocols. Prerequisites: CS 110; CS 121.

CS 266. QR: Network Secrty & Cryptography. 3 Credits.

CS 275. QR: Mobile App Development I. 3 Credits.
A projects-based course focusing on software development for mobile devices, including the concepts of event-driven programming, GUI design and implementation, utilization of hardware sensors, and client/server applications. A significant part of the course is devoted to a multi-month team development project. Prerequisite: CS 120, Senior standing. Pre/co-requisites: Recommended: CS 148 or CS 204.

CS 287. QR: Data Science I. 3 Credits.
Data harvesting, cleaning, and summarizing. Working with non-traditional, non-numeric data (social network, natural language textual data, etc.). Scientific visualization using static and interactive 'infographics.' A practical focus on real datasets, and developing good habits for rigorous and reproducible computational science. Project-based. Prerequisites: CS 020 or CS 021; STAT 141 or STAT 143 or STAT 211. Pre/co-requisites: Recommended: CS 110; Math 122 or Math 124. Cross-listed with: STAT 287.

CS 288. QR: Statistical Learning. 3 Credits.
Statistical learning methods and applications to modern problems in science, industry, and society. Topics include: linear model selection, cross-validation, lasso and ridge regression, tree-based methods, bagging and boosting, support vector machines, and unsupervised learning. Prerequisites: STAT 143, STAT 183 or STAT 211. Cross-listed with: STAT 288.

CS 294. Undergraduate Research. 1-18 Credits.
Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.
CS 302. **Modeling Complex Systems. 3 Credits.**

CS 352. **Evolutionary Computation. 3 Credits.**

CS 354. **Deep Learning. 3 Credits.**

CS 387. **Data Science II. 3 Credits.**
Advanced data analysis, collection, and filtering. Statistical modeling, monte carlo statistical methods, and in particular Bayesian data analysis, including necessary probabilistic background material. A practical focus on real datasets and developing good habits for rigorous and reproducible computational science. Prerequisite: STAT 287 or CS 287 or Instructor permission. Cross-listed with: STAT 387.

CS 391. **Master's Thesis Research. 1-18 Credits.**

CS 392. **Master's Project. 1-6 Credits.**
Prerequisite: Department permission.

CS 395. **Advanced Special Topics. 1-18 Credits.**
Subject will vary from year to year. May be repeated for credit with Instructor permission.

CS 491. **Doctoral Dissertation Research. 1-18 Credits.**
Credit as arranged.

CS 496. **Advanced Special Topics. 1-18 Credits.**
See Schedule of Courses for specific titles.