COMPUTATIONAL MATHEMATICS, SCIENCE, AND ENGINEERING CMSE

Department of Computational Mathematics, Science, and Engineering

College of Natural Science

180 Introduction to Data Science
Fall, Spring. 4(4-0) Interdepartmental with Statistics and Probability. Administered by Statistics and Probability. P: (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) Not open to students with credit in STT 301.
Pervasiveness and utility of data in modern society. Obtaining and managing data. Summarizing and visualizing data. Ethical issues in data science. Communication with data. Fundamentals of probability and statistics.

201 Computational Modeling and Data Analysis I
Fall, Spring. 4(4-0) P: MTH 124 or MTH 132 or MTH 152H or LB 118 SA: NSC 204
Computational modeling using a wide variety of applications examples. Algorithmic thinking, dataset manipulation, model building, data visualization, and numerical methods all implemented as programs.

202 Computational Modeling and Data Analysis II
Fall, Spring. 4(4-0) P: CMSE 201 SA: NSC 205
Standard methods and tools for computational modeling and data analysis using simulation techniques, data mining, and machine learning.

314 Matrix Algebra with Computational Applications
Fall, Spring, Summer. 3(3-0) Interdepartmental with Mathematics. Administered by Mathematics. P: (MTH 133 or MTH 153H or LB 119) and (CMSE 201 or CSE 231) R: Not open to students in the Actuarial Science Major or in the Bachelor of Arts in Computational Mathematics or in the Bachelor of Science in Computational Mathematics or in the Bachelor of Science in Mathematics or in the Bachelor of Arts in Mathematics or in the Bachelor of Science in Mathematics, Advanced or in the Bachelor of Arts in Mathematics, Advanced or in the Mathematics Minor or in the Mathematics-Elementary Disciplinary Teaching Minor or in Mathematics-Secondary Disciplinary Teaching Minor.
Numerical methods in linear algebra with applications to systems of equations and eigenvalue problems, and geometry.

381 Fundamentals of Data Science Methods
Fall, Spring. 4(4-0) Interdepartmental with Statistics and Probability. Administered by Computational Mathematics, Science, and Engineering. P: (STT 180 and MTH 314 and CMSE 201 and STT 380) or (STT 180 and MTH 314 and CMSE 201 and STT 441 and STT 442)
Data science methods, including unsupervised learning and supervised learning, feature extraction, dimension reduction, clustering, regression and classification.

382 Optimization Methods in Data Science
Fall, Spring. 4(4-0) P: CMSE 202 and CMSE 381
Concepts, mathematical foundations, methods, and algorithms of optimization in data modeling, all applied to modeling real-world data.

401 Methods for Parallel Computing
Spring of odd years. 4(4-0) P: (CMSE 202 and CSE 232) and (MTH 126 or MTH 133 or MTH 153H or LB 119) Not open to students with credit in CSE 415.
Core principles, techniques, and use of parallel computation using modern supercomputers. Parallel architectures and programming models. Message-passing and threaded programming. Principles of parallel algorithm design. Performance analysis and optimization.

402 Data Visualization Principles and Techniques
Spring of even years. 3(3-0) P: (CMSE 202) and (MTH 234 or MTH 254H or LB 220)
Core principles, methods, and techniques of effective data visualization. Visualization toolkits. Vector and scalar data. Multivariate visualization. Relationship between data analysis and visualization.

404 Introduction to Machine Learning
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering and Statistics and Probability. Administered by Computer Science and Engineering. P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) and MTH 314 RB: Basic linear algebra R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Data Science Major.
Core principles and techniques for machine learning including algorithms, model design, and programming.

410 Bioinformatics and Computational Biology
Spring. 3(2-2) Interdepartmental with Biochemistry and Molecular Biology and Microbiology and Molecular Genetics and Plant Biology. Administered by Computational Mathematics, Science, and Engineering. P: {(CMSE 201 and LB 144 and LB 145) or (CMSE 201 and BS 161 and BS 162) or (CMSE 201 and BS 181H and BS 182H)} and (STT 200 or STT 201 or STT 231 or STT 421 or STT 351 or ECE 280)
Computational approaches in modern biology with a focus on applications in genomics, systems biology, evolution, and structural biology.

411 Computational Medicine
Spring of even years. 3(3-0) Interdepartmental with Biochemistry and Molecular Biology and Microbiology and Molecular Genetics. Administered by Computational Mathematics, Science, and Engineering. P: (CMSE 201 and LB 144 and LB 145) or (CMSE 201 and BS 161 and BS 162) or (CMSE 201 and BS 181H and BS 182H)
Computational approaches in biology with a focus on medicine.

491 Selected Topics in Computational Mathematics, Science, and Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
Topics selected to supplement and enrich existing courses and lead to the development of new courses.

492 Selected Topics in Data Science
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. Interdepartmental with Computer Science and Engineering and Statistics and Probability. Administered by Computational Mathematics, Science, and Engineering. R: Approval of department.
Topics selected to supplement and enrich existing courses in Data Science.

495 Experiential Learning in Data Science (W)
Fall, Spring. 4(2-4) Interdepartmental with Computer Science and Engineering and Statistics and Probability. Administered by Computational Mathematics, Science, and Engineering. P: (CSE 232 and CMSE 382) and completion of Tier I writing requirement R: Open to seniors.
Team-based data science projects on realistic, large-scale data.

499 Independent Study in Computational Mathematics, Science, and Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.
Supervised individual research or study in an area of computational or data science.

801 Introduction to Computational Modeling and Data Analysis
Fall, Spring. 3(3-0) RB: One semester of introductory calculus SA: NSC 801
Introduction to computational modeling using a wide variety of application examples. Algorithmic thinking and model building, data visualization, numerical methods, all implemented as programs. Command line interfaces. Scientific software development techniques including modular programming, testing, and version control.

802 Methods in Computational Modeling
Fall, Spring. 3(3-0) RB: (CMSE 801) or equivalent experience SA: NSC 802
Standard computational modeling methods and tools. Programming and code-management techniques.

820 Mathematical Foundations of Data Science
Spring. 3(3-0) RB: CMSE 802 or equivalent experience in programming and numerical methods. Differential equations at the level of (MTH 235 or MTH 255H or (MTH 340 and MTH 442) or (MTH 347H and MTH 442)). Linear algebra at the level of (MTH 309 or MTH 317H). Probability and statistics at the level of STT 231.
Fundamental mathematical principles of data science that underlie the algorithms, processes, and methods of data-centric thinking, and tools based on these principles.

821 Numerical Methods for Differential Equations
Spring. 3(3-0) RB: CMSE 802 or equivalent experience in programming and numerical methods. Differential equations at the level of (MTH 235 or MTH 255H or (MTH 340 and MTH 442) or (MTH 347H and MTH 442)). Linear algebra at the level of (MTH 309 or MTH 317H)
Numerical solution of ordinary and partial differential equations, including hyperbolic, parabolic, and elliptic equations. Explicit and implicit solutions. Numerical stability.

822 Parallel Computing
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering. Administered by Computational Mathematics, Science, and Engineering. RB: Calculus at the level of MTH 133. Ability to program proficiently in C/C++, basic understanding of data structures and algorithms (both at the level of CSE 232). Basic linear algebra and differential equations.
Core principles, techniques, and use of parallel computation using modern supercomputers. Parallel architectures. Parallel programming models. Principles of parallel algorithm design. Performance analysis and optimization.

823 Numerical Linear Algebra
Spring. 3(3-0) RB: (CMSE 802) or equivalent experience in programming and numerical methods. Linear algebra at the level of MTH 309 or MTH 317H.
Methods in modern numerical linear algebra for solving linear systems, least squares problems, and eigenvalue problems. Efficiency and stability of algorithms in numerical linear algebra.

830 Foundations of Data Science
Spring. 3(3-0) RB: (CMSE 201 or CSE 231 or CMSE 801) and (MTH 235 or MTH 340 or MTH 347H) and ((MTH 309 or MTH 314 or MTH 317H) and STT 810) R: Not open to doctoral students in the Computational Mathematics, Science and Engineering.
Core mathematical principles that underlie the algorithms and methods used in data science. Applications to problems in data analysis.

831 Computational Optimization
Spring. 3(3-0) RB: (CMSE 201 or CMSE 801 or CSE 231) and (MTH 235 or MTH 340 or MTH 347H) and ((MTH 309 or MTH 314 or MTH 317H) and STT 810)
Applications and algorithms for finite-dimensional linear and non-linear optimization problems.

841 Foundation in Computational and Plant Sciences
Spring. 3(3-0) Interdepartmental with Biochemistry and Molecular Biology and Crop and Soil Sciences and Horticulture and Plant Biology. Administered by Horticulture.
Computational modeling applied to plant biology. Data analysis, algorithmic thinking, model building, bioinformatics, and molecular biology using coding and computational resources.

843 Forum in Computational and Plant Sciences
Fall, Spring. 1(1-0) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Biochemistry and Molecular Biology and Crop and Soil Sciences and Horticulture and Plant Biology. Administered by Plant Biology.
Professional development focused on diverse modes of communication in support of interdisciplinary science with an emphasis on plant and computational sciences.

844 Frontiers in Computational and Plant Sciences
Spring. 3(3-0) Interdepartmental with Biochemistry and Molecular Biology and Crop and Soil Sciences and Horticulture and Plant Biology. Administered by Crop and Soil Sciences. RB: Basic programming, mathematical modeling, and statistics
Interdisciplinary research interfacing computational and plant sciences. Molecular system biology, phenomics, and mechanisms connecting genotype and phenotype

890 Selected Topics in Computational Mathematics, Science, and Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
Topics selected to supplement and enrich existing courses.

891 Independent Study in Computational Mathematics, Science, and Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.
Topics selected to supplement and enrich existing courses.

899 Master's Thesis Research
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open to master's students in the Department of Computational Mathematics, Science, and Engineering.
Master's thesis research

999 Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to doctoral students in the Department of Computational Mathematics, Science, and Engineering.
Doctoral dissertation research.