COMPUTER SCIENCE (CS)

Visit the Course Schedule Search website to find out when courses will be offered during the academic year.

Read more about the courses within this subject prefix in the descriptions provided below.

CS 800 - Internship
Credits: 1
Provides an opportunity to apply academic experience in settings associated with future professional employment. A written proposal for the internship must be approved by the department chair. The proposal must specify what the student will learn from the internship, why the student is properly prepared for the internship, and what supervision will be available to the student during the internship. A mid-semester report and a final report are required.
Repeat Rule: May be repeated for a maximum of 3 credits.
Grade Mode: Graduate Credit/Fail grading

CS 812 - Compiler Design
Credits: 4
Formal languages and formal techniques for syntax analysis and parsing; organization of the compiler and its data structures; code generation. LL and LR parsing; automatic generation of scanners and parsers from high-level descriptions. Implementation of features from imperative and object-oriented languages. Students are required to design and implement a compiler for a simple language. Students are expected to have background in computer organization.
Grade Mode: Letter Grading

CS 820 - Systems Programming
Credits: 4
Study and simulation of various types of systems that include assemblers, linkers, memory management, concurrency and other resource management techniques. Students are expected to have background in Computer Organization, Operating Systems Fundamentals or equivalent.
Grade Mode: Letter Grading

CS 822 - Cloud Computing Systems
Credits: 4
The course covers a variety of topics in cloud computing systems, or more precisely, distributed systems that enable modern cloud computing. The topics include virtualization and its impact on system design, cloud-scale storage, cloud data processing and machine learning systems, and cloud configuration management. The course also covers the latest advancements in cloud computing/systems, IoT, edge, and fog computing. Students are expected to have background in operating systems fundamentals.
Grade Mode: Letter Grading

CS 823 - Performance Evaluation of Computer Systems
Credits: 4
This class introduces the main concepts, techniques, and tools needed to evaluate the performance of computer systems under various configurations and workloads. The techniques allow one to perform capacity planning based on quality of service requirements of users and workload characteristics. The course is mainly based on the use of analytic queuing network models of computer systems. The performance techniques are applied to study the performance of centralized, distributed, parallel, and client/server systems. The course also discusses performance measuring tools for operating systems such as Unix and Windows NT. Students are expected to have background in operating systems fundamentals.
Grade Mode: Letter Grading

CS 825 - Computer Networks
Credits: 4
Introduction to fundamental concepts of computer networks and exploration of widely-used networking technologies. Topics include principles of congestion and error control; network routing; local, wireless and access networks; application protocol design; and network programming. In-depth discussion of the Internet suite of protocols.
Grade Mode: Letter Grading

CS 827 - Software Security
Credits: 4
Mechanisms and implementation of techniques in software security. Various fundamental security topics include cryptography, access control, protocols, software vulnerabilities, and reverse engineering. Students are expected to have background in Computer Organization, Assembly Language, Fundamentals of Cybersecurity.
Grade Mode: Letter Grading

CS 830 - Introduction to Artificial Intelligence
Credits: 4
In-depth introduction to artificial intelligence concentrating on aspects of intelligent problem-solving. Topics include situated agents, advanced search techniques, knowledge representations, logical reasoning techniques, reasoning under uncertainty, advanced planning and control, and learning. Students are expected to have background in data structures.
Grade Mode: Letter Grading

CS 833 - Mobile Robotics
Credits: 4
An introduction to the foundational theory and practices in mobile robotics. Topics include Kinematics of wheeled mobile robots. Seniors for mobile robots, robot navigation and perception, robot vision, localization and mapping of mobile robots. Hands-on experience directed towards implementation with a real robot. Students are expected to have background in programming.
Grade Mode: Letter Grading

CS 835 - Introduction to Parallel and Distributed Programming
Credits: 4
Programming with multiple processes and threads on distributed and parallel computer systems. Introduces programming tools and techniques for building applications on such platforms. Course requirements consist primarily of programming assignments. Students are expected to have background in operating systems fundamentals and computer organization.
Grade Mode: Letter Grading

CS 845 - Formal Specification and Verification of Software Systems
Credits: 4
Course focuses on the formal specification and verification of reactive systems, most notably concurrent and distributed systems. Topics relevant to these systems, such as non-determinism, safety and liveness properties, asynchronous communication or compositional reasoning, are discussed. We rely on a notation (T LA+, the Temporal Logic of Actions) and a support tool (TLC, the TLA+ Model Checker). Students are expected to be knowledgeable in logic and to be able to write symbolic proofs in predicate calculus. A basic understanding of the notions of assertion, precondition, and post-condition is also assumed.
Grade Mode: Letter Grading

CS 850 - Machine Learning
Credits: 4
The course covers machine learning methods and their applications. Students will gain an in-depth understanding of when and why machine learning is effective and how to apply it successfully. The course will study foundational machine learning models to build intuition and then explore contemporary machine learning methods. Students will use a scripting language to get hands-on experience in working with real-world datasets. The course requires prior programming experience in a scripting language such as Python, R, Julia, or MATLAB. It also requires some familiarity with linear methods in the form of an introductory linear algebra or linear models course. Students are expected to have background in statistics and programming.
Grade Mode: Letter Grading

CS 851A - Reinforcement Learning
Credits: 4
Reinforcement learning studies how agents can learn to act to achieve goals in complex, stochastic environments. This course introduces students to fundamental theoretical concepts of reinforcement learning, standard algorithms, and practical techniques. In addition to theoretical topics, the course involves implementing basic algorithms in a high-level programming language. Programming and statistics required prior to taking this course.
Grade Mode: Letter Grading

CS 852 - Foundations of Neural Networks
Credits: 4
Neural networks are a class of machine learning models which have recently revolutionized many applied machine learning domains such as natural language understanding, image/video processing, bioinformatics, time series analysis. This course teaches students to develop new neural network architectures from scratch and customize them. The course covers all necessary foundations of neural networks including gradient descent optimization and vector calculus. Students will learn how to design models using idioms such as observed variables, latent variables, gate variables and different functions as well as a wide range of state-of-the-art architectures as design examples. Students are expected to have background in data structures.
Grade Mode: Letter Grading

CS 853 - Information Retrieval and Generation Systems
Credits: 4
Fundamental algorithms and techniques for text processing and text-based information retrieval, synthesis, and generation systems. Topics include how to build an end-to-end information access system, such as a Web search engine or a chat agent.
Grade Mode: Letter Grading

CS 855 - Computer Vision
Credits: 4
Studying techniques that make a machine 'see' and 'understand' the world in a human-like fashion. The course discusses the theory behind common computer vision techniques and trains students on designing their own algorithms for understanding image or video. Students are expected to have background in statistics and programming.
Grade Mode: Letter Grading

CS 857 - Mathematical Optimization for Applications
Credits: 4
This course introduces the foundations of mathematical optimization and reinforces them via applications. The content includes convex optimization, first and second-order methods, constrained problems, duality, linear and quadratic programming, as well as discrete and non-convex optimization. Applications will focus on machine learning methods but also include problems from engineering and operations research. Students are required to have a mastery of Calculus II and programming proficiency in MATLAB, R, Java, C, Python, or equivalent.
Equivalent(s): MATH 857
Grade Mode: Letter Grading

CS 858 - Algorithms
Credits: 4
An introduction to important concepts in the design and analysis of algorithms and data structures, including implementation, complexity, analysis, and proofs of correctness. Understanding of basic data structures, familiarity with proof methods and basic concepts from discrete mathematics and the ability to program with recursion.
Grade Mode: Letter Grading

CS 859A - Natural Language Processing
Credits: 4
This class covers natural language processing, including both methods and well-known applications. Methods discussed will range from classical probabilistic methods such as Naive Bayes and Hidden Markov Models, to contemporary neural network methods, including word vector models, recurrent neural networks, and Transformer-based models. Applications discussed will include text classification, machine translation, and conversation systems. Data structures and statistics required prior to taking this course.
Grade Mode: Letter Grading

CS 860 - Human-Computer Interaction
Credits: 4
This course is a broad introduction to designing, prototyping, and evaluating user interfaces in the context of Human-Computer Interaction (HCI) theory and practice. Additional topics may include the history of computer interfaces, theories of human cognition and perception, observational techniques, and experimental design. Coursework includes lectures, programming assignments, writing assignments, class presentations, and group projects.
Grade Mode: Letter Grading

CS 861 - Programming Language Concepts and Features
Credits: 4
Explores the main features of modern, high-level, general-purpose programming languages from the user (programmer) standpoint. Students learn how specific features of programming languages can be used effectively in solving programming problems. The course is also an opportunity to use paradigms that expand on simple imperative programming, such as object-oriented, functional and concurrent programming. Students are expected to have background in operating systems fundamentals and Computer organization, and some knowledge of Java.
Grade Mode: Letter Grading

CS 870 - Computer Graphics
Credits: 4
Input-output and representation of pictures from hardware and software points of view; interactive techniques and their applications; three-dimensional image synthesis techniques. Students are expected to have background in Data Structures and Computer Organization.
Grade Mode: Letter Grading

CS 875 - Database Systems
Credits: 4
Database analysis, design, and implementation. Focus on the relational model. Data description and manipulation languages, schema design and normalization, file and index organizations, data integrity and reliability. Usage of selected DBMS. Students are expected to have background in data structures.
Grade Mode: Letter Grading

CS 880 - Topics
Credits: 4
Material not normally covered in regular course offerings. May be repeated.
Grade Mode: Letter Grading

CS 881 - Data Science for Knowledge Graphs and Text
Credits: 4
This course covers advanced text processing and machine learning algorithms and techniques for data science with knowledge graph and text data. This includes a wide range of algorithms for neural networks, machine learning, graph processing, text processing, and information retrieval with a focus of gaining insights into the knowledge stored in data. This an implementation-intensive research-oriented seminar, where a particular data science application will be developed by reading research publication and implementing a software prototype.
Prerequisite(s): CS 852 with a minimum grade of B- or CS 853 with a minimum grade of B- or CS 859A with a minimum grade of B-.
Grade Mode: Letter Grading

CS 898 - Master's Project
Credits: 3
Master's Project.
Grade Mode: Letter Grading

CS 899 - Master's Thesis
Credits: 1-6
Master's Thesis.
Repeat Rule: May be repeated for a maximum of 6 credits.
Grade Mode: Graduate Credit/Fail grading

CS 900 - Graduate Seminar
Credits: 1
Regularly scheduled seminars presented by outside speakers, UNH faculty, and graduate students. Topics include reports of research ideas, progress, and results.
Grade Mode: Graduate Credit/Fail grading

CS 920 - Distributed Systems and Algorithms
Credits: 3
Covers fundamental topics in distributed systems: time, global state, synchronization, election, consensus, distributed file systems, security. Also includes a study of several distributed applications. Students are expected to have background in operating system fundamentals.
Grade Mode: Letter Grading

CS 925 - Advanced Computer Networks
Credits: 3
Design and analysis of computer networks. Modeling and performance evaluation, queuing theory applied to computer networks. Traffic flow management and error control. Routing algorithms and protocols. Switch and router architectures. Selected issues in high-speed network design. Optical networks.
Prerequisite(s): CS 825 with a minimum grade of B-.
Grade Mode: Letter Grading

CS 927 - Software Security Analysis
Credits: 3
This course covers advanced research topics in software security. The main focus is automatic software analysis techniques, such as symbolic execution, taint analysis, and fuzz testing.
Grade Mode: Letter Grading

CS 931 - Planning for Robots
Credits: 3
How do drones, self-driving cars, and underwater robots decide what to do? This graduate seminar is focused on research in the area of planning, which is the part of AI concerned with deciding what to do. The idea is to learn what research in the area is like by actually doing some of it. The exact topic will be determined by the interests of the participants. Student from prior years are welcome to take the class again and either extend their previous work or choose a new topic.
Prerequisite(s): CS 830 with a minimum grade of B- or CS 833 with a minimum grade of B-.
Repeat Rule: May be repeated for a maximum of 6 credits. May be repeated up to 2 times.
Grade Mode: Letter Grading

CS 933 - Human Robot Interaction
Credits: 3
Human robot interaction (HRI) is a multidisciplinary research domain that investigates the issues involved with smooth integration of robots in the human society. This course will discuss the evolution of HRI research over the past two decades with an emphasis on HRI algorithms that promote safe, meaningful, and goal-oriented human-robot interactions. Topics also include experimental design methodologies commonly used in HRI studies.
Prerequisite(s): CS 830 with a minimum grade of B- or CS 833 with a minimum grade of B- or CS 850 with a minimum grade of B-.
Repeat Rule: May be repeated for a maximum of 6 credits.
Grade Mode: Letter Grading

CS 950 - Advanced Machine Learning
Credits: 3
Course covers advanced machine learning techniques for making good decisions driven by data. The main focus areas are reinforcement learning, exploration-exploitation trade-off, mathematical optimization methods, and practical applications. Group-based Project on a selected topic.
Repeat Rule: May be repeated for a maximum of 9 credits.
Grade Mode: Letter Grading

CS 959 - Fair, Accountable and Transparent Machine Learning
Credits: 3
The bulk of the course will consist of reading and discussing papers about model fairness, model interpretability, and the ethical and accountable use of machine learning (ML), ranging from classic methods to contemporary topics. Applicable to those doing research on ML, using ML as a research tool for other fields, or thinking about the ethics and policy surrounding ML use.
Grade Mode: Letter Grading

CS 980 - Advanced Topics
Credits: 3
Advanced Topics.
Grade Mode: Letter Grading

CS 998 - Independent Study
Credits: 1-6
Independent Study.
Grade Mode: Letter Grading

CS 999 - Doctoral Research
Credits: 0
Doctoral Research.
Grade Mode: Graduate Credit/Fail grading
Special Fee: Yes