Class Schedule - Fall 2018

Computer Science

CS 598 **Special Topics**  credit: 2 TO 4 hours.

Subject offerings of new and developing areas of knowledge in computer science intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

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<tr>
<th>CRN</th>
<th>Type</th>
<th>Section</th>
<th>Time</th>
<th>Days</th>
<th>Location</th>
<th>Instructor</th>
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<td>12:30 PM - 01:45 PM</td>
<td>TR</td>
<td>1131 - Siebel Center for Comp Sci</td>
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</tbody>
</table>

Credit Hours: 4 hours

Cyber-Physical-Human Systems

Restricted to Graduate - Urbana-Champaign.

This course is oriented to engineering and computer science students who would like their research on interactive systems and technologies to be informed by relevant research in the social, behavioral and cognitive sciences, and to students in these sciences who would like their research to be relevant to technology or engineering design. The format will combine group projects and seminar discussions based on readings to be provided from the "Oxford Handbook of Cognitive Engineering" (J.D. Lee & A. Kirlik, 2013, NY: OUP), whose table of contents (list of topics to be covered) can be found on OUP and related websites. Open to graduate students and to senior undergraduates by permission of instructor.

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Credit Hours: 4 hours

Foundations of Data Curation

Restricted to Graduate - Urbana-Champaign. Restricted to MCS:Computer Sci Online -UIUC or NDEG:Computer Science Onl-UIUC.

This course is for students that are in the Computer Science MCS-DS Program. NON-DEGREE SEEKING STUDENTS MAY ENROLL ON A SPACE-AVAILABLE BASIS WITH THE CONSENT OF THE DEPARTMENT. TO REQUEST ENROLLMENT, PLEASE COMPLETE THE "NON-DEGREE ENROLLMENT REQUEST FORM" HERE: https://illinois.edu/fb/sec/9478165 Additional Coursera ID verification and ProctorU fees may apply To register for this course you must use the Computer Science CRN 69375 / CS 598 AO2

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Credit Hours: 4 hours

Lang/Abst f High-Perf Sci Comp

Restricted to Graduate - Urbana-Champaign.

Languages and Abstractions for High-Performance Scientific Computing This practically-oriented class considers programming language tooling for the construction of high-performance numerically-based software targeting distributed-memory GPU and wide-vector multi-core machines. Topics covered include: Machine Abstractions and Hardware Realities, Kernels and the Anatomy of High-Performance Code, Measuring and Understanding Performance (Types of measurements, performance counters and derived quantities, instrumentation and measurement error), Construction and Design of Domain-Specific Languages (array and scalar languages, parallel primitives, intermediate representations, metaprogramming), Translation and Compilation Techniques (symbolic manipulation, interfacing with computer algebra, kernel fusion, polyhedral representation and transformation), Code Generation and Just-in-Time Compilation, Performance Modeling and Tuning. Prerequisites: Knowledge of C and Python, interest in numerical applications, prior exposure to GPU programming and elementary compiler concepts.

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Credit Hours: 4 hours

Adversarial Machine Learning
Machine learning has seen a remarkable rate of adoption in recent years across a broad spectrum of industries and applications. Many applications of machine learning techniques are adversarial in nature, insofar as the goal is to understand adversarial strategies and therefore detect or defend against attacks. Forensic analysis of malware, which incorporates clustering, anomaly detection, and even vision systems in autonomous vehicles, are all potentially subject to attack. In response to these concerns, there is an emerging literature on adversarial machine learning, which spans both the analysis of vulnerabilities in machine learning algorithms and algorithmic techniques which yield more robust learning. In this class, we will survey an array of these issues and techniques from both the cybersecurity and machine learning research areas. In particular, we consider the problems of adversarial evasion, where the attacker changes behavior to escape being detected, and poisoning, where training data itself is corrupted. We discuss both the evasion and poisoning attacks and the associated defensive techniques in deep neural networks and other machine learning models. We also consider techniques and applications of generative adversarial networks (GANs). Prerequisites: This course is restricted to students with machine learning and deep learning background. The students should be comfortable implementing and training standard deep neural networks in standard frameworks like pytorch or tensorflow.

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**Credit Hours:** 4 hours

**Deep Learning**

*Restricted to Graduate - Urbana-Champaign.*

**Software Testing for All**

*Restricted to Graduate - Urbana-Champaign.*

**Data Mining Capstone**

*Restricted to MCS:Computer Sci Online - UIUC or NDEG:Computer Science Onl-UIC.*

**Advanced Bayesian Modeling**

*Restricted to Graduate - Urbana-Champaign. Restricted to MCS:Computer Sci Online - UIUC or NDEG:Computer Science Onl-UIC.* Restricted to online MCS-DS students. Additional ID Verification Coursera and ProctorU fees may apply. For more details on this course section, please see http://engineering.illinois.edu/online/courses/. Non-Degree seeking students may enroll on a space-available basis with consent. To request enrollment, please complete the “Non-Degree Enrollment Request Form” here: https://illinois.edu/ib/seed/9478165 Sections (and CRNs) for on-campus, degree-seeking students are: STAT 578 A1 (30959). Equivalency: CS 598 section DSO (CRN 69343) is equivalent to STAT 578 section DSO (CRN 48733). This is not true for all sections of CS 598 and STAT 578: it only applies to these specific sections in the fall 2017 term. Since this is not an official cross-listing, they might not automatically be recognized as equivalent for your degree audit. To determine whether extra steps need to be completed for either section to count towards your degree, contact your advisor. For up-to-date information about statistics course registration, please see our registration update pages: go.illinois.edu/StatisticsRegistration

**TOPIC:** Advanced Bayesian Modeling

Description: This class meets with CS 598 section DSO (CRN 69343). Practical methods and models for Bayesian data analysis. Topics include Bayesian fundamentals, prior selection, posterior inference tools, hierarchical models, methods of Bayesian computation, model evaluation, and ordinary and generalized regression models. Emphasis on computational implementation. **Prerequisites:** STAT 420 and knowledge of R.
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Credit Hours: 4 hours
Advanced Bayesian Modeling
Additional Coursera ID verification and ProctorU fees may apply. This is a pilot course and no additional seats will be released.

Credit Hours: 4 hours
Advanced Bayesian Modeling
Machine Learning Computation Bio
Restricted to Graduate - Urbana-Champaign.
This course focuses on modern machine learning techniques in computational biology, including probabilistic modeling, feature selection, graphical models, approximate inference and learning, Monte Carlo methods and neural networks. Students will learn the development of the theoretical concepts for these methods and the applications of these methods to a variety of problems in computational biology. This course is appropriate for graduate students in computer science, bioengineering, mathematics and statistics. Familiarity with basic statistics, probability and algorithms is expected.

Credit Hours: 4 hours
Energy-Efficient Comp Architec
Restricted to Graduate - Urbana-Champaign.
Topic: Energy-Efficient Computer Architecture
This course will discuss recent issues and research trends in designing computer architectures for energy efficiency. The course will start with an analysis of process variation and wear-out, which constrains and affects energy efficiency. We will examine models and techniques for variation tolerance at different levels. They include body biasing, processors with timing speculation, and variation-aware application scheduling. We will then focus on low-voltage computer architecture, which is our best hope for energy efficiency. We will examine how to reduce voltage guard-bands and manage voltage droops. Higher-level techniques include pipeline design for low voltage, efficient eDRAM refresh, extensive power gating, and effective on-chip controllers. Next, we will consider 3D architectures and how they can improve energy efficiency. Finally, we will focus on extreme-scale computer architectures, which are designed from the ground up for energy efficiency. They will bring together all of the concepts discussed in the course into a single platform. Pre-requisite courses: Required: CS433 or equivalent; Recommended: CS533 or equivalent.

Credit Hours: 4 hours
Social Spaces on the Internet
Restricted to Graduate - Urbana-Champaign.
Topic: Social Spaces on the Internet
Social Spaces on the Internet. The Internet is home to a panoply of varieties of human interaction. Social media, interactive games, telepresence, online environments, and simple text e-mails now mediate our normal experiences of education, medicine, politics, business, sociality, collective action, and more. Unbeknownst to many users, these systems incorporate algorithmic interventions that alter prior expectations. As the Internet has become an infrastructure for social life and society itself, our ability to measure and represent that society is transforming. This class explores the presentation of self, the presentation of collectives, the presentation of news, and social dynamics in these online spaces — and how algorithmic intervention shapes them from the perspective of social signalling theory. Topics covered include: resumes of the 22nd century, why people share “fake” news, the mitigation of trolling, ethics, and bias in social media systems. Upon completion of this course, students will have an up-to-date understanding of the design of social media interfaces with incentive structures from social signaling theory.

Credit Hours: 4 hours
Advanced Multimedia Systems
Restricted to Graduate - Urbana-Champaign.
Advanced Multimedia Systems Topic: Advanced Multimedia Systems. Multimedia data and underlying systems and networks that service multimedia (multi-modal sensory) data are becoming ubiquitous. In the "Advanced Multimedia Systems" class we will...
explore major advances that are made in multimedia data, systems and networks to enable next generation multimedia applications such as Skype, YouTube, Flickr and others. We will take the end-to-end approach and explore an integrated view of multimedia systems ranging from 2D and 3D video and audio, advanced compression techniques H.264, MPEG4 and MPEG-7, new multimedia transport protocols and Quality of Service, Content Distribution and Peer-to-Peer networks, multi-modal synchronization, machine learning and deep learning techniques for multi-modal data, services such as Voice-over-IP, Video Conferencing, Video-on-Demand, and subjective and objective Quality of Experience evaluation methods for next generation multimedia applications.

Credit Hours: 4 hours
Statistical Reinforcement Learning
Restricted to Graduate - Urbana-Champaign.
Statistical Reinforcement Learning Topic: Theory of reinforcement learning, with a focus on sample complexity analyses. Reinforcement learning is a machine learning paradigm for sequential decision-making. The course will provide the necessary background and the mathematical tools for understanding the statistical properties of RL algorithms and the challenges. Specific material will include: (1) basics of bandits and Markov Decision Processes, (2) finite sample guarantees of approximate dynamic programming (both tabular and function approximation), (3) importance sampling and Monte-Carlo methods, (4) state abstraction theory, (5) PAC exploration theory, (6) advanced topics, such as exploration theory in large state spaces. Prerequisites: probability and statistics, linear algebra, and basic concepts of machine learning. Some familiarity with Markov chains and numerical analysis are also recommended. Restriction(s): Restricted to Graduate - Urbana-Champaign.

Credit Hours: 4 hours
Mach Lrng for Signal Processing
Restricted to Graduate - Urbana-Champaign.
Topic: Machine Learning for Signal Processing. Prerequisite: Linear algebra, Probability theory. Today we see an increasing need for machines that can understand complex real-world signals, such as speech, images, movies, music, biological and mechanical readings, etc. In this course we will cover the fundamentals of machine learning and signal processing as they pertain to this goal, as well as exciting recent developments. We will learn how to decompose, analyze, classify, detect and consolidate signals, and examine various commonplace operations such as finding faces from camera feeds, organizing personal music collections, designing speech dialog systems and understanding movie content. The course will consist of lectures and student projects and presentations. Students are expected to have a working knowledge of linear algebra, probability theory, and programming skills to carry an implementation of a final project (preferably in MATLAB, but all languages are welcome).

Credit Hours: 4 hours
Practical Statistical Learning
Restricted to MCS:Computer Sci Online -UIUC or NDEG:Computer Science Onl-UIUC.

Credit Hours: 4 hours
Practical Statistical Learning
Additional Coursera ID verification and ProctorU fees may apply. This is a pilot course and no additional seats will be released

Credit Hours: 4 hours
HCl for ML
Restricted to Graduate - Urbana-Champaign.
Explores the use of data-driven methods to support creative design processes by examining recent work in human computer-interaction, product design, cognitive science, machine learning, graphics, vision, and natural language processing. Students will read and discuss recent papers from these fields, and work in teams on a multi-week project to build data-driven tools to solve real-
Practical data mining and machine learning knowledge is emphasized: crowdsourcing and web scraping, model and feature selection, parameter tuning. The course has no formal prerequisites, but students should be algorithmically and programmatically mature.

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<tr>
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<th>Days</th>
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<td>1214 - Siebel Center for Comp Sci</td>
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Credit Hours: 4 hours
Algorithmic Game Theory
Restricted to Graduate - Urbana-Champaign.
Description: Algorithmic game theory has become more relevant than ever before with the advent of online markets, ad auctions, social networks, and recommendation systems, where rational agents interact to achieve selfish goals. The last two decades have witnessed the development of a rich theory in this area and deep mathematical connections have been established. The first half of the course will provide a broad introduction to games and market models, solution concepts, equilibrium computation & complexity, price of anarchy, auctions, and others. The second half will address a selection of advanced topics and research projects.

Credit Hours: 4 hours
Real Time Systems
Restricted to Graduate - Urbana-Champaign.
Modern Real Time Systems The landscape of real time computing has changed greatly. IoTs, robots, self-driving cars, drones and smart cities are coming. Sensors and actuators drivers are now integrated into miniature computers, and multicore chips with GPU are already in the market. • What are the application models and platform technologies assumed by existing real time computing technologies? • What are existing technology’s limitations in i) supporting the new needs and ii) exploiting capabilities of new platforms? • How do we bring an existing technology, e.g., real time computing, into a new era? In the 90’s, the instructor’s team brought the then older state of the art real time computing technology into the then modern era, winning IEEE’s 2016 Simon Ramo Medal that awards members with exceptional achievements in system engineering and science. Let’s identify the opportunities offered by the “new continent” known as modern real time computing. This class is more about how to do research than a technology deep diving.

Credit Hours: 4 hours
Advance Bioinformatics
This course introduces a selection of topics in bioinformatics (mostly genomics) with a focus on probabilistic methods and statistical analysis, as well as basic principles of data science and computational sciences. Who this is for: The course will help graduate students aspiring to become bioinformatics researchers as well as students who are interested in data sciences in general and are looking for interesting applications. The course is less ideal for students interested in a casual exposure to the buzz surrounding bioinformatics. A research project (conceptualization and implementation) is a major component of the course grade, making the course unsuitable for students with little or no programming experience. Syllabus will tentatively include: Basic Molecular Biology, Probability/Statistics (probabilistic modeling, hypothesis testing, sampling), Introduction to Selected Bioinformatics topics (such as sequence alignment, enhancer prediction, epigenomics, modeling of gene expression, modeling of population evolution), and research paper reading on the selected topics.

Credit Hours: 4 hours
Machine Learning Theory
Restricted to Graduate - Urbana-Champaign.
This course will cover both basic material and certain advanced topics in machine learning theory. The core of the course will investigate the standard statistical learning theory model, along with its usual decoupling into representation, optimization, and generalization. The course will also touch on other learning models, for instance active learning and online learning. Specific material will include neural networks, linear regression, SVMs, boosting, consistency, VC dimension, Rademacher complexity,
dimensionality reduction, and k-means. Grades will be based on homework and a final project. Prerequisites: basic probability, basic linear algebra.

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<td>11:00 AM - 12:15 PM</td>
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<td>1103 - Siebel Center for Comp Sci</td>
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Credit Hours: 4 hours
Geometric Approx Algorithms
Restricted to Graduate - Urbana-Champaign.
Topic: Geometric Approximation Algorithms We study approximation algorithms in computational geometry -- how to solve problems involving geometric data faster when we do not need exact answers, with provable guarantees on the quality of the solutions. We will examine a variety of problems, about approximating the shape of point clouds (e.g., convex hull, diameter, width, and minimum enclosing ball), proximity (e.g., nearest neighbors, spanners, and minimum spanning trees), range counting, clustering (e.g., k-center), shortest paths in geometric graphs, and geometric versions of NP-hard optimization problems (e.g., set cover, independent set, and traveling salesman). A variety of techniques will be encountered (grids, quadtrees, coresets or sketching, random sampling, separators, linear programming relaxation, dimensionality reduction, etc.). Prerequisite: CS 374 or equivalent.

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Credit Hours: 4 hours
Reliability of Cloud-Scale Sys
Restricted to Graduate - Urbana-Champaign.
The purpose of this course is to teach the principles and practices of reliability engineering in modern "cloud-scale" systems, and expose students to the research of software and system reliability. We will look at how large-scale systems fail in the real world, and we will study the state-of-the-art reliability techniques and practices, including those widely adopted in industry and new ideas proposed by academia. This is a research-oriented seminar course with a major course project. Website: https://tianyin.github.io/cs598-fa18/