USC Viterbi School of Engineering

DSCI 599: Machine Learning for a Secure Internet

Units: 4.0
Spring 2025 --- TuesThurs --- 8:00-9:50AM

Instructor: John Heidemann
Contact Info: johnh@isi.edu

Location: GFS 207

Catalogue Course Description

Machine Learning for a Secure Internet: introduction to the design principles, layering, protocol design/analysis, networked applications, Internet structure/architecture, protocols for transport/congestion control, and network security. Application of ML algorithms for networking data and packet traces.
Recommended preparation: Familiarity with python

Course Description

The goal of the course is to introduce students to state-of-the-art research on reasoning with network and cyber security data. The class projects will play a central role in the course to provide hands-on experience with applying ML algorithms to real-world networking data.

This course will teach data science students to collect, clean, and develop ML models for networking and cyber security data. The ML algorithms will include statistical learning, classification, clustering, link prediction, anomaly detection, Bayesian models, and similar algorithms. The course will enable students to:

- Develop understanding of ML methods for experimentation and correlational research for networking and cyber security
- Determine the required statistical analyses for modeling and evaluation of networked systems

The course topics will be particularly relevant to students interested in networked systems such as IoT and cellular networks and cyber security.

Learning Objectives

After completing this course, students will be able to:

Design and Execute Networking and Cyber Security Experiments

- describe how setup a networking experiment and collect data
- describe how setup a cyber security experiment and collect data
- describe how clean and process the network and log data
- choose the appropriate research design for their research questions, while considering both validity and rigor
- plan and evaluate choices in determining the specific design of an experiment

Application of ML Algorithms on Networking and Cyber Security Experiments

- select the appropriate ML algorithms for the experiment
- run the statistical test and understand the output
- write up and interpret the results of the statistical tests
- conduct analysis to determine the likelihood of finding a significant results

Technological Proficiency and Hardware/Software Required

All students will need introductory familiarity with python programming.

Required Readings and Supplementary Materials

Title: *Computer Networks: A Systems Approach*
Authors: Larry Peterson and Bruce Davie

Source: https://github.com/SystemsApproach/book

Additional set of Readings, Lectures, and Discussion Charts will be posted regularly on our course website. A list of reference texts will also be posted on the same site

Grading Breakdown

Type	Count	Weightage	Total Weightage
Hands-on Assignments • Clean, model, and analyze networking data • Apply one or more ML algorithm and statistical analysis methods	4	15%	60%
Cumulative Midterm • 90 minute exam • Combination of multiple-choice questions and short answers • Two or more long analysis questions	1	20%	20%
Cumulative Final • 90 minute exam • Combination of multiple-choice questions and short answers • Two or more long analysis questions	1	20%	20%

Academic Integrity for this Class

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the USC Student Handbook. The general USC guidelines on Academic Integrity and Course Content Distribution are provided later in this syllabus.

Please ask the instructor [and/or TA(s)] if you are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Class Recordings and Course Content Distribution: You may not record this class without the express permission of the instructor and all other students in the class. Distribution of any notes, recordings, exams, or other materials from a university class or lectures — other than for individual or class group study — is prohibited without the express permission of the instructor; violations will be considered an intentional act to facilitate or enable academic dishonesty and reported to the university

Use of Generative AI in this Course

Generative AI is not permitted: Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Course Evaluations

Course evaluation occurs at the end of the semester university-wide. It is an important review of students' experience in the class. The process and intent of the end-of-semester evaluation should be provided. In addition, a mid-semester evaluation is recommended practice for early course correction. You may choose to contact CET for support in creating a mid-semester evaluation.

Course Schedule

Week	Topic	Assignments
Week 1	Introduction to Course logistics with Networking overview and ML Applications	
Week 2	Network Architecture and ML background	Assigned: Assignment 1

Week 3	The Internet Applications and data collection	
Week 4	Network topology, Links, and Access and ML for representation	
Week 5	Routing and ML for QoS optimizations	Due: Assignment 1 Assigned: Assignment 2
Week 6	Addressing and ML solutions	
Week 7	Advanced topics with current state of art in AI-based routing	
Week 8	Review and Midterm Exam	Due: Assignment 2
Week 9	Transport Protocols and ML-based control	Assigned: Assignment 3
Week 10	Advanced topics with current state of art in AI-based congestion control	
Week 11	Network naming and ML for automation	
Week 12	Network Security and ML for anomalous behavior	Due: Assignment 3 Assigned: Assignment 4
Week 12	Advanced topics with current state of art in AI-based cyber security	
Week 13	Internet of Things (IoT)	
Week 14	Advanced topics with current state of art in AI-based IoT management	
Week 15	Review material for the final exam	Due: Assignment 4
FINAL		*Due on university-scheduled date of the final exam*

All the topics above will discuss Machine learning algorithms for networks including statistical learning, classification, link prediction, network clustering, graphical models, anomaly detection, graph identification causal Bayesian models, predictive and causal modeling and similar algorithms.

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct — which includes any act of dishonesty in the production or submission of academic work (either in draft or final form) — is in contrast to the university's mission to educate students through a broad array of academic, professional, and extracurricular programs.

This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are their own original work and prepared specifically for this course and section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonestly and is strictly prohibited. (Living our Unifying Values: The USC Student Handbook, page 13).

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the Financial Aid Office webpage for undergraduate- and graduate-level SAP eligibility requirements and the appeals process.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-2500
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health-promoting habits and routines that enhance quality of life and academic performance.