DSCI 599: Optimization Techniques for Data Science
Units: 4
Spring 2024 – Fridays – 2:00-5:20pm

Location: VHE 210

Instructor: Satish Kumar Thittamaranahalli
Office: TBD
Office Hours: TBD
Contact Info: thittama@usc.edu (please include "DSCI-599" in the subject line and CC the Teaching Assistant)

Course Description
This course will cover topics in optimization gleaned from several research communities: algorithms, artificial intelligence, machine learning, and mathematics. The various optimization techniques will be covered with sufficient context and background material. Their applications will be demonstrated on problems of interest in data science.

Learning Objectives
1. Broadly understand major algorithms used in graph theory and discrete optimization.
2. Understand linear programming, convex programming, and duality.
3. Broadly understand machine learning, including supervised, unsupervised, and reinforcement learning.
4. Understand foundational material in linear algebra and multivariate calculus required for data science.
5. Understand foundational material in probability and statistics.
6. Broadly understand heuristic search, constraint programming, and graphical models.

Recommended Preparation
Basic programming skills and a basic understanding of algorithm design, mathematics, and engineering principles are strongly encouraged. Knowledge at the level of CSCI-270 or CSCI-570.

Course Notes
The course can be taken for credit or for a letter grade. The lectures will be in-person, in a traditional classroom setting. However, the assignments will be available on Blackboard. The course announcements will also be made via Blackboard and associated class email lists.

Technological Proficiency and Hardware/Software Required
The course content on Blackboard can be accessed via USC login credentials. Students without a personal computer can utilize the [USC Computing Center Laptop Loaner Program](#). In addition, students can also utilize [Blackboard Help for Students](#) and [Software Available to USC Campus.](#)

Required Readings and Supplementary Materials
The reading material for the course will be based on published technical papers available via the ACM/IEEE/Springer digital libraries or freely available online. All USC students have automatic access to these digital archives.

Optional Readings and Supplementary Materials
1. Stuart J. Russell and Peter Norvig, 2020. Artificial Intelligence: A Modern Approach, Fourth Edition.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 2022. Introduction to Algorithms, Fourth Edition.
3. Ethem Alpaydın, 2020. Introduction to Machine Learning, Fourth Edition.

Description and Assessment of Assignments
Grading will be based on students' understanding of lecture material, the correctness of their programs, and their ability to conduct comprehensive project work. Students can work in groups of 1-2 but should mention their individual contributions.

Participation
Students are encouraged to ask questions in the classroom during lecture hours. They are also encouraged to elicit guidance for their class project during office hours or by arrangement with the instructor.

Grading Breakdown

Assessment Tool	Points	% of Grade
Programming Assignments	40	40
Class Project	30	30
Final Exam	30	30
TOTAL	100	100

Grading Scale
The grading will be done on a curve: A student's grade will depend on their relative performance compared to that of the other students.

Assignment Submission Policy
Students are required to submit the assignments on USC's Blackboard portal. One submission per team is sufficient. However, the names and USC IDs of all students on the team must be clearly mentioned.

Grading Timeline
Feedback and grades will be available within 1-2 weeks after the assignment due dates.

Course Specific Policies
Recording or taking pictures of classroom material is strictly prohibited.

Attendance
Students are required to attend classes and take down notes.

Classroom Norms
Students are discouraged from talking to each other in class. Instead, they are encouraged to ask questions and interact directly with the instructor. The use of electronic devices for activities not related to the course is strictly prohibited.

Zoom Etiquette
If the office hours of the TA or the instructor are on Zoom, the students are required to wait for their turn politely. Recording of online conversations is strictly prohibited.

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 is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

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 original work and prepared specifically for the course/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.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

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]().

Students are encouraged to talk to the instructor if they are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution. They are also encouraged to talk to the instructor if they are unsure about what constitutes plagiarism, including the submission of code written by, or otherwise obtained from someone else.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an "F" grade on the assignment, exam, and/or in the course.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit the 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 relationship to the class, whether obtained in class, via email, on the internet, or via any other media. ([Living our Unifying Values: The USC Student Handbook](), page 13).

Course Evaluations
Course evaluation occurs university-wide at the end of the semester. It is an important review of students' experiences in the class. The student feedback will be used to improve future versions of the course.

Use of Generative AI in this Course
[Description of if/how Generative AI and similar tools may be used 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 Schedule
The following is a tentative course schedule subject to change.

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Introduction to the Course; Local Search and Dynamic Programming.	Lecture Notes; Research Papers.	
Week 2	Linear Algebra and Multivariate Calculus; Applications in Data Science.	Lecture Notes; Research Papers.	
Week 3	**Holiday (Labor Day)**		
Week 4	Perceptron Learning, Linear Regression, Logistic Regression, and Neural Networks.	Lecture Notes; Research Papers.	**Assignment 1**
Week 5	Linear Programming, Quadratic Programming, and Convex Programming; Duality; Applications.	Lecture Notes; Research Papers.	
Week 6	Support Vector Machines, Nonlinearity, and Kernel Methods.	Lecture Notes; Research Papers.	
Week 7	Graph Theory and Cornerstone Graph Algorithms; Maxflow; Applications.	Lecture Notes; Research Papers.	**Project Update 1**
Week 8	Graph Embedding; FastMap and Its Applications.	Lecture Notes; Research Papers.	**Assignment 2**
Week 9	Probability, Statistics, and Randomization.	Lecture Notes; Research Papers.	
Week 10	Constraint and Weighted Constraint Satisfaction Problems; Applications.	Lecture Notes; Research Papers.	
Week 11	Graphical Models: Bayesian Networks, Markov Random Fields, and Constraint Networks.	Lecture Notes; Research Papers.	**Assignment 3**
Week 12	Heuristic Search; A* and Focal Search; Applications.	Lecture Notes; Research Papers.	**Project Update 2**
Week 13	Causal Reasoning; Planning and Scheduling; Workflows.	Lecture Notes; Research Papers.	
Week 14	Case Studies.	Lecture Notes; Research Papers.	**Assignment 4**
Week 15	Student Presentations.		
FINAL	**Final Project Report**		Due on the university-scheduled date of the final exam.

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

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

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

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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.

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 is comprised 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) 740-5086 or (213) 821-8298*
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.