CSCI 699: Information Theoretical Lower Bounds
Units: 4.0
Spring 2024 – Thursdays – 3:30-6:50PM

Location: TBD

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Office Hours: TBD
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Catalogue Description

We will introduce some information theoretical methods to prove communication complexity lower bounds and streaming lower bounds.

Course Description

Communication complexity is a computational model which captures communication cost between several parties to jointly compute a function. There are several players in the model with each having their own input. The goal to compute a joint function based on the inputs, while minimizing communication bits. Besides communication complexity itself, lower bounds in this model also capture many other computational models such as time-space tradeoffs for data structures, streaming algorithms, sketching algorithms, sub-linear time algorithms, and many more. This course will introduce several techniques to prove communication lower bounds as well as their applications to streaming lower bounds.

Learning Objectives

The course is designed to enable students to:

1. Understand communication complexity models, including deterministic communication, non-deterministic communication, and randomized communication.
2. Understand several lower bound techniques such as rank method, discrepancy, information complexity and lifting theorems.
3. How to apply communication complexity lower bounds to streaming lower bounds.

Recommended Preparation

Knowledge at the level of CSCI 170 and MATH 407

Course Notes

Grading includes two parts:

- Three problem sets. (50%)
- A presentation of a research paper

Description of Assignments and How They Will Be Assessed

There are two homework sets with each of 25%. Homework problems will be released two weeks before the deadline.

Grading Breakdown

Assessment Tool (assignments)	% of Grade
Homework 1	25%
Homework 2	25%
Presentation	50%
TOTAL	

Grading Scale

A: >=90%
B: >=80%
C: >=70%
D: >=60%

Assignment Submission Policy
Assignments should be submitted via emails.

Academic Integrity
- Group collaboration. It is allowed to collaborate with classmates as a group (up to three students in each group). Each group only needs to submit one copy of their homework solutions.
- It is allowed to use any materials from the textbook or lecture notes.
- It is not allowed to find solutions online or ask for solutions from anyone other than your group members.

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.

Use of Generative AI in this Course
Generative AIs are not allowed in this course.

Course Schedule

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Deterministic Communication Complexity		
Week 2	Deterministic Communication Lower Bounds		
Week 3	Non-Deterministic Communication		
Week 4	Non-Deterministic Communication		
Week 5	Randomized Communication Complexity		
Week 6	Discrepancy Method		
Week 7	Information Complexity		
Week 8	Information Complexity		Homework 1 Due on Friday
Week 9	Lifting Theorems		
Week 10	Lifting Theorems		
Week 11	Streaming Lower Bounds		
Week 12	Streaming Lower Bounds		
Week 13	Student Presentation		
Week 14	Student Presentation		Homework 2 Due on Friday
Week 15	Student Presentation		
FINAL	**Presentations Review**		Refer to the final exam schedule in the USC *Schedule of Classes* at classes.usc.edu.

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.

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 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).

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.