Course Proposal

Proposed Course Number: COMP SCI 285CC
Course Catalog Title: Communication Complexity
Short Title: Communication Complexity
Units: 4
Grading Basis: Letter grade
Format: Lecture only
GE or Major/Minor requirement: None
Requisites: Graduate standing (required) and mathematical maturity (strongly encouraged)

Description

Consider a function *f* whose arguments are distributed among several parties, making it impossible for any one party to compute *f* in isolation. *Communication complexity theory* studies how many bits of communication are needed to evaluate *f*. A trivial approach is for the parties to communicate their inputs to each other. While this costly solution is optimal in some cases, one can often accomplish the task with surprisingly little communication. To cite a basic example, one can check with accuracy 99% if two geographically separated databases are identical by communicating only *eight* bits, regardless of how large the databases actually are! Communication complexity was pioneered in 1979 by Turing award winner Andrew Yao and has since blossomed into a central area of theoretical computer science, with deep open questions, beautiful mathematics, and a vast array of applications. This graduate course is a self-contained introduction to communication complexity, with coverage of the fundamentals, key classic theorems, and current research directions.

Justification

Communication is a common bottleneck. It arises whenever a computational problem requires coordination among several parties, each with an incomplete view of the input. Moreover, the communication bottleneck is often present even when no transmission of data occurs. Indeed, many computational problems involve an implicit flow of information among several components and are therefore subject to the limitations of multiparty communication. This makes it imperative to study communication in a clean, abstract, and unified way.

Over the decades, communication complexity theory has proven to be a powerful tool in virtually all areas of theoretical computer science and beyond, including computational learning, pseudorandom generators, streaming algorithms, quantum computing, data structures, mechanism design, and chip layout. Speaking more broadly yet, this course showcases a variety of mathematical techniques (matrix-analytic methods, geometric duality, extremal combinatorics, etc.) that the students can apply to a large number of other areas.

Instructor Expertise

The instructor has two decades' worth of research expertise in communication complexity theory. He is a leader in this research area and has solved a number of longstanding open problems in it. In addition to his research qualifications, the instructor has consistently demonstrated excellence in teaching communication complexity to a broad spectrum of students in computer science, mathematics, and engineering, as borne out by his teaching evaluations below.

Supplemental Information

No extra resources are necessary.

Grading Structure

- **Scribe notes, 30%.** Scribe notes are a complete and polished write-up of a lecture, with bibliographic references filled in and technical details carefully worked out for all proofs. Preparing scribe notes allows one to internalize the material on a fundamentally new level and experience the thrill of someone writing this theory for the first time. Each student scribes 1-2 lectures.
- **Midterm exam, 30%.** The midterm is a challenging set of problems to be solved at home within 10 days. The problems require a deep synthesis of the material and a novel approach to each problem.
- **Final exam 30%.** The final exam is cumulative. Analogous to the midterm, it is administered as a take-home exam to be completed within 10 days.
- **Participation, 10%.** Participation is collected throughout the quarter and graded on a credit/no credit basis.
- **Weekly challenge problems, extra credit.** At the end of each week, the instructor assigns a challenge problem. Working on these problems is optional but strongly encouraged. Students give brief presentations of their solutions in class for extra credit.

Effective Date: Spring 2022

Syllabus: A detailed syllabus for the most recent offering is available at https://web.cs.ucla.edu/~sherstov/teaching/2021-winter

Enrollment and Student Evaluations

The instructor has offered this course annually or biannually starting in 2012. The enrollment and student evaluation numbers for the most recent 5 offerings are shown below.

Term	**Enrollment**	**Average Evaluation Score for Instructor**	**Average Evaluation Score for Course**
14F	7	9	8.83
16S	9	8.88	8.38
18S	14	8.89	8.89
19S	12	9	9
21W	8	8.67	8.67