CPSC 536Z: Introduction to Communication Complexity
Syllabus

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1 Course Description

This course will introduce the basic concepts and research directions in communication complexity. This includes both "core" communication complexity topics (i.e. understanding communication for its own sake) as well as a variety of applications.

2 Logistics

- Time: Friday 2-5pm
- Location: SWNG 308
- Website: https://harmless.ink/teaching/communication.html
- Office hours: Monday 3-4pm (tentative)
- Lecture notes will be available after the lectures.

3 Prerequisites

I am aiming to have mostly self-contained lectures, but students will need to know undergraduate-level linear algebra, discrete math, and algorithms.

4 Materials

The lectures will be self-contained, so I don't expect students to require a textbook. However, here are a few excellent textbooks for learning communication complexity, or complexity in general:

- *Communication Complexity and Applications*, by Anup Rao and Amir Yehudayoff (Cambridge University Press, 2020).
- *Boolean Function Complexity*, by Stasys Jukna (Springer-Verlag, 2012). At https://web.vu.lt/mif/s.jukna/boolean/index.html you can get an early draft for free, or I can send you a draft of the 2nd edition.

- *Communication Complexity*, by Eyal Kushilevitz and Noam Nisan (Cambridge University Press, 1996).

5 Grading

There will be 2 or 3 homework assignments, and a course project. For the course project, I encourage students to look for either applications of communication complexity to their area interest, or to dive into more detail on one of the open problems we will discuss in class.

- Homework: $\sim 50\%$
- Project: $\sim 50\%$

6 Tentative Schedule

Deterministic Communication

1. Introduction, definitions, summary of applications.
2. Lower bounds and the log-rank conjecture.
3. Application to circuit complexity.

Randomized Communication

1. Definitions and examples (Equality, k-Hamming Distance, Greater-Than)
2. Lower bound for Disjointness
3. Applications to streaming algorithms and others.
4. Connections to learning theory (margin, sign-rank, others to be determined).
5. Others to be determined.

Generalized Models

1. Number-on-Forehead.