CS 2429F – Fall 2014
Location: HA 410 (likely to change)
Time: Tuesday 3-5

Instructor: Toniann Pitassi

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Office hours: by appointment

Course Web Site:

http://www.cs.toronto.edu/ toni/Courses/CommComplexity2014/CS2429.html
Refer to this site periodically for important announcements and other information. All handouts will be available on the site in postscript or pdf form.

Course Materials:

The recommended book for this course is *Communication Complexity* by Kushilevitz and Nisan. Each lecture will additionally have supplemental reading material such as a paper or lecture notes, available on the website.

Course Description

This is a topics course in communication complexity, information complexity and applications. This is a vibrant and currently very active area of complexity theory. The setup consists of two players, Alice and Bob, who hold n-bit strings x and y respectively. The basic question in communication complexity is: how many bits must be communicated in order for them to compute a joint function, $f(x, y)$ of their inputs? The basic and inter-related question in information complexity is: how much information must be revealed (about x to Bob, and about y to Alice, or about x and y to an eavesdropper) in order to compute $f(x, y)$? In this course we will study these fundamental concepts and their interrelations. We will see some surprising protocols, and explore techniques for proving inherent limitations with respect to these measures, with the goal of developing a unifying theory of interactive information theory. We will then focus on the large and beautiful body of applications of communication complexity in Computer Science. The only prerequisite for this course is the equivalent of CS364 (undergraduate

1

complexity theory). However a graduate course in computational complexity (CS2401) will be very helpful.

(1.) Introduction to two-player communication complexity. Basic concepts and definitions, motivation, connections to complexity theory and logic. Definition of NOF communication complexity model.

(2.) Deterministic, randomized, and nondeterministic complexity. Connections between the models.

(3.) Lower bound methods. Fooling sets, rank, discrepancy method, the pattern matrix method and lower bounds via polynomial degree, lower bounds via information complexity.

(4.) Applications of communication complexity lower bounds: (1) Lower bounds on Extended Formulations of linear programming and semidefinite programs for NP-hard problems (2) Circuit Complexity lower bounds via communication complexity (3) Proof complexity lower bounds via communication complexity, (4) data structure lower bounds, (5) streaming lower bounds, (6) privacy.

(5.) Wrapup and open problems.

Grading and Assignments
Grading will be based on 2 assignments (25 percent each) which will be handed out during the semester, plus presentation of one paper to the class, by yourself or with a partner (50 percent), together with lecture notes to accompany your presentation. You will have at least two weeks to work on each assignment. The work you submit must be your own. You may discuss problems with each other; however you should prepare written solutions alone. Class attendence is mandatory and you are encouraged to ask many questions in class. I will present many open problems during the course and hope that some of you will solve some of these problems! It is a great area with lots of connections to other problems, and a wealth of interesting open problems.