

CS 860 - Quantum Lower Bounds

Spring 2020 Course Outline

Last revised: June 22, 2020

Course website: <https://cs.uwaterloo.ca/~s4bendav/CS860S20.html>

Course message board: <https://piazza.com/uwaterloo.ca/spring2020/cs860>

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Please note that any term-specific content of this document is decided tentatively at the beginning of the term, and is subject to change. See the course website for current, up-to-date information.

CS 860 Description

This course is a graduate reading course on quantum lower bounds: in other words, the study of what we cannot do with computers we do not have. We will focus on lower bound techniques in concrete computational models, including query complexity and communication complexity. More specifically, we will cover most or all of the following topics:

1. The hybrid method
2. Quantum certificate complexity
3. Query measures such as sensitivity and block sensitivity
4. The positive adversary method and its various forms
5. The negative adversary method
6. The polynomial method and symmetrization techniques
7. Dual polynomials (generalized discrepancy), and the related notions of discrepancy and sign degree
8. “Ironic” lower bounds
9. Some of Zhandry’s methods
10. approximate rank and gamma 2 norm in communication complexity
11. Quantum information complexity.

Each week, lecture notes will be posted to provide background on one or more of these lower bound techniques, and one or more papers will be assigned as readings. Students will take turns presenting the papers in weekly video meetings.

Additionally, we will have one assignment on quantum lower bounds, as well as a course project.