

CS 798/QIC 890 Advanced Topics in Quantum Information Theory

Course Outline

Description

This is a follow-up course to CS 766/QIC 820 Theory of Quantum Information, which students are assumed to have taken. It will cover a selection of advanced topics in the theory of quantum information, as described below.

Mode of delivery

This will be a fully online course. Video lectures will be prepared by the instructor and linked to the course web page (and will also be made available through Learn). Optional tutorial sessions will be offered through video conferencing.

Topics

The course will cover the following topics. The number of lectures on each topic varies with the material, and topics may be added or subtracted depending on the amount of time required for each lecture.

1. Generalized measures of entropy, particularly max-relative entropy, smoothed variants of max-relative entropy, and the families of entropic quantities they induce, such as conditional min-entropy.
2. Applications of semidefinite/conic programming, and convex optimization more generally, to quantum information theory. Specific topics covered will include Tsirelson's theorem, the semidefinite program hierarchy of Navascués, Pironio, and Acín, and the quantum strategies (also known as the quantum combs) framework.
3. Concentration results for unitarily invariant measures, including Hastings' refutation of the additivity conjecture. We will follow the path to this theorem due to Aubrun, Szarek, and Werner, which goes through asymptotic geometric analysis.

Reference material

Some of the topics to be covered can be found in the instructor's textbook on quantum information theory: J. Watrous. *The Theory of Quantum Information*. Cambridge University Press, 2018. (A free version of the pre-publication manuscript is available from the instructor's web page.) In addition, for each of the lectures, a relevant list of references will be provided.

Grading

Course grades will be based 100% on problem sets to be assigned periodically throughout the course.