Computational Mathematics Seminar Series

Attempting to Reverse the Irreversible in Quantum Physics

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Abstract:

Some mathematical consequences of the postulates of quantum physics are several entropy inequalities established in the 1970s, such as the strong subadditivity of quantum entropy and the monotonicity of quantum relative entropy under physical processes. These entropy inequalities are statements of irreversibility and thus have been connected to thermodynamics and to establishing optimality of communication protocols in quantum information theory. Strong subadditivity is the statement that the entropy sum of two individual systems is larger than entropy sum of their union and intersection. Monotonicity of quantum relative entropy is the statement that the relative entropy between two quantum states does not increase after they each undergo the same physical process. These inequalities, along with joint convexity of relative entropy and concavity of conditional quantum entropy, are all known to be equivalent to each other, and thus we can say that together they constitute a fundamental law of quantum information theory. In this talk, I will highlight recent progress on the "recovery problem," that is, how well can we try to reverse an irreversible physical process, or, can we refine our understanding of this fundamental law of quantum information theory? In particular, after giving some background, I will focus the discussion on a "remainder term" for monotonicity of quantum relative entropy and I will also show how the aforementioned entropy inequalities are equivalent to each other even with remainder terms present. This is joint work with Kaushik Seshadreesan (LSU), Marius Lemm (Caltech), and Mario Berta (Caltech) from arXiv:1403.6102, arXiv:1410.1441, arXiv:1410.1443, arXiv:1412.0333, arXiv:1412.4067.

Speaker's Bio:

Mark M. Wilde is an Assistant Professor in the Department of Physics and Astronomy and the Center for Computation and Technology at Louisiana State University. He is the recipient of a National Science Foundation Career Development Award and the APS-IUSSTF Professorship Award in Physics. He is also a Senior Member of the IEEE. His current research interests are in quantum Shannon theory, quantum optical communication, quantum computational complexity theory, and quantum error correction.

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