Fast Sublinear Algorithms for Error Detection and Correction

Abstract:

In today's world there are huge amounts of data that need to get reliably stored or transmitted. However, some amount of noise or corruption is inevitable. An error-correcting code is a scheme for robustly representing data in the form of a codeword that allows one to detect and correct errors in transmission. Locally-testable and locally-decodable codes are special families of error-correcting codes that admit highly efficient algorithms that detect and correct errors in sublinear time with high probability, probing only a small number of entries of the corrupted codeword. While locally-testable and locally-decodable codes have been intensely studied in the past 2 decades, in recent years there has been even further incentive for their study due to their relevance for transmission and storage of massive data and the successful implementation of local codes in cloud storage systems.

In this talk, I will show an exponential improvement on the best-known running time of error detection and correction algorithms for locally-testable and locally-decodable codes. Specifically, I will describe new families of locally-testable codes with constant rate that can detect a constant fraction of errors in time \((\log n)^\{O(\log \log n)\}\) and new families of locally-decodable codes of constant rate that can correct a constant fraction of errors in time \(\exp(\sqrt{\log n})\). Prior to that, the best known running time for such codes was \(n^{\epsilon}\) (for a constant \(\epsilon\)) using several, quite different, constructions.

(Based on joint work with Swastik Kopparty, Or Meir and Shubhangi Saraf)