

Speaker: Alexander Schmidhuber (MIT)

Title: A quantum algorithm for Khovanov homology

Abstract:

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One of the central challenges in quantum algorithm design is to identify problems of genuine computational interest that admit exponential speedups over classical approaches. Shor's algorithm for factoring is a landmark example, and quantum algorithms for approximating the Jones polynomial have similarly demonstrated exponential advantage. In this talk, we present a quantum algorithm that estimates the ranks of Khovanov homology groups using Hodge theory. This approach is general and can be applied to a broad class of homology problems given certain assumptions.

Based on this construction, we show that estimating the Betti numbers of Khovanov homology is universal for various models of quantum computation. While classical algorithms for Khovanov homology scale exponentially in the number of crossings of a knot, our quantum algorithm is efficient provided the corresponding Hodge Laplacian thermalizes in polynomial time and has a sufficiently large spectral gap. We give numerical and analytical evidence for both statements and conclude with an open questions regarding analytic bounds on the spectral gap for general knots.