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The matrix permanent and determinant as an eigenvalue problem

The permanent of a square matrix is the symmetric analogue of the usual determinant, but where the signatures of the permutations (i.e. the signs appearing in the expansion of the function) are ignored. Despite the fact that both of these functions yield the same exponential number of terms, the determinant is efficiently computable classically; in contrast, determining the permanent of a matrix is #P-hard, and the discovery of a classically efficient algorithm would have profound consequences for the theory of computation and for recent claims of quantum supremacy. I will introduce an approach to computing the determinant and permanent, via the spectrum of the adjacency matrix of a weighted directed hypercube graph. Gaussian elimination of the original matrix corresponds to deleting vertices and reweighting edges of the adjacency matrix, projecting out the generalized zero eigenvectors while preserving the non-zero eigenvalues. I will discuss how the determinant and permanent respectively map to non-interacting spinless fermions and hard-core bosons hopping on a one-dimensional lattice, and approaches to obtaining the permanent via a quantum algorithm. This is collaborative work with Abhijeet Alase