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A quantum algorithm for solving linear systems of equations

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Solving linear systems of equations is a common problem that arises both on its own and as a subroutine in more complex problems: given a matrix A and a vector b, find a vector x such that Ax=b. We consider the case where one doesn't need to know the solution x itself, but rather an approximation of the expectation value of some operator associated with x, e.g., x'Mx for some matrix M. In this case, when A is sparse, N by N and has condition number kappa, classical algorithms can find x and estimate x'Mx in O(N sqrt(kappa)) time. Here, we exhibit a quantum algorithm for this task that runs in poly(log N, kappa) time, an exponential improvement over the best classical algorithm.

This talk is based on arXiv:0811.3171, which is joint work with Avinatan Hassidim and Seth Lloyd.