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Constant Factor Analysis of Optimal Quantum Linear Solvers in Practice

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We extend the findings of Costa et al. (arXiv:2312.07690), which demonstrated that the discrete adiabatic quantum linear system solver exhibits constant factors approximately 1,200 times smaller in practice than previously estimated by worst-case bounds. In the present work, we introduce a comparison between the adiabatic-based quantum walk method and the more recent “shortcut” quantum linear system solver proposed by Dalzell (arXiv:2406.12086), which achieves asymptotically optimal scaling $O(\kappa \log(1/\epsilon))$ with favourable constant factors, especially when the solution norm is known. Specifically, we conduct a comprehensive numerical analysis contrasting the two methods in two regimes: when the norm of the solution is unknown and when it is known. Our results reveal a region in parameter space—particularly where the solution norm is known—where the shortcut method outperforms the quantum walk approach in terms of constant factor. This advantage may prove especially valuable for algorithms solving differential equations via Hamiltonian simulation.

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