Polynomial-time degenerate ground state approximation of gapped 1D Hamiltonians.

Christopher T. Chubb,[1] Steven T. Flammia[1]

[1] *Centre for Engineered Quantum Systems, School of Physics, The University of Sydney, Sydney, NSW 2006, Australia.*

In spite of a plethora of no-go results that prevent classically efficient simulation of quantum systems in general, heuristic methods[1] have seen great success, proving typically efficient in practice. The downside of these heuristic methods is that we lack a rigorous understanding of how, and for which systems, they fail[2]. Provably efficient algorithms – even if practically surpassed by heuristic methods – are of key importance for understanding the true worst-case complexity of simulation.

The cutting edge for provably efficient simulation is the ground state approximation of 1D spin systems. Under the assumption of a gap, there exists a provably efficient algorithm[3, 4] for approximation of a unique ground state of such systems; we present ongoing work to extend this algorithm to work for degenerate systems. This result comes in the wake of a recent degenerate extension of the area law[5], an important structural bound on the complexity of ground states. In practice this algorithm is no match for heuristic analogues such as the density matrix renormalisation group. However, it does add to the increasing understanding of the systems for which provably efficient simulation is attainable, and might hopefully lead to a future algorithm that is both provably *and* practically efficient.

References

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