Quantum Science & Engineering Center

Quantum Computing Seminar Series

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Catalytic Embeddings: From Gate Teleportation to Circuit Synthesis

Monday, February 28, 2022 | 12–1pm | Zoom

Abstract

Leading proposals for fault-tolerant quantum computing rely on the implementation of some finite set of encoded gates -- often Clifford+T -- using a combination of unitary circuits and gate teleportation via distilled resource states. Gates which admit an exact representation over this finite set are synthesized into unitary circuits, while gates which do not admit such a representation are implemented through gate approximation. While asymptotically optimal methods for both over Clifford+T exist, gate approximation remains a significant cost center in fault-tolerant quantum computation.

We introduce an alternative to gate approximation, called catalytic embedding. In this framework, gates which cannot be exactly represented over the encoded fault-tolerant gates are applied through interaction with qubits in fixed, re-usable catalyst states. This allows circuits to be made arbitrarily precise with only constant overhead with respect to circuit volume, using either gate approximation or distillation to prepare the catalyst states. As not every unitary may admit a catalytic embedding over the target gate set, we give explicit conditions and systematic constructions for catalytic embeddings, notably for gates whose entries come from algebraic number rings. This includes all diagonal gates in the Clifford hierarchy, and more generally diagonal gates whose eigenvalues are constructible numbers.

Meeting Information

https://gmu.zoom.us/j/93426209769?pwd=TjNmaWpvMlYxRzZGUkNzeHdPV2g3QT09

About the Seminar Series

The Quantum Computing Seminar Series are a series of working seminars organized and hosted by QSEC's quantum computing subgroup on Mondays. These events are free and open to the public. More information is available on QSEC's Computing Events and Mathematical Sciences Department's Quantum Computing Seminars. For any questions, contact qsec@gmu.edu.