

Quantum Circuit Rewriting using e-graphs

An E-graph is a data structure that can represent all equivalent expressions under a set of rewriting rules in a compact and efficient way. E-graphs are used for program synthesis and optimization in classical computing, among other use cases. The goal of the thesis is to explore the usage of e-graphs for representing and optimizing quantum circuits. The work should involve the following steps

- Investigate existing e-graph libraries for their suitability for quantum circuit rewriting.
- Investigate approaches to specify quantum circuits on 1,2, and 3 qubits in a way that is amenable to rewriting using circuit equivalence rules.
- Develop a complete set of rewrite rules for 1-3 qubits and implement the approach in a chosen e-graph software library.
- Validate the developed approach against a set of existing known circuit identities.
- Develop heuristics to optimize quantum circuits extraction from e-graphs according to several target optimization criteria (e.g., number of gates, circuit depth).
- Develop an approach to apply the basic 1-3 qubit optimizations to quantum circuits of arbitrary size.

Requirements

- Solid knowledge of quantum computing (circuit model)

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