Optimization in quantum circuits of $c - Z$ and SWAP gates

Marc Bataille, PhD student, LITIS (University of Rouen, France)

28/11/2019

Abstract

A big part of the quantum noise arising in current experimental implementations comes from errors on two-qubits gates. So reducing the number of these gates in a given circuit is an important issue in quantum computing. In this presentation we study the algebraic structure underlying the quantum circuits composed by SWAP gates and controlled Pauli-Z gates and we apply our results to minimize the number of gates in such circuits.

In a first part we show that for a given number of qubits there's only a finite set of such circuits and we give the structure of the corresponding group. From there we deduce an efficient algorithm to minimize the number of gates in this type of circuits for the complete graph topology. In a second part we establish a connexion with Coxeter groups and we use it, together with the Dehn's algorithm, to build a heuristic to reduce a circuit for the LNN (Linear Nearest Neighbor) topology. Finally we provide another more efficient heuristic and benchmark it with the previous one.

Most of the results presented here come from a paper recently published in Journal of Physics A ("Quantum circuits of $c - Z$ and $SWAP$ gates : optimization and entanglement").