replacing MAR17-2016-006887.

Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Efficiently characterizing the total error in quantum circuits[1] ARNAUD CARIGNAN-DUGAS, JOEL J. WALLMAN, JOSEPH EMERSON, Institute for quantum computing, University of Waterloo — A promising technological advancement meant to enlarge our computational means is the quantum computer. Such a device would harvest the quantum complexity of the physical world in order to unfold concrete mathematical problems more efficiently. However, the errors emerging from the implementation of quantum operations are likewise quantum, and hence share a similar level of intricacy. Fortunately, randomized benchmarking protocols provide an efficient way to characterize the operational noise within quantum devices. The resulting figures of merit, like the fidelity and the unitarity, are typically attached to a set of circuit components. While important, this doesn't fulfill the main goal: determining if the error rate of the total circuit is small enough in order to trust its outcome. In this work, we fill the gap by providing an optimal bound on the total fidelity of a circuit in terms of component-wise figures of merit. Our bound smoothly interpolates between the classical regime, in which the error rate grows linearly in the circuit's length, and the quantum regime, which can naturally allow quadratic growth. Conversely, our analysis substantially improves the bounds on single circuit element fidelities obtained through techniques such as interleaved randomized benchmarking.

[1]This research was supported by the U.S. Army Research Office through grant W911NF- 14-1-0103, CIFAR, the Government of Ontario, and the Government of Canada through NSERC and Industry Canada.

Arnaud Carignan-Dugas
Institute for quantum computing, University of Waterloo

Date submitted: 11 Nov 2016 Electronic form version 1.4