Error estimation in current noisy quantum computers

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Abstract

One of the main important features of the noisy intermediate-scale quantum (NISQ) era is the correct evaluation and consideration of errors. In this paper, we analyze the main sources of errors in current (IBM) quantum computers and we present a useful tool (TED-qc) designed to facilitate the total error probability expected for any quantum circuit. We propose this total error probability as the best way to estimate a lower bound for the fidelity in the NISQ era, avoiding the necessity of comparing the quantum calculations with any classical one. In order to contrast the robustness of our tool we compute the total error probability that may occur in three different quantum models: 1) the Ising model, 2) the Quantum-Phase Estimation (QPE), and 3) the Grover's algorithm. For each model, the main quantities of interest are computed and benchmarked against the reference simulator's results as a function of the error probability for a representative and statistically significant sample size. The analysis is satisfactory in more than the 99% of the cases. In addition, we study how error mitigation techniques are able to eliminate the noise induced during the measurement.

References

Unai Aseguinolaza, Nahual Sobrino, Gabriel Sobrino, Joaquim Jornet-Somoza, Juan Borge, arXiv:2302.06870

Figures

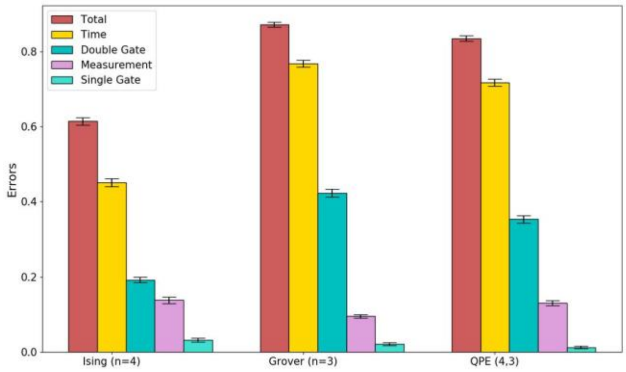

Figure 1 Error contributions in the three different studied quantum circuits. The error contributions are coming from three main sources: Time, measurement, and gate operations (single and double).