A novel approach to noisy gates for simulating quantum computers

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Abstract

We present a novel method for simulating the noisy behaviour of quantum computers, which allows to efficiently incorporate environmental effects in the driven evolution implementing the gates on the qubits. We show how to modify the noiseless gate executed by the computer to include any Markovian noise, hence resulting in what we will call a noisy gate. We compare our method with the IBM Qiskit simulator, and show that it follows more closely both the analytical solution of the Lindblad equation as well as the behaviour of a real quantum computer, where we ran algorithms involving up to 18 qubits; thus, it offers a more accurate simulator for NISQ devices. The method is flexible enough to potentially describe any noise, including non-Markovian ones.

References

[1] G. D. Bartolomeo, M. Vischi, F. Cesa, R. Wixinger, M. Grossi, S. Donadi, A. Bassi arXiv:2301.04173

Figures

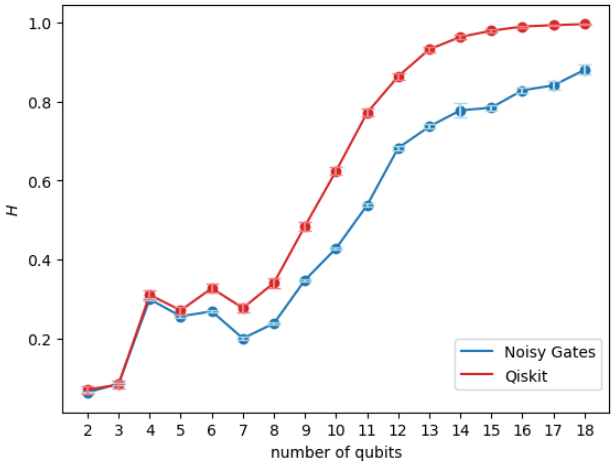

Figure 1: Hellinger Hellinger distance for the $QFT^{\dagger}$ algorithm for n = 2, . . . , 18 qubits. Each value is the mean of 100 independent simulations for the noisy gates, in blue, and for the Qiskit simulations, in red.