Contribution ID: **7** Type: **Oral**

Real-time error mitigation for variational optimization on quantum hardware

Monday 11 March 2024 15:30 (20 minutes)

The development of quantum computers as tools for computation and data analysis is continually increasing, even in the field of machine learning, where numerous routines and algorithms have been defined, leveraging the high expressiveness of quantum systems to process information. In this context, one of the most stringent limitations is represented by noise. In fact, the devices currently available are not clean enough to implement complex routines. One of the strategies that can be adopted to face this problem is called quantum error mitigation: the noise configuration of a device is learned as a noise map, which is then used to mitigate the results. In this talk, we present a real-time error mitigation algorithm applicable in the context of optimizing a quantum variational model. In particular, we use the Importance Clifford Sampling method to mitigate both predictions and gradients in a gradient-based optimization procedure. This process is carried out by monitoring the device's noise, so that the noise map is re-learned when the previous one becomes unreliable. The routine we describe can easily be extended to any training context and, being problem-agnostic, can be applied to any type of problem addressable with optimization techniques. We present the algorithm and then show promising results obtained by training noisy quantum circuits up to eight qubits.

Significance

We put forward the inclusion of error mitigation routines in the context of training quantum variational models. We have concretized the theoretical findings from the Los Alamos National Laboratory (https://arxiv.org/pdf/2109.01051.pdf) implementing an efficient and computationally lightweight algorithm.

References

Pre-print (under review): https://arxiv.org/abs/2311.05680
Code: https://github.com/qiboteam/rtqem

Experiment context, if any

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Session Classification: Track 1: Computing Technology for Physics Research

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