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Error-aware quantum circuit compilation

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Reliably executing quantum algorithms on noisy intermediate-scale quantum (NISQ) devices is challenging, as they are severely constrained and prone to errors. Efficient quantum circuit compilation techniques are therefore crucial for overcoming their limitations and dealing with their high error rates. These techniques consider the quantum hardware restrictions, such as the limited qubit connectivity, and perform some transformations to the original circuit so that it can be executed on a given quantum processor. Certain compilation methods use error information based on calibration data to further improve the success probability or the fidelity of the circuit to be run. However, it is uncertain to what extent incorporating calibration information in the compilation process can enhance the circuit performance. For instance, considering the most recent error data provided by vendors after calibrating the processor might not be functional enough as quantum systems are subject to drift, making the latest calibration data obsolete within minutes.
In this talk, we will discuss how different usage of calibration data impacts the circuit fidelity, by using several compilation techniques and quantum processors (IBM Perth and Brisbane). To this aim, we will present a framework that incorporates some of the state-of-the-art noise-aware and non-noise-aware compilation techniques and allows the user to perform fair comparisons under similar processor conditions. Our experiments yield valuable insights into the effects of noise-aware methodologies and the employment of calibration data. The main finding is that pre-processing historical calibration data can improve fidelity when real-time calibration data is not available due to factors such as cloud service latency and waiting queues between compilation and execution on the quantum backend.

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