How much can we learn from quantum random circuit sampling?

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December 19, 2025

The last two decades have witnessed quantum computing technologies increasingly move from theoretical proposals to functioning experimental platforms. A key obstacle to building reliable quantum devices is the presence of hardware errors, which must be identified and quantified before they can be corrected. In this work, we adopt a statistical perspective on the problem of error estimation in quantum devices. Building upon a technique introduced by Google Quantum AI known as random circuit sampling (RCS), we develop statistical methodologies for estimating the location and nature of errors in randomized quantum circuits. The model governing this problem is a high-dimensional latent variable model, which shares some common features with mixed-membership models and other discrete latent variable models. On the one hand, we establish the information-theoretic limits of parameter estimation in this model, allowing us to show that reliable estimation is possible even for large-scale devices. On the other hand, we apply our methods to characterize the noise profile of a state-of-the-art quantum processor built by Google Quantum AI.

This talk is based on joint work with Daniel Mark, Wenjie Gong, Bingtian Ye, Yury Polyanskiy, and Soonwon Choi.