TQC TALKS @IIIT-DELHI

Meeting Link
April 25, 8PM IST

Noise-induced shallow circuits and absence of barren plateaus

(joint work with Armando Angrisani, Soumik Ghosh, Sumeet Khatri, Jens Eisert, Daniel Stilck Franca, and Yihui Quek)

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ABSTRACT

Motivated by realistic hardware considerations of the pre-fault-tolerant era, we comprehensively study the impact of uncorrected noise on quantum circuits.

We first show that any noise 'truncates' most quantum circuits to effectively logarithmic depth, in the task of computing Pauli expectation values. We then prove that quantum circuits under any non-unital noise exhibit lack of barren plateaus for cost functions composed of local observables. But, by leveraging the effective shallowness, we also design a classical algorithm to estimate Pauli expectation values within inverse-polynomial additive error with high probability over the ensemble. Its runtime is independent of circuit depth and it operates in polynomial time in the number of qubits for one-dimensional architectures and quasi-polynomial time for higher-dimensional ones.

Taken together, our results showcase that, unless we carefully engineer the circuits to take advantage of the noise, it is unlikely that noisy quantum circuits are preferable over shallow quantum circuits for algorithms that output Pauli expectation value estimates, like many variational quantum machine learning proposals. Moreover, we anticipate that our work could provide valuable insights into the fundamental open question about the complexity of sampling from (possibly non-unital) noisy random circuits.

BIOGRAPHY

Antonio is a PhD student in the group of Jens Eisert at FU-Berlin.

He is interested in various mathematical aspects of quantum information and computing. For example, he likes to think about questions related to quantum learning theory, the impact of noise on quantum devices, and the classical simulability of classes of quantum states.

Before starting his PhD, Antonio received a bachelor's degree from the University of Pisa and then a joint master's degree from the University of Trento and SISSA in Trieste.

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