Potential and limitations of near-term quantum computing

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Quantum computers promise the efficient solution of some computational problems that are classically intractable. For many years, they have been primarily objects of theoretical study, as only in recent years, protagonists have set out to actually build intermediate-scale quantum computers. This creates an interesting state of affairs, but also begs for an answer to the question what such devices are possibly good for.

In this talk, we will present both encouraging as well as discouraging insights into near-term quantum computing, alongside a number of results offering substantial progress. We will discuss rigorous quantum advantages in paradigmatic problems [1,2], and will explore the use of quantum computers in machine learning [3,4] and optimization [5].

At the same time, we will find strong limitations, by providing efficient classical algorithms for instances of quantum algorithms, hence "de-quantizing" them [6,7], and by identifying limitations to quantum error mitigation [8]. Interestingly, it may depend on fine print of the non-unital quantum noise to what extent quantum computing with no error correction may be feasible [9]. The talk will end on the note that quantum simulation remains one of the most promising applications of near-term quantum devices [10,11].

References

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Figures

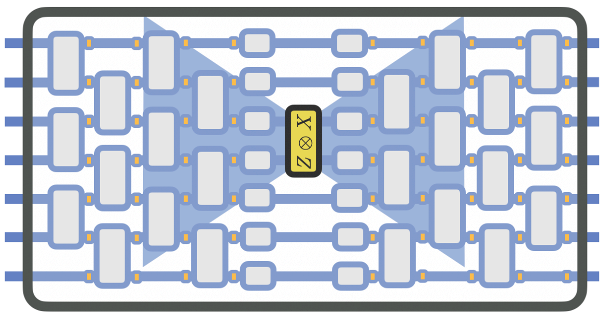

Figure 1: Efficient classical simulation for quantum circuits undergoing non-unital noise.