Variational measurement-based quantum computation for generative modeling

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Measurement-based quantum computation (MBQC) [1] offers a fundamentally unique paradigm for designing quantum algorithms. Indeed, due to the inherent randomness of quantum measurements, the natural operations in MBQC are not deterministic and unitary but are rather augmented with probabilistic byproducts. Yet, the main algorithmic use of MBQC so far has been to completely counteract this probabilistic nature to simulate unitary computations expressed in the circuit model. In this work, we propose designing MBQC algorithms that embrace this inherent randomness and treat the random byproducts in MBQC as a resource for computation. As a natural application where randomness can be beneficial, we consider generative modeling, a task in machine learning centered around generating complex probability distributions. To address this task, we propose a variational algorithm, Quantum Circuit Born machine (QCBM) [2], based on MBQC, with Clifford Quantum Cellular Automata (C-QCA) (Fig.1) as the equivalent circuit of MBQC model, equipped with control parameters that allow to directly adjust the degree of randomness to be admitted in the computation.

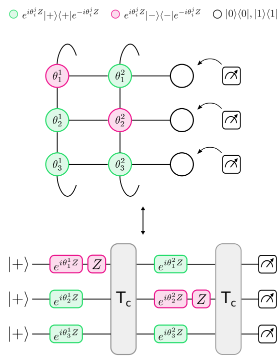

Fig. 1: Circuit picture of an MBQC based on C- QCA. Picture shows circuit translation from a MBQC model.

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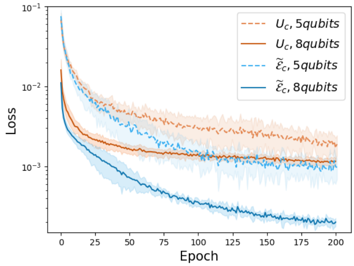

Fig. 2: Variational MBQC learning performance on a double Gaussian across various system sizes.

Our numerical findings (Fig.2) indicates that this additional randomness can lead to significant gains in learning performance in certain generative modeling tasks. These results highlight the potential advantages of exploiting the inherent randomness of MBQC and motivate further research into MBQC-based algorithms.

References

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