Approximate Quantum Compiling for Quantum Simulation: A Tensor network based approach

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Abstract

We introduce a framework to combine classical Tensor Network techniques with quantum computing for the purpose of quantum simulation. The method uses Tensor Network based methods to efficiently compile Trotterized time-evolution operators into short-depth quantum circuits and combines aspects of Approximate Quantum Compiling (AQC), Matrix Product States (MPS) and classical optimization techniques to achieve this. We demonstrate the effectiveness of this technique on simulations on a number of different models on up to 100 qubits and discuss the wide variety of quantum simulation problems that could benefit from this approach.

References

[1] Niall F. Robertson, Albert Akhriev, Jiri Vala, Sergiy Zhuk, arxiv: 2301:08609

Figures

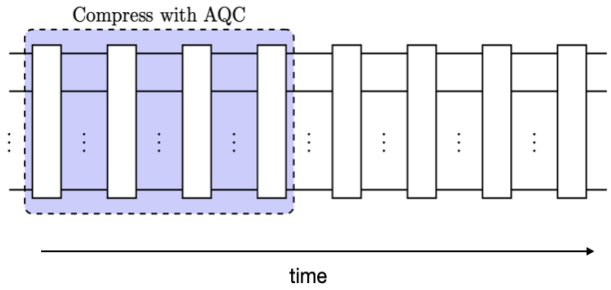

Figure 1: The AQCtensor workflow: the first part of the circuit (classically simulatable) is compressed to a shallow circuit. The remaining part (difficult to simulate classically) is simulated on the quantum device.

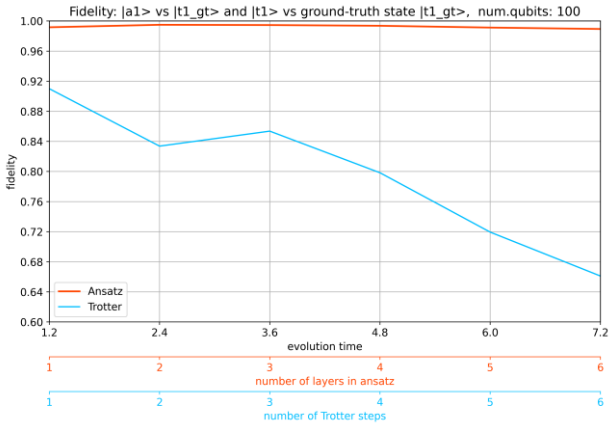

Figure 2: Blue line: the fidelity of the Trotterized circuit with the quasi-exact state. Red line: the fidelity of the optimised circuit with the quasi-exact state.