Boosting ground states preparation with double-bracket quantum algorithms

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A couple of references

Double-bracket quantum algorithms for diagonalization

Marek Gluza

This work proposes double-bracket iterations as a framework for obtaining diagonalizing quantum circuits. Their implementation on a quantum computer consists of interlacing evolutions generated by the input Hamiltonian with diagonal evolutions which can be chosen variationally. No qubit overheads or controlled-unitary operations are needed but the method is recursive which makes the circuit depth grow exponentially with the number of recursion steps. To make near-term implementations viable, the proposal includes optimization of diagonal evolution generators and of recursion step durations. Indeed, thanks to this numerical examples show that the expressive power of double-bracket iterations suffices to approximate eigenstates of relevant quantum models with few recursion steps. Compared to brute-force optimization of unstructured circuits double-bracket iterations do not suffer from the same trainability limitations. Moreover, with an implementation cost lower than required for quantum phase estimation they are more suitable for near-term quantum computing experiments. More broadly, this work opens a pathway for constructing purposeful quantum algorithms based on so-called double-bracket flows also for tasks different from diagonalization and thus enlarges the quantum computing toolkit geared towards practical physics problems.

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Check out this because:

1. Marek is a very nice and smart guy;
2. it contains math foundations of this talk;

Double-bracket quantum algorithms for high-fidelity ground state preparation

Matteo Robbiati, Edoardo Pedicillo, Andrea Pasquale, Xiaoyue Li, Andrew Wright, Renato M. S. Farias, Khanh Uyen Giang, Jeongrak Son, Johannes Knörzer, Siong Thye Goh, Jun Yong Khoo, Nelly H.Y. Ng, Zoë Holmes, Stefano Carrazza, Marek Gluza

Ground state preparation is a key area where quantum computers are expected to prove advantageous. Double-bracket quantum algorithms (DBQAs) have been recently proposed to diagonalize Hamiltonians and in this work we show how to use them to prepare ground states. We propose to improve an initial state preparation by adding a few steps of DBQAs. The interfaced method systematically achieves a better fidelity while significantly reducing the computational cost of the procedure. For a Heisenberg model, we compile our algorithm using CZ and single-qubit gates into circuits that match capabilities of near-term quantum devices. Moreover, we show that DBQAs can benefit from the experimental availability of increasing circuit depths. Whenever an approximate ground state can be prepared without exhausting the available circuit depth, then DBQAs can be enlisted to algorithmically seek a higher fidelity preparation.

Comments:	5 pages + appendix, 4 figures, code available at: this https URL
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And this because:

1. I am going to follow this paper;
2. there are some nice figures;