



VQompress

State Preparation via Quantum Compression With applications to VQE

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(*The Three Qiskiteers*)



Motivation



- NISQ computations are severely depth-limited
- In the absence of QRAM, state preparation circuits are expensive (in depth)

Can we reduce the cost of state preparation circuits?

Multi-Discriminant States (MDS) for VQE

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Hartree-Fock States
(oversimplified)

$|111000\rangle$

$|100110\rangle$

$|001110\rangle$

Computational basis states
corresponding to a discriminant of an
electron configuration

MDS States

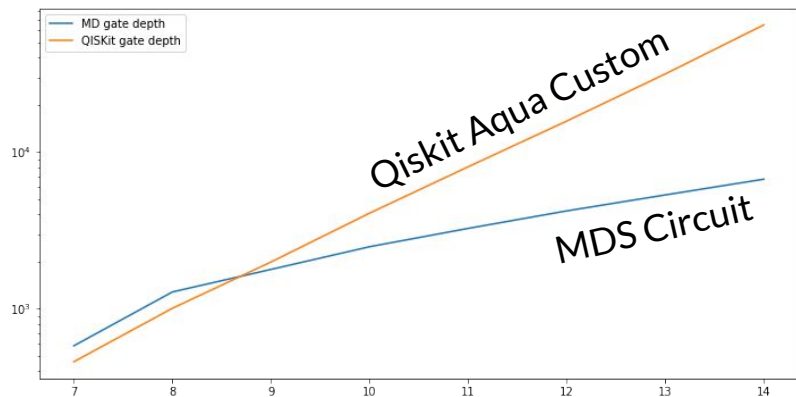
$$\begin{aligned} & 0.19^*|111000\rangle \\ + & 0.6^*|100110\rangle \\ + & 0.78|110010\rangle \end{aligned}$$

Real valued superposition over
discriminants of an electron configuration

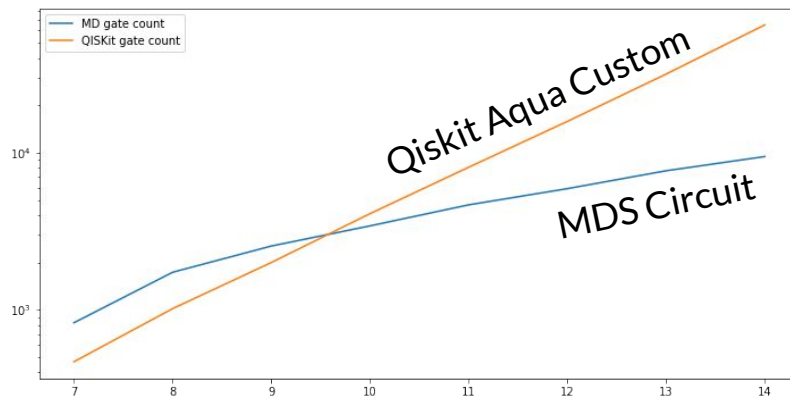
Qiskit vs. our method (MDS Circuit) for generating MDS States



Gate **depth** (log-scale)

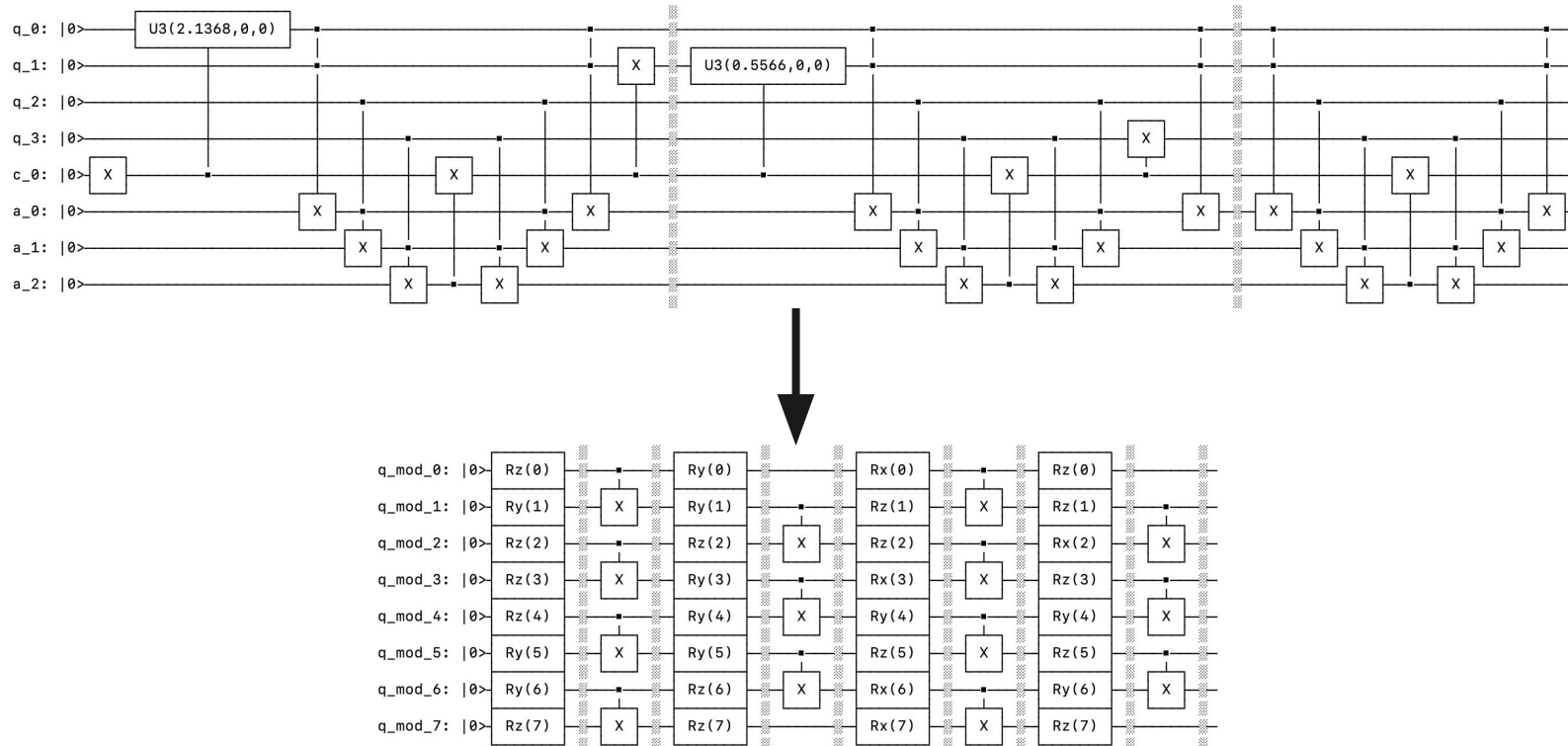


Gate **count** (log-scale)



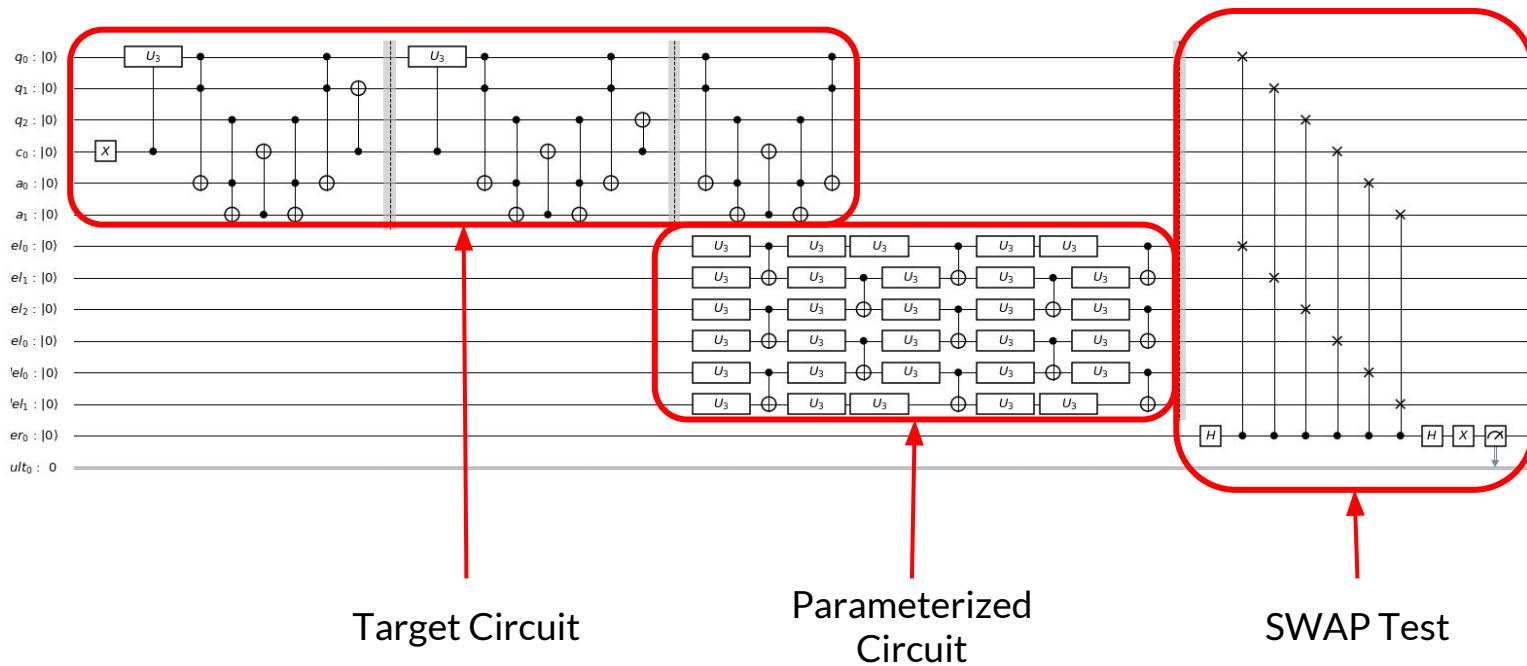
Number of Qubits composing MDS State

Quantum Compression via QNNs

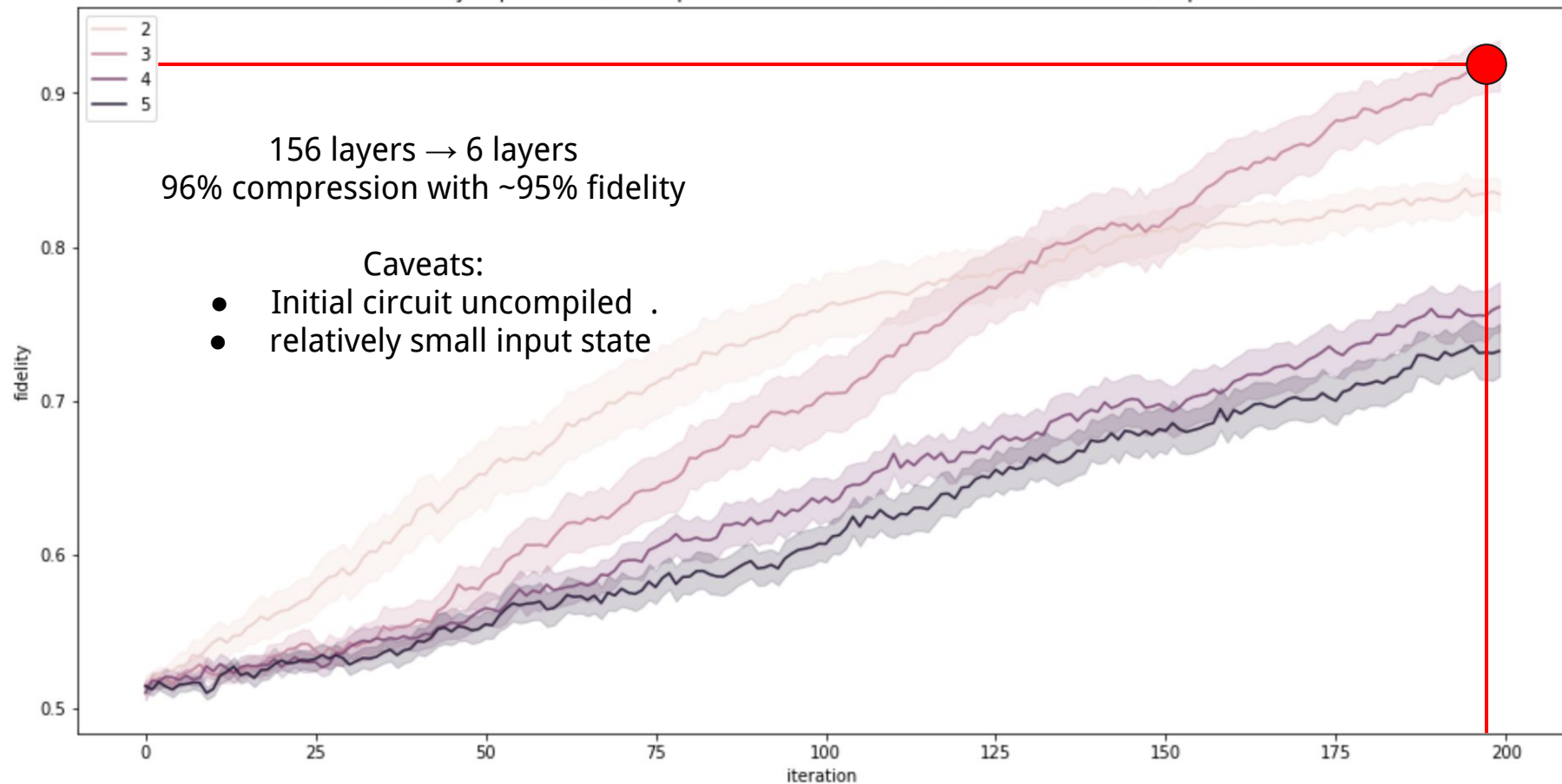


Quantum Compression Procedure

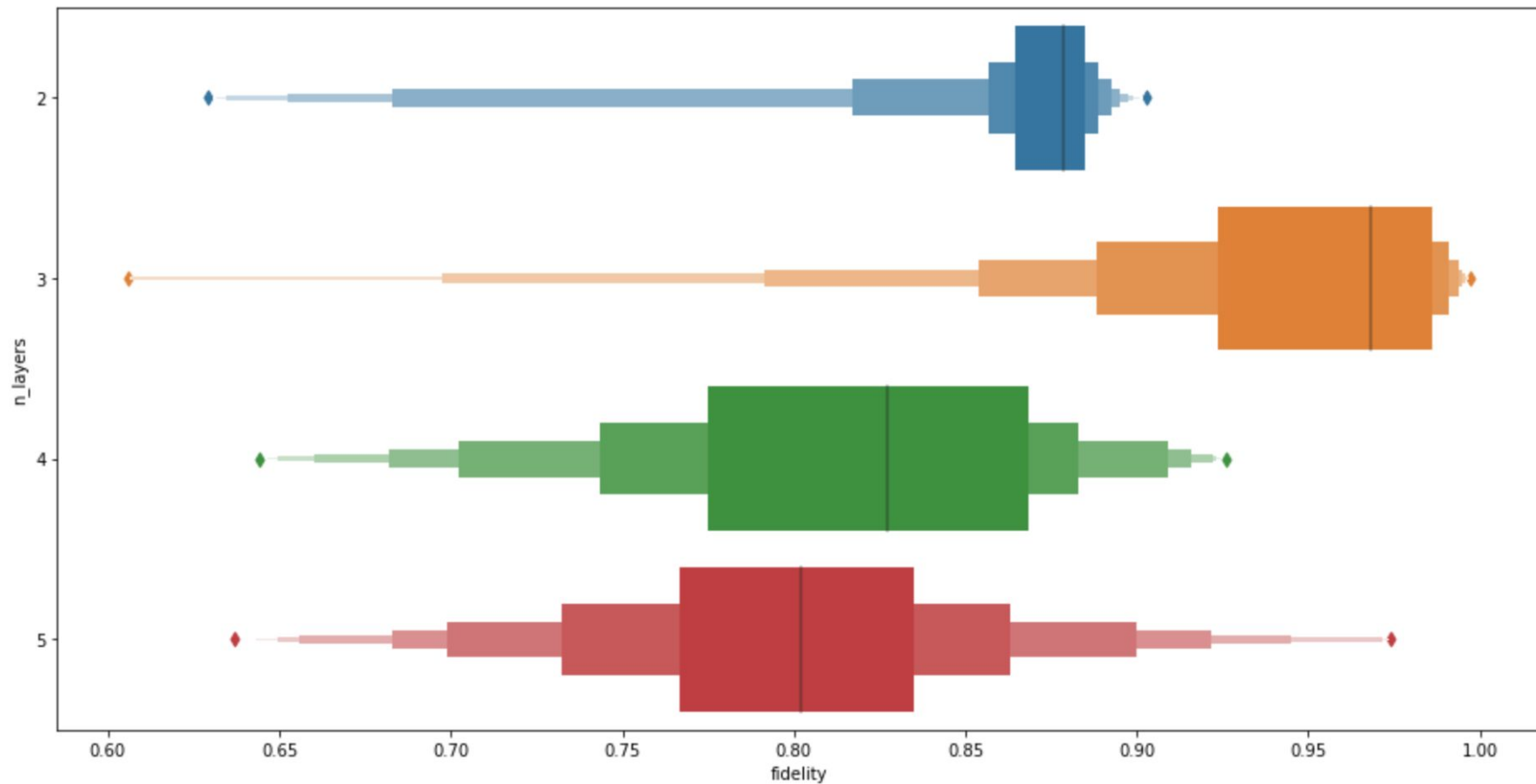
- $2n+1$ qubits required to learn n -qubit state



Fidelity improvement with optimiser iterations. (Two determinants with four qubits)



Distribution of Maximum Fidelities





Future Work

- Sequential training techniques
(combat high dimensionality of parameter space)
- Tailored optimization functions
- Incorporation of transpiling techniques / compiling to restricted topologies.