Development of Novel Quantum Algorithms

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July 5, 2024 - August 9, 2024

Article

Evidence for the utility of quantum computing before fault tolerance

https://doi.org/10.1038/s41586-023-06096-3

Received: 24 February 2023

Accepted: 18 April 2023

Published online: 14 June 2023

Open access

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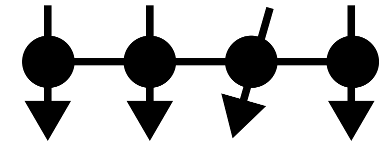
Quantum computing promises to offer substantial speed-ups over its classical counterpart for certain problems. However, the greatest impediment to realizing its full potential is noise that is inherent to these systems. The widely accepted solution to this challenge is the implementation of fault-tolerant quantum circuits, which is out of reach for current processors. Here we report experiments on a noisy 127-qubit processor and demonstrate the measurement of accurate expectation values for circuit volumes at a scale beyond brute-force classical computation. We argue that this

The aim of the project is to simulate the dynamics of the two-dimensional transverse-field Ising model using Classiq platform.

Steps in the project



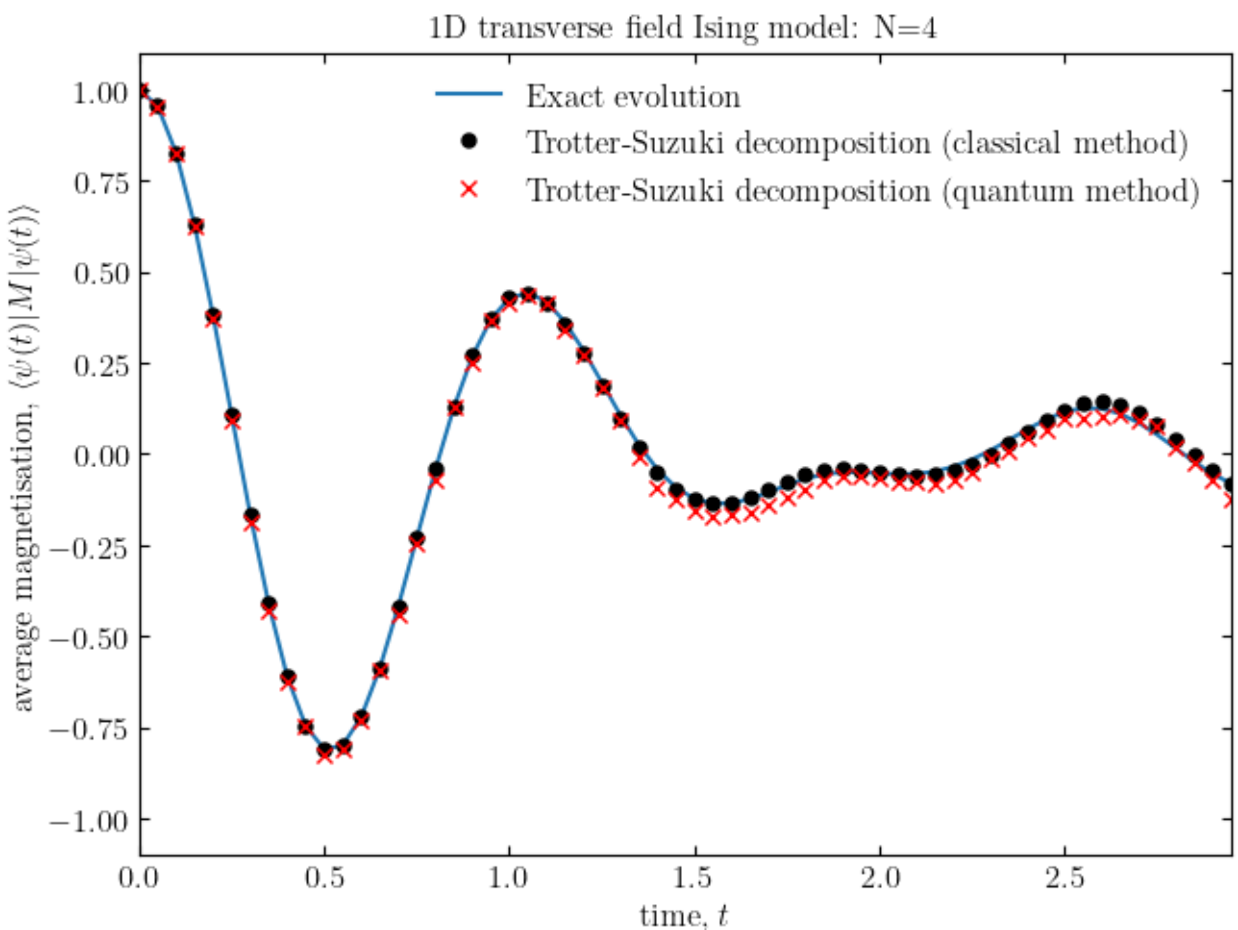
1. Toy model: one-dimensional transverse-field Ising model
   (a) small system size: N=4 qubits
   (b) exact system's evolution vs Trotter-Suzuki decomposition (Classiq)
   (c) analyze how the magnetization changes over time

2. Enlarged model: two-dimensional transverse-field Ising model
   (a) larger system size: NxM (3x3, 5x5)
   (b) exact system's evolution vs Trotter-Suzuki decomposition (Classiq)
   (c) analyze how the magnetization changes over time
   (d) analyze the circuit depth, width and number of 2-qubit gates

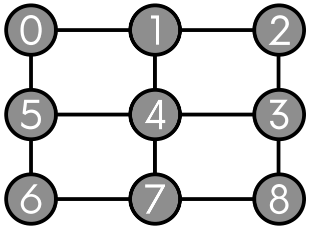
3. Optimize the solution according to the hardware
   (a) adjust the connections to the ibm_fez

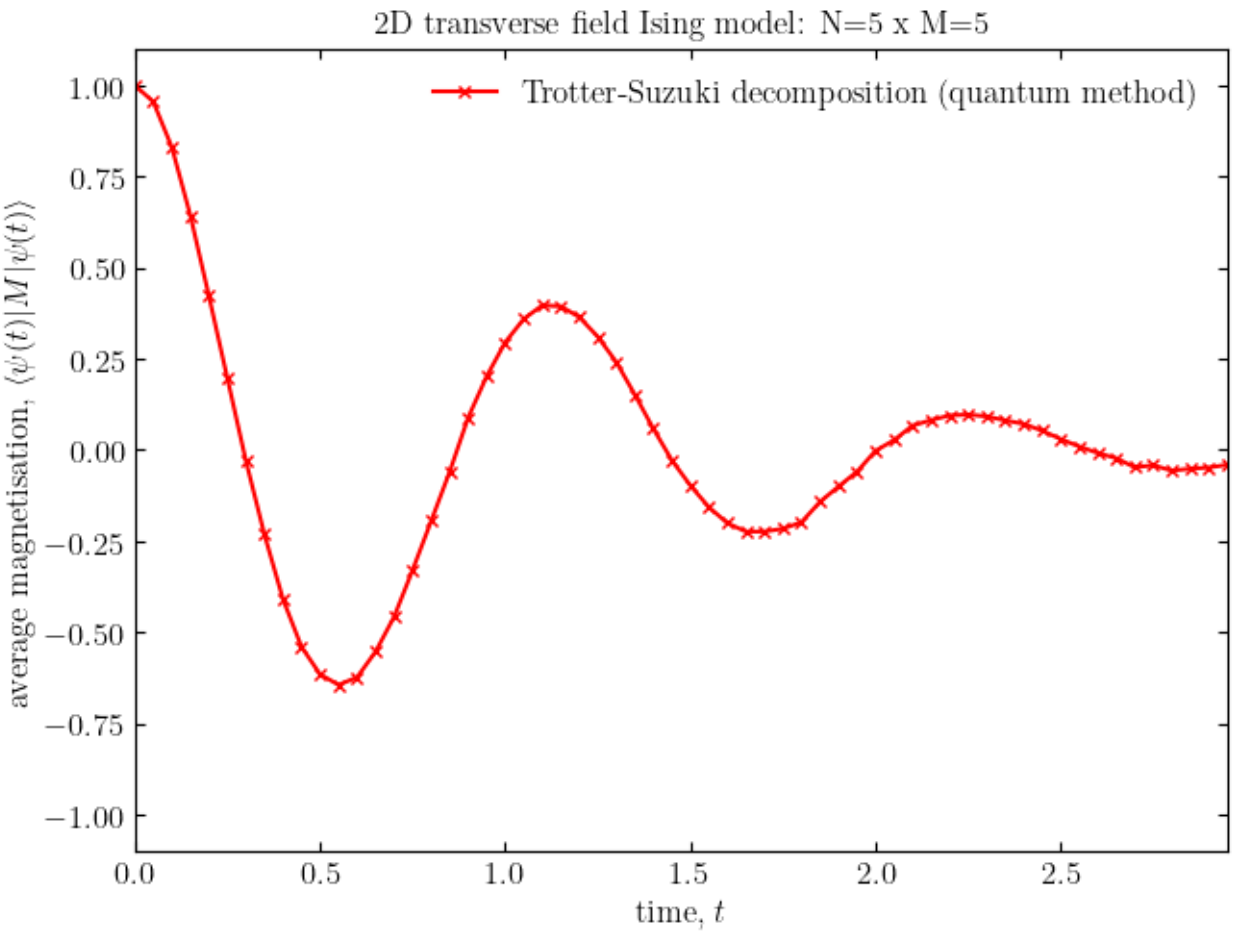
4. Error mitigation (discussion)

1. Toy model: one-dimensional Ising model

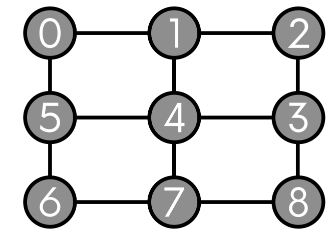


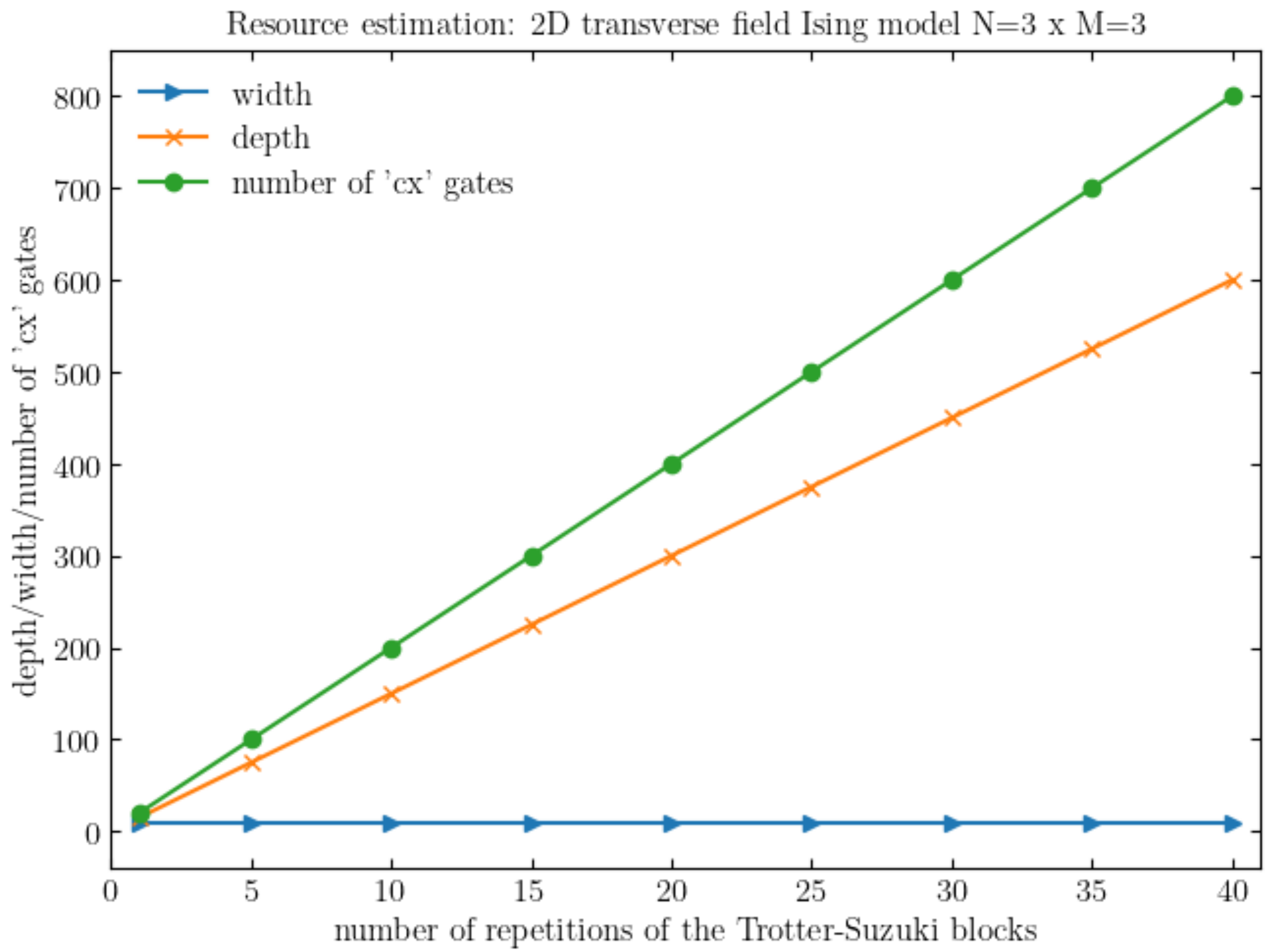
2. Enlarged model: two-diemsional Ising model



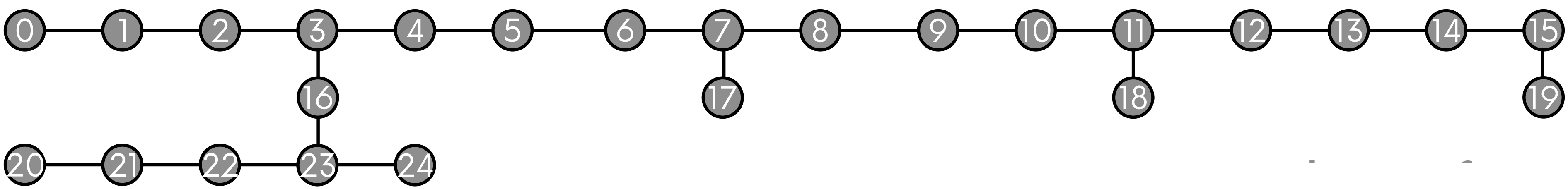


2. Enlarged model: resource estimation

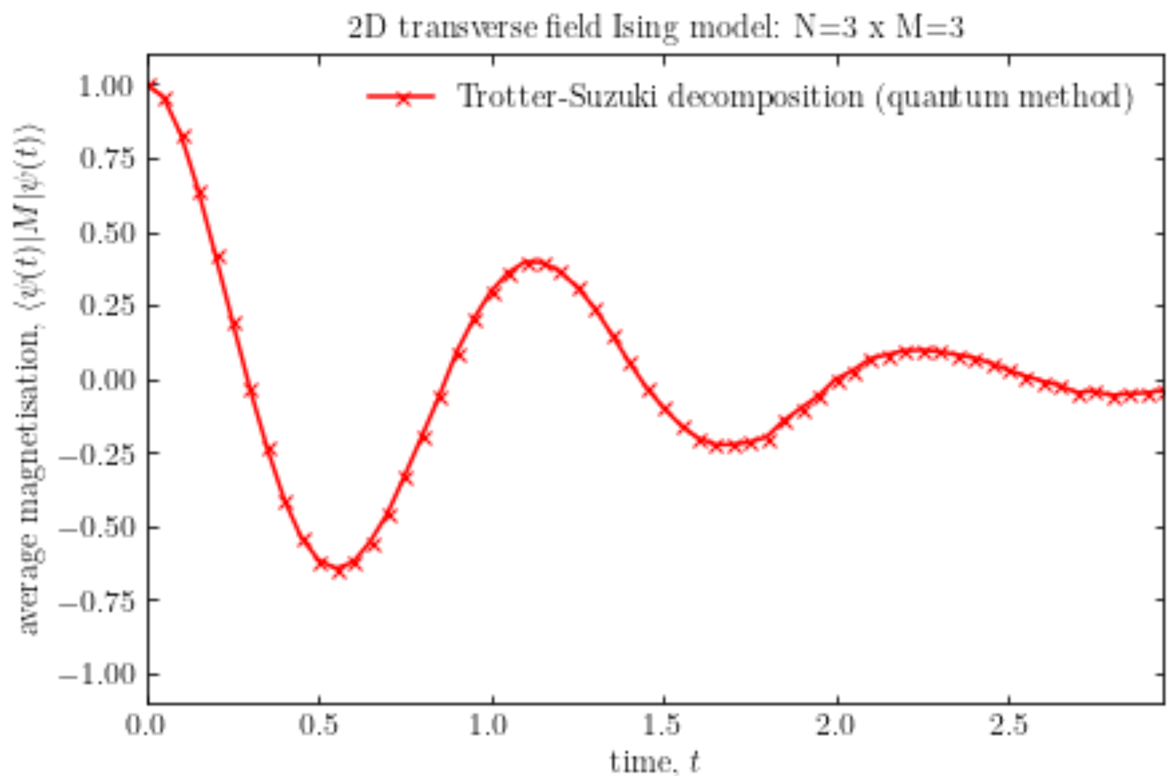




3. Optimize the solution according to the hardware (ibm_fez)



Depth: 180
Gates:
{'h': 750, 'rz': 735, 'cx': 720}
Width: 25



Future scope

1. Implement toy model for zero-noise extrapolation for error mitigation on theclassiq platform (depolarizing Kraus gates)

2. Implement the full scope of the IBM paper to learn any noise model on a real hardware

3. Run that model on an available quantum processor

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