Code Concatenation

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Outline

Introduction

Problem statement

Problem

The Threshold Theorem theoretically enables Quantum Error Correction, and the multiple concatenation of codes formulates the theorem itself. Compiling the quantum circuits results after code concatenation is challenging because: a) there will be many qubits involved in the final circuit; b) each code used within the concatenation might have its own supported gate set (logical operators)

Methods

Methods

Implementation of Steane code

1. Create Bloqs required to encode the Steane code
2. Create a Bloq to encode the Steane code in Qualtran
3. Enable to concatenated the Steane code with itself
4. Draw diagrams for level of concatenations
   1. Plot qubits and operation growth

Methods

Logical error rates for Steane code

1. Convert Bloqs to stim circuits
2. Extend circuit with syndrome extraction
3. Add noise and detectors to the circuit
4. Decode circuit via pymatching
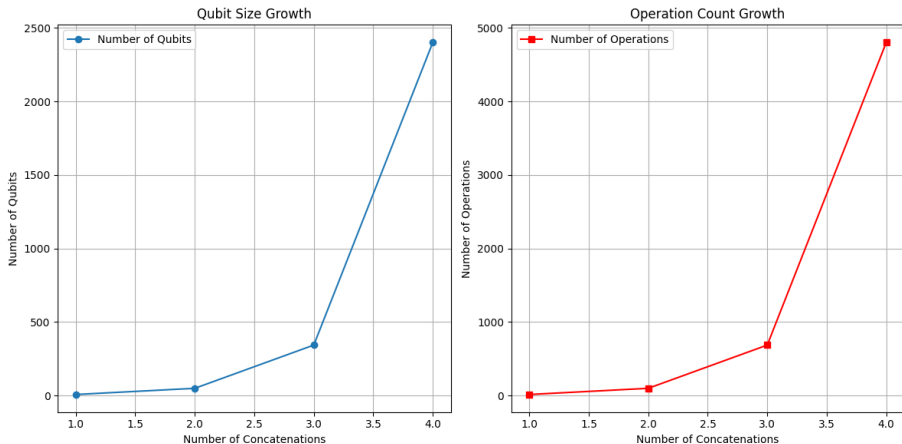5. Plot logical error rates

Results

Results

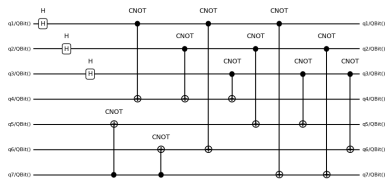

Figure: Qubit and Operation growth

Results

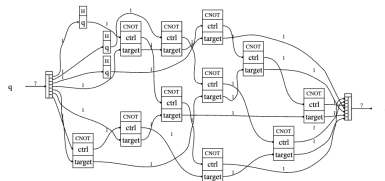Figure: Musical score representation

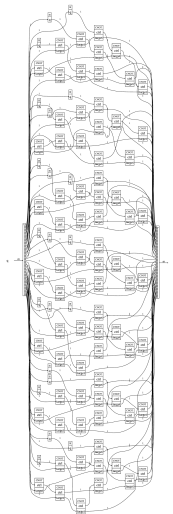Figure: Bloq graph representation

Results

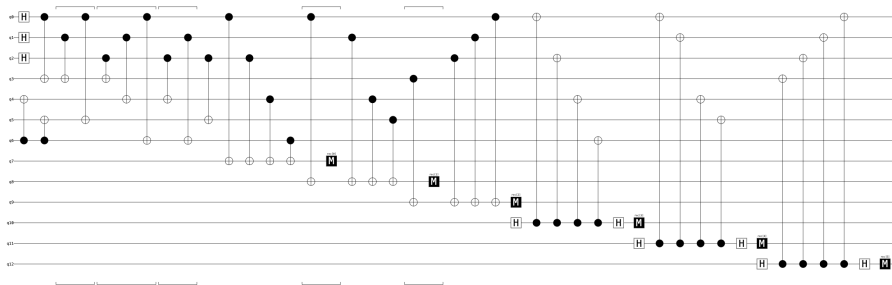Figure: Concatenated Steane code graph representation

Results

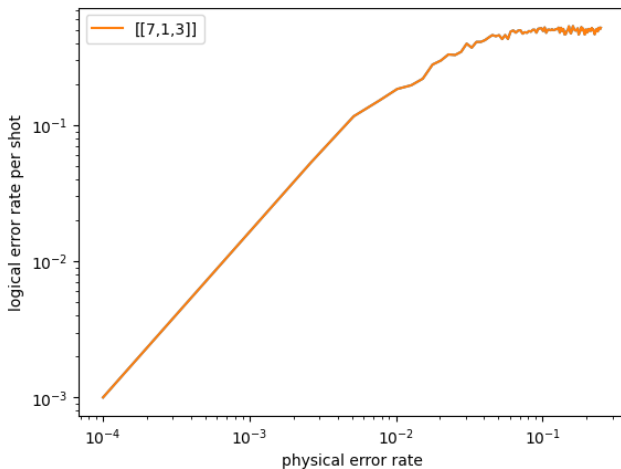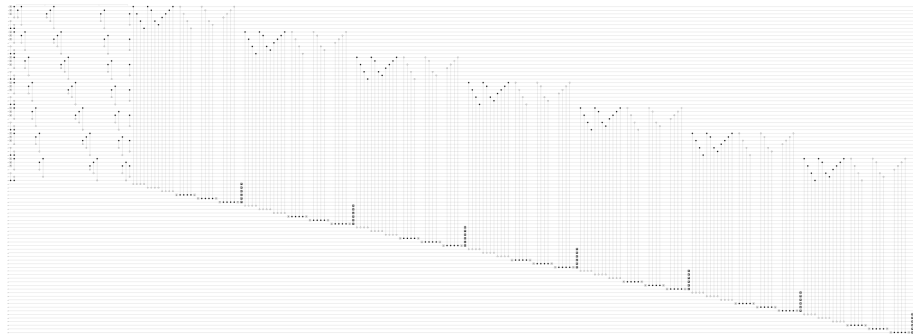Figure: Steane code encoding and syndrome extraction circuit

Results

Figure: Steane code logical error rate

Results

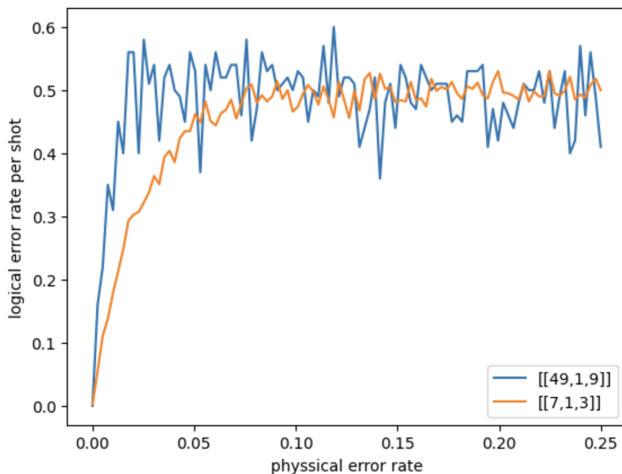Figure: Concatenated Steane code syndrome extraction circuit

Conclusion

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Figure: Logical error rates of [[7,1,3]] and [[49,1,9]]