Outline for Quantum Computing Presentation 2

Content of Presentation

Breadth:

High-level overview of background:

1. Machine-level compilation
    a. Decomposition of high-level language constructs into a series of one- and two-qubit operations that can be executed on the target system;
    b. Mapping of the variables defined by the programmer to locations in the system, in tandem with generation of appropriate execution of gates between qubits unfortunately placed far apart;
    c. Generation of low-level control for the hardware itself.
2. IBM's 20-qubits quantum processor
    a. Tokyo
    b. Poughkeepsie
3. Error model
4. Tomography
5. Randomized benchmarking
6. Architecture-aware compilation

Problem statement:

NISQ (Noisy, Intermediate-Scale Quantum) computing requires error mitigation to achieve meaningful computation. The authors needed to develop a compilation tool in order to maximize the success probability of real-world subroutines such as an adder circuit.

Methodology:

1. Establish a metric for choosing among possible paths and circuit alternatives for executing gates between variables placed far apart within the processor;
2. Test this approach on two IBM 20-qubit systems named Tokyo and Poughkeepsie;
3. Analysis results and suggest future improvements.

Major result:

For a circuit within the capabilities of the hardware, our compilation increases estimated success probability and reduces KL-divergence relative to an error-oblivious placement.

Depth:

Specific Algorithm:

1. Assess the ability to accurately predict the success rate of a given circuit using the product of the individual gate success probabilities as the estimated success probability(ESP).
    a. Path selection for remote CNOT
    b. Circuit selection for remote CNOT
2. Build on the capability and compile and test complete circuits.
    a. Search space
    b. The optimization algorithm
    c. Subroutines for compilation algorithm
    d. Experimental evaluation of compilation

Evaluation and analysis:

Impacts on the research field:

N/A

Who should care:

Quantum computer designers;
Quantum algorithm developers;
Quantum computing scientists.

Why is this important:

This paper exhibited a working error-aware compilation, which is crucial for future quantum computer design. The paradigm described in the paper can be incorporated directly into standard release of current quantum systems.

Is it believable:

Yes.

24 citations for pre-print version(Since May.2019)
4 citations for published version(Since May.2020)

Limitations:

Even in the relatively simple case of selecting a two-hop path, the best success rate is only 70%.

Relation between ESP and KL divergence vanished on complex circuit.

Not considered memory errors.

Quality of Presentation

Structure:
Outline the content of the talk?

Professional preparation and delivery:
Well rehearsed?
Slides well organized and clear?

Timing:
Fit properly in 30 mins?