Comparing Extrapolation Methods (2)

Pulse Stretching and Gate Insertion

November 24, 2020

Results from *Almost* Thanksgiving Weekend!

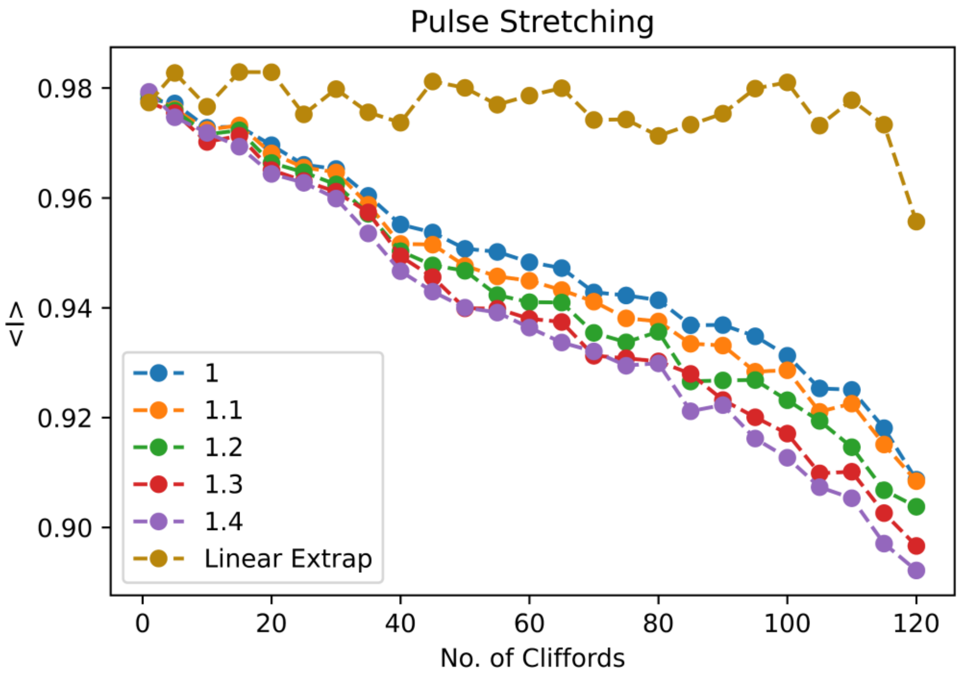
Randomized Benchmarking

Same Procedure as shown in last week slides but now with 10^5 samples instead of 10^4

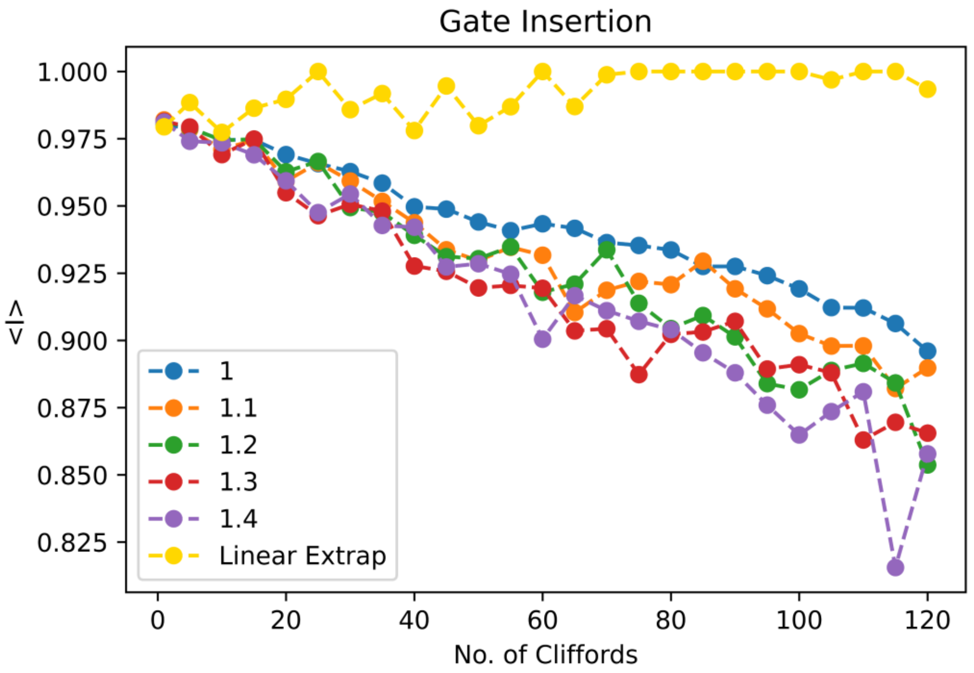
- All qubits are initialized in the 0 state
- Then we generate a circuit of n gates which add up to identity
- Result should be all qubits in 0 state but practically, due to noise, that is dependent on number of gates in the circuit
- The more gates, the more noise and hence less probability of getting the initial state
- In the following slides, on top of the number of gates, we amplify noise using pulse stretching and gate insertion.
- Ideally, extrapolated outcomes should imply that P(initial state) = 1

Single Qubit Randomized Benchmarking

Pulse Stretching

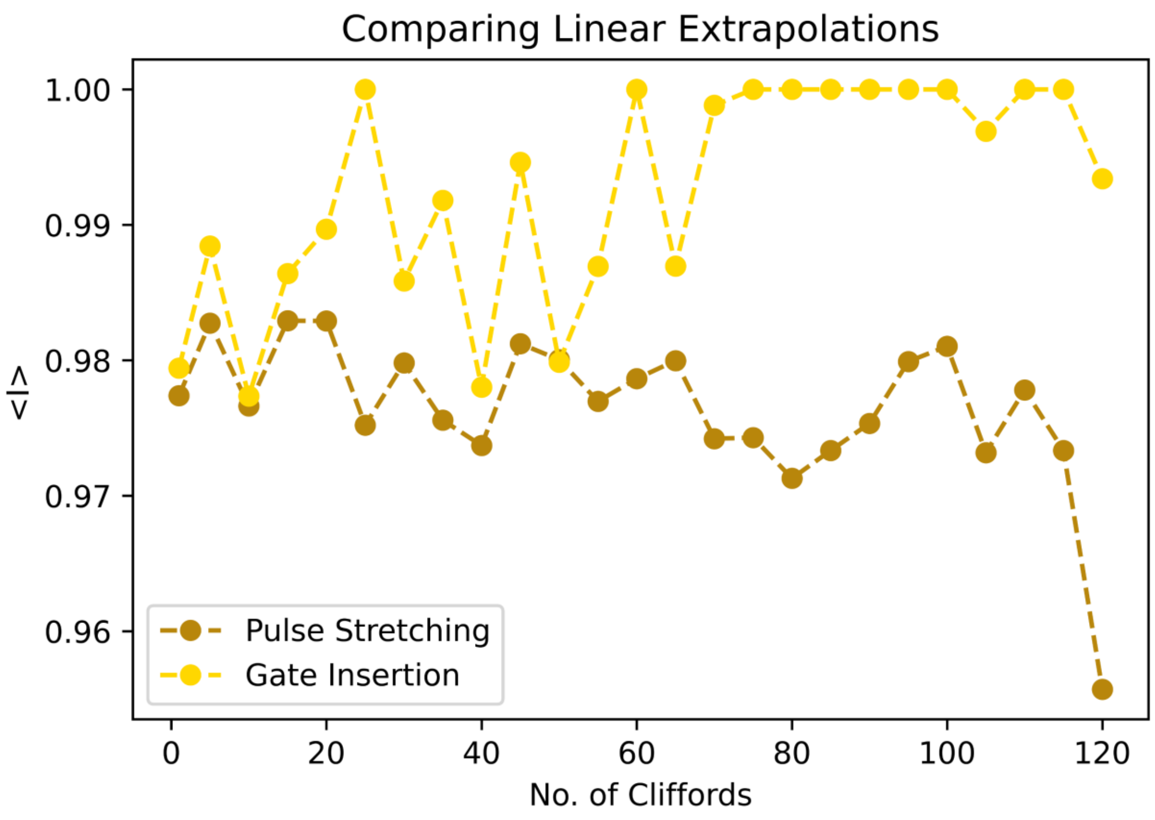


Gate Insertion



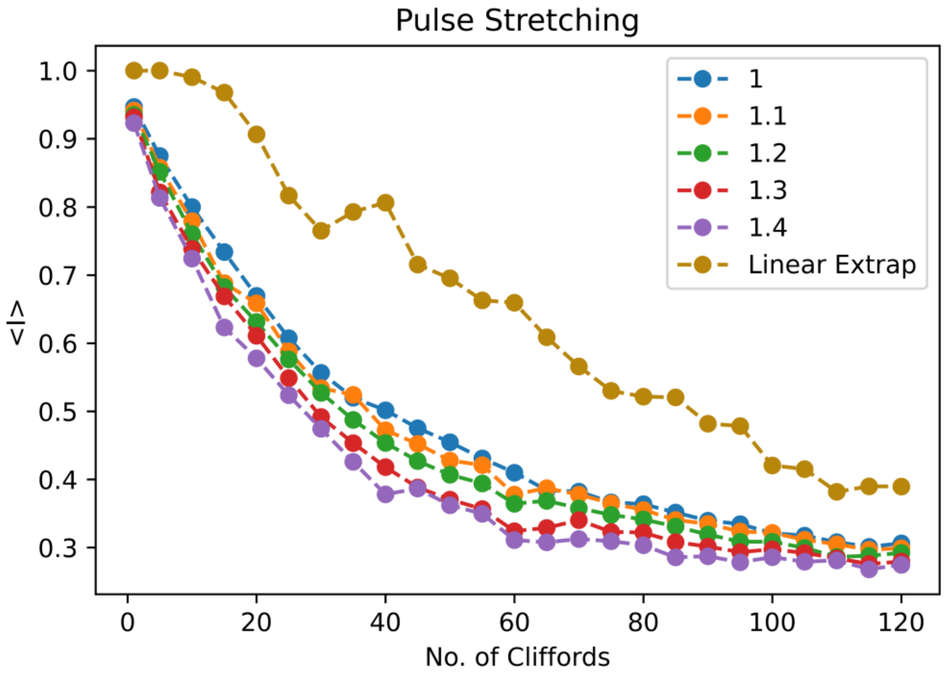
Comparing Extrapolations
Single Qubit Data

- Probabilities greater than 1 are set to 1
- Only comparing linear extrapolation data because drastic fluctuations with high order polynomials + Richardson

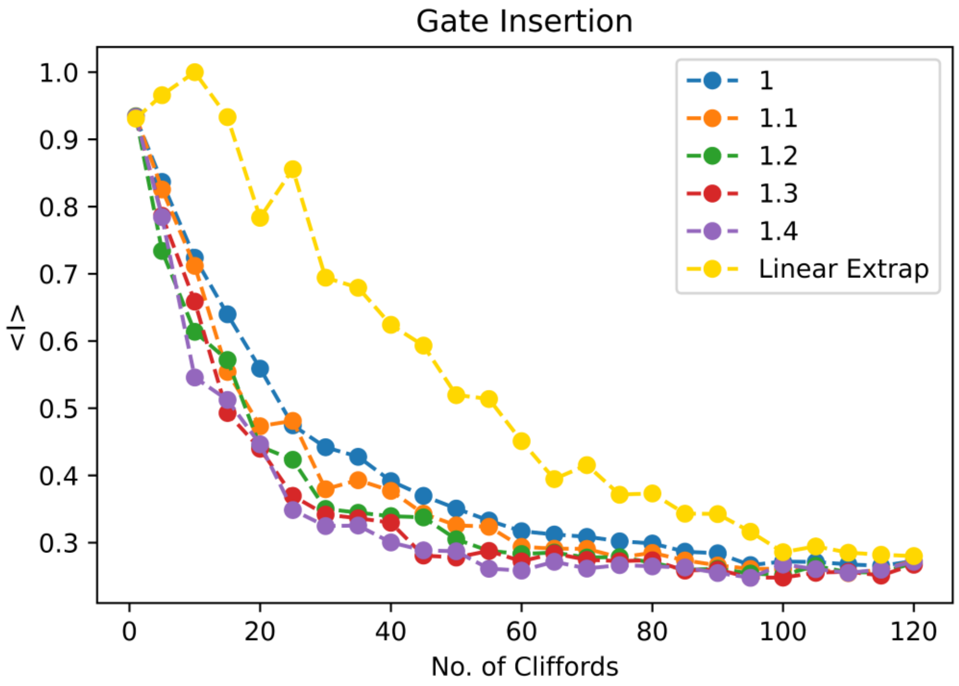


Two Qubit Randomized Benchmarking

Pulse Stretching



Gate Insertion

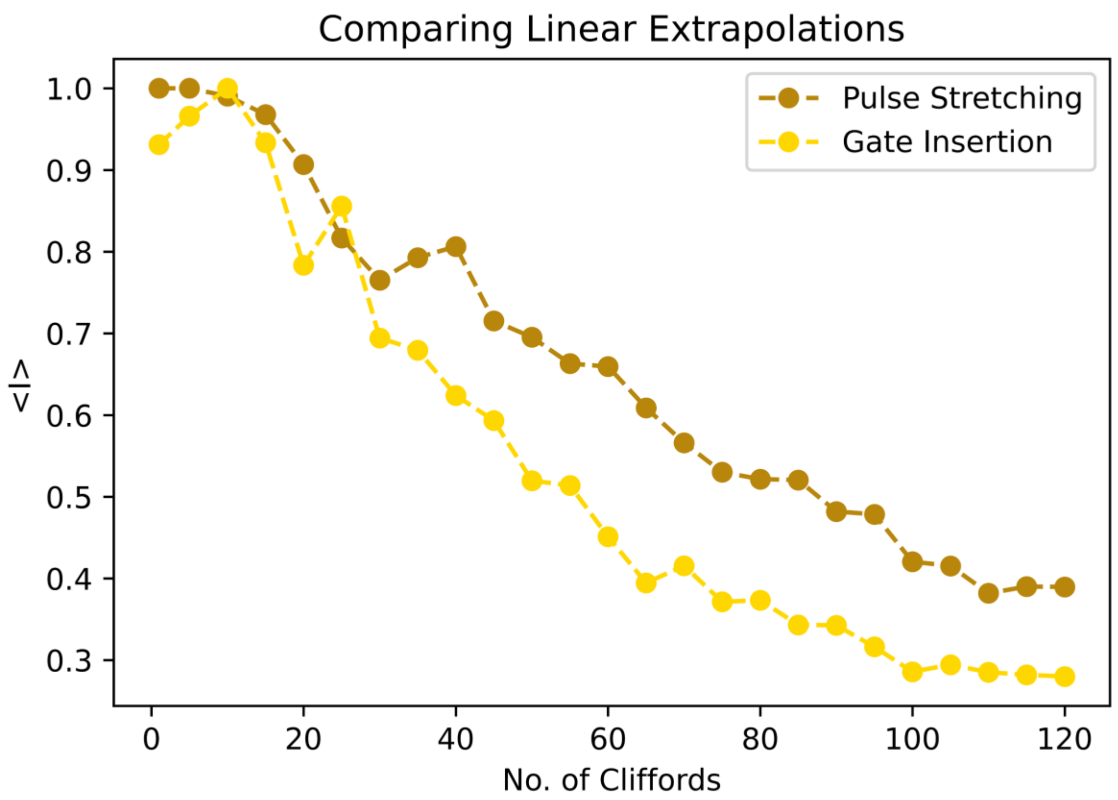


* The gate count as shown by x axis is representative of the circuit before it went through gate insertion procedure

Comparing Extrapolations

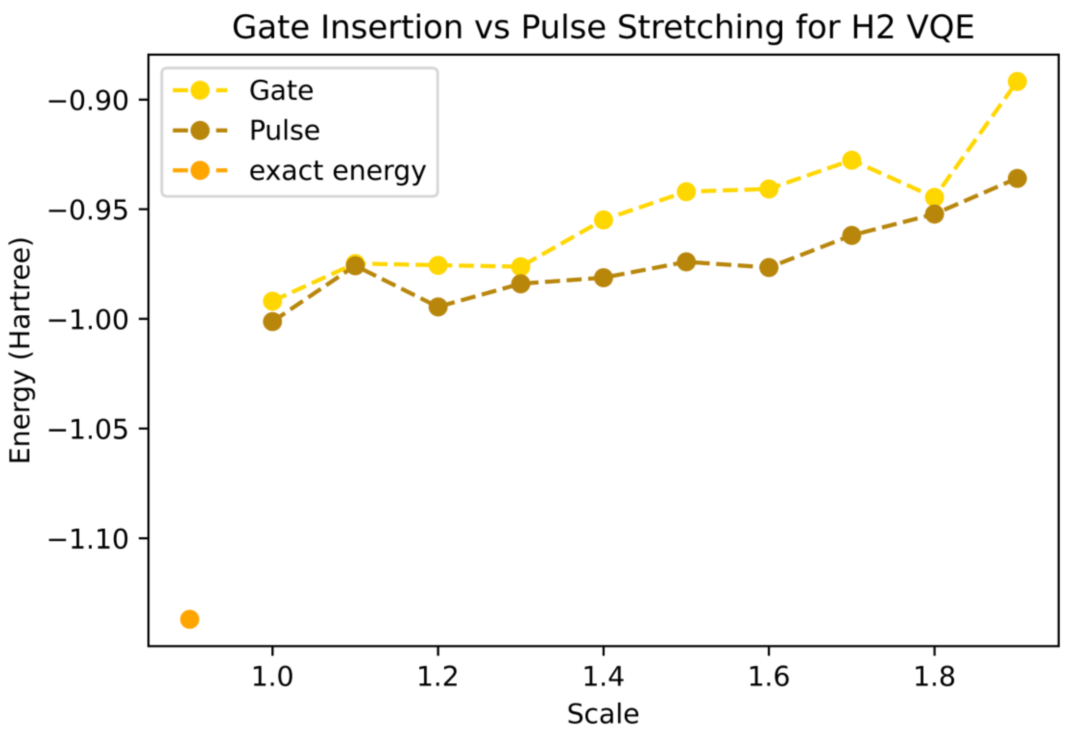
Two Qubit Data

- Probabilities greater than 1 are set to 1
- Only comparing linear extrapolation data because drastic fluctuations with high order polynomials + Richardson
- Now it seems that pulse is better, especially for higher depth circuits, than gate insertion

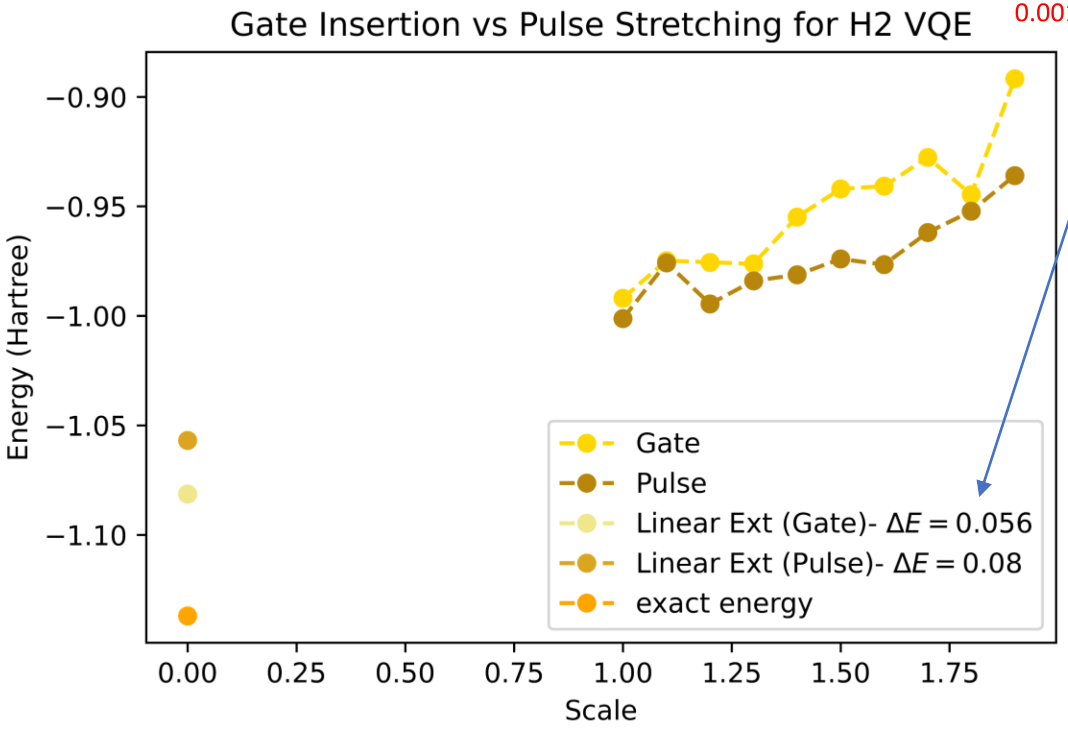


VQE on H_2 molecule Optimized Parameters on Casablanca Noise Model

Raw Data



With Linear Extrapolation



Hopefully, applying readout error mitigation, these differences get within chemical 0.001 H!