CNOT-ting VQE (2)

Meeting with Professor Schnetzer and Rikab
July 21, 2020

Background

Debugging CNOT-ting

- Last time we discussed 2 approaches to CNOT-ting VQE
  - CNOT-ting the optimized circuit
  - CNOT-ting all the circuits involved in VQE
- I used the former approach even though its not ‘proper’ because the latter one wasn’t working -- as we scaled the noise, no significant differences between computed energies
- Possible solution was to use absurd noise scalings like 1001 to debug it
- Turns out, when I did so, I couldn’t see any differences
- Obviously then, there was a bug in the code.

Background

Burlington Trouble

- Also last time, Professor Schnetzer pointed out that VQE energies computed on Burlington device were absurd.
- A solution was to do simulations using Burlington Device noise model or maybe do same experiments on a different quantum computer.

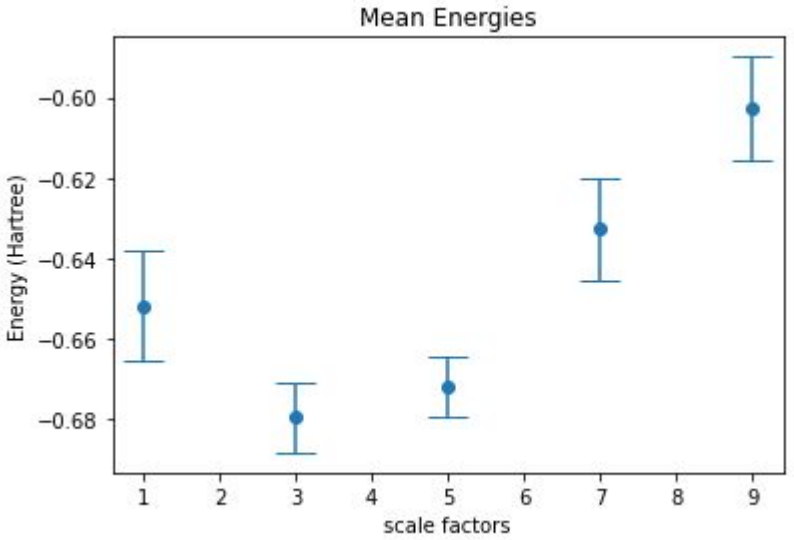
Experiments shown in slides 5-8 use the proper CNOT-ting VQE approach - Whenever there is a circuit being evaluated at any point in VQE process, we CNOT it.

CNOT-ting VQE

(Burlington Device)

This is very weird. Instead of being a concave down curve, the energy curve looks more concave up.

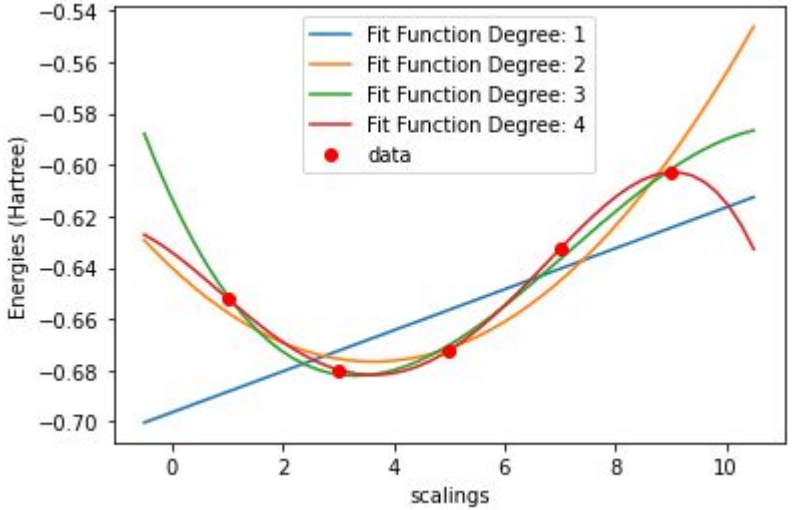
*Look at the energy scale. The exact energy is -1.13 Hartree. The energy at noise scale = 1 should be double the value that is shown in the graph

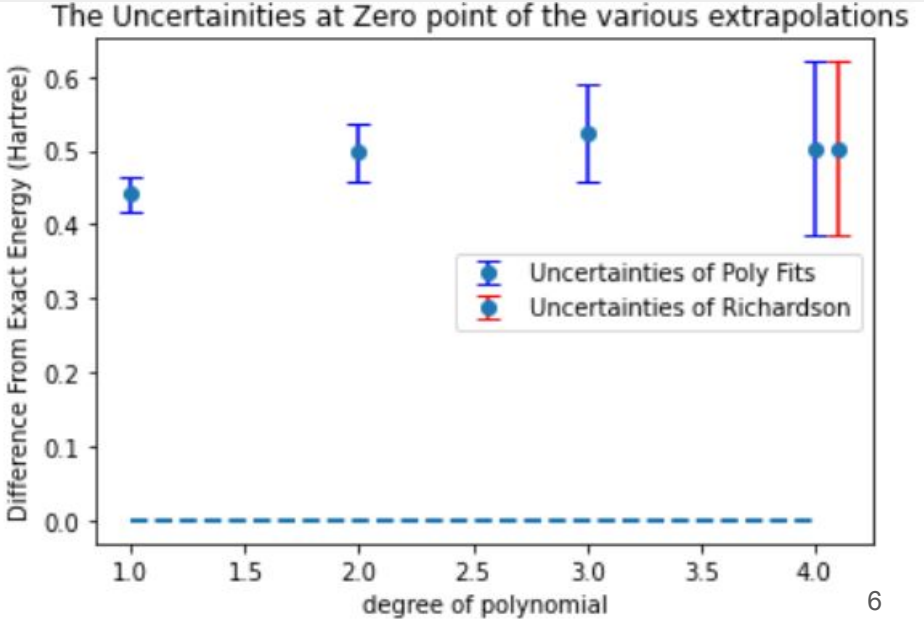


- 5 samples for each point

Extrapolating CNOT-ted VQE

(Burlington Device)

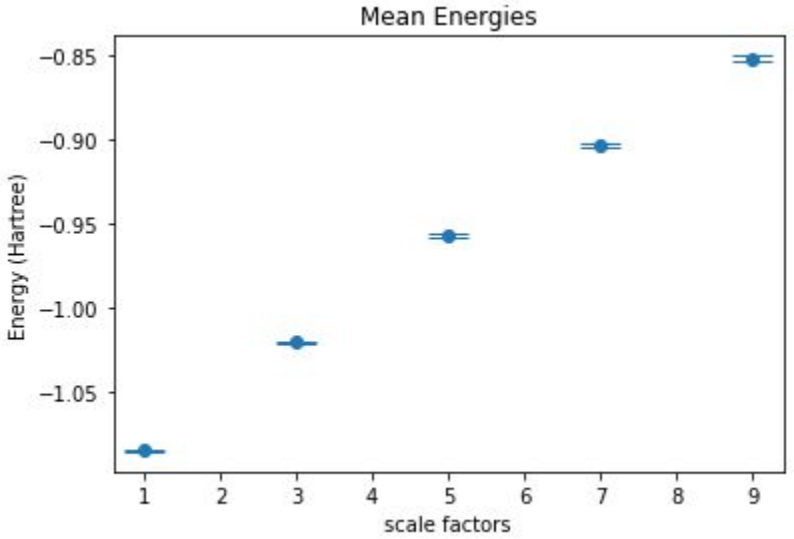




CNOT-ting VQE

(Burlington Noise Model - Simulation)

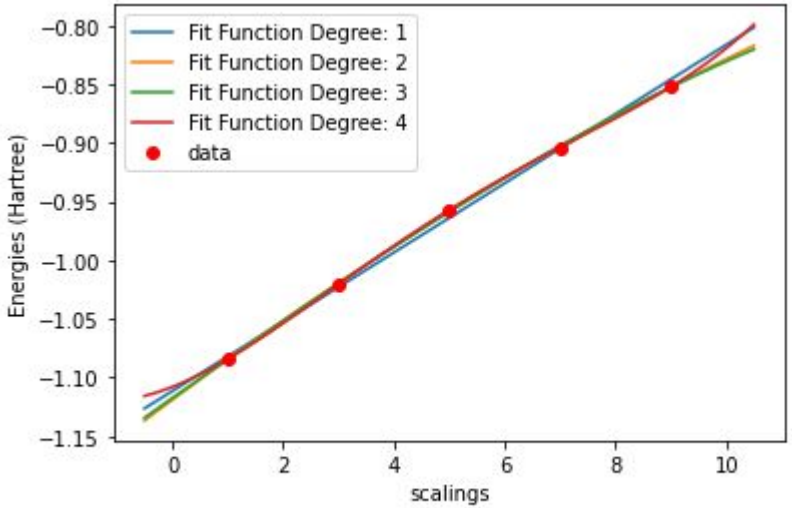
This is much better. Why don’t we get such results on the real device then? Either the noise model is not a very good model or there is some issue with the Burlington Device.

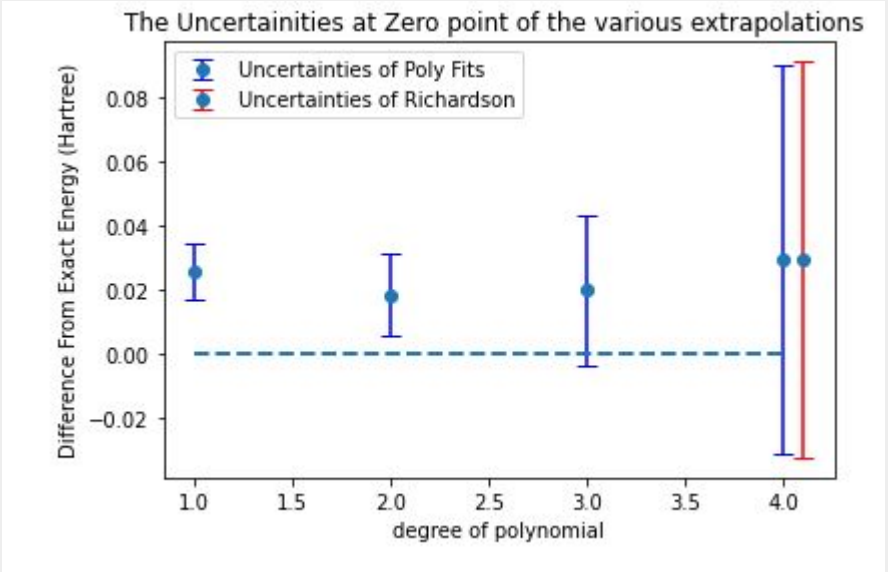


- 100 samples for each point

Extrapolating CNOT-ted VQE

(Burlington Noise Model - Simulation)





Burlington Trouble

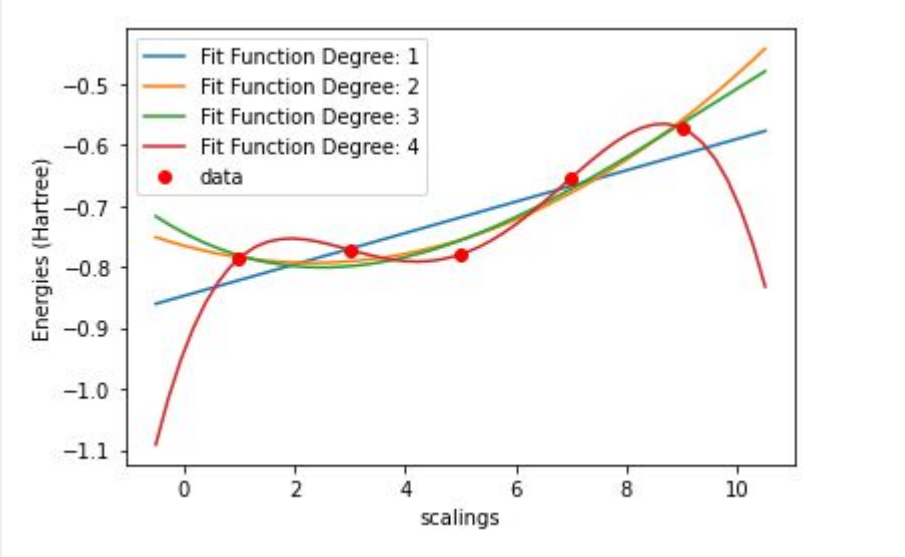
Comparison with London Device

- With the London Device, it’s results are consistent with its noise model simulator-- CNOT technique is working for both London Device and London noise simulator
- Also, London Device is a lot more accurate as well
- Burlington device however is another story altogether.

Burlington Trouble

Here, we amplify noise through CNOT-ting in the optimized circuit.

When I did the same experiment last week with London Device, I got a y = x line i.e. much better result. (With only 1 sample for each point though)



- 20 samples for each point

Next Steps

- If CNOT-ting VQE is working on London, let’s do this at multiple separations between the hydrogen atoms
- Also, add in more noise scaling points. This will help in comparing the polynomial fits with Richardson
- Also revisiting chi square and f statistics...why are they so small?