Gate Insertion and Noise

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I. OUTLINE

Some of the most promising near-term applications of quantum computers lie in solving classically intractable problems in chemistry, leading to potential breakthroughs in disease prevention. However, quantum computers of today are both highly susceptible to errors and limited by the number of qubits to correct them. For the near term, scientists are exploring error mitigation techniques to reduce the effects of quantum computational noise. One such popular technique is Zero Noise Extrapolation (ZNE) which approximates the 'zero error' solution by deliberately increasing the noise in the device.

Noise can be amplfied in 2 ways: stretching gate pulses and inserting noisy gates in the quantum circuit. In pulse stretching, we are slowing down gate operations by elongating the microwave pulses, thus requiring more hardware level control. It assumes that noise is constant in time and that the total gate time after stretching of pulses cT in within the coherence window i.e. $cT < T_1, T_2$. While the first assumption is questionable since IBMQ's devices T_1, T_2 times fluctuate over times, it is avoidable if all experiments can be done quickly (with short time intervals in the middle). The second assumption however constains the number of stretch factors

Extrapolation requires study of the different noise amplification techniques, each of which makes some assumptions about the noise model:

1. Gate Insertion : Assumes that all non-relaxation errors are depolarizing
2. Pulse Stretching: Assumes that the decoherent time constants T_1, T_2 are constant over the entire duration of experiment.

While gate insertion has been regarded as less attractive, there has been little studied over how different forms of noise affect efficacy of this noise amplification technique.

II. NEW DEVELOPMENTS

III. CONCLUSIONS

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Appendix: Appendix

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