ZNE error mitigation with mid-transpilation noise amplification #4

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Outline

- Zero Noise Extrapolation **in a nutshell**
- **Work Plan**
- Short **Demo**

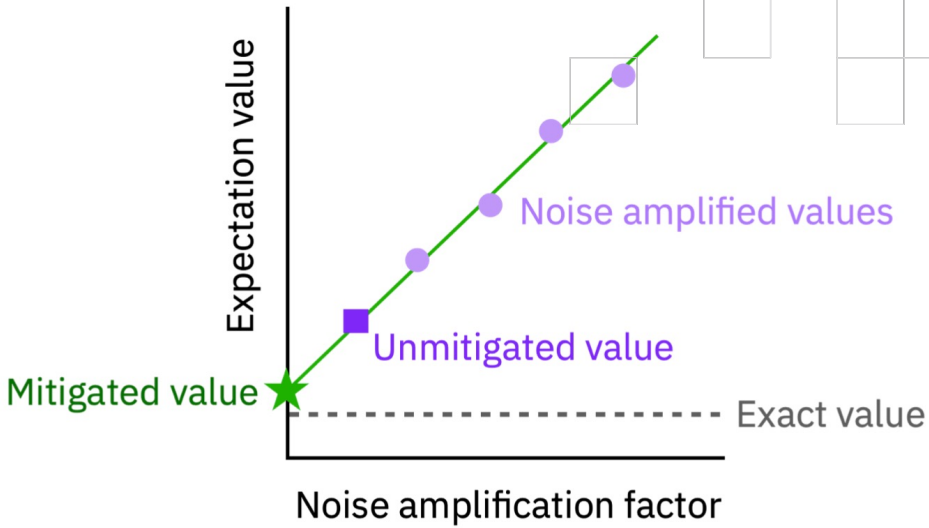
ZNE: Brief introduction:

Goal: Mitigate the effects of **gate errors** in expectation value computations

Steps:

1. Amplify the noise introduced by the gates of the circuit

2. Extrapolate the noisy expectation values to the zero-noise limit

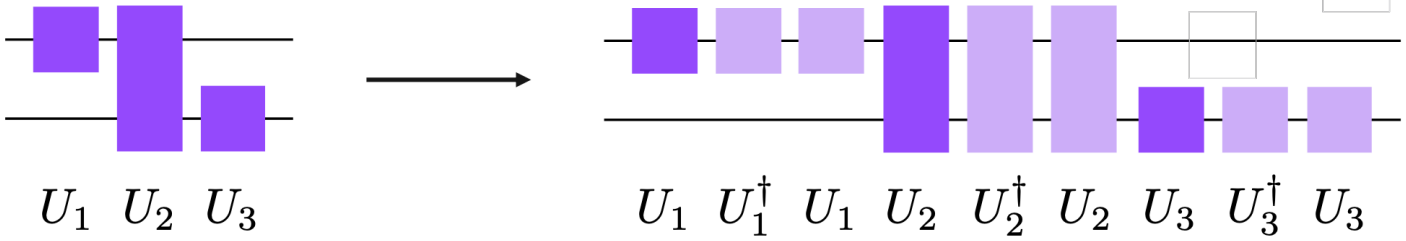


Incrementally make things worse to **fit a curve back to the best**
- Increment = Noise factor

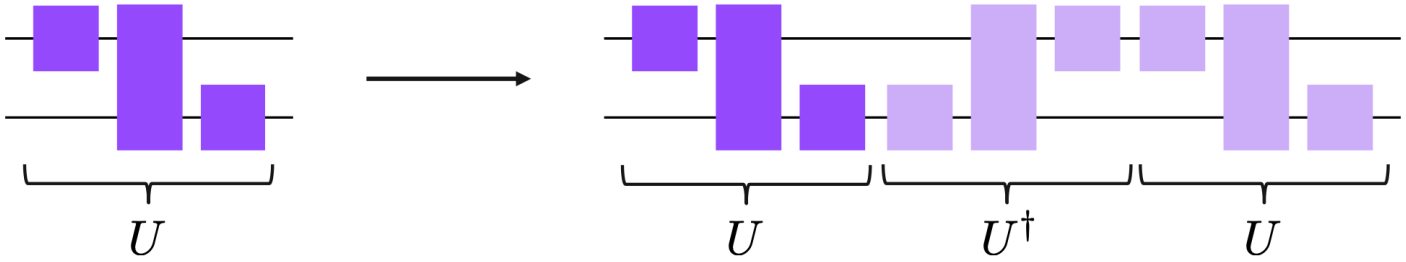
Image adapted from the **tutorial docs** in the prototype-zne module:
https://github.com/qiskit-community/prototype-zne/tree/main/docs/tutorials

Noise amplification in Digital ZNE

Local folding – repeatedly folding the **gates** inside the circuit



Global folding – repeatedly folding the whole **circuit**



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Work Plan

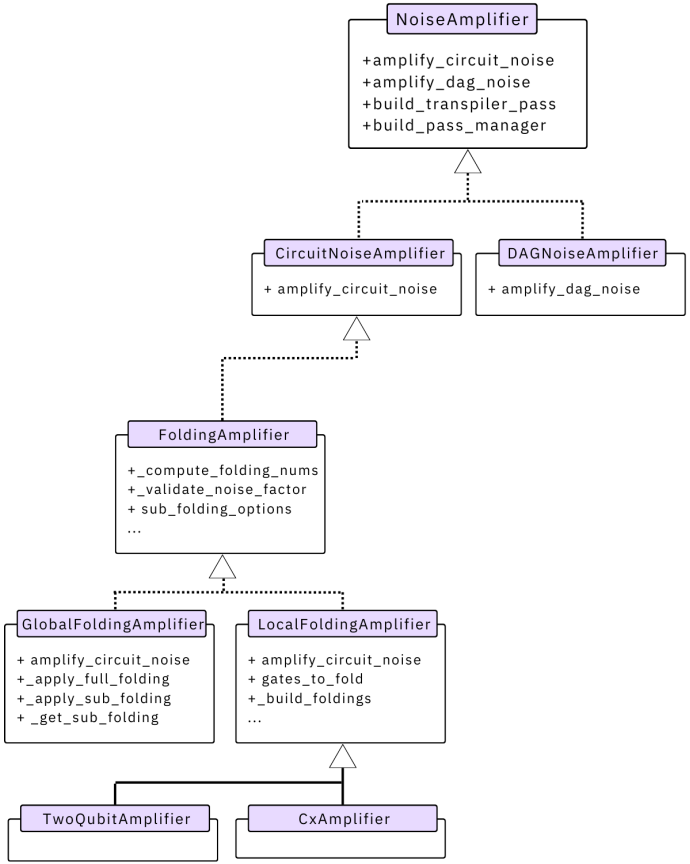
Goal:

Make noise amplification more efficient and improve overall error mitigation

Prototype ZNE: https://github.com/qiskit-community/prototype-zne

Current Structure:

- Extends CircuitNoiseAmplifier
- Folding is done on the QuantumCircuit API
- Noise Amplification happens pre-transpilation
- Error mitigation is less precise in general



Work Plan

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Make noise amplification more efficient and improve overall error mitigation

Prototype ZNE: https://github.com/qiskit-community/prototype-zne

PR: https://github.com/qiskit-community/prototype-zne/pull/36

Proposed Structure:

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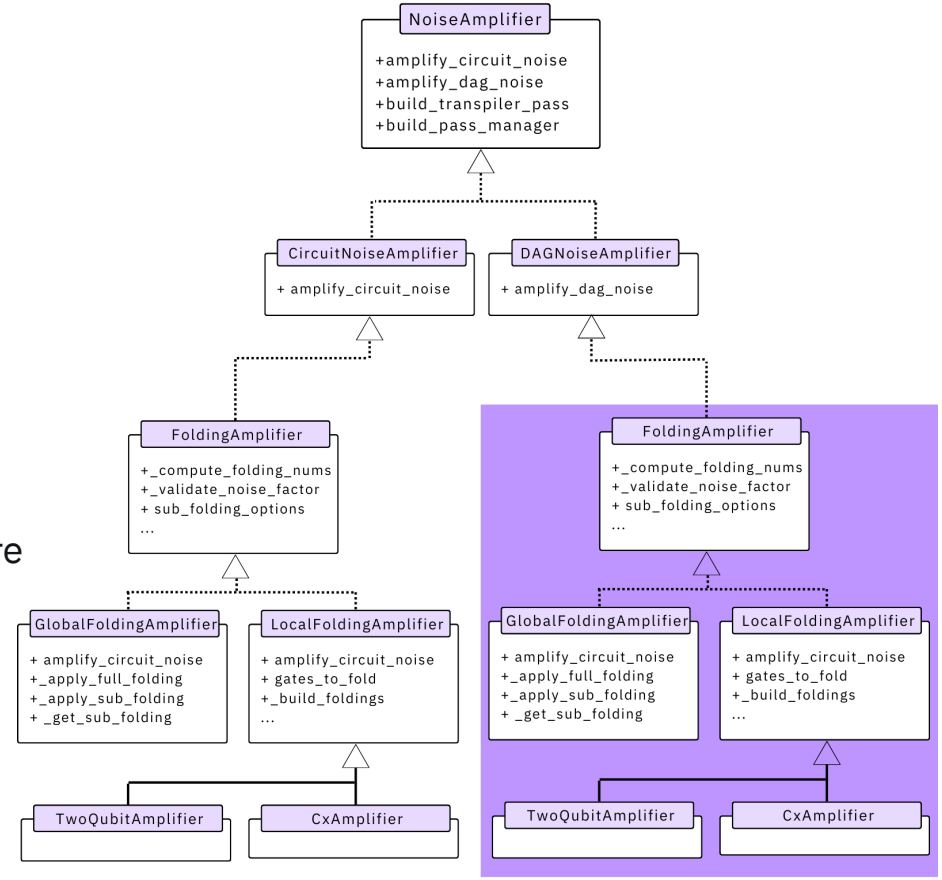
- Extends DAGNoiseAmplifier
- Folding is done on the DAGCircuit API
- Noise Amplification happens mid-transpilation
- Error mitigation is more precise
- More efficient computationally



Where are we right now?

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Thank you for your time.

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