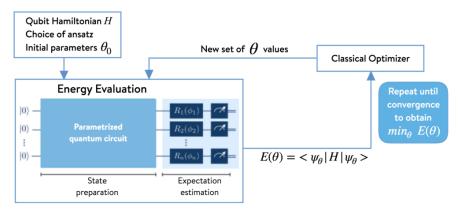
Variational Quantum Eigensolver _____ - SQUANDER -

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Scientific Modelling Computer Laboratory May 7, 2025

Variational Quantum Eigensolver (VQE)



Source: qmunity.thequantuminsider.com

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Classical Optimization Processes

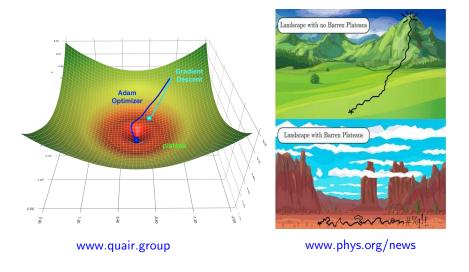
Gradient-based methods

- Gradient Descent
- Parameter Shift Rule (Quantum GD)
- ADAM (Adaptive Moment Estimation)
- BFGS (Broyden–Fletcher– Goldfarb–Shanno)

Gradient-free methods

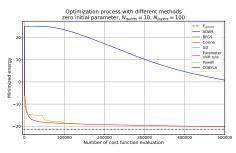
- Powell's method
- COBYLA (Constrained Optimization BY Linear Approximation)
- Nelder–Mead
- Batched Line Search
 Strategy (SQUANDER built-in)

Barren Plateau (BP) Problem



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Zero-Initial Parameter Vector

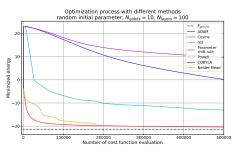


Optimization process with different methods

$$N_{ab} = 10$$

$$N_{ab} = 14$$

Random-Initial Parameter Vector



Optimization process with different methods random initial parameter, Naubits = 14, Niavers = 100 --- Eggana - ADAM - BEGS Cosine GD Parameter shift rule Minimized energy -20 100000 200000 300000 400000 Number of cost function evaluation

$$N_{ab} = 10$$

$$N_{qb} = 14$$

d=2d=3d=4d=2 $N_{qubits} = 12$, $N_{layers} = 100$ d=3 $N_{qubits} = 12, N_{layers} = 100$ $N_{aubits} = 12$, $N_{layers} = 100$ — Eprono — ADAM - Cosine - Cosine - Cosine 20 - Powell - Powell mized energy 300000 400000 200000 100000 Number of cost function evaluations Number of cost function evaluations Number of cost function evaluations

Seed Value Change

