How Will the Quantum Future Become the Quantum Now?

Reuben Brasher

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Quantum is Now

What is a computer?

A computer is an isolated system for performing repeatable experiments controlled by user input.

What is a quantum computer?

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- Quantum ML is a neural net where some layers happen to be quantum.
- Computation, both distributed and local quantum perform a series of transforms on data.
- Both classical and quantum computations are parameterized and the parameters of the computations are learned to minimize a loss function.

What to we want as an ideal?

A general purpose quantum computer realizes

$$U(\theta)\left|0\right\rangle^{k}\left|\psi\right\rangle = \left|\textit{something useful}\right\rangle,$$

where $U(\theta)$ is a unitary transform parameterized (perfectly) by θ and ψ encodes arbitrary classical data.

How do we do that?

Encode the data by

$$U(\theta_\psi)\,|0\rangle^n = |0\rangle^k\,|\psi\rangle\,,$$

where $U(\theta_\psi)$ is a unitary transform parameterized (perfectly) by θ_ψ depending on ψ. Hence

$$U(\theta)U(\theta_\psi)\,|0\rangle^n = |\textit{something useful}\rangle\,.$$

What happened?

What has happened that computation simplifies to

$$U(\phi_\psi)\,|0\rangle^n = |\textit{something useful}\rangle\,,$$

where ϕ_ψ depends on classical data.