

The Quantum Virtual Machine

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Quantum Computers

$$|\phi\rangle = \alpha_0|0\rangle + \alpha_1|1\rangle = \begin{bmatrix} \alpha_0 \\ \alpha_1 \end{bmatrix}$$

$$\alpha_i \in \mathbb{C}$$

$$|\alpha_0|^2 + |\alpha_1|^2 = 1$$



are quantum computers
real?

yes!

- IBM – [Heron 133](#) qubit processor
- Google – [Bristlecone 72](#) qubit processor

- IonQ – [Forte 32](#) qubit processor
- Quantinuum – [H2 32](#) qubit processor
- Rigetti – [Ankaa 84](#) qubit processor

- QuEra – [Aquila 256](#) qubit processor

A futuristic, dark blue cityscape at night, viewed from an elevated perspective. The buildings are illuminated with various colors of light, including orange, yellow, and green. The central building is the largest and most prominent, with a dark, textured facade. The overall atmosphere is mysterious and high-tech.

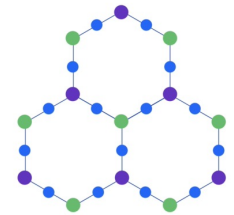
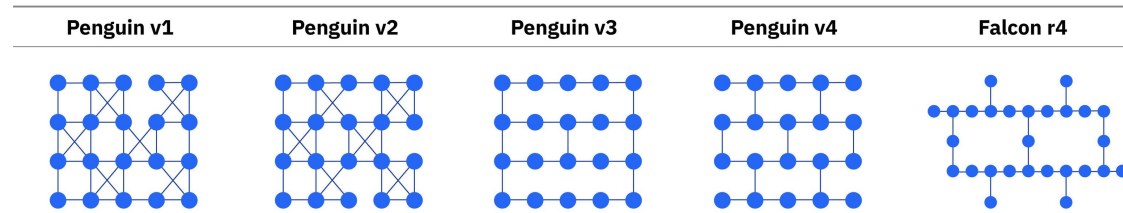
but there is a catch...

instruction set

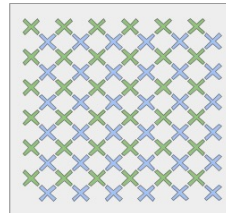
- each device implements a different instruction set:
 - [ibm](#): $U1(\lambda)$, $RX(\pi/2)$, CX
 - [ionq](#): $GPI(\varphi)$, $VirtualZ(\theta)$, $MS(\varphi_0, \varphi_1)$, $ZZ(\theta)$
 - [quantinuum](#): $U1(\lambda, \varphi)$, $RZ(\pi/2)$, $ZZ()$, $RZZ(\theta)$

connectivity

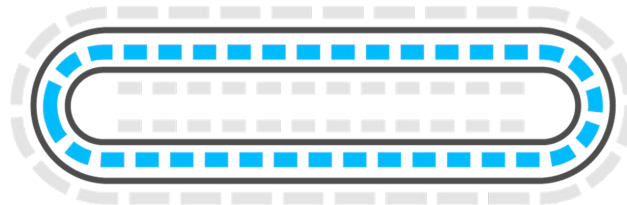
- [ibm](#)



- [google](#)



- [quantinuum](#):



noise

- ibm: 99.812 (avg), 93.21 (readout)
- google: 99.9 (1q), 99.4 (2q), 99 (readout)
- ionq: 99.98 (1q), 99.3 (2q)
- quantinuum: 99.997 (1q), 99.8 (2q)

The image features a complex, isometric 3D architectural rendering of a futuristic city or data center. The structures are dark, with various levels and platforms, and are illuminated with numerous small, colorful lights in shades of orange, yellow, green, and blue. The overall aesthetic is high-tech and digital. In the center of the image, the letters "QVM" are displayed in a clean, white, sans-serif font. Below the text is a thick, white, wavy horizontal line that spans across the width of the text.

QVM

a formal definition

- A QVM is triplet (I, N, T) where:
 - **I is the instruction set:** the set of supported instructions
 - **N is the noise model:** a random variable that given an instruction, returns another instruction representing the noise based on some probability distribution
 - **T is the topology:** a graph representing connectivity among qubits

benefits

- theoretical complexity calculations
- provides definitions for compilers
- create software emulators
- model fault-tolerant devices

thanks!

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