

The Intersection of Quantum Computing, Artificial Intelligence and Cryptography

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Wifi: IBM Developer // ibmdevelopersf

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Program Start @ 12:30p

IBM Developer



Hi, I'm Dave

I'm a developer advocate for IBM in San Francisco. I also help organize:

- The SF JavaScript Meetup
- IBM Developer SF Meetup
- ForwardJS San Francisco && Ottawa

I participate in meetups, hackathons, webinars and write articles about technology for IBM and other organizations.



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Defining Artificial Intelligence:

“By AI we mean anything that makes machines act more intelligently. Our work includes basic and applied research in machine learning, deep question answering, search and planning, knowledge representation, and cognitive architectures.”

IBM Research



Americans who say AI has had a mostly or very positive impact on their lives:

79%

Americans who say increased use of AI
will eliminate more jobs than it creates:

73%

↳ A Brief History of Artificial Intelligence



“I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.”

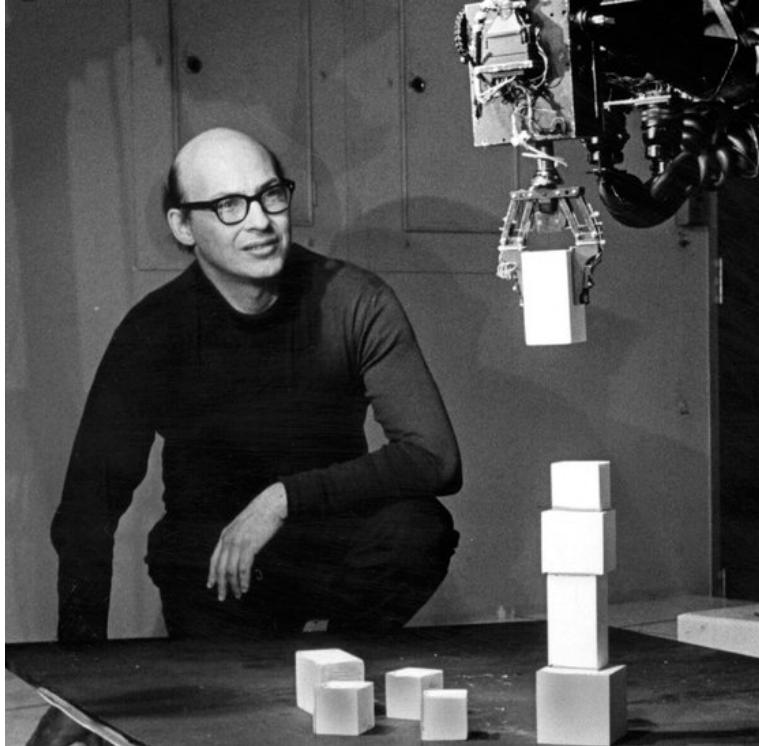
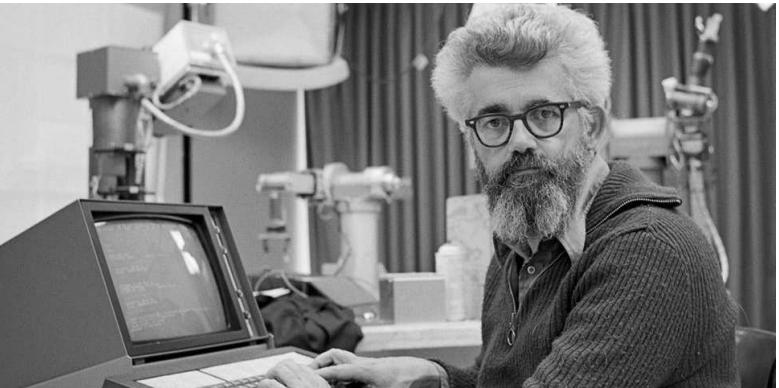
Alan Turing

[Computing Machinery and Intelligence](#)



DSRPAI Organizers

John McCarthy and
Marvin Minsky



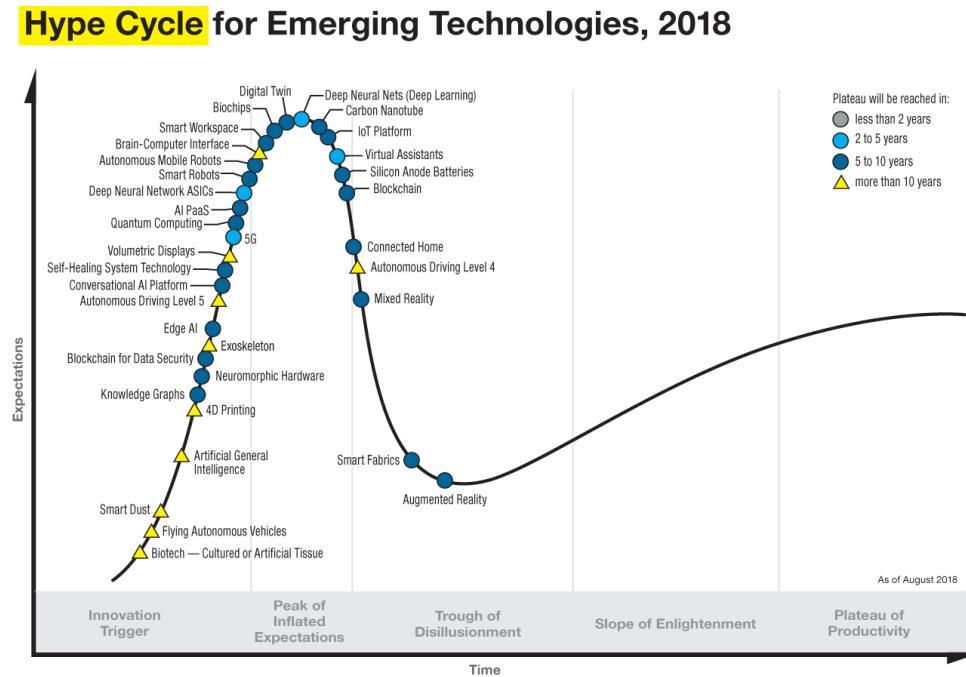


Attendees of Dartmouth Summer Research Project on Artificial Intelligence (DSRPAI)
50 years after the conference: Figure 1. Trenchard More, John McCarthy, Marvin Minsky,
Oliver Selfridge, and Ray Solomonoff. Photo by Joe Mehling

The Gartner Hype Cycle

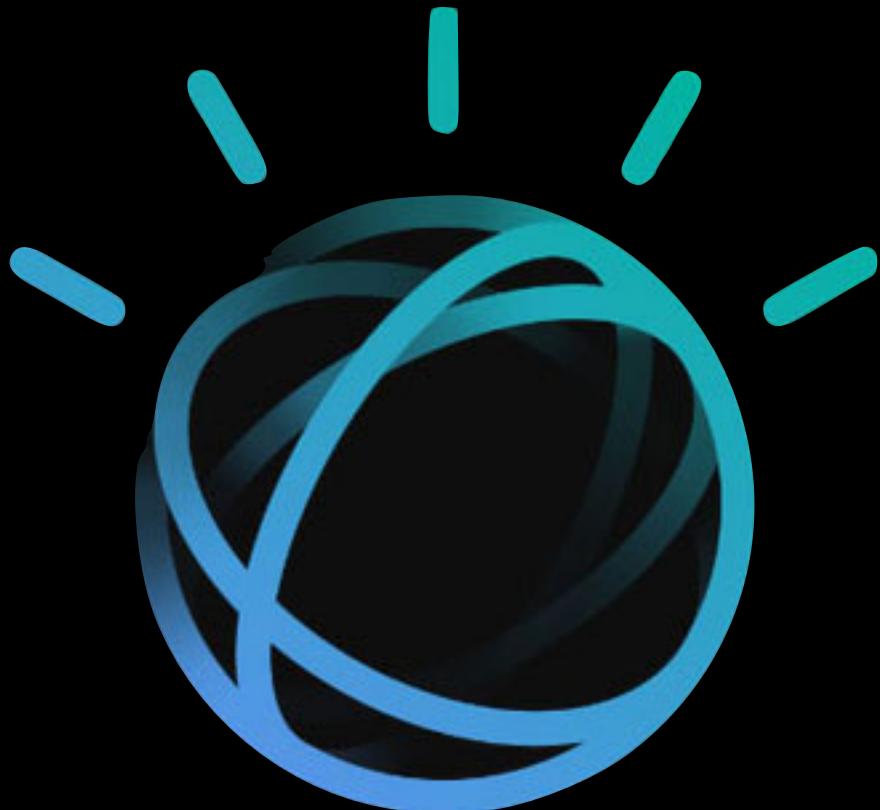
Artificial intelligence has been an emerging technology for decades, with amazing promises and occasional troughs of disillusionment. These are called “AI winters”

Many current emerging technologies as of 2018/2019 have their roots in AI research

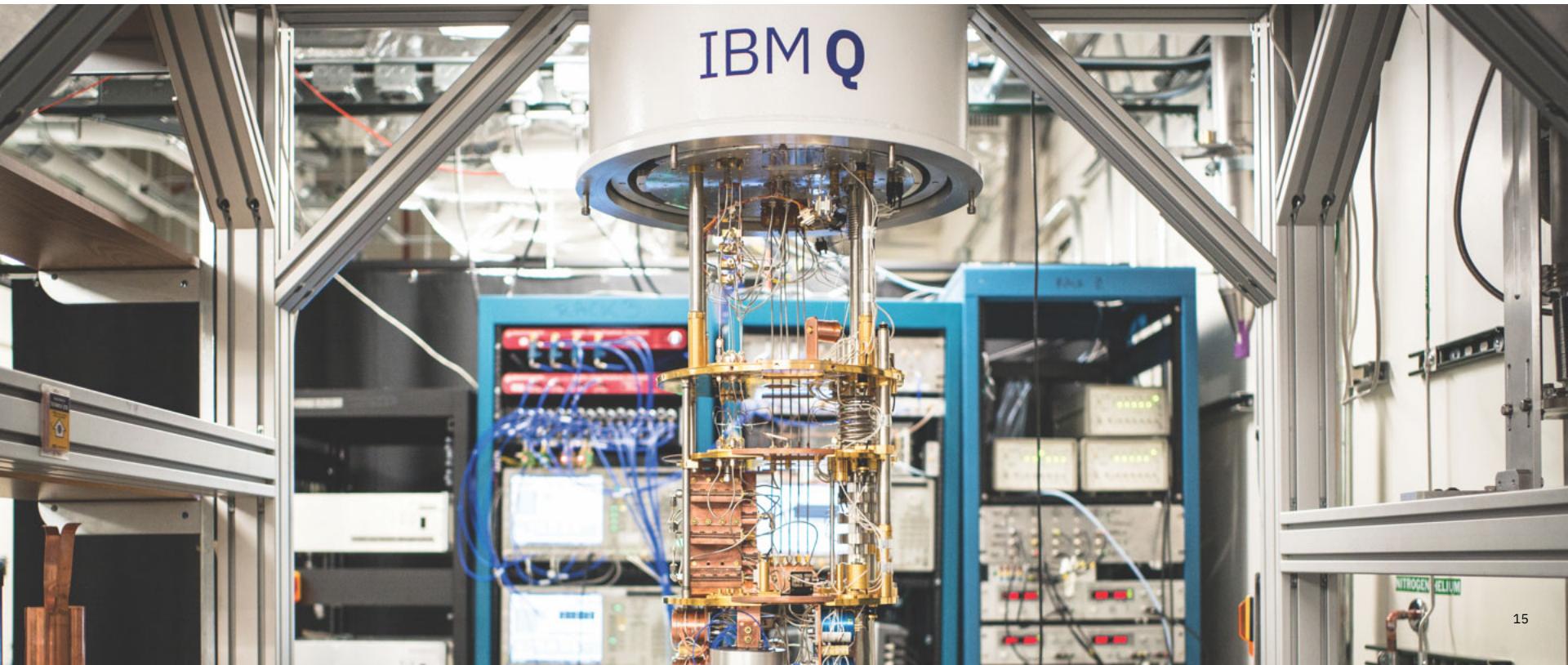




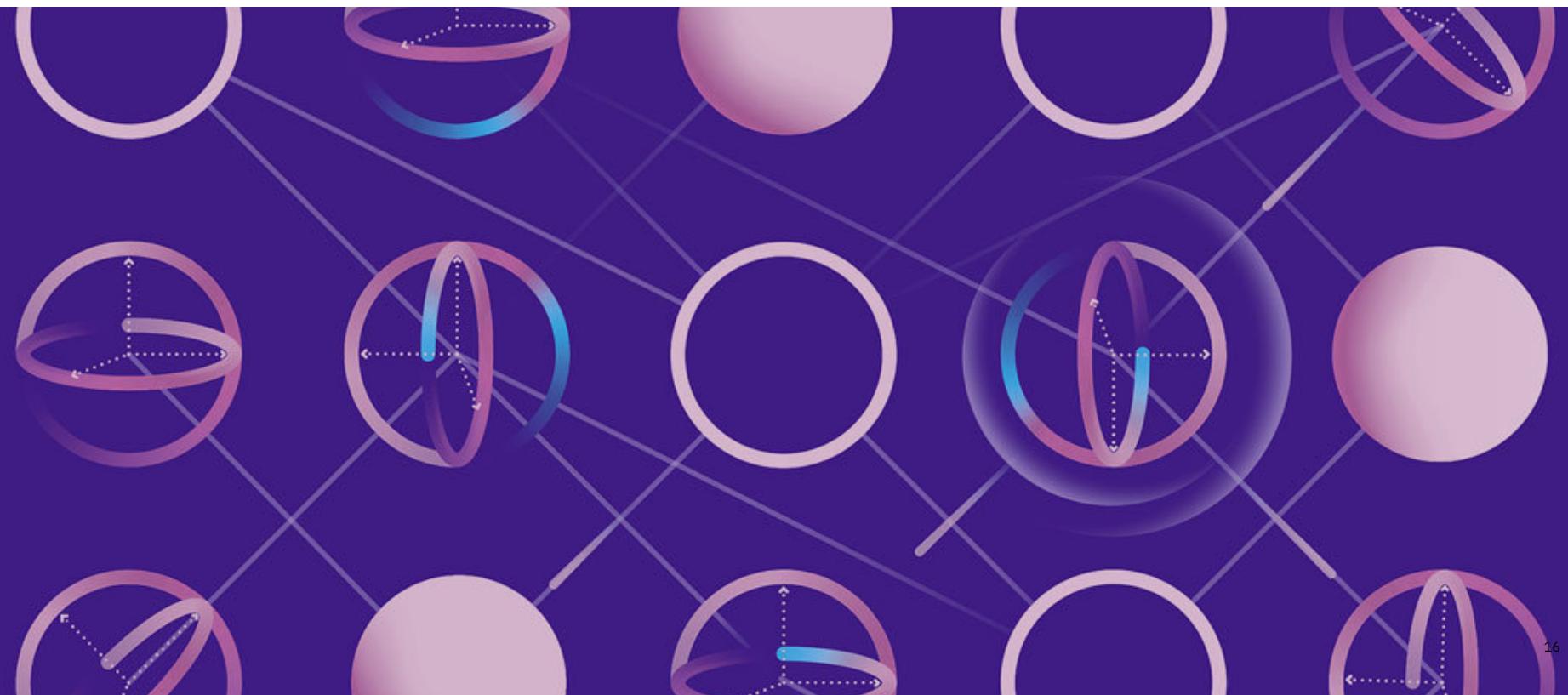
Garry Kasparov and Deep Blue, 1997



↳ Introduction to Quantum Computing

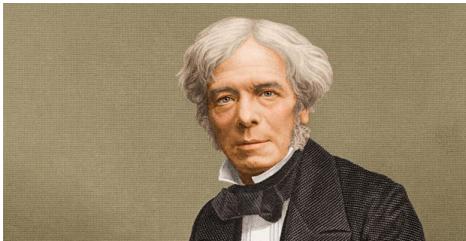


Quantum Theory

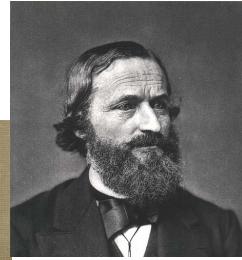


The History of Quantum Theory

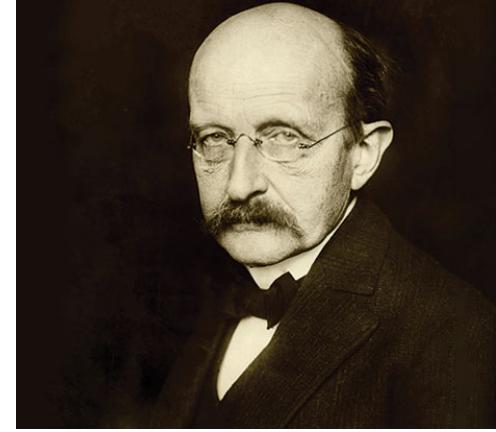
Michael Faraday



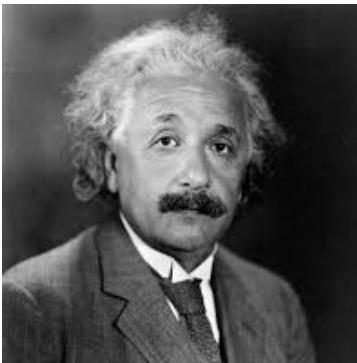
Gustav Kirchoff



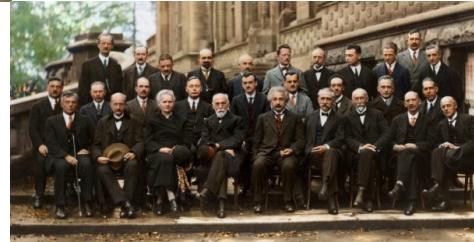
Max Planck



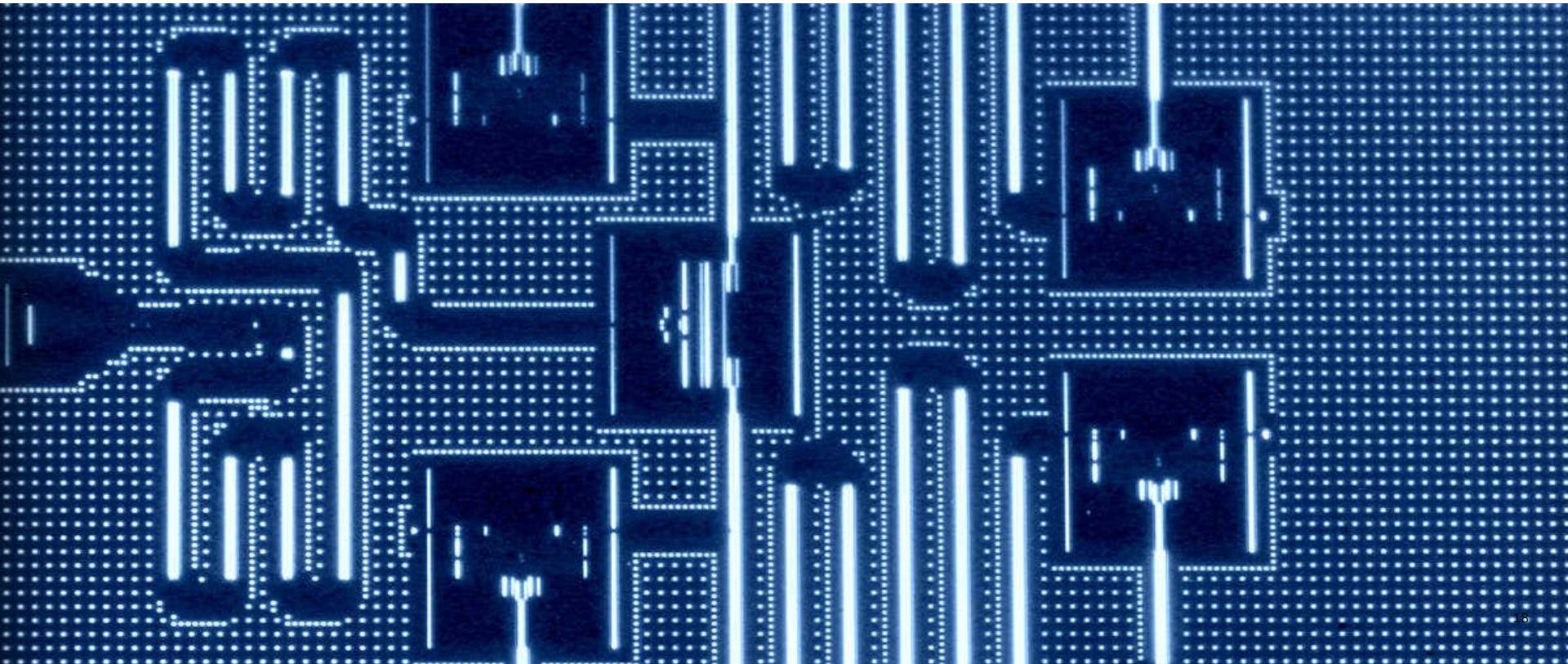
Albert Einstein



Louis de Broglie



↳ Quantum Processors



Quantum Processors: Superposition

- Classical computers: zeroes and ones
- Quantum computers: zero AND one
- Relationship between qubits and states

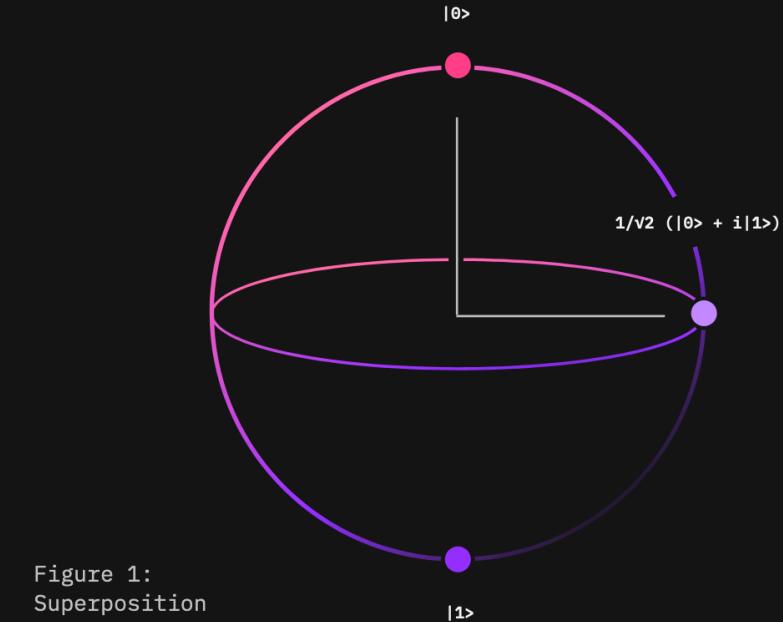


Figure 1:
Superposition

Quantum Processors: Entanglement

Entanglement is a famously counter-intuitive quantum phenomenon describing behavior we never see in the classical world. Entangled particles behave together as a system in ways that cannot be explained using classical logic.

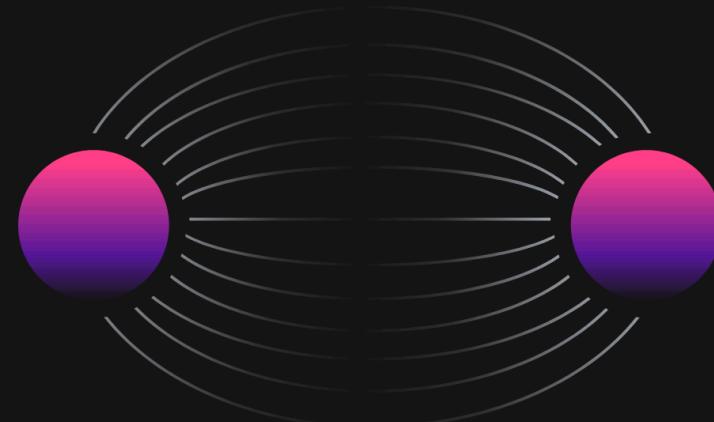


Figure 2:
Entanglement

Quantum Processors: Interference

Quantum interference can be understood similarly to wave interference; when two waves are in phase, their amplitudes add, and when they are out of phase, their amplitudes cancel.

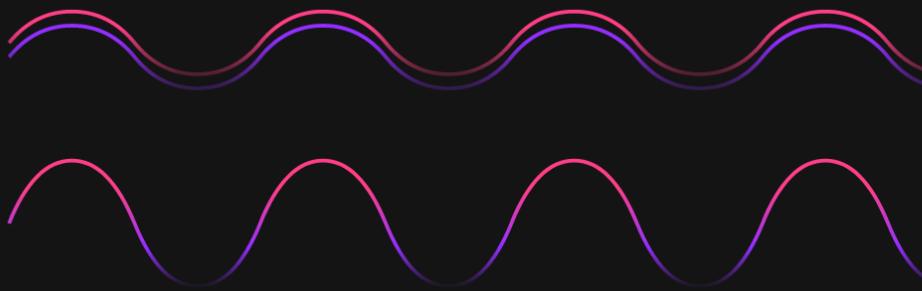
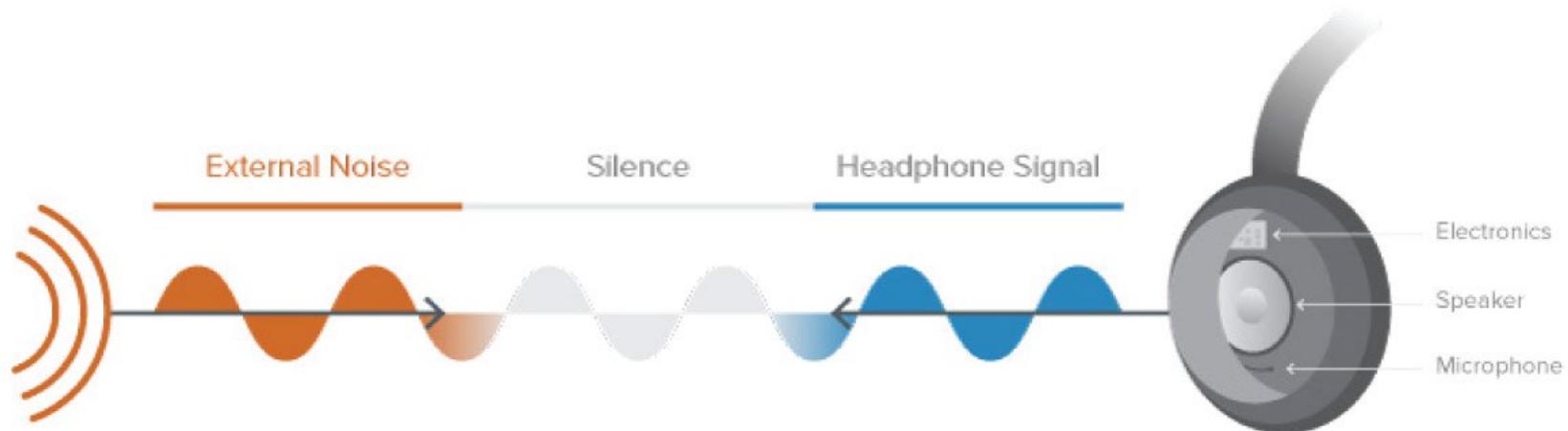
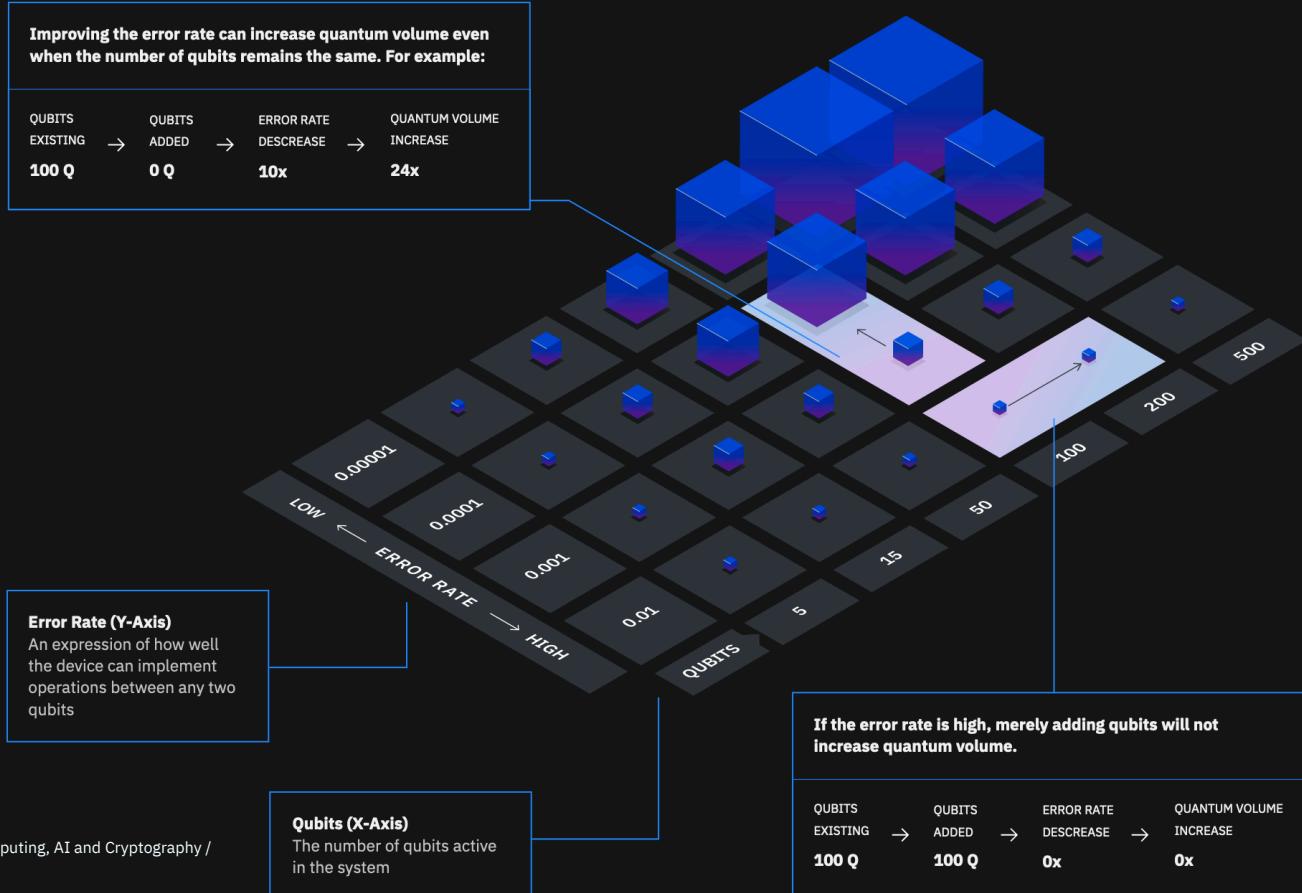


Figure 3:
Positive Interference

Noise Cancelling Headphones

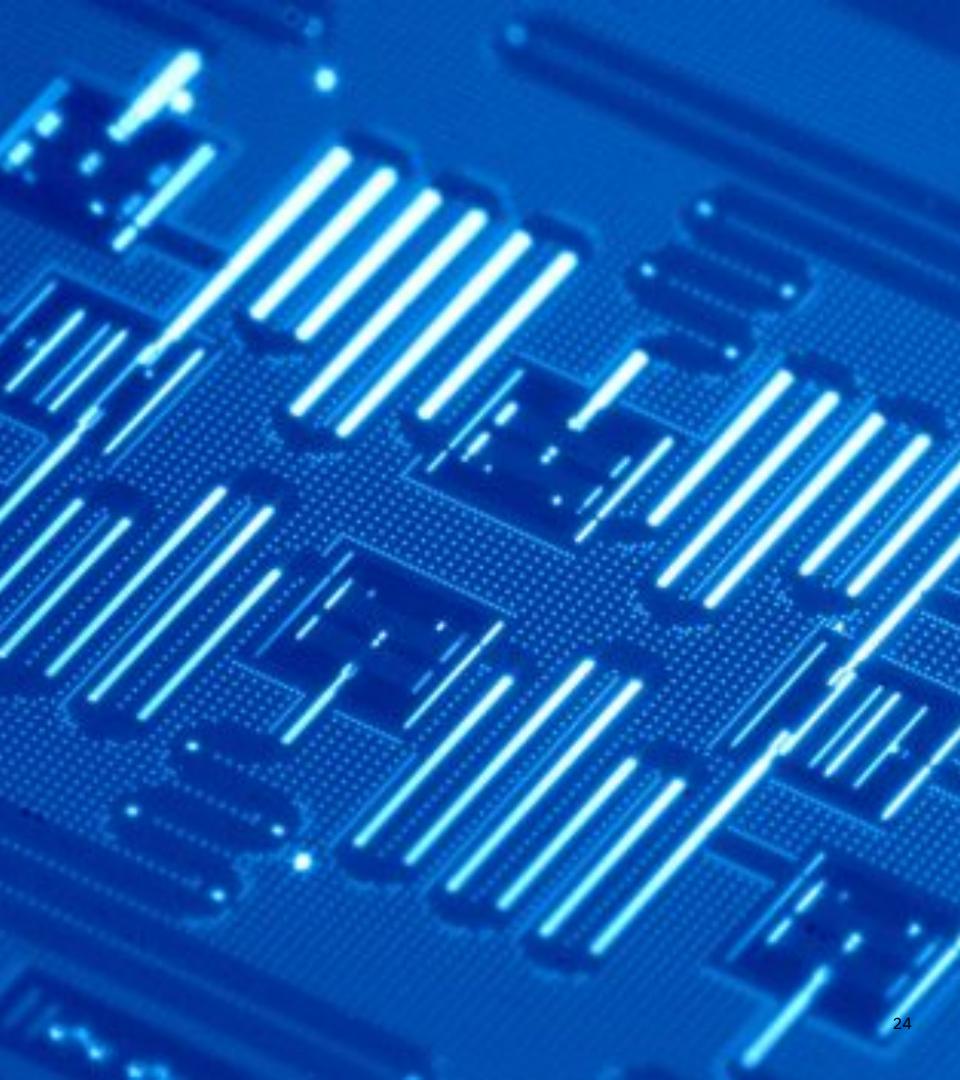


Scaling Quantum Systems



Quantum Computers Inside Out

- Superconducting Josephson Junctions
- Macroscopic Quantum Phenomena
- Microwave resonators to address and couple qubits
- Very low temperature



Quantum Computers: Inside Out

IBM Q system inside a dilution refrigerator



Quantum Computers: Inside Out



↳ Quantum Computing, Artificial Intelligence & Cryptography



AI and Crypto Influcence

Quantum and Vice Versa

AI controls quantum computers

Auantum states are extremely sensitive to constant interference from their environment. The plan is to combat this using active protection based on quantum error correction. A team has presented a quantum error correction system that is capable of learning thanks to AI.

Quantum computers breaking cryptography

Data that is being stored today using existing cryptography methods will eventually be cracked by quantum computers capable of exponentially faster computational performance. A leading candidate for quantum-safe cryptography standard lies in lattice cryptography.

AI neural networks

A team at Heriot-Watt University hope to produce a breakthrough quantum computer which leads to AI that operates at unprecedented speed, automatically making very complex decisions in a very short time

Supervised learning with quantum enhanced feature spaces

As quantum computers become more powerful, they will be able to perform feature mapping on highly complex data structures that classical computers cannot. (IBM is giving away these feature-mapping algorithms via [Qiskit Aqua](#))

Lattice Field Cryptography

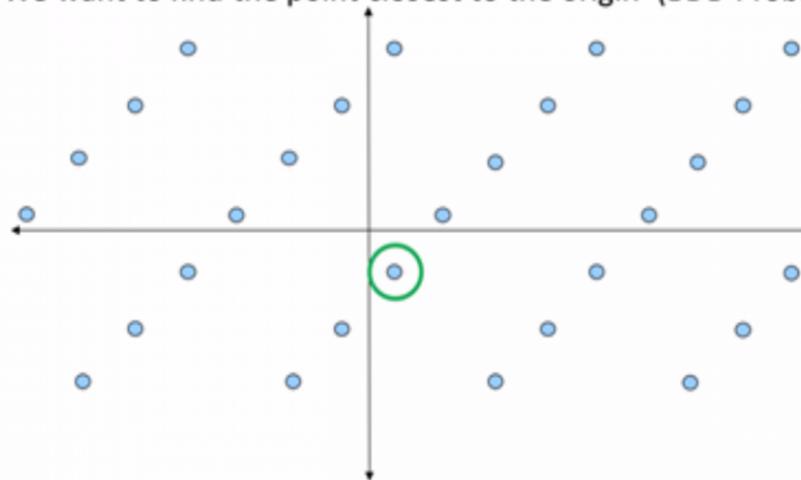
“[L]attice problems have a unique characteristic that will make it reasonably impenetrable by quantum computing. It requires solving for two unknowns – a multiplier array and an offset. [...] it is extremely difficult for quantum computing to solve the lattice problems - the shortest vector problem (SVP) and the closest vector problem (CVP) – upon which lattice cryptography is built.”

Forbes

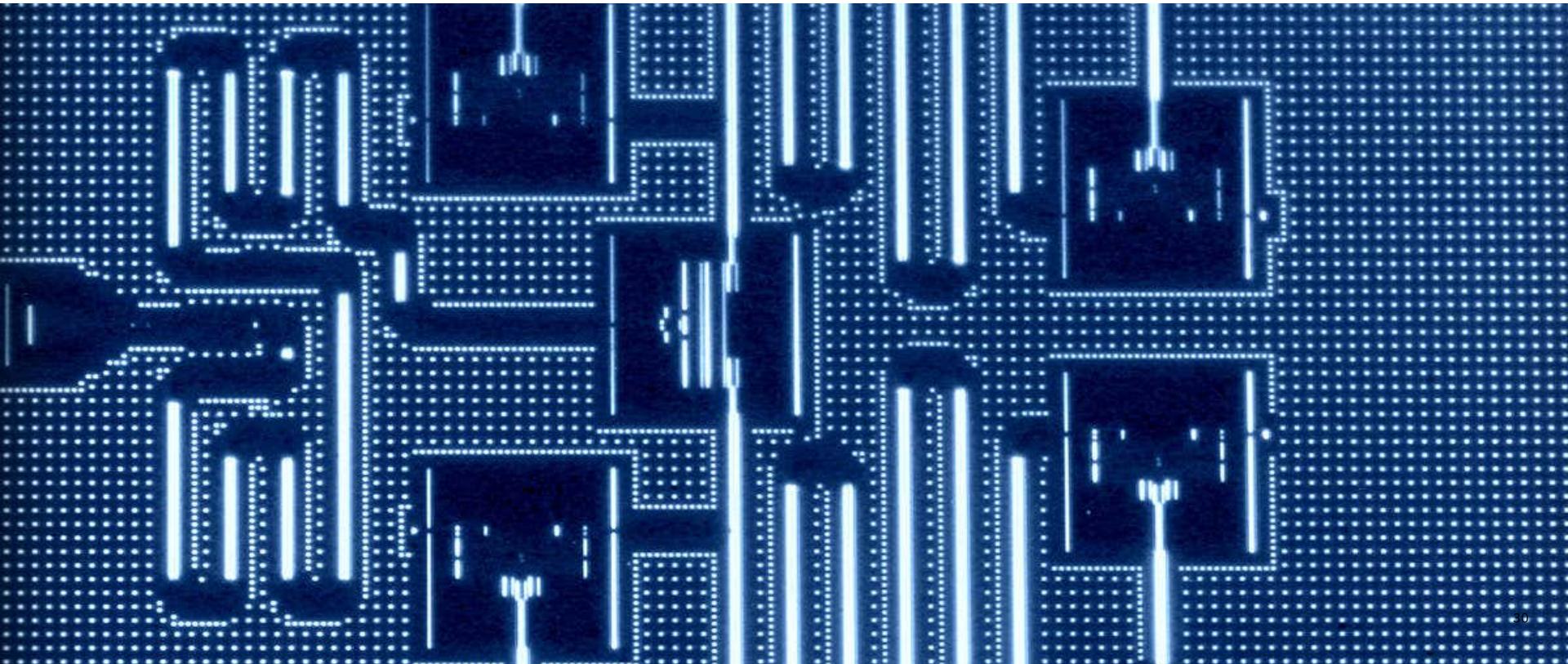
Why is this “Lattice” Crypto?

All solutions $\begin{pmatrix} \mathbf{y} \\ \mathbf{e} \end{pmatrix}$ to $\mathbf{A}\mathbf{y} + \mathbf{e} = \mathbf{z} \pmod{p}$ form a “shifted” lattice.

We want to find the point closest to the origin (BDD Problem).



↳ Let's Code a Quantum Computer



Step 0: Sign Up for IBM Cloud Account

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Step 1: Visit the Q Experience

<https://quantum-computing.ibm.com/login>

Quantum Computing Demo

“It seems probable that once the machine thinking method had started, it would not take long to outstrip our feeble powers... They would be able to converse with each other to sharpen their wits. At some stage therefore, we should have to expect the machines to take control.”

Alan Turing

Intelligent Machinery, A Heretical Theory
1951



09.09.19

SERVERLESS HANDS-ON WORKSHOP

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Organized by Angie K and 6 others



THU, AUG 1, 12:00 PM

Lunch and Learn: IBM Blockchain Platform 2.0 Internals Workshop

44 Tehama St



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