



EQUINOX

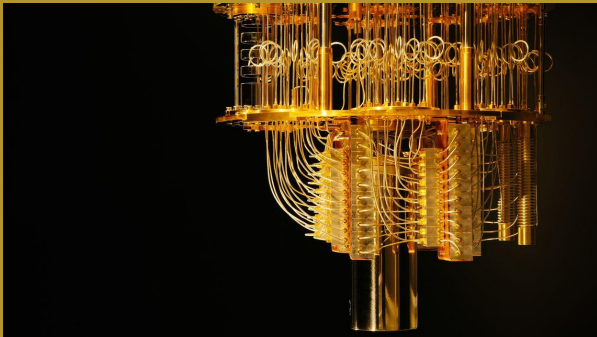
AI&DATA LAB



Business Course Structure

Introduction to QC

Thursday 4th August



What is QC?
What you should know
about QC

Applications and Big
Players

Thursday 11th August



How can QC generate
value
Which companies lead the
way

Assignment 1: Due

Quantum Strategy

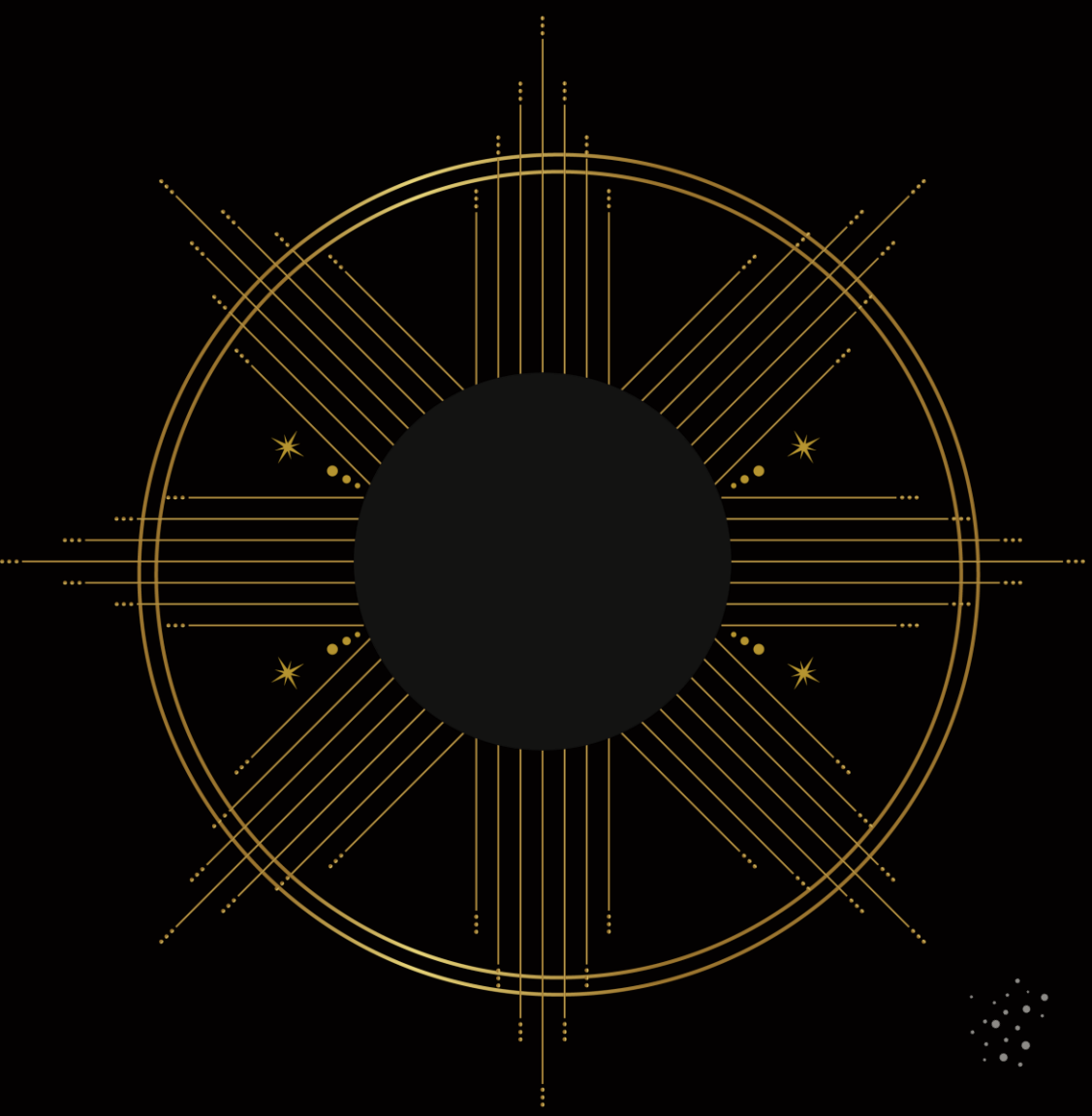
Thursday 18th August



Quantum Mindset
How can QC be integrated
Generating capabilities

Assignment 2 Due





Introduction to Quantum Computing

Bringing QC to business



Introduction to
Quantum
Computing

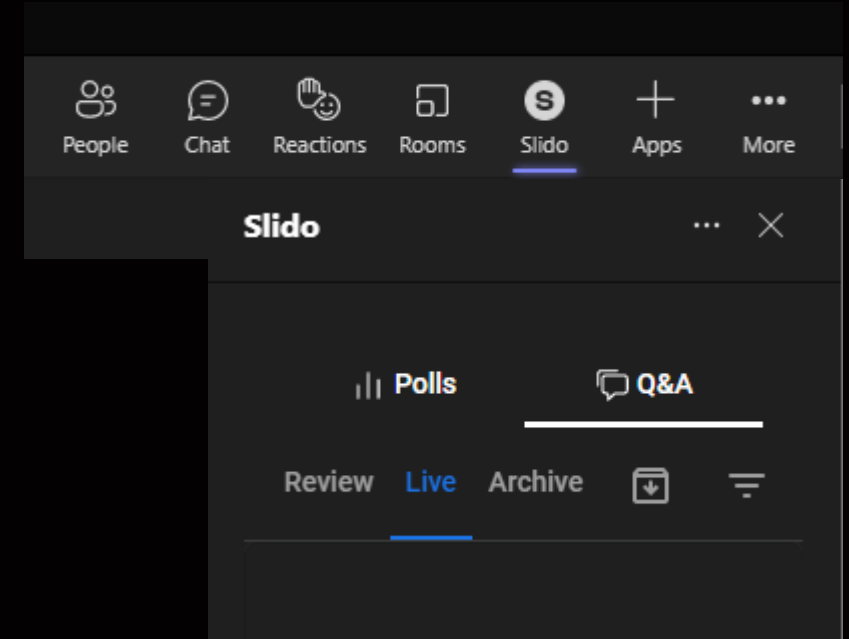
Contents

- 1.What is quantum computing
- 2.Key definitions
- 3.How to learn more



QnA

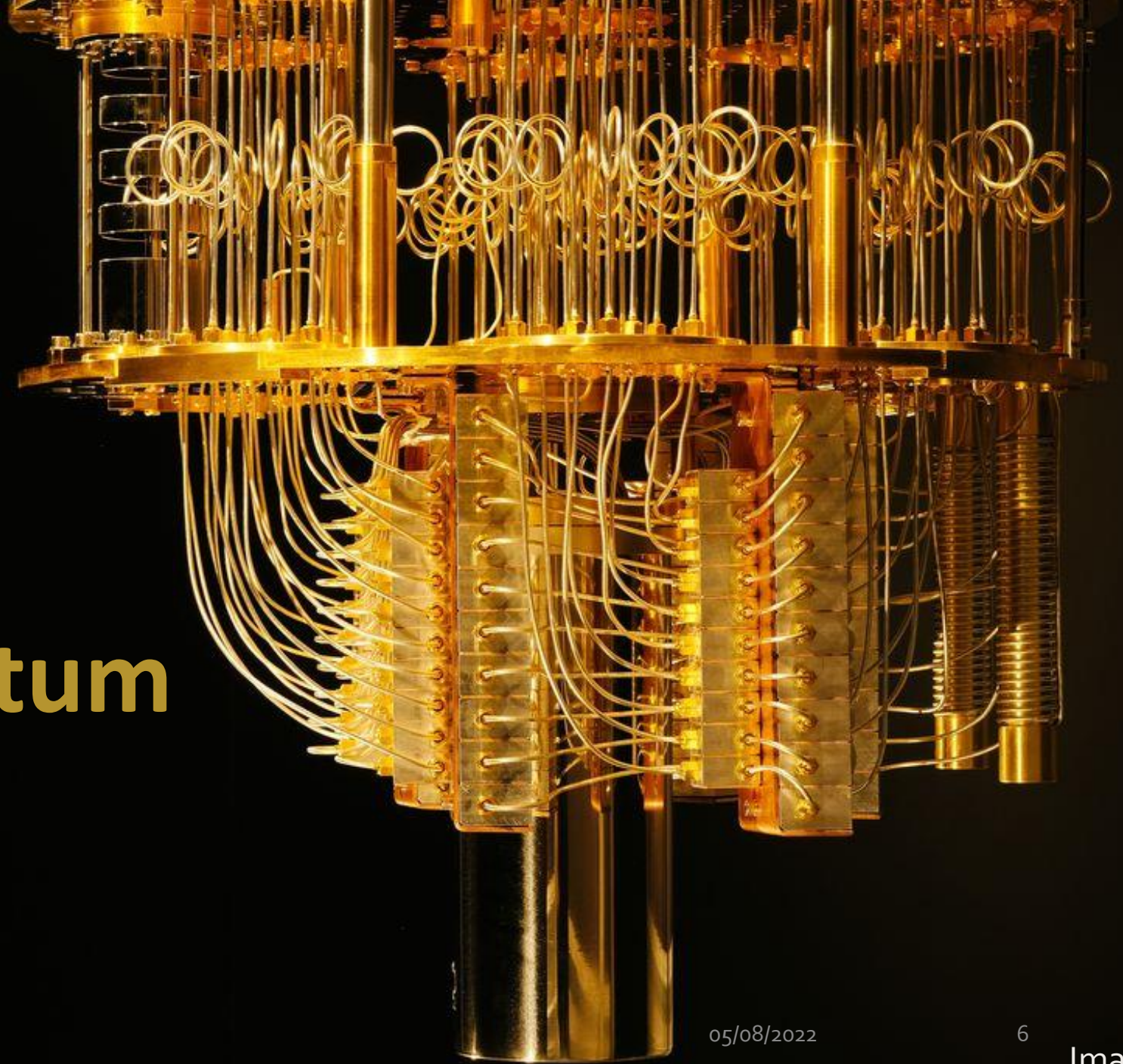
- We use Slido for Q&As and polls
- Teams app users can see Slido at the bottom of the meeting
- Web users can go to slido.com and enter the number **#2835880**



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What is Quantum Computing?



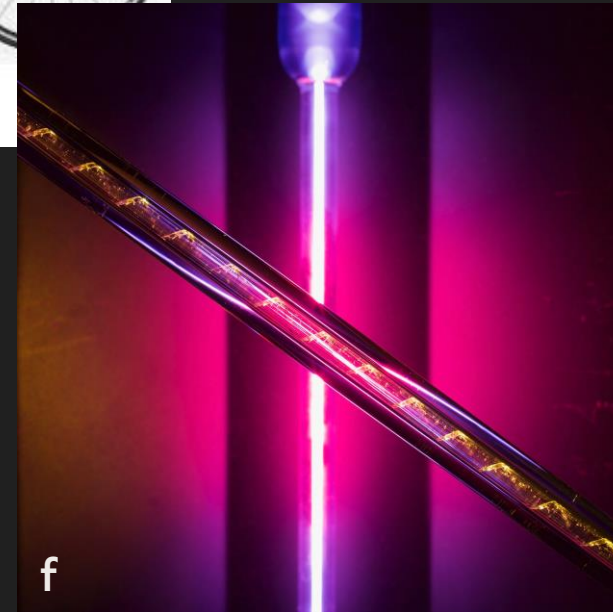
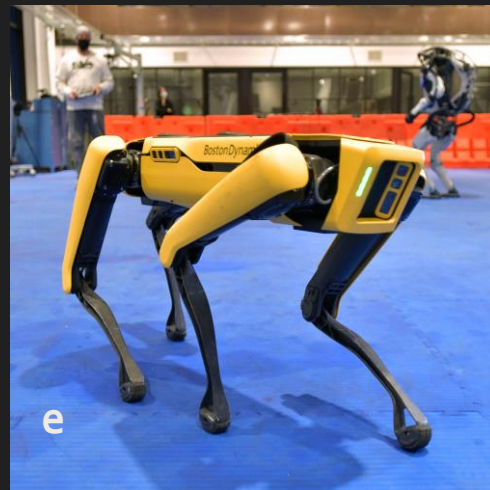
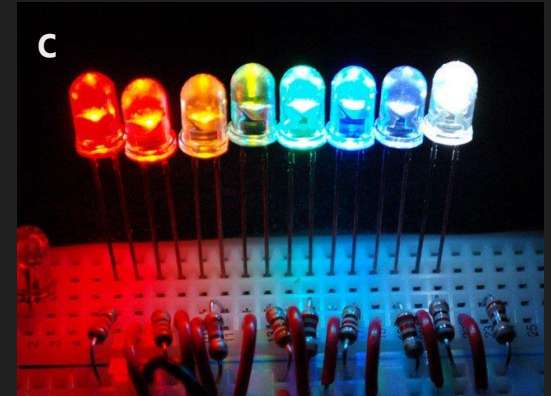
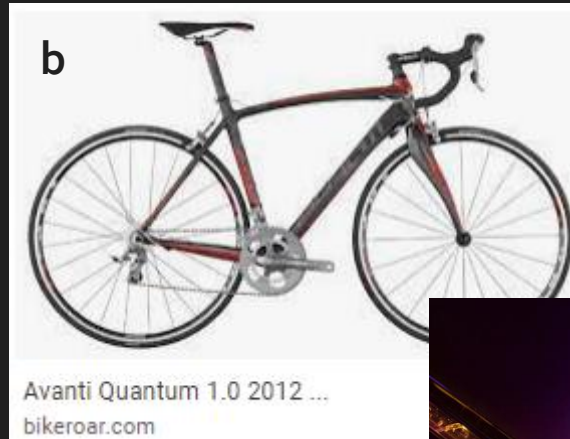
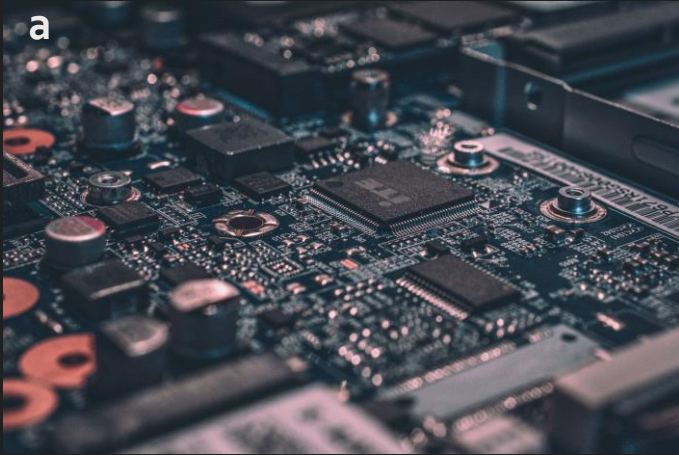
05/08/2022

6

Image: IBM

Which of these are quantum?

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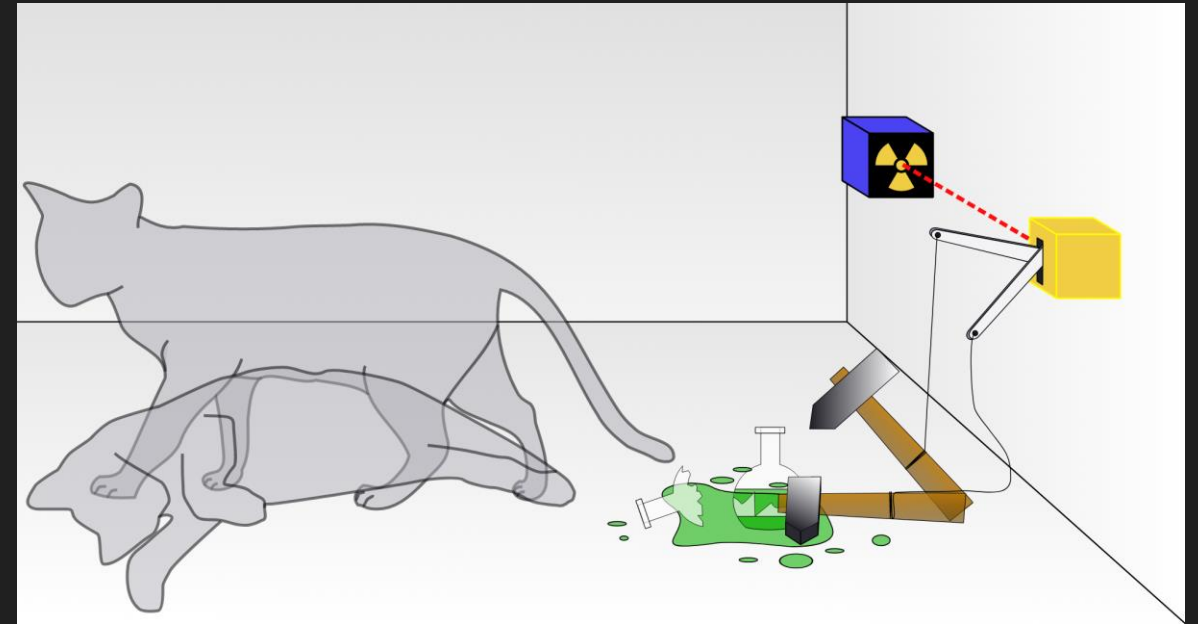
ORCA Computing
orcacomputing.com



How is quantum?



Number of coins	1	2	3	4	5	n
# possible combinations	2	4	8	16	32	2^n



Superposition

How is quantum?



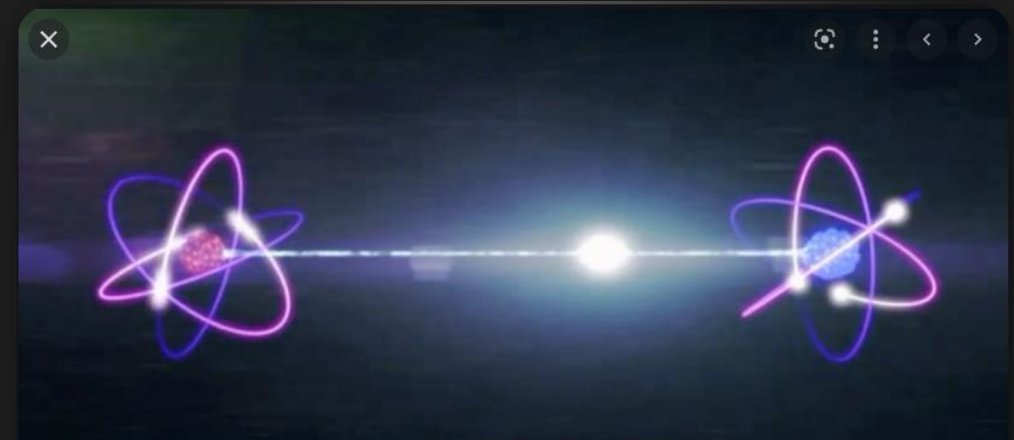
EINSTEIN ATTACKS QUANTUM THEORY

Scientist and Two Colleagues
Find It Is Not 'Complete'
Even Though 'Correct.'

SEE FULLER ONE POSSIBLE

Believe a Whole Description of
'the Physical Reality' Can Be
Provided Eventually.

Entanglement



UMass Blogs

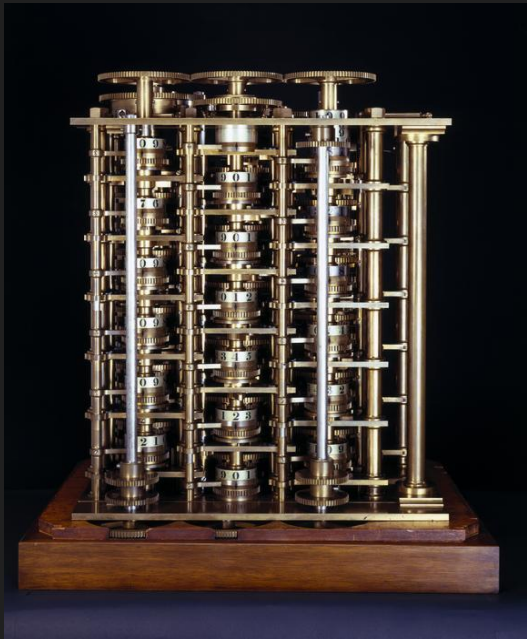
Disproving Einstein: the Phenomenon of Quantum Entanglement and Implications of Quantum Computing –
Techbytes

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Visit



How do Computers Work?

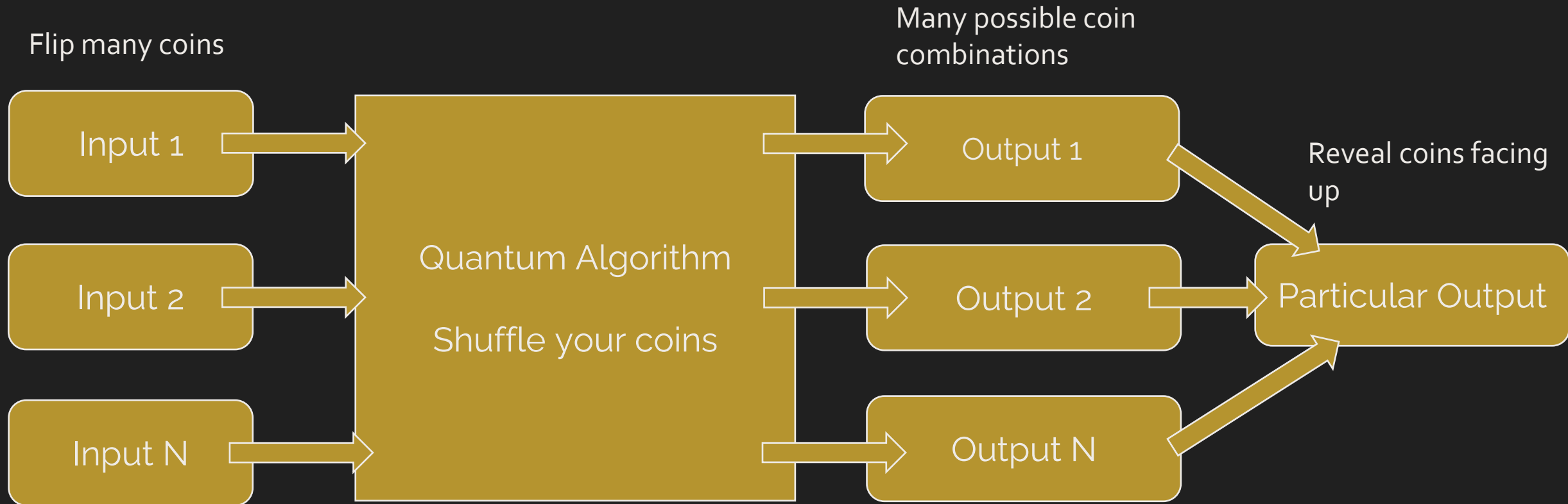


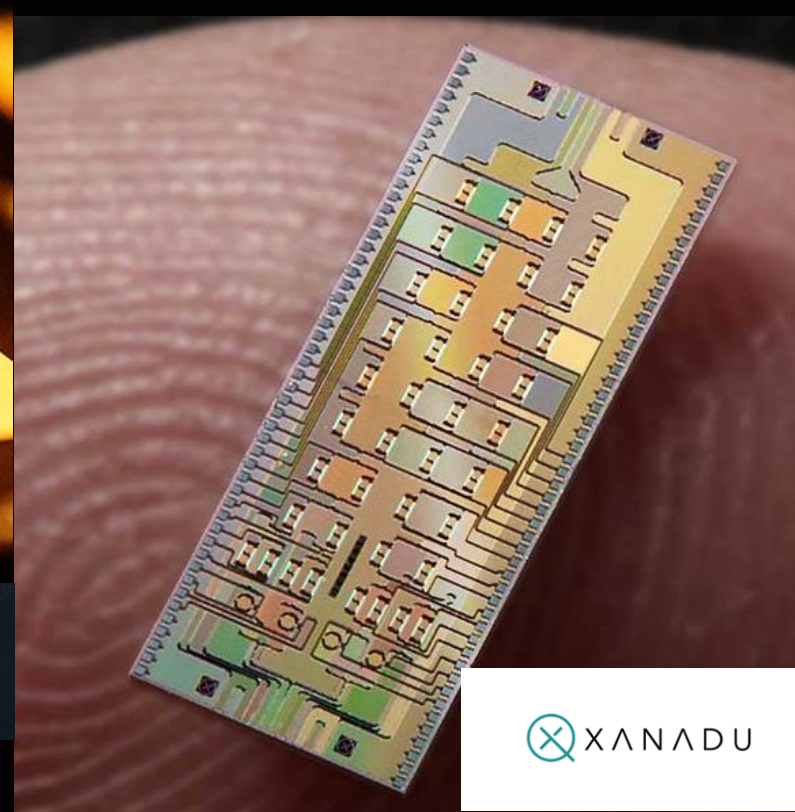
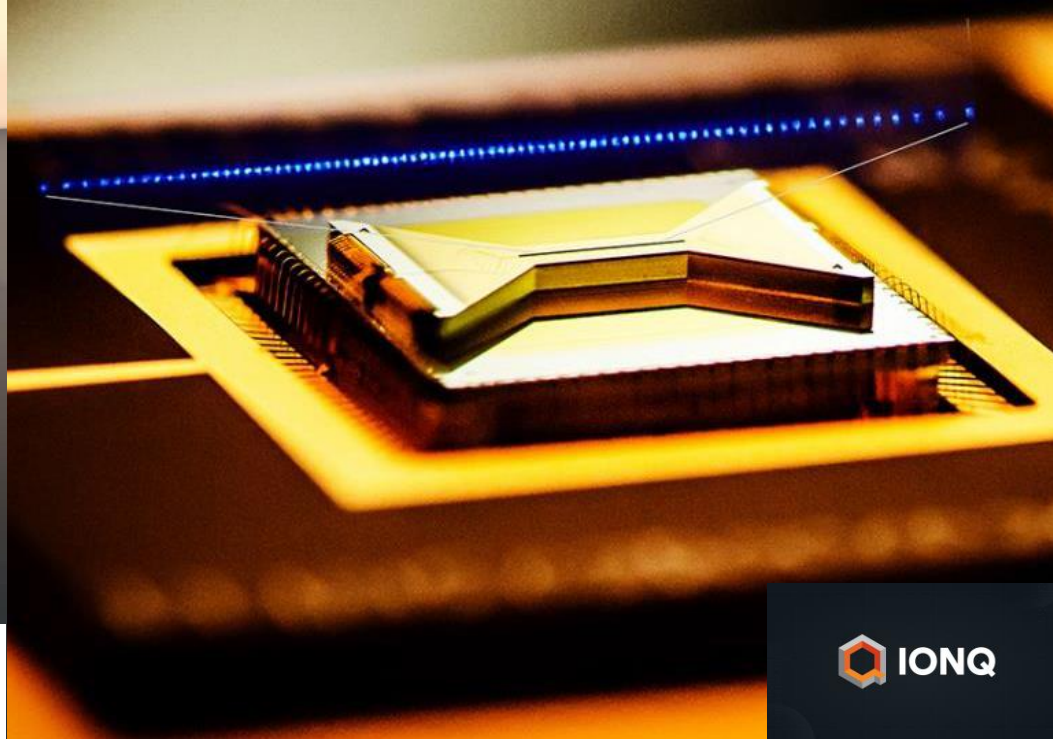
Babbage Difference
Engine 1822



IBM Summit 2018c

How Quantum Computers Work





Quantum computers today



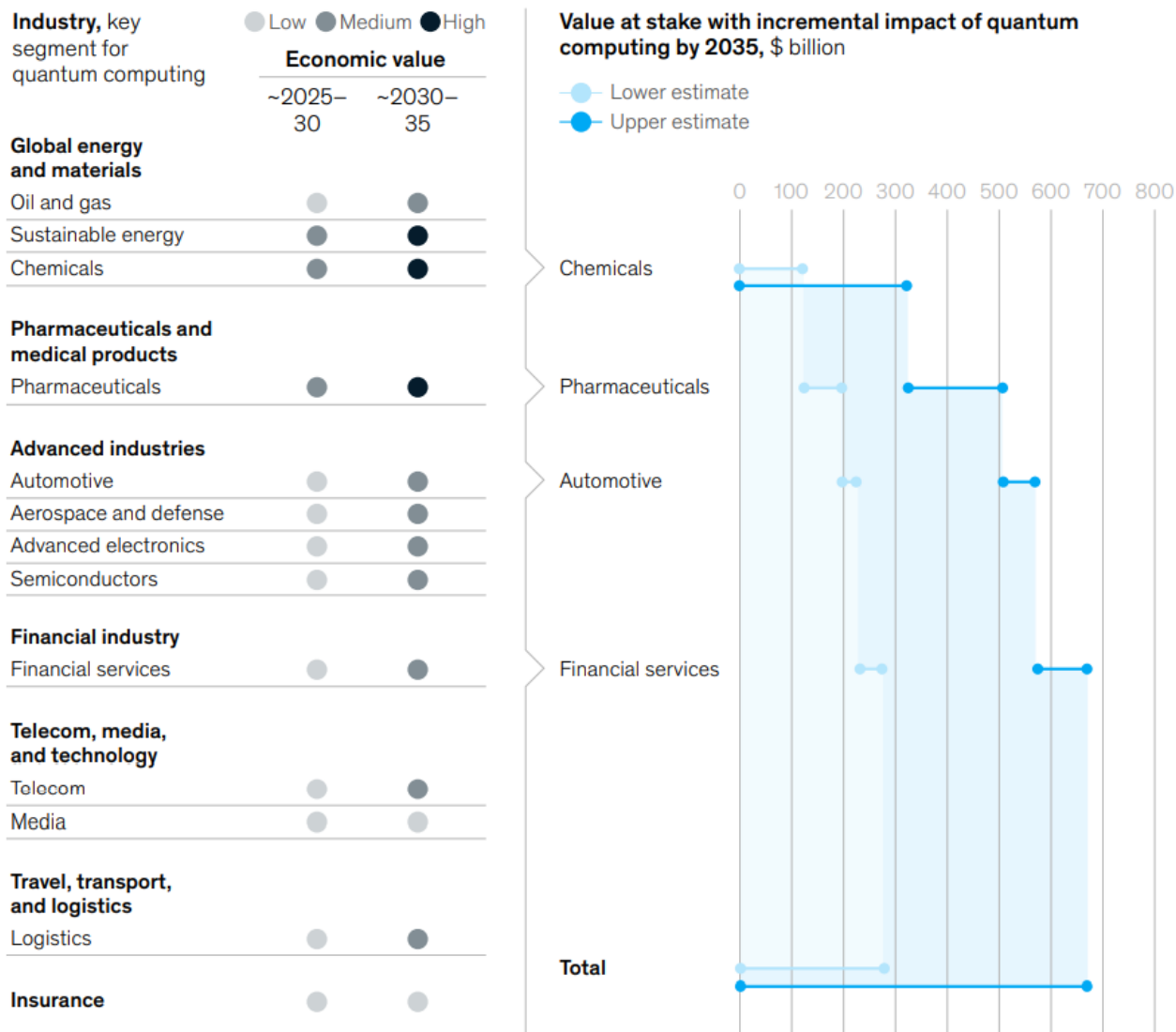
Why the excitement around QC?

- Potential to impact many industries
- Numerous reports estimate value generation in the hundreds of billions
- Implications for national security

Source: McKinsey & Company: Quantum computing: An emerging ecosystem and industry use cases, December 2021

Exhibit 6

Conservatively, we estimate that the value at stake in pharmaceuticals, chemicals, automotive, and finance use cases could be up to nearly \$700 billion.



Note: Viability and value of use cases is uncertain due to the immaturity of quantum-computing technology and the industry; given that business-value estimates are speculative and on the conservative side, they are intended to guide research toward areas of quantum applications with a high value potential, rather than to serve as definitive projections for business value.

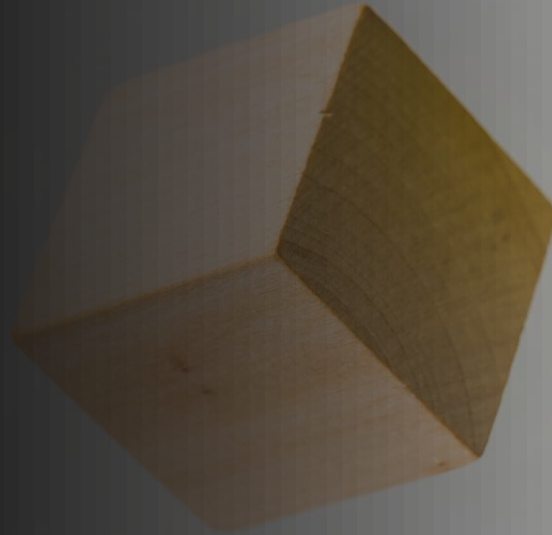
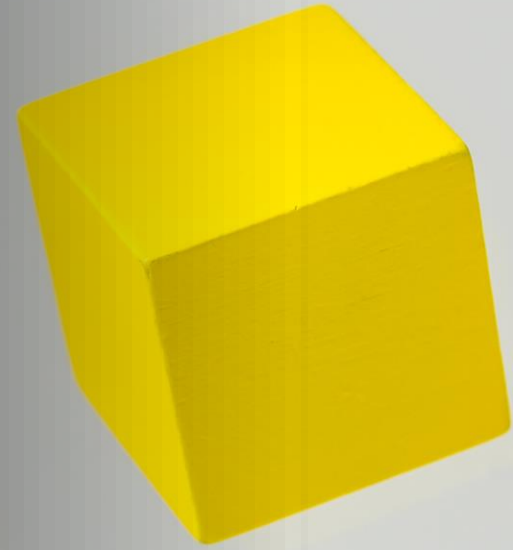
Quantum Computing Myths

- Not faster versions of normal computers
- Not smaller versions of normal computers
- Consumers won't buy one
- Not going to replace normal computers
- Do not require a PhD in physics or computer science to use





Key Definitions



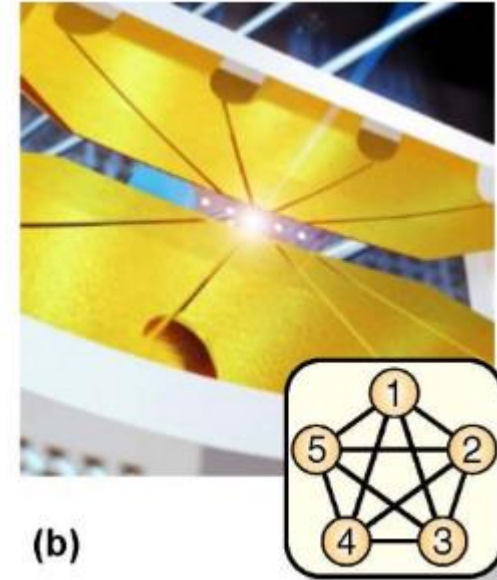
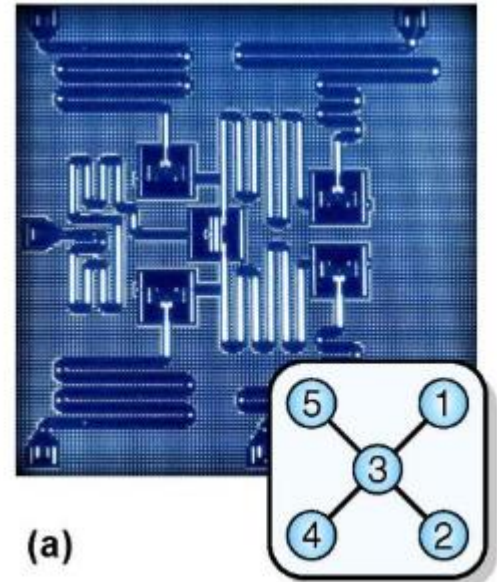
Quantum Advantage



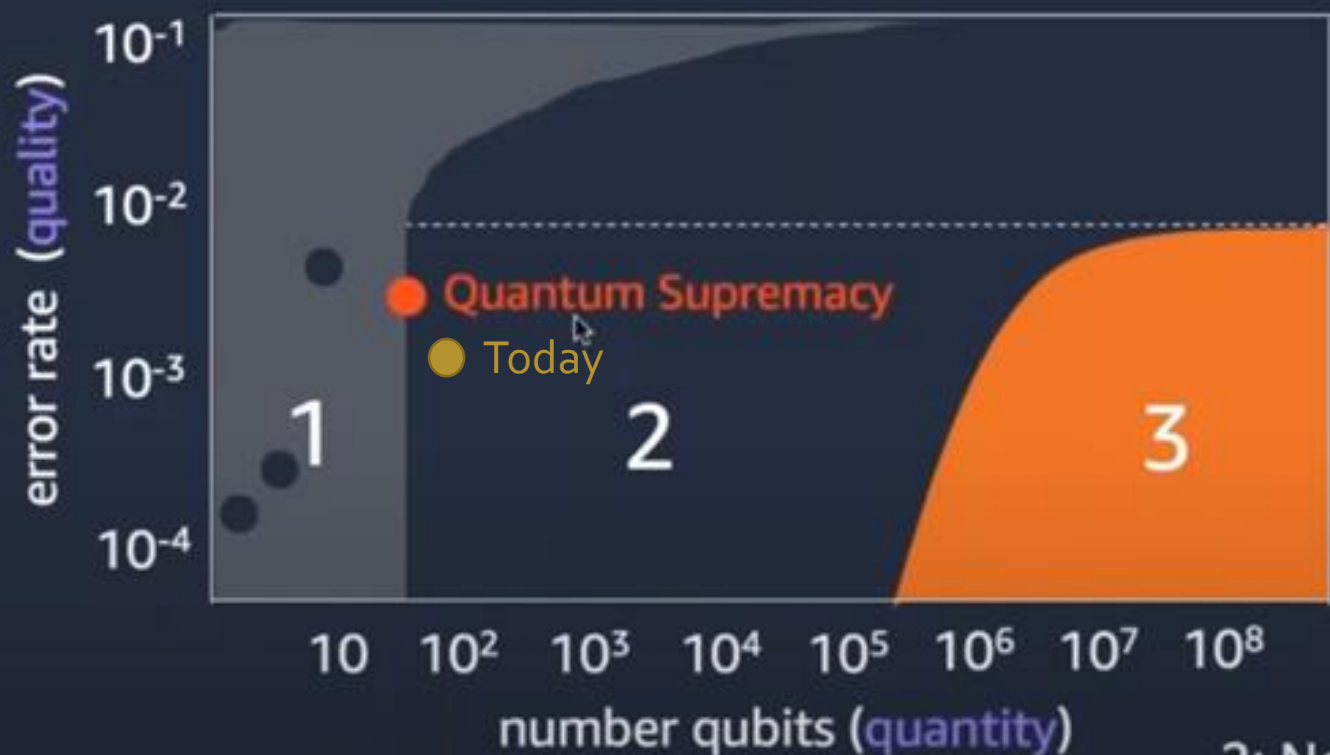
- Faster, more accurate or cheaper than the best classical alternative
- No universal definition of quantum advantage
- Application dependent
- Classical HPC/AI raise the bar each year

Qubit

- The qubit is the smallest unit of a quantum computer
- Each qubit is a controlled quantum state
- **Physical qubit:** Today's qubits are physical qubits: irreducible quantum systems that can carry out computation
- **Logical qubits:** Combining many physical qubits to produce higher quality logical qubits that can perform computations with much higher accuracy



QC Now vs the Future



1: Classically simulatable

2: Noisy Intermediate-Scale Quantum (NISQ)

3: Quantum Computing with error correction

Fault Tolerant QC



- **Fault-Tolerant** qubits with error correction that can carry out all quantum algorithms
- Associated with million (physical) qubit machines
- Optimistic outlook: could be achieved by 2030
- Sometimes called “Fairy Tale” QC from pessimistic NISQ people

Marketing speak

- **Quantum inspired:** Classical computing algorithms developed using ideas from quantum computing
- **Quantum as a Service (QaaS):** Access to QC over the cloud, key component of our strategy
- Sometimes people use the same terms with different meanings- ask to clarify how the algorithm works to confirm their meaning


Quantum Supremacy

- QC can carry out computation that the most powerful supercomputer can't do in a reasonable time
- Google claimed to have achieved this in 2019 (IBM contested this)
- Recently this term has fallen out of popularity

[nature](#) > [articles](#) > article

Article | [Published: 23 October 2019](#)

Quantum supremacy using a programmable superconducting processor

[Frank Arute](#), [Kunal Arya](#), ... [John M. Martinis](#) 

[+ Show authors](#)

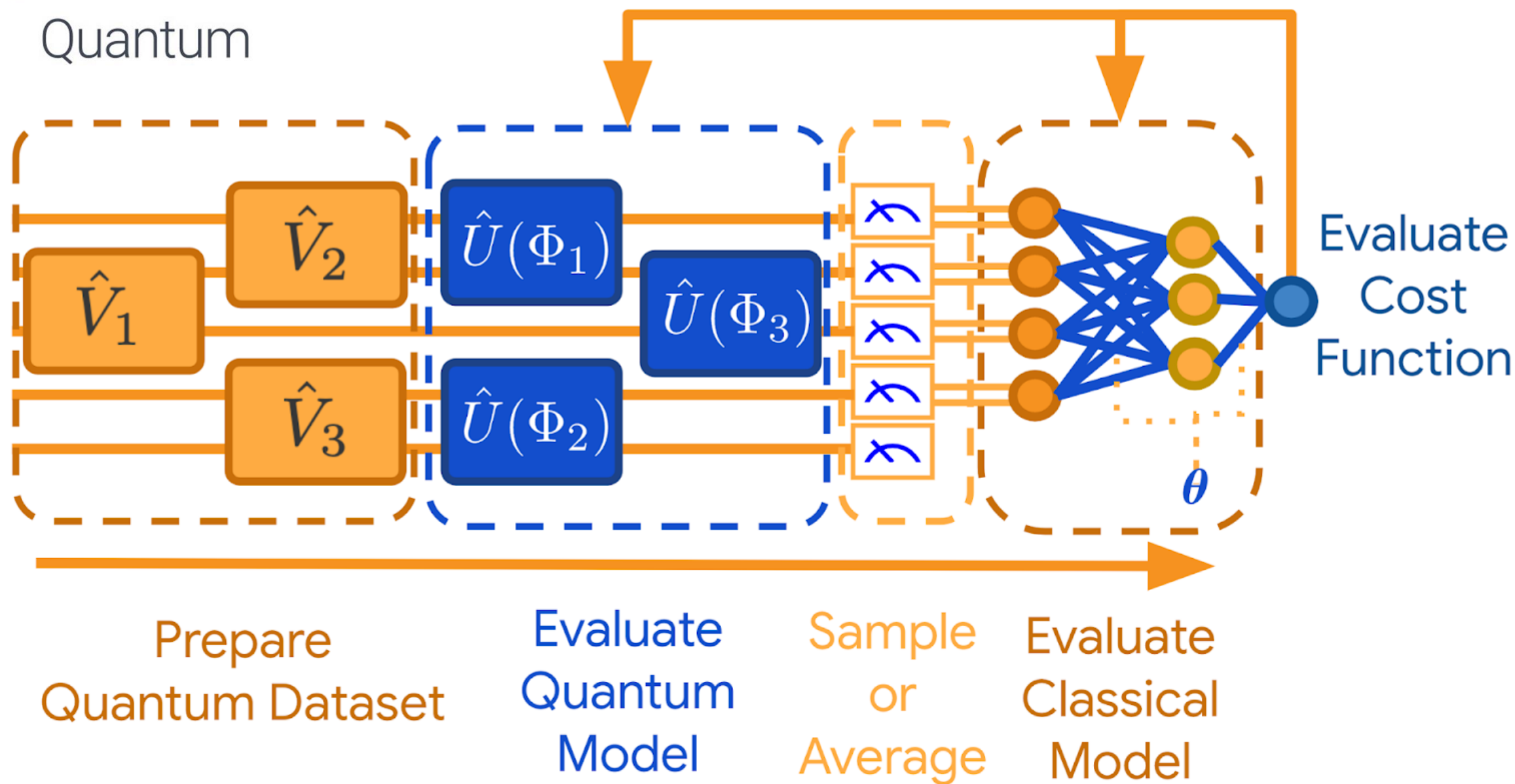
[Nature](#) **574**, 505–510 (2019) | [Cite this article](#)

902k Accesses | **1825** Citations | **6174** Altmetric | [Metrics](#)

Quantum Machine Learning

- Integration of classical ML models with QC
- One of the most exciting, and uncertain applications of QC
- There is no proven, or demonstrated, significant advantage to using QC for ML
- Boston Consulting group estimated that quantum machine learning could offer \$150-220 bn of value creation

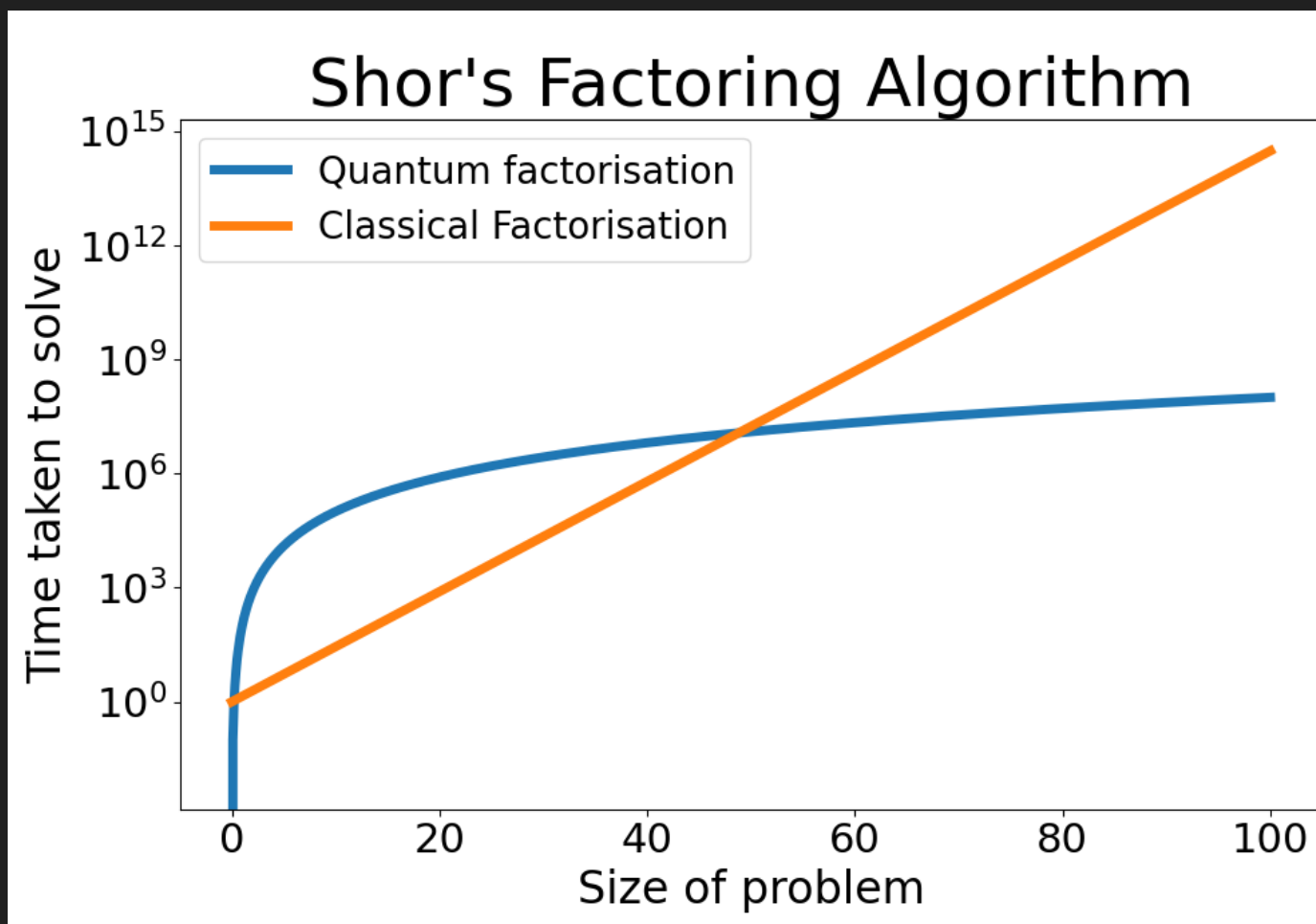




Shor's Algorithm



Credit: Ars Technica

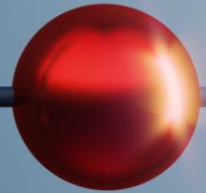


- 4,100 logical qubits could break current 2048-bit RSA



How to learn more

Engaging with the quantum ecosystem



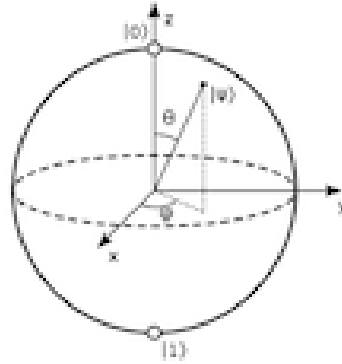
Quantum Latino

“ bringing together researchers, entrepreneurs, start-ups, and industry collaborators to participate, learn, exchange ideas, connect, network, and grow, to be part of an ever-growing quantum community in Latin-America”



Good sources for news

Quantum Computing Report
Where Qubits Entangle with Commerce



QUANTUM PIRATES

QUANTUM COMPUTING CURATED NEWS

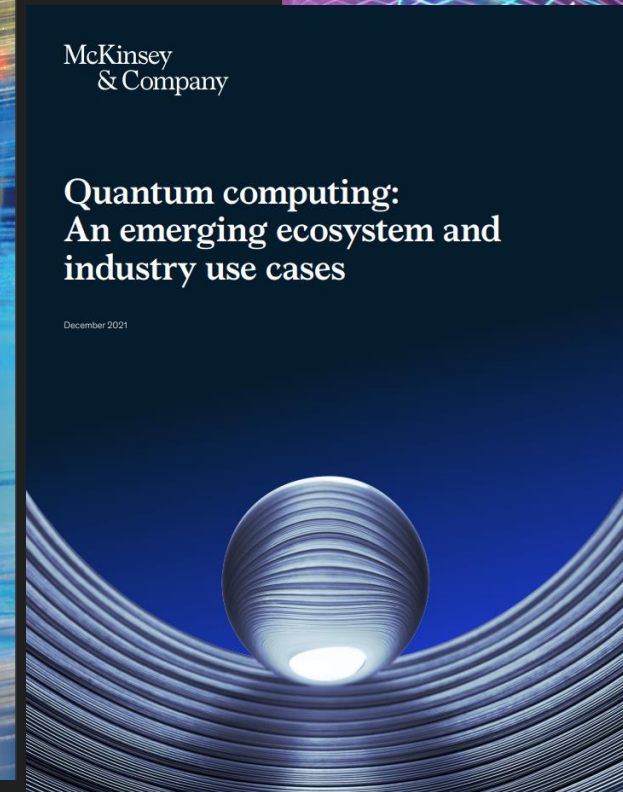
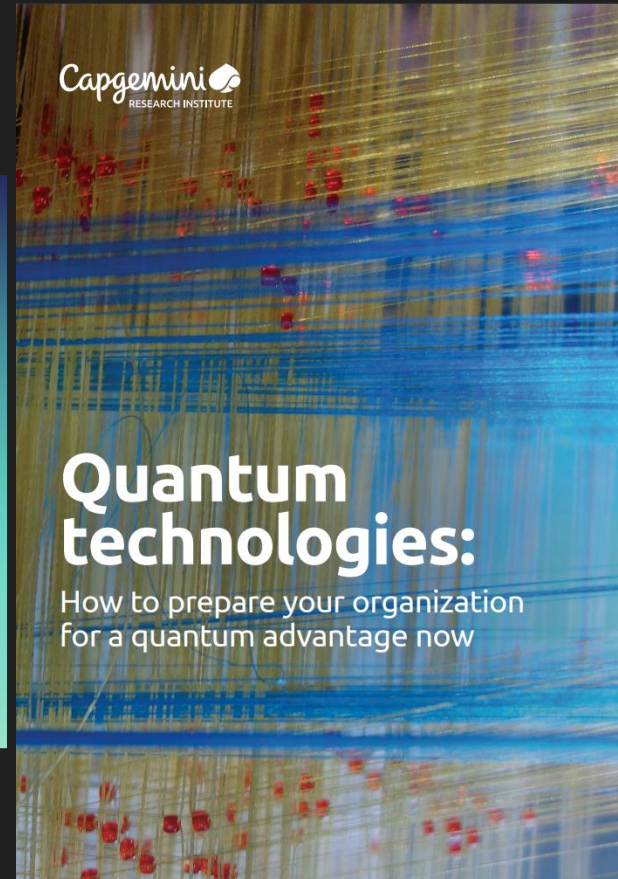


THE
QUANTUM
INSIDER



Reports

Accenture, Capgemini & BCG have published free reports on Quantum Computing



What Happens When 'If' Turns to 'When' in Quantum Computing?

July 2021
By Jean-François Bobier, Matt Langione,
Edward Tao, and Antoine Gourevitch



Podcasts



PODCAST

Noisy Intermediate-Scale Podcast

Michał Stęchły



PODCAST

The Quantum Pod

Zapata Computing



PODCAST

The Qubit Guy's Podcast

Yuval Boger (a.k.a. The Qubit Guy)



PODCAST

The Post-Quantum World

Protiviti

Summary

- The content covered today should make press releases, LinkedIn posts and marketing material more comprehensible
- References to the broader quantum ecosystem to help keep up-to-date with developments
- Next time: What are the applications of QC and who are the big players

Assignment 1 [Due 11th August]

Choose one of these articles, or another of your choice.

- [Nvidia announces quantum programming platform](#)
- [IonQ Hyundai collaboration](#)
- [Multiverse Computing Digital Twin Initiative with Bosch Group](#)
- [Quantum Data Centre of the Future Project](#)

Additional sources:

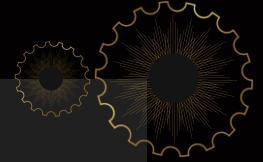
Choose one of your own from:

[The Quantum Insider](#)
[Quantum Pirates](#)
[Quantum Computing Report](#)

1. What is the technology? (for example is it an algorithm, a new hardware development...)
2. Which industry(ies) are likely to be directly affected?
3. Why is it exciting?
4. How does it fit with established technologies/future technologies?
5. [Challenge] Consider one limitation of the technology or potential barrier to scalability/commercialisation

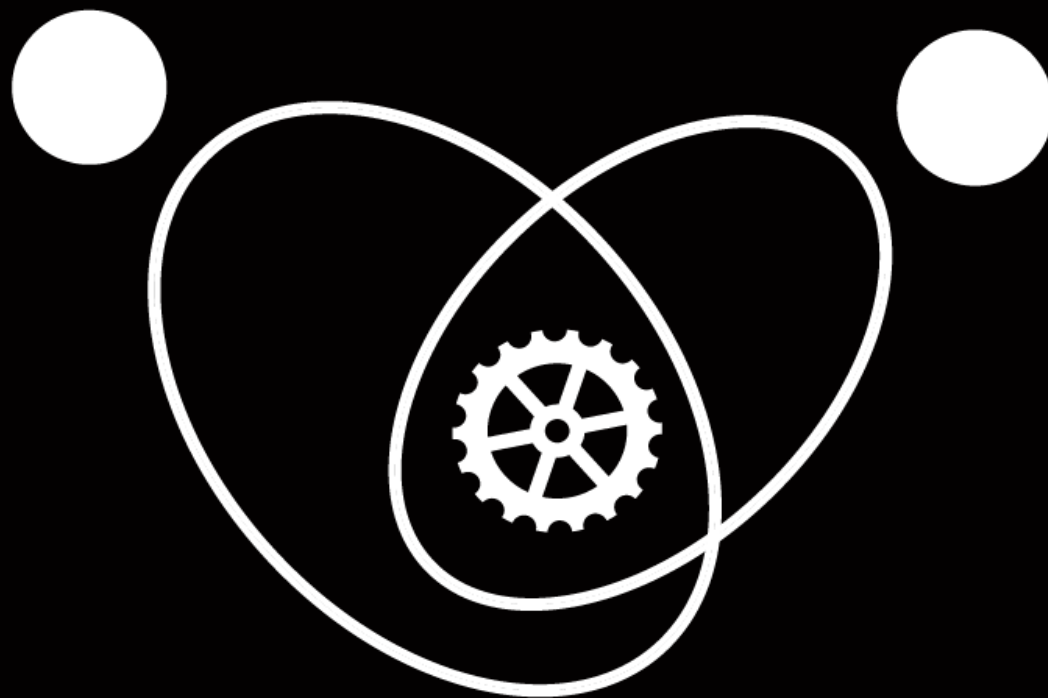


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