The Quantum Decade

A playbook for achieving awareness, readiness, and advantage

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What’s in the book

Foreword

Introduction

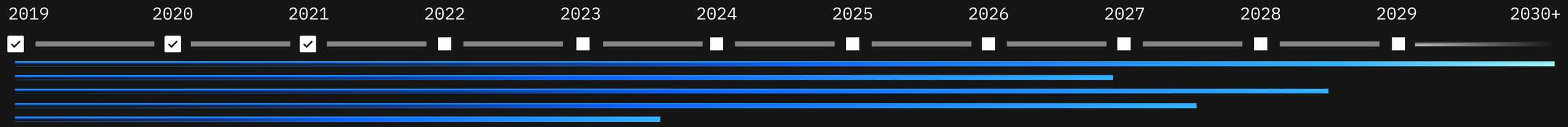
Chapter One: Quantum awareness and the age of discovery

Chapter Two: Quantum readiness and the power of experimentation

Chapter Three: Quantum Advantage and the quest for business value

Industry Guides:

Airlines
Banking and financial markets
Chemicals and petroleum
Healthcare
Life sciences



The Quantum Decade

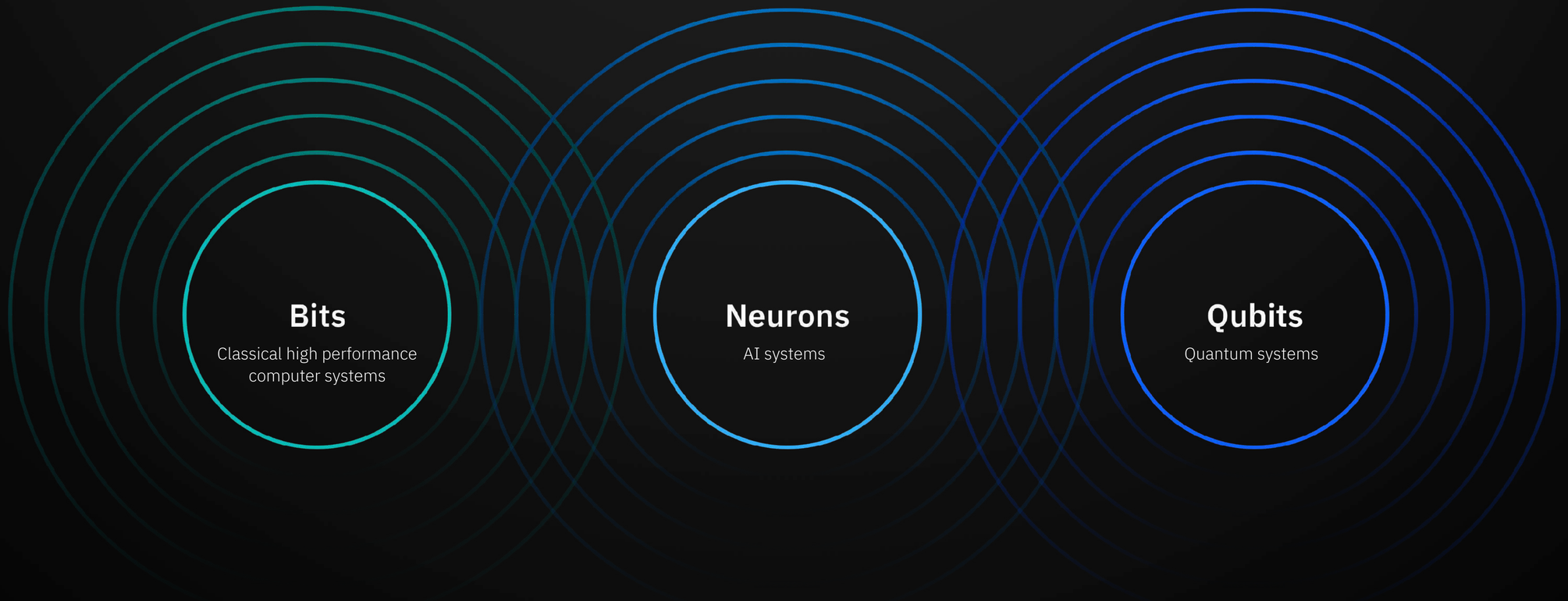
There is a closing window to become quantum-ready and prepare to capitalize on new innovations that quantum computing will make possible.

We are in the Quantum Decade, and as we accelerate the pace of discovery, enterprises of all kinds need to pay close attention.

Quantum computing completes a trinity of technologies

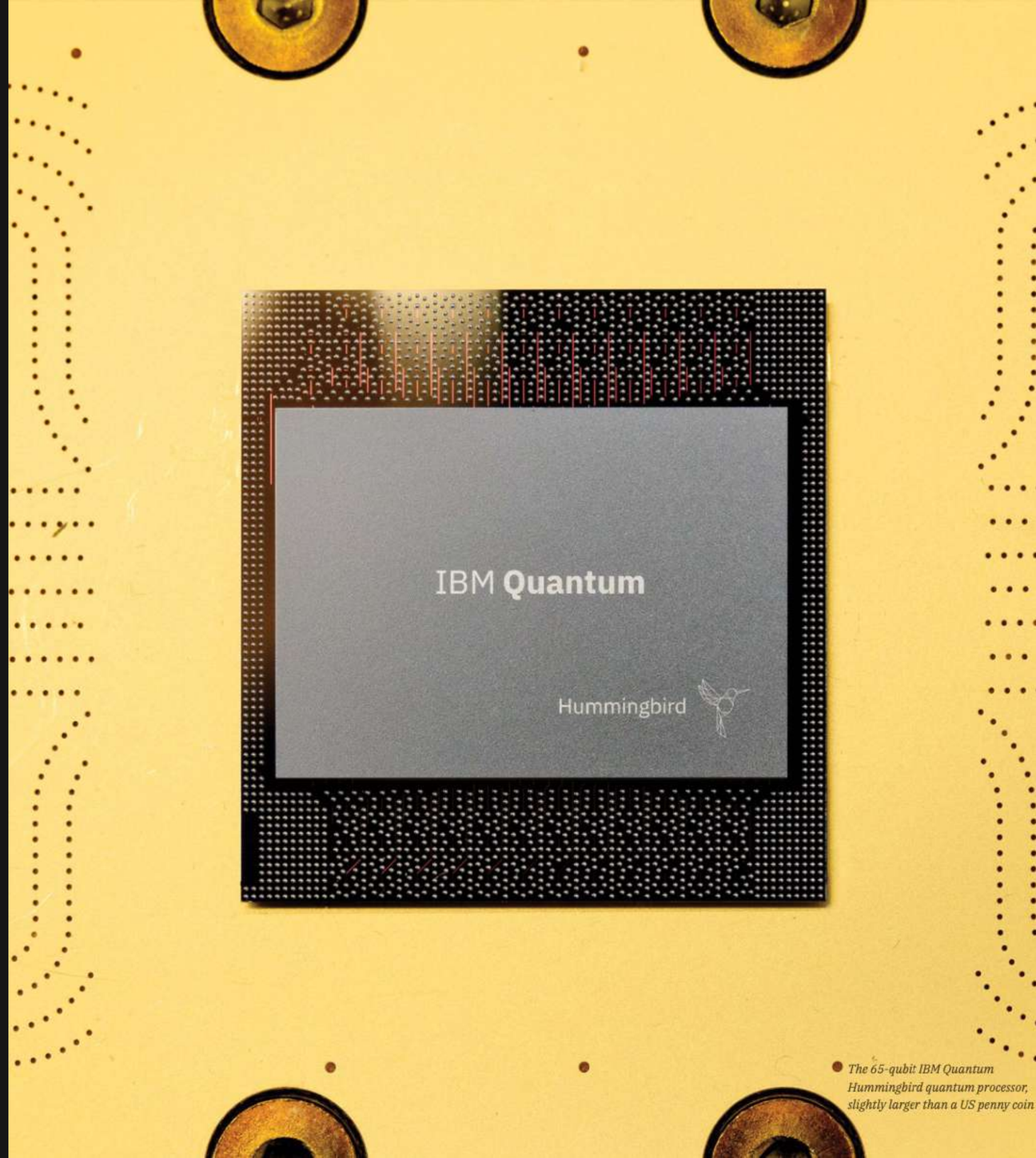
IBM **Quantum**

The synergies created by this triad, not quantum computing alone, are driving the future of computing.



Chapter One: Awareness

Computing paradigm evolving from an age of analytics to an age of discovery



The 65-qubit IBM Quantum Hummingbird quantum processor, slightly larger than a US penny coin

“The materials discovery process is unbearably slow. Companies don’t have time to experiment endlessly.

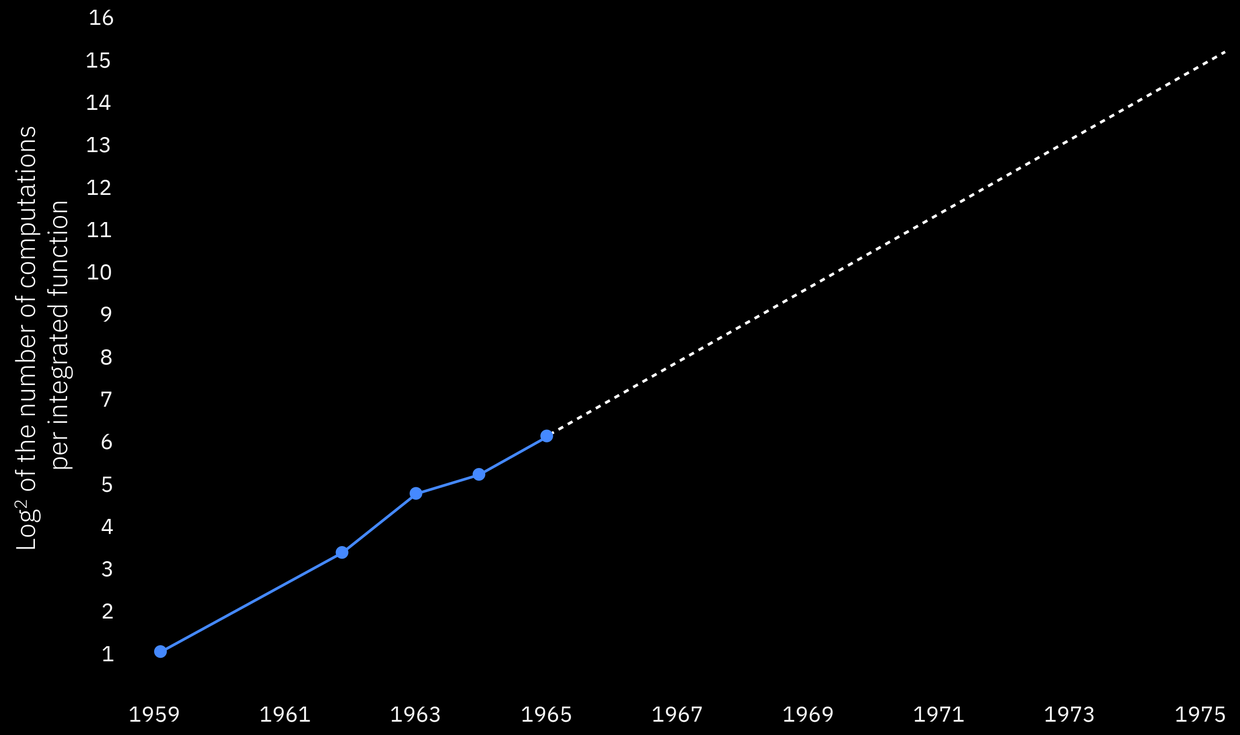
Quantum computing can give us an exponential leap in discovery.”

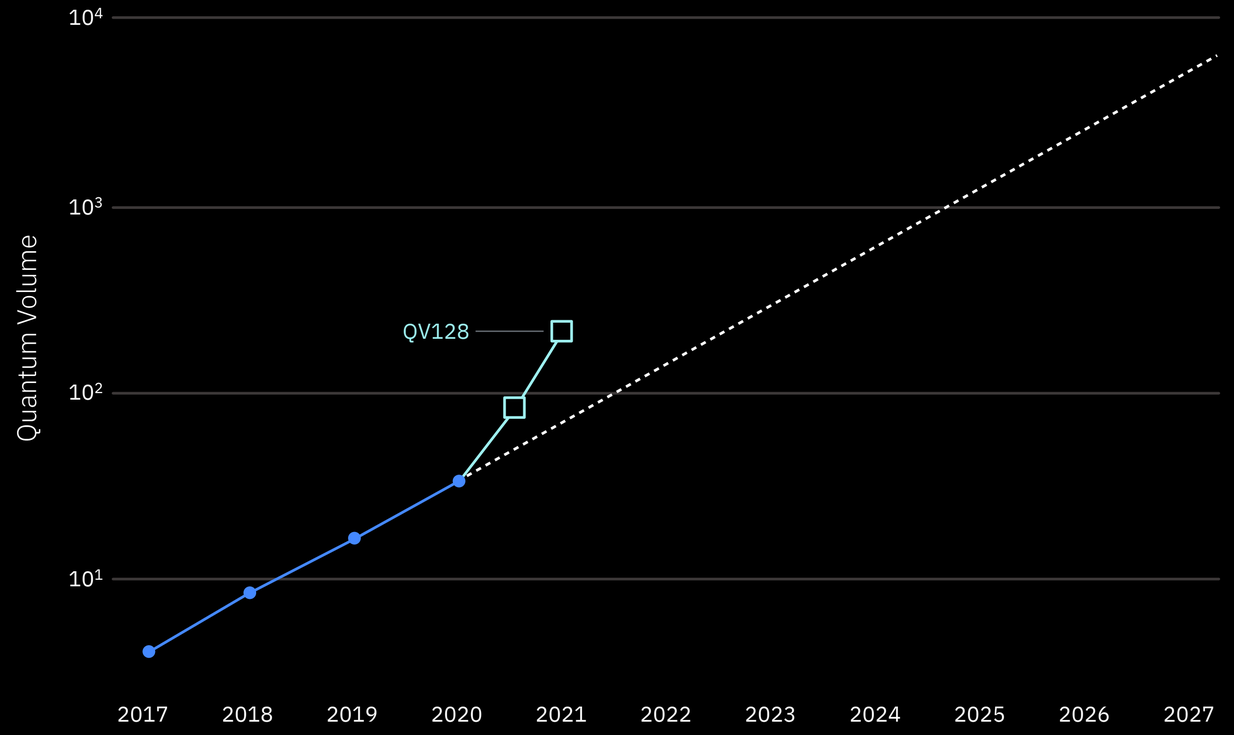
Doug Kushnerick

formerly with Technology Scouting and Ventures ExxonMobil Research and Engineering

“Moore’s Law is coming to an end and classical computing is reaching its limits just as our demand is starting to surge.”

Richard Debney
Vice President, Digital Technology : BP





Quantum computing can *help expedite solutions to complex computational problems* that face business and society.

What makes this the Quantum Decade?

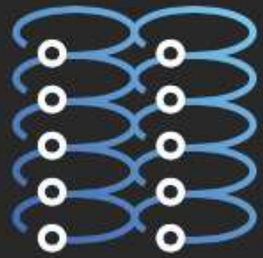
Mounting pressure to solve exponential problems

Discovery of new materials

Managing complex financial risk

Re-engineering supply chains for resilience

Quantum technology at a tipping point

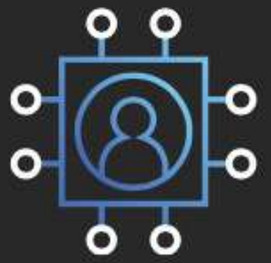


Hardware scaling from 127 qubits in 2021 to 1,000 qubits in 2023

Software developments for frictionless quantum computing

Algorithmic improvements and greater circuit quality, capacity, and variety

Quantum ecosystems scaling



Open innovation fosters collaborative learning

Users trained to apply quantum computing to real-world problems

>2 billion circuits on IBM Quantum Services per day

“CEOs of Fortune 500 companies have a once-in-a-lifetime opportunity. They cannot afford to play catch-up.

It’s time to break tradition and educate themselves about what quantum computing can do for them.”

Ilyas Khan

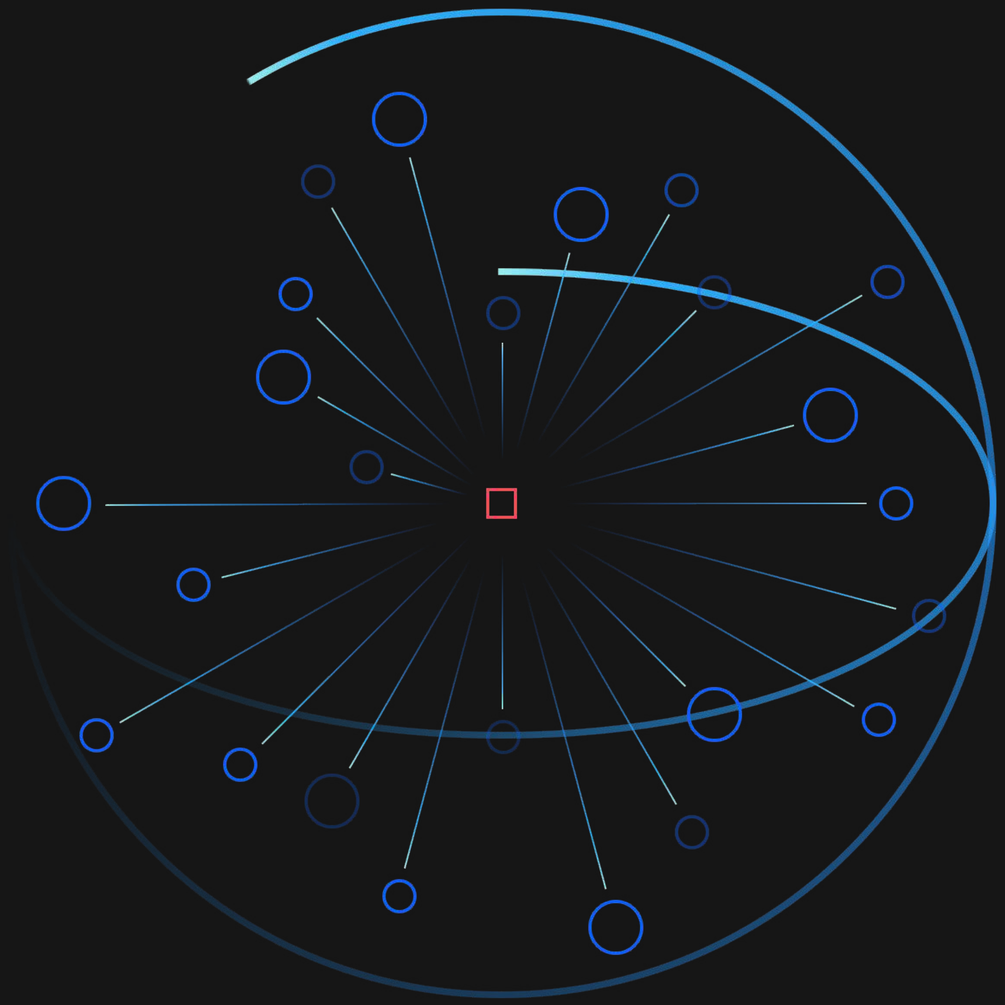
Founder and CEO
Cambridge Quantum Computing

Questions to ask

How would your team, your executives, your board define the case for quantum computing?

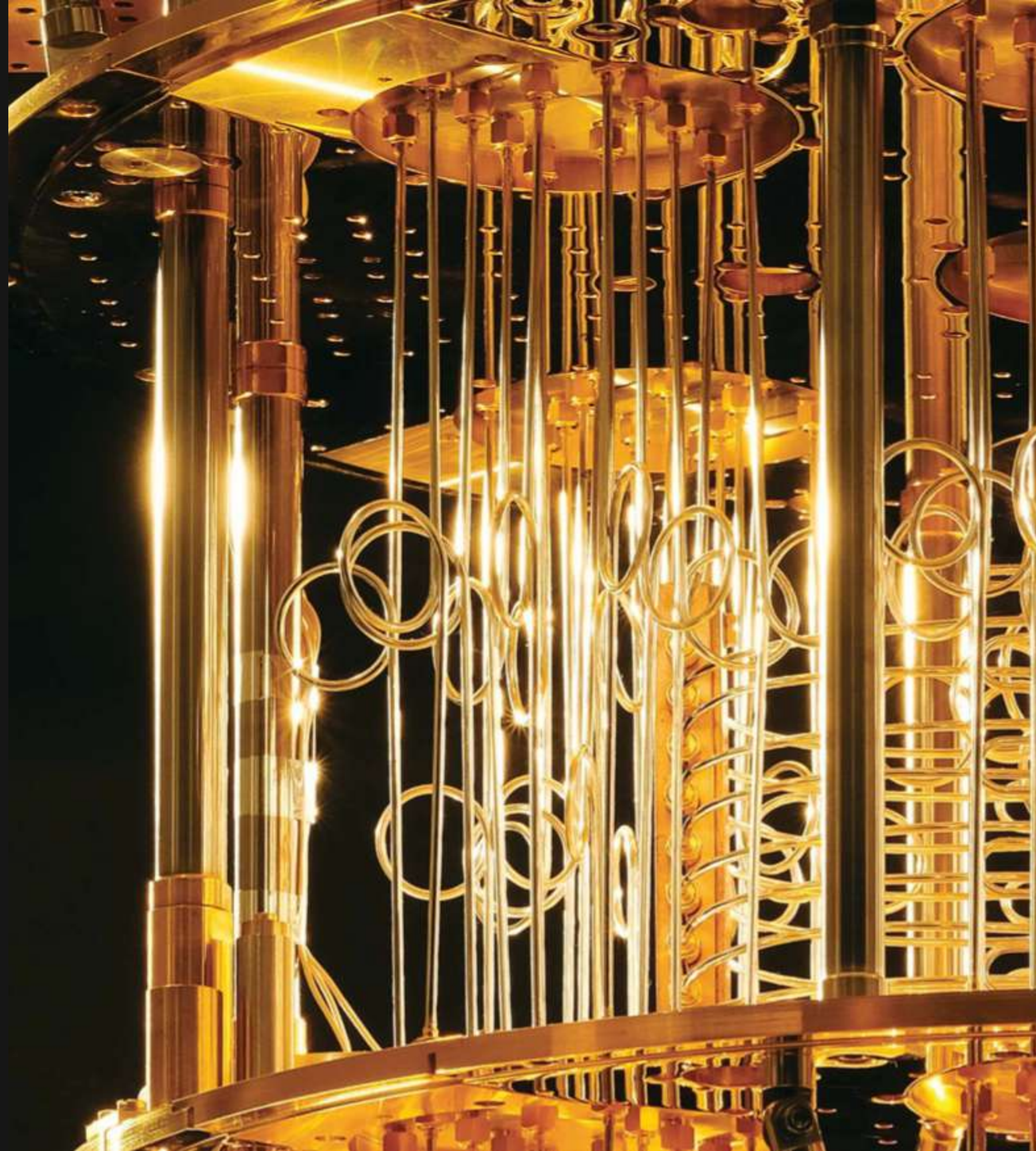
What steps are your clients taking to become – or compete with - a discovery driven enterprise?

How are you educating yourself on quantum computing possibilities?

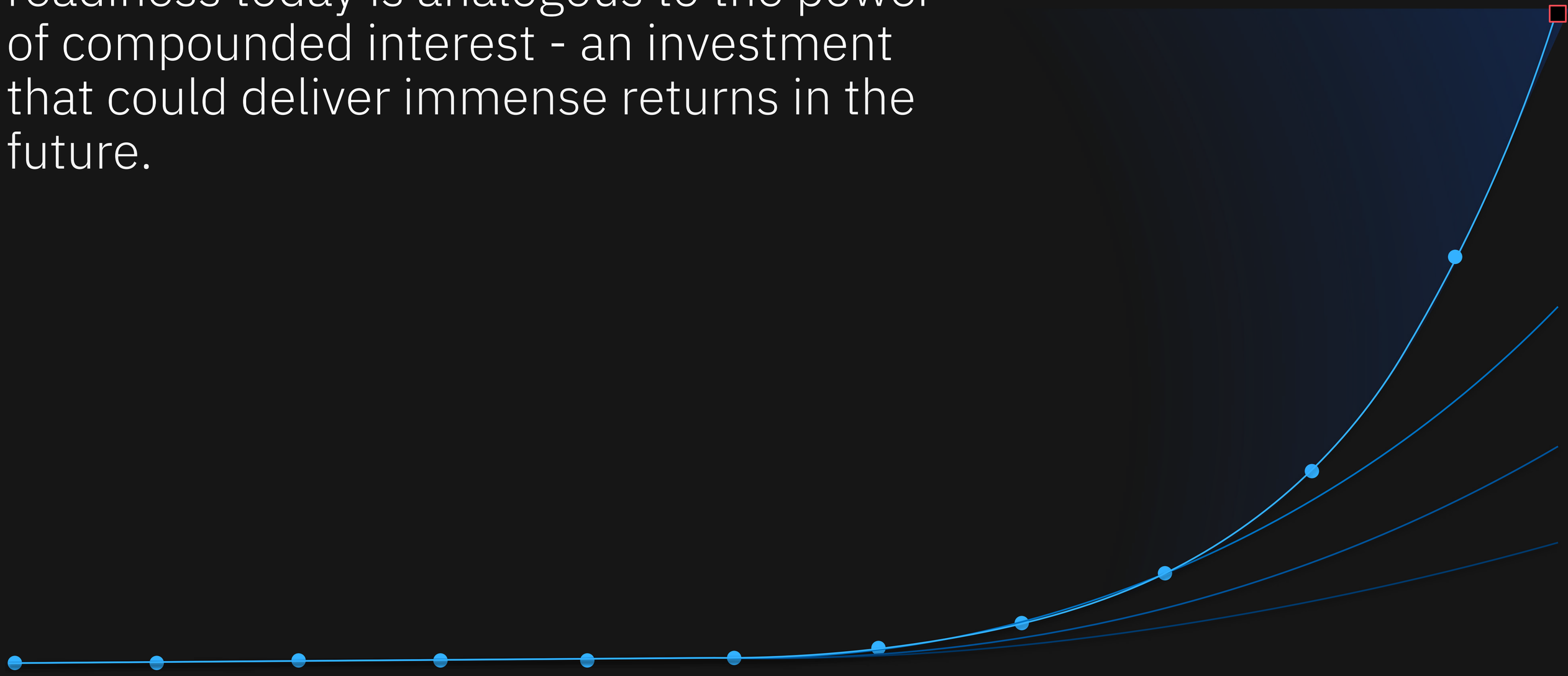


Chapter Two: Readiness

Accelerating digital transformation in the context of preparing for quantum computing

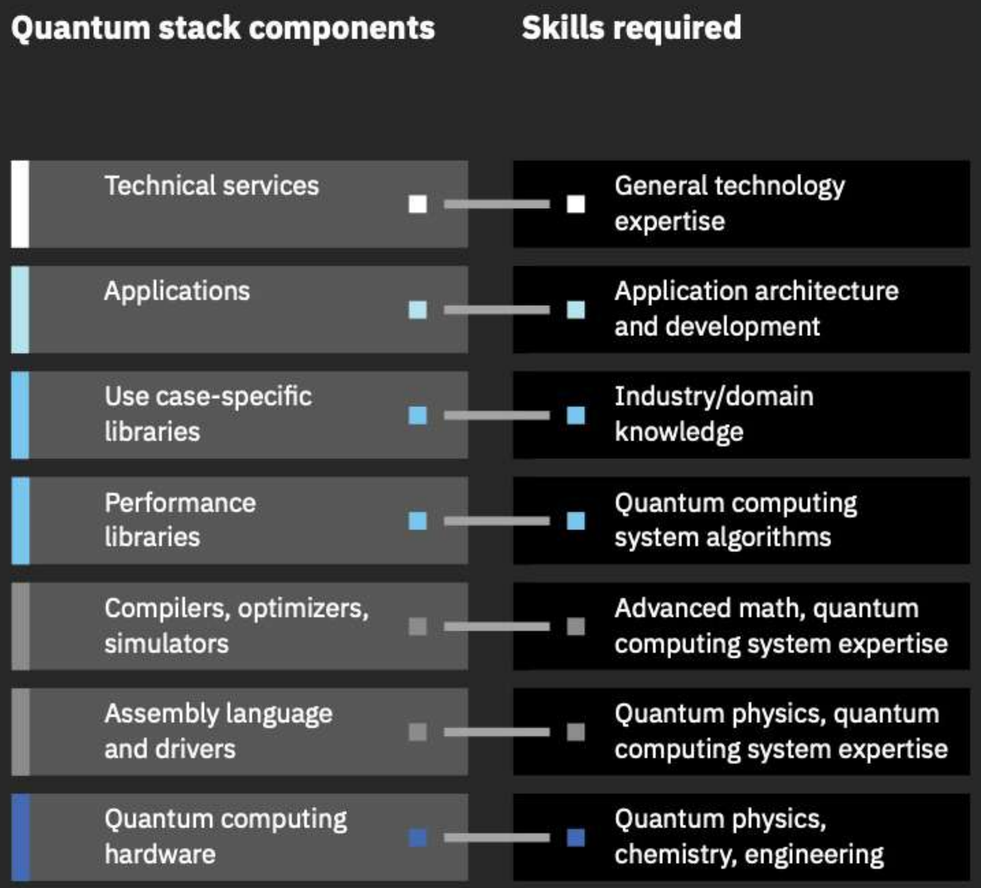


A relatively small investment in quantum readiness today is analogous to the power of compounded interest - an investment that could deliver immense returns in the future.



Talent & transformation for the quantum age

Quantum computing is going to require new skills that will be some of the most in-demand skills in the world.



What components and skills can help you achieve quantum computing literacy?

“If anything slows down the Quantum Decade, it’s unlikely to be the technology. It will be the talent.

There’s access to capital, a lot of interest, and we will have the technology. It’s the people that we need.”

Prineha Narang

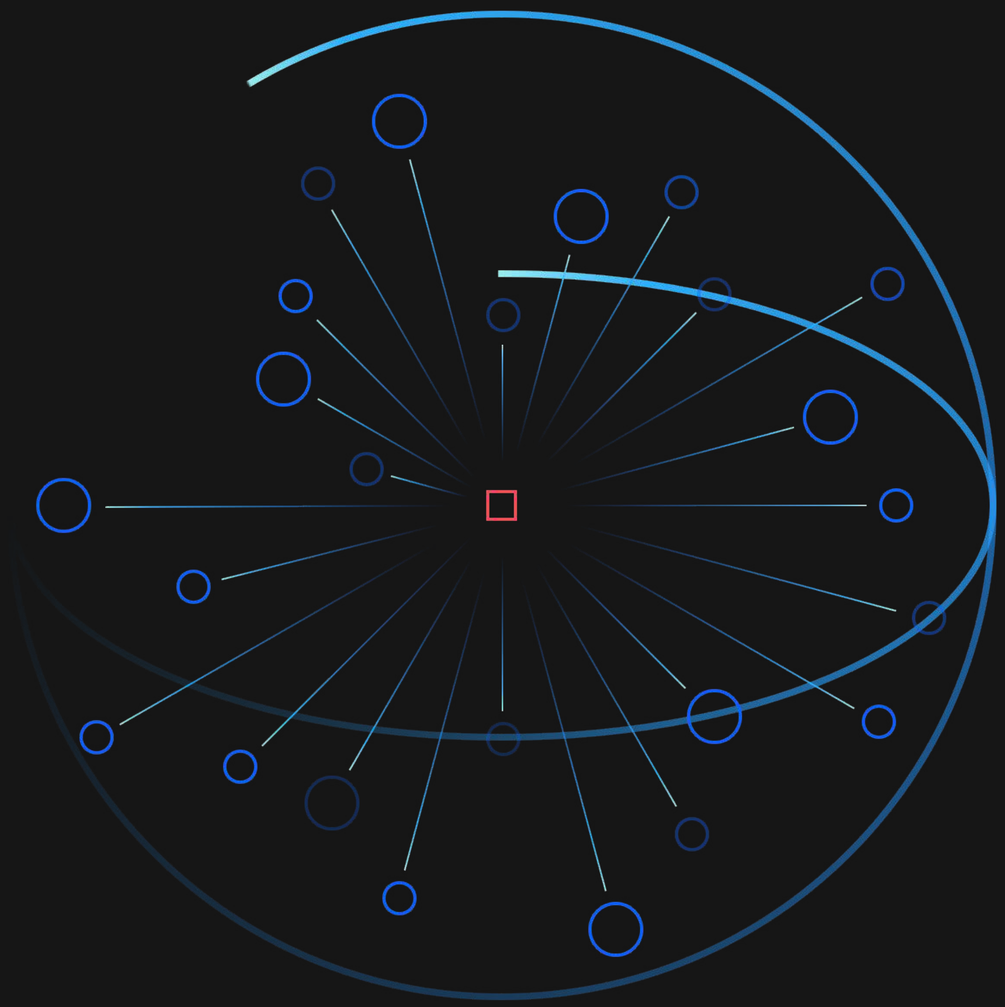
Assistant Professor of Computational Materials Science Harvard University

Questions to ask

What types of quantum computing experiments could you be conducting now?

How can quantum computing partner with classical computing within a particular workflow?

What steps can you take to foster quantum computing literacy within your organization?



Chapter Three: Advantage

Where quantum computers plus classical systems can do significantly better than classical systems alone

The realized business value of quantum computing will come in waves

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Wave 1
Low tide

Low key murmurs in some research corners

Wave 2
High tide

Breakthroughs are more structured and commonplace

Wave 3
Tsunami

Breakthroughs grow more complex and revolutionary

Quantum Advantage occurs when a computing task of interest to business or science can be performed more efficiently, more cost effectively, or with better quality using quantum computers.

In the near-to-medium term, quantum computing can be applied to problems in three areas

Simulation
Such as modeling processes and systems that occur in nature

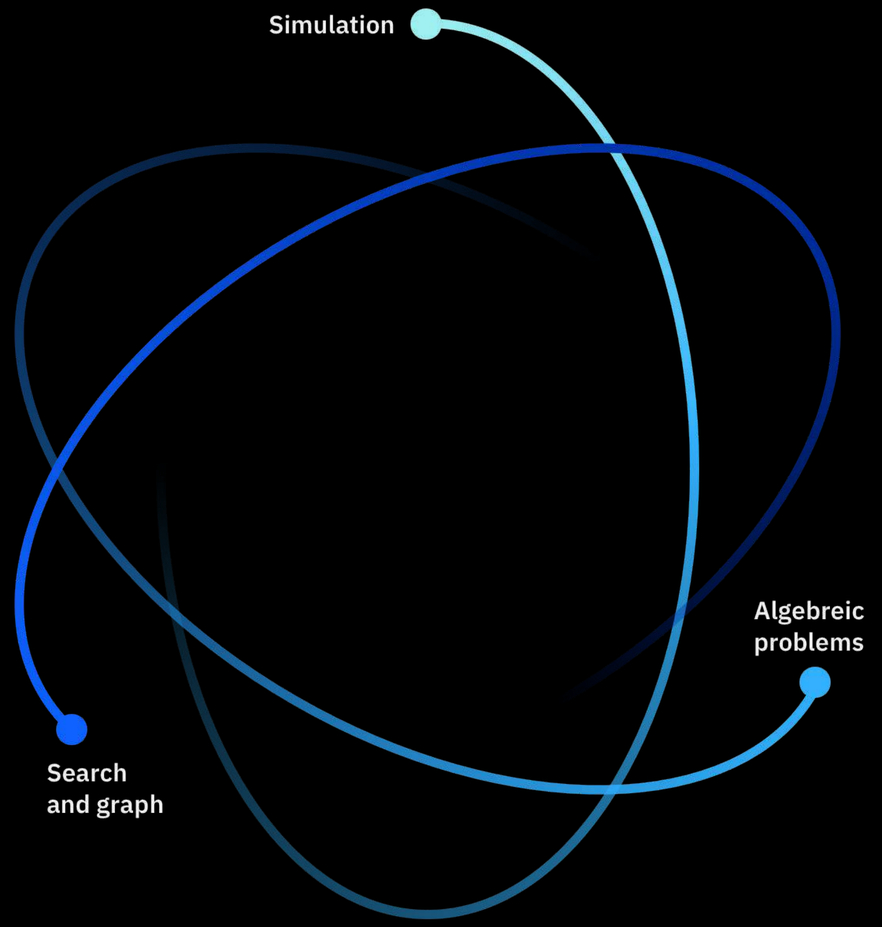
- Chemistry
- Pharmaceuticals
- Materials
- Electric batteries

Search and graph
Involving searching for the best or “optimal” solution in a situation with many possible answers

- Sampling
- Travel and transportation
- Logistics / supply chain
- Network infrastructure
- Air traffic control
- Work scheduling

Algebraic problems
Including applications for machine learning

- Adaptive vendor / customer interactions
- Decision support
- Training



“Exponential acceleration can occur after an initial use case.

What we learn from those early use cases can be applied to others.”

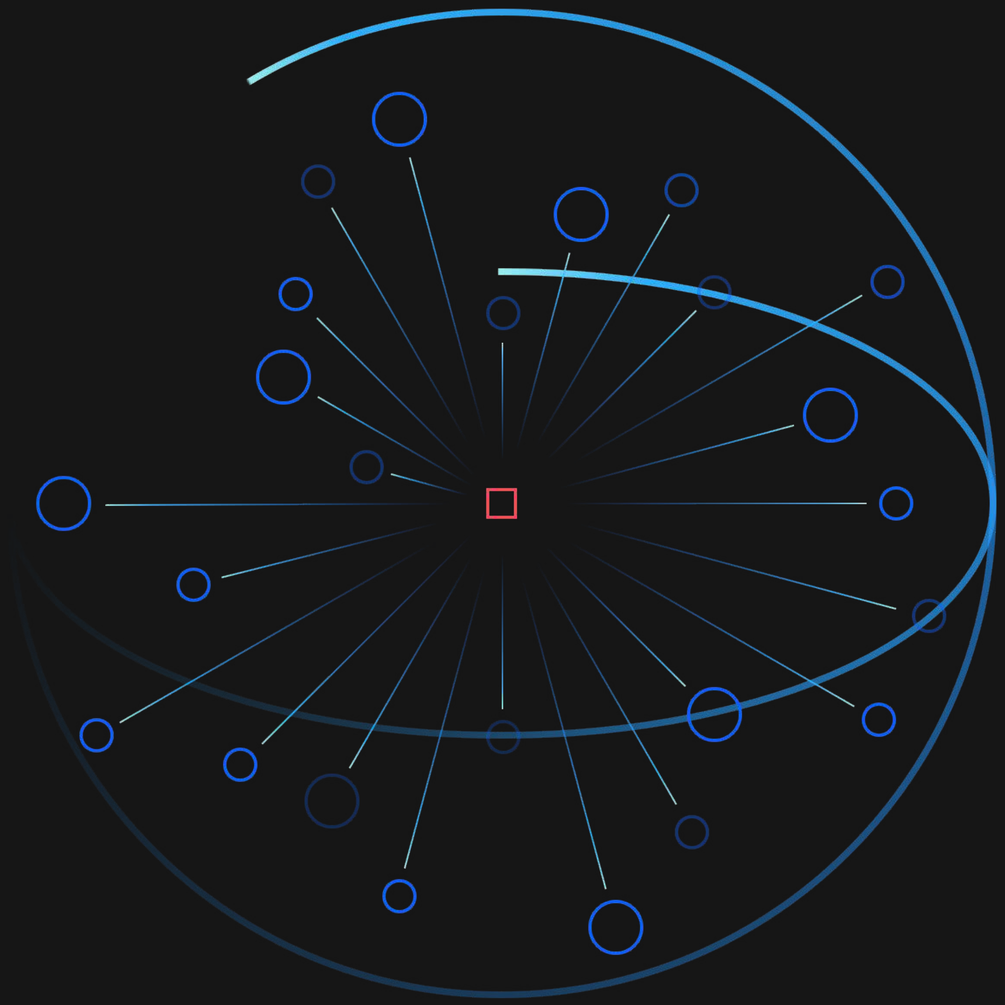
Sabrina Maniscalco

Professor of Quantum Information and Logic,
University of Helsinki
CEO, Algorithmiq Oy

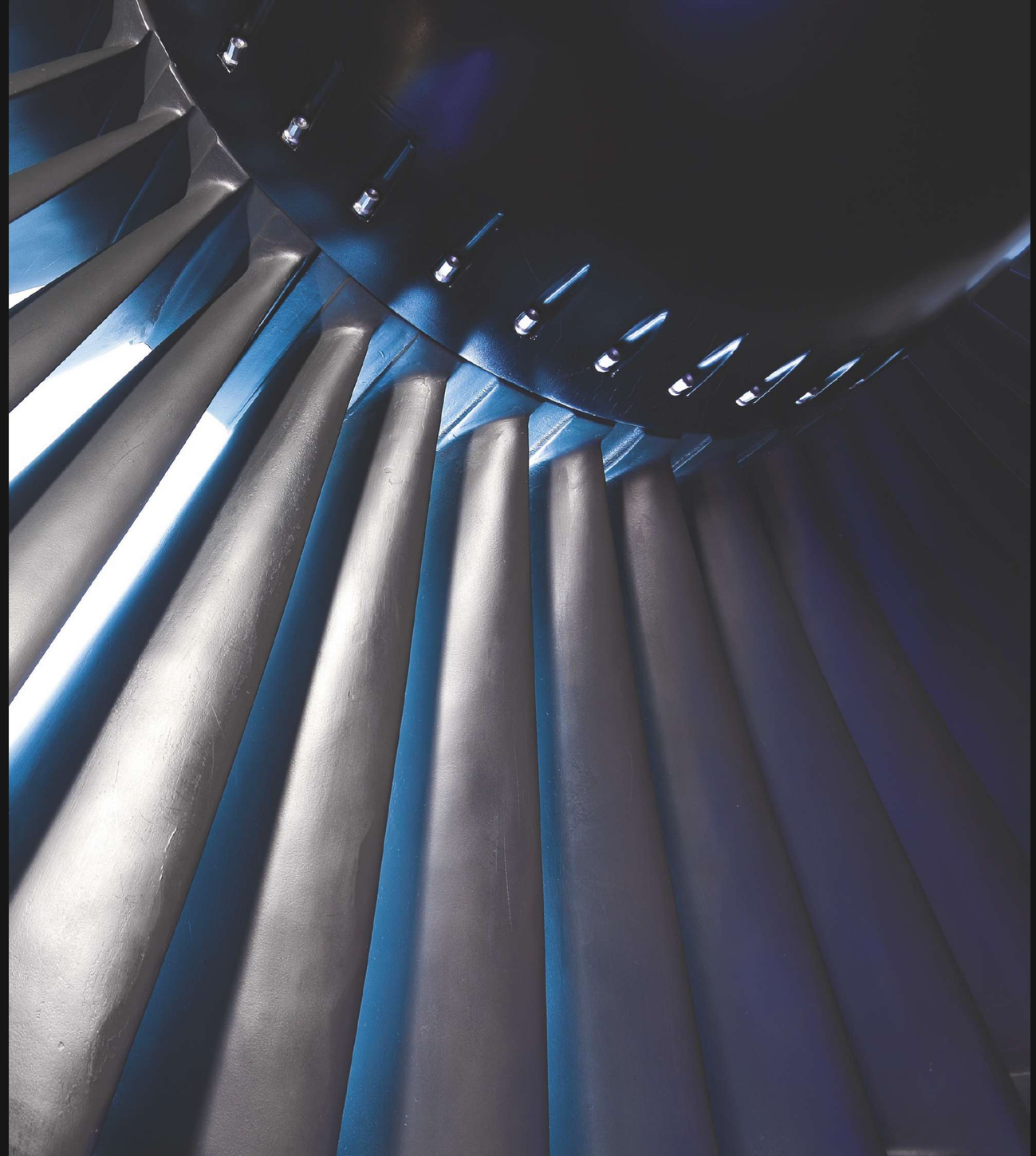
Questions to ask

Where do you see your organization positioned during each of the “three waves” of Quantum Advantage?

How do simulation, search, and algebraic use cases play in the problems intractable to your industry?



Industry Guides



Airlines

Untangling operational disruption for airlines (IROPS)

Enhancing contextual personalized services for airline customers

Optimizing airline network planning globally

Banking and financial markets

Targeting and prediction

Risk profiling

Trading optimization

Chemicals and petroleum

Developing chemical products, including catalysts and surfactants

Optimizing feed-stock routing, refining, and taking product to market

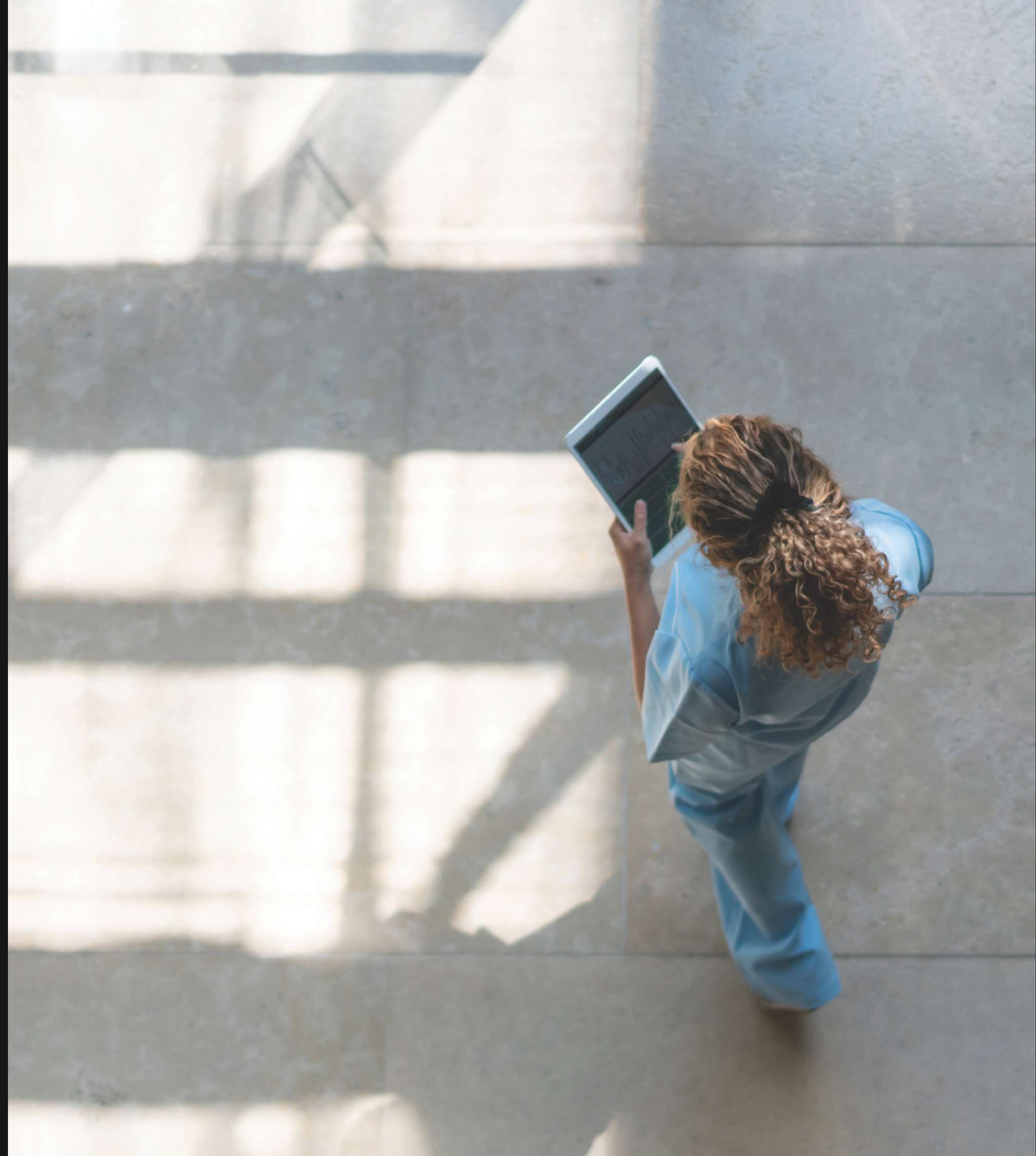
Expanding reservoir production

Healthcare

Diagnostic assistance

Insurance premiums and pricing

Precision medicine



Life sciences

Creating precision medicine therapies by linking genomes and outcomes

Improving patient outcomes by enhancing the efficiency of small-molecule drug discovery

Developing novel biological products based on protein folding predictions