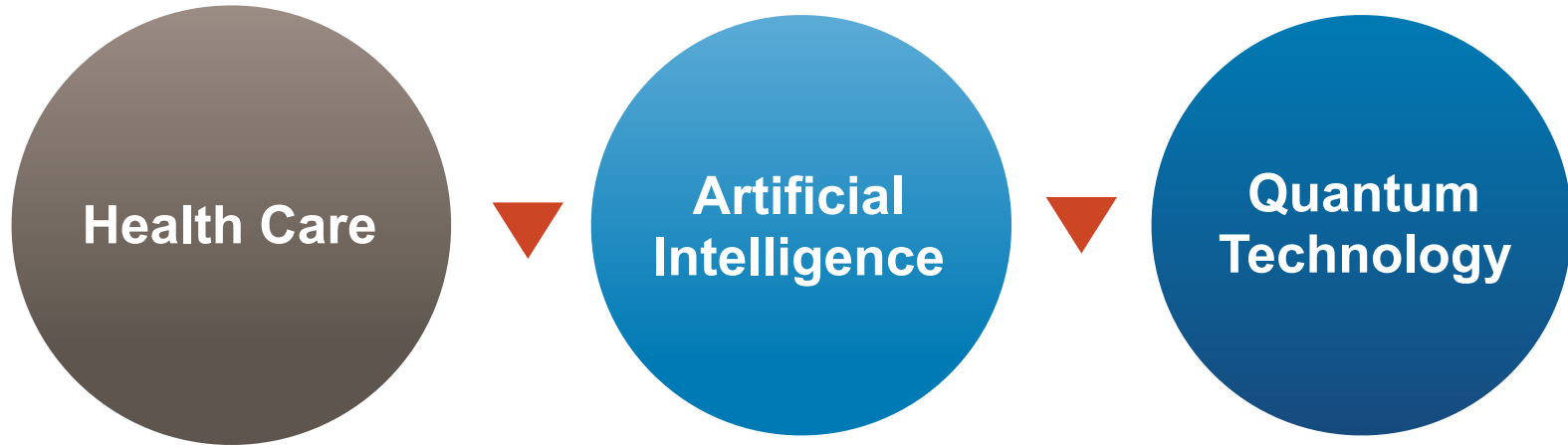


How Quantum Technologies is Poised to Disrupt Healthcare?

“Understanding what actions you can take today will prepare your organization against the the threats (and opportunities) of tomorrow.”
- Timothy Hollebeek

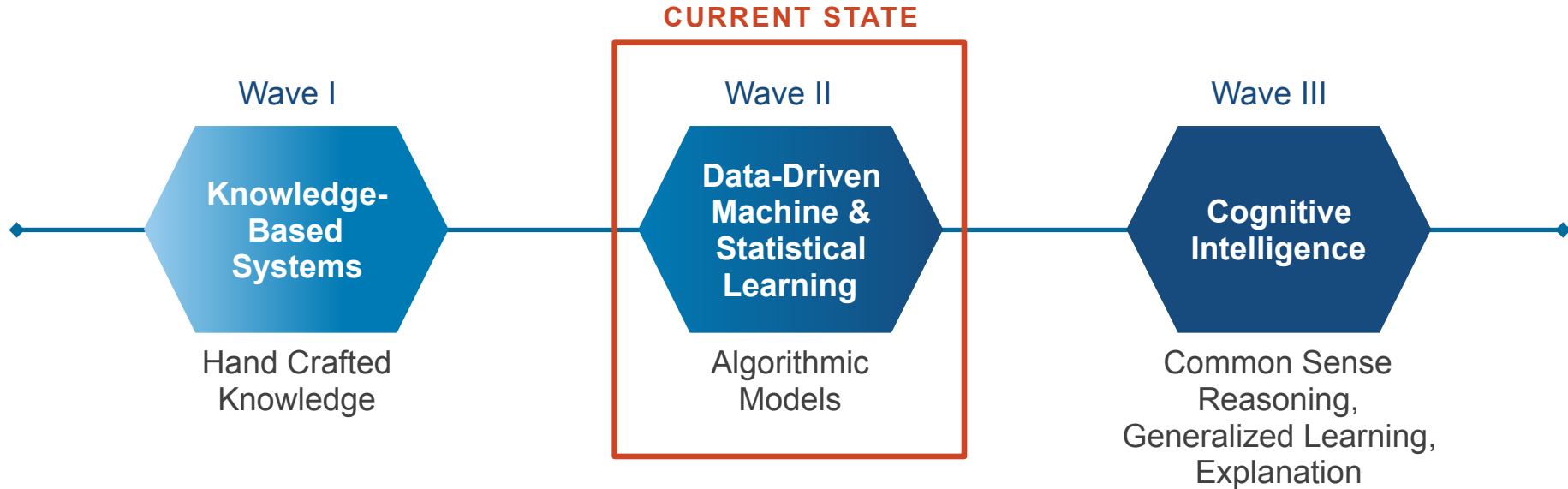
JAMES M. DZIERZANOWSKI, PHD
DECEMBER 14, 2019

Technology Evolution and Health Care



The Three Waves of Artificial Intelligence (AI)

Emerging technologies building powerful, open AI ecosystems



Cognitive Evolution of Artificial Intelligence

Symbolic/Algorithmic Integration
Knowledge Representation
TRUST, Ethics, Explanation/X-AI



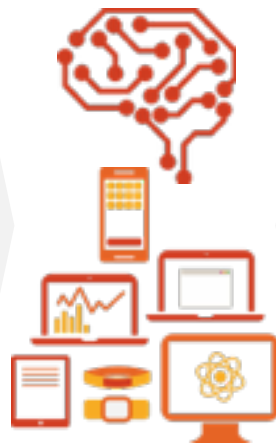
Cybersecurity Applications
Nation-State Threats



Information Overload
Automation and Augmentation
Learning with Reduced Data Sets



NEXT WAVE OF AI



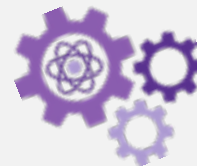
ADDRESSING TOMORROW'S CHALLENGES



Neuroscience Modeling,
Multi-Agent Intelligence SW,
Autonomous, Robotics,
Vehicles, Voice and NLP



EDGE, Neuromorphic Chips,
Cloud Computing, Evolving
Algorithmic Architectures

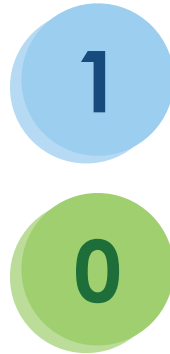


Quantum for Machine Learning
Gradient Descent and
Optimization Problems

Classical and Quantum Computation

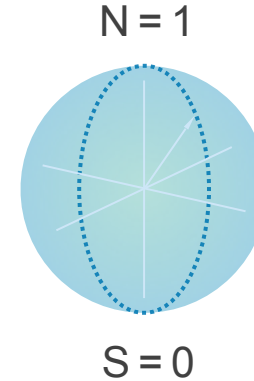
Basically, the principle of quantum computational power is 2^n vs. $2n$, or exponential — not linear.

Standard Bit
(2 states)



vs.

QuBit
(Many states)



Quantum Technology Concepts



Platform(s)



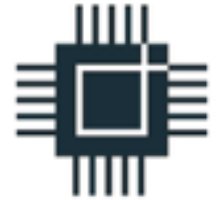
Qubits

$$\begin{aligned} |0\rangle &= \begin{bmatrix} 1 \\ 0 \end{bmatrix} \\ |1\rangle &= \begin{bmatrix} 0 \\ 1 \end{bmatrix} \\ |+\rangle &= \frac{|0\rangle + |1\rangle}{\sqrt{2}} \\ |-\rangle &= \frac{|0\rangle - |1\rangle}{\sqrt{2}} \end{aligned}$$

Superposition



Entanglement



Measurement

Quantum Internet and Planning Scenarios



	CLASSICAL COMPUTER	QUANTUM COMPUTER
CLASSICAL NETWORK	<p>Classical Post-Quantum Cryptography A gradual transition towards Quantum resistant systems and services.</p> <p>While a transition will need up to ten years to become fully Quantum resistant, it will be a gradual process (SW and HW upgrades). Initial focus will be on critical data and infrastructure.</p>	<p>Quantum Computing Towards Quantum advantage or supremacy and beyond - solving problems classical computers cannot.</p> <p>Universities, research institutions and tech companies are working to make Quantum computers a reality (pragmatic). New ways of coding and types of programming interfaces are becoming available.</p>
QUANTUM NETWORK	<p>Quantum Communication/Network Creating a fundamentally different Internet.</p> <p>While fundamentally different, networks will have nodes with Quantum processors, fiber lines with optical (quantum) switches – used by governments, big tech and telecom – with high security need customers.</p>	<p>Quantum Cloud Unleashing the full power of Quantum technologies.</p> <p>When combining Quantum computing with quantum communication, blind computing becomes a reality. Being ‘blind’ means the distributed system is fully secure. Data or app information interception is impossible.</p>

Data Encryption/Protection Impacts by QC



Ten-Year Market Forecast

MARKETS

- Governments
- Military, Intelligence
- Telecom
- Financial Services
- **Health/Medical Records**
- General Biz Apps
- Disaster Recovery
- Consumer Products

TECHNOLOGY

- Commercial Giants such as IBM, Google, Microsoft
- Embedded Crypto, Firmware
- Cloud, Mobile, Devices, IoT
- Credit Card Transactions
- Web Browsers
- Cryptocurrencies (BC)
- **Databases (Long-Lived Data)**

STANDARDS

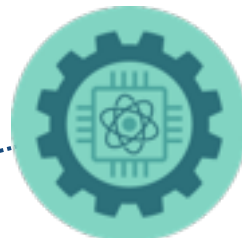
- NIST Selection Process
- IETF
- ETSI (Certification)
- Cloud Security Alliance
- ITU-T
- Multi-National Interests:
NSA, EU, USG, China....

As in all things
Crypto, one
must envision
the long view.

Algorithm Creation
Open Vetting by Community
Commercialization
Ongoing Threat Analysis
Rinse & Repeat

Quantum and Healthcare Application Benefits

Complex Problems in Chemistry, Material Science, Pharma, Molecular Physics (and Wall Street)



Machine Learning and Optimization, Addressing Gradient Descent Issues

Evolutionary Cybersecurity Threats, Data Encryption/Cryptography and Data Harvesting Attacks



Sensors, Imaging Enhancements



Multi-Party Modeling
Data Protection

Quantum Technology Challenges



International Focus, Commercial Development & USG Funding Support Global View, Funding

Problem Selection Applying the right technology to the right problem

Technology is in 'Early Adopter' Phase Research to Application

Conceptual Understanding Origins in Theoretical Modern Physics and Computer Science

Analytics / Algorithmic Modeling Adding value from data and QC algorithmic models

Tools, Infrastructure and Workforce / Researcher Skillsets Platform and skill development

Future State and Cross Domain Opportunities Healthcare opportunities and technical capabilities

A Quantum Technology Strategy is a plan designed to dramatically enhance the many ways computation occurs in healthcare.

Security of Data

Data Science Algorithmic Evolution

Hard Problems Classical vs. Quantum

Future of AI R & D

Healthcare Possibilities and Partnerships



Thank You

