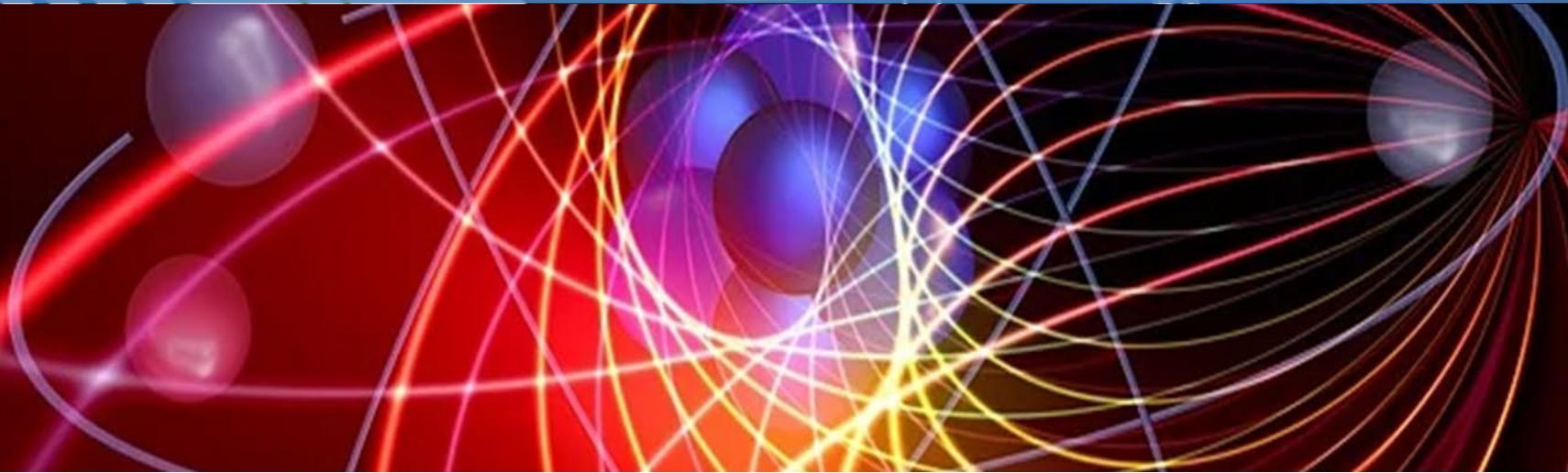




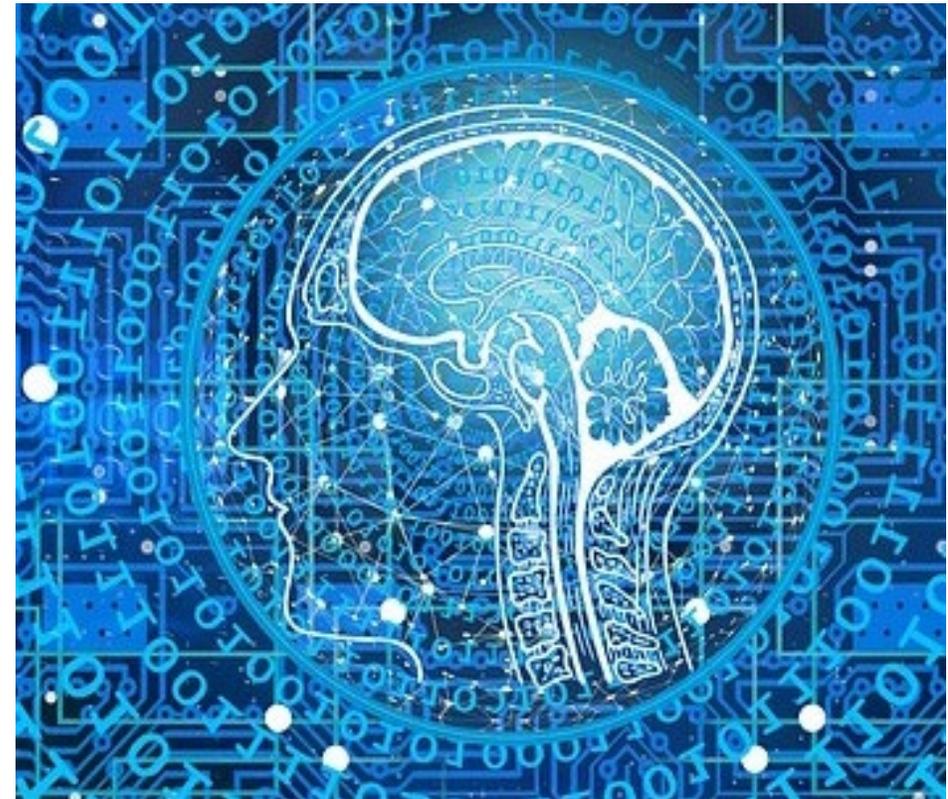
AI and Quantum: *Tools That Will Change the World*

Dr. Darren Mollot, Director, Exploratory Research and Innovation

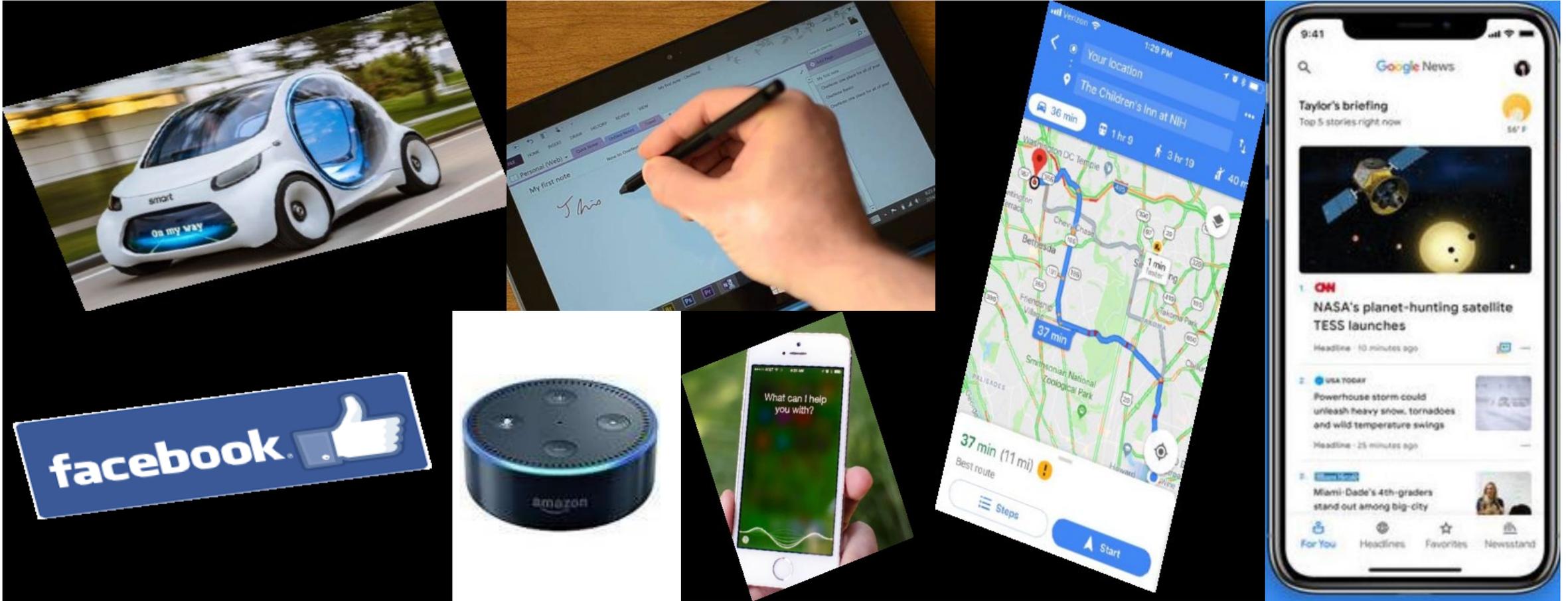


AI is a technology that can mimic human intelligence in performing tasks.

- Pattern recognition
- Decision making
- Visual perception
- Speech recognition
- Information processing
- Behavior adaptation
- Autonomous control
- Optimization, and more.

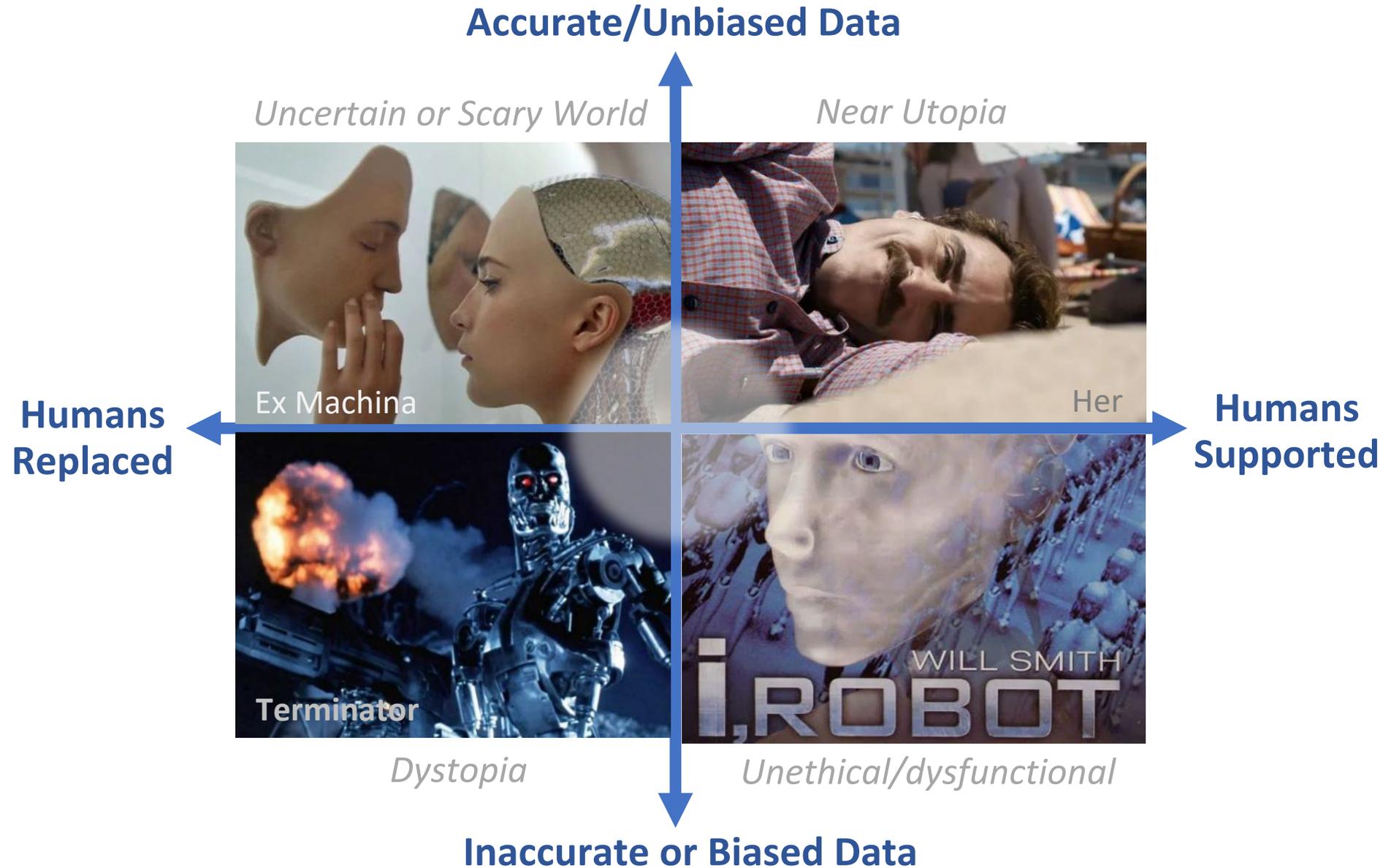


Familiar AI Applications



www.techradar.com/news/everything-you-need-to-know-about-the-new-google-news-app

Potential AI Futures



Feb. 2019: Executive Order 13859

June 2019: – Year-1 Action Plan (OMB)
– Federal Data Strategy: Framework for Consistency (White House)
– National AI R&D Strategic Plan Update



June 4, 2019

M-19-18

MEMORANDUM FOR THE HEADS

FROM: Russell T. Vought
Acting Director

SUBJECT: Federal Data Strategy

New tools, technologies, and norms are essential to the Government's mission delivery, service to the American people, and order to leverage these opportunities, interoperability, and best practices in the digital age.

This memorandum establishes a Federal Data Strategy that helps the Government through consistent data infrastructure and fully leverage data as a strategic asset for protection and security that the American people deserve.

Purpose & Overview

This Strategy enables agencies—and the American people, in part from our data assets and of protecting a common set of data principles and best practices that help the American people get more value for the public.¹ The Strategy includes information policy and guidance,² and public comments received in response to the *Data Strategy*.

¹ Federal data drives the U.S. economy and civic engagement, and would not benefit from the use of data. This Strategy will be sponsored data by increasing accessibility and use to support and public use.

² Including the Paperwork Reduction Act, the E-Government Act of 2002 (E-Gov), the Government Information Act, the Freedom of Information Act, the Federal Information Security Management Act, and the Federal Information Security Act, among others.

³ Including OMB Circular A-130 Managing Information as an Asset.



THE NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH AND DEVELOPMENT STRATEGIC PLAN: 2019 UPDATE

A Report by the

SELECT COMMITTEE ON ARTIFICIAL INTELLIGENCE

of the

NATIONAL SCIENCE & TECHNOLOGY COUNCIL

JUNE 2019

“American leadership in AI is of paramount importance to maintaining the economic and national security of the United States and to shaping the global evolution of AI in a manner consistent with our Nation’s values, policies, and priorities.”

-- Executive Order 13859

Artificial Intelligence Technology Office

Transform DOE into a world-leading AI enterprise by accelerating the research, development, delivery, and adoption of AI.

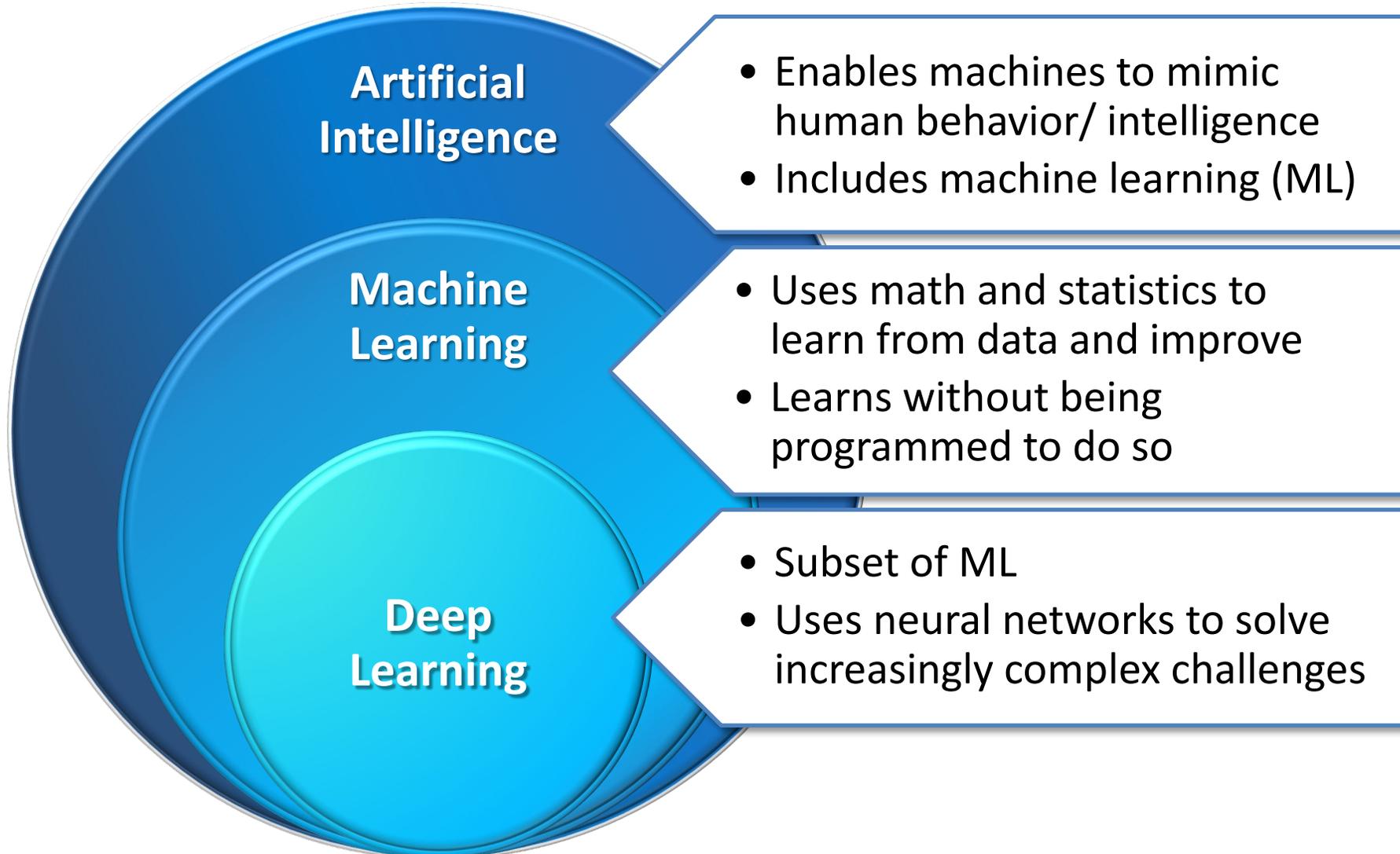


Mission:

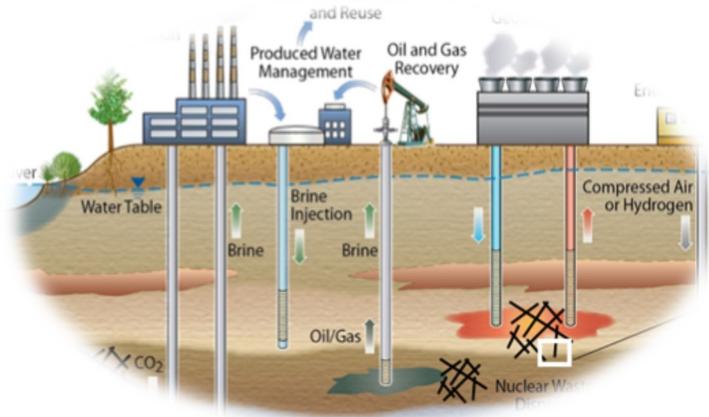
- Accelerate the delivery of AI-enabled capabilities
- Scale the development and impact of AI
- Synchronize AI activities to
 - Advance core DOE missions
 - Expand partnerships
 - Support U.S. AI leadership.

Coordination Across DOE

- Business & Operations
- Office of Science
- Office of Intelligence
- Power Marketing Admins.
- Applied Energy Programs
- Environmental Management
- NNSA
- CIO/Cybersecurity



Fossil Energy (FE): AI Targeted Benefits



Subsurface



Advanced Power Systems

Carbon Storage	Oil & Gas Recovery
<ul style="list-style-type: none"> • Improved imaging of subsurface • Improved prediction and forecasting • Real-time decision making 	<ul style="list-style-type: none"> • Faster, cheaper, safer drilling • Cost-efficient completions • Real-time decision-making

Materials Development	Condition-based Maintenance	Plant Cybersecurity
<ul style="list-style-type: none"> • Property prediction • Experiment prioritization • Accelerated discovery 	<ul style="list-style-type: none"> • Wear analytics • Advanced monitoring • Reduced downtime 	<ul style="list-style-type: none"> • Continuous analytics • Anomaly detection • Instant response

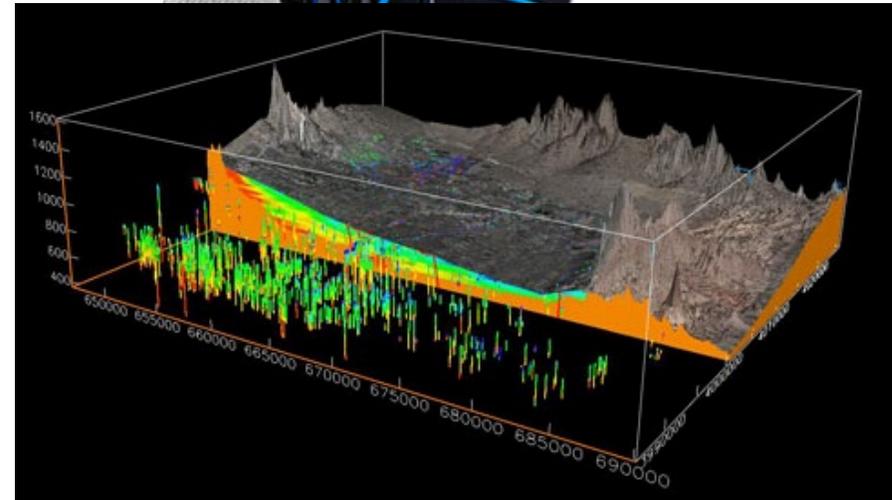
AI & ML can leverage the following confluence of resources:

- **New sensing systems** (e.g., fiber optics) provide robust data sets to support more complex analytics.
- **High performance computing** improves and accelerates modeling of complex systems.
- **Decades of data** collection are available...

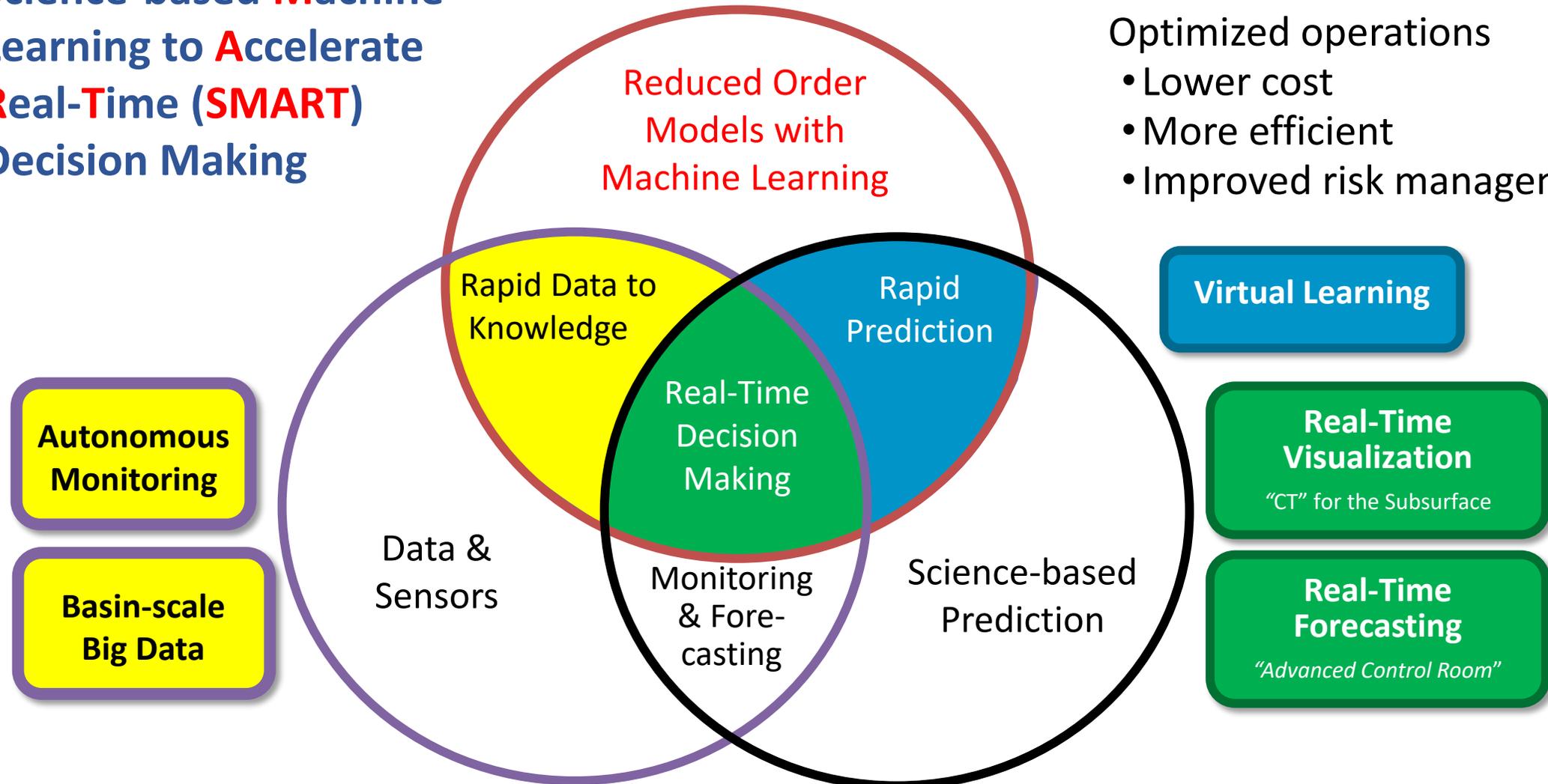
...creating the opportunity to *transform subsurface operations.*



Sierra



Science-based Machine Learning to Accelerate Real-Time (SMART) Decision Making



- Extensive Data
 - ML and AI
- ➔ Real-time interpretation and integration of subsurface data
- ➔ More precise execution of subsurface operations

Exploration ➔ Characterization ➔ Drilling ➔ Completion ➔ Production ➔ Decommissioning

Novel Data

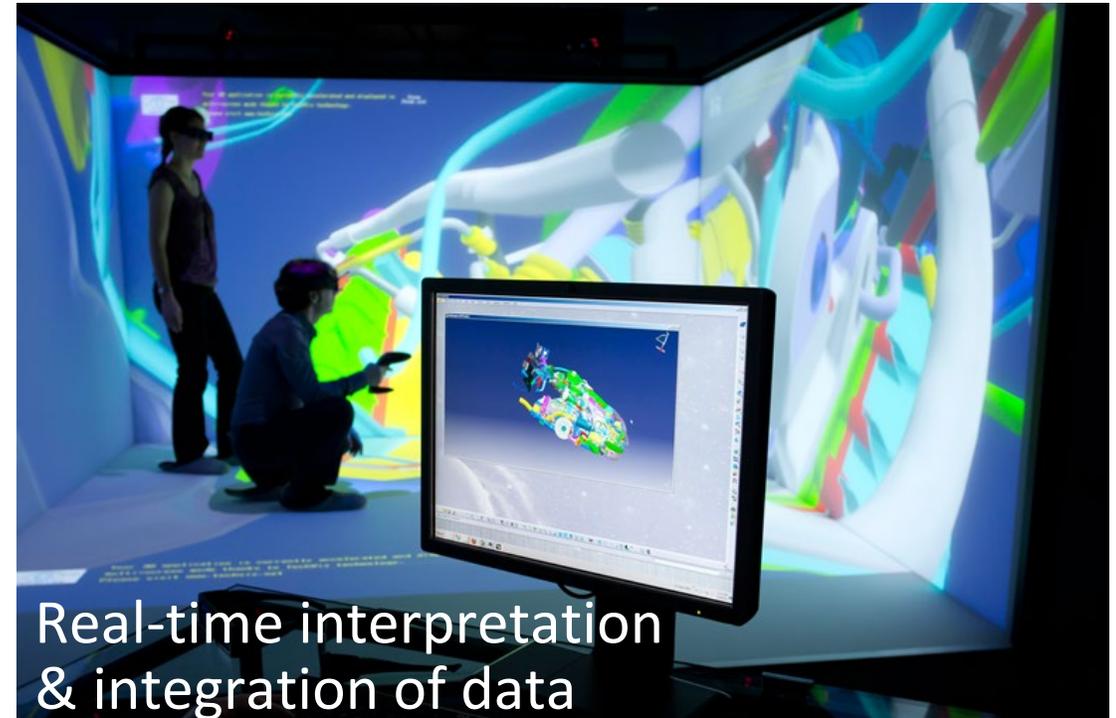
- Distributed acoustic & chemical sensing
- Reservoir monitoring
- Quantum sensing

AI Methods

- Machine learning
- Neural networks

Applications

- Model natural fracture networks
- Predict fracture propagation
- Accurately interpret downhole data
- Prioritize well design performance variables





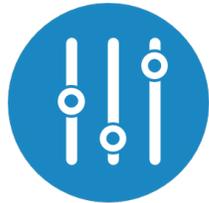
CONDITION BASED
MONITORING



CYBERSECURITY



DIAGNOSTICS &
INSPECTION



PROCESS CONTROL
& OPTIMIZATION



OPERATIONS-BASED
ASSESSMENT



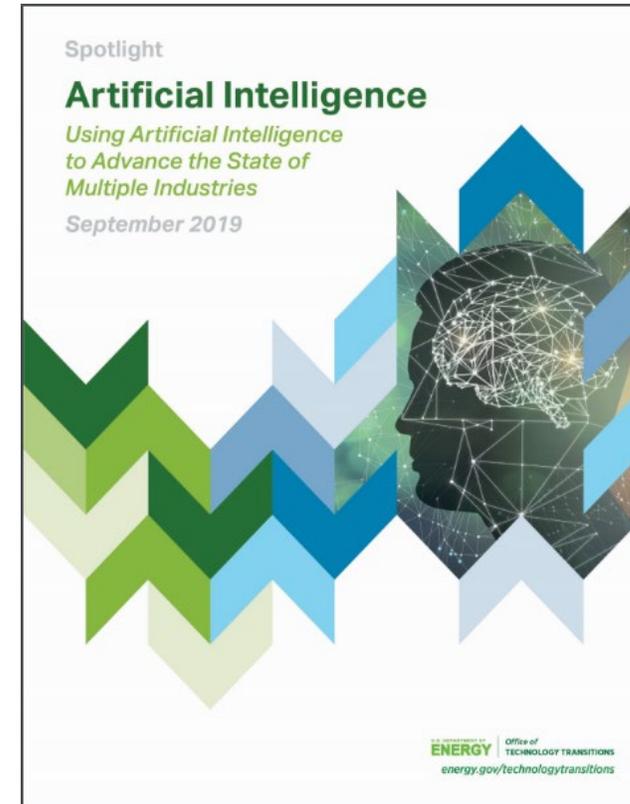
SOFTWARE & TOOLSET
DEVELOPMENT

Exploit access to high-precision data to increase **coal plant flexibility, reliability, and performance:**

- Develop and leverage novel materials and sensors
- Hybrid AI/physics-based models
- Cyber secure systems and operations
- Data analytics and control to improve:
 - fault detection
 - root cause of failure determination
 - process control improvements
 - condition-based maintenance
 - prediction of remaining useful life

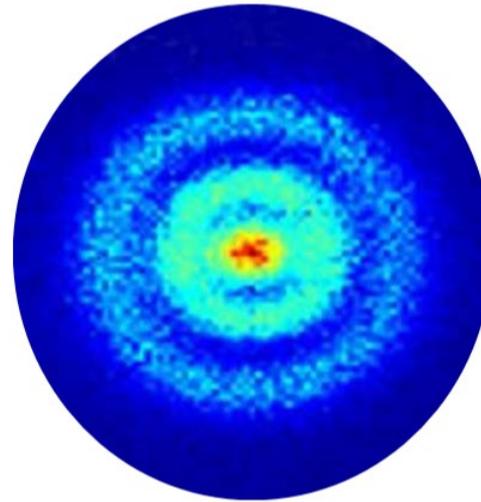
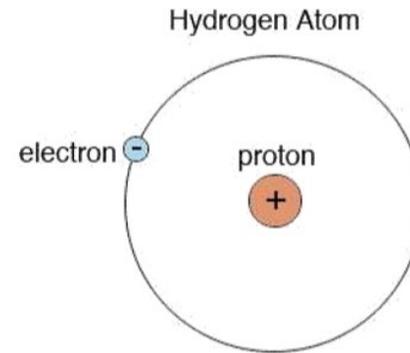
Sources of Information on AI

- DOE Spotlight on Artificial Intelligence
www.energy.gov/technologytransitions/downloads/technology-spotlights-and-success-stories
- Blogs, Podcasts, Feeds
www.artificial-intelligence.blog/rss-feeds
- Videos (TED Talks, Coursera, many more)
- Glossaries
(e.g., www.aitrends.com/ai-glossary , others)
- Communities
 - Data analytics & big data
 - Technology & innovation
 - Robotics
 - Business intelligence
 - Open Source
 - Education
 - Machine learning
 - Health
 - Neural networks
 - Python
 - AI startups
 - Cloud computing
 - Heavy research
 - Natural language processing

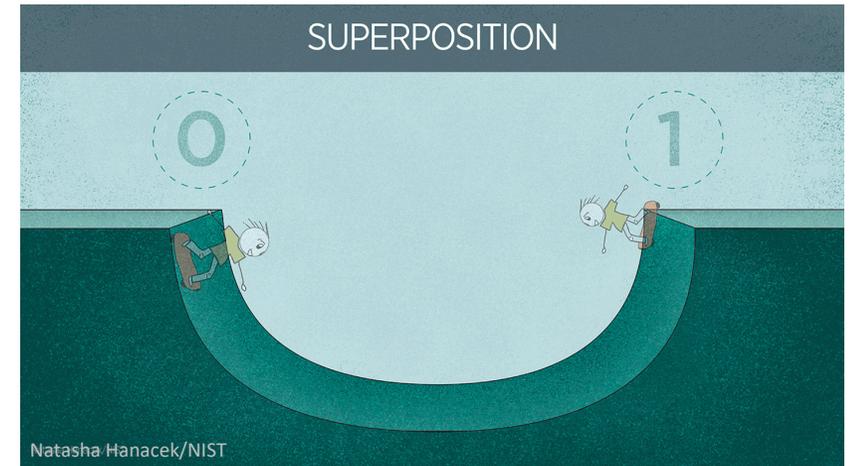


What is quantum information science?

- QIS merges two fields:
 - Quantum mechanics
 - Information and computation theory
- In quantum mechanics, the *wave function* describes all knowledge about the system
- QIS uses the properties of quantum mechanics:
 - Superposition
 - Entanglement
 - Probabilistic nature



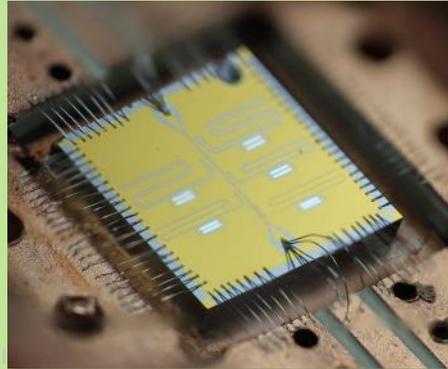
Stodolna et al. PRL 110, 213001 (2013)



Sensing

Build on exquisite sensitivity of quantum state to the environment:

- Electric and magnetic fields
- Acceleration, rotation, and gravity
- Temperature
- Imaging



Communications

Respond to disruptive new technologies by using the laws of quantum physics to protect data:

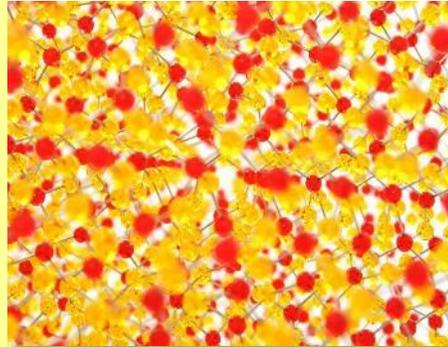
- Quantum key distribution
- Quantum repeaters
- Quantum teleportation



Simulation

Take advantage of quantum properties in chemical reactions to enable and expedite:

- Drug discovery
- Materials science
- Industrial processes



Computing

- Search very large, unsorted data sets to quickly uncover patterns or anomalies
- Integrate diverse data sets
- Improve and transform our ML and AI capabilities
- Solve long-standing and emerging challenges

