

IBM Research Technology Vision

TEK at IBM Research 2018
Rueschlikon

March 14, 2018

Stephan Schneider

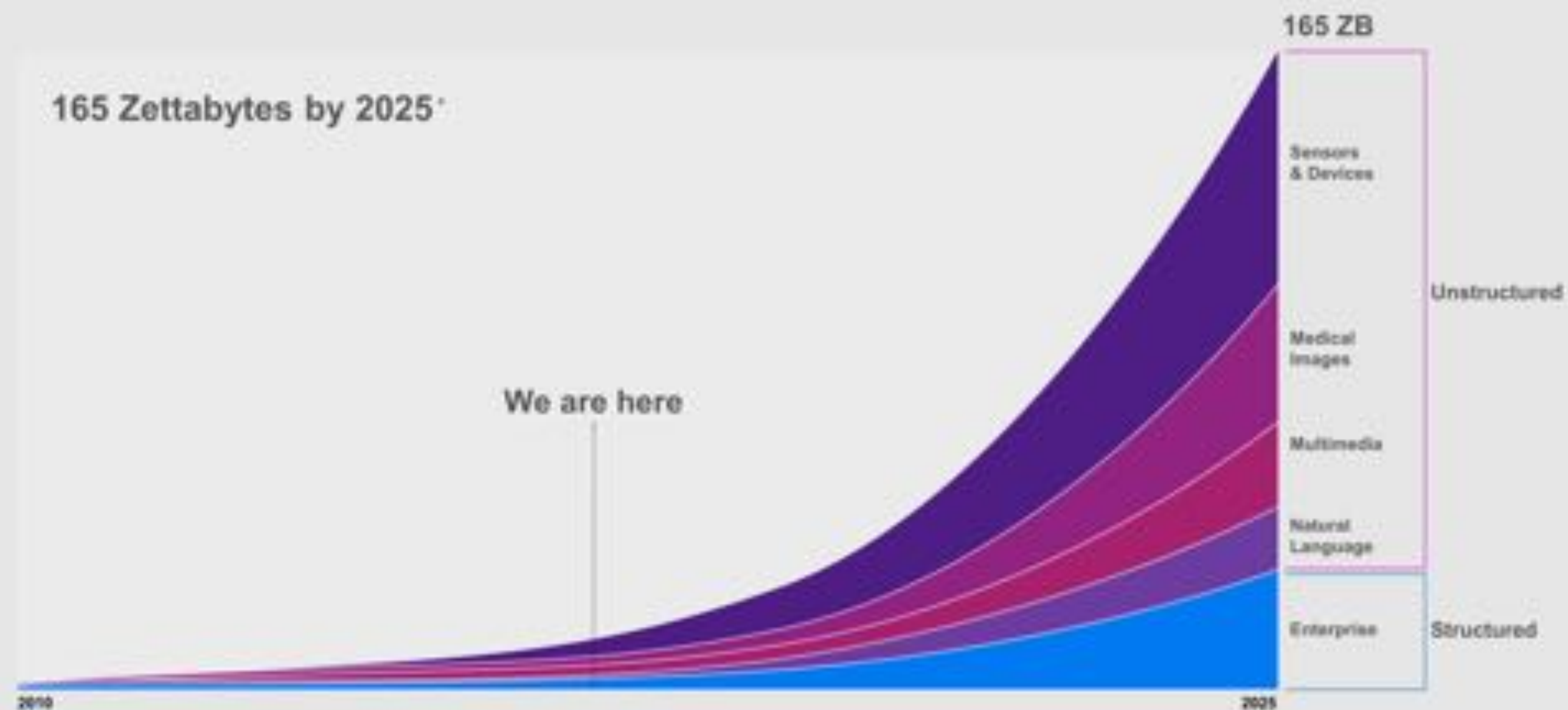
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Quantum Computing Evangelist*

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TsunBigData@Data

Data is transforming every industry

165 Zettabytes by 2025*



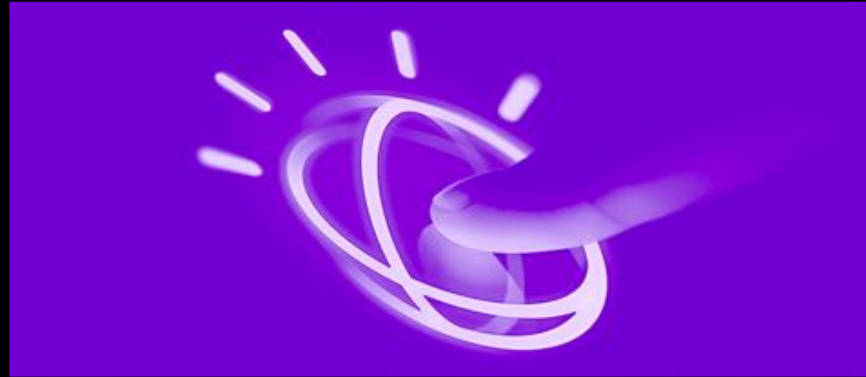
*Source IDC. IBM projections based on analyst report

Strategic imperatives

Reimagining computing



Developing core AI



Transforming industries through science and AI

Defining and optimizing blockchain

Strategic imperatives: Developing core AI

AI will have enhanced reasoning abilities and will be widely distributed, helping us make decisions instantly.



Advancing Broad AI



Signal Comprehension:
From video and text to rich human perception

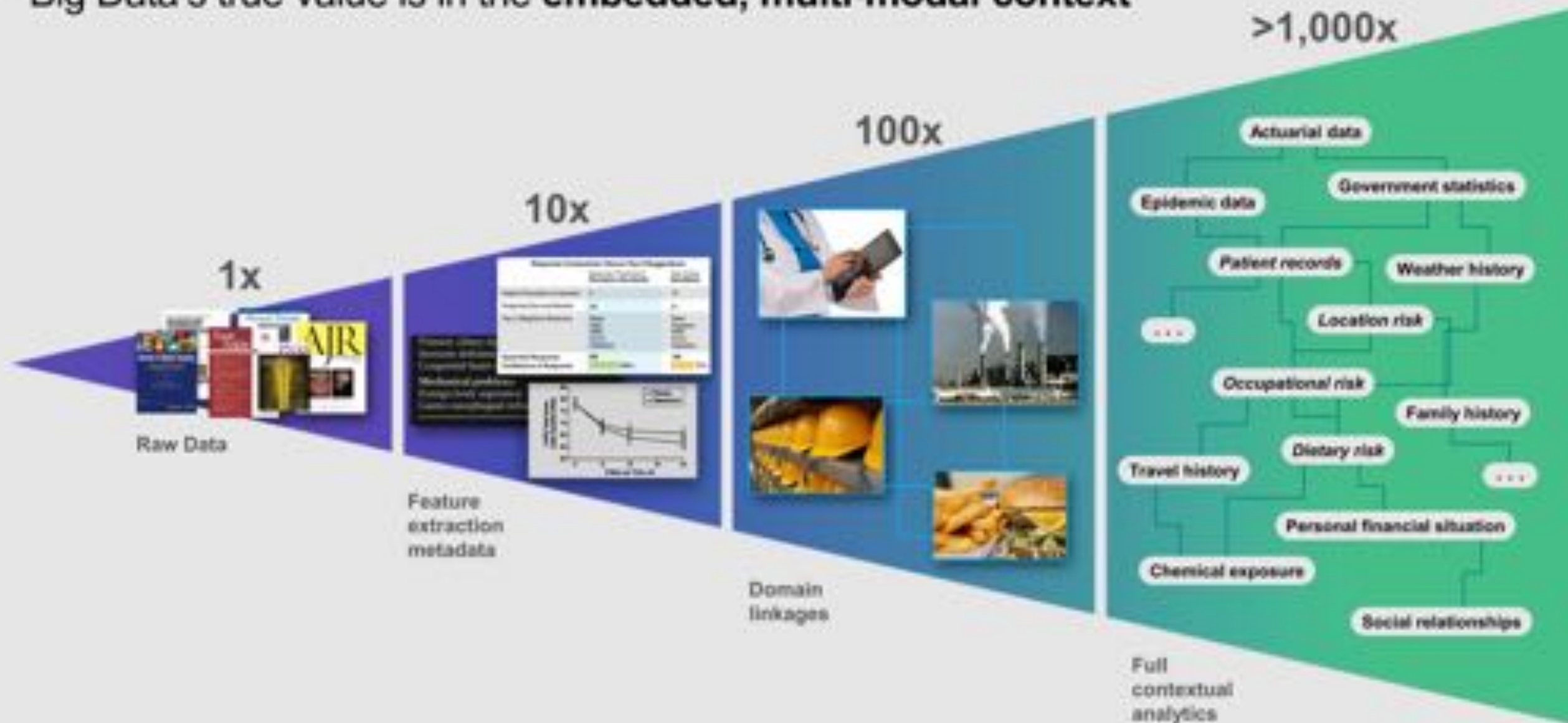


Learning and Reasoning:
From scalable machine learning to making a case



Interaction:
Understanding language, tone, emotion and context

Big Data's true value is in the **embedded, multi-modal context**



New AI horizons

Cognitive Discovery

Knowledge



Inference & Simulation

Evidence & Experiments

Augmenting the scientific discovery process with cognitive approaches

Found in Translation: AI for Organic Chemistry

"Found in Translation"
Predicting outcomes of complex organic chemistry reactions using neural sequence-to-sequence models

Take the Test!

What do I get here?
Our model has predicted product for those reactants. You can get access to the attention weight by clicking on the link here-below.

Basically those weights indicates which inputs token atoms are influencing the prediction for the next token atoms.

BACK DONE

Predict Reaction << Get SMILES Example 5 Example 6

[RXN PREDICTION]
BrCCOC1CCCC1.Cc1[nH]c2ccc(C(=O)O)[c2c1C>>Cc1[nH]c2ccc(C(=O)O)CCOC3CCCC3)cc2c1C

Confidence: 0.87
> Attention Weight

[SMILES]
BrCCOC1CCCC1.Cc1[nH]c2ccc(C(=O)O)[c2c1C>>Cc1[nH]c2ccc(C(=O)O)CCOC3CCCC3)cc2c1C

[SMILES]

IBM Research AI

1011-1020 ...
1021-1030 ...
1031-1040 ...
1041-1050 ...
1051-1060 ...
1061-1070 ...
1071-1080 ...
1081-1090 ...
1091-1100 ...
1101-1110 ...
1111-1120 ...
1121-1130 ...
1131-1140 ...
1141-1150 ...
1151-1160 ...
1161-1170 ...
1171-1180 ...
1181-1190 ...
1191-1200 ...
1201-1210 ...
1211-1220 ...
1221-1230 ...
1231-1240 ...
1241-1250 ...
1251-1260 ...
1261-1270 ...
1271-1280 ...
1281-1290 ...
1291-1300 ...
1301-1310 ...
1311-1320 ...
1321-1330 ...
1331-1340 ...
1341-1350 ...
1351-1360 ...
1361-1370 ...
1371-1380 ...
1381-1390 ...
1391-1400 ...
1401-1410 ...
1411-1420 ...
1421-1430 ...
1431-1440 ...
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1451-1460 ...
1461-1470 ...
1471-1480 ...
1481-1490 ...
1491-1500 ...
1501-1510 ...
1511-1520 ...
1521-1530 ...
1531-1540 ...
1541-1550 ...
1551-1560 ...
1561-1570 ...
1571-1580 ...
1581-1590 ...
1591-1600 ...
1601-1610 ...
1611-1620 ...
1621-1630 ...
1631-1640 ...
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1791-1800 ...
1801-1810 ...
1811-1820 ...
1821-1830 ...
1831-1840 ...
1841-1850 ...
1851-1860 ...
1861-1870 ...
1871-1880 ...
1881-1890 ...
1891-1900 ...
1901-1910 ...
1911-1920 ...
1921-1930 ...
1931-1940 ...
1941-1950 ...
1951-1960 ...
1961-1970 ...
1971-1980 ...
1981-1990 ...
1991-2000 ...

Learned

[Two columns of highlighted text]

Strategic imperatives: Transforming industries through science and AI



Artificial intelligence will integrate seamlessly into the workplace.







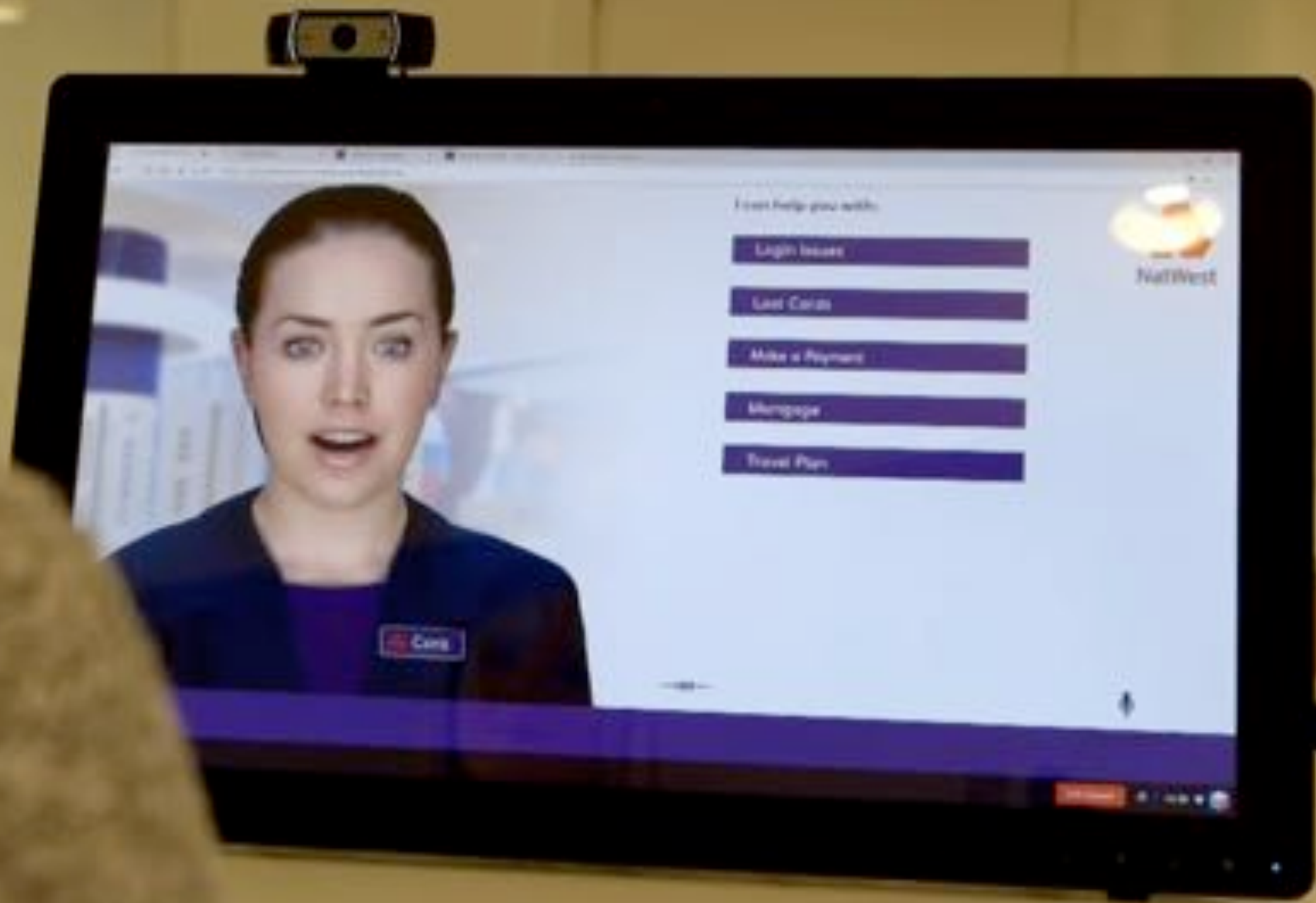
Human

Machine

Assisting People with Disabilities







Washing Machine



Rinse



Spin



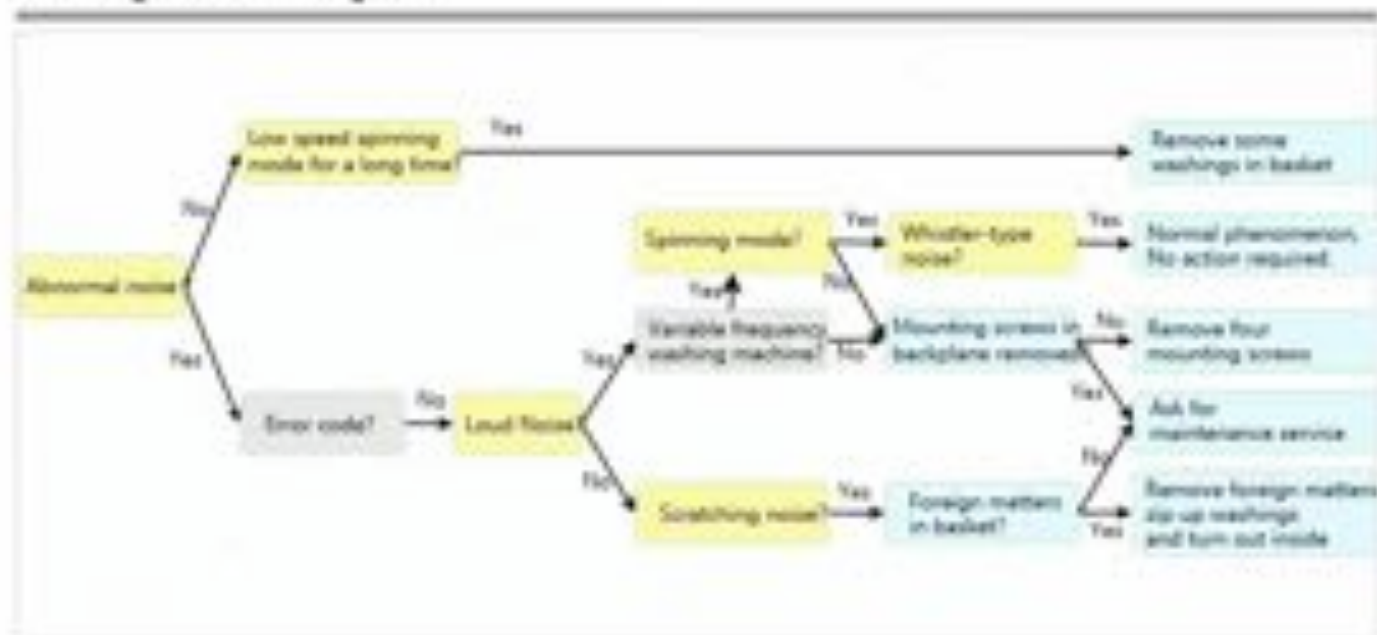
Drain



Stop



Washing Machine Diagnosis



Time

-



Status

Strategic imperatives: Reimagining computing



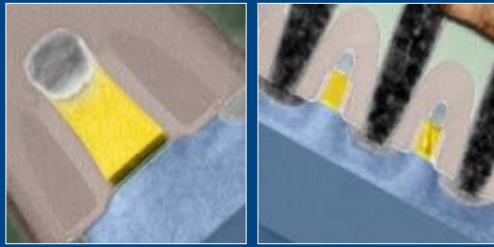
A quest for new materials,
devices and architectures to
radically change what it means
to compute



We are pushing the limits of chip technology

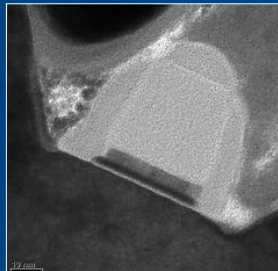
Conventional scaling efforts

New materials and devices to extend core logic, memory and I/O technology roadmaps



Scaling:
22, 14, 10, 7, 5 nanometer nodes

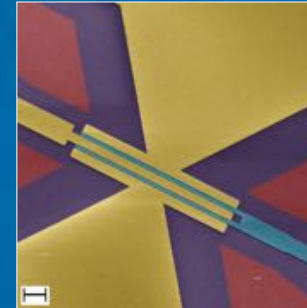
III/V
Devices



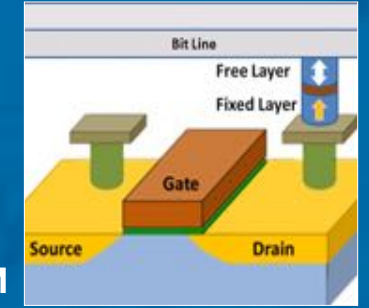
Silicon
Photonics



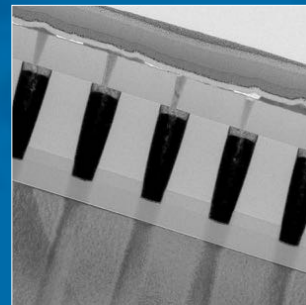
Carbon
Devices



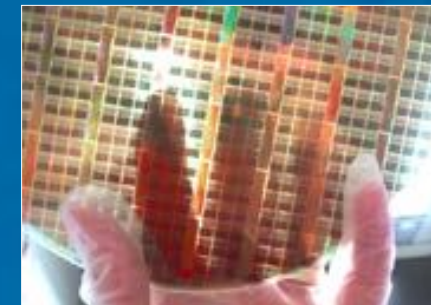
MRAM



Phase-
change
materials



3D



Brain-Inspired Neuromorphic Systems



Saliency



Saliency + Classification



Object Centers

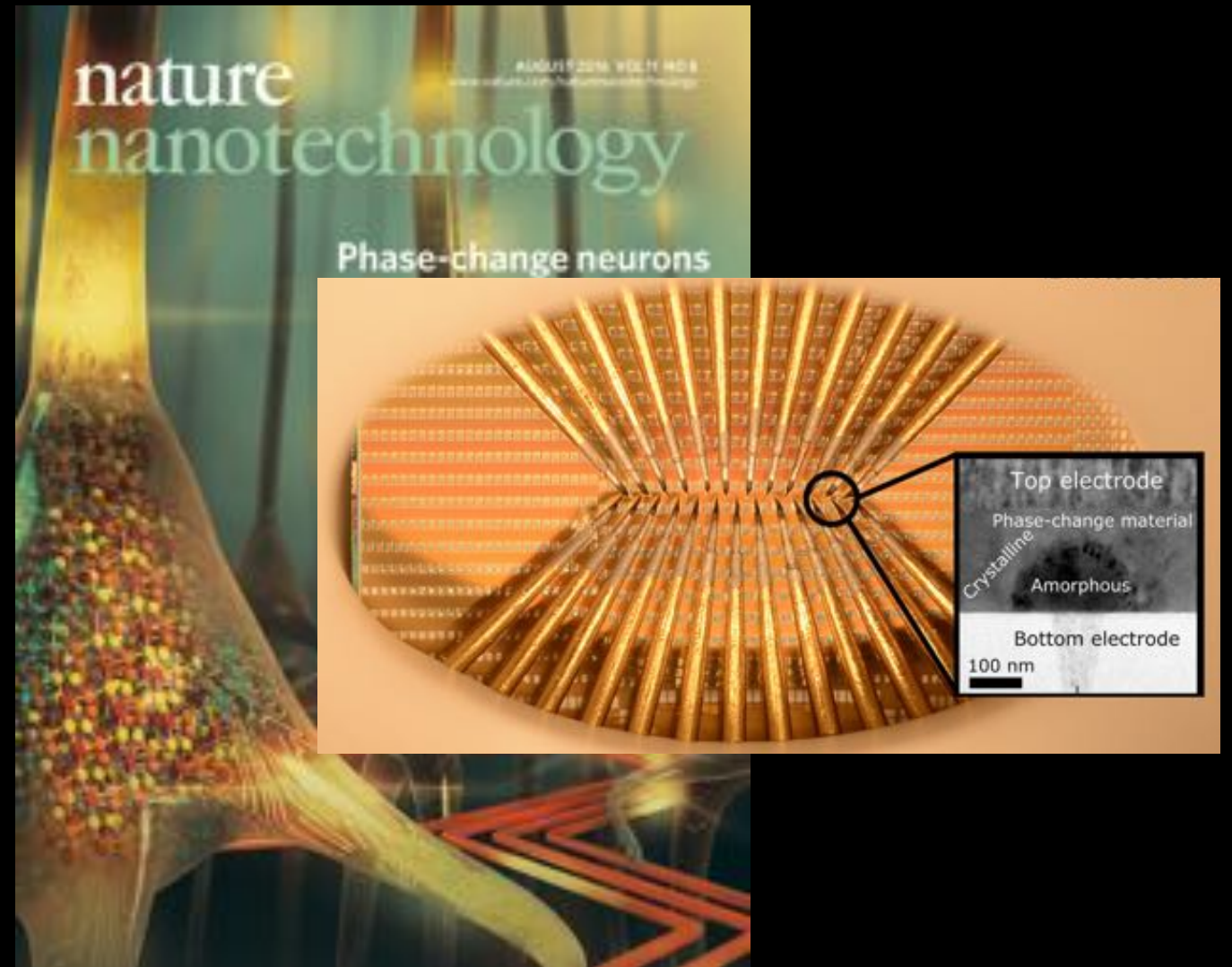
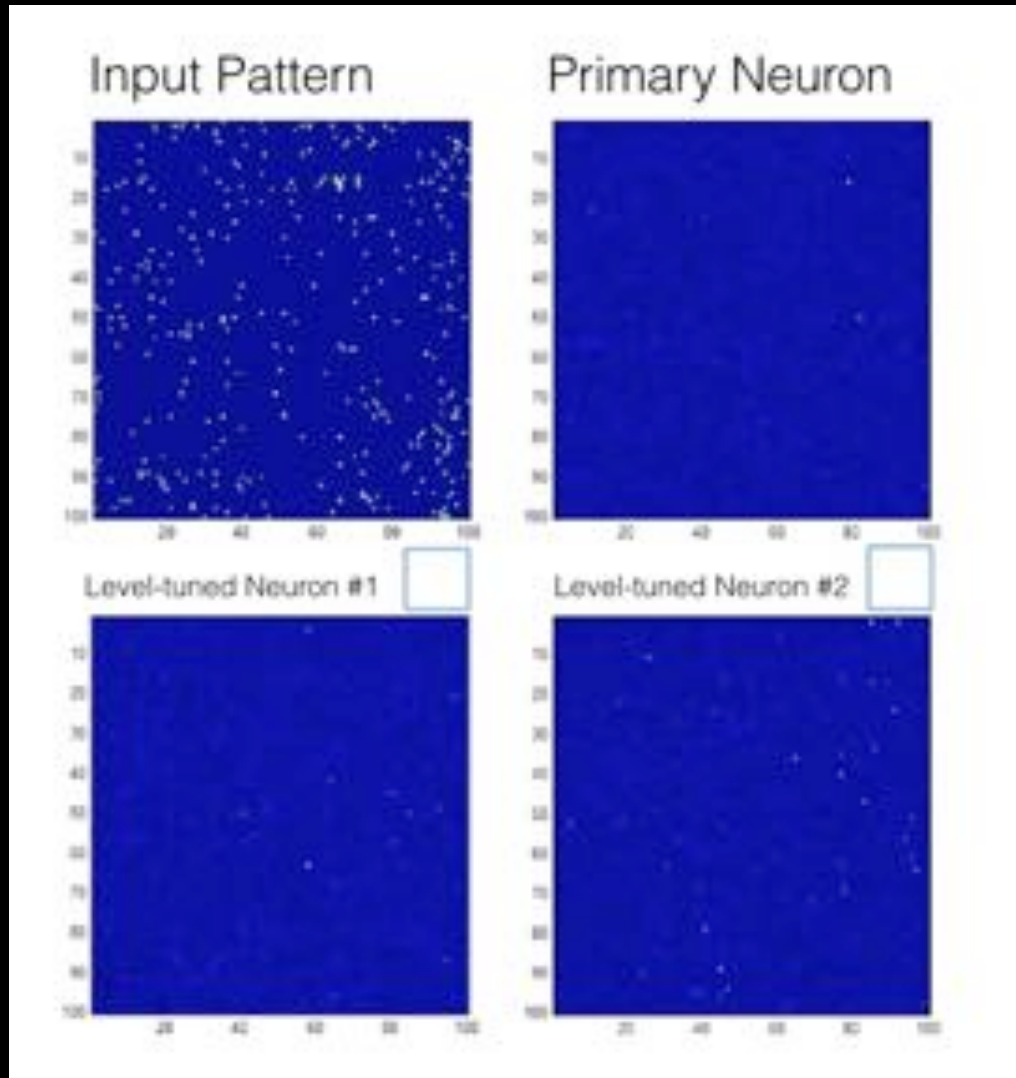


Output

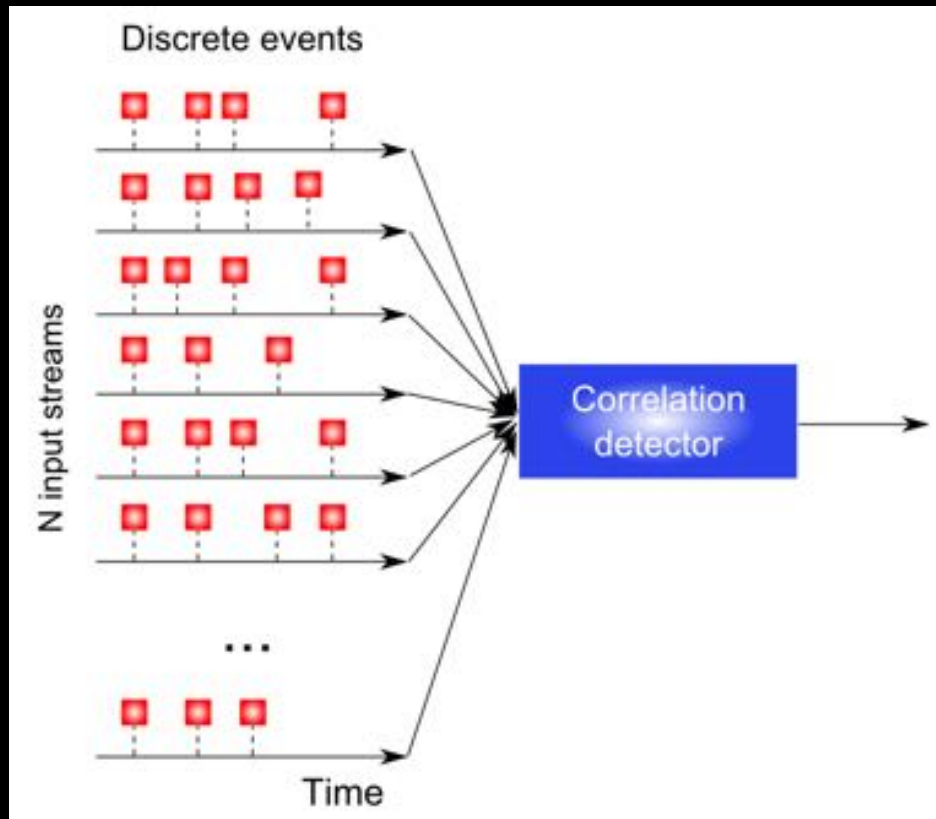




Detecting Correlations with a Spiking Neural Network



Temporal correlation detection



Algorithmic goals

- Determine whether some of the input data streams are statistically correlated
- Gain selectivity specifically to the correlated inputs
- Observe variations in the activity of the correlated input
- Quickly react to occurrence of coincident inputs in the correlated inputs
- Continuously and dynamically re-evaluate the learned statistics

Use only unsupervised learning & consume very low power



FINANCE



SCIENCE



MEDICINE



BIG DATA



IoT at the EDGE

IBM is building first universal quantum computers
for business and science



<https://www.research.ibm.com/ibm-q/>

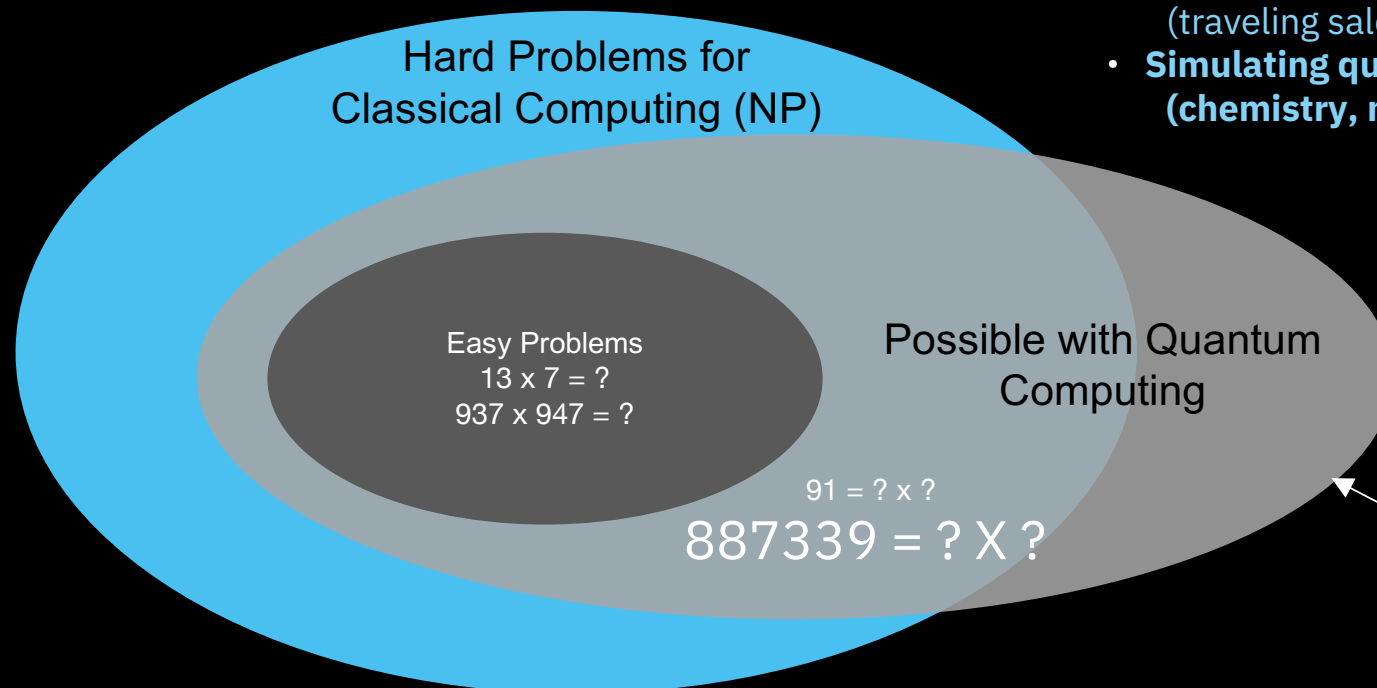
Quantum Computing as a path to solve intractable problems

Many problems in business and science are too complex for classical computing systems

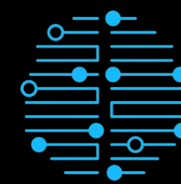
“hard” / intractable problems:

(exponentially increasing resources with problem size)

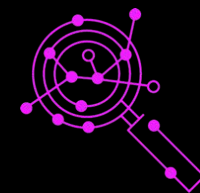
- **Algebraic algorithms**
e.g. factoring, systems of equations, for machine learning, cryptography,...
- **Combinatorial optimization**
(traveling salesman, optimizing business processes)
- **Simulating quantum mechanics**
(chemistry, material science,...)



Material,
Chemistry



Machine
Learning



Optimization

What are the basic units of information ?

Bit:

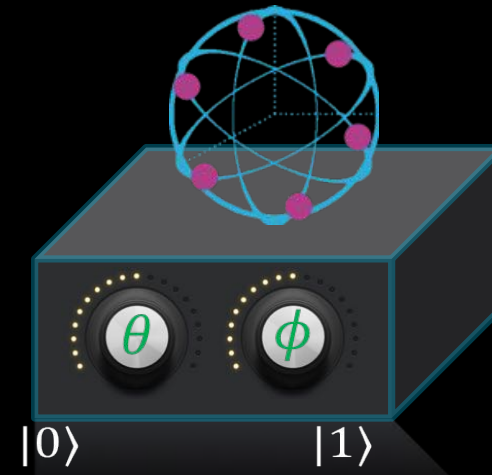


Bit state: 0 or 1

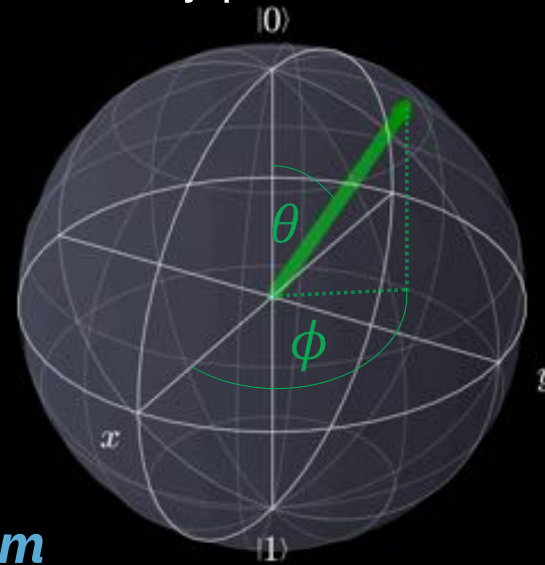


classical

Qubit:



Qubit state: 0 and 1, at the same time (= superposition) represented by point on (Bloch-)Sphere



quantum



Building a Universal Quantum Computer





Qubit 0 properties

f	5.35 GHz
T_1	54 μ s
T_2	74.3 μ s
κ_q	2.6×10^{-3}

2016-04-27 02:47



User Guide

Composer

My Scores

Name: Grover's Search Algorithm, IT

Real Quantum Processor



- Simulate
- Run
- View
- Save
- Save as
- Results
- Help

GATES: X, Z, Y, H, S, T, CNOT, MEASURE



Strategic imperatives: Defining and optimizing blockchain

Blockchain will do for trusted transactions what the Internet did for information.



Research leadership for IBM Blockchain

Leadership in
cryptography
for blockchain

Advanced
consensus
algorithms

AI +
blockchain

IoT devices
designed around
blockchain

Blockchain for Aerospace MRO

An irrefutable ledger to record flight events, operation conditions and maintenance actions. These logs can be kept in the cloud and shared across different parties including the original equipment manufacturer, the airline and the maintenance repair operator.

Image: Wikimedia Commons



Mobile Wallet

The Electric Car Which Pays for Itself

Charging

No need to manage various accounts with different service providers

Parking and Valet Services

Find and pay for desired parking spaces

Immutable Car Pass

A record for all car maintenance, milage, ownership, battery charges

Car Sharing

Accept payments and authorise vehicle access by 3rd parties, such as delivery services

