Open FinTech Forum

AI, Blockchain & Kubernetes on Wall Street

The Reality of Quantum Computing

Now and in the Future

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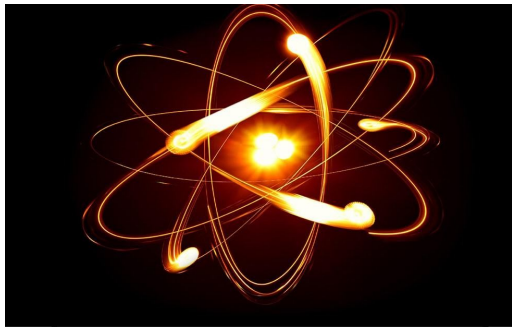
Great Expectations

- But the current state: Wild West
  - Funding: Governments see a chance to win a tech race in a new field. Billions of dollars are being spent
  - Confusion: Quantum Theory is counterintuitive. People dream of revolutionary solutions that a mostly based on missing some of the basics of QM.

A survey of existing approaches to quantum computing and their usefulness to current issues i the financial industry and an outlook to the future giving an estimate as to when competitive approaches to help solve issues may emerge from this direction of investigation.

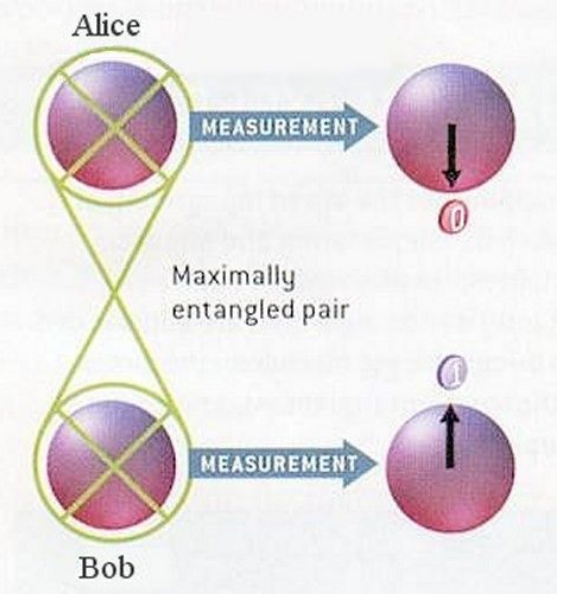
Quantum Mechanics: Basics

- Basic law at the lowest level. Everything is governed by QM.
- Schroedingers Wave function describes potentials of events
- Outcomes happen *measurements*
- von Neumann put down the basic theoretical work on Computer Science after publishing a book on the basics of QM.
- Numerous strong opinions on QM by Scientists

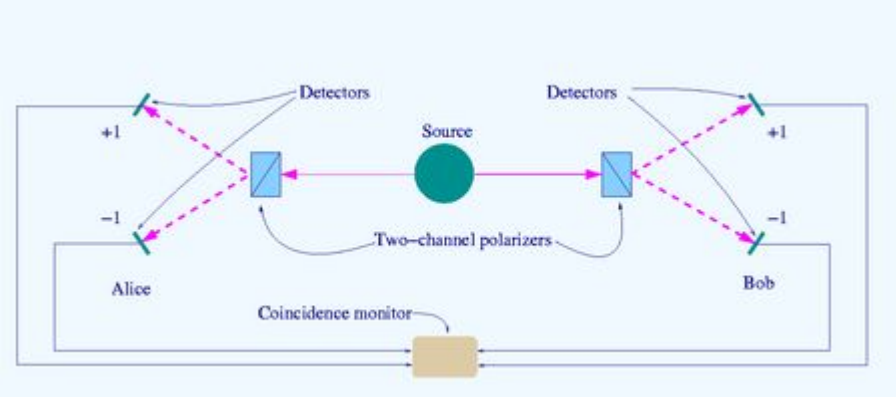


Quantum Mechanics: EPR Paradox

- Two quantum entangled particles in a “superposition”. One quantum system.
- Measurement of the spin on one determines the spin at the other after particles have separated.
- Spooky action at a distance?
- Communication faster than light?



Quantum Mechanics: Bells Inequality



- Mixed vs Entangled state changes statistics.
- If we create two entangled particles we can verify that the quantum system is not leaking information (which would be a measurement)
- John Bell: Proof that quantum mechanics is wrong was possible!
- This is the basic of *quantum secured communication*

Warning: Scientist utterly frustrated with QM

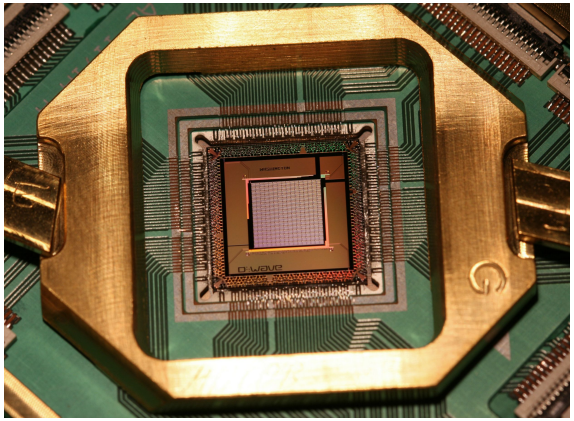
- Einstein: Unreasonable concept of Reality
- Schroedinger: Suggest the wave does not represent probabilities.
- Bell: We can prove that QM is wrong
- Bohm: Pilot wave makes QM deterministic
- Hawking: GUT will explain indeterminacies. They ultimately do not matter since they are restricted to a very low level.

What works: Quantum Cryptography

(use of QM phenomena for crypto)

- Single entanged system that provides detection of someone listening in.
- Securing keys against quantum computing approaches to break them by increasing the difficulties to break them using classical methods.
- Using Quantum mechanical systems to create new type of keys that are not breakable anymore with classic approaches even if more computational power becomes avialable.

Things called a “Quantum Computer”



- Miniaturized experiment in chip form to explore quantum effects.
- Quantum Cryptography
- D-WAVE Quantum Computer
- Quantum gates/Qubit based systems
- Experimental Computers in Labs and Research facilities
  - Photon based on chip technology. On chip mirrors.
  - Superconducting quantum computing

Shor’s algorithm

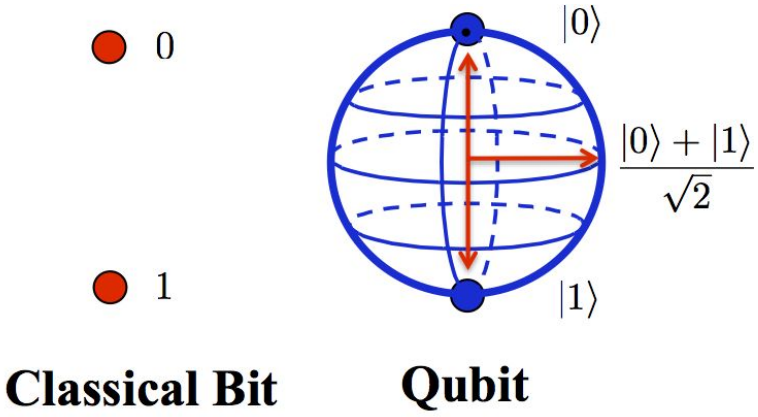
- A Quantum factorization algorithm (quantum fourier transformation) that is probability based. Solutions must be verified classically.
- Classic algorithms are exponential, quantum based ones are polynominal.
- Points to the possibility to develop quantum algorithms that can solve time intensive algorithms faster which could be an advantage for a company doing so in financial services. However, that may not be feasable given the effort that Shor’s algorithm required. Maybe when other quantum algorithms become workable.

D-Wave Quantum Computer

- First commercially available Quantum computer
- Origins not in quantum informatics but condensed matter physics.
- D-Wave 2000Q has 2048 Qubits.
- Controversy if this is a real quantum computer or not.
- Divergent claims of performance increases and counterclaims of doing the same performance on a classical computer.

Qubit: Maybe 0 and maybe 1

- Quantum Gates
- Reversibility
- Decoherence
- Scaling problems: Exponential relations
- Qubit max is Google: 72 bit, IBM: 50 Intel: 49 D-Wave: 2048



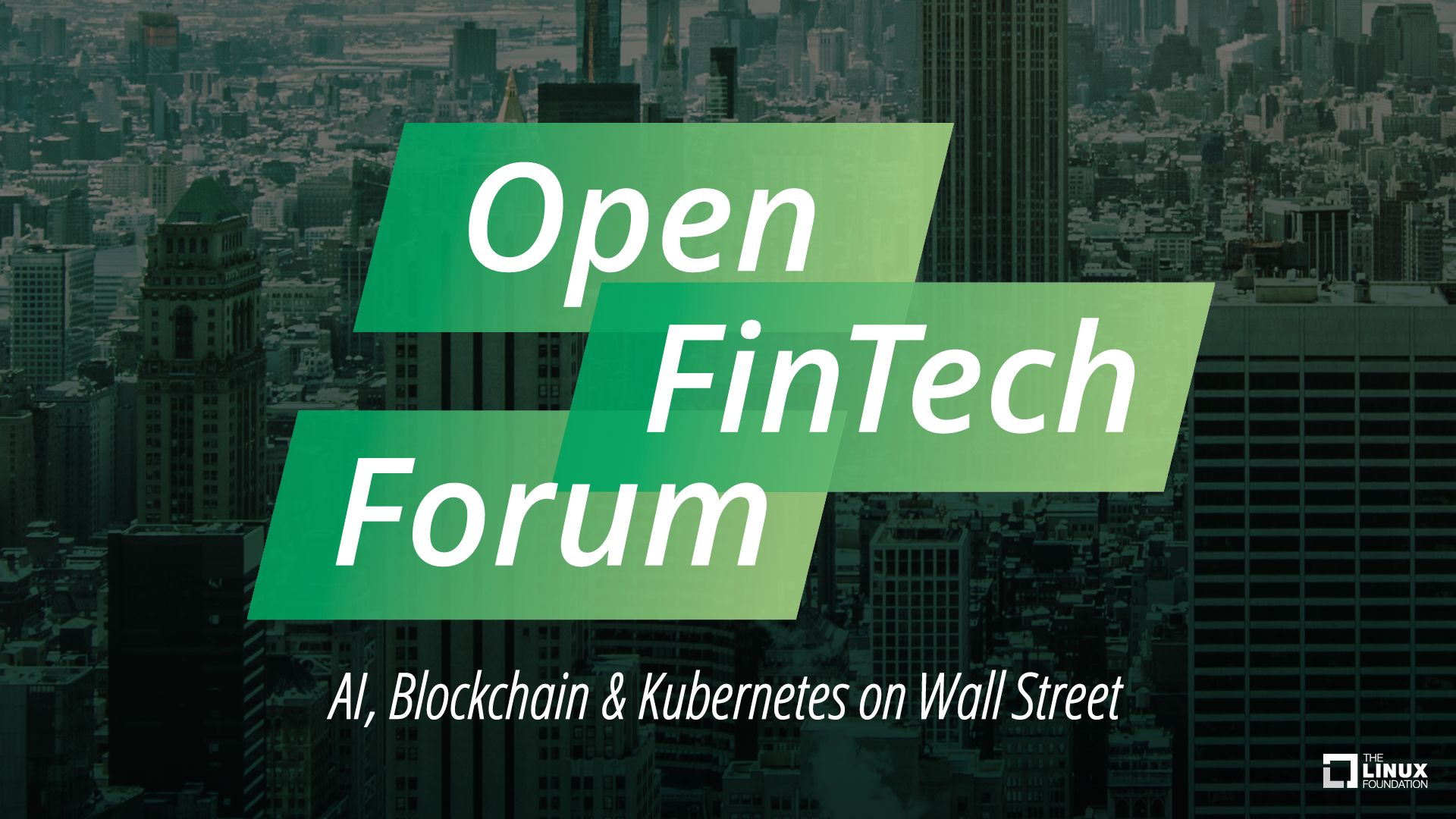
Use cases for Qbits

- Cryptography. Key breaking.
- Solving complex mathematical problems.
- Machine learning
- Health
- HPC areas
- Searching through large data sets (?)

What is useful for Financial Technology?

- Generally these approaches improve High performance computing which is key to various use cases.
- Quantum cryptography is likely going to be mandatory to secure communication in the future. Security is an ever increasing set of issues.

- Qubits and Quantum Operator point to a future in which we can design algorithms using quantum concepts.
- Currently quantum computing is a pretty confusing field that would need to stabilize before it can be useful in the financial technology sector.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