Quantum Computing

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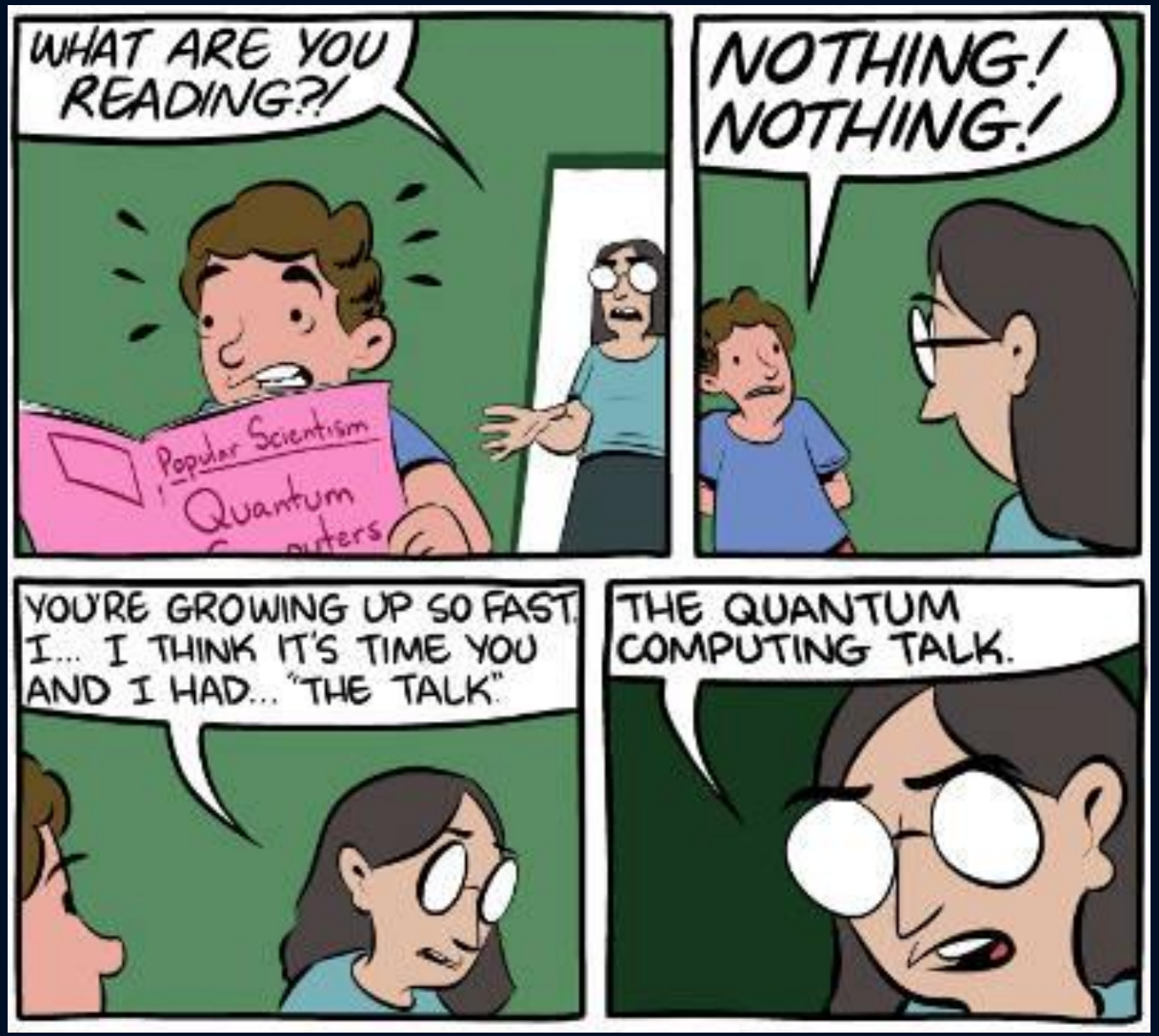
Contents

- Glossary
- Quantum Computing in Brief
- Methodology
- State of the Art and Open Issues
- Industry Leaders, Startup
- Bibliography

Glossary

- **Quantum Computing** is computing using quantum-mechanical phenomena, such as superposition and entanglement.
- **Qubit or Quantum bit** is the basic unit of quantum information—the quantum version of the classical binary bit physically realized with a two-state device.
- **Superposition** is a fundamental principle of quantum mechanics. It states that, much like waves in classical physics, any two (or more) quantum states can be added together ("superposed") and the result will be another valid quantum state;
- **Entanglement** is a physical phenomenon which occurs when pairs or groups of particles are generated, interact, or share spatial proximity in ways such that the quantum state of each particle cannot be described independently of the state of the other(s), even when the particles are separated by a large distance—instead, a quantum state must be described for the system as a whole.

Quantum Computing in Brief



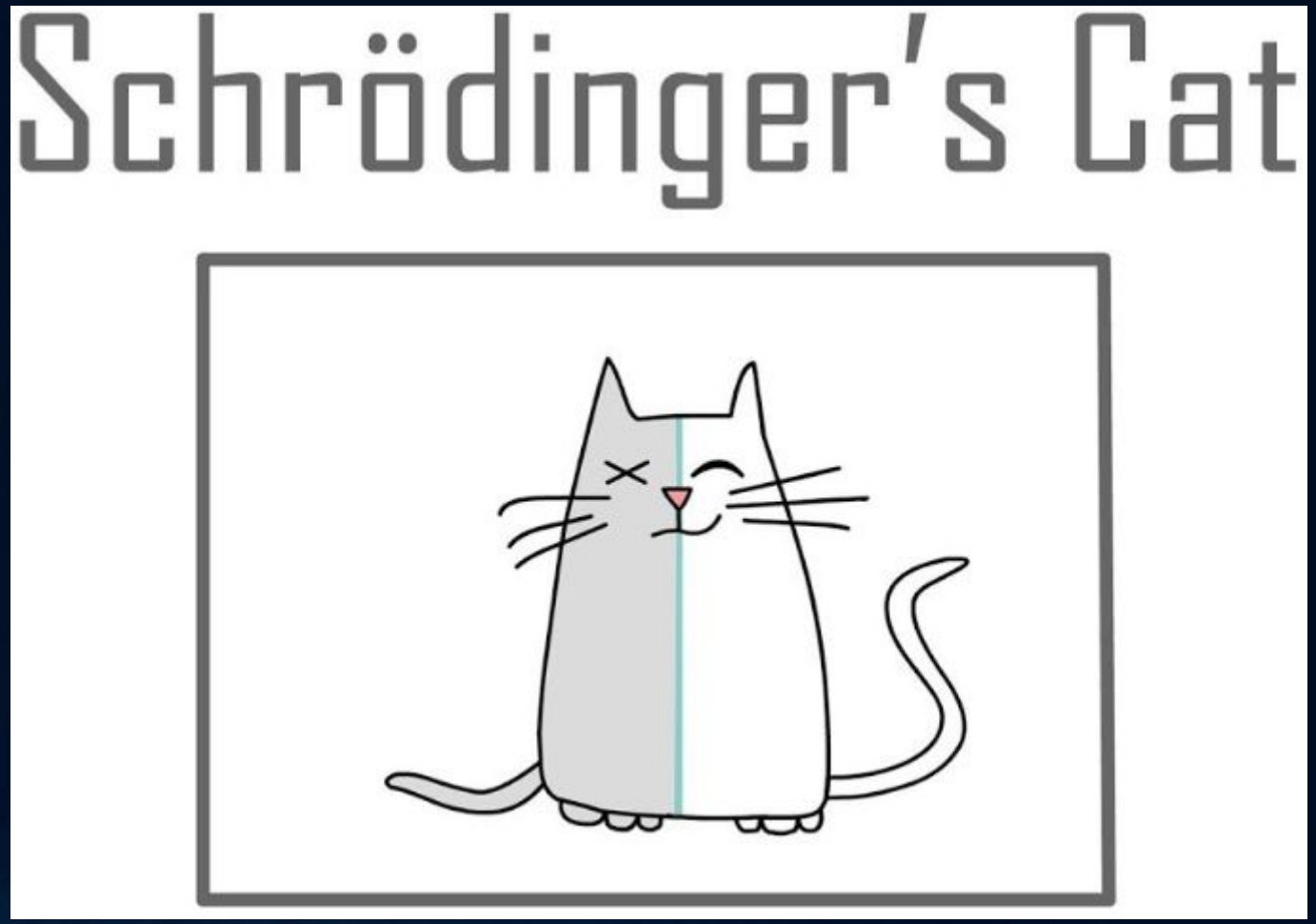
Quantum Computing in Brief:

- A quantum system replaces classical bits with quantum qubits
- Qubits follow the superposition principle and can exist as “0” and “1” at the same time
- Using qubits, one could process all possible combinations at the same time

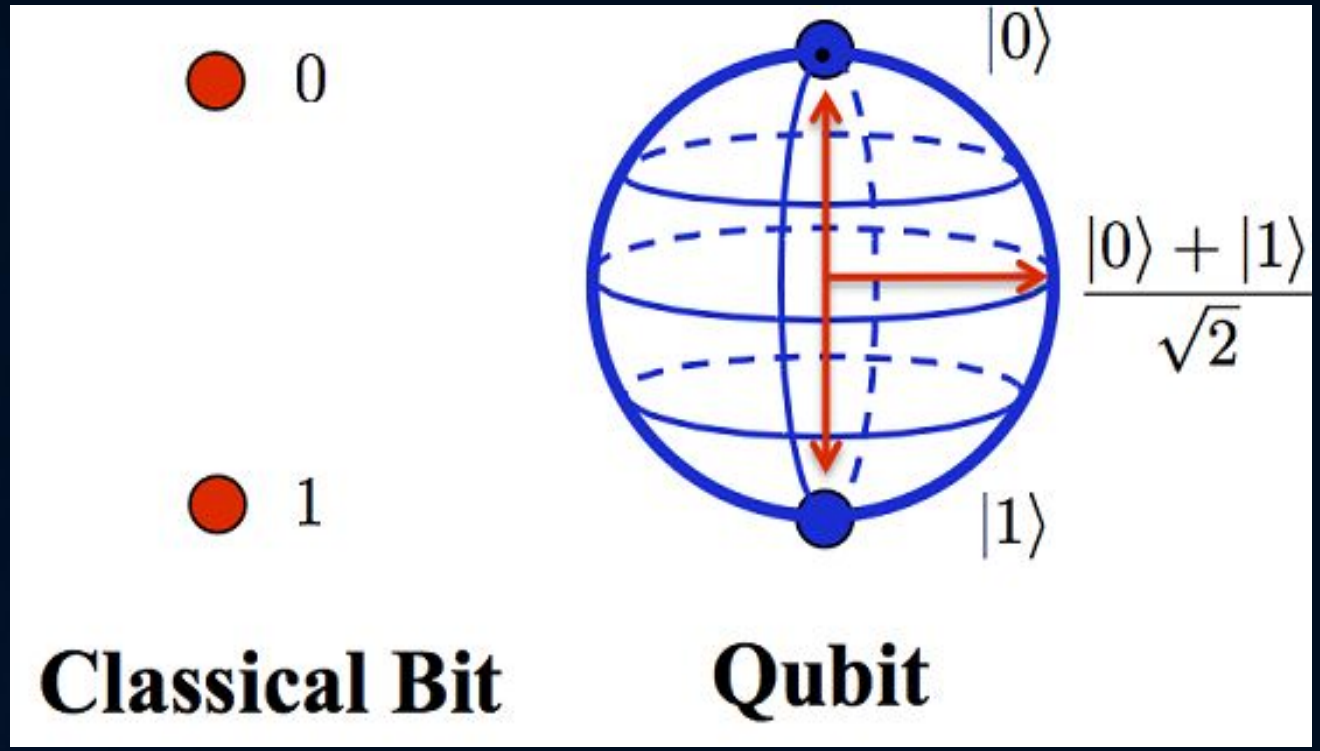
Quantum Computing in Brief: Quantum Theory

- Energy, like matter, consists of discrete units, rather than solely as a continuous wave.
- Elementary particles of both energy and matter, depending on the conditions, may behave like either particles or waves.
- The movement of elementary particles is inherently random, and, thus, unpredictable.
- The simultaneous measurement of two complementary values, such as the position and momentum of an elementary particle, is inescapably flawed; the more precisely one value is measured, the more flawed will be the measurement of the other value.

Methodology:
Developments of Quantum Theory



Methodology: Superposition

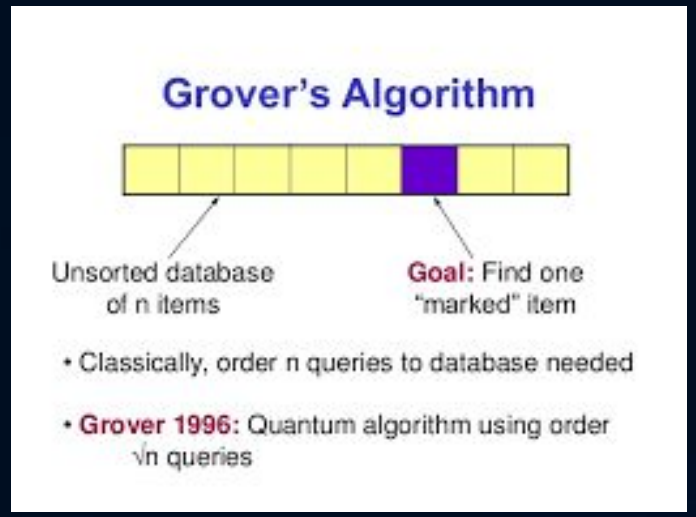


Methodology:
Quantum Programming
Shor's algorithm

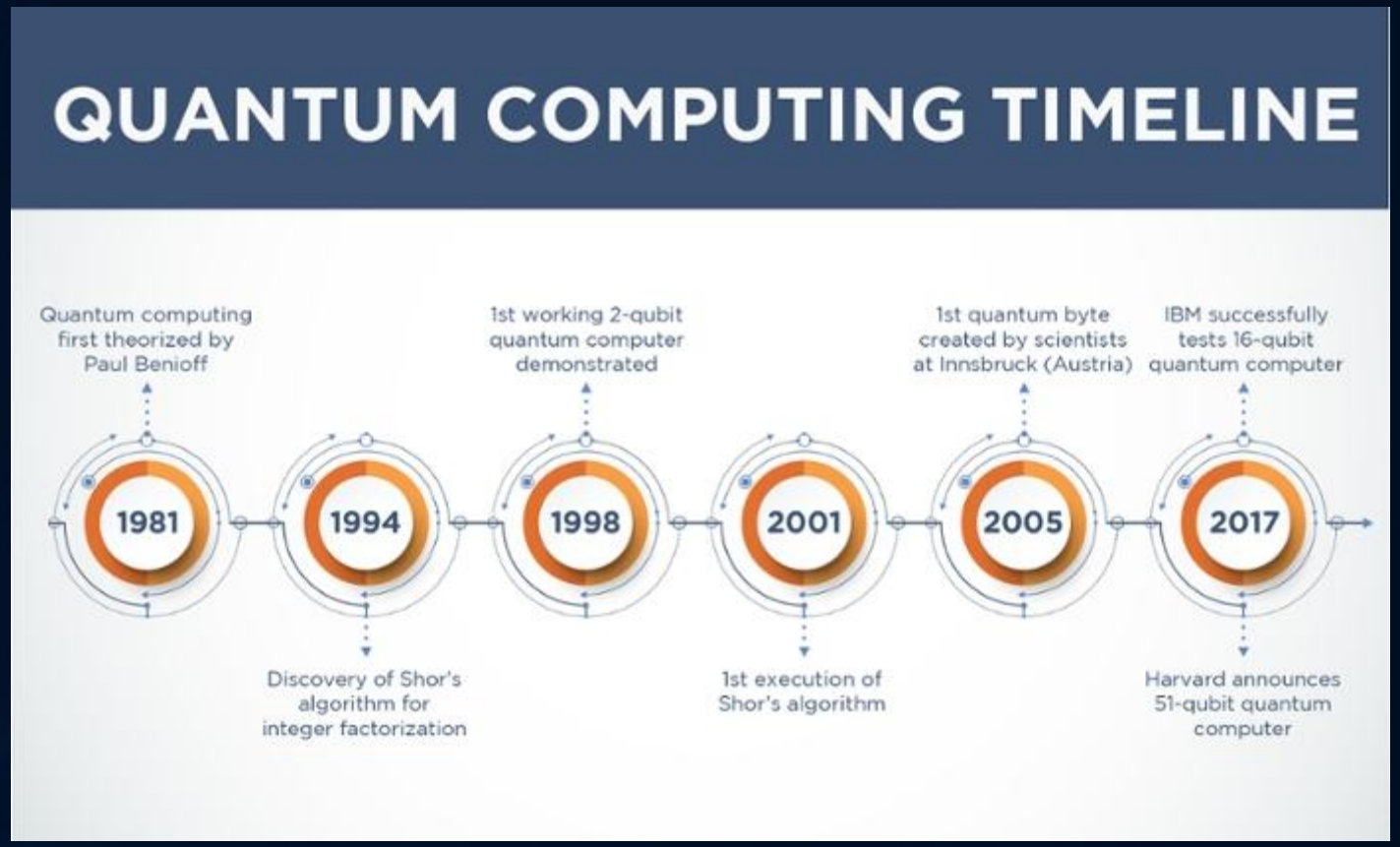
- Shor's algorithm is a quantum algorithm for integer factorization, informally, it solves the following problem: Given an integer M, find its prime factors.
- On a quantum computer, to factor an integer N, Shor's algorithm runs in polynomial time (the time taken is polynomial in logN, which is the size of the input).

Methodology:
Quantum Programming
Grover's algorithm

- Grover's algorithm is a quantum algorithm that finds with high probability the unique input to a black box function that produces a particular output value, using just $O(\sqrt{N})$ evaluations of the function, where N is the size of the function's domain



State of the Art and Open Issue:
State of the Art



State of the Art and Open Issue: Open Issue

- Interference
- Error correction
- Output observance

Industry Leaders, Startups

Name	Score	Pubs	Confs	Grants	Patents	TSMs	News	Web
Microsoft	7169.7	63	25	–	46	–	135	–
Massachusetts Institute of Technology	2313.1	159	48	33	–	–	127	–
IBM	2092.8	82	13	5	31	–	126	–
Harvard University	1605.4	165	8	18	3	–	73	–
Google	1313.2	29	6	–	4	–	176	–
University of Oxford	1029.6	184	44	62	–	–	41	–
D-Wave Systems	800.6	16	4	–	36	–	89	8
1Qb Information Technologies	782.5	–	–	–	6	2	–	–
University of Waterloo	619.4	229	61	–	–	–	32	–
National University of Singapore	617.0	214	57	1	–	–	46	–


HOW'S YOUR QUANTUM COMPUTER PROTOTYPE COMING ALONG?
GREAT!
Dilbert.com DilbertCartoonist@gmail.com
THE PROJECT EXISTS IN A SIMULTANEOUS STATE OF BEING BOTH TOTALLY SUCCESSFUL AND NOT EVEN STARTED.
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CAN I OBSERVE IT?
THAT'S A TRICKY QUESTION.

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THANK FOR ATTENTION!