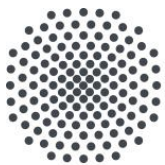


Quantum Computing Fundamentals



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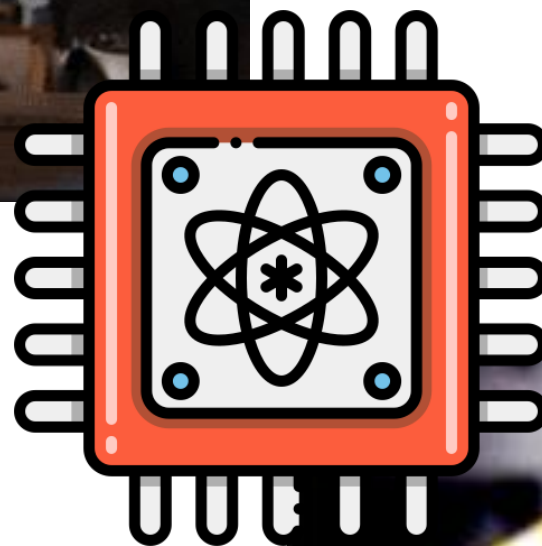
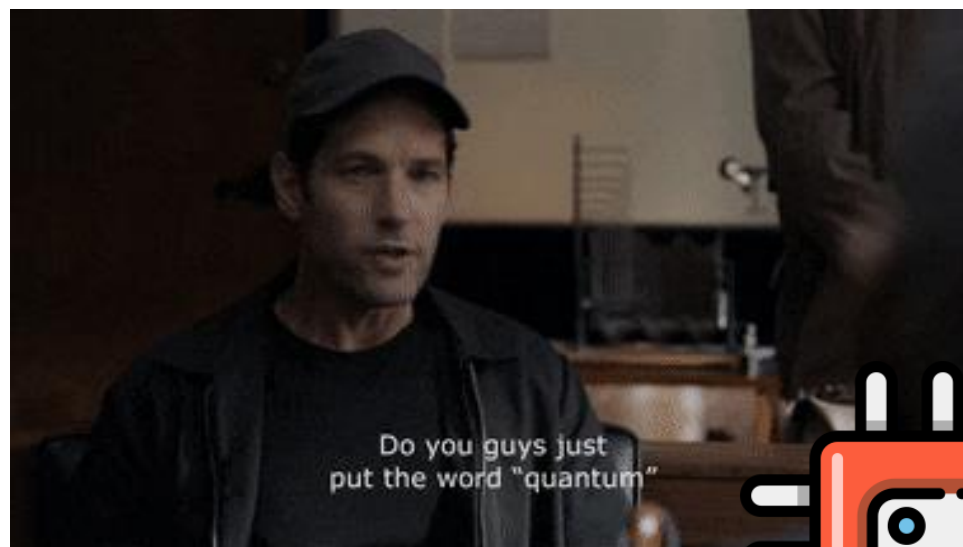
Martin Beisel
Juan M. Murillo

Institute of Architecture of Application Systems

Jose Garcia-Alonso
Benjamin Weder



UNIVERSIDAD
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Introduction to Quantum Computing

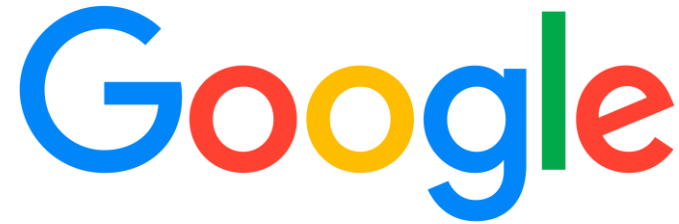
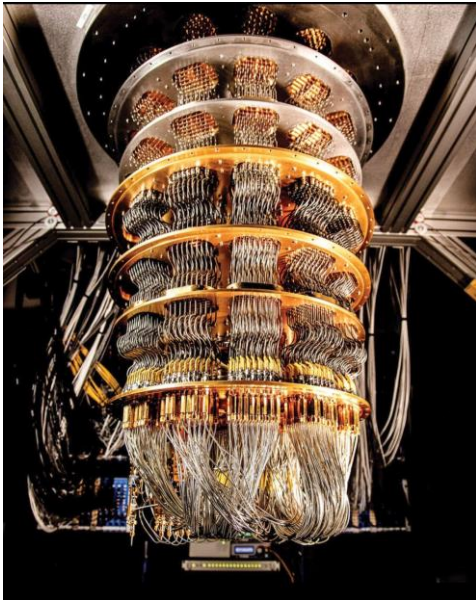
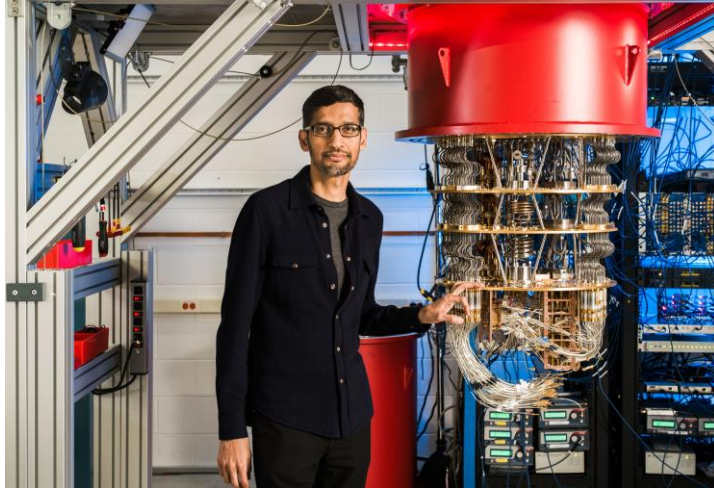
Introduction to Quantum Computing



1900s

- Einstein
- Planck
- Bohr
- Feynman
- Schrödinger
- ...

Introduction to Quantum Computing



The Quantum Computing Company™

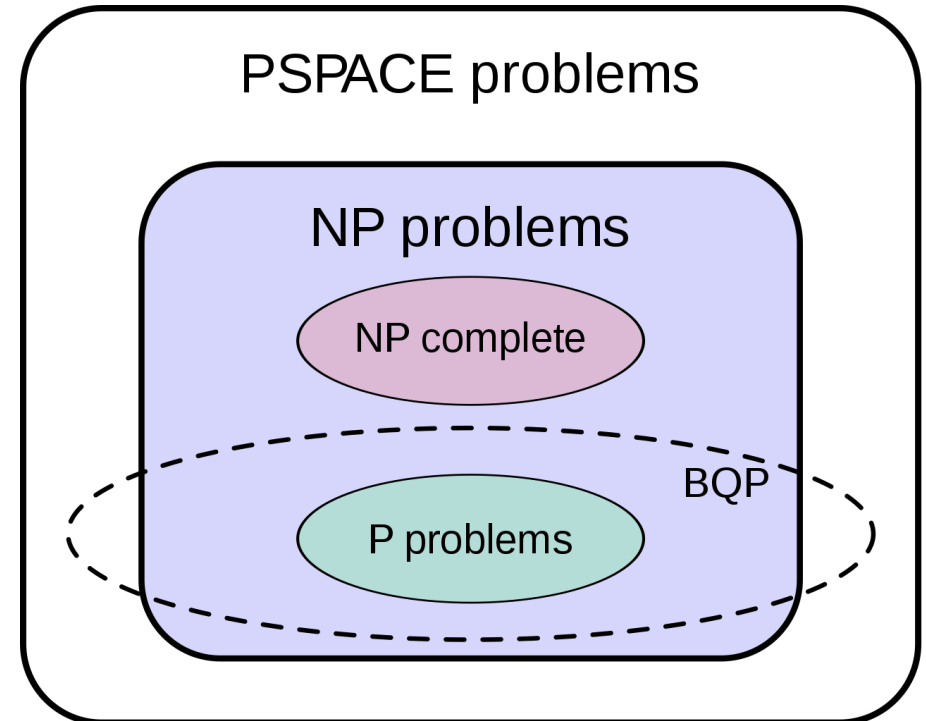


Fundamental Principles

Fundamental Principles

- **Computational complexity theory**

Bounded-error Quantum Polynomial time (BQP) is the class of decision problems solvable by a quantum computer in polynomial time, with an error probability of at most $1/3$ for all instances



Fundamental Principles

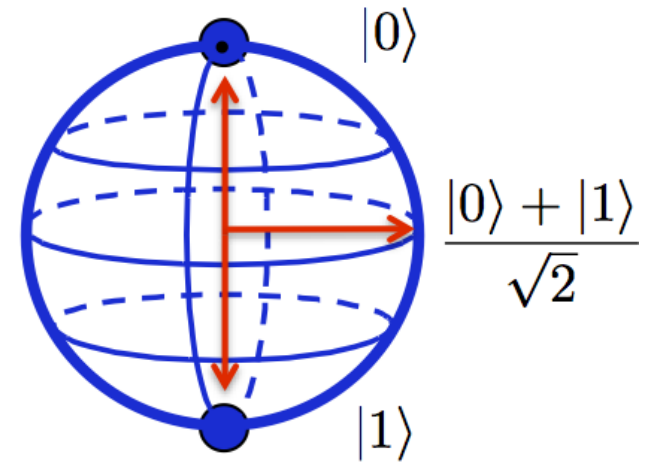
- Qubit

Basic unit of quantum information

● 0

● 1

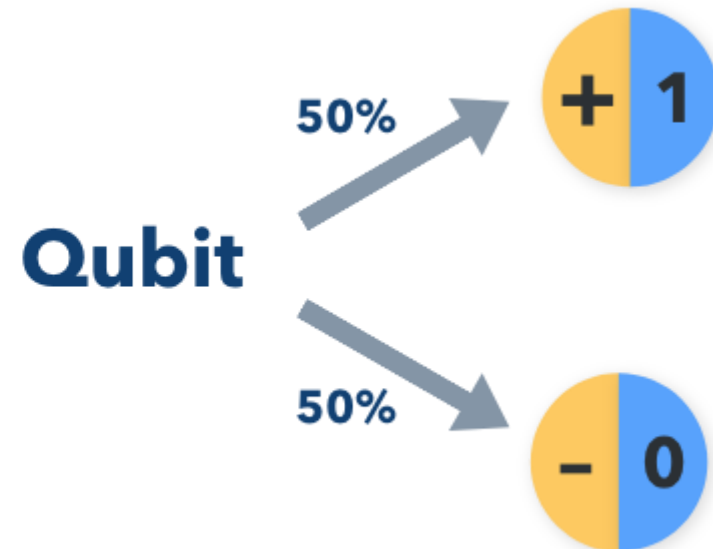
Classical Bit



Qubit

Fundamental Principles

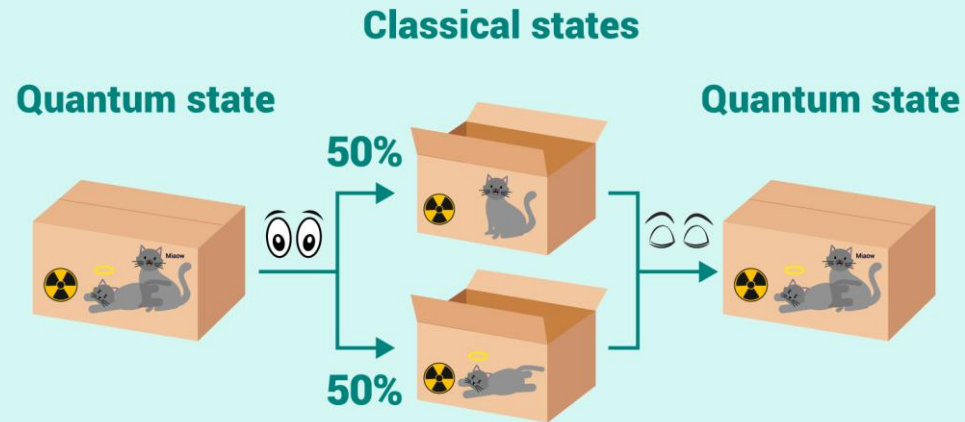
- Qubit collapse



Fundamental Principles

- Qubit superposition

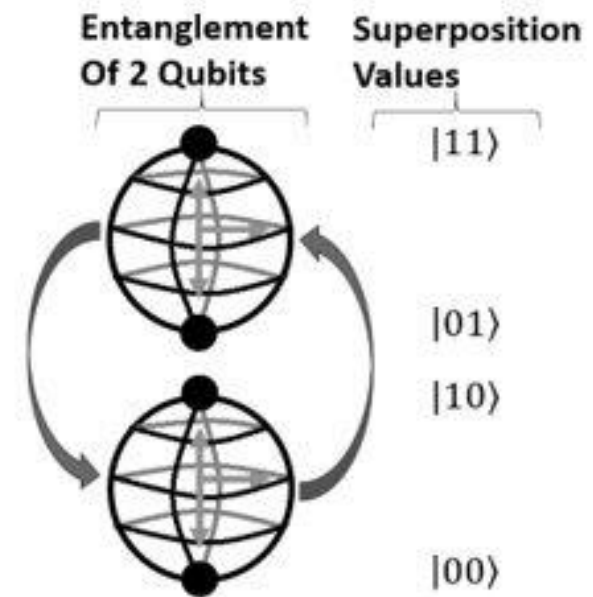
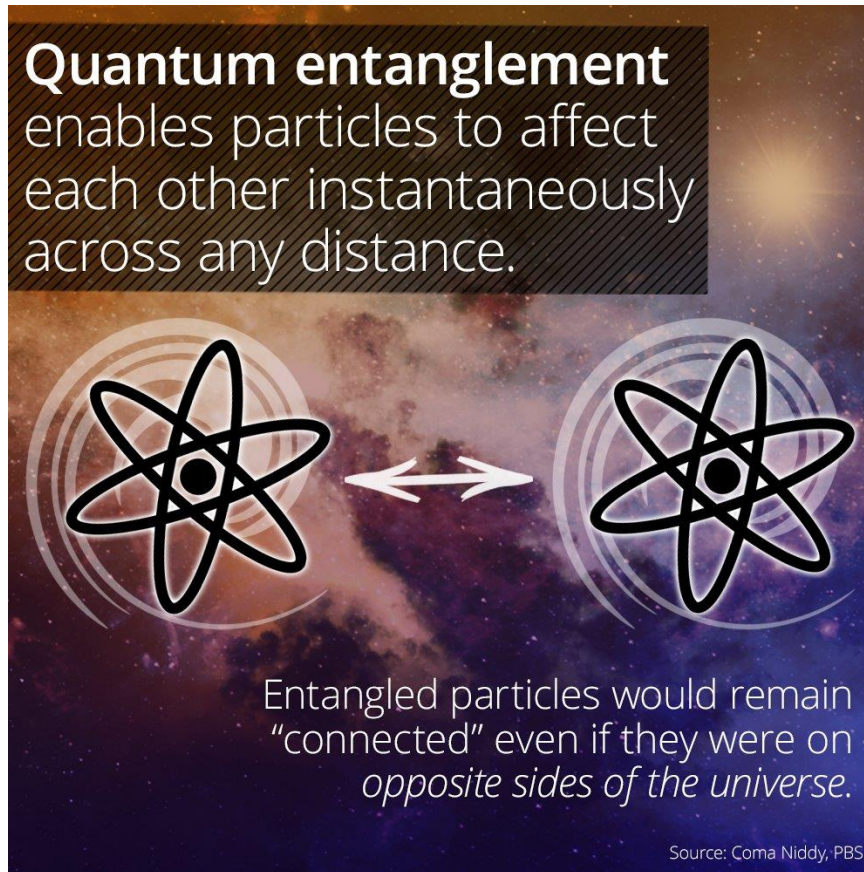
Schrödinger's Cat



The observation changes the quantum state of 'dead AND alive' to a classical state of 'dead' OR 'alive'. Without observation, the cat restores its superposition of states.

Fundamental Principles

- Qubit entanglement

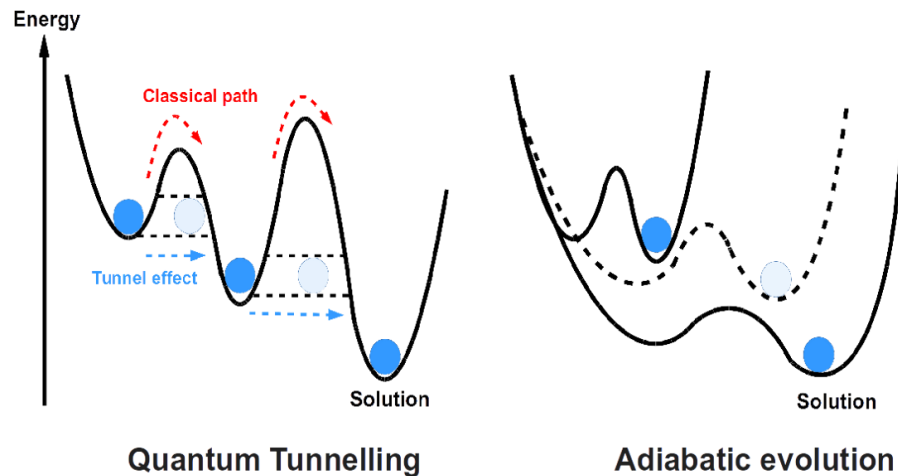


Quantum Programming

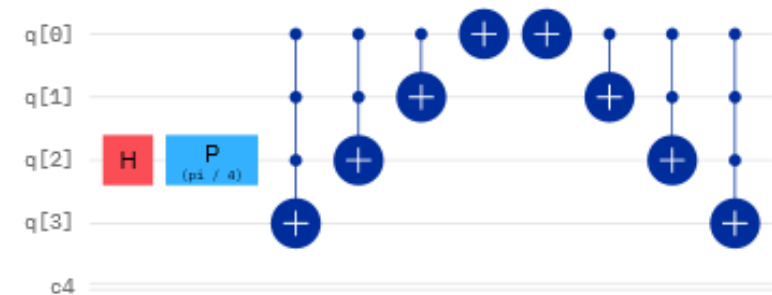
Quantum Programming

■ Types of programming

Quantum annealing (which also includes adiabatic quantum computation) is a quantum computing method used to find the optimal solution of problems involving many solutions

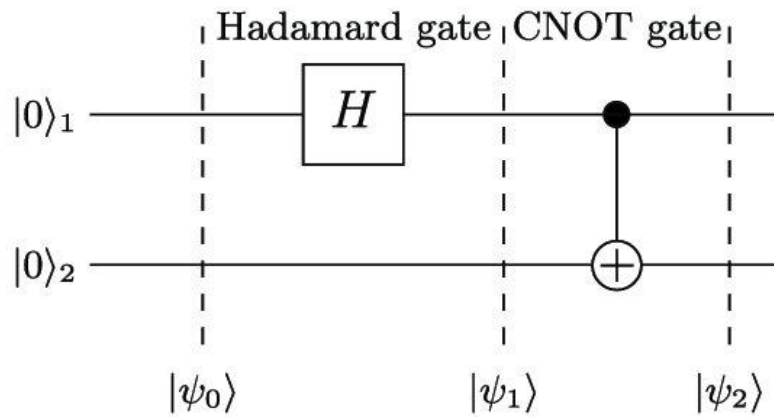


Universal quantum gate model is based on creating quantum structures using stable qubits and solving today's problems with **quantum circuits**

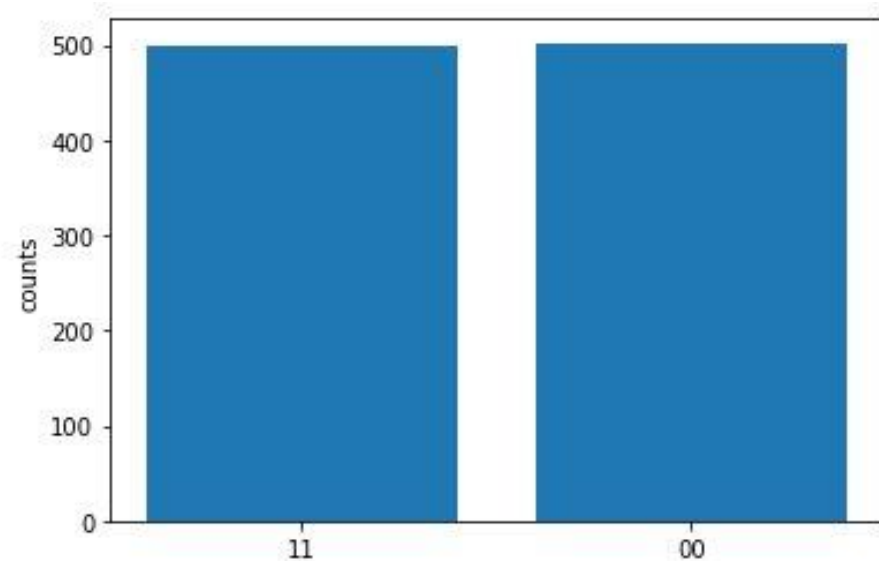


Quantum Programming

- Quantum circuits

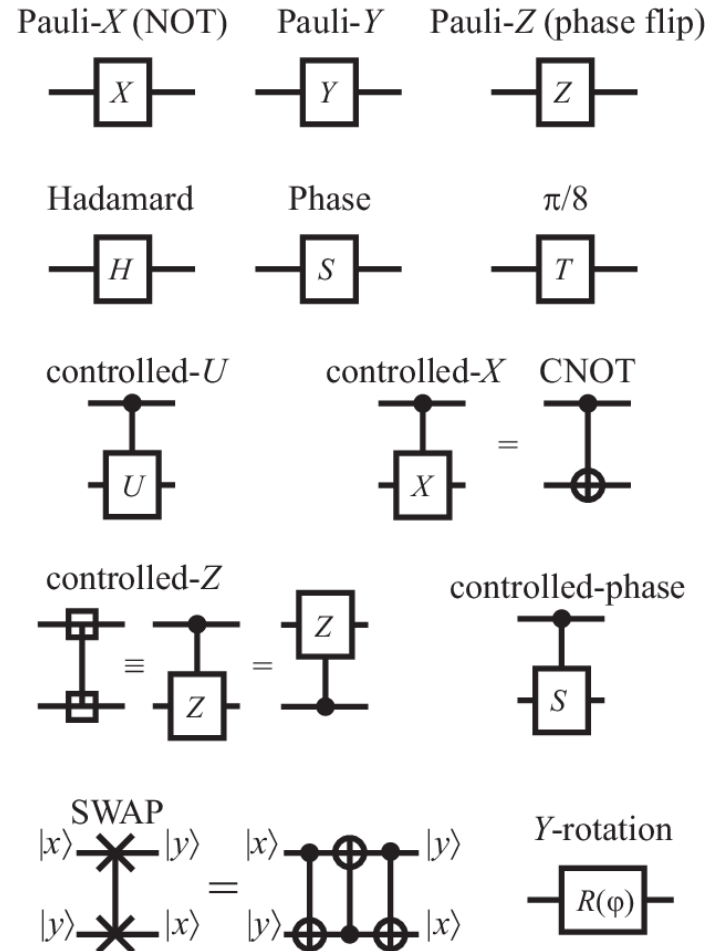


```
bell = Circuit().h(0).cnot(0, 1)
```



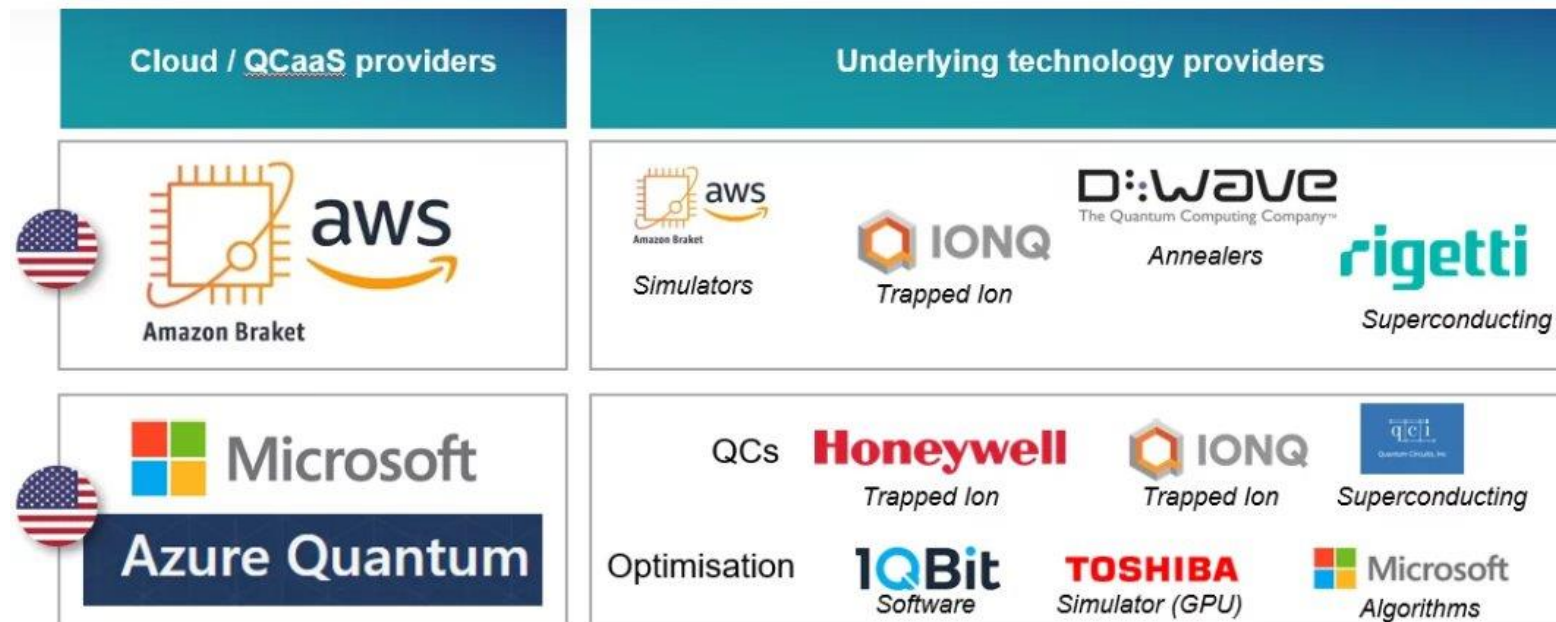
Quantum Programming

- Quantum gates

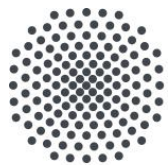


Quantum Programming

- Quantum Service Providers



Quantum Computing Fundamentals



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