Introdução a Quantum Computing

Alexandre Silva - BCC

Objetivos

- Mostrar um pouco o mundo da computação quântica;
- Dar o pontapé inicial;
- Instigar o estudo dessa área.

MATERIAIS

github.com/Dpbm/introduction-to-quantum-computing/

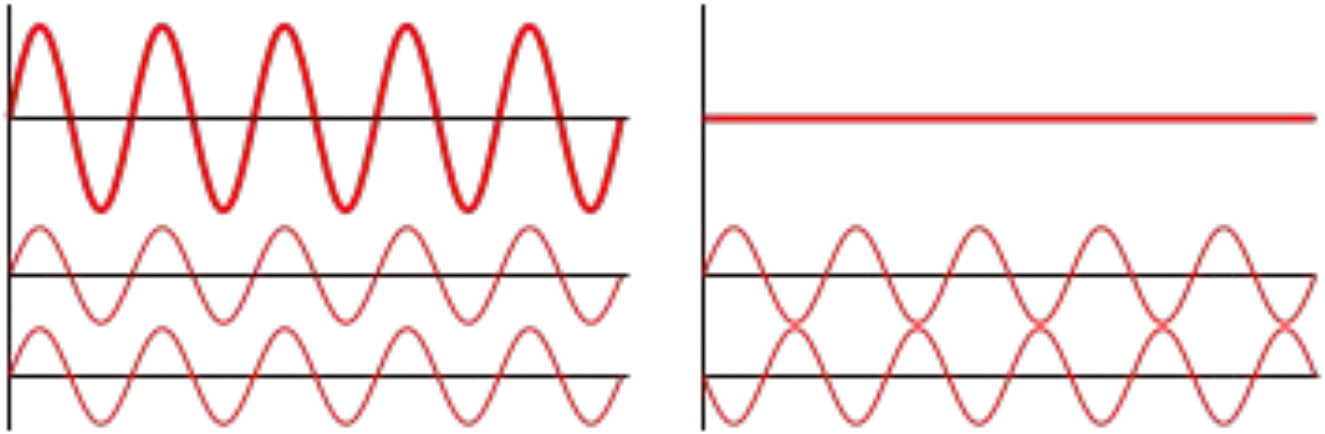
O que é computação quântica?

“Computação quântica é uma tecnologia, emergente, que se aproveita da mecânica quântica para resolver problemas”.

Fonte: IBM

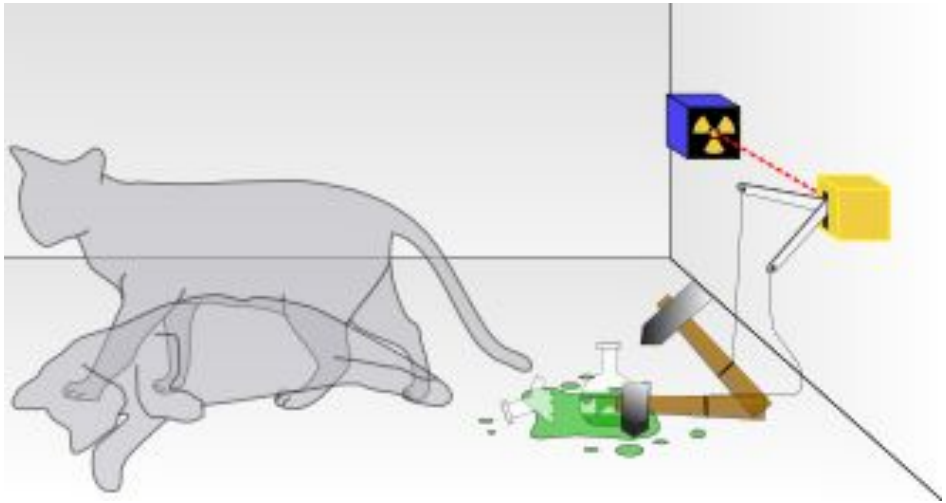
Quais efeitos ela se aproveita?

Interferência



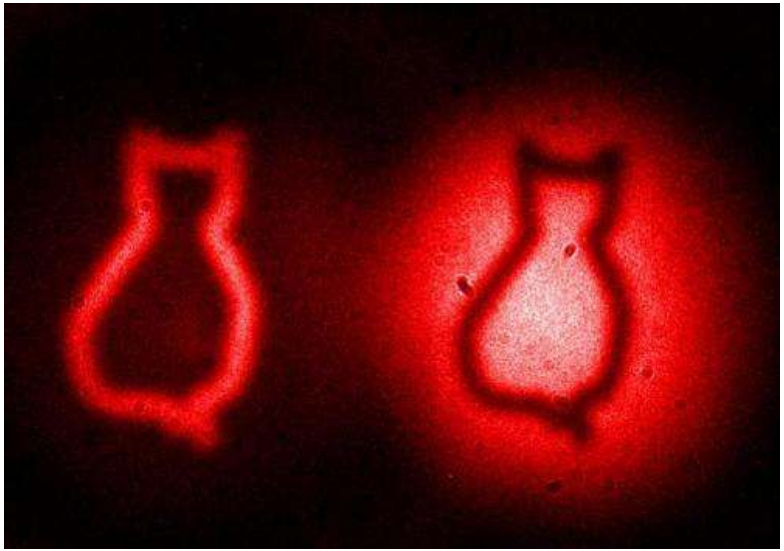
Fonte: Wikipedia

Superposição



Fonte: Wikipedia

Entanglement



Fonte: PhysOrg

Princípio da incerteza de Heisenberg

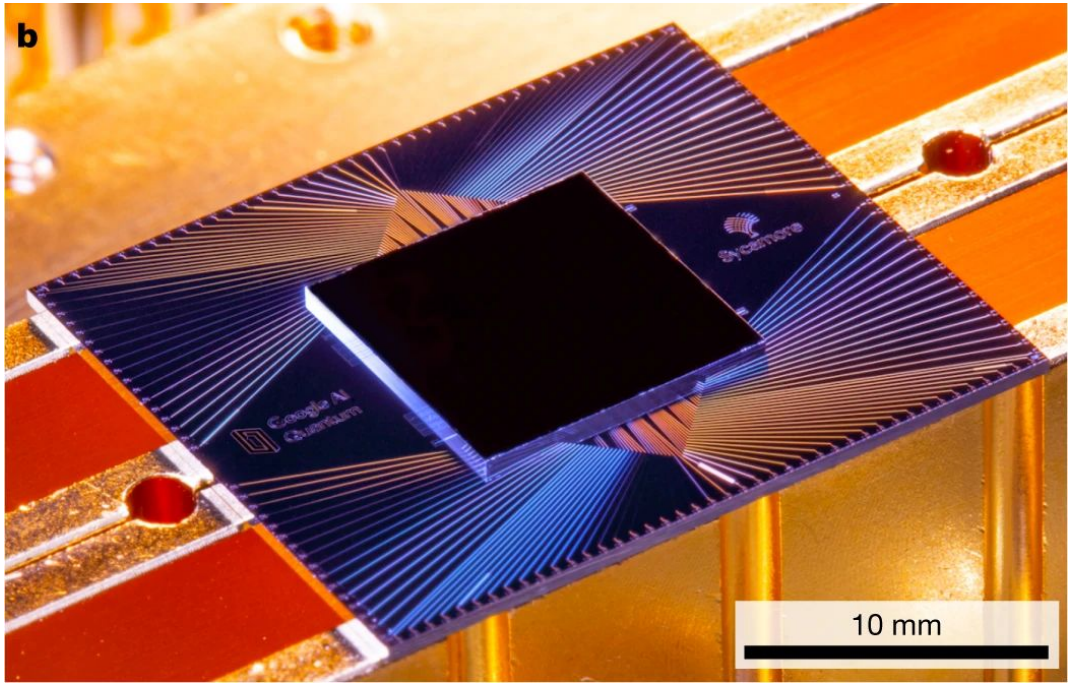
Fonte: Caltech

Tipos de Computadores Quânticos

Fonte: YouTube

Fonte: Pasqal

Fonte: IBM



Fonte: Nature

Fonte: Youtube

Senai São Paulo
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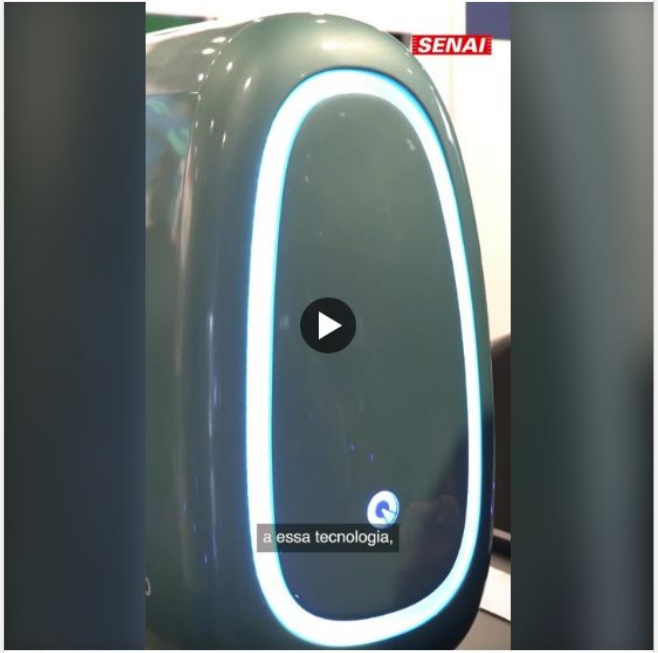
O SENAI-SP recebeu o primeiro computador educacional quântico do Brasil! Com a missão de democratizar o acesso a essa tecnologia, vamos mobilizar grupos de estudantes, pesquisadores, professores e empresários para propagar o conhecimento básico e possibilitar o desenvolvimento de novas aplicações para o seu uso. Assista e saiba mais!

#SENAISP #quantico #computadorquantico #tecnologia



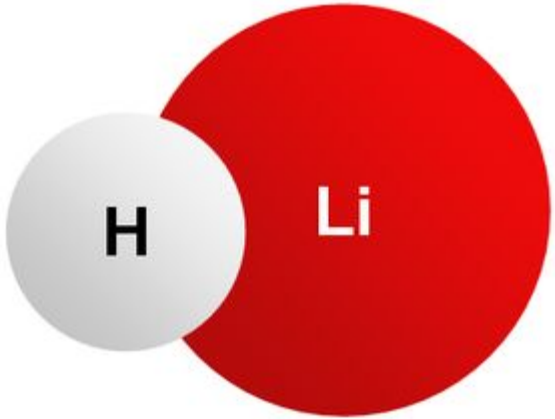
1,144 27 comments · 150 reposts

Tipo	Prós	Contras
Superconducting	Facil de produzir; Veloz.	Erros; Preço.
Trapped ions	Estável; Rearranjo de conexões; Mais barato.	Camára de vácuo; Mais lento;
Neutral atoms	Flexível; Escalável.	Mais lento; Estados são perdidos.
NMR	Teoricamente estável; Escalável para certas aplicações.	Limitados; Erros(tempo gates/tempo de coerencia);

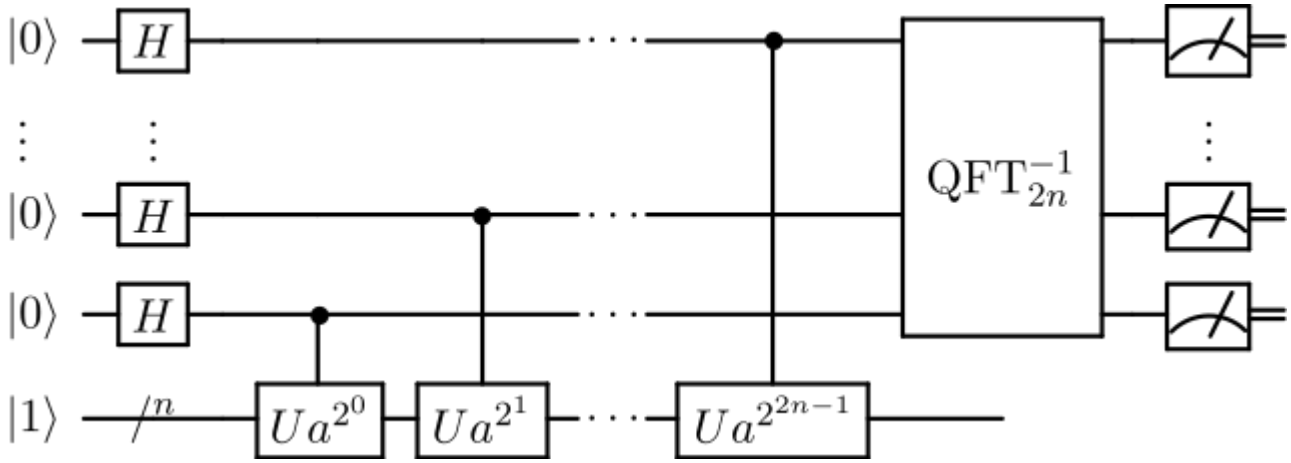
Aplicações

Alguns casos de uso

- Quimíca;
- Física;
- Criptografia;
- Banco de dados;
- Machine learning;
- Problemas NP.



Fonte: Wikipedia



Fonte: Wikipedia

ars TECHNICA

BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE STORE

REALITY CHECK —

RSA's demise from quantum attacks is very much exaggerated, expert says

Expert says the focus on quantum attacks may distract us from more immediate threats.

DAN GOODIN - 1/25/2023, 10:15 PM

Enlarge

64

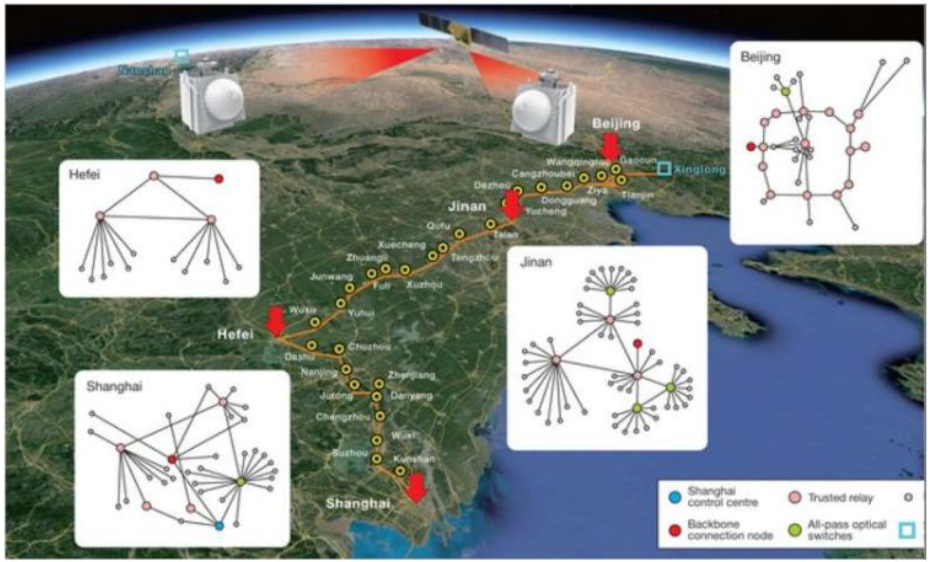
Three weeks ago, panic swept across some corners of the security world after researchers discovered a breakthrough that, at long last, put the cracking of the widely used RSA encryption scheme within reach by using quantum computing.

Fonte: ArsTechnica

JANUARY 6, 2021

The world's first integrated quantum communication network

by University of Science and Technology of China



Chinese scientists have established the world's first integrated quantum communication network, combi…

Chinese scientists have established the world's first integrated quantum

Fonte: PhysOrg

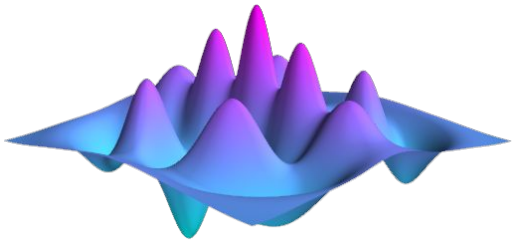
Ferramentas

Plataformas

- AWS (Braket);
- Azure;
- IBM;
- IONQ;
- Pasqal;
- Dwave;
- IQM.

Programação

- Braket;
- Q#;
- Cirq;
- Qiskit;
- tket;
- openqasm;
- PennyLane;
- QuTip.



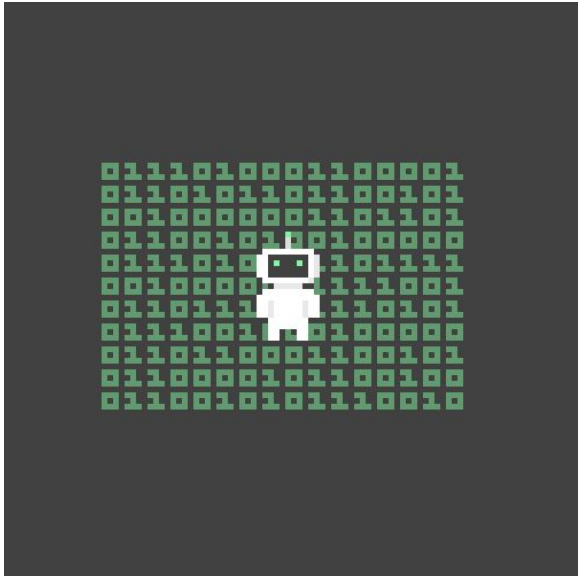
Qiskit

PENNYLANE

Como funciona?

Computação Clássica

- Binário (0, 1);
- Cada unidade é denominada Bit;
- Informações podem ser manipuladas usando operações Booleanas;
- Representação de inúmeros tipos de informação (imagens, aúdios, texto, números, etc.).

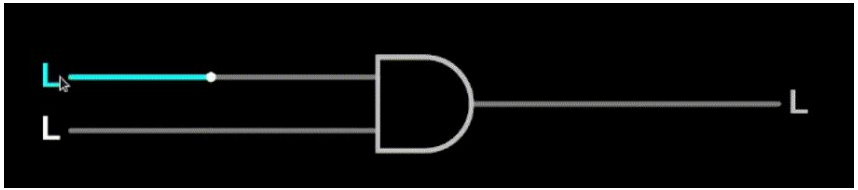


Fonte: Giphy

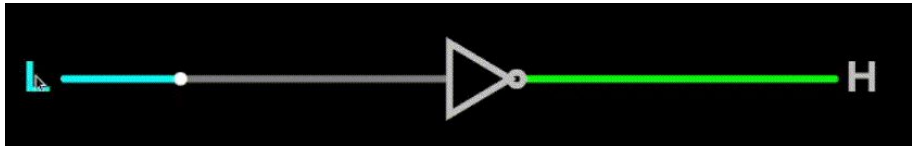
Fonte: MercadoLivre

Fonte: YouTube(Kurzgesagt)

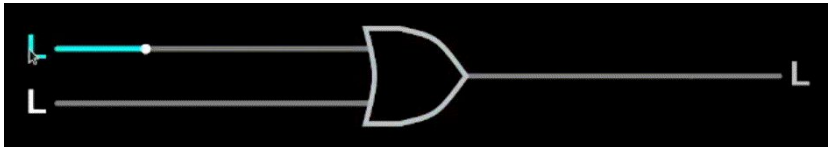
AND



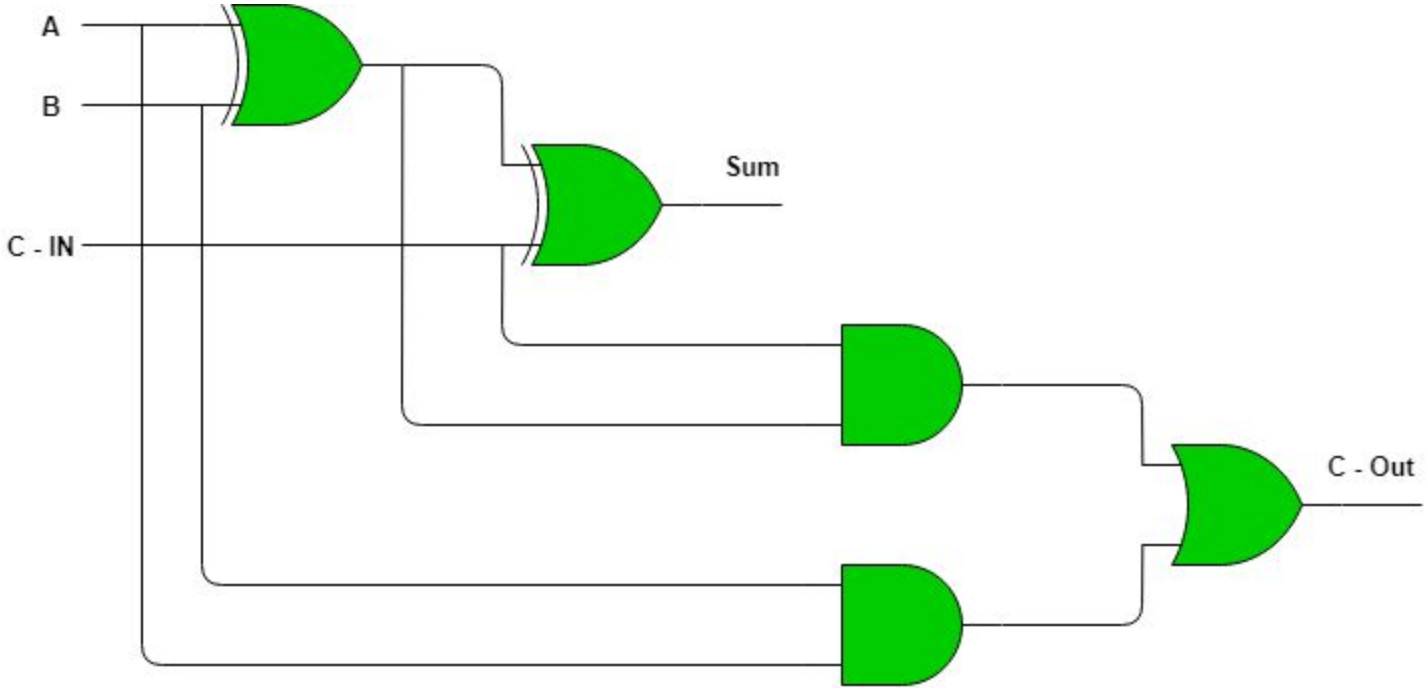
NOT



OR



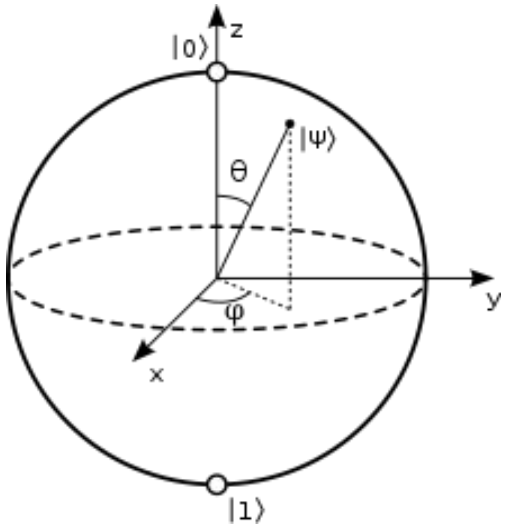
Somador completo



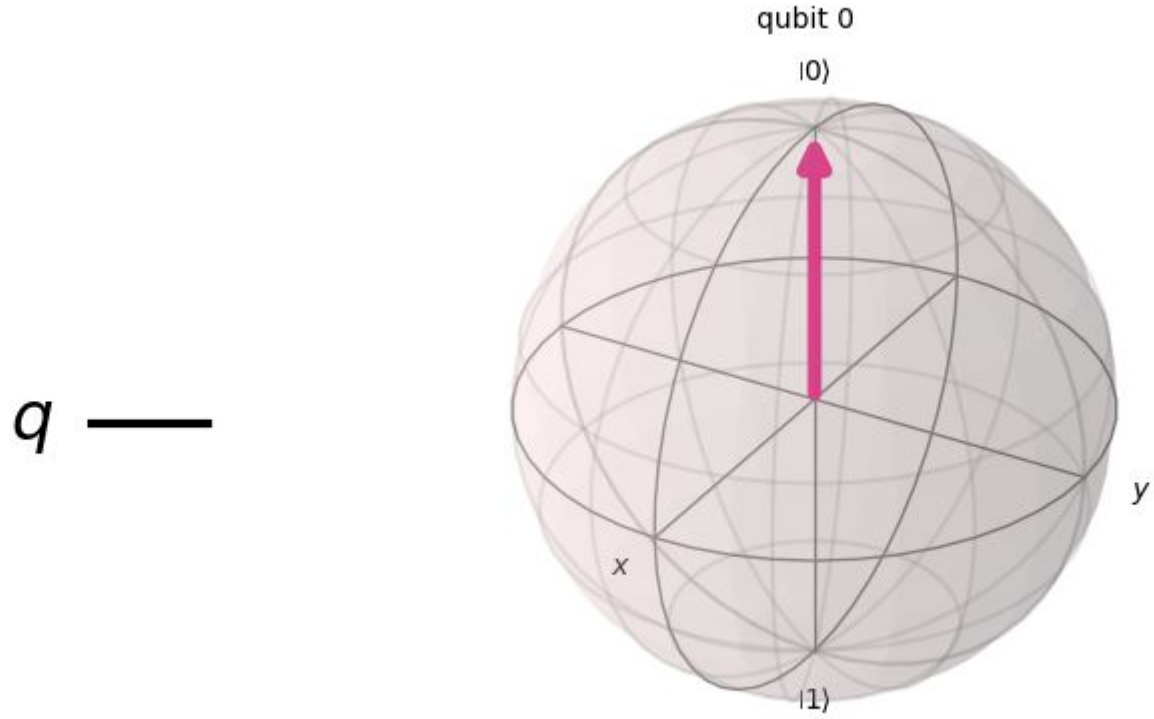
Fonte: GeeksForGeeks

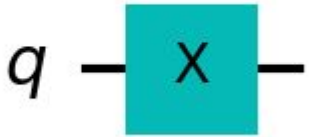
Computação Quântica

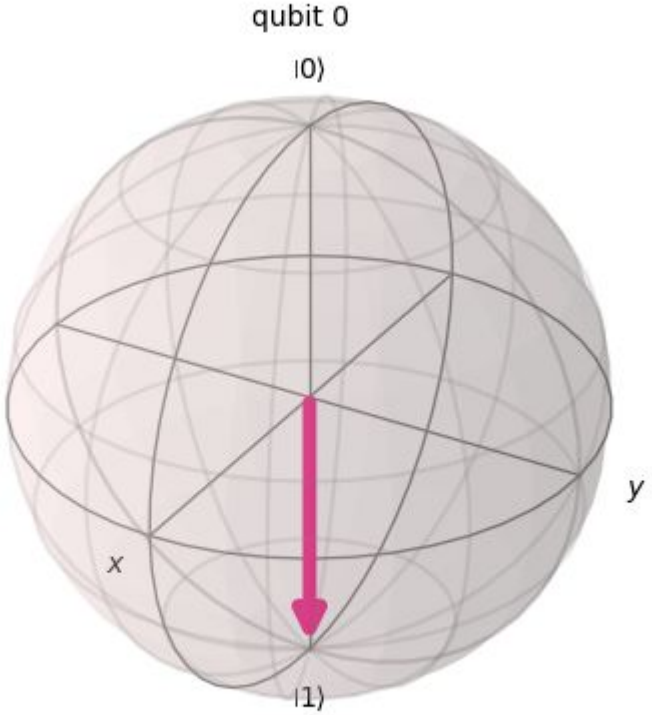
- Qubits (0, 1 e tudo entre isso);
- Representa Amplitudes/probabilidades;
- Pode ser visto como um ponto em uma esfera (Bloch Sphere);
- Precisa de várias medições:
  - Perturbações.

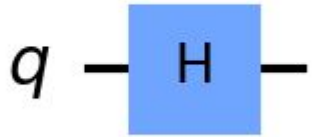


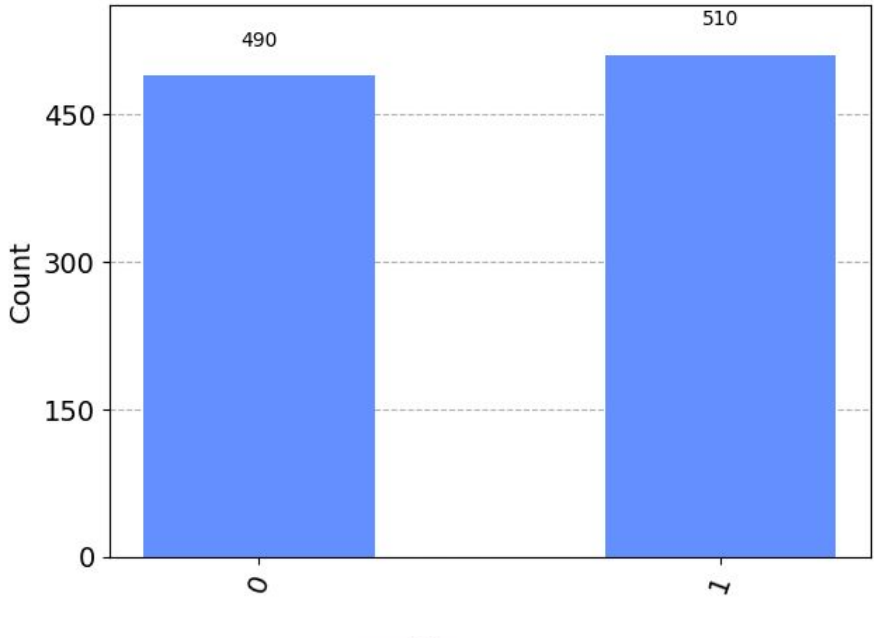
Fonte: Wikipedia


q
qubit 0
|0⟩
y
x
|1⟩

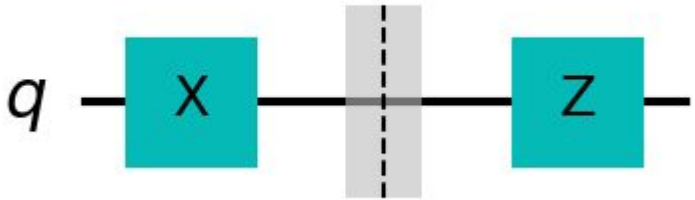

q
X


qubit 0
|0⟩
y
x
|1⟩

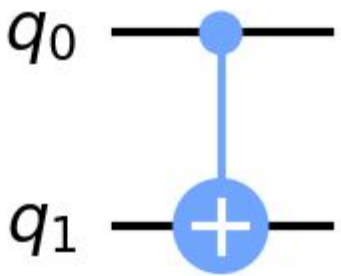

q
H


490
510
450
300
150
0
Count
0
1

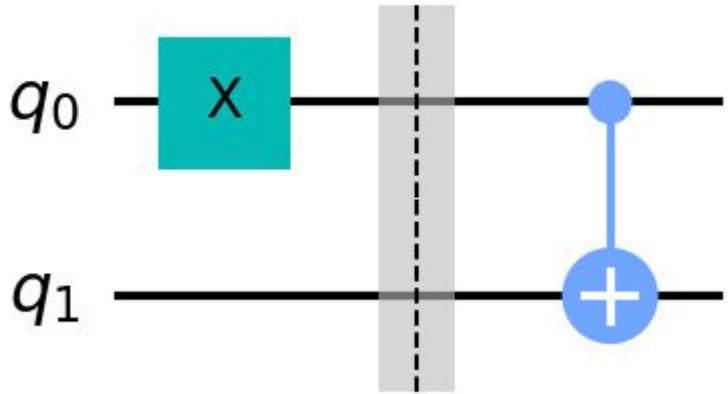
$|0\rangle$



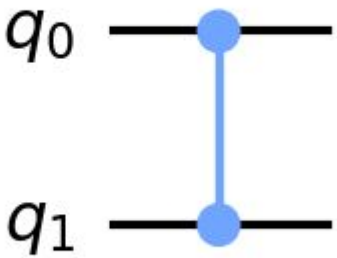
$-|1\rangle$



$|00\rangle$



$|10\rangle$



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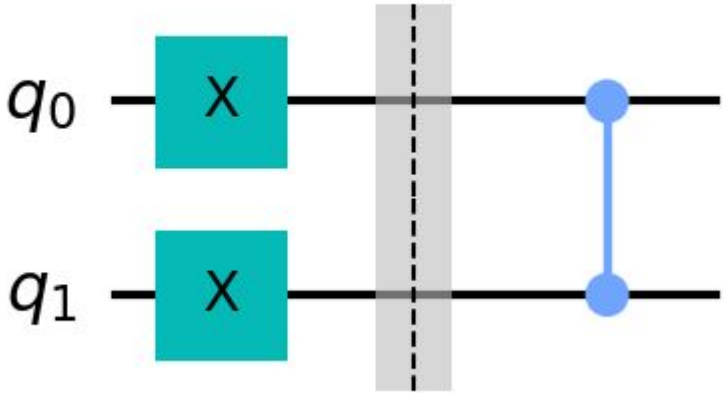
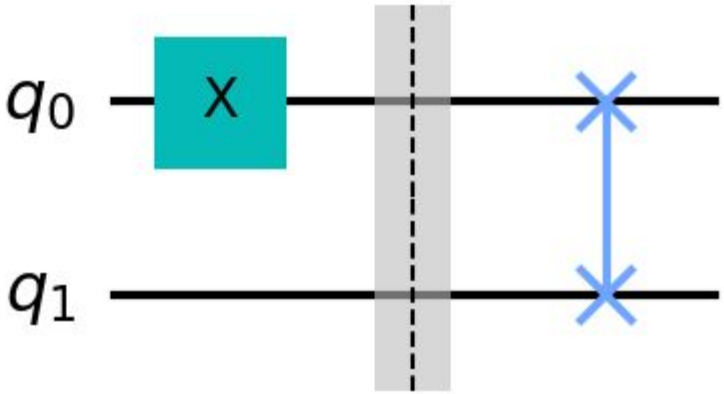
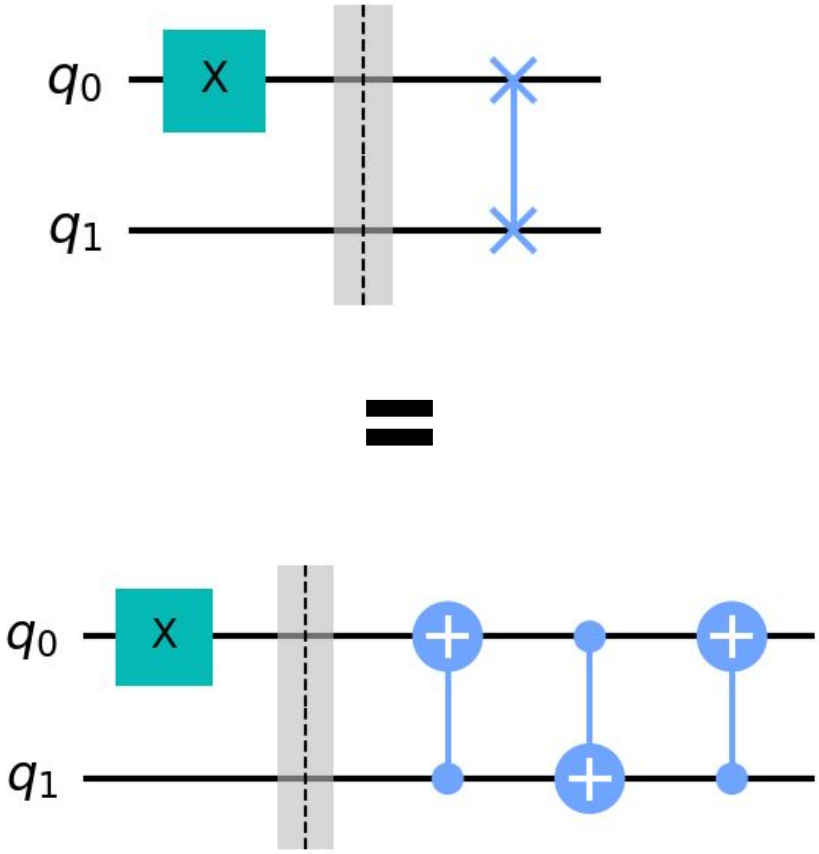
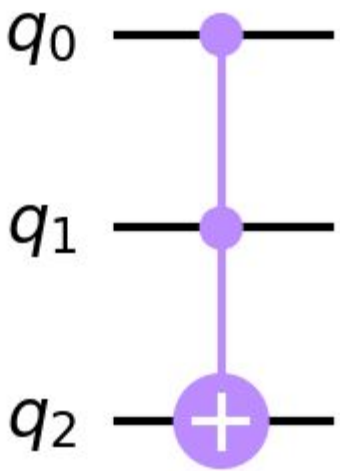


$-|11\rangle$



$|10\rangle$


q_0
X
q_1
=
q_0
X
q_1



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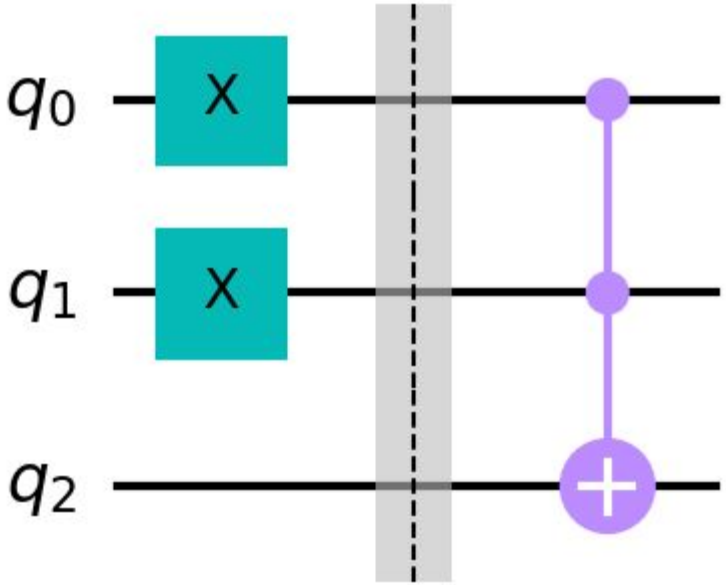
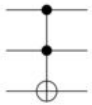


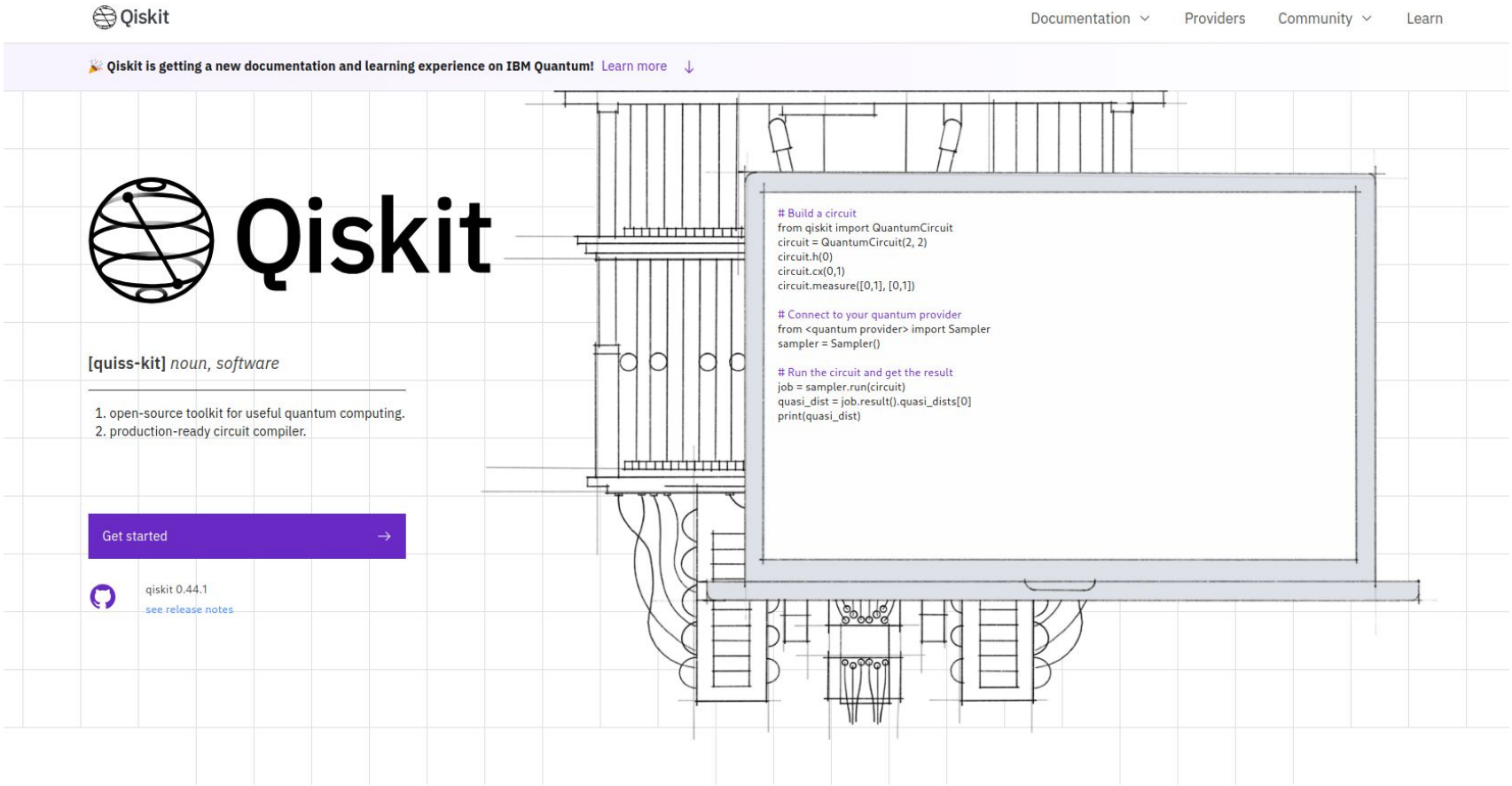
$|111\rangle$

Operator	Gate(s)		Matrix
Pauli-X (X)			$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
Pauli-Y (Y)			$\begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$
Pauli-Z (Z)			$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
Hadamard (H)			$\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
Phase (S, P)			$\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$
$\pi/8$ (T)			$\begin{bmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{bmatrix}$
Controlled Not (CNOT, CX)			$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$
Controlled Z (CZ)			$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$
SWAP			$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
Toffoli (CCNOT, CCX, TOFF)			$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$

Fonte: [Wikipedia]


DEMOS

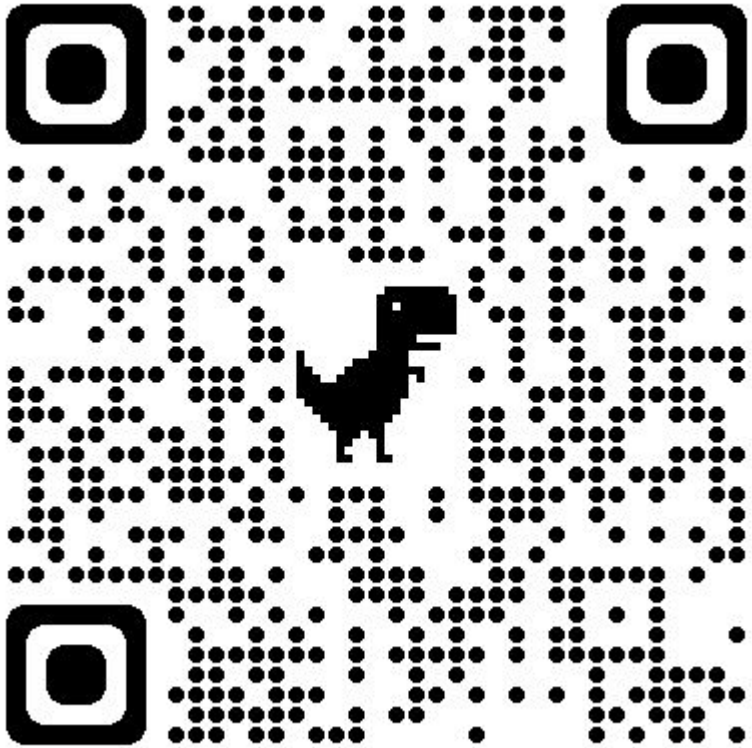
Próximos passos?

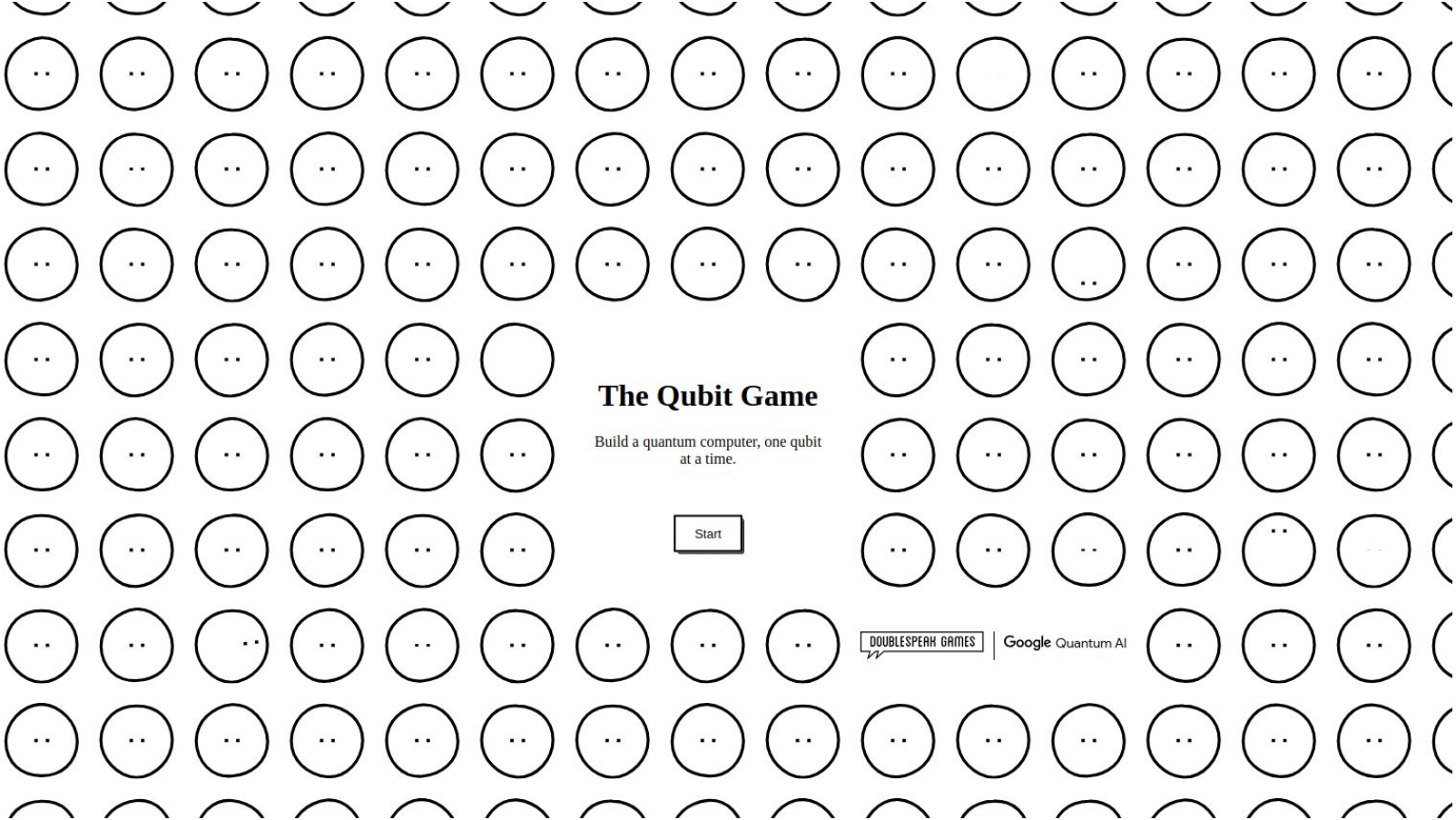


What Can Qiskit Do

qiskit.org

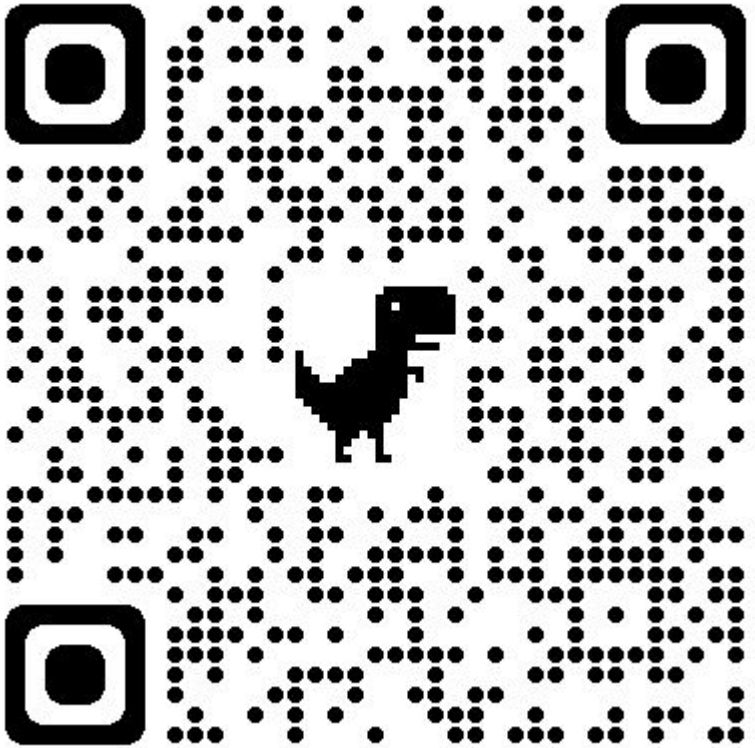
github.com/Dpbm/quantum





quantumai.google/education/thequbitgame

kiedos.art/quantum-games-list/



Obrigado pela Atenção😊