Introdução a Quantum Computing

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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/

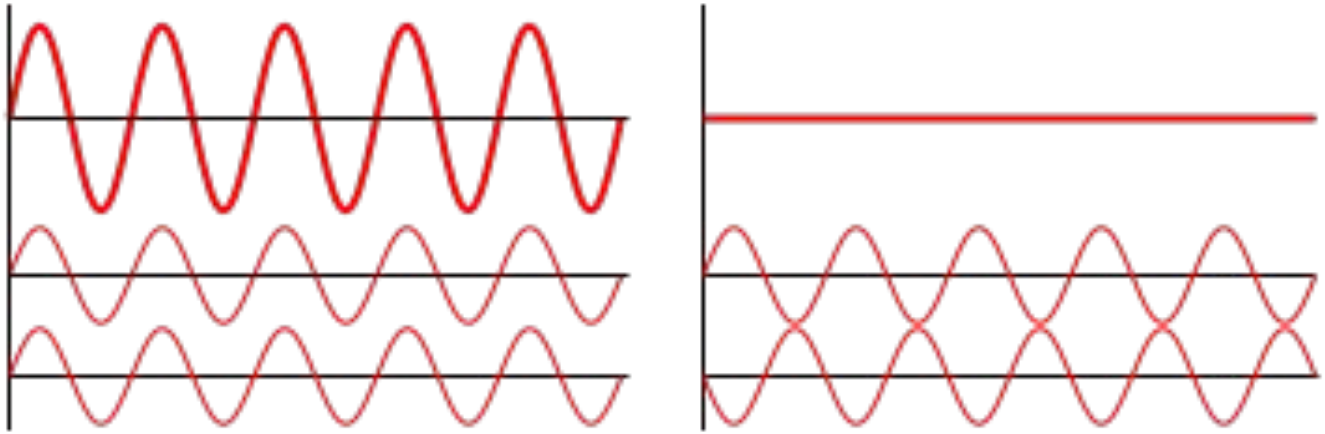
O que é computação quântica?

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

Fonte: IBM

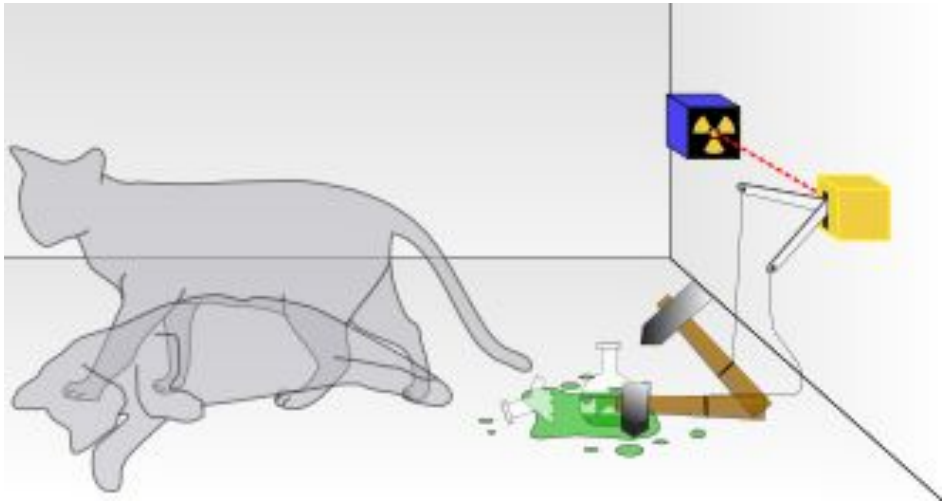
Quais efeitos ela se aproveita?

Interferência



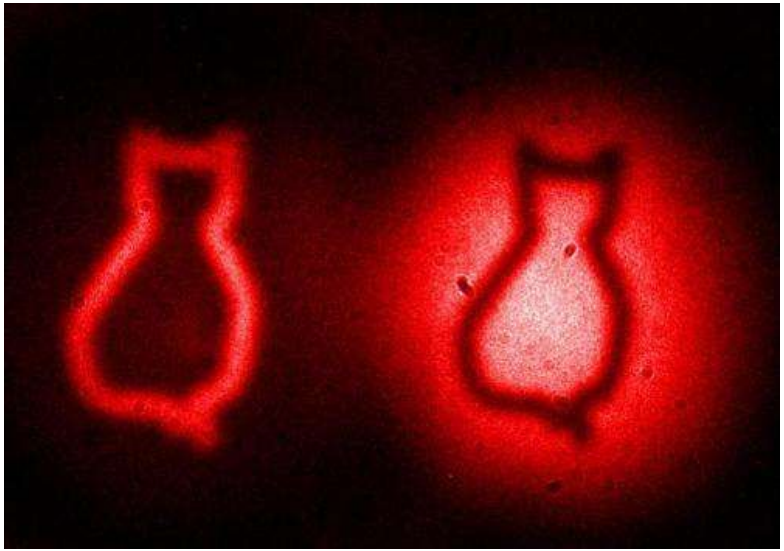
Fonte: Wikipedia

Superposição



Fonte: Wikipedia

Entanglement



Fonte: PhysOrg

Como está hoje?

Fonte: IBM

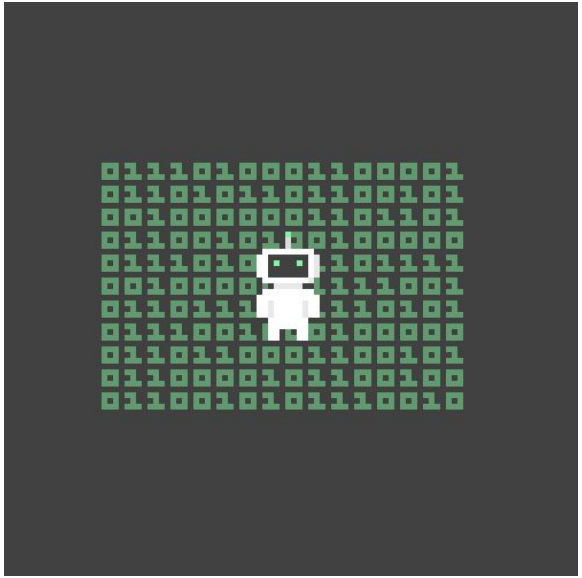
Plataformas

- AWS (Braket);
- Azure;
- IBM;
- IONQ;
- Pasqal;

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.).

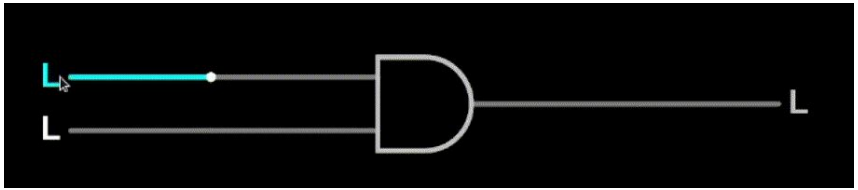


Fonte: Giphy

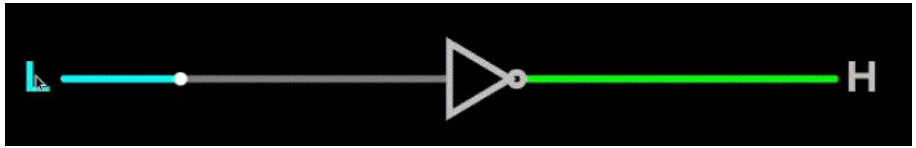
Fonte: MercadoLivre

Fonte: YouTube(Kurzgesagt)

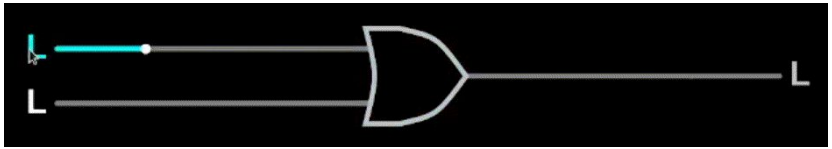
AND



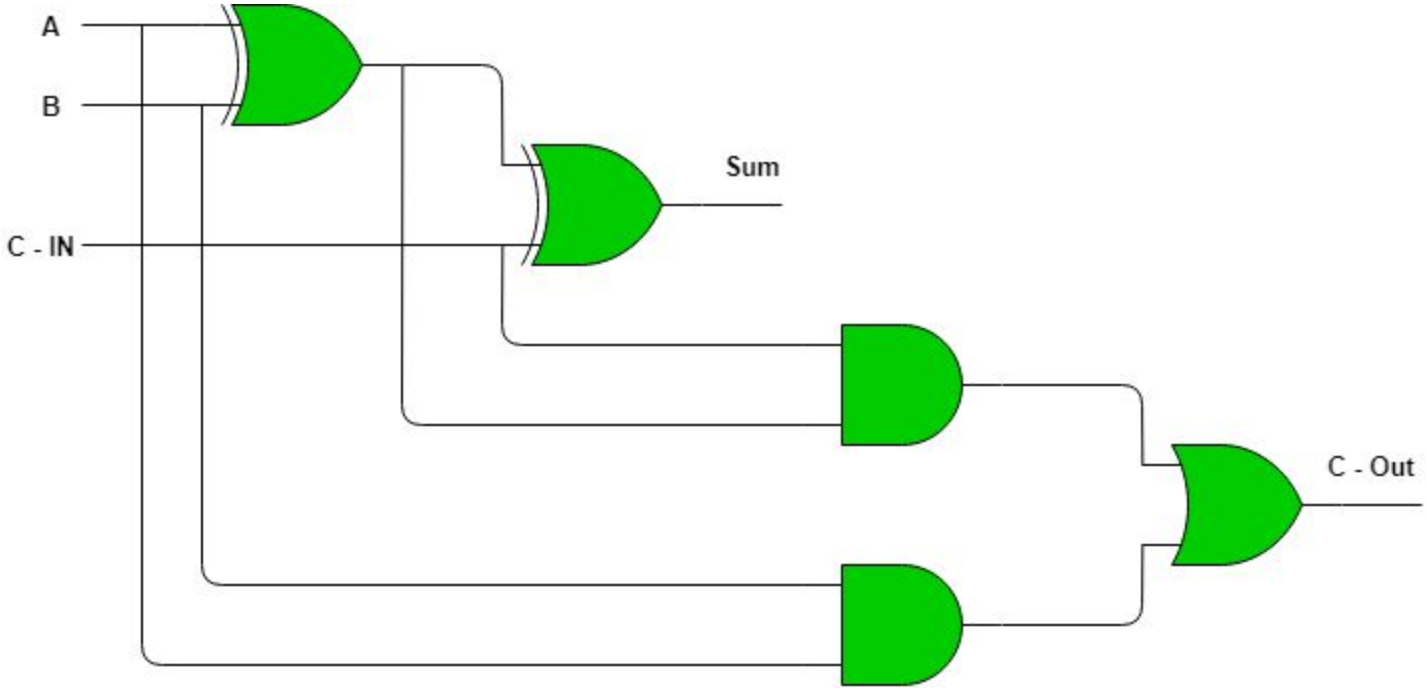
NOT



OR



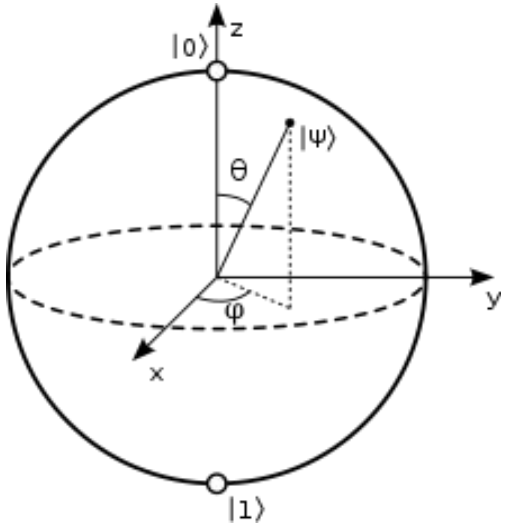
Somador completo



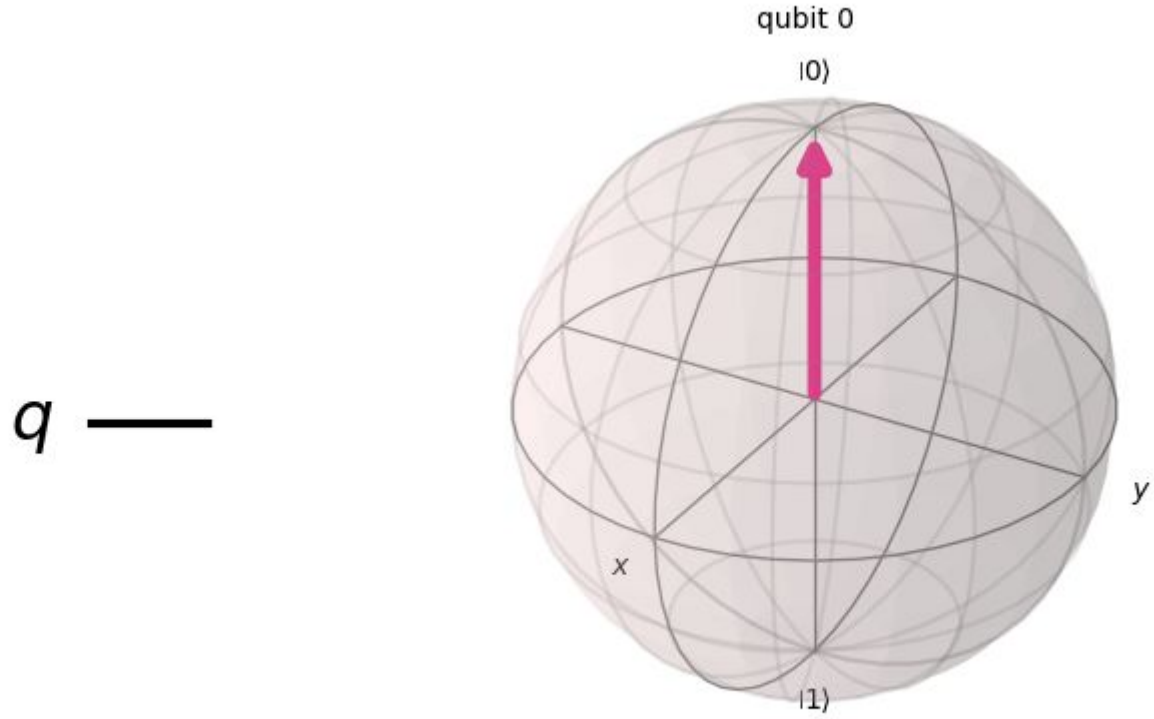
Fonte: GeeksForGeeks

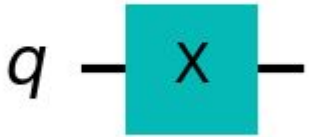
Computação Quântica

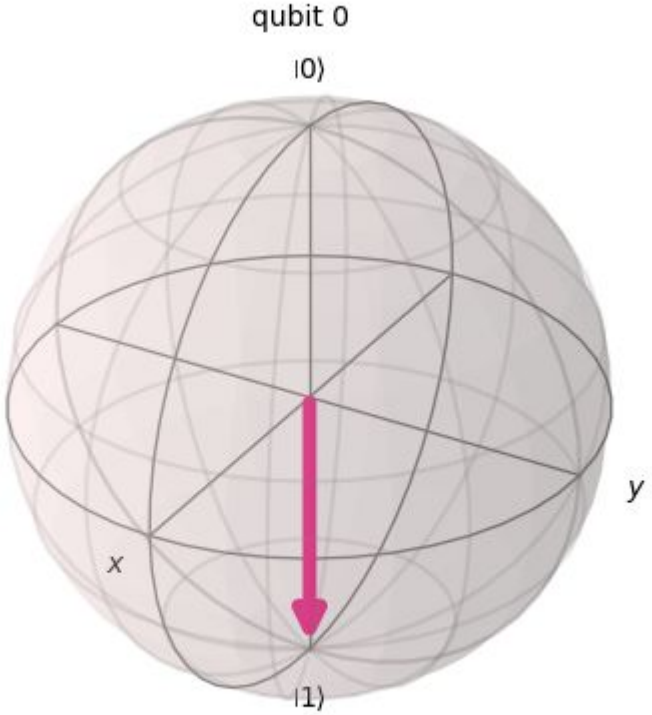
- Qubits (0, 1 e tudo entre isso);
- Representa Amplitudes/probabilidades;
- Pode ser visto como um ponto em uma esfera (Bloch Sphere);
- Precisa de várias medições:
  - Perturbações;
  - Principio da incerteza de Heisenberg.

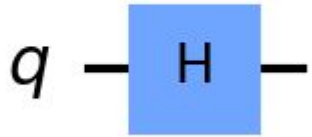


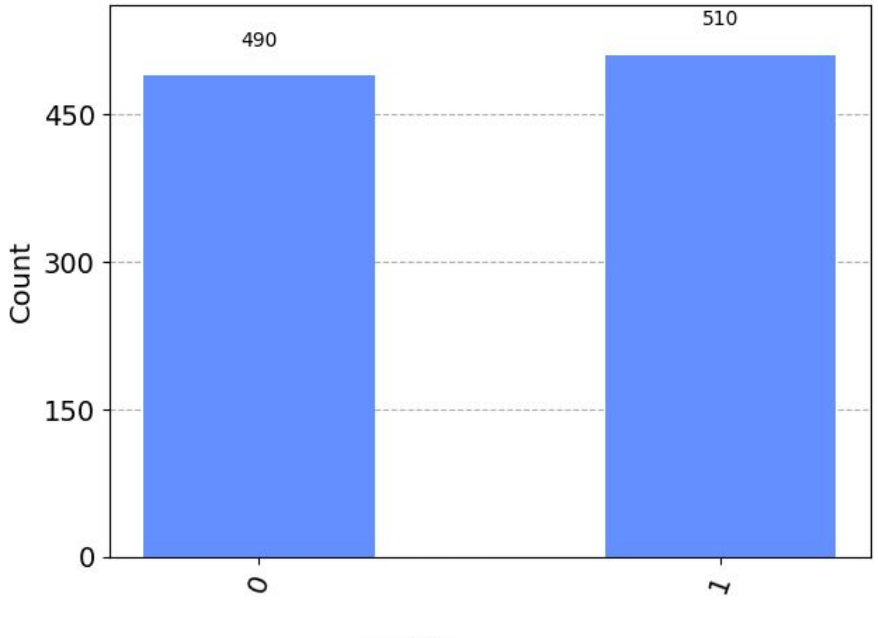
Fonte: Wikipedia


q
qubit 0
|0⟩
y
x
|1⟩

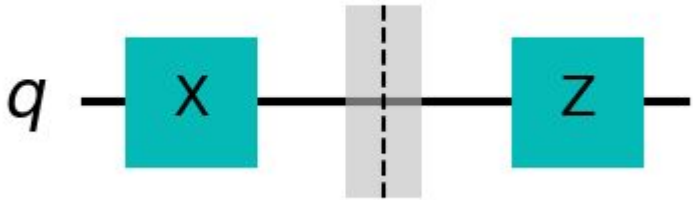

q
X


qubit 0
|0⟩
y
x
|1⟩

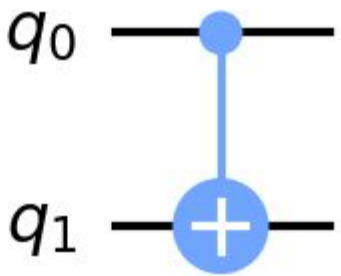

q
H


490
510
450
300
150
0
Count
0
1

$|0\rangle$



$-|1\rangle$



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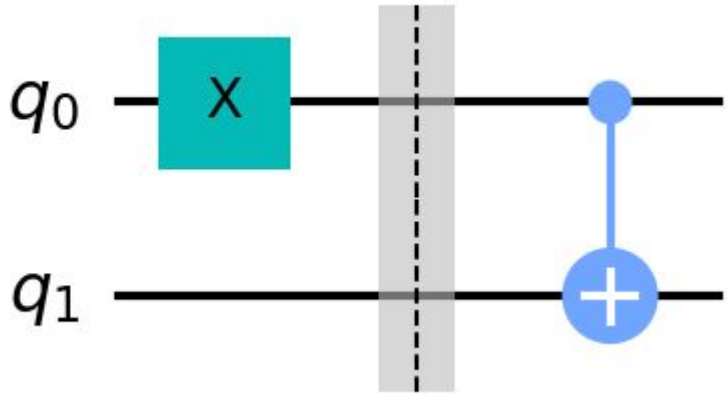
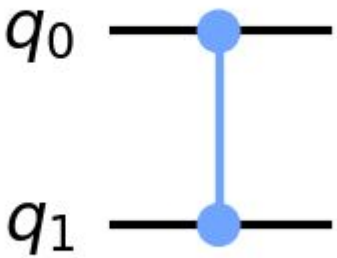


$|10\rangle$



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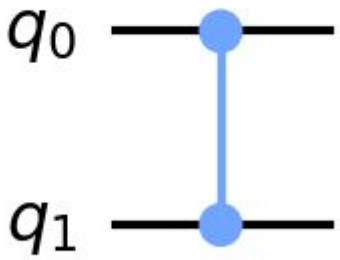

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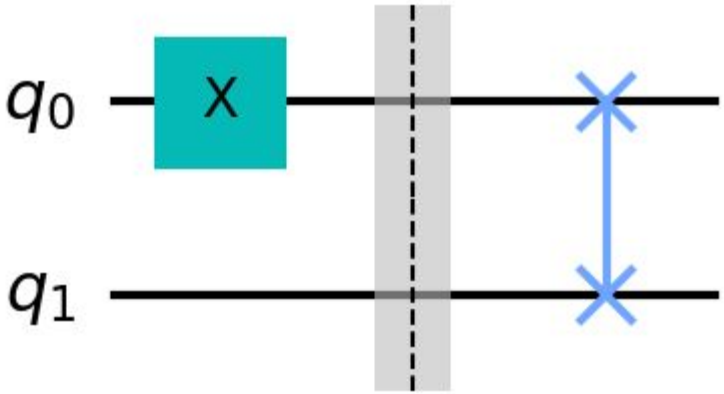
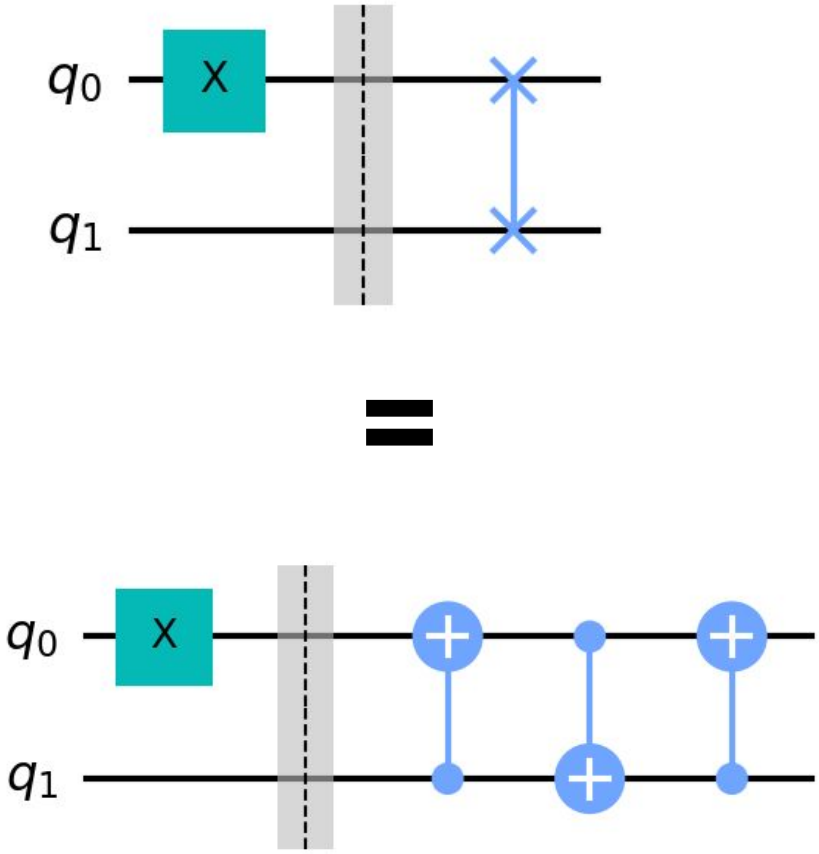
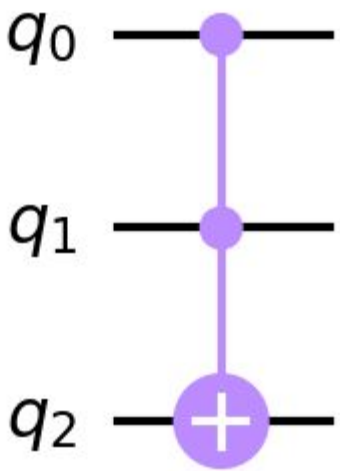


$|10\rangle$


q_0
X
q_1
=
q_0
X
q_1



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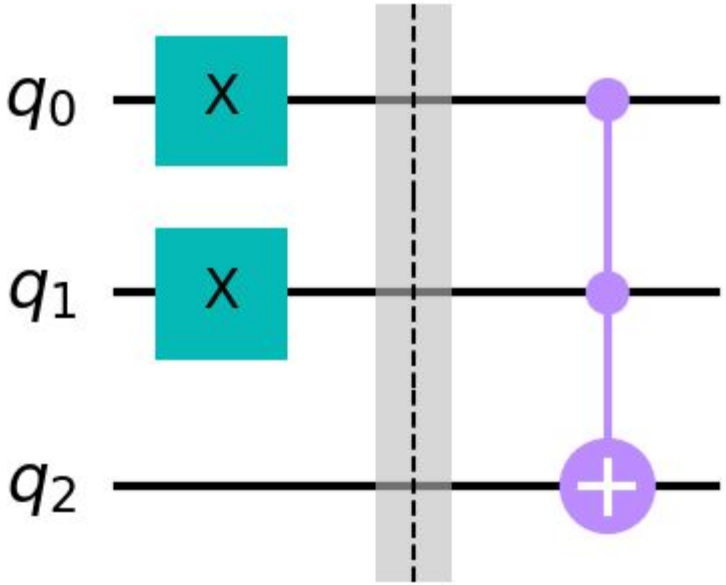
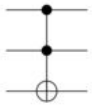


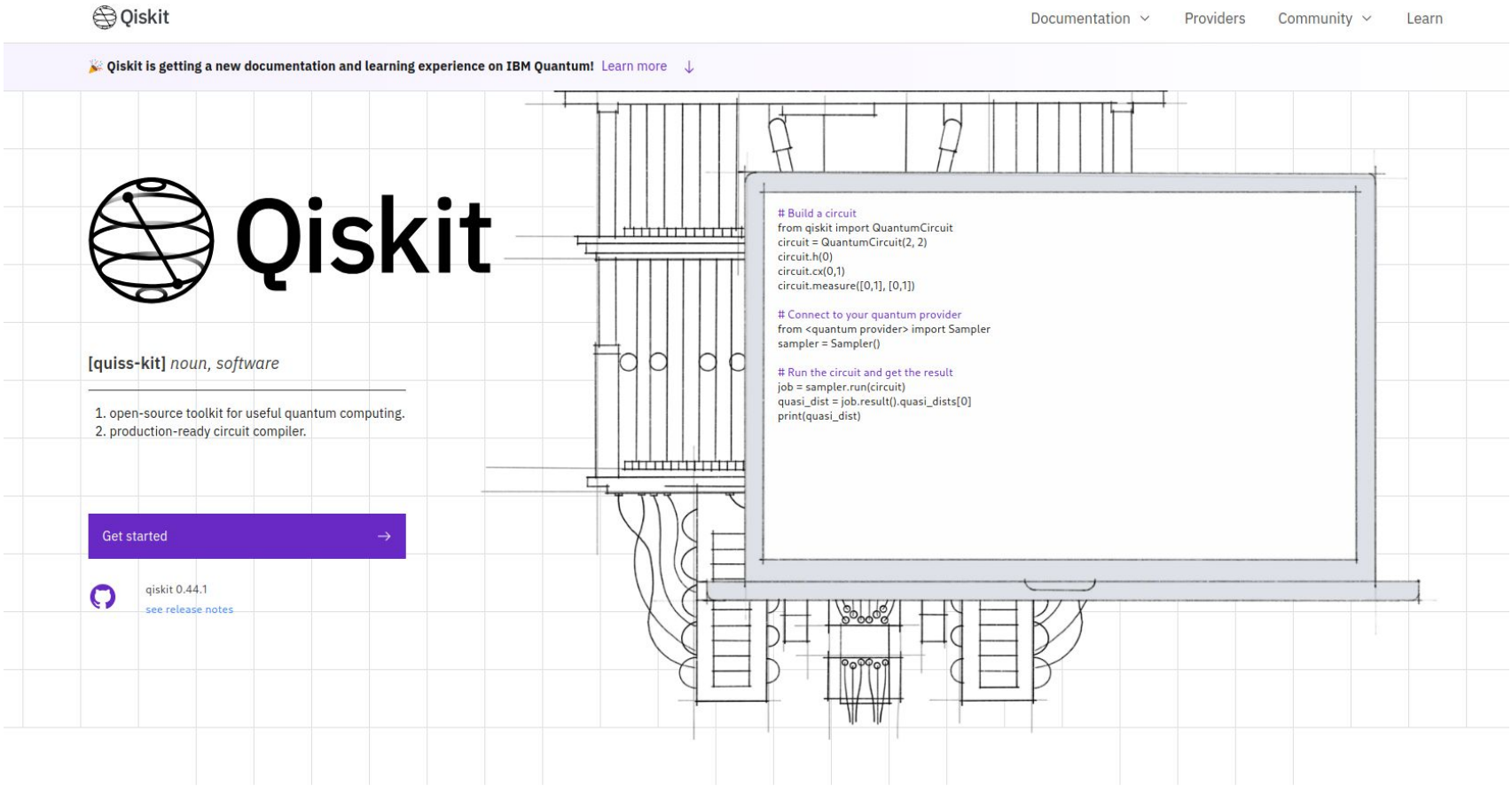
$|111\rangle$

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

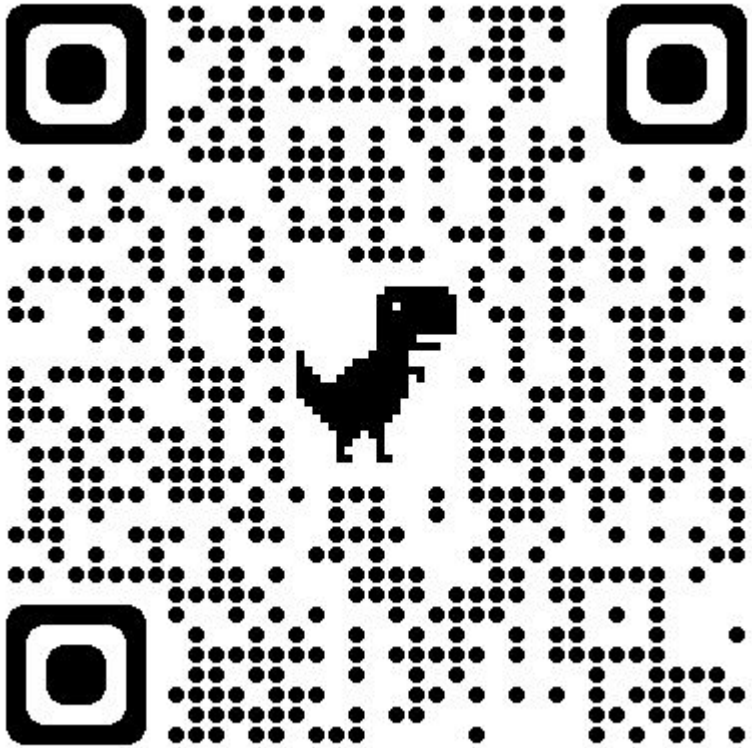
Próximos passos?

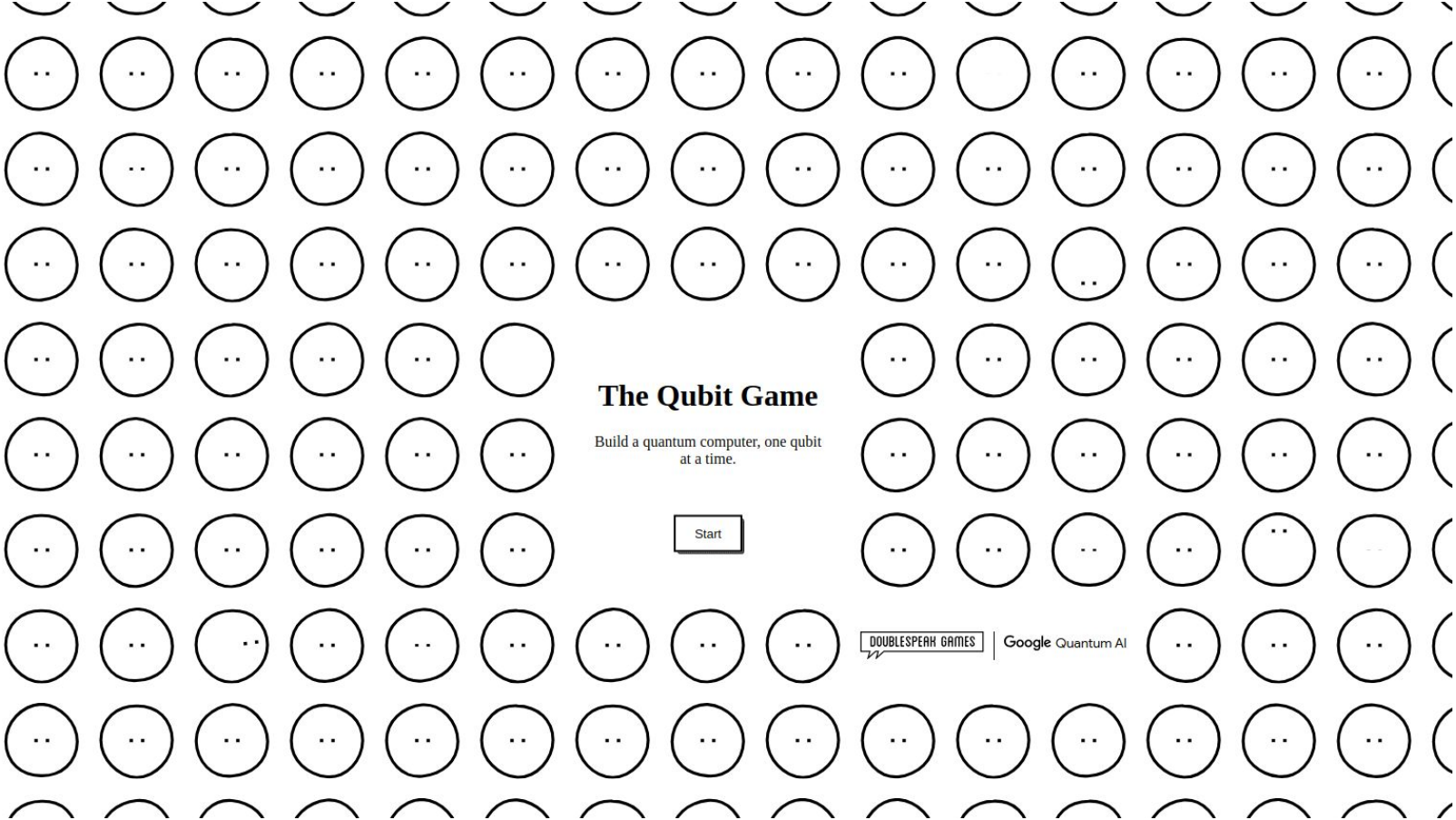


What Can Qiskit Do

qiskit.org

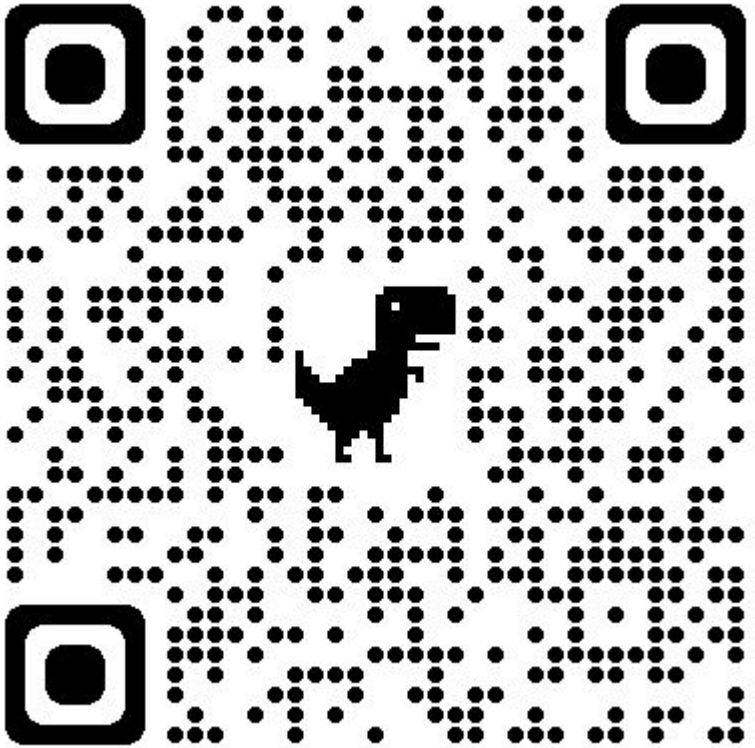
github.com/Dpbm/quantum





quantumai.google/education/thequbitgame

kiedos.art/quantum-games-list/



Obrigado pela Atenção😊