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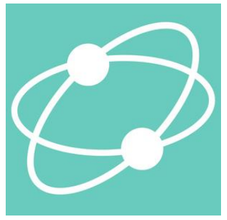
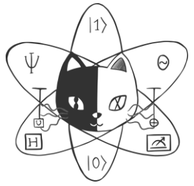
QISKIT FALL FEST



¿Cómo iniciar en los algoritmos cuánticos?



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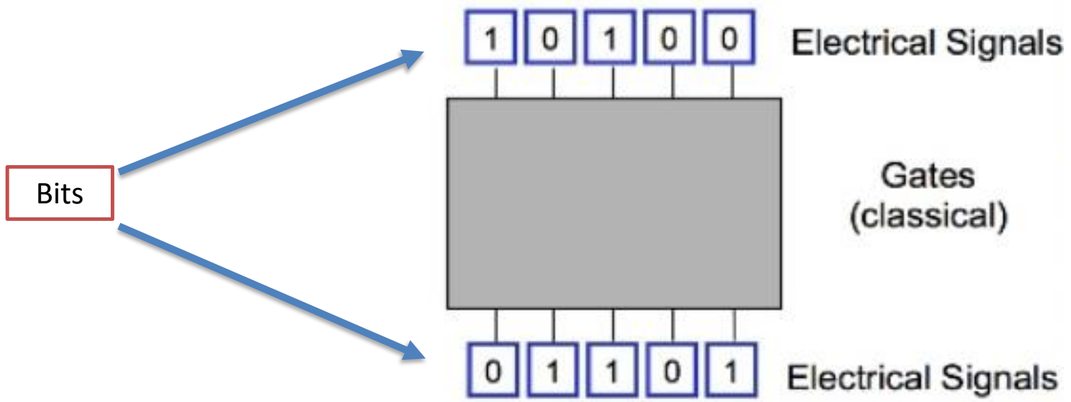
¿Qué es un algoritmo?

$$f : \{0,1\}^n \mapsto \{0,1\}^m$$

- Es una función de n bits a m bits



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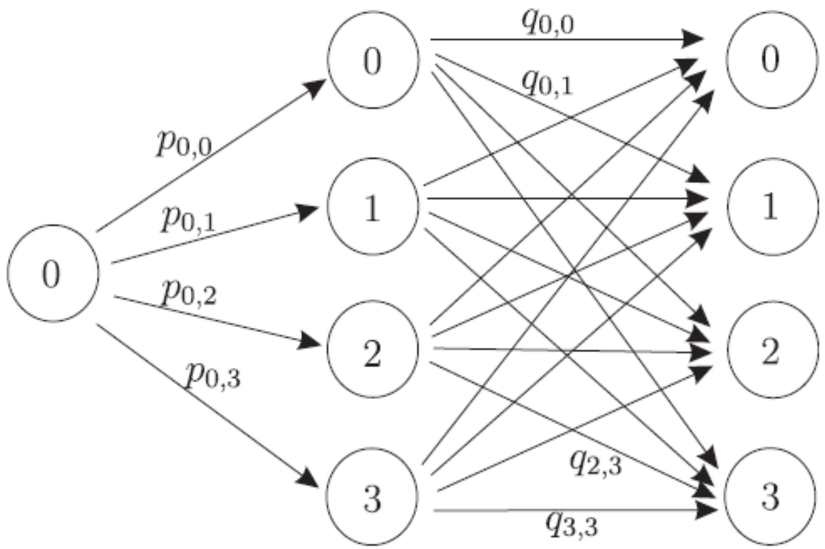
Una computadora clásica probabilística



- Es adecuado, restringirnos solamente a las funciones que van de n bits a 1 bit.

$$f_i : \{0,1\}^n \mapsto \{0,1\}$$

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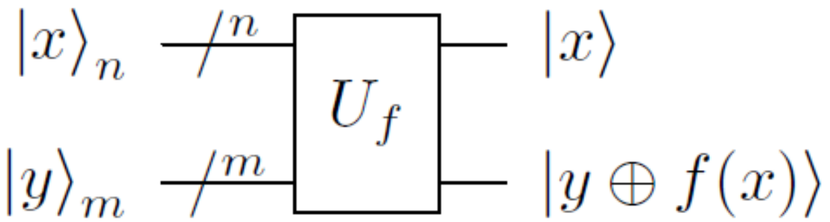
Un evaluador cuántico de funciones (oráculo)

$$U|x\rangle_n|y\rangle_m = |x\rangle_n|y \oplus f(x)\rangle_m$$



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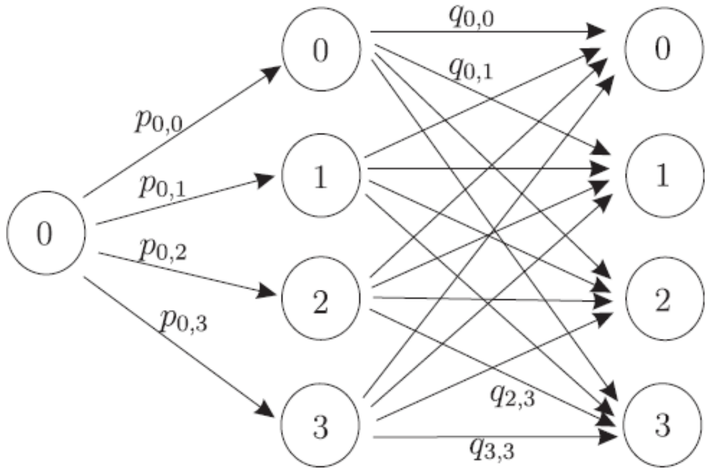
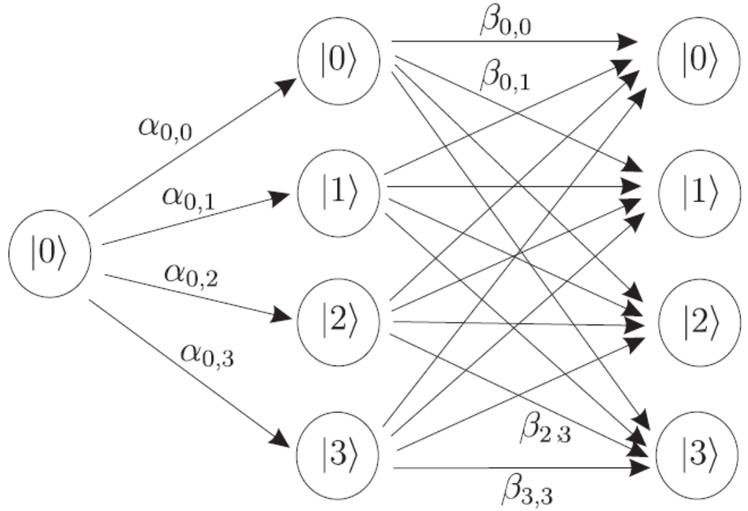
$$f_i : \{0,1\}^n \mapsto \{0,1\}$$

Una computadora clásica probabilística



$$\text{prob} \propto \sum_j p_{0,j} q_{j,3} = \sum_j |\alpha_{0,j} \beta_{j,3}|^2$$

Una computadora cuántica



$$\text{prob} \propto \left| \sum_j \alpha_{0,j} \beta_{j,3} \right|^2$$

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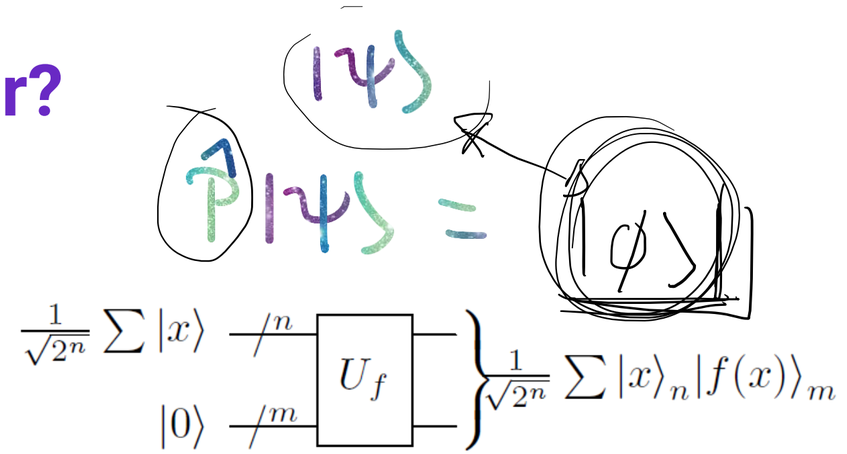
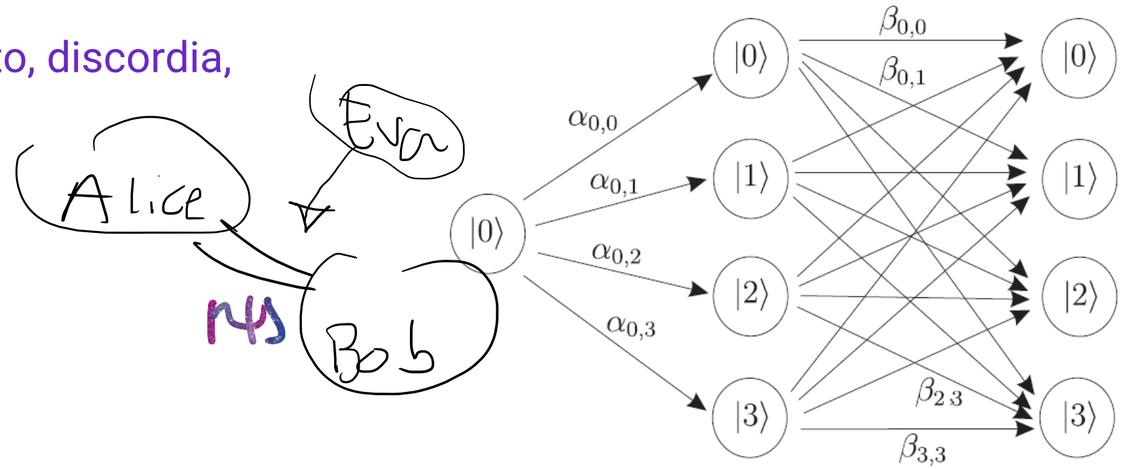
¿Qué características cuánticas podemos aprovechar?



- Superposición de estados (espacio de Hilbert)
- Interferencia de amplitudes de probabilidad (números complejos)
- Crecimiento exponencial de la base (2^n)
- Correlaciones entre los elementos de la base (enredamiento, discordia, steering, etc……)
- Paralelismo cuántico (los operadores son lineales)
- Teorema de no clonación (medición de un sistema cuántico)
- Etc…



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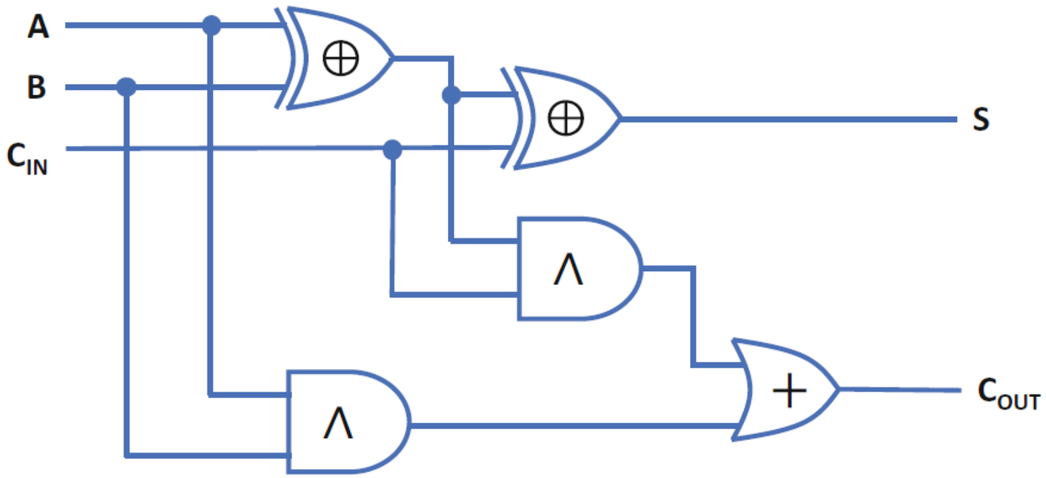
$$U_f$$

Sumador clásico

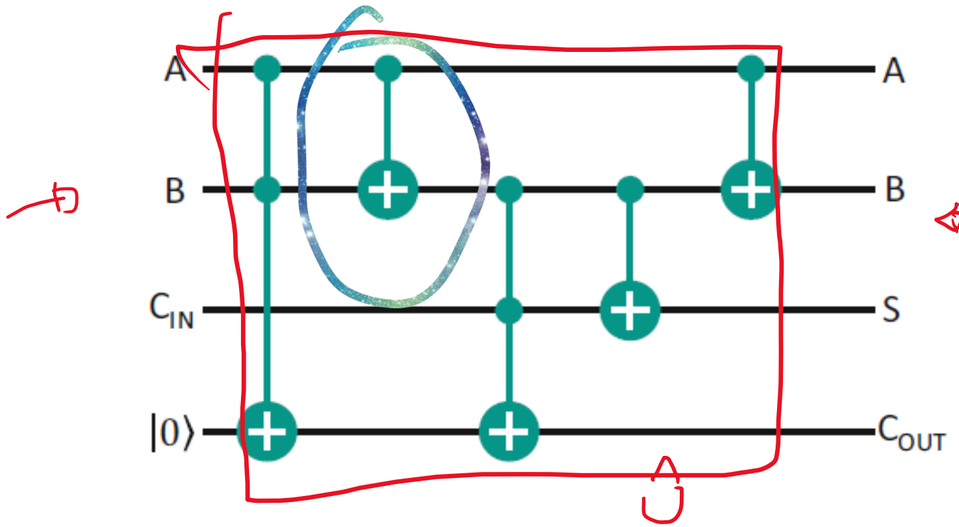
$$S = A \oplus B \oplus C_{IN}$$



$$C_{OUT} = (A \wedge B) + (A \oplus B) \wedge C_{IN}$$

Sumador cuántico

$$|\psi\rangle = |A\rangle|B\rangle|C_{IN}\rangle|0\rangle$$



$$|A\rangle|B\rangle|S\rangle|\ C_{OUT}\ \rangle$$

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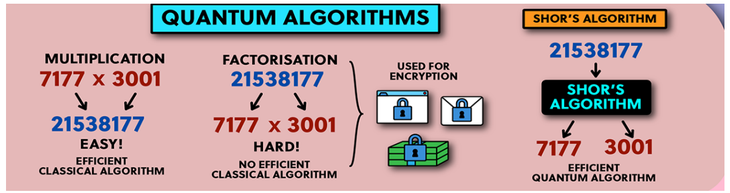
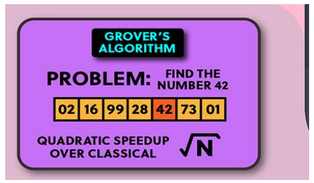
Tres grandes categorías de los algoritmos cuánticos

(las cuales usan algunas o todas las características anteriores)

1. Basados en la transformada cuántica de Fourier
   - Deutsch-Josza, Shor, …



2. Basados en la búsqueda cuántica
   - Grover, …



3. Simulaciones cuánticas

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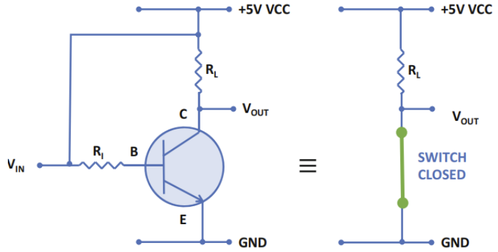
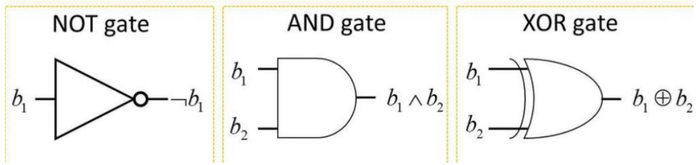


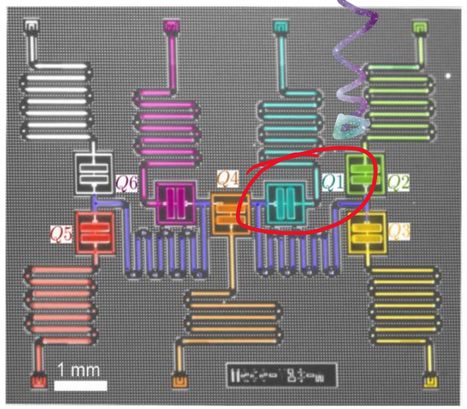


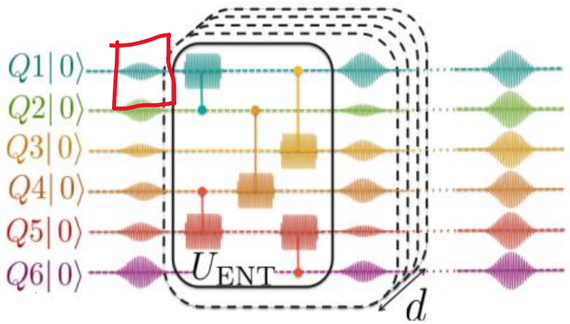
1

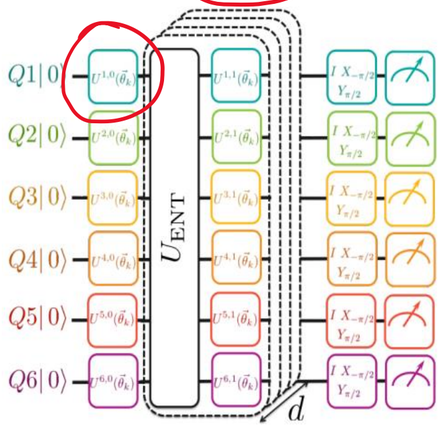
2

3

4

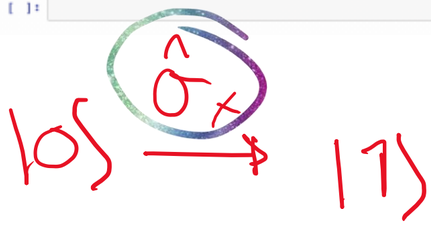






IBM

```
In [1]: import pandas as pd

In [2]: from fugue_notebook import setup
        setup()

Out[2]:

In [3]: df = pd.DataFrame({'a':[1,2,3,4], 'b':[1,2,3,4]})
        df.to_csv('df.csv', index=False)

In [*]: %%fsql
        -- This SQL cell sees the dataframe defined in the previous cell
        SELECT *
          FROM df
         WHERE a > 2
         PRINT

In [ ]: %%fsql
        df2 = LOAD "/Users/kevinkho/Work/fugue/df.csv" (header=TRUE, infer_schema=TRUE)
        SELECT *
          FROM df2
         WHERE b < 2
         PRINT
          SAVE OVERWRITE "/Users/kevinkho/Work/fugue/df.csv"

In [ ]:
```



QuantumQuipu

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qBraid

JÜLICH Forschungszentrum

QWORLD

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3. Simulaciones cuánticas (ecuación de Schrödinger)

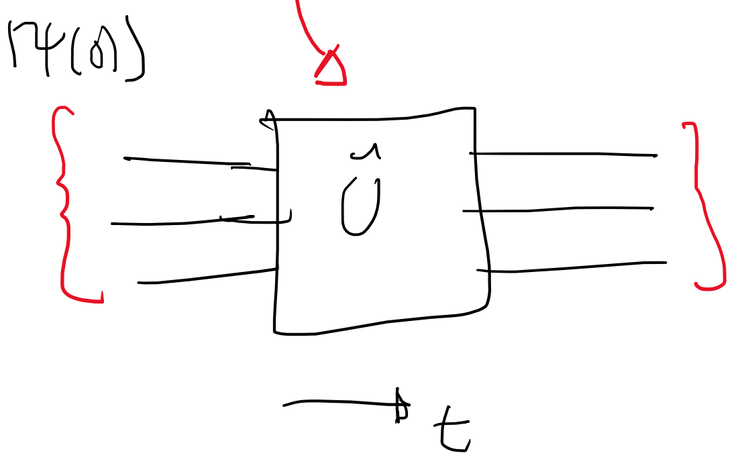
Postulados de la mecánica cuántica

$$\hat{H}|\psi\rangle = i\hbar \frac{\partial}{\partial t}|\psi\rangle \iff |\psi(t)\rangle = \hat{U}|\psi(0)\rangle$$

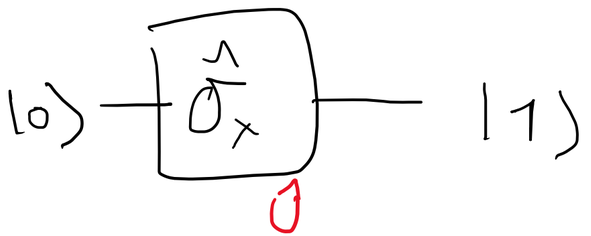
Hamiltoniano (toda la física)

↑ fármacos, proteínas

matriz unitaria



|ψ(t)⟩



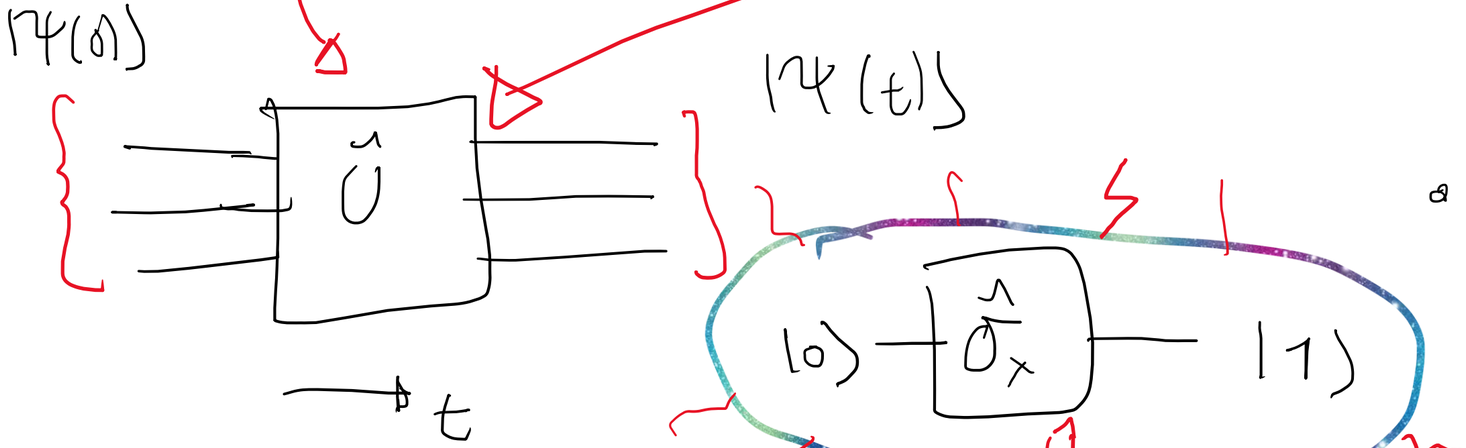
ESCUELA EN ESPAÑOL
QISKIT FALL FEST

3. Simulaciones cuánticas (ecuación de Schrödinger)

Postulados de la mecánica cuántica

$|\psi(t)\rangle = \hat{U}|\psi(0)\rangle$

matriz unitaria



Caos cuántico

- Caracterizar los circuitos (regulares o caóticos)

- Corrección de errores
  - circuitos estabilizadores

SYK

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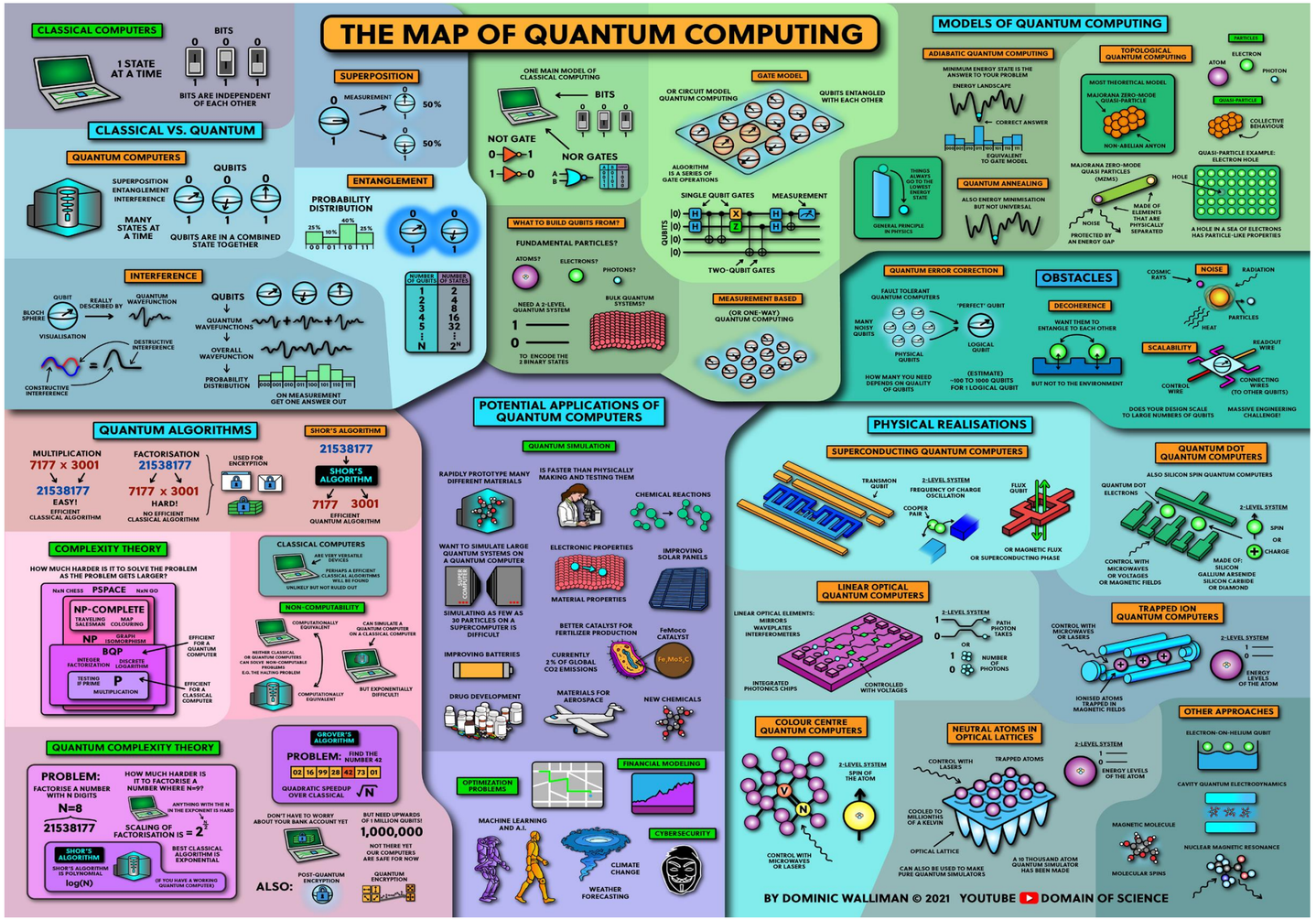

Referencias