# Quantum Computing for Everyone with Qiskit

PyLadiesBCN - 17/June/2022

Honda cmx500 Rebel

# About me

- Ph.D in Computational Chemistry (2015)
- Scientific + Technology background
- Involved in PyLadiesBCN since ¿2013?
- Formally a PyLadiesBCN collaborator since 2019 (after gintonic *rite*)
- Working as software developer/ product owner 2015-2022
- HPC Specialist in HPCNow! since January 2022
- “Professora col·laboradora” in UOC (Master BiB) since 2018

# What shall we talk about today?

1. Classical and Quantum Computers
2. Bits and Qubits
3. How to code
4. Hands-on!

# Classical and Quantum Computers

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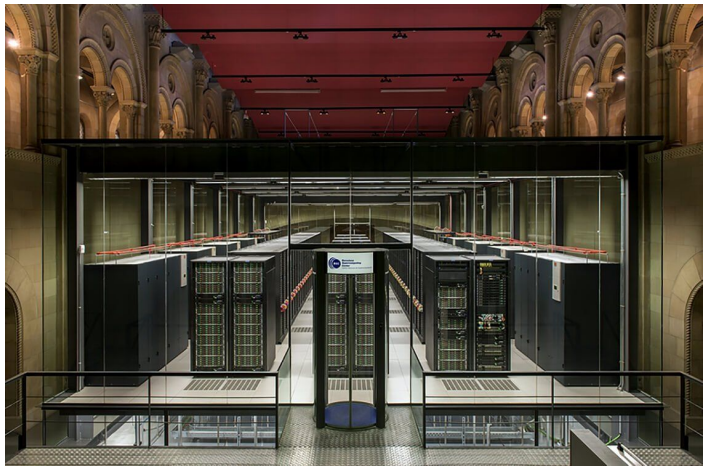
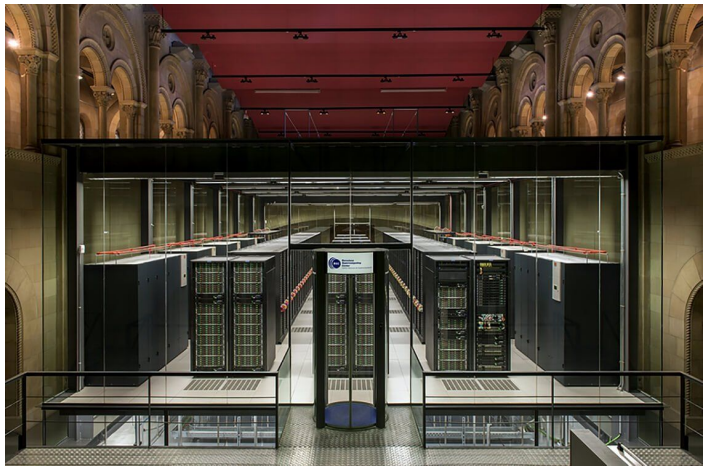


# Classical and Quantum Computers



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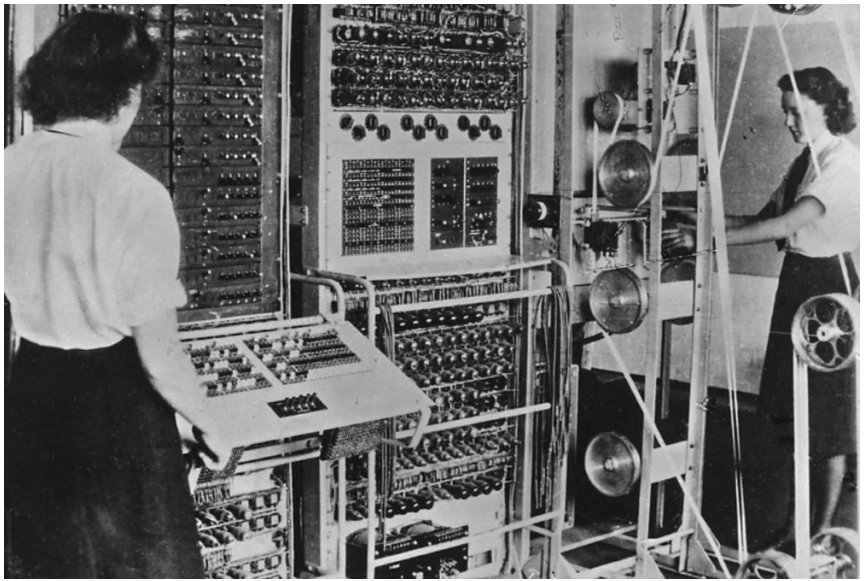

Colossus - WWII


IBM Q One - 2019

# Bits and Qubits

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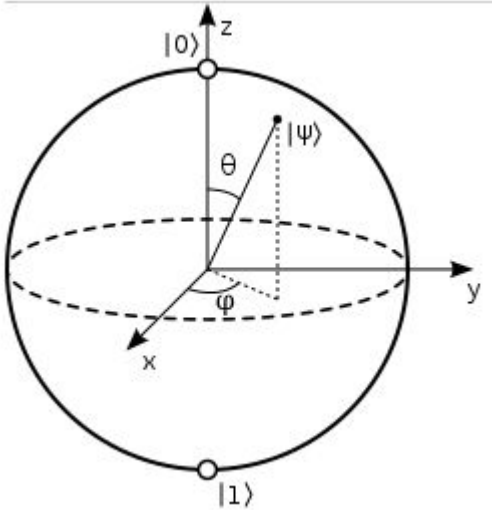


n states (one for “side” of the sphere):

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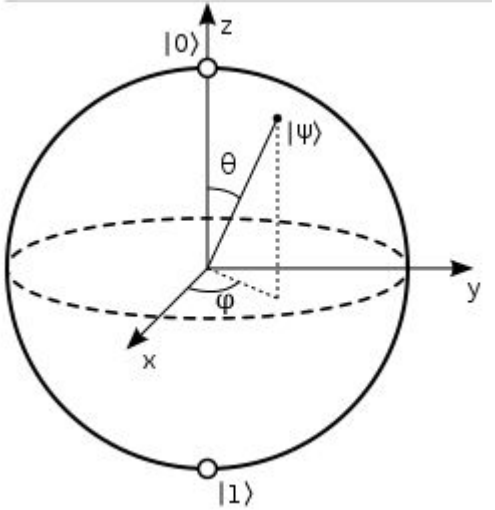
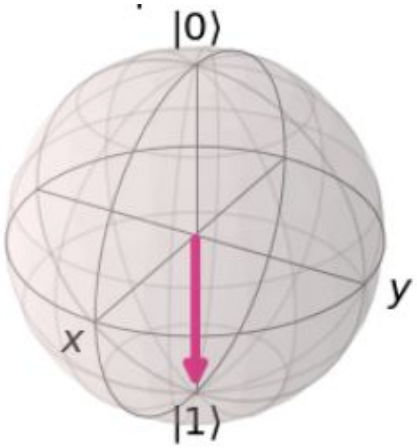
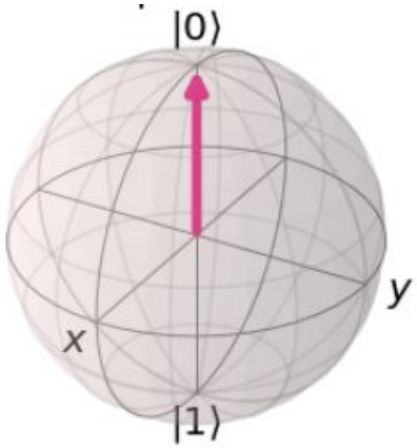


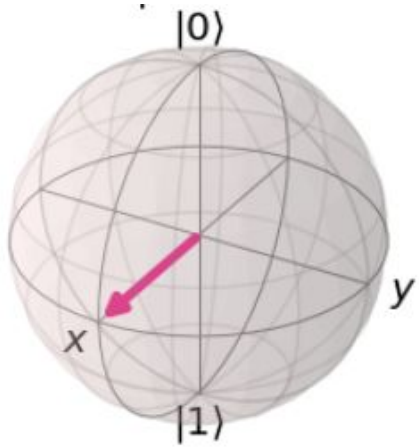

n states (one for “side” of the sphere):

$$|\psi\rangle = cos\frac{\theta}{2}|0\rangle + e^{i\varphi}sin\frac{\theta}{2}|1\rangle$$

# ~~Bits and~~ Qubits

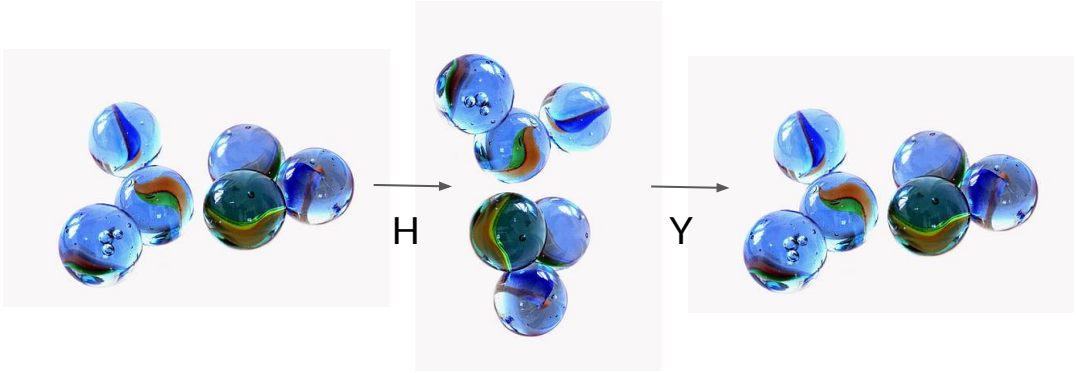


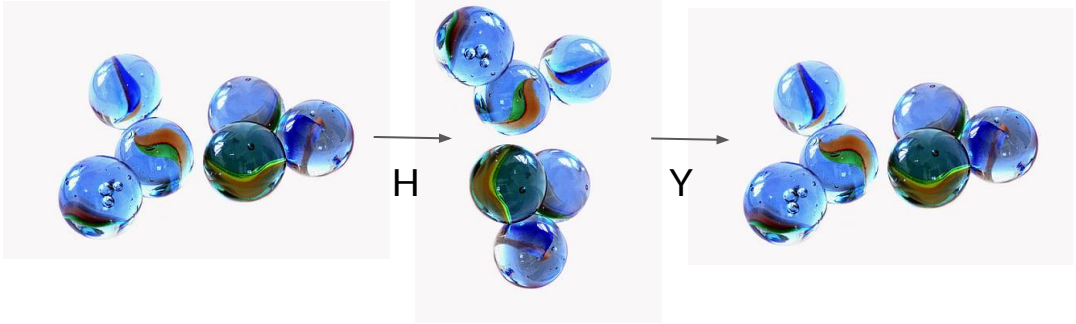




**SUPERPOSITION**: same qubit can have multiple states!!!

# ~~Bits and~~ Qubits: measurement


H
Y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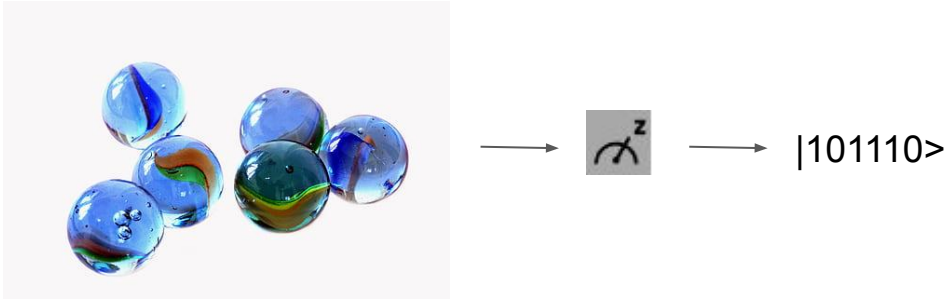
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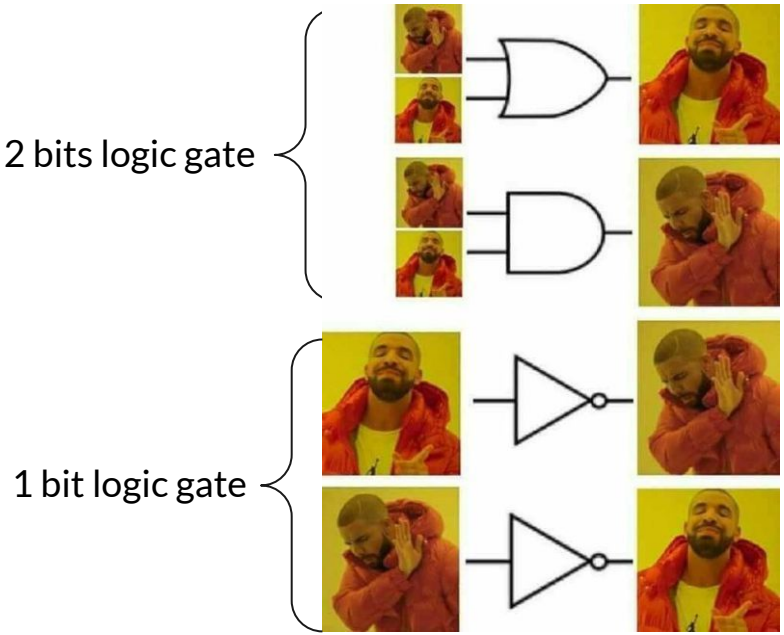
# How to code *quantumly speaking? (back to classics)*



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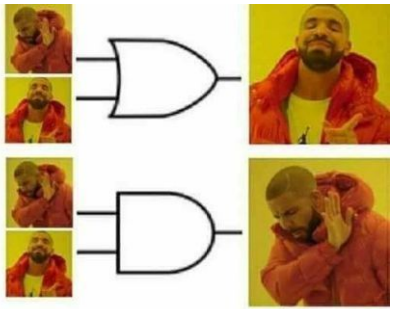
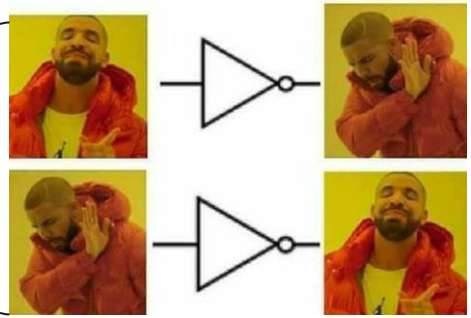
2 bits logic gate

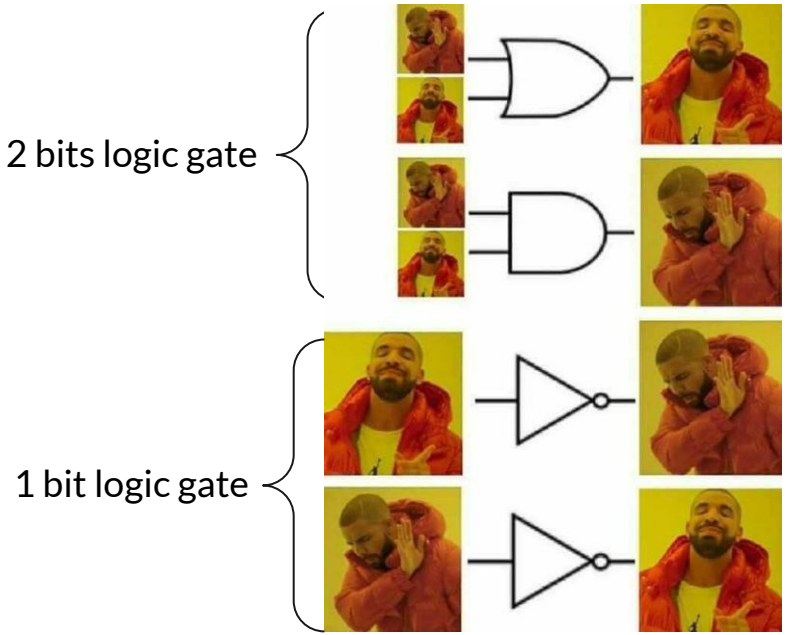


1 bit logic gate



x 10600 M (Ryzen 7 5800H)
x 16000 M (Apple M1)

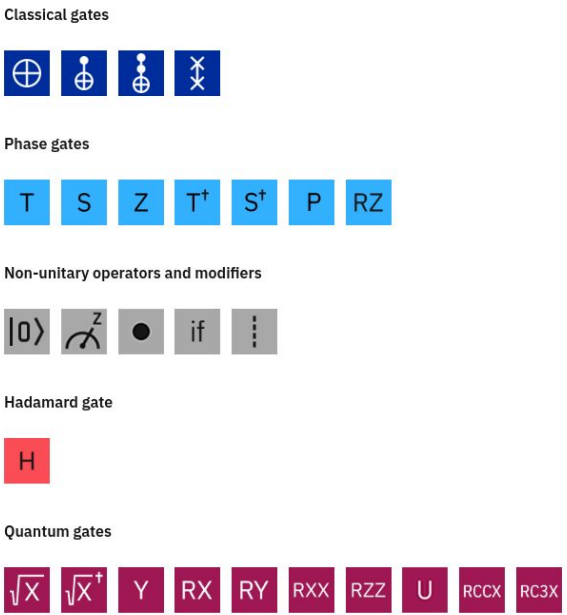
# How to code *quantumly speaking? (back to classics)*




x 10600 M (Ryzen 7 5800H)
x 16000 M (Apple M1)

Machine code ← compiler ← Programming language

# How to code *quantumly speaking?* quantum gates



# How to code *quantumly speaking?* quantum gates

Classical gates

Phase gates

T S Z $T^\dagger$ $S^\dagger$ P RZ

Non-unitary operators and modifiers

|0⟩ if

Hadamard gate

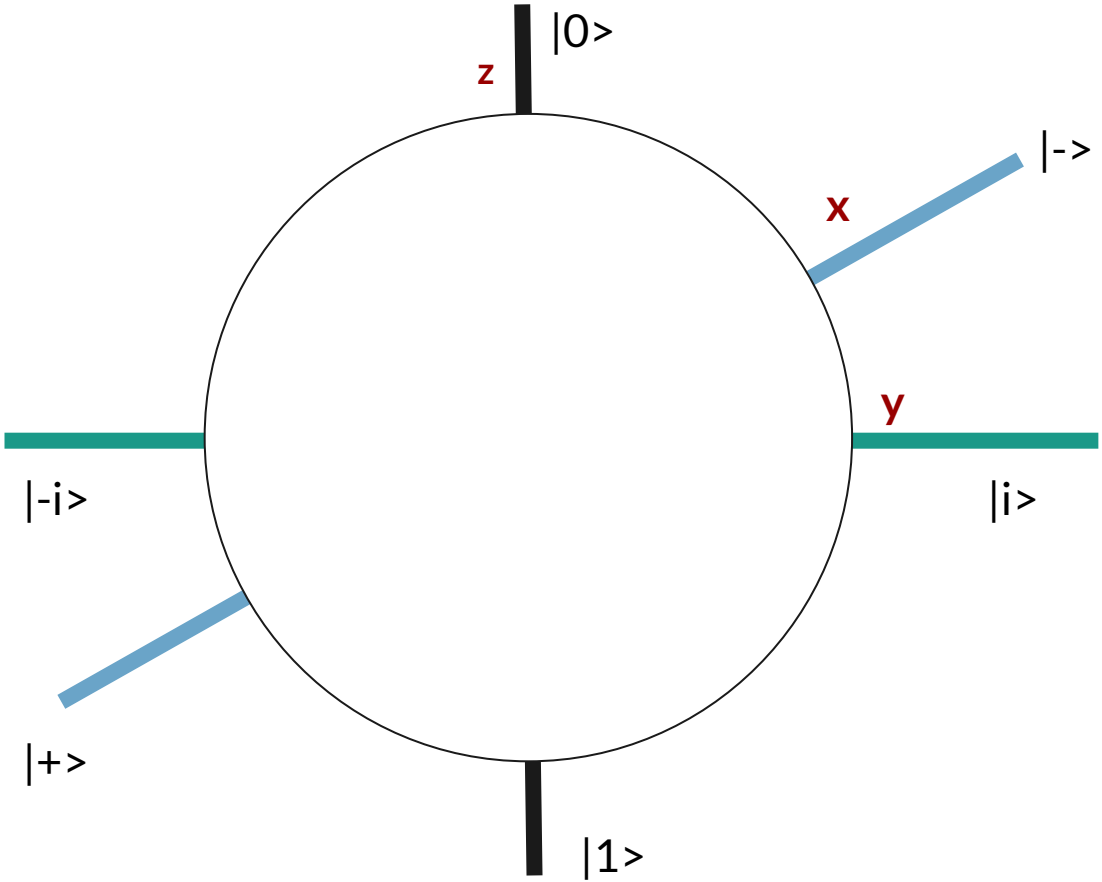
H

Quantum gates

√X $\sqrt{X}^\dagger$ Y RX RY RXX RZZ U RCCX RC3X

let's spin the ball!

# Some quantum gates...




**Pauli X gate** -> 180° in x-axis

**Pauli Y gate** -> 180° in y-axis

**Pauli Z gate** -> 180° in z-axis

**Phase gate** -> 90° in z-axis

**T gate** -> 45° in z-axis

# Some quantum gates...

**Pauli X gate** -> 180° in x-axis

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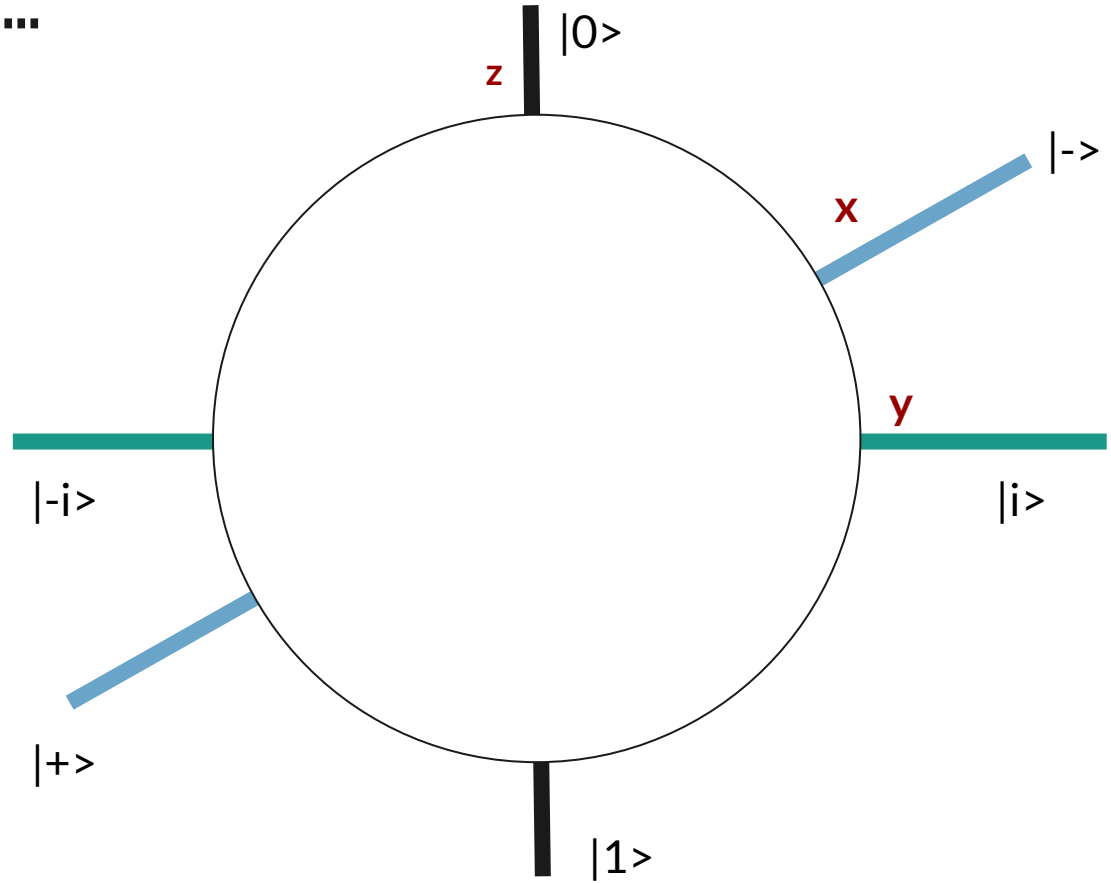
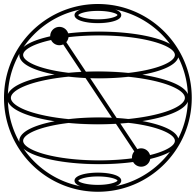


# How to code *quantumly speaking?*

"Assembler like" code (in Python):



Qiskit (IBM)

Cirq (Google)


PennyLane (Xanadu)

# Hands-on!!!! (notebook 1)

```
conda create --name qiskit-pyladies
conda activate qiskit-pyladies
pip install qiskit
pip install jupyterlab
pip install pylatexenc
```

# The mother of the gates: Hadamard gate

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Spin 90º in y-axis and 180º in x-axis

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Spin 90º in y-axis and 180º in x-axis

**Result**: the “vector” is in the equator

# The mother of the gates: Hadamard gate + CNOT gate

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+ **CNOT gate** -> 2 qubit gate: flips qubit_2 if qubit_1 (control qubit) is |1>

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Spin 90º in y-axis and 180º in x-axis

**Result**: the “vector” is in the equator

+ **CNOT gate** ->
2 qubit gate: flips qubit_2 if qubit_1 (control qubit) is |1>

entanglement

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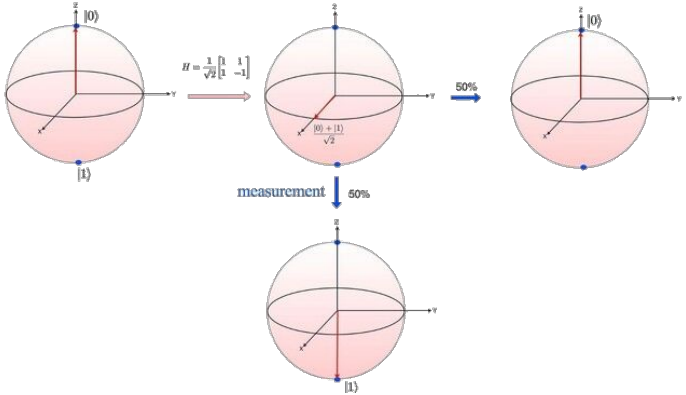
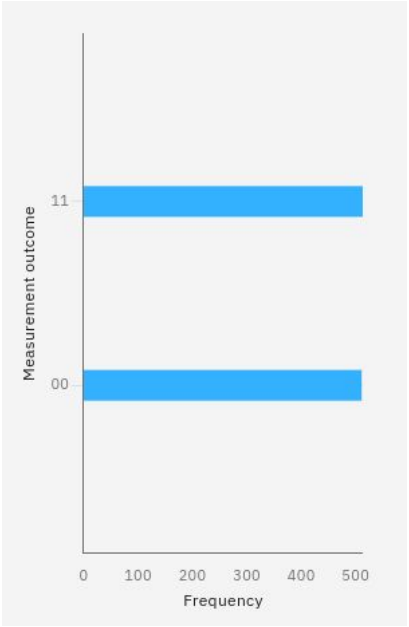
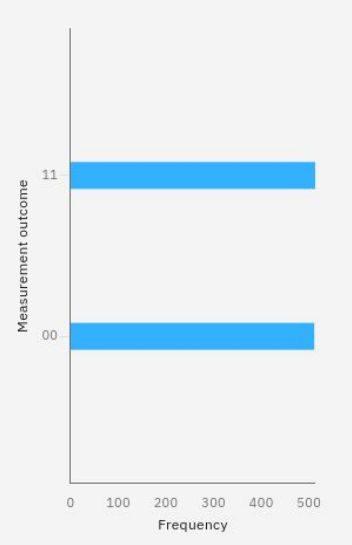


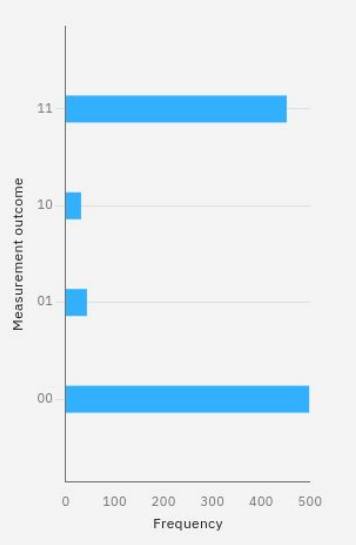




# Hands-on!!!! (notebook 2)

# Hadamard gate + CNOT gate in REAL quantum computers

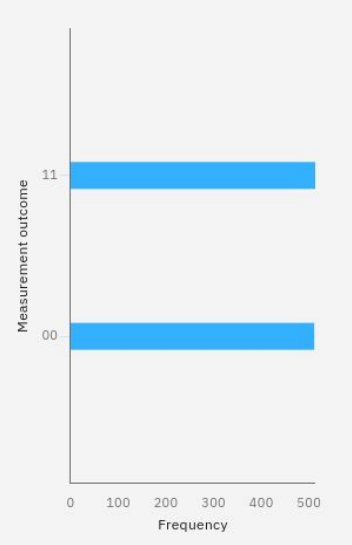



“fake” quantum computer




100% real, no fake, quantum computer

# Hadamard gate + CNOT gate in REAL quantum computers

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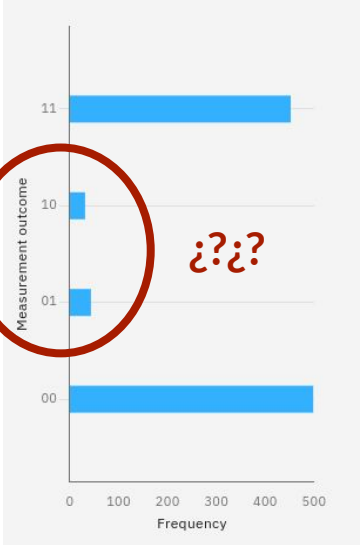


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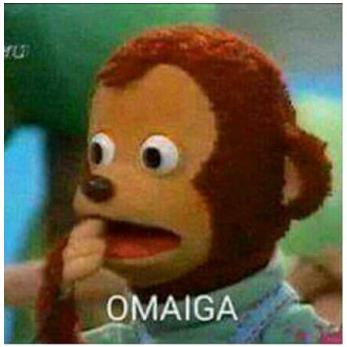


GRACIES PER LA VOSTRA ATENCIÓ
SI N'HEU POSAT


¿EING?
DE ENTERERADO NADA ME HE
memegenerator.es