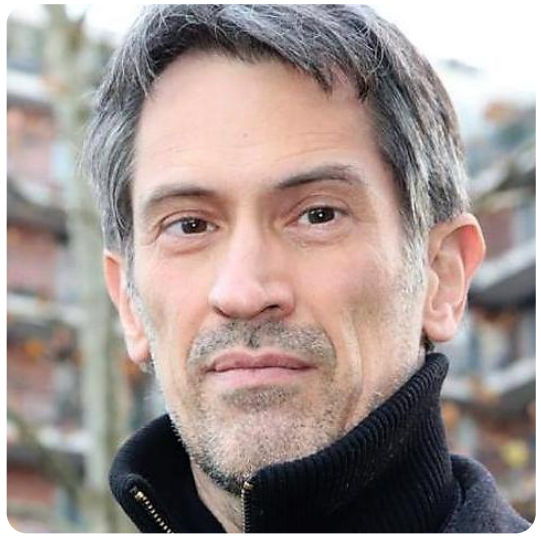
Introduction to Quantum Computing

Paolo Cremonesi

POLITECNICO
MILANO 1863

The Team



- Paolo Cremonesi (instructor)

- Riccardo Pellini (assistant)

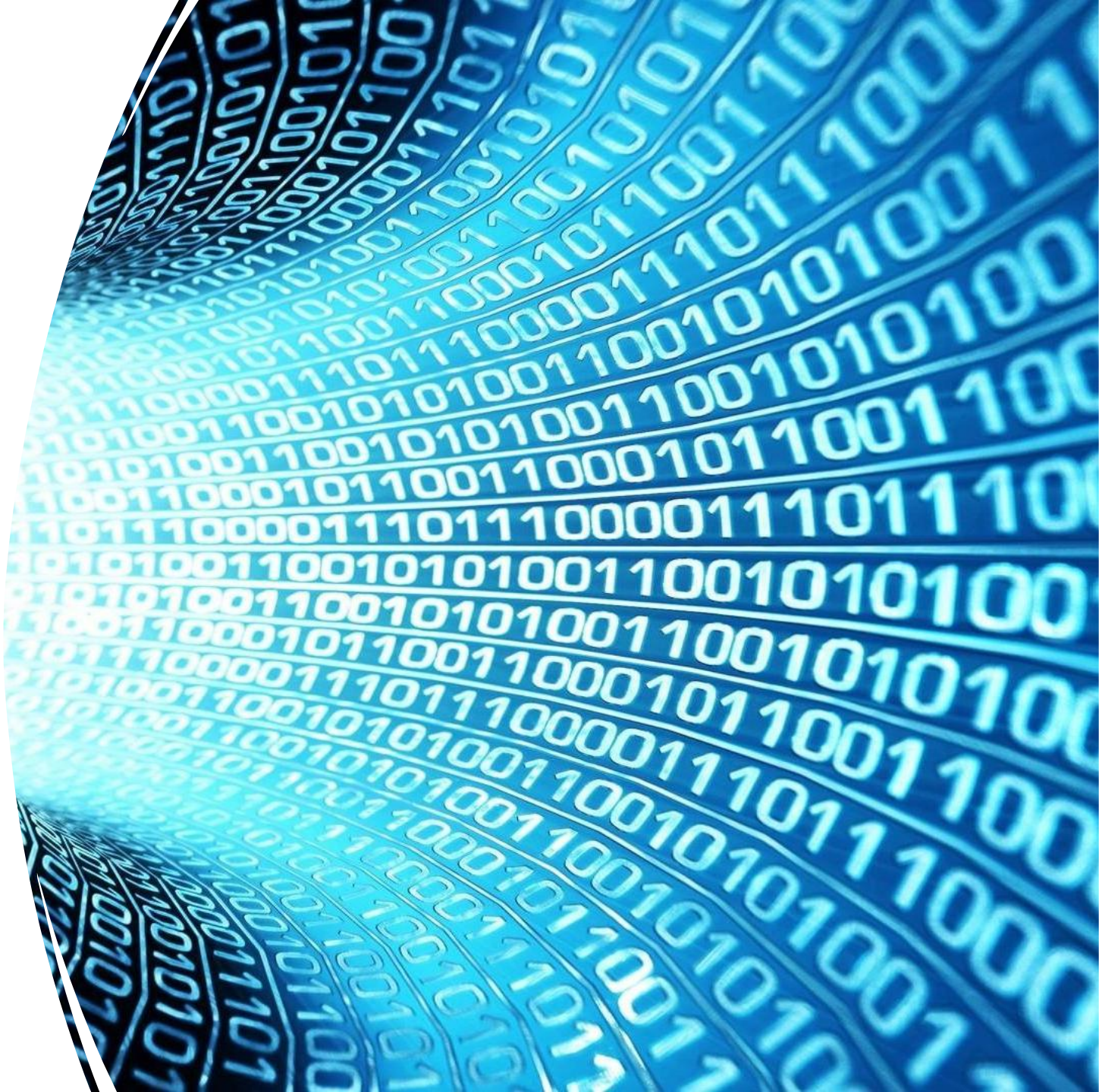
Study Material

- Slides, notes and recordings from the course
  - WeBeep: 059432 - QUANTUM COMPUTING (CREMONESI PAOLO) [2024-25]

- Additional material
  - *Quantum Computing: A Gentle Introduction*
    by **Eleanor Rieffel** and **Wolfgang Polak** (The MIT Press, 2011)
  - https://learning.quantum.ibm.com/course/basics-of-quantum-information
  - https://learning.quantum.ibm.com/course/fundamentals-of-quantum-algorithms

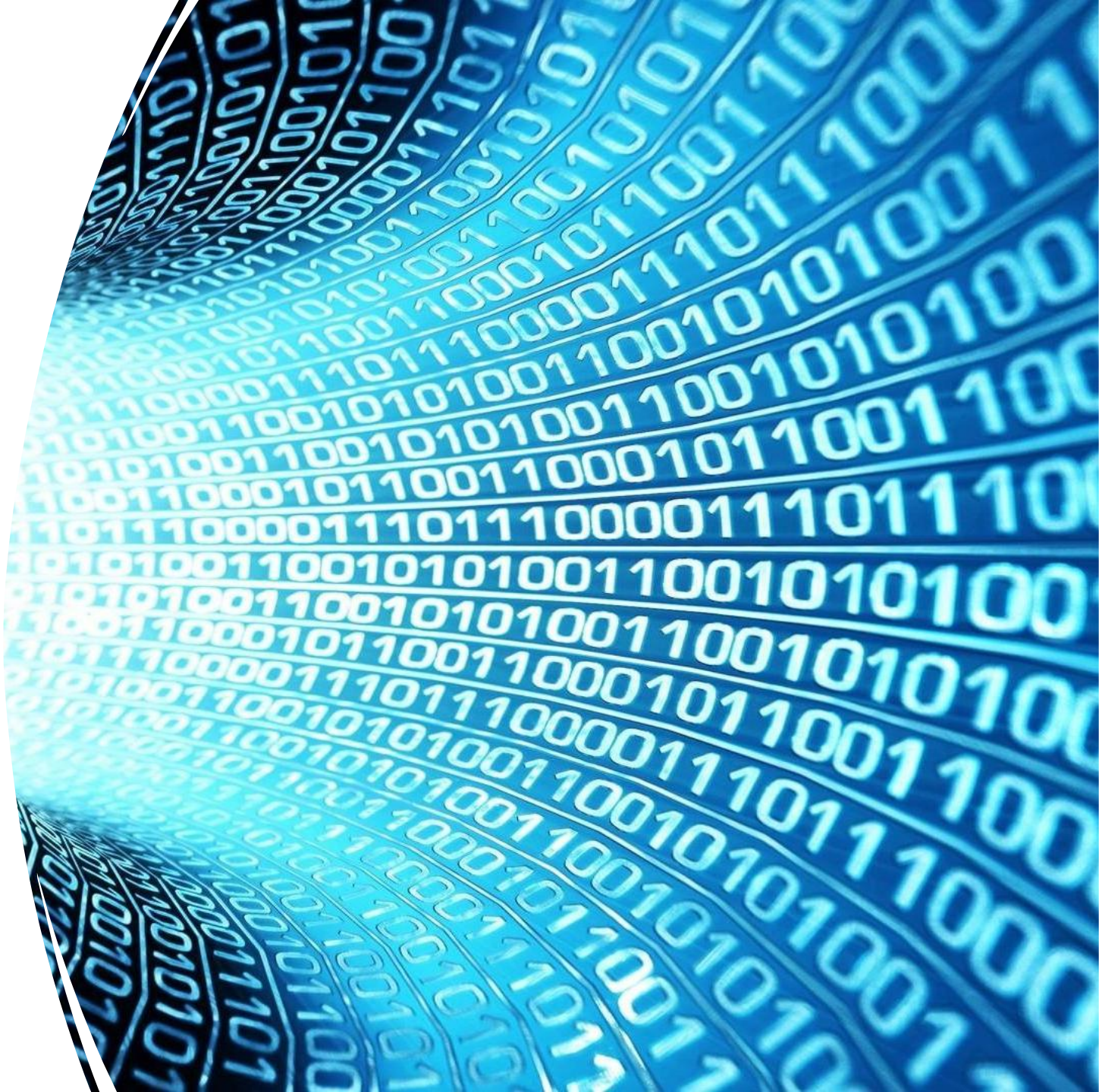
A quantum computer ...

.... It's not just a more powerful version of the computers we use today



A quantum computer ...

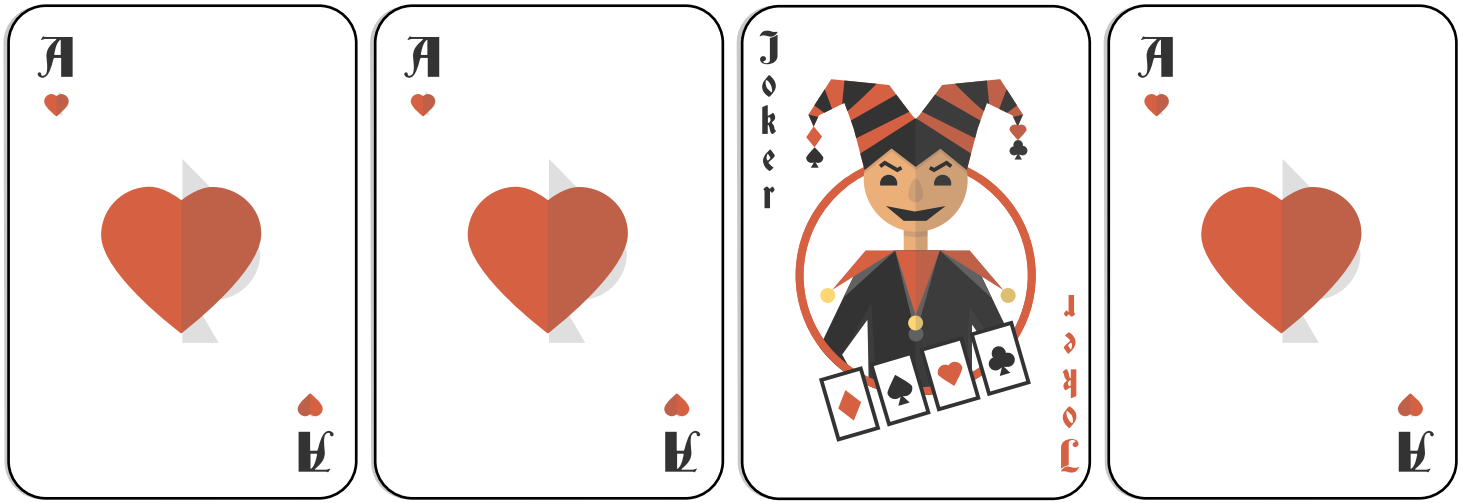
... It is something completely different, based on new and seemingly mysterious scientific knowledge, where the boundary between reality and science fiction is blurring.



The magic of quantum computers

We have four cards:

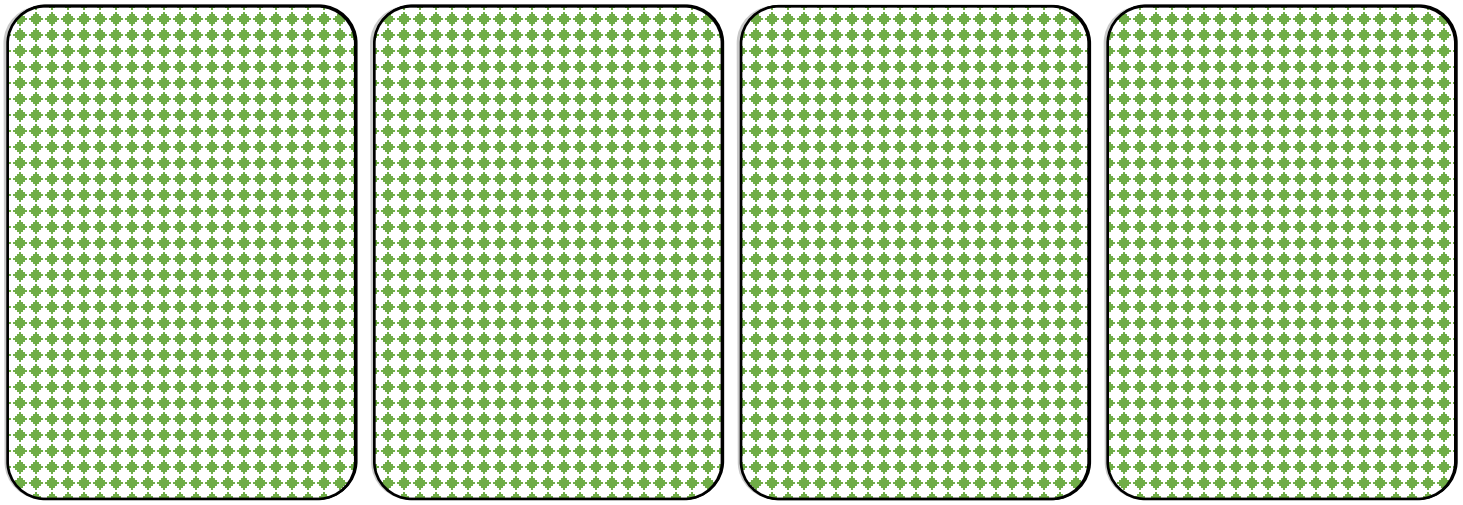
Three Aces and a Joker



The magic of quantum computers

We turn and mix them

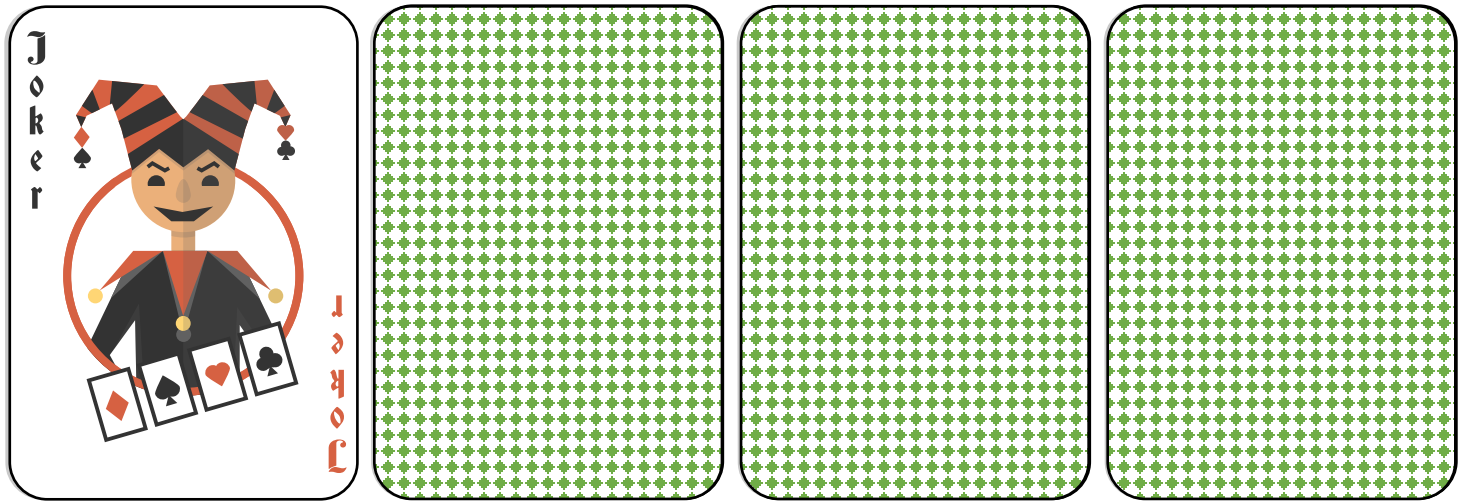
How many cards do we have to turn to find where the Joker is?



The magic of quantum computers

With a regular computer:

If you are lucky, just turn one card

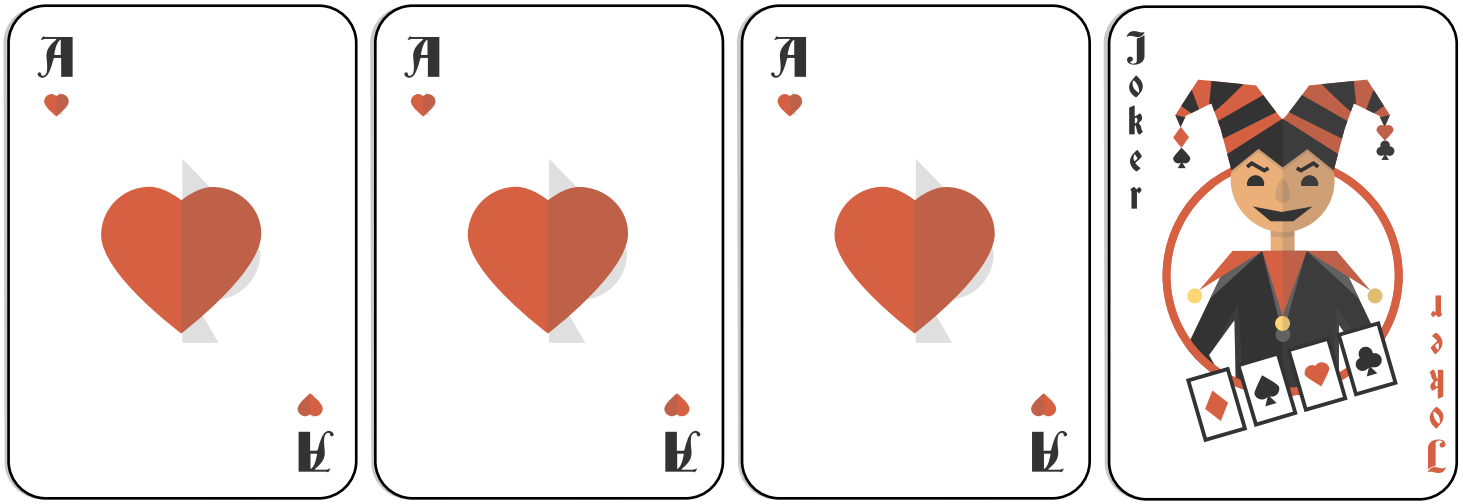


The magic of quantum computers

With a regular computer:

If you are lucky, just turn one card

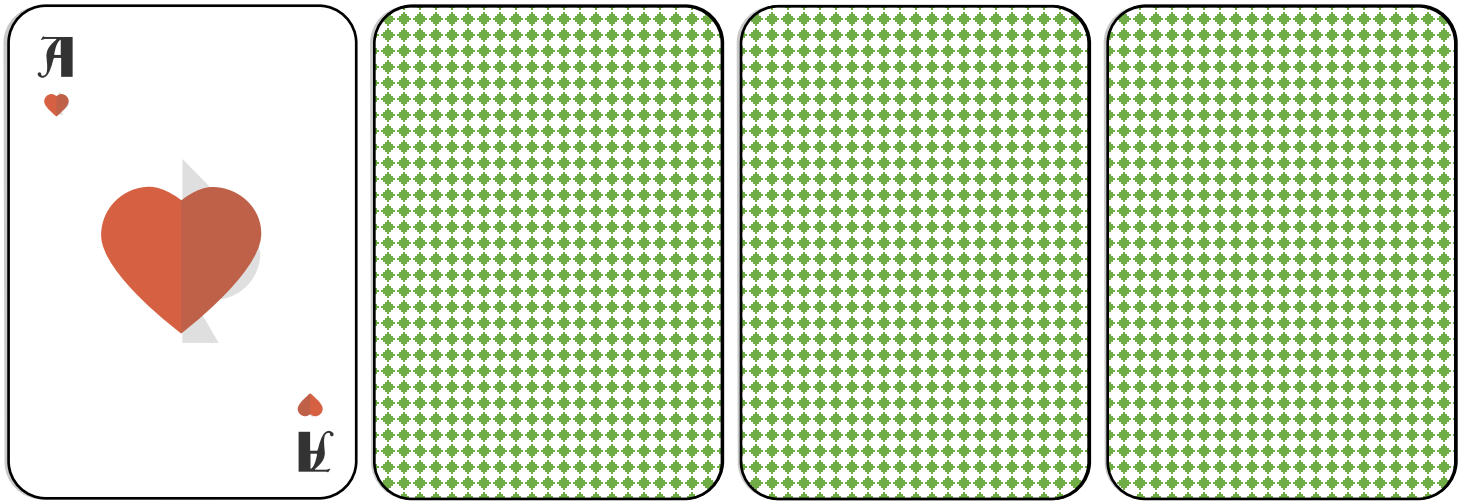
If you are unlucky, you have to turn three cards



The magic of quantum computers

With a quantum computer:

Just turn one card



How is a qubit made?

Technology	*Operation*
Superconductors	20 mK
Photons	1 K
Electrons	1 K
Ions	High vacuum
Atoms	High vacuum
Diamonds	Environment
Topological	…
…	…

How is a Quantum Computer made?

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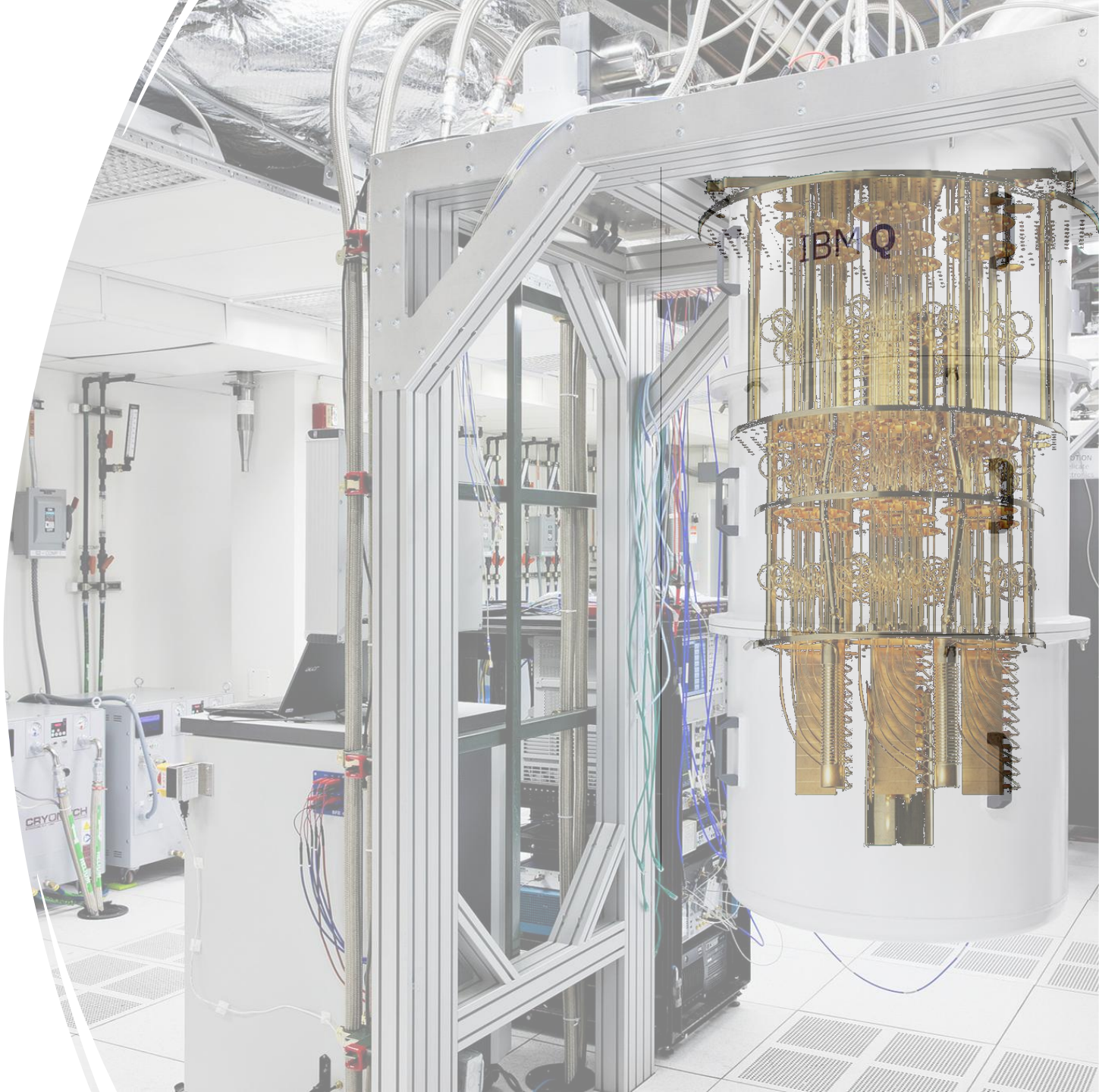

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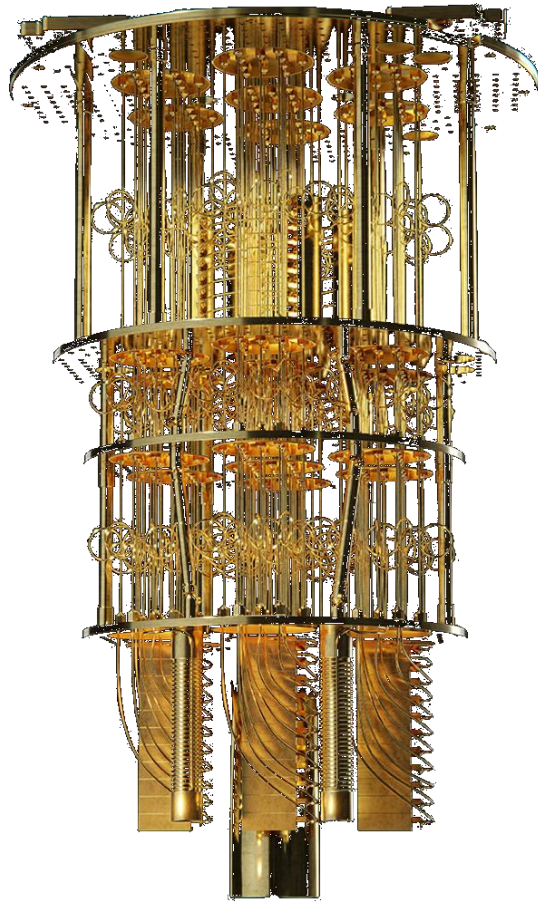

How is a Quantum Computer made?

Producers of Quantum Computers