QUANTUM
TO THE PROGRAMMING
@fernandoescolar

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developer at SCRM - Lidl International Hub

www.developerro.com

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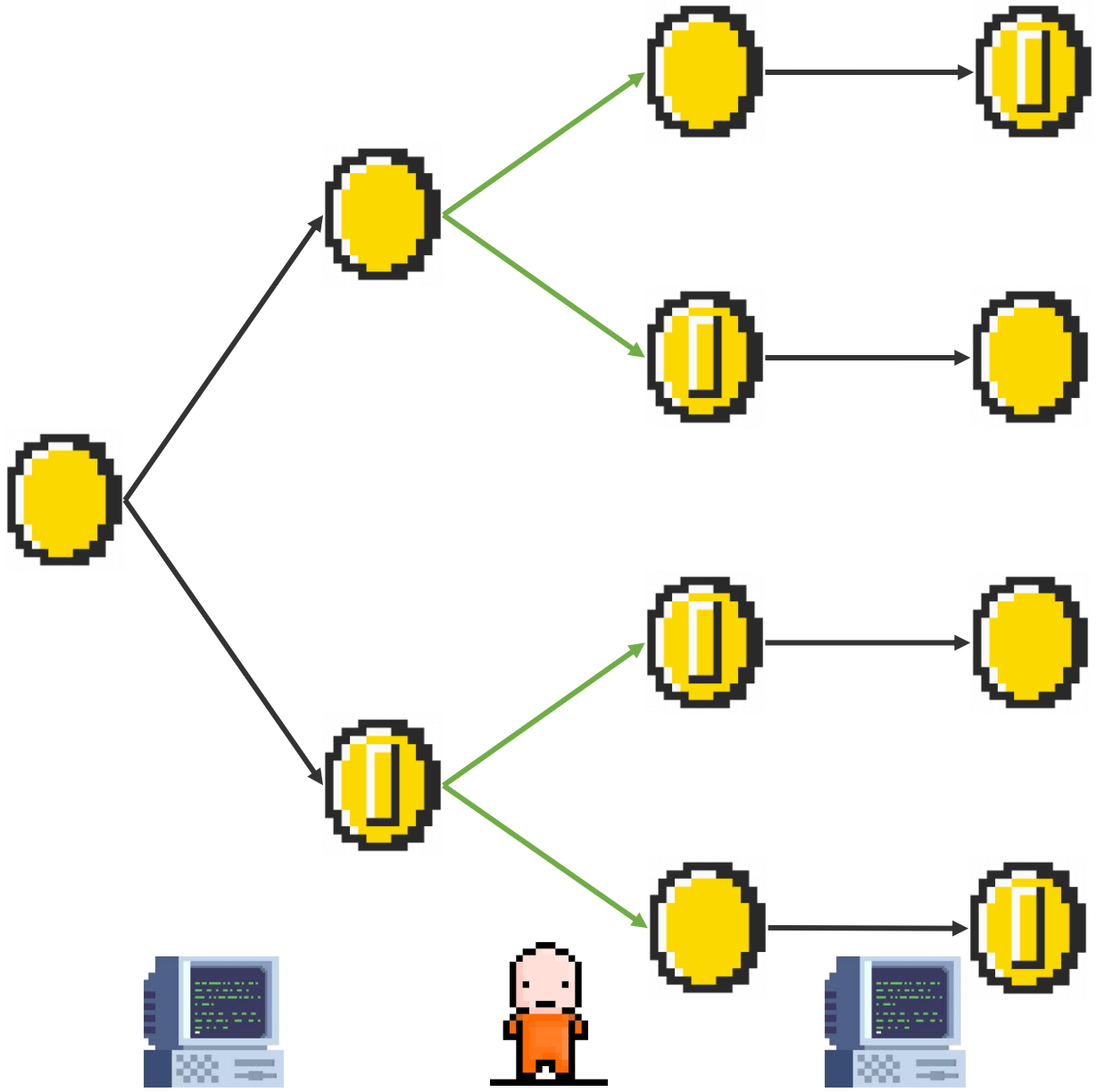
Quantum Flip coins game

https://www.ted.com/talks/shohini_ghose_a_beginner_s_guide_to_quantum_computing



Classic computer:

50% - 50%

Quantum computer:

97% - 3%

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Paul Benioff

70#

Quantum computing

80#

quantum mechanical model of Turing Machines

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bit

qubit

Schrodinger's cat experiment

Schrodinger`s cat

An opaque box

Poisonous gas bottle

A device that releases gas when a particle decays

A particle with a 50% probability of disintegrating in time X

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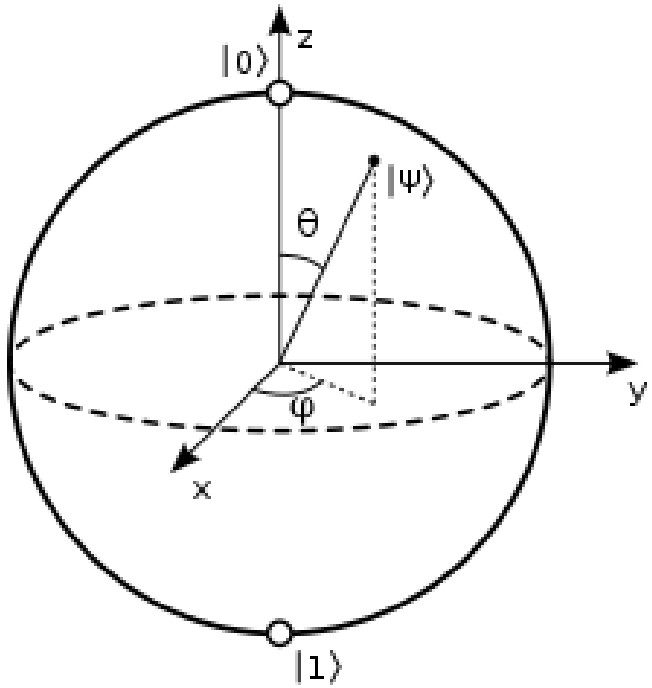
$$(\alpha \cdot |0\rangle + \beta \cdot |1\rangle)$$

where: $|\alpha|^2 + |\beta|^2 = 1$

Bloch sphere

$$r_\alpha e^{i\Phi_\alpha}|0\rangle + r_\beta e^{i\Phi_\beta}|1\rangle$$

- Z axis: |1> or |0>
- X axis: |+> or |->
- Y axis: |i> or |-i>



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11 binary = 3 decimal

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$$a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle$$

where: $|a|^2 + |b|^2 + |c|^2 + |d|^2 = 1$

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Classic logic gates

NOT

Input	Output
0	1
1	0

YES

Input	Output
0	0
1	1

AND

Input		Output
0	0	0
0	1	0
1	0	0
1	1	1

XOR

Input		Output
0	0	0
0	1	1
1	0	1
1	1	0

OR

Input		Output
0	0	0
0	1	1
1	0	1
1	1	1

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Quantum logic gates

Z	
Input	Output
$\|0\rangle$	$\|0\rangle$
$\|1\rangle$	$\|-1\rangle$

X	
Input	Output
$\|0\rangle$	$\|1\rangle$
$\|1\rangle$	$\|0\rangle$

SWAP	
Input	Output
$\|00\rangle$	$\|00\rangle$
$\|01\rangle$	$\|10\rangle$
$\|10\rangle$	$\|01\rangle$
$\|11\rangle$	$\|11\rangle$

CNOT		
Control	Target	Output
$\|0\rangle$	$\|0\rangle$	$\|00\rangle$
$\|0\rangle$	$\|1\rangle$	$\|01\rangle$
$\|1\rangle$	$\|0\rangle$	$\|11\rangle$
$\|1\rangle$	$\|1\rangle$	$\|10\rangle$

H	
Input	Output
$\|0\rangle$	$\frac{\|0\rangle + \|1\rangle}{\sqrt{2}}$
$\|1\rangle$	$\frac{\|0\rangle - \|1\rangle}{\sqrt{2}}$

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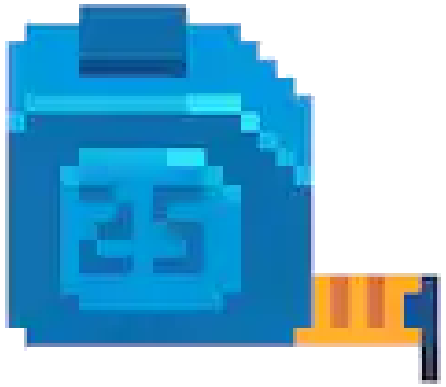
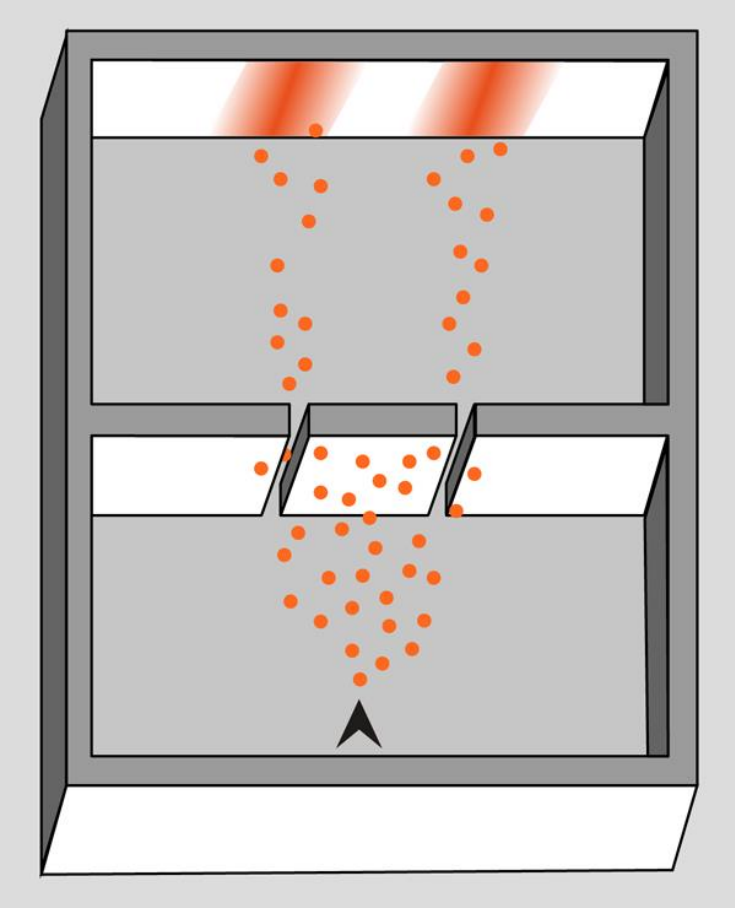
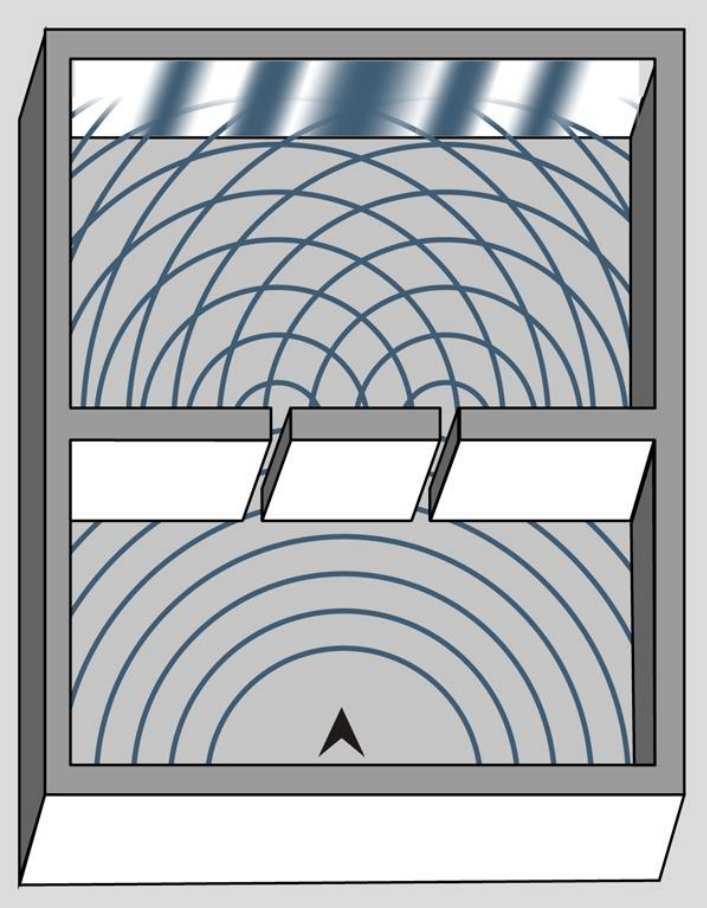
Measure



Young's interference experiment

double-slit interferometer





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THIS IS
FINE.

demo

```
$ dotnet tool install -g Microsoft.Quantum.IQSharp
$ dotnet new -i Microsoft.Quantum.ProjectTemplates
$ dotnet new console -lang Q#
```


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Entanglement

$$a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle$$

$$\frac{1}{\sqrt{2}}|00\rangle + 0|01\rangle + 0|10\rangle + \frac{1}{\sqrt{2}}|11\rangle$$

$$\frac{1}{\sqrt{2}}|00\rangle + \frac{1}{\sqrt{2}}|11\rangle$$

Measure(q1) = 0 -> Measure(q2) = 0
Measure(q1) = 1 -> Measure(q2) = 1

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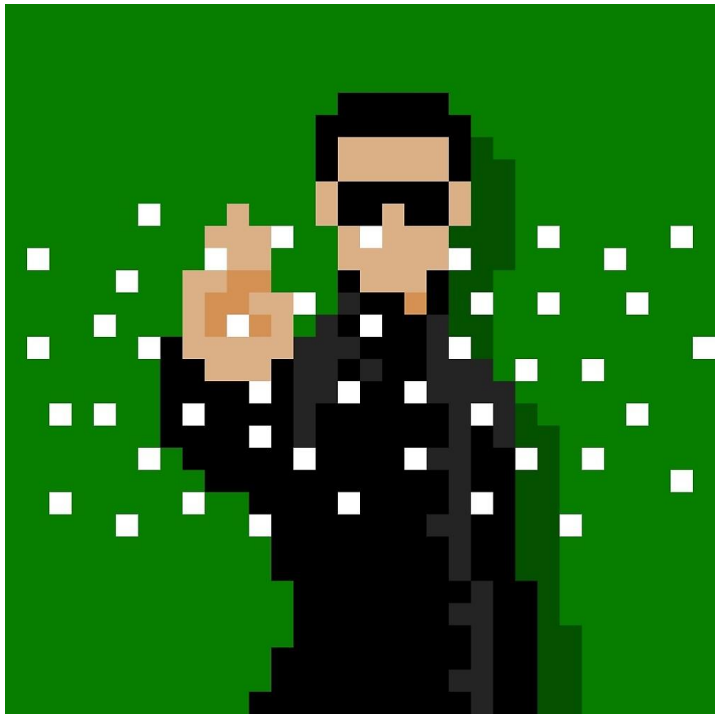
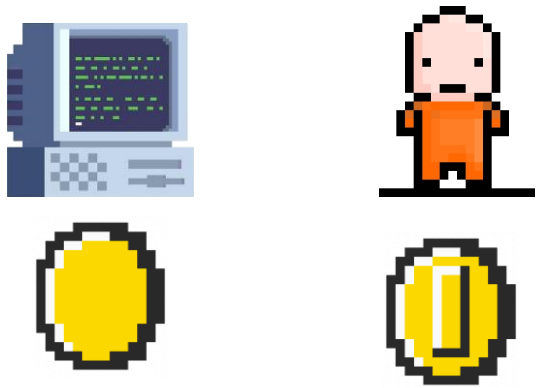
Teleport

why dodge bullets?



https://www.nature.com/articles/nature23675

demo



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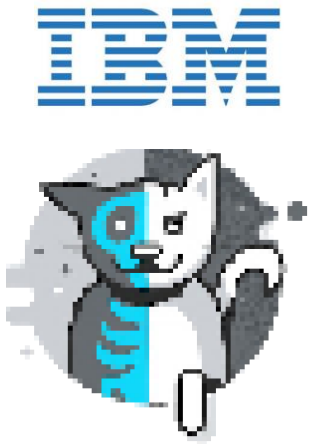
demo



Meanwhile,
in the RealWorld

30 qubits = 10 teraflops

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Application examples

Quantum cypher

- Private keys (Heisenberg principle)

Farmacy Molecules Models

- The same quantum properties

New network models

- Quantum networks based on teleportation

Faster search

- N elements N/2 cycles vs $\sqrt{N}$ cycles

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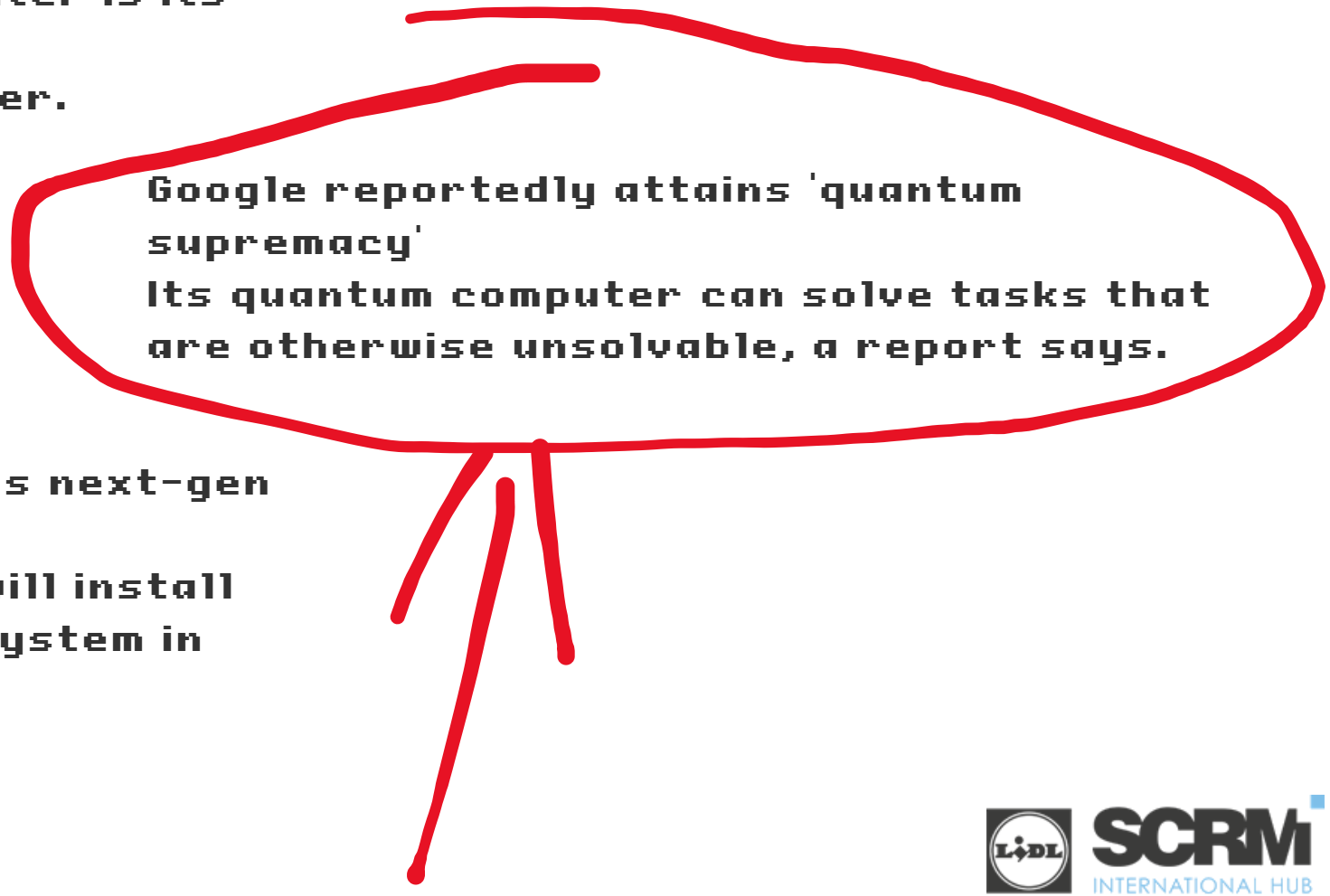
2019 News

Intel Fabricates 49 Qubit Superconducting Chip

IBM's new 53-qubit quantum computer is its biggest yet
The system will go online in October.

Google reportedly attains 'quantum supremacy'
Its quantum computer can solve tasks that are otherwise unsolvable, a report says.



Nuclear weapons lab buys D-Wave's next-gen quantum computer
Los Alamos National Laboratory will install D-Wave's 5,000-qubit Advantage system in 2020.

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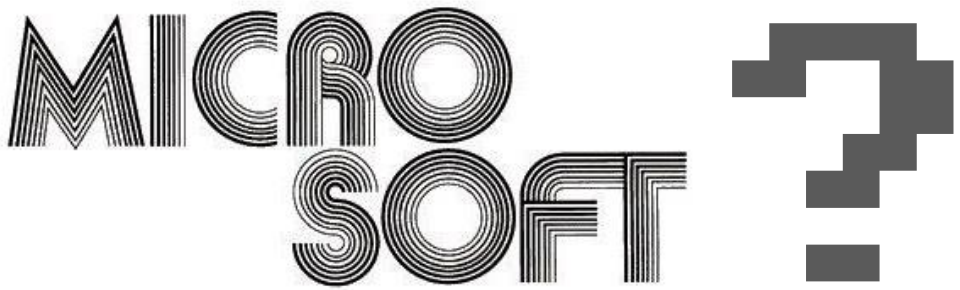
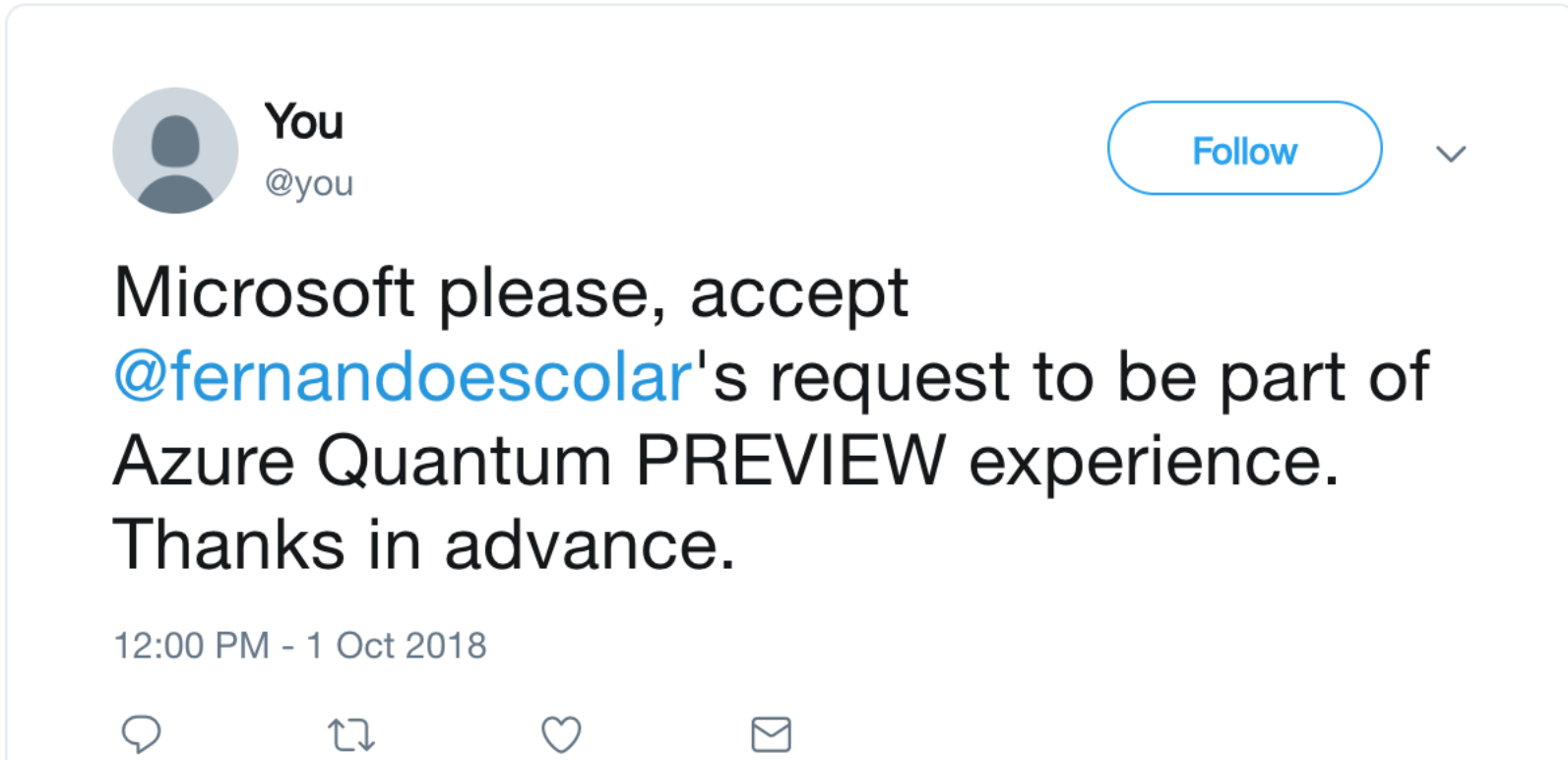
2020 News

Novel error-correction scheme developed for quantum computers
https://phys.org/news/2020-03-error-correction-scheme-quantum.html

D-Wave Opens Quantum-Computing Resources to Coronavirus Research

https://www.wsj.com/articles/d-wave-opens-quantum-computing-resources-to-coronavirus-research-11585763422


MICRO
SOFT
?


You
@you
Follow
Microsoft please, accept @fernandoescolar's request to be part of Azure Quantum PREVIEW experience. Thanks in advance.
12:00 PM - 1 Oct 2018

Thanks for playing

@fernandoescolar

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