HPC Now!

Playing with Quantum Computing without Quantum Computers

16th USERS CONFERENCE - RES

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R&D Manager

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Installation

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Quantum Computer by definition

A quantum computer is...

... built using the laws of quantum mechanics.

Richard P. Feynman, (1985).
Optics News.

... a hypothetical machine that uses principles of quantum mechanics for their basic operations

Peter W. Shor, (1998).
Documenta Mathematica. 467-486

... a device that directly exploits quantum mechanical phenomena to perform a calculation.

Mikael P. Johansson, (2021).
Quantum Computing – A European Perspective. PRACE

Classification of Quantum Computers

There are many ways to group quantum computers:

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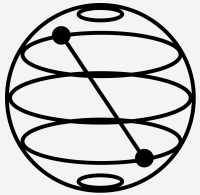
... and many more

Quantum computing without (too much) extra investment

Some quantum emulators (or simulators…)

https://thequantuminsider.com/2022/06/14/top-63-quantum-computer-simulators-for-2022/



Qiskit
https://qiskit.org/
IBM
Python

myQLM (community version of QLM)
https://atos.net/en/lp/myqlm
Atos
Python

Quantum Exact Simulation Toolkit
https://quest.qtechtheory.org/
University of Oxford
C/C++

Pennylane
https://pennylane.ai/
Xanadu
Python

How to start playing with a quantum emulator?

Option 1: using your laptop

```
pip install qiskit
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```python
from qiskit import QuantumCircuit, assemble, Aer
from qiskit.visualization import plot_histogram

# create quantum circuit
qc = QuantumCircuit(1)          # 1 quantum register, 1 classical register

qc.x(0)                         # add a gate to the circuit
qc.measure_all()                # add measurement at the end

# run
sim = Aer.get_backend('aer_simulator')
qobj = assemble(qc)             # Assemble a list of circuits or pulse schedules into a Qobj
result = sim.run(qobj).result()  # run circuit, get results

# output statistics
counts = result.get_counts()    # extract statistics from results
print(counts)
```

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Option 2: using your cluster

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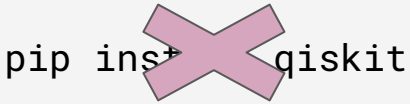

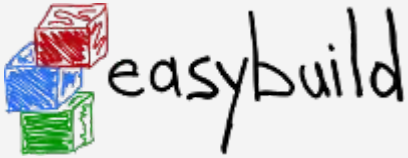


```
$ eb Qiskit-0.31.0-foss-2021a.eb --robot
$ [easybuild stuff]
$ module load Qiskit-0.31.0-foss-2021a
```

WARNING! Using quantum emulators can cause memory issues

Example with 10 qubits:

2^{10} states x 8 bytes = **9 KB**

Example with 53 qubits:

2^{53} states x 8 bytes = **72 PB**

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Memory requirements

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Quantum computing cloud resources

Vendors

XANADU

https://pennylane.xanadu.ai/

IBM **Quantum**

https://quantum-computing.ibm.com/

Cloud providers

https://aws.amazon.com/braket/

https://azure.microsoft.com/es-es/services/quantum/

Public efforts to provide quantum technology to the general public

High Performance Computer – Quantum Simulator hybrid.
Integrate two simulators and deploy an European HPC-QS infrastructure to provide a non-commercial cloud access to European users.
https://www.hpcqs.eu/

Boost the Spanish quantum infrastructure. It will provide one quantum computer and three simulators to the RES, support to develop software and training.
https://quantumspain-project.es/

Take home messages

- Quantum technology is a vivid field.
- Quantum computing is not (so) accessible yet, but there are quite solutions to start experimenting with.
- In the next years, some quantum computing devices will be available for the public (at least in Spain/Europe).

We are hiring now!

Open positions

- SysOps Engineer (NZ)
- Linux Systems Administrator (NZ)
- SysOps Engineer (EMEA)

careers@hpcnow.com

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Thank you for your attention
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