



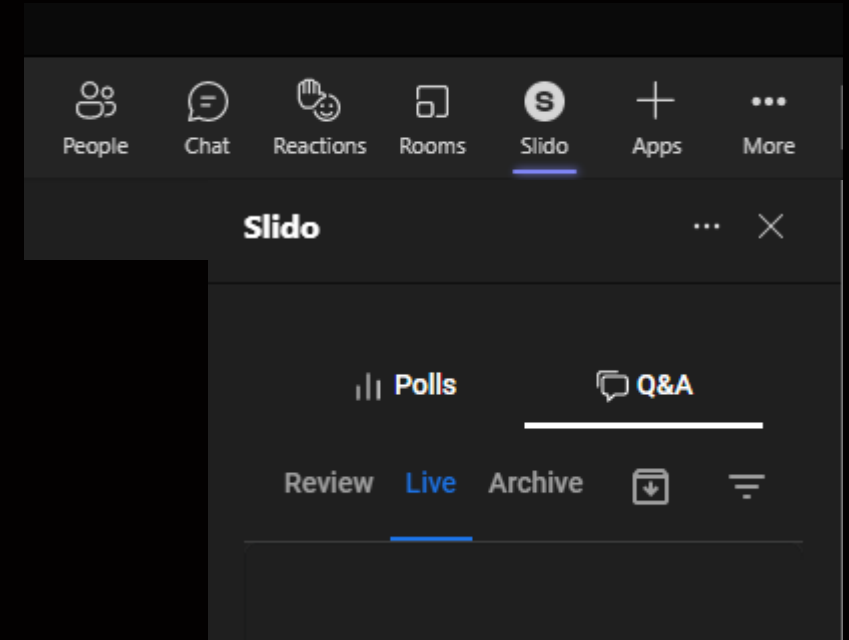
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QnA

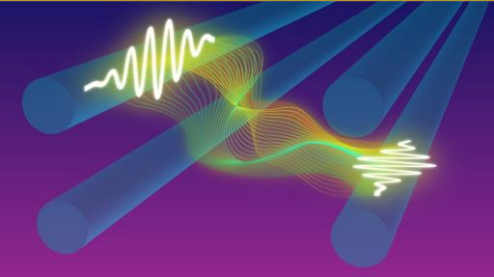
- We use Slido for Q&As and polls
- Teams app users can see Slido at the bottom of the meeting
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Technical Course Structure

Multiple Qubits

Thursday 15th September

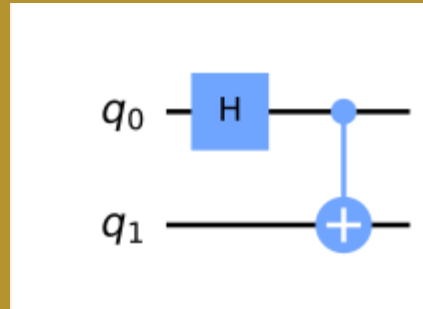


Multi-qubit states
Entanglement revisited
Multi-qubit gates

Assignment 2 Due
Tomorrow

Quantum Circuits

Thursday 22nd September



How to program a QC
IBM Quantum Experience

Assignment 3 Due

Quantum Algorithms

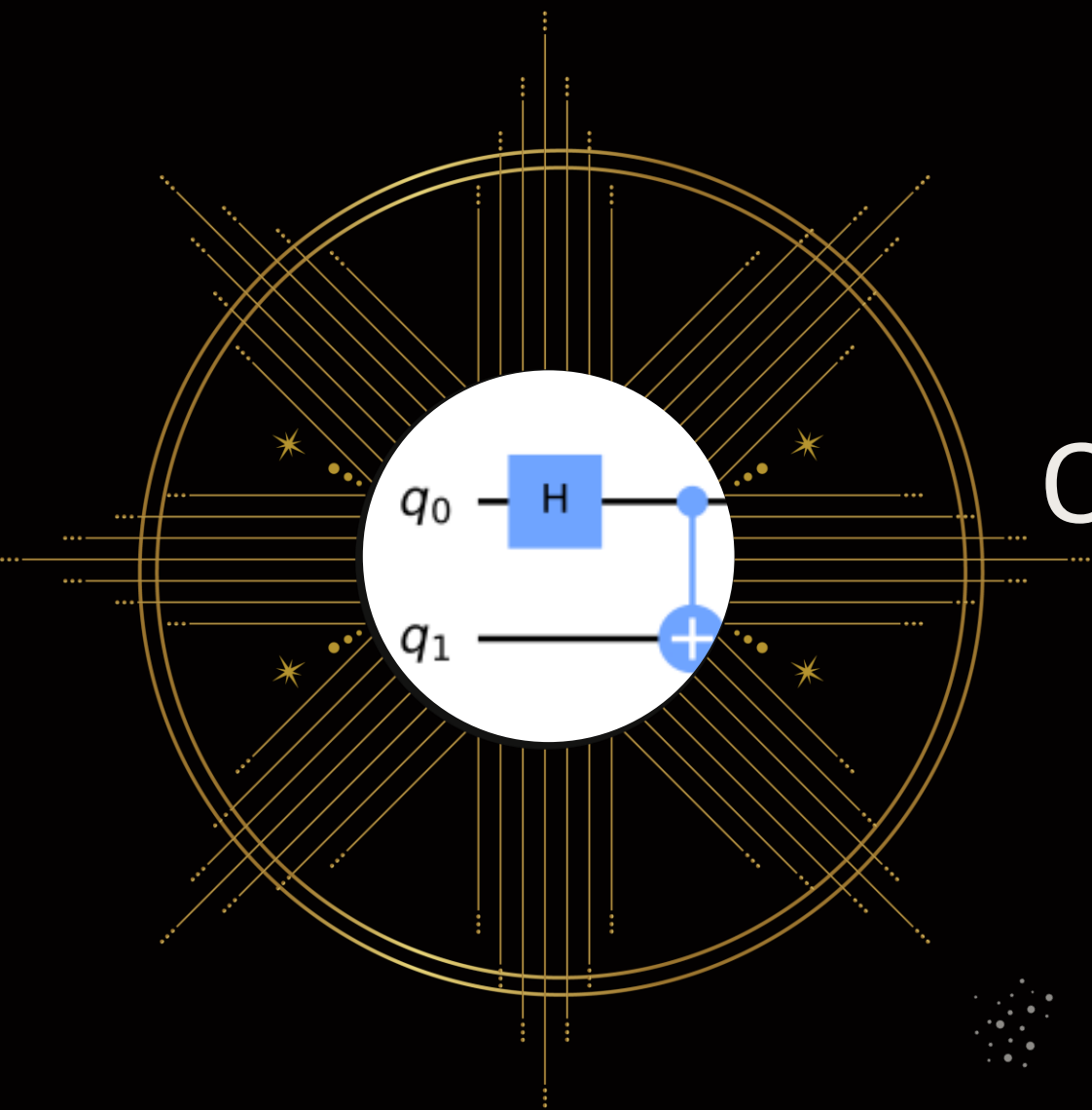
Thursday 29th September



Shor's Algorithm, Grover's
algorithm
Practical considerations

Assignment 4 Due





Quantum Circuits

Quantum computing



Course materials

EquinoxAI / YAltQC Public

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Code Issues 6 Pull requests Projects Wiki Security Insights

<https://github.com/EquinoxAI/YAltQC/tree/main/Chapters>

main YAltQC / Chapters /

Go to file

Add file

...

tclarke21 Added FakeBogotaV2 backend d990e43 1 minute ago History

..		
Images	Added brief section on qudits	14 days ago
0_Acknowledgements.ipynb	Gracias Luis!	9 days ago
10_Grover.ipynb	I renamed 1 folder and everyone loses their minds!	28 days ago
11_Shor.ipynb	Added references, another image #4 #7	24 days ago
12_QML.ipynb	I renamed 1 folder and everyone loses their minds!	28 days ago
1_What_is_quantum.ipynb	#8 Fixed	18 days ago
2_What_is_quantum_computing.ipynb	#4 added quantum algorithms diagram	18 days ago
3.1_Complex_numbers.ipynb	#8 Fixed	18 days ago
3.2_Linear_algebra.ipynb	Moved ket to linear algebra section #3	15 days ago
4_Dirac_Notation.ipynb	Gracias Luis!	9 days ago
5_Single_Qubits_&_Bloch_Sphere.ipynb	#9 added an i	2 hours ago
6_Multiple_Qubits.ipynb	#6 1st version of Assignment 4	17 minutes ago
7_Quantum_circuits.ipynb	Added FakeBogotaV2 backend	1 minute ago
8_Quantum_algorithms.ipynb	I renamed 1 folder and everyone loses their minds!	28 days ago

This week's content

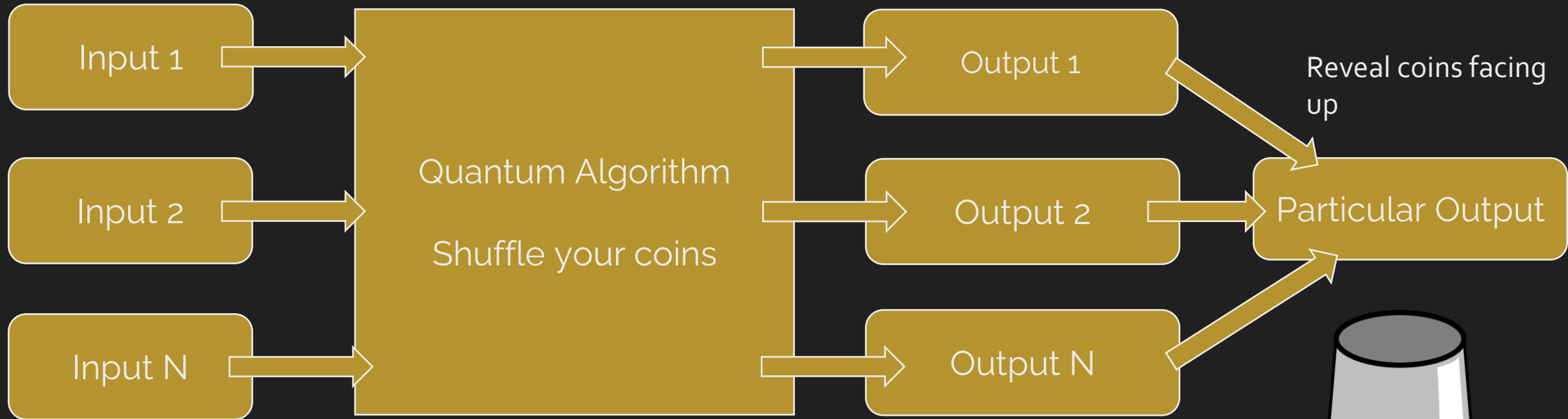


How Quantum Computers Work

Quantum Algorithm: Set of instructions that describes how you change the state of the (quantum) computer

Spin many coins

Many possible coin combinations



Installing Qiskit on your local machine (optional)

- Runs on Windows, macOS, Linux
- Requires python 3.8 or newer
- Numpy, matplotlib are also required
- We're using Qiskit 0.38
- Anaconda is recommended for managing your environment
- Run "pip install qiskit" from anaconda prompt, or terminal
- You may also need to install some additional packages for visualisation. They can be done from the terminal too
- Install [instructions on the Qiskit website](#)



ibm_nairobi

System status ● Online
 Processor type **Falcon r5.11H**

Qubits	QV	CLOPS
7	32	2.6K



ibm_oslo

System status ● Online
 Processor type **Falcon r5.11H**

Qubits	QV	CLOPS
7	32	2.6K



ibmq_manila

System status ● Online
 Processor type **Falcon r5.11L**

Qubits	QV	CLOPS
5	32	2.8K



ibmq_quito

System status ● Online
 Processor type **Falcon r4T**

Qubits	QV	CLOPS
5	16	2.5K



ibmq_belem

System status ● Online
 Processor type **Falcon r4T**

Qubits	QV	CLOPS
5	16	2.5K



ibmq_lima

System status ● Online
 Processor type **Falcon r4T**

Qubits	QV	CLOPS
5	8	2.7K



simulator_stabilizer

Simulator status ● Online
 Simulator type **Clifford simulator**

Qubits
5000

simulator_mps

Simulator status ● Online
 Simulator type **Matrix Product State**

Qubits
100

simulator_extended_stabilizer

Simulator status ● Online
 Simulator type **Extended Clifford (e.g. Clifford+T)**

Qubits
63

ibmq_qasm_simulator

Simulator status ● Online
 Simulator type **General, context-aware**

Qubits
32

simulator_statevector

Simulator status ● Online
 Simulator type **Schrödinger wavefunction**

Qubits
32

Assignment 4

- Coding assignment
- Download assignment_4.ipynb
- Upload to
- 6 regular questions
- 2 optional challenge questions
- Due Friday 23rd September
- [Link to the assignment](#)

Thomas Clarke
Quantum Computing Technical Foundations
September 22, 2022

Assignment 4: Quantum Circuits

Assignment Due: Friday 30th September

You may have noticed this assignment looks different to the others. For this week you get to do quantum computing, using a real quantum processor!

You can [register for an IBM ID here](#)

For each of these questions, you can simulate the circuit, generate a histogram of your results & interpret it.

I will provide the building blocks & some hints

If you want to run any circuit on a noisy backend (FakeBogotaV2), copy the cell, uncomment it out and replace "your_circuit" with the name of your circuit.
If you want to run it on a real IBM quantum computer, the easiest way to do it is using the IBM Quantum Lab. Otherwise you'll need to setup your account on your local machine

```
In [ ]: # transpiled_circuit = transpile("your_circuit", backend_bogota)

# backend_bogota.run(transpiled_circuit)
```

```
In [57]: import qiskit
import numpy as np
from qiskit import QuantumCircuit, Aer, execute
from qiskit.tools.visualization import plot_histogram
from qiskit.providers.fake_provider import FakeBogotaV2

sim = Aer.get_backend('aer_simulator')
backend_bogota = FakeBogotaV2()
```





New file +



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qiskit-tutorials

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quantum-challenge

a year ago

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Untitled1.ipynb

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Untitled1.ipynb



Code



Python 3 (ipykernel)



```
[1]: import numpy as np
```

```
# Importing standard Qiskit libraries
```

```
from qiskit import QuantumCircuit, transpile, Aer, IBMQ
```

```
from qiskit.tools.jupyter import *
```

```
from qiskit.visualization import *
```

```
from ibm_quantum_widgets import *
```

```
from qiskit.providers.aer import QasmSimulator
```

```
# Loading your IBM Quantum account(s)
```

```
provider = IBMQ.load_account()
```

```
<frozen importlib._bootstrap>:219: RuntimeWarning: scipy._lib.messagestream.MessageStream size changed, may indicate binary incompatibility. Expected 56 from C header, got 64 from PyObject
```

```
[ ]:
```



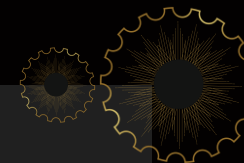
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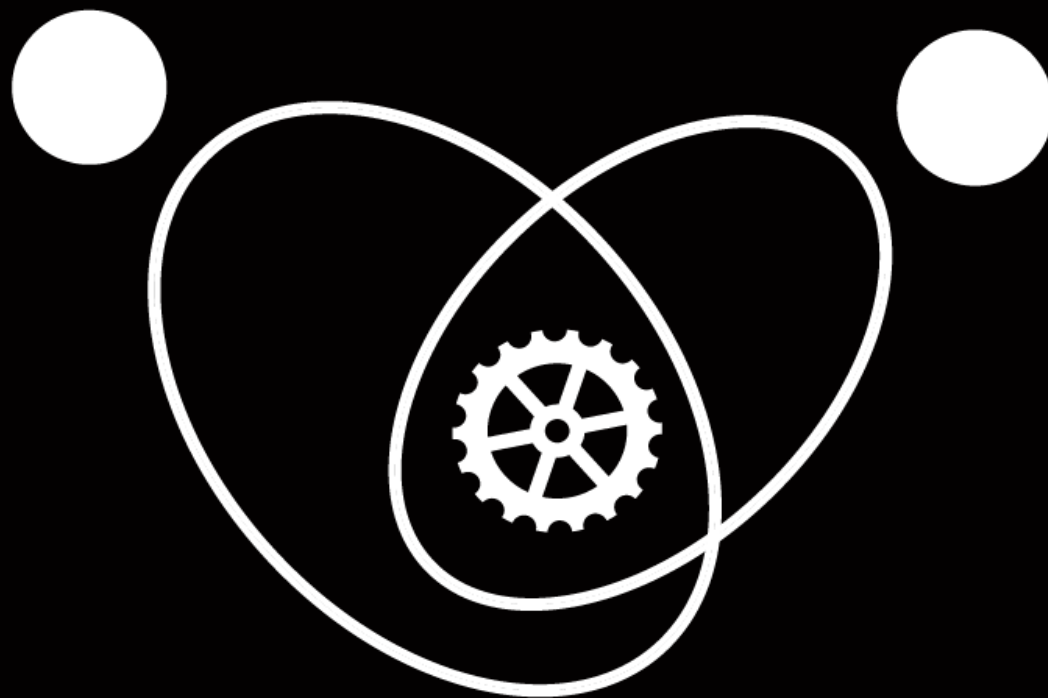


Audience Q&A Session

① Start presenting to display the audience questions on this slide.

GRACIAS





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