Python/Qiskit 入門

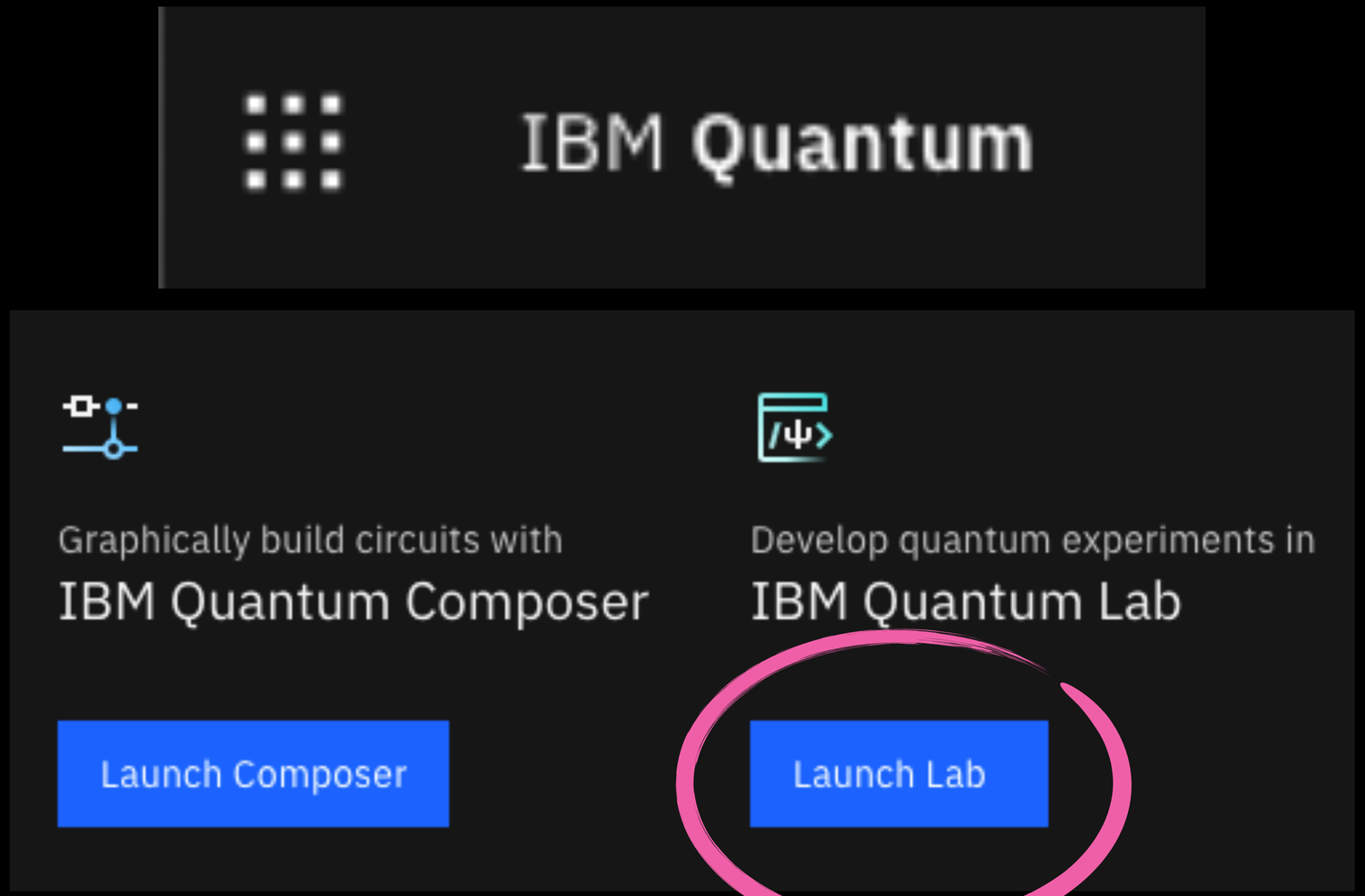
高中量子科技課程

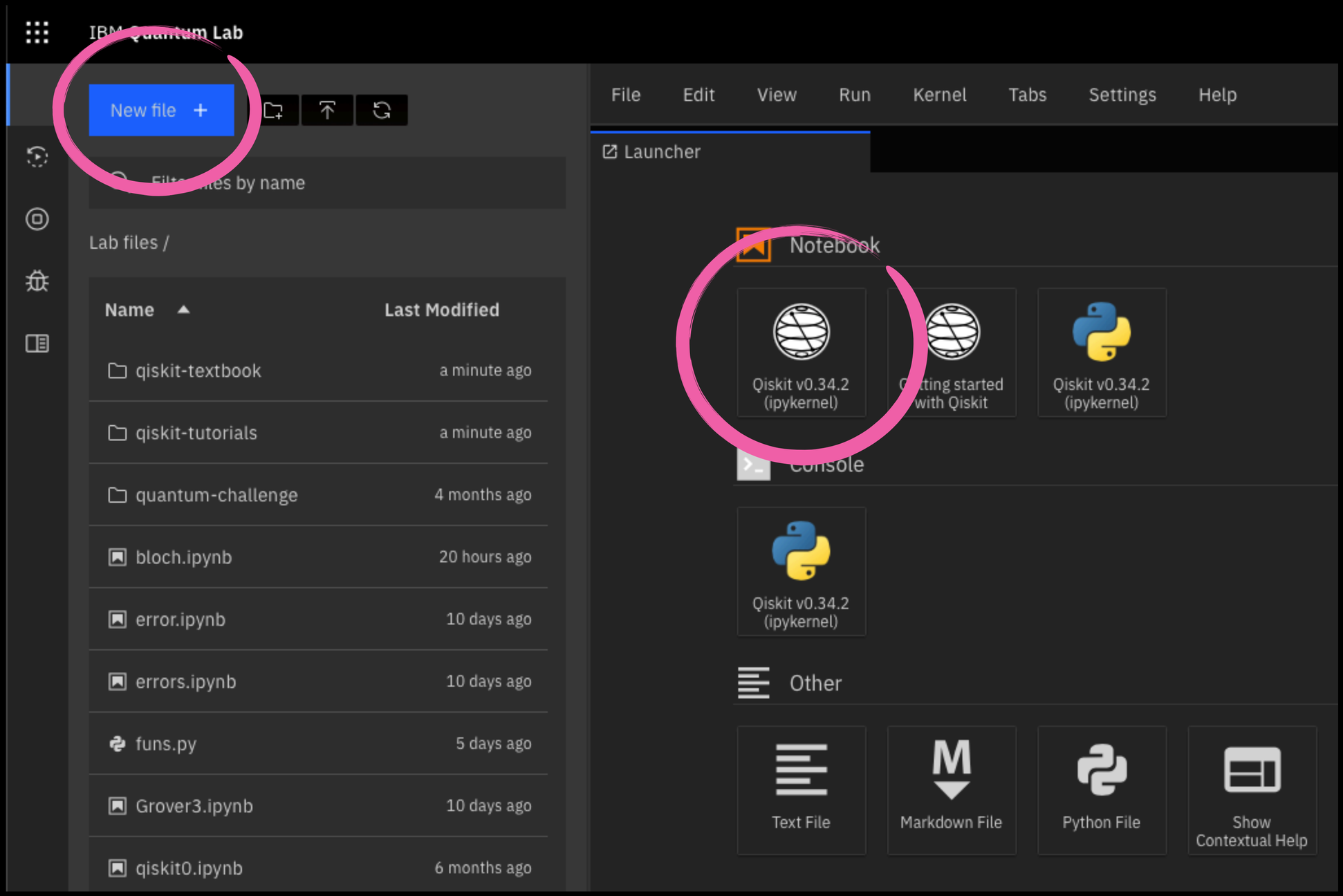
課程安排

- Python 入門
- Qiskit 實作

Python 入門

- 循序結構：
  - 函式 function
  - 物件 object
- 選擇結構：`if`
- 重複結構：迴圈 loop


IBM Quantum
Graphically build circuits with
IBM Quantum Composer
Launch Composer
Develop quantum experiments in
IBM Quantum Lab
Launch Lab


IBM Quantum Lab
New file +
Filter files by name
Lab files /
Name
Last Modified
qiskit-textbook
a minute ago
qiskit-tutorials
a minute ago
quantum-challenge
4 months ago
bloch.ipynb
20 hours ago
error.ipynb
10 days ago
errors.ipynb
10 days ago
funs.py
5 days ago
Grover3.ipynb
10 days ago
qiskit0.ipynb
6 months ago
File
Edit
View
Run
Kernel
Tabs
Settings
Help
Launcher
Notebook
Qiskit v0.34.2 (ipykernel)
Getting started with Qiskit
Qiskit v0.34.2 (ipykernel)
Console
Qiskit v0.34.2 (ipykernel)
Other
Text File
Markdown File
Python File
Show Contextual Help

循序結構

- 程式一行一行循序執行

循序結構

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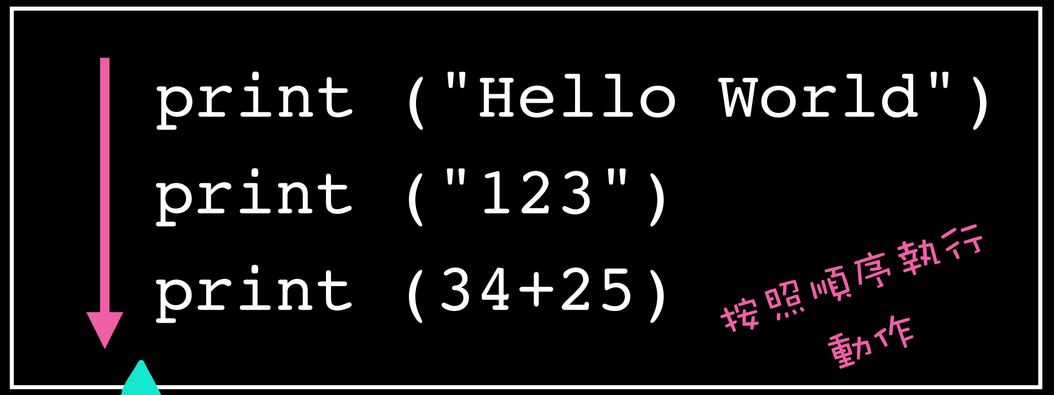
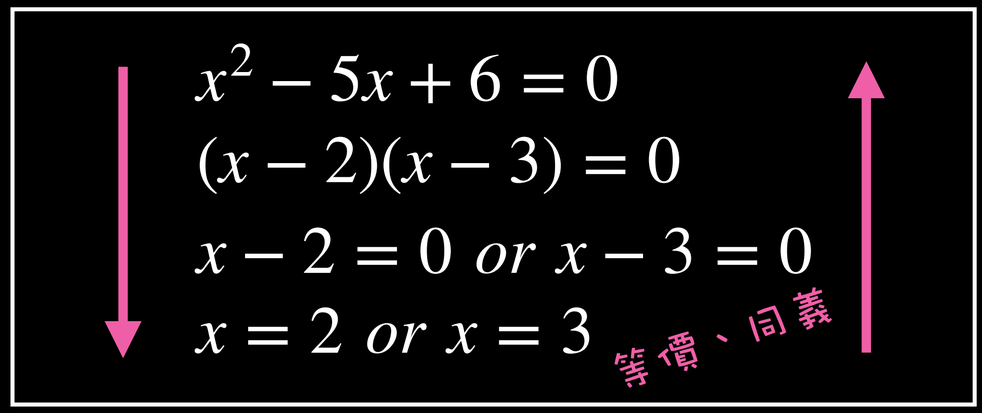
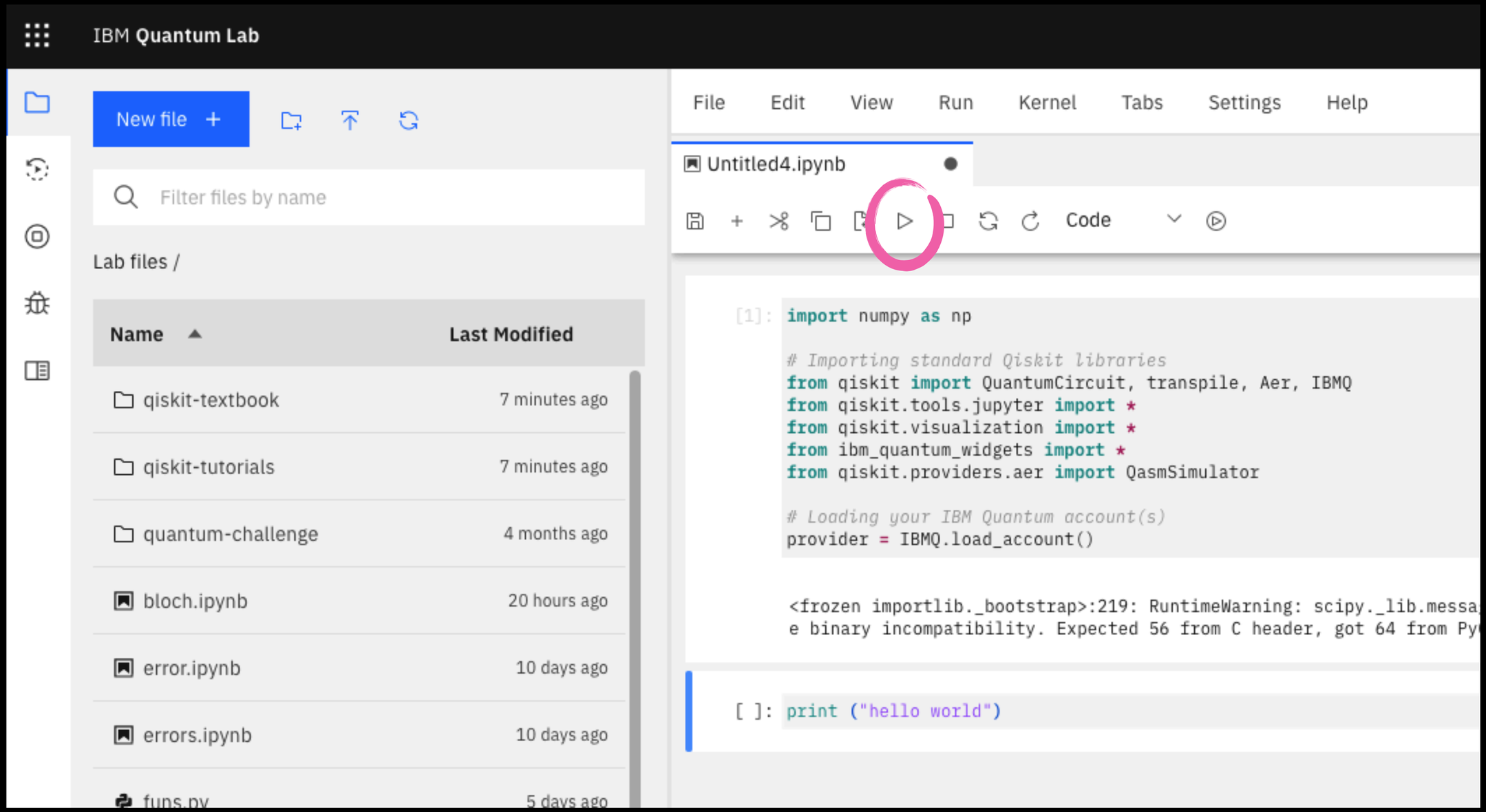


程式

(請注意句首不可隨意空白)



數學演算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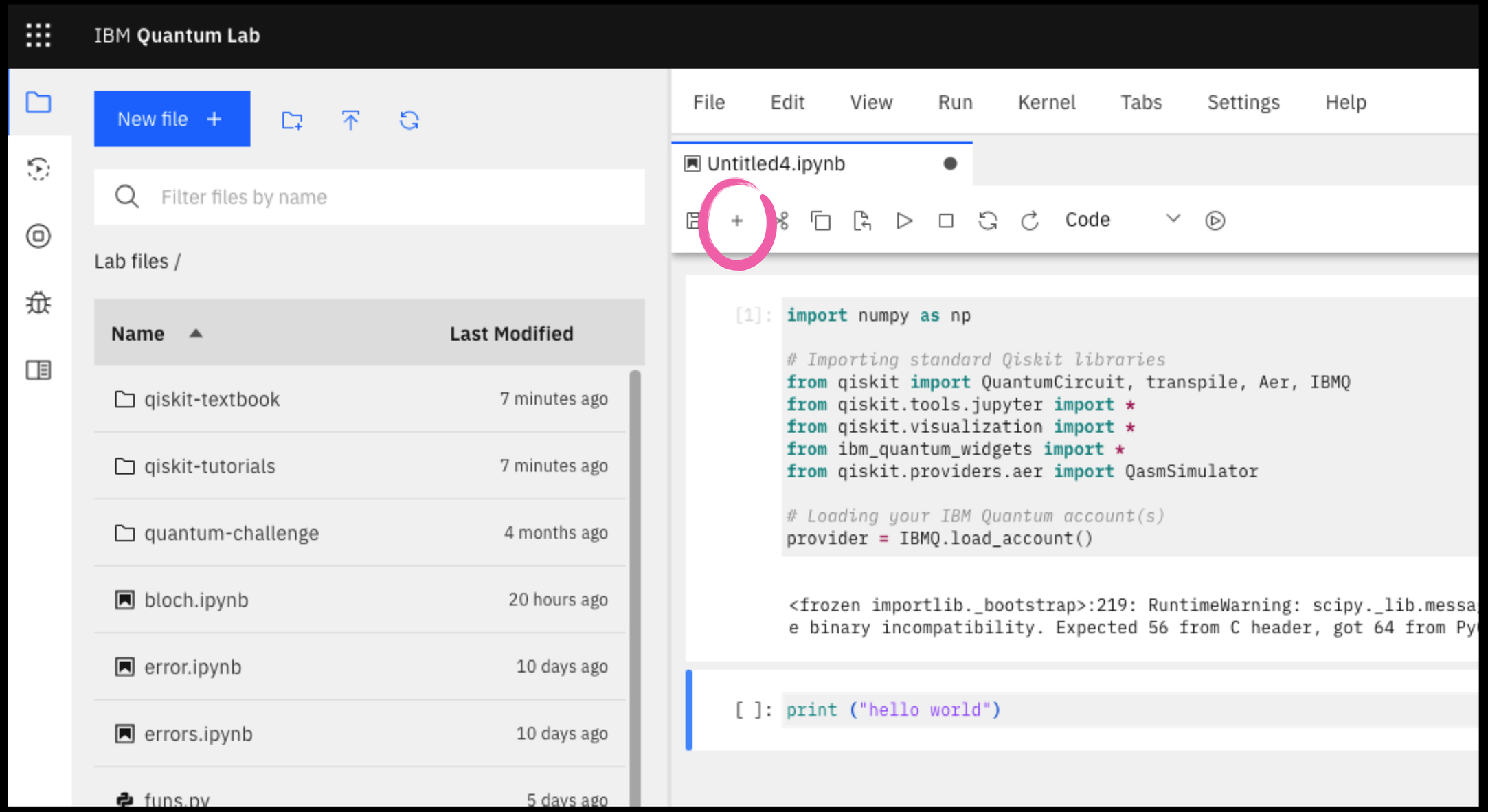
Untitled4.ipynb
Code
[1]:
import numpy as np
# Importing standard Qiskit libraries
from qiskit import QuantumCircuit, transpile, Aer, IBMQ
from qiskit.tools.jupyter import *
from qiskit.visualization import *
from ibm_quantum_widgets import *
from qiskit.providers.aer import QasmSimulator
# Loading your IBM Quantum account(s)
provider = IBMQ.load_account()
<frozen importlib._bootstrap>:219: RuntimeWarning: scipy._lib.messa
e binary incompatibility. Expected 56 from C header, got 64 from Py
[ ]:
print ("hello world")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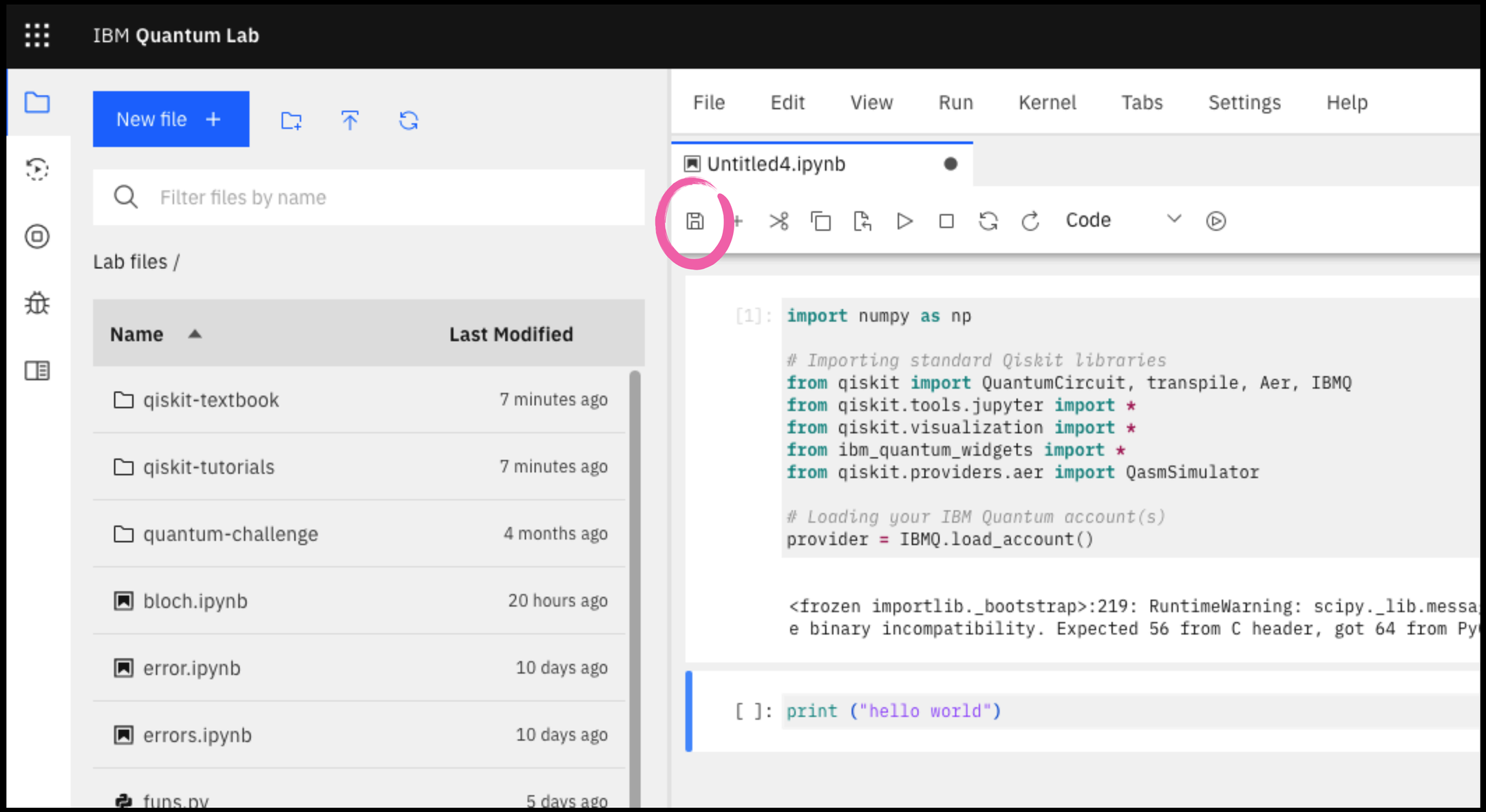
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[ ]:
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循序結構

- 練習：用 Python 程式輸出

```
I enjoy the class.
456
121212
```

函式 function

```
def fun():
    print ("hi")
    return
```

... 定義 define

```
fun()
fun()
fun()
```

... 呼叫 (執行) call

... 呼叫 (執行) call

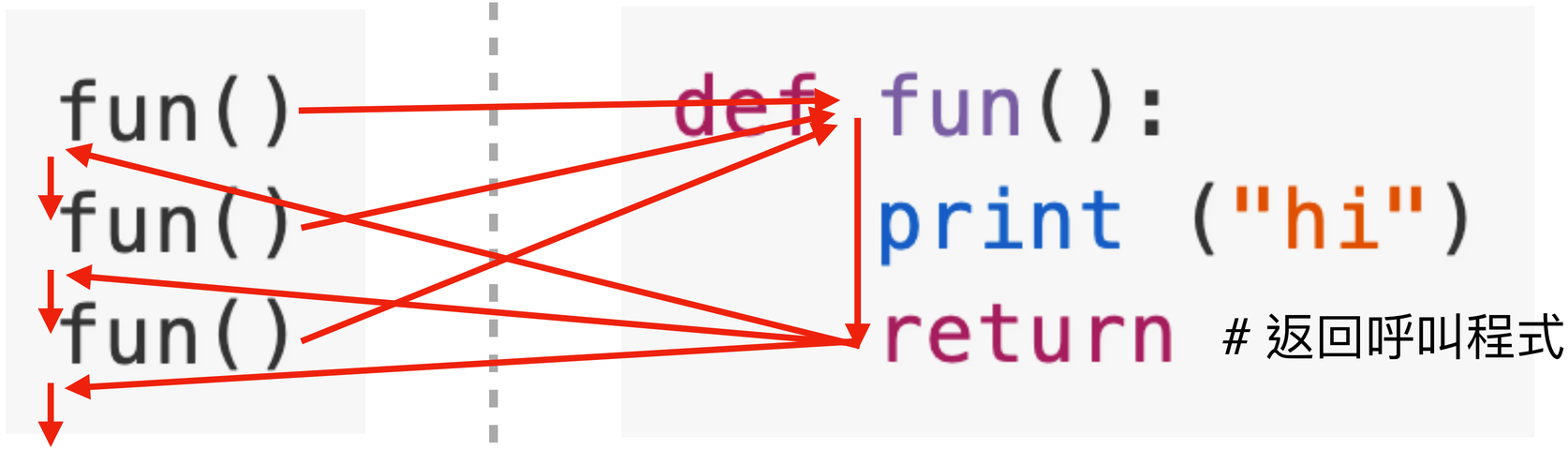
... 呼叫 (執行) call

```
def fun():
    print ("hi")
    return
```

```
fun()
fun()
fun()
```

```
fun()
fun()
fun()
```

```
def fun():
    print ("hi")
    return
```



- 參數
- 回傳值

... 函式：填表要求完成某個動作

- import (匯入）module (模組)

提供的功能：　量子計算　機器學習　數學工具　…

modules/套件：　qiskit　tensorflow　numpy　…

語言/環境：　Python

開始建構一個 quantum circuit ...

(circuit 名稱可以自己取)

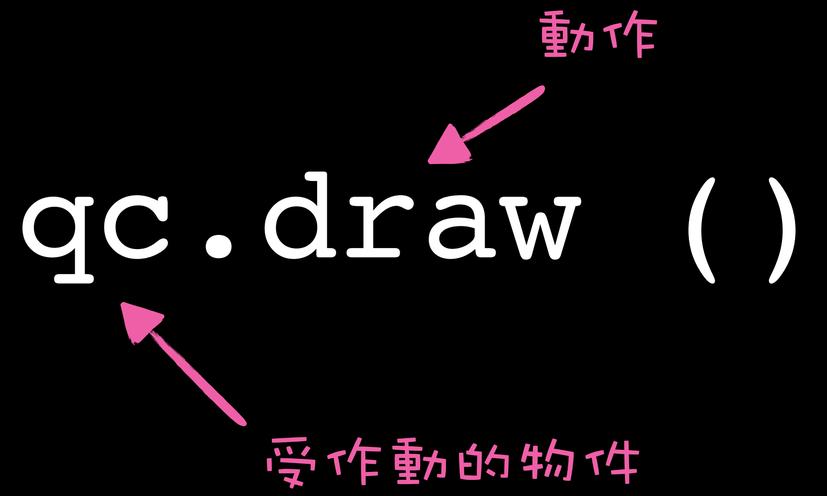
指定參數 (1 個 qubit, 1 個 classical bit)

```
qc = QuantumCircuit (1, 1)
```

指定為回傳值

qubit 0 接上 haclamard gate ...

先將目前的 circuit 畫出來看看 ...



接下來你可以做 2 (3) 件事

1. 用模擬器後端模擬執行 (量測)
2. 用實機執行 (量測)
3. 看狀態向量 (理論，狀態不塌縮)

在要量測的 qubit 上接上 measurements ...

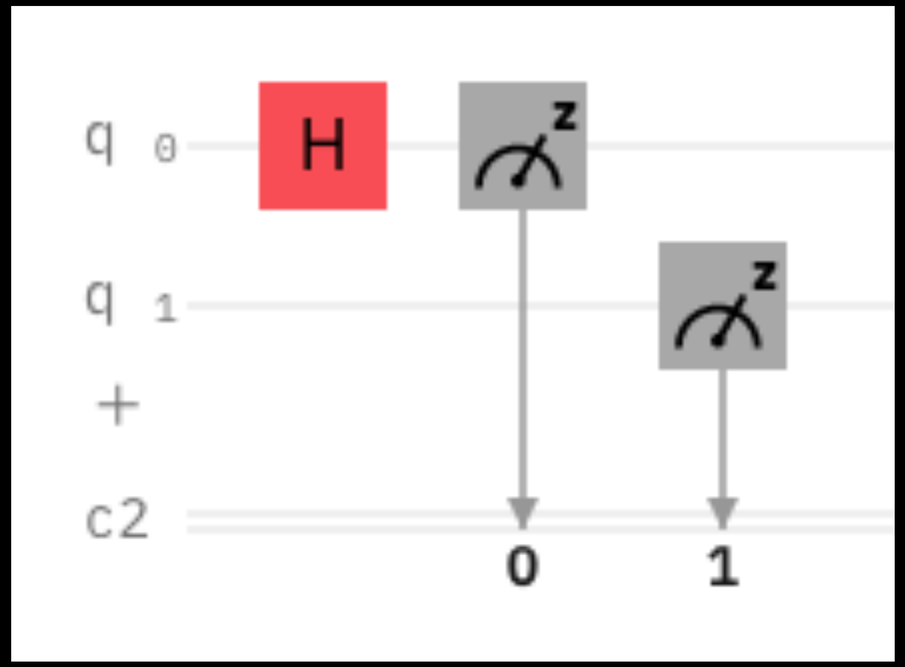
1. 用模擬器後端模擬執行

```
sim = QasmSimulator()
comp = transpile (qc, sim)
sres = sim.run (comp, 1024).result().get_counts (qc)
```

看結果 ...

```
print (sres) # 文字
plot_histogram(sres) # 統計（直方）圖
```

- 練習：在 IBM Quantum Lab 建構並模擬執行以下之 quantum circuit



先看重複結構，再回來看如何 2. 實機執行 ...

2. 用實機執行

```
from qiskit import execute
from qiskit.tools.monitor import job_monitor
```

```
backend = IBMQ.get_provider('ibm-q').get_backend('ibmq_lima')
job = execute (qc, backend = backend, shots = 1024)
job_monitor (job, interval = 5)
rres = job.result().get_counts(qc)
```

(找 5/7 qubits, Online, pending jobs 低的)

看結果 ...

```
print (rres) # 文字
plot_histogram(rres) # 統計（直方）圖
```

2. 用實機執行 (續)

實機雜訊圖 ... (也可以直接在網頁上看)

```
plot_error_map(backend)
```

挑戰題：

如何用實機執行得到更接近理論的結果？

重複結構 (迴圈 loop)

```
print (1)
print (2)
print (3)
```

```
for i in range (3):
    print (i)
```

(縮排：空四格)

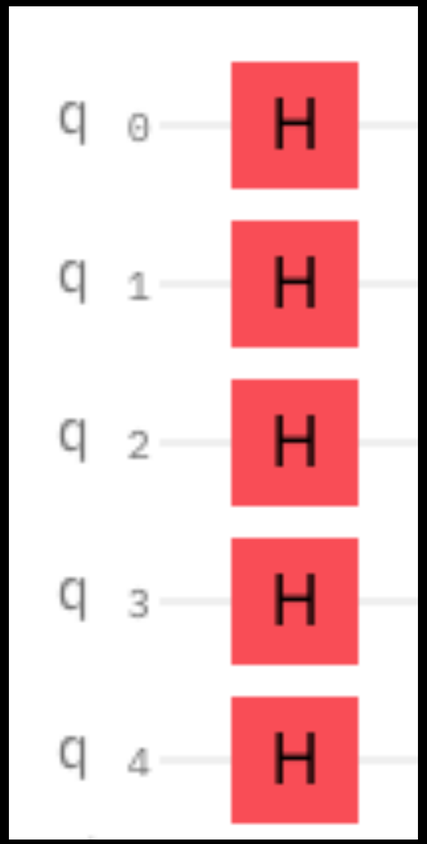
重複結構

- 練習：用 Python 迴圈輸出

```
0
1
2
3
4
5
6
7
8
9
```

重複結構

- 練習：用迴圈建構如右的 quantum circuit (另開新檔 New File 或用不同的名字)



回去看 2. 實機執行 ...

3. 看狀態向量

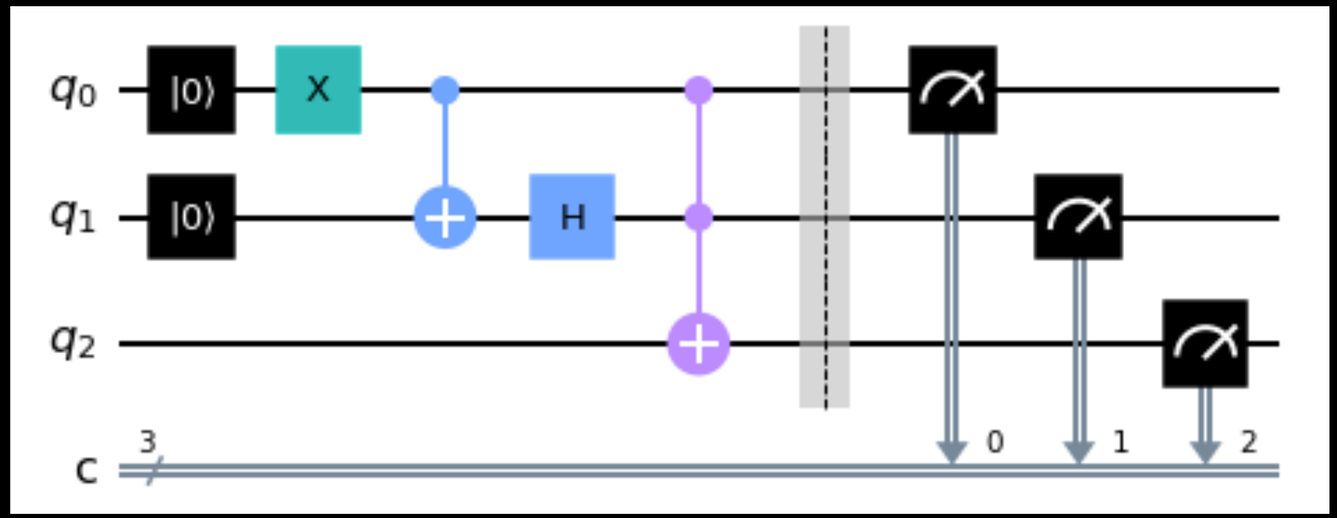
```
from qiskit.quantum_info import Statevector
```

```
Statevector.from_instruction(qc).draw("latex", prefix=" ")
```

```
plot_bloch_multivector(Statevector.from_instruction(qc))
```

初學 Quantum Gates

```
sg = QuantumCircuit (3, 3)
sg.reset (0)
sg.reset (1)
sg.x (0)
sg.cx (0, 1)
sg.h (1)
sg.ccx (0, 1, 2)
sg.barrier ()
sg.measure_all ()
sg.draw ()
```



初學 Quantum Gates

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sg.reset (0)
sg.reset (1)

sg.x (0)


sg.cx (0, 1)


sg.h (1)

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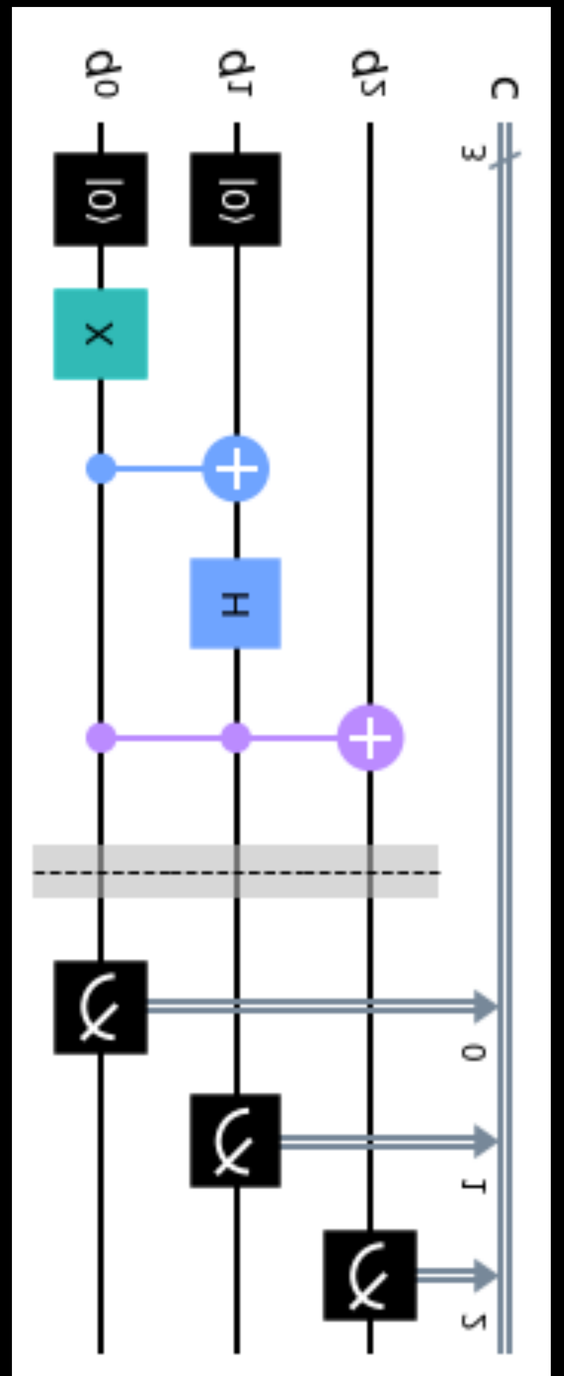
sg.barrier ()


sg.measure_all ()
```



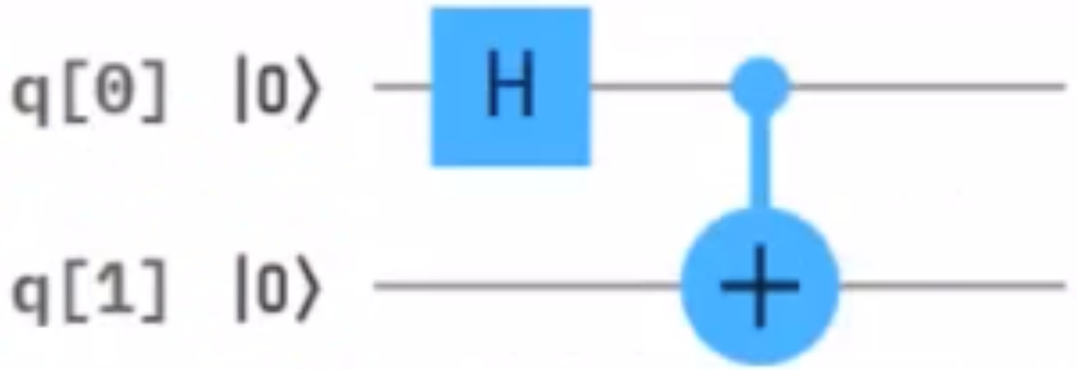
Bell state

$$\frac{1}{\sqrt{2}}(|00> + |11>)$$

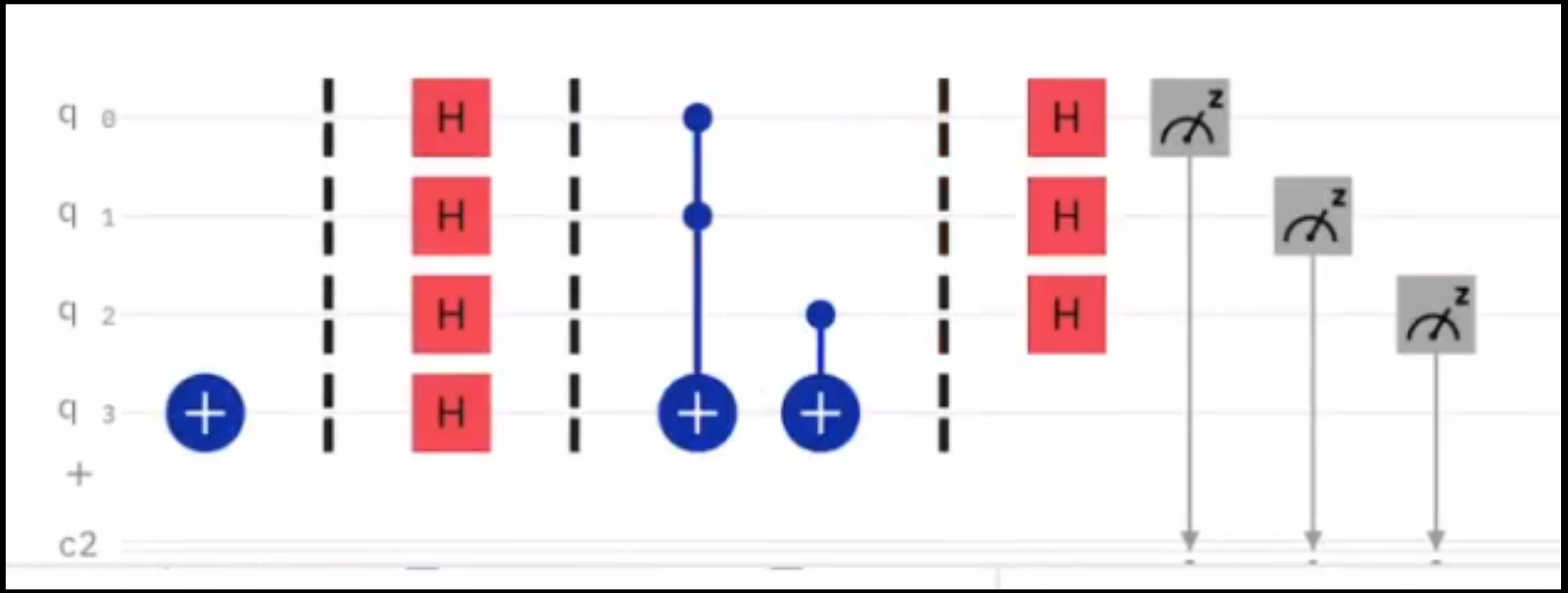
$$\frac{1}{\sqrt{2}}(|01> + |10>)$$

$$\frac{1}{\sqrt{2}}(|00> - |11>)$$

$$\frac{1}{\sqrt{2}}(|01> - |10>)$$



2022/2/19 黃琮暐老師課程截圖



Deutsch-Josza (2022/2/26 黃琮暐老師課程截圖)

The Atoms of Computation

AND

$q_1\ q_0$	q_2
0 0	0
0 1	0
1 1	1
1 0	0

OR

$q_1\ q_0$	q_2
0 0	0
0 1	1
1 1	1
1 0	1

XOR

$q_1\ q_0$	q_2
0 0	0
0 1	1
1 1	0
1 0	1

Qiskit Applications

IBM Quantum Challenge Africa 2021

IBM Quantum Challenge Fall 2021