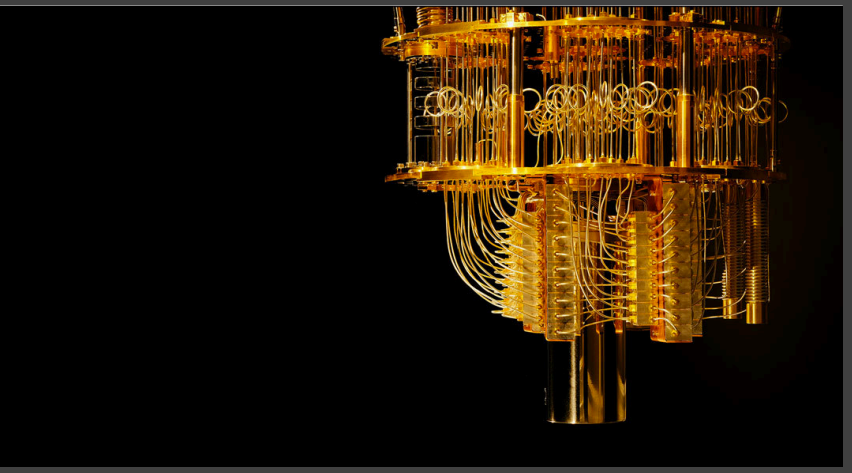


# IBM Quantum Experience Overview

IBM Client Center Montpellier

JM Torres | torresjm@fr.ibm.com

27 mars – 2 avril 2020

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ibm q

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Environ 195 000 000 résultats (0,52 secondes)

## IBM Q - Quantum Computing - IBM Research

www.research.ibm.com ▾ Traduire cette page

**IBM Q** is an industry first initiative to build universal quantum computers for business and science. Our cross-disciplinary team is developing scalable quantum ...

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## Experience - IBM Q

www.ibm.com ▾ Traduire cette page

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## IBM Q Experience

quantumexperience.ng.bluemix.net ▾ Traduire cette page

Run algorithms and experiments on **IBM's** quantum processor via **IBM** Cloud.

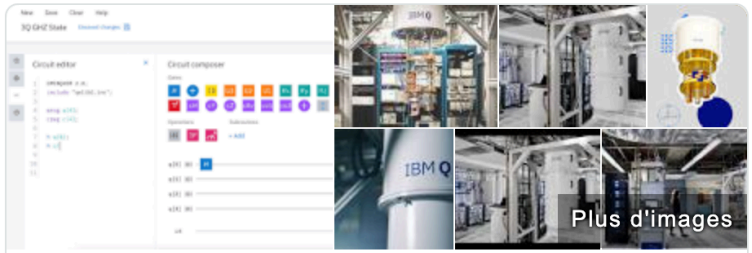
## CES 2019 : Est-ce qu'IBM vient de dévoiler le premier ordinateur …

www.zdnet.fr ▾

9 janv. 2019 - Le système **Q** System One a une conception modulaire et des composants conçus pour minimiser les interférences. Le plan d'**IBM** est tout ...

## IBM Q Experience - Wikipedia

en.wikipedia.org ▾ Traduire cette page




## IBM Q Experience

Traduit de l'anglais - IBM Q Experience est une plate-forme en ligne qui donne aux utilisateurs du grand public accès à un ensemble de prototypes de processeurs quantiques d'IBM via le cloud, un forum en ligne sur Internet ... Wikipédia (anglais)

Afficher la description d'origine

*Commentaires*

### Afficher les résultats pour

IBM Q System One (Ordinateur)

IBM Q System One est le tout premier ordinateur quantique commercial au ...

# Sign in to IBM Q Experience

What is IBM Q Experience? Learn more

| | | |
|---|---|---|
| IBMid | Google | GitHub |
| Twitter | LinkedIn | Email |

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## New here? Get started with the IBM Q Experience!

### Circuit Composer

Explore the graphical interface for creating and testing circuits

Create a circuit →

### Qiskit Notebooks

Create your first notebook and start using Qiskit

Create a notebook →

Pending results (1)

| Status | Id | Account | Backend |
|---|---|---|---|

Your backends (7)

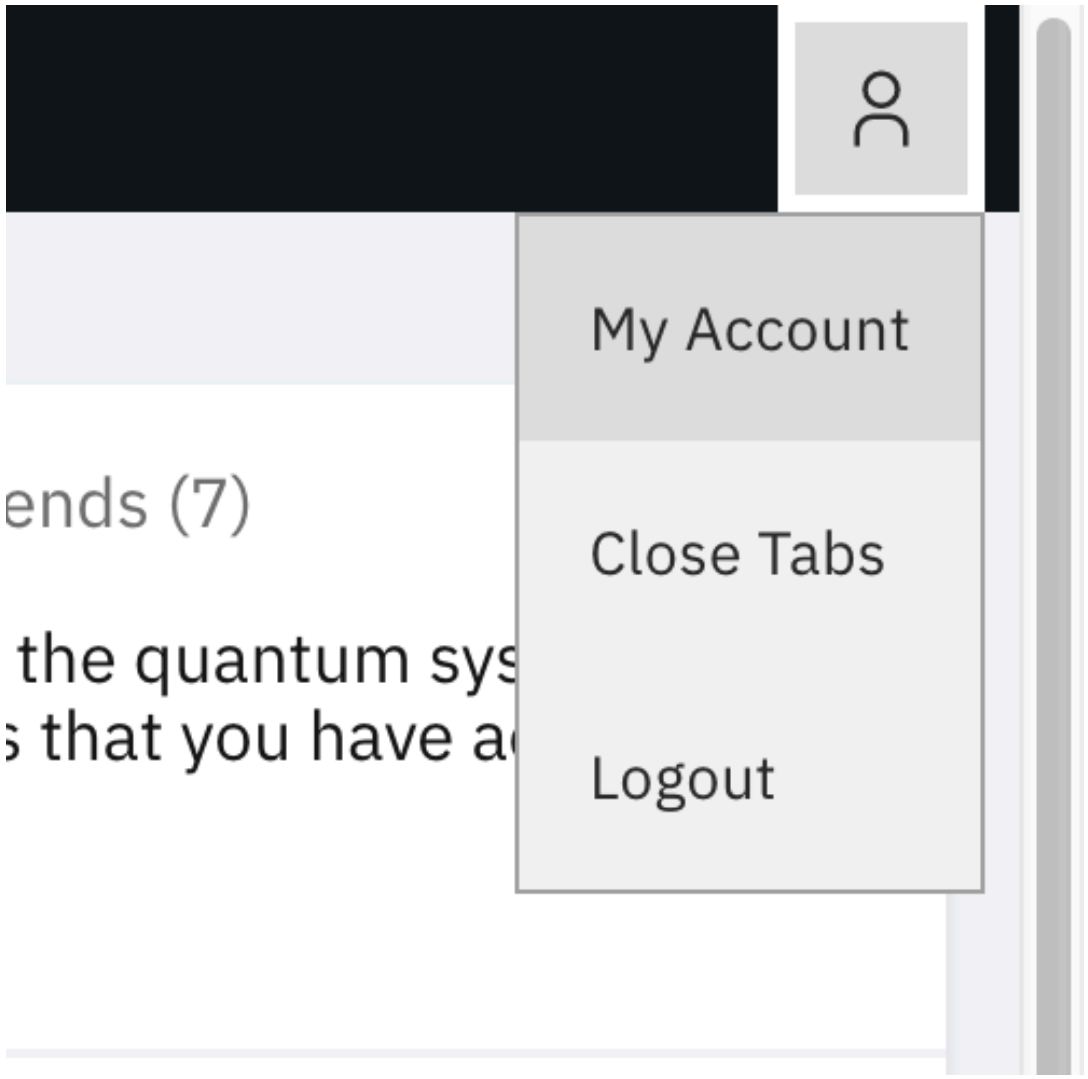
These are the quantum systems and simulators that you have access to.

Got it!

online
**ibmq_poughkeepsie** (20 qubits)
Queue: 0 runs

online
**ibmq_20_tokyo** (20 qubits)
Queue: 0 runs

online
**ibmq_16_melbourne** (14 qubits)
Queue: 132 runs


My Account
Close Tabs
Logout
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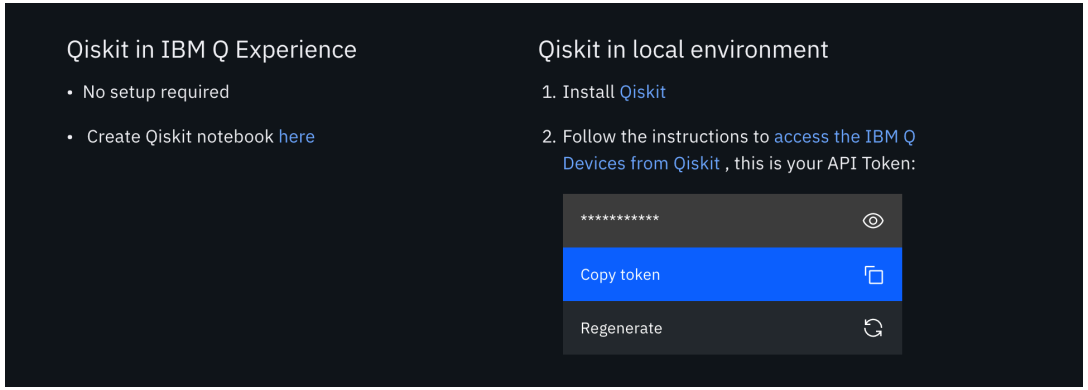
s that you have a


Qiskit in IBM Q Experience
No setup required
Create Qiskit notebook here
Qiskit in local environment
1. Install Qiskit
2. Follow the instructions to access the IBM Q Devices from Qiskit , this is your API Token:
**********
Copy token
Regenerate

Qiskit | Terra | Aer | Aqua | Ignis | IBM Q | Community | Tutorials | API Documentation

# Welcome to Quantum.

Qiskit is an open-source quantum computing software development kit for leveraging today's quantum processors in research, education, and business

Join the Slack community

## Qiskit 0.12

Featuring faster circuit transpilation times, a wider variety of classical simulation methods, more device characterization routines, and a host of new quantum applications, the premiere quantum computing software framework just got even better.

Learn more

## Coding with Qiskit

Would you like to learn how to code a quantum computer? Take a look at the Coding with Qiskit Video Series, where Abraham Asfaw explains everything you need to know. Starting with installing Qiskit, to investigating the latest algorithms and research topics.

Watch it

Qiskit

English

Search docs...

Installing Qiskit
Getting Started with Qiskit
The Qiskit Elements
Development Strategy
Contributing to Qiskit
Release Notes
Frequently Asked Questions
API References

# Qiskit API documentation

Qiskit is an open-source framework for working with quantum computers at the level of circuits, pulses, and algorithms.

A central goal of Qiskit is to build a software stack that makes it easy for anyone to use quantum computers. However, Qiskit also aims to facilitate research on the most important open issues facing quantum computation today.

You can use Qiskit to easily design experiments and run them on simulators and real quantum computers.

Qiskit consists of four foundational elements:

- Qiskit Terra: Composing quantum programs at the level of circuits and pulses with the code foundation.
- Qiskit Aer: Accelerating development via simulators, emulators, and debuggers
- Qiskit Ignis: Addressing noise and errors
- Qiskit Aqua: Building algorithms and applications

> **Note**
>
> This is the Qiskit API documentation. For detailed workflow examples, please sign in to the IBM Q Experience to explore Qiskit tutorials.

# Installing Qiskit

## Requirements

Qiskit supports Python 3.5 or later.

We recommend installing Anaconda, a cross-platform Python distribution for scientific computing. Jupyter, included in Anaconda, is recommended for interacting with Qiskit.

Qiskit is tested and supported on the following 64-bit systems:

- Ubuntu 16.04 or later
- macOS 10.12.6 or later
- Windows 7 or later

Using Qiskit on Windows requires VC++ runtime components. We recommend one of the following:

- Microsoft Visual C++ Redistributable for Visual Studio 2017
- Microsoft Visual C++ Redistributable for Visual Studio 2015

## Install

We recommend using Python virtual environments to cleanly separate Qiskit from other applications and improve your experience.

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Queue: 132 runs

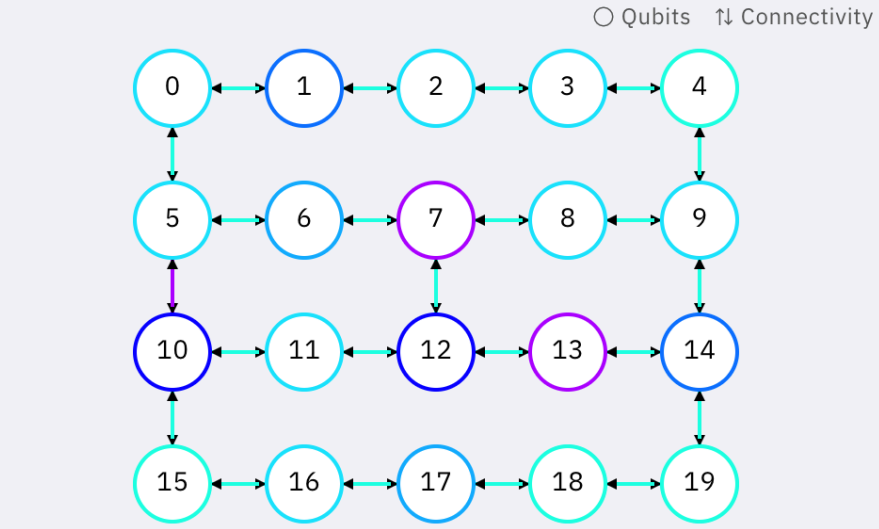
# ibmq_poughkeepsie v1.2.0

online

Queue: 0 runs

**Accounts:**

**Hub:** ibm-q-france
**Group:** quantum
**Project:** onboarding-test




**Single-qubit U3 error rate**

1.215e-3 7.721e-3

**CNOT error rate**

1.014e-2 1.000e+0

Download Calibrations

| Qubits | Online since | Basis gates |
|---|---|---|
| 20 | 2018-08-29 | u1, u2, u3, cx, id |

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Quantum Algorit...

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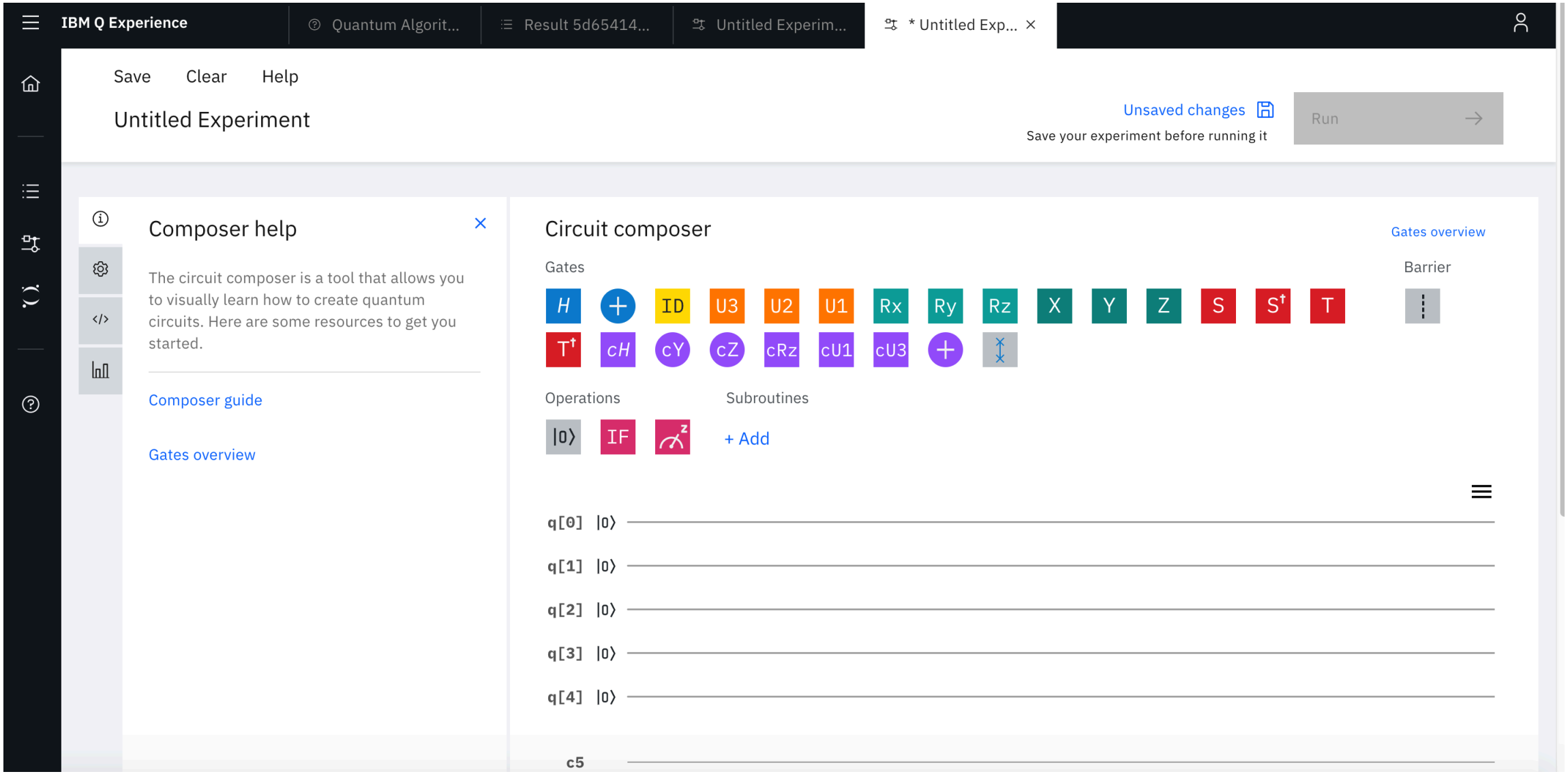
IBM Q Experience
Quantum Algorit...
Result 5d65414...
Untitled Experim...
* Untitled Exp...
Save
Clear
Help
Untitled Experiment
Unsaved changes
Save your experiment before running it
Run
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cZ
cRz
cU1
cU3
Operations
Subroutines
|0⟩
IF
+ Add
q[0] |0⟩
q[1] |0⟩
q[2] |0⟩
q[3] |0⟩
q[4] |0⟩
c5

# Overview of Quantum Gates

Overview of Quantum Gates

## H gate

The H or Hadamard gate rotates the states $|0\rangle$ and $|1\rangle$ to $|+\rangle$ and $|-\rangle$, respectively. It is useful for making superpositions. As a Clifford gate, it is useful for moving information between the x and z bases.

| Composer reference | Qasm reference | Learn more |
| --- | --- | --- |
|  | `h q[0];` | Quantum gates: Hadamard and S |

## CX gate

The controlled-X gate is also known as the controlled-NOT. It acts on a pair of qubits, with one acting as 'control' and the other as 'target. It performs an X on the target whenever the control is in state $|1\rangle$. If the control qubit is in a superposition, this gate creates entanglement.

| Composer reference | Qasm reference | Learn more |
| --- | --- | --- |
|  | | |

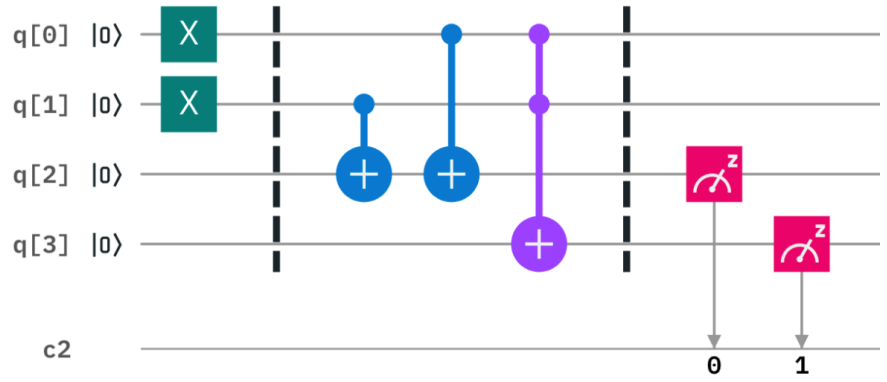
**Contents**

# Introduction to Quantum Circuits

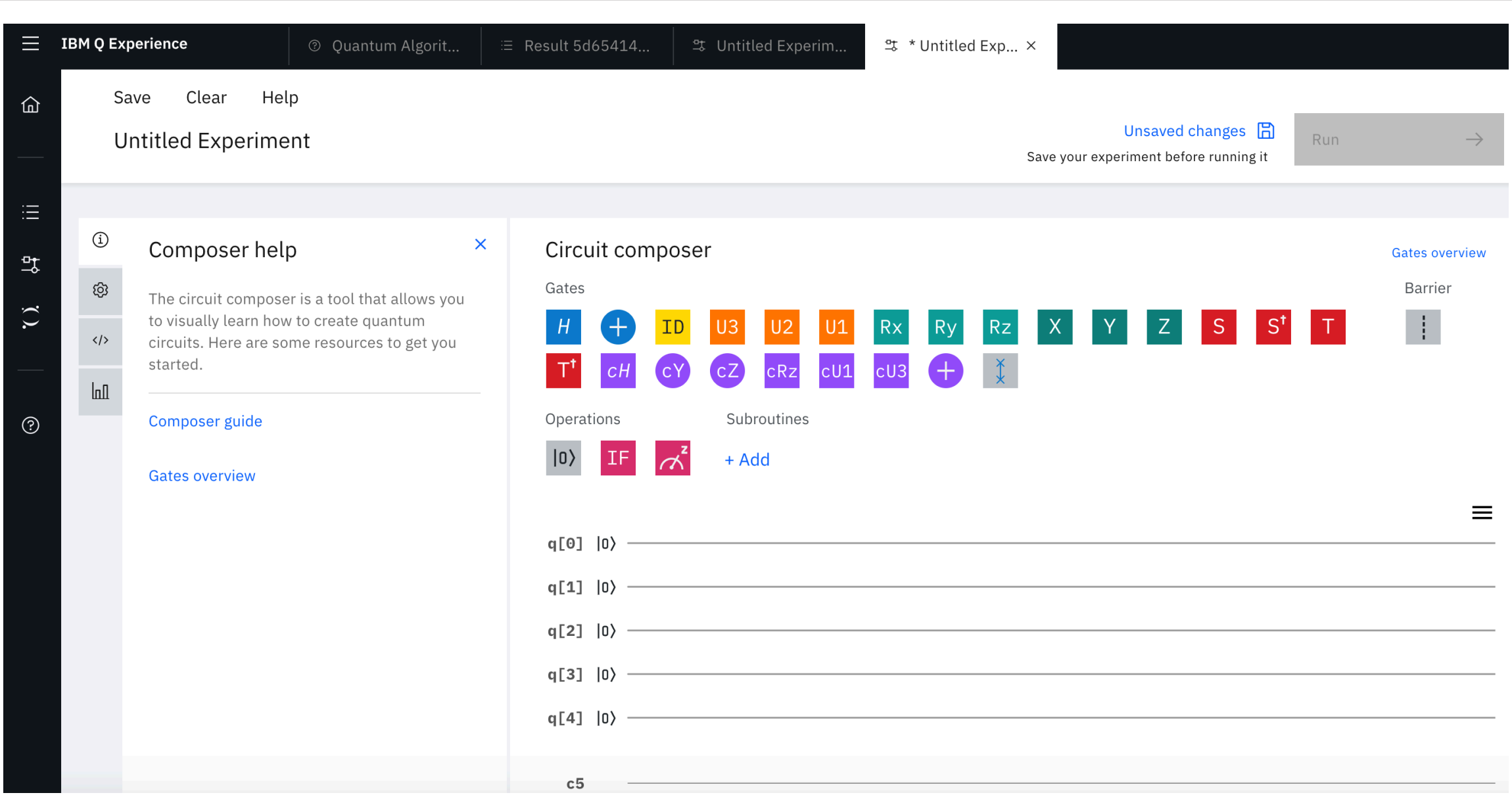


## Getting started with quantum circuits

If you think quantum mechanics sounds challenging, you are not alone. All of our intuitions are based on day-to-day experiences, and so are better at understanding the behavior of balls and bananas than atoms or electrons. Though quantum objects can seem random and chaotic at first, they just follow a different set of rules. Once we know what those rules are, we can use them to create new and powerful technology. Quantum computing will be the most revolutionary example of this.




*A quantum circuit to calculate 1+1*


IBM Q Experience
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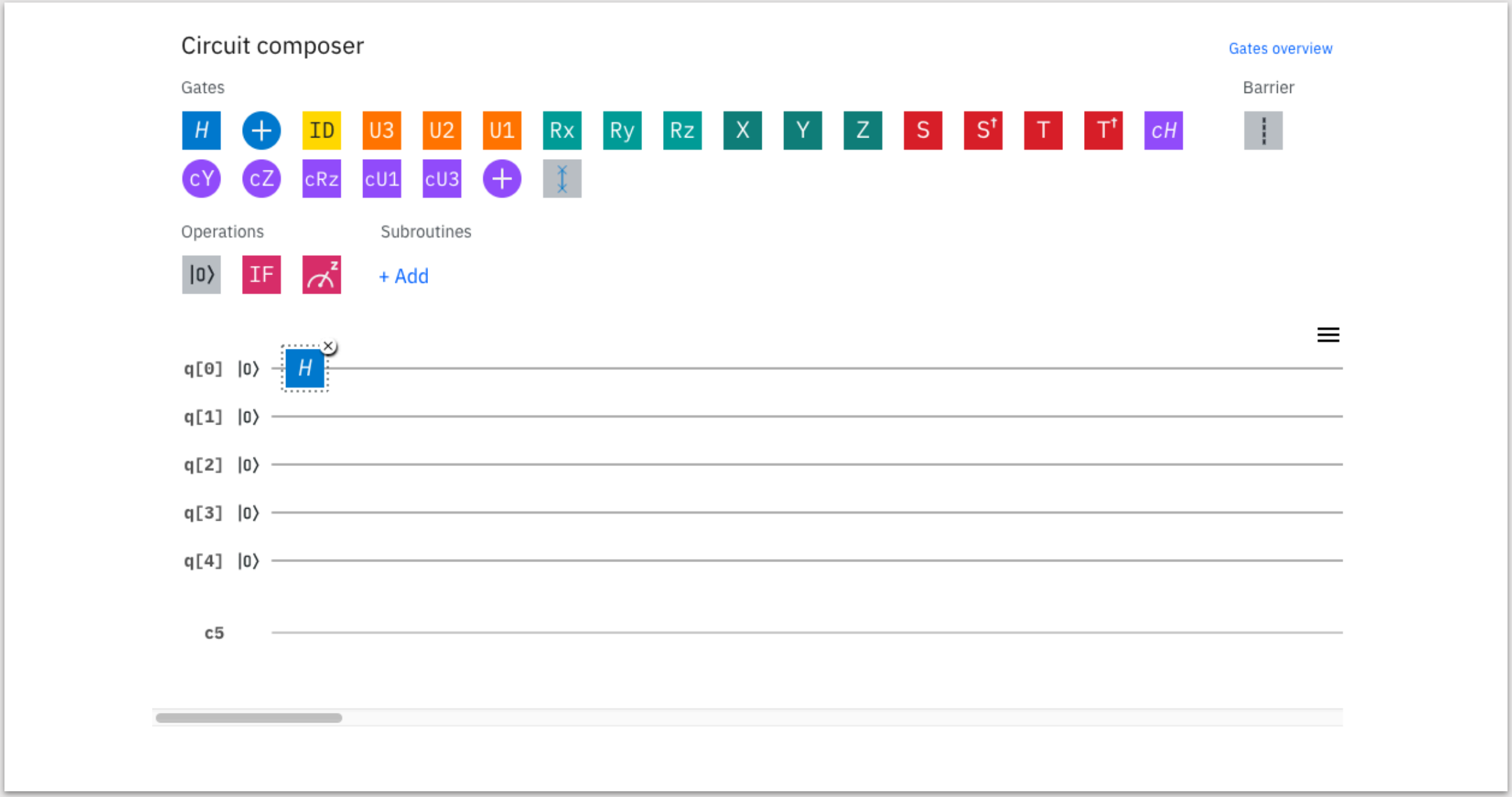
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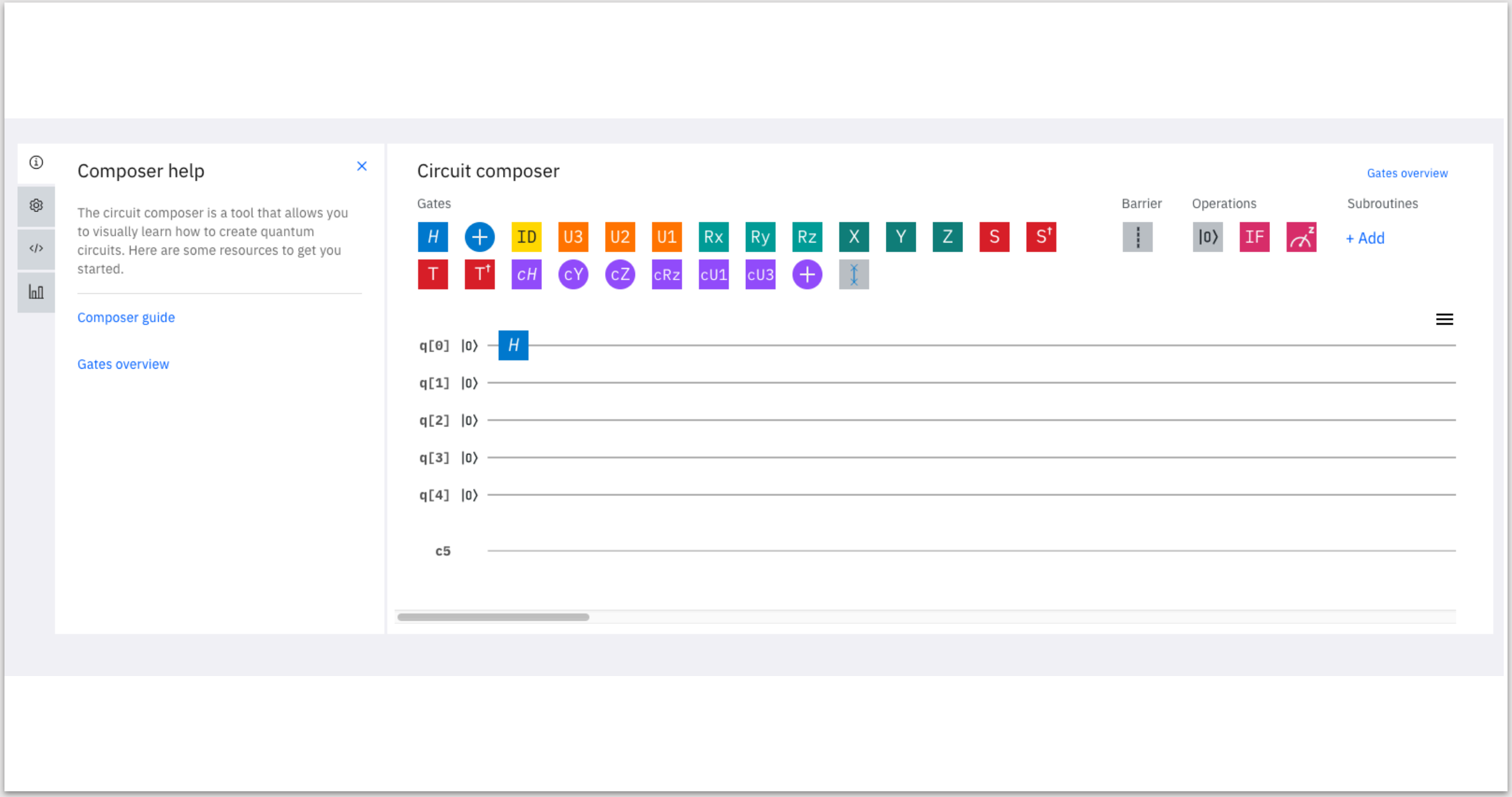
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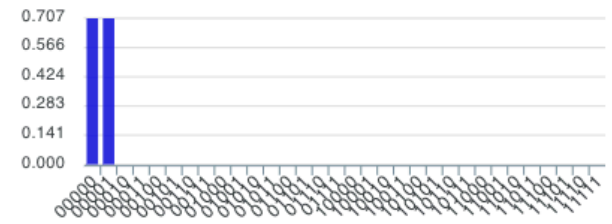
c5

## Visualizations

Statevector

Statevector




The height of the bar is the complex modulus.
The color of the bar is based in the complex argument or phase.

```
[ 0.707+0j, 0.707+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j,
0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j,
0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j,
0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j, 0+0j ]
```

The qubit 0 is the one that is furthest to the right on the state.

## Circuit composer

Gates overview

Gates

H ⊕ ID U3 U2 U1 Rx Ry Rz X Y Z S S† T T† cH

cY cZ cRz cU1 cU3 ⊕ ‖

Barrier

Operations

|0⟩ IF

Subroutines

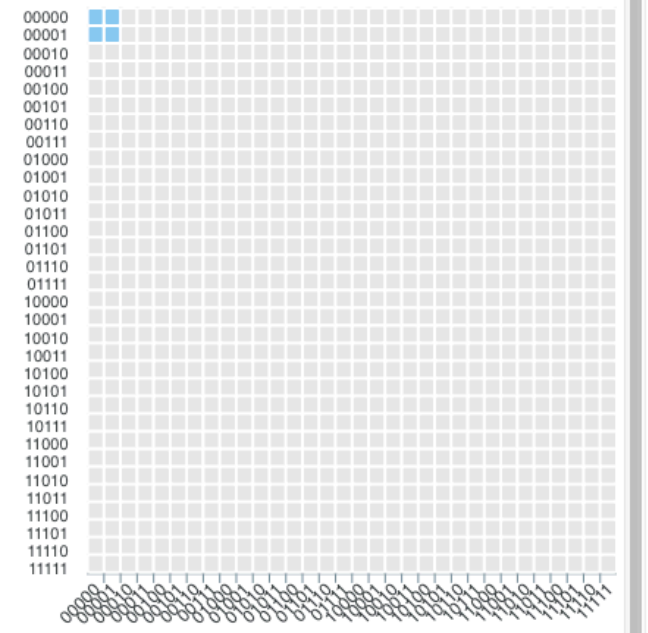
+ Add

## Visualizations

Density Matrix

Re[ρ]

[-1, 0] 0 [0, 1]

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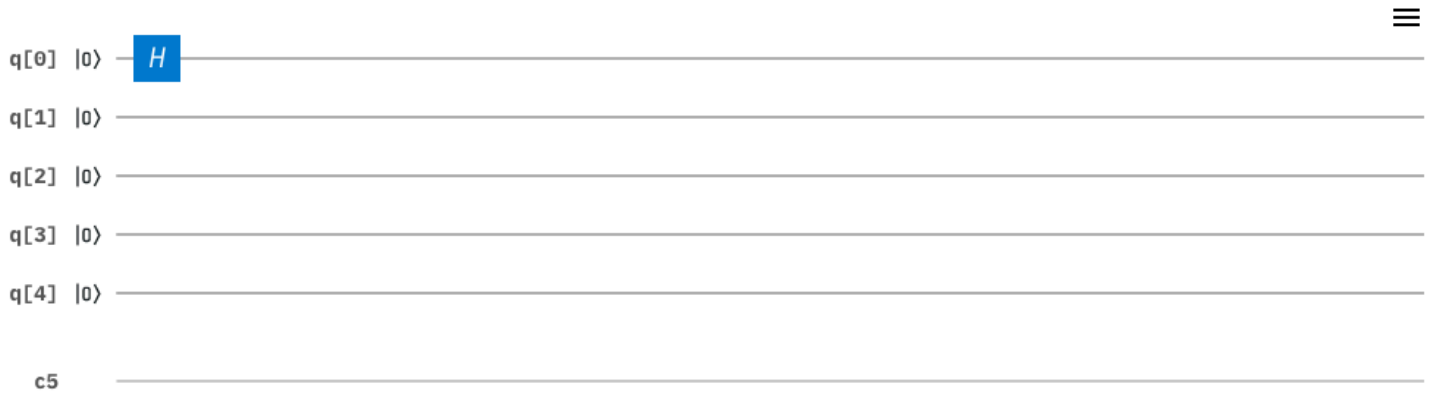
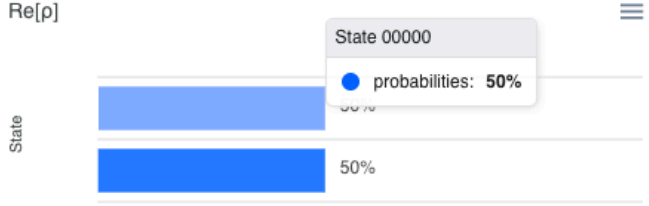


## Visualizations

Measurement Probabilities

Re[ρ]

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H + ID U3 U2 U1 Rx Ry Rz X Y Z S S† T T† cH

cY cZ cRz cU1 cU3 + ‡

Barrier

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|0⟩ IF

Subroutines

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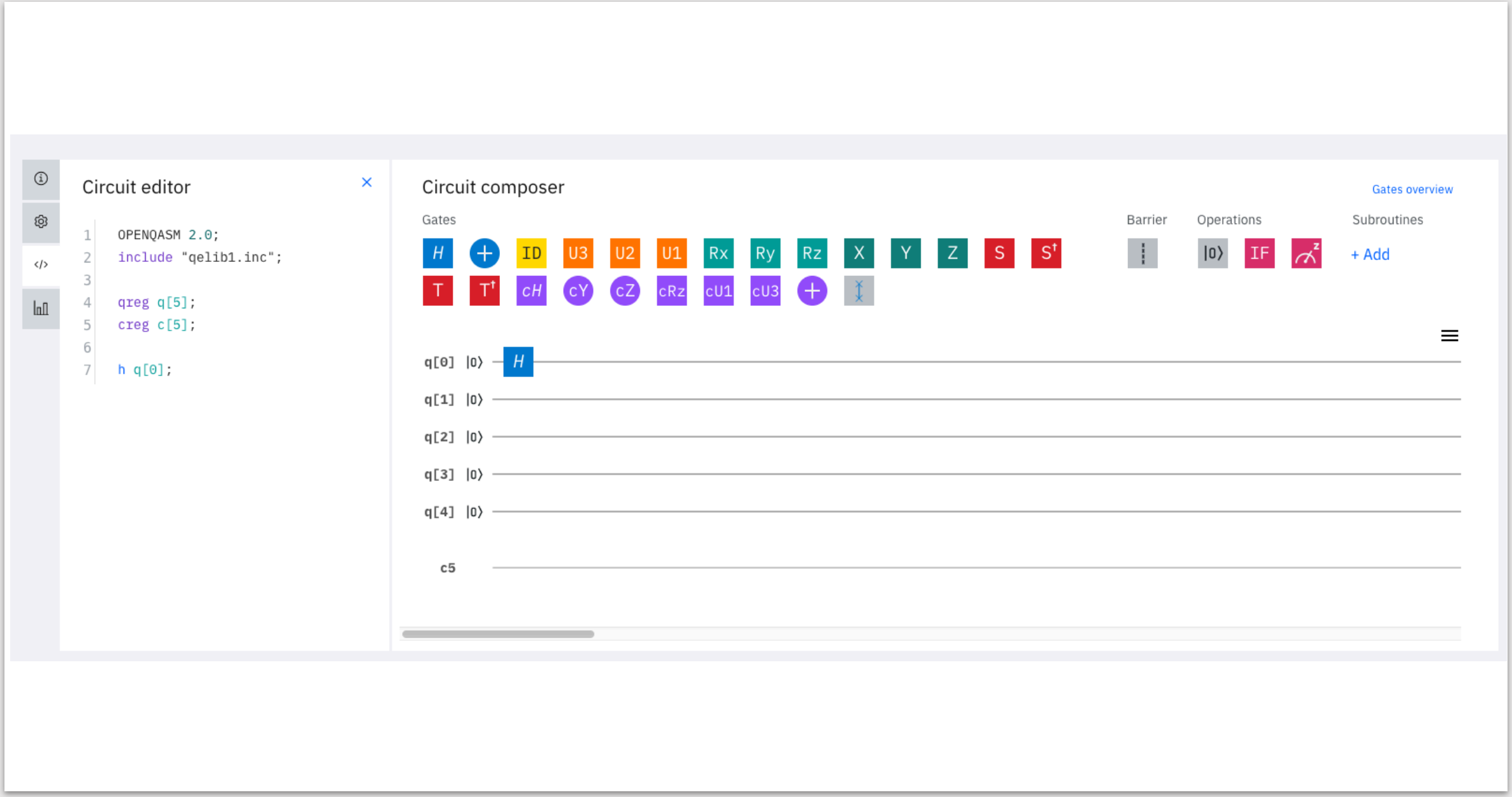
Circuit editor
1 OPENQASM 2.0;
2 include "qelib1.inc";
3
4 qreg q[5];
5 creg c[5];
6
7 h q[0];
Circuit composer
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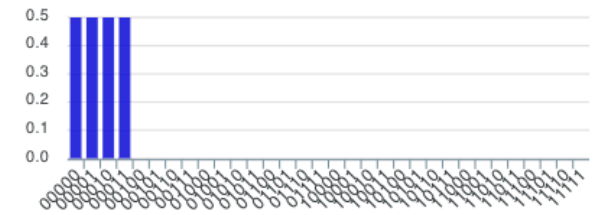


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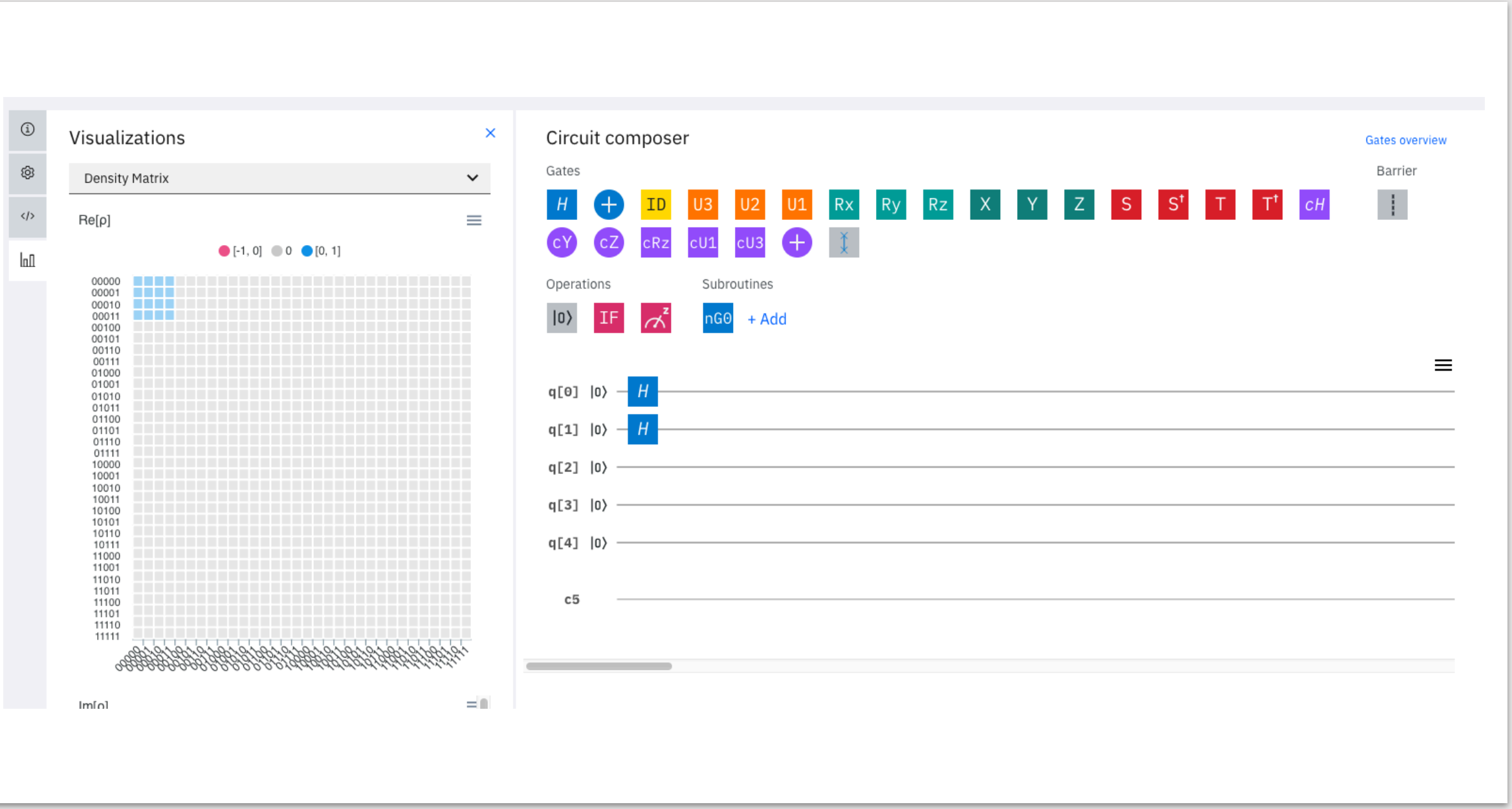
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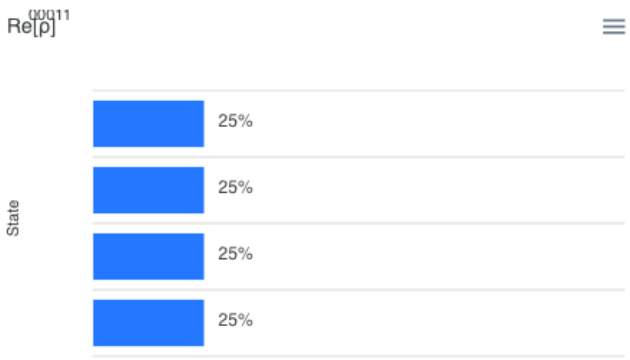


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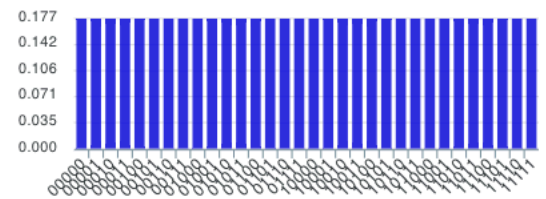
Statevector

Statevector




```
The height of the bar is the
complex modulus.
The color of the bar is based
in the complex argument or
phase.
```

```
[ 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j, 0.177+0j,
0.177+0j, 0.177+0j ]
```

```
The qubit 0 is the one that is
furthest to the right on the
state.
```

## Circuit composer

Gates overview

Gates

H ID U3 U2 U1 Rx Ry Rz X Y Z S S† T T† cH

cY cZ cRz cU1 cU3

Barrier

Operations

|0⟩ IF

Subroutines

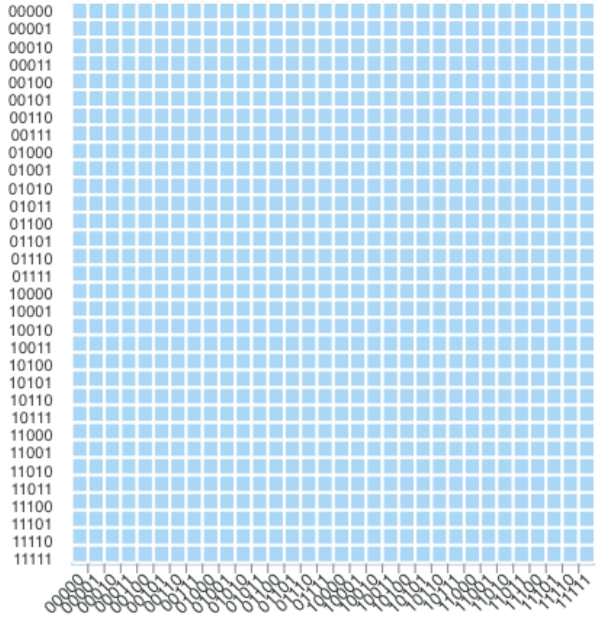
nG0 + Add

## Visualizations

Density Matrix

Re[ρ]

[-1, 0] 0 [0, 1]




## Circuit composer

Gates overview

Gates

H ID U3 U2 U1 Rx Ry Rz X Y Z S S† T T† cH

cY cZ cRz cU1 cU3

Barrier

Operations

|0⟩ IF

Subroutines

nG0 + Add

## Circuit editor

```
1  OPENQASM 2.0;
2  include "qelib1.inc";
3
4  qreg q[2];
5  creg c[2];
6
7  h q[0];
8  h q[1];
```

## Circuit composer

Gates overview

Gates: H, +, ID, U3, U2, U1, Rx, Ry, Rz, X, Y, Z, S, S†, T, T†, cH, cY, cZ, cRz, cU1, cU3, +, ↕

Barrier

Operations: |0⟩, IF, z

Subroutines: + Add


## Pending results

No results available

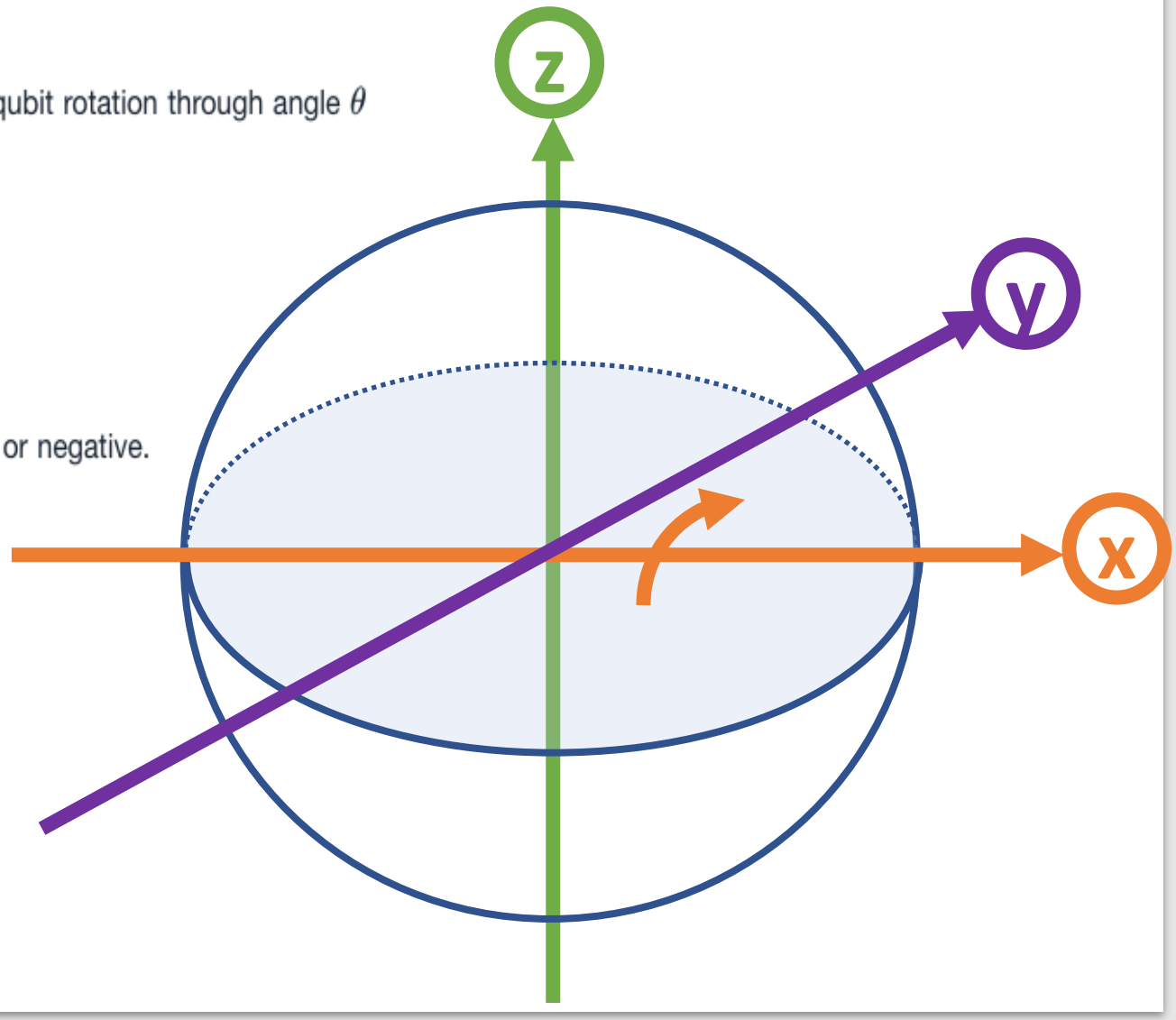
# Rx Gate

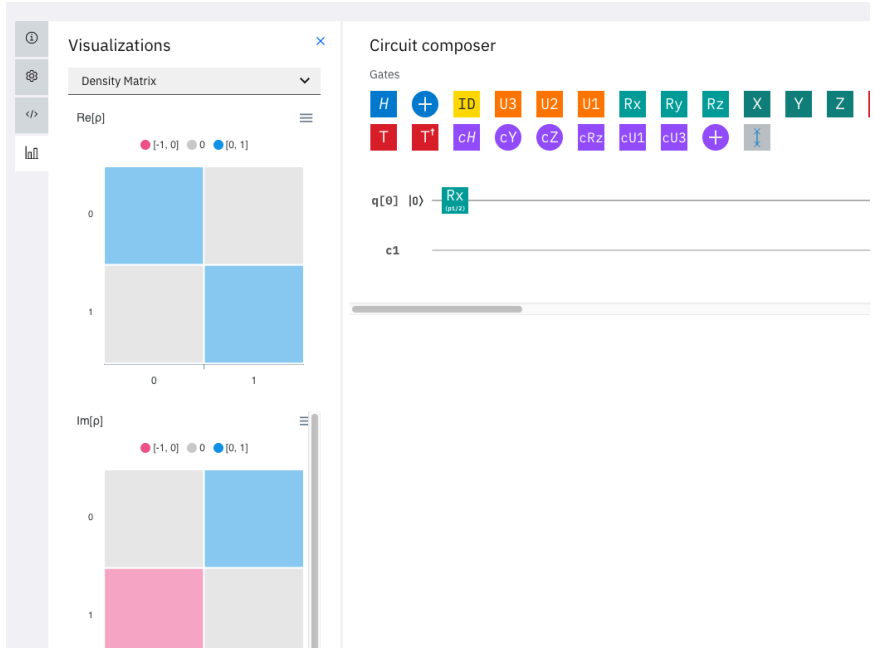
The Rx gate is one of the Rotation operators. The Rx gate is a single-qubit rotation through angle $\theta$ (radians) around the x-axis.

$$R_x(\theta) = \begin{pmatrix} \cos\left(\frac{\theta}{2}\right) & -i\sin\left(\frac{\theta}{2}\right) \\ -i\sin\left(\frac{\theta}{2}\right) & \cos\left(\frac{\theta}{2}\right) \end{pmatrix}$$

The angle of rotation must be specified in radians and can be positive or negative.

```
rx(θ)q[0];
```






$$R_X\left(\frac{\pi}{2}\right) = \begin{pmatrix} \cos\frac{\pi}{4} & -i\sin\frac{\pi}{4} \\ -i\sin\frac{\pi}{4} & \cos\frac{\pi}{4} \end{pmatrix} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{-i}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}$$

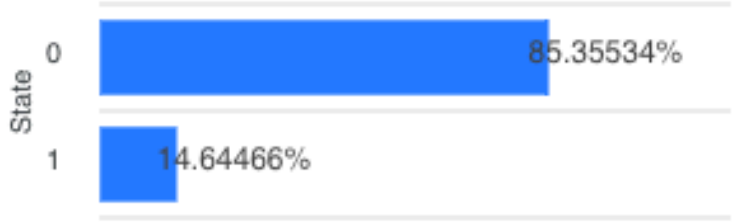
$$|\psi>= R_X\left(\frac{\pi}{2}\right)|0> = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{-i}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix} \times \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} \end{pmatrix}$$

$$|\psi><\psi| = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \frac{-i}{\sqrt{2}} \end{pmatrix} \times \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{i}{\sqrt{2}} \end{pmatrix} = \frac{1}{2}\begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$$

## Visualizations

Measurement Probabilities

Re[ρ]




```
The qubit 0 is the one that is
furthest to the right on the
state.
```

## Circuit composer

Gates

H | + | ID | U3 | U2 | U1 | Rx | Ry

T† | cH | cY | cZ | cRz | cU1 | cU3 | +

← *Your circuit* > *rx*

*Subroutine params*

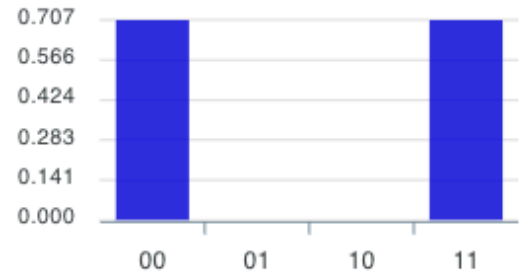
**theta**

pi/4

## Visualizations

Statevector

Statevector



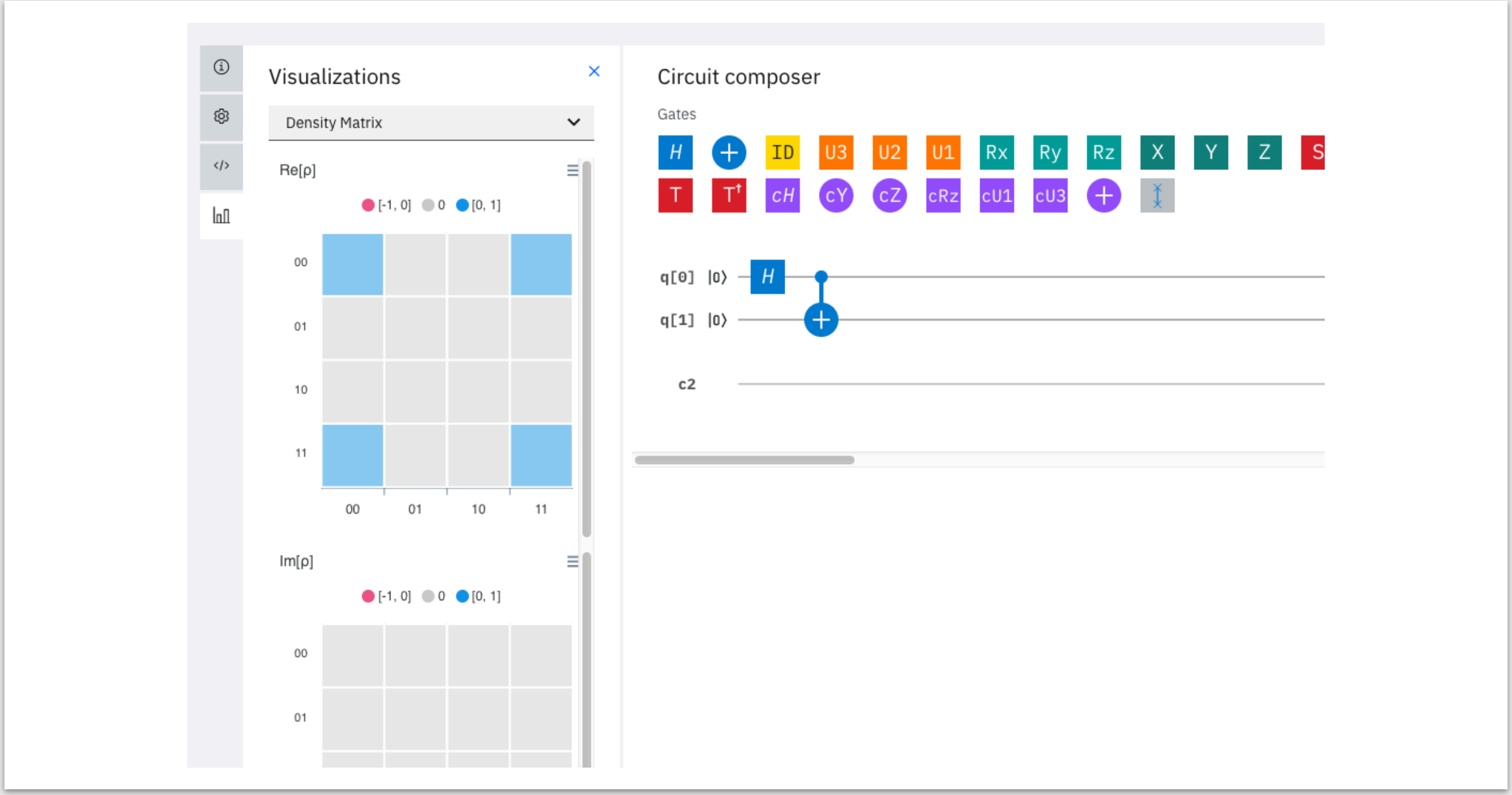

The height of the bar is the complex modulus.
The color of the bar is based in the complex argument or phase.

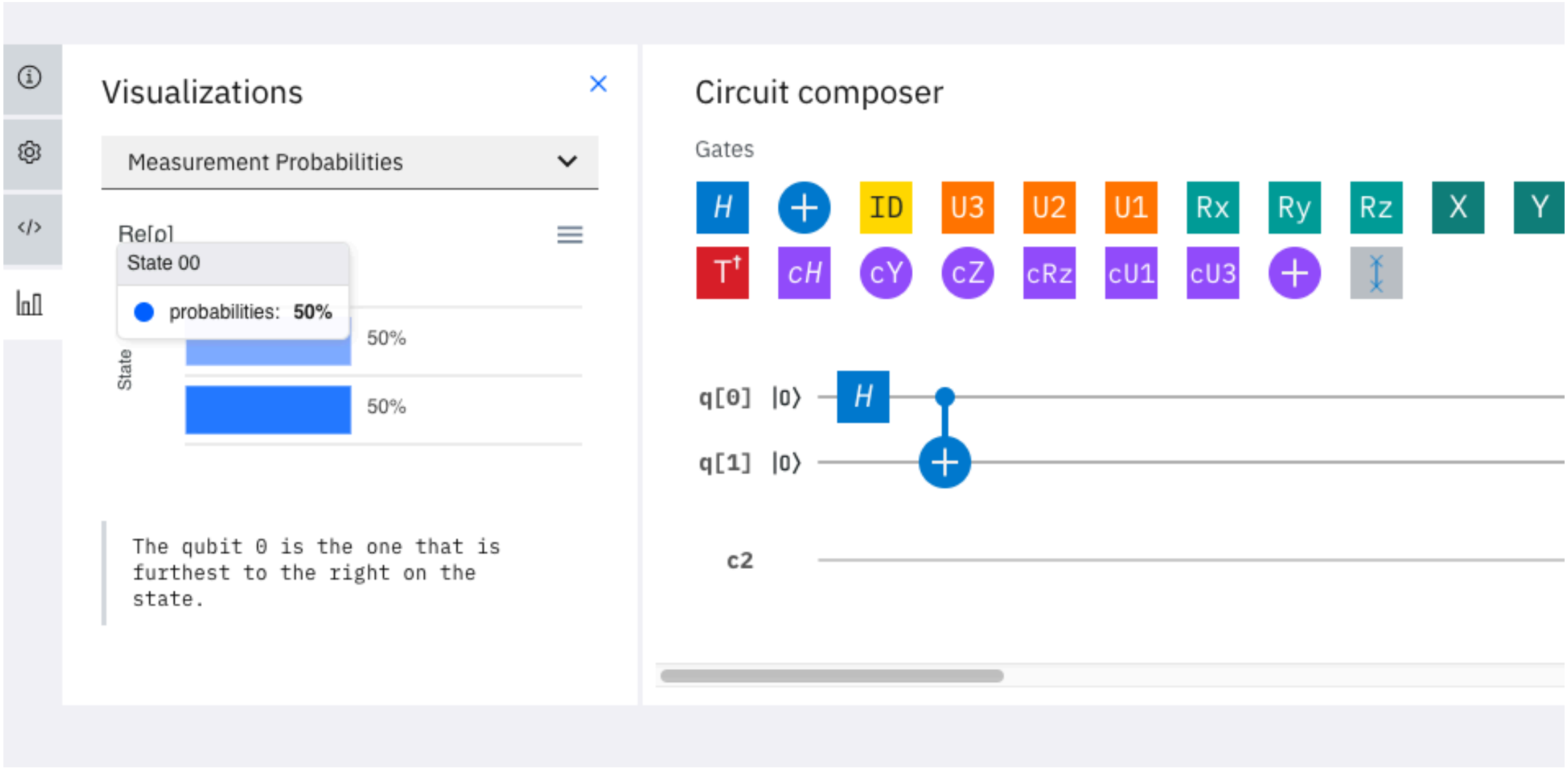
```
[ 0.707+0j, 0+0j, 0+0j, 0.707+0j ]
```

The qubit 0 is the one that is furthest to the right on the state.

## Circuit composer

Gates



Visualizations
Density Matrix
Re[ρ]
[-1, 0]
0
[0, 1]
00
01
10
11
Im[ρ]
Circuit composer
Gates
H
ID
U3
U2
U1
Rx
Ry
Rz
X
Y
Z
S
T
T†
cH
cY
cZ
cRz
cU1
cU3
q[0] |0⟩
q[1] |0⟩
c2

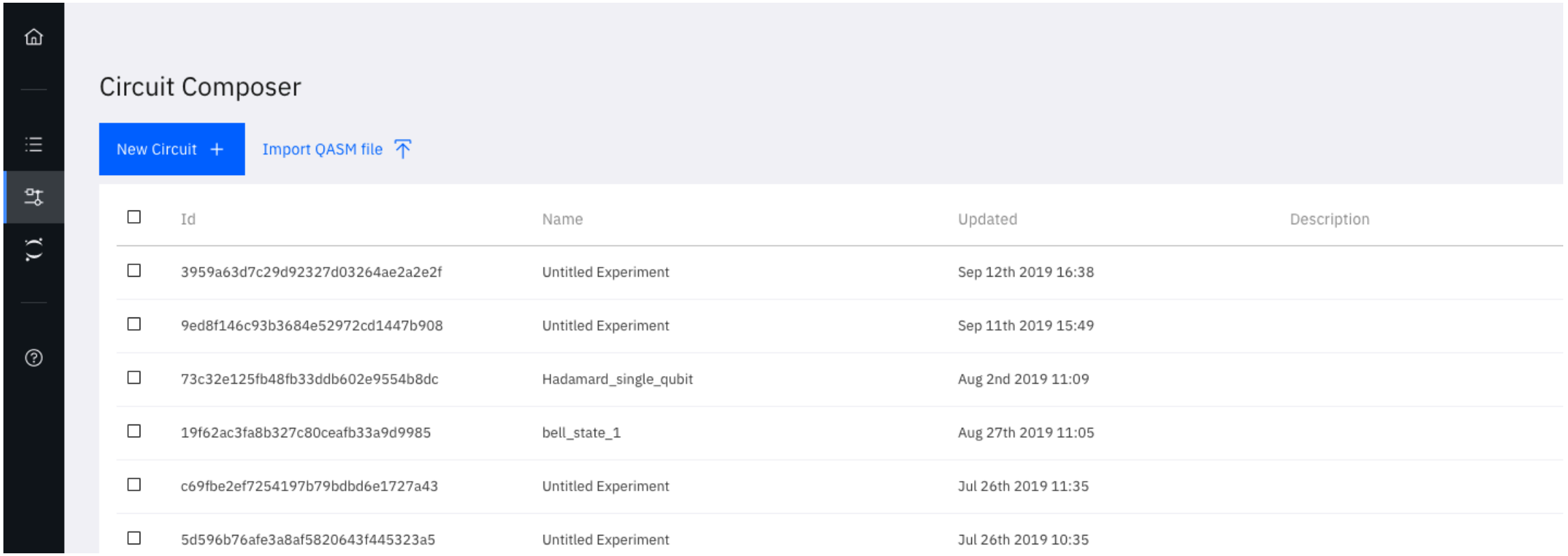

Visualizations
Measurement Probabilities
Re[ρ]
State 00
probabilities: 50%
50%
50%
State
The qubit 0 is the one that is furthest to the right on the state.
Circuit composer
Gates
H
ID
U3
U2
U1
Rx
Ry
Rz
X
Y
T†
cH
cY
cZ
cRz
cU1
cU3
q[0] |0⟩
q[1] |0⟩
c2

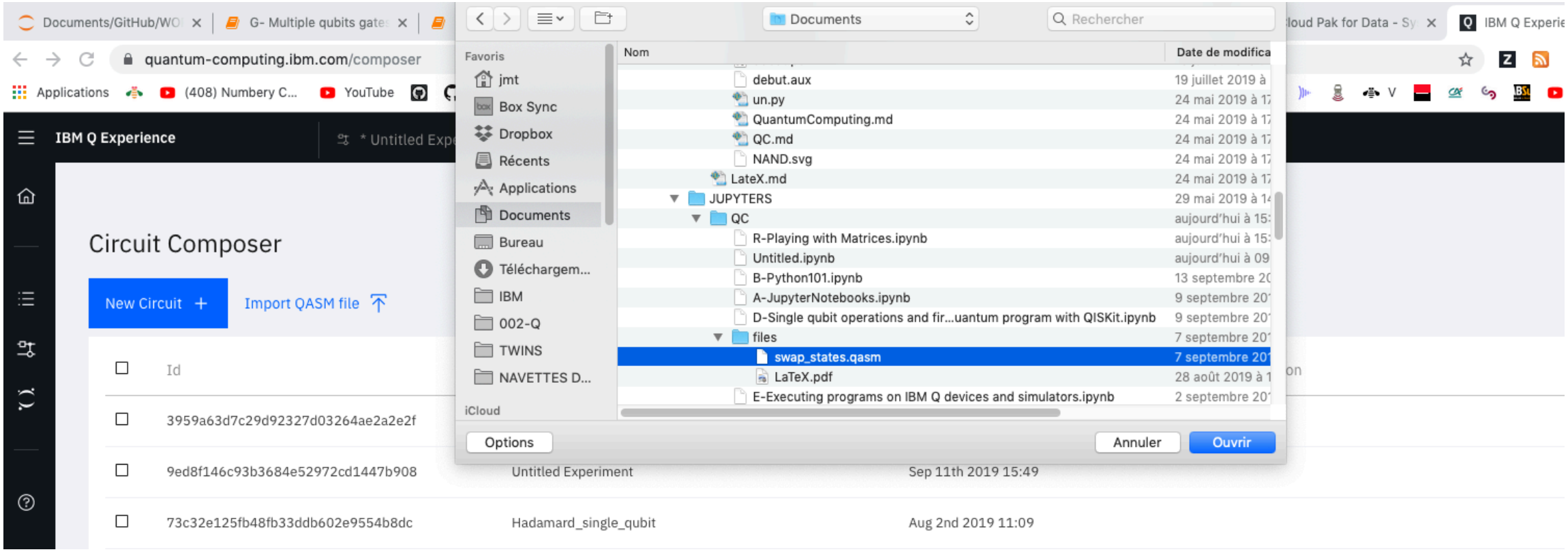
$$|00> = \begin{pmatrix}1\\0\\0\\0\end{pmatrix} \xrightarrow{H} \frac{1}{\sqrt{2}}\begin{pmatrix}1\\0\\1\\0\end{pmatrix}$$

- Applying CNOT(0,1):

$$\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{pmatrix} \times \frac{1}{\sqrt{2}}\begin{pmatrix}1\\0\\1\\0\end{pmatrix} = \frac{1}{\sqrt{2}}\begin{pmatrix}1\\0\\0\\1\end{pmatrix}$$

$$DM = \frac{1}{2}\begin{pmatrix}1\\0\\0\\1\end{pmatrix} \times (1\ 0\ 0\ 1) = \frac{1}{2}\begin{pmatrix}1&0&0&1\\0&0&0&0\\0&0&0&0\\1&0&0&1\end{pmatrix}$$


Circuit Composer
New Circuit +
Import QASM file
Id
Name
Updated
Description
3959a63d7c29d92327d03264ae2a2e2f
Untitled Experiment
Sep 12th 2019 16:38
9ed8f146c93b3684e52972cd1447b908
Untitled Experiment
Sep 11th 2019 15:49
73c32e125fb48fb33ddb602e9554b8dc
Hadamard_single_qubit
Aug 2nd 2019 11:09
19f62ac3fa8b327c80ceafb33a9d9985
bell_state_1
Aug 27th 2019 11:05
c69fbe2ef7254197b79bdbd6e1727a43
Untitled Experiment
Jul 26th 2019 11:35
5d596b76afe3a8af5820643f445323a5
Untitled Experiment
Jul 26th 2019 10:35


quantum-computing.ibm.com/composer
Applications
(408) Numbery C...
YouTube
IBM Q Experience
Circuit Composer
New Circuit +
Import QASM file
Id
3959a63d7c29d92327d03264ae2a2e2f
9ed8f146c93b3684e52972cd1447b908
Untitled Experiment
Sep 11th 2019 15:49
73c32e125fb48fb33ddb602e9554b8dc
Hadamard_single_qubit
Aug 2nd 2019 11:09
Documents
Rechercher
Favoris
jmt
Box Sync
Dropbox
Récents
Applications
Documents
Bureau
Téléchargem...
IBM
002-Q
TWINS
NAVETTES D...
iCloud
Nom
Date de modifica
debut.aux
un.py
QuantumComputing.md
QC.md
NAND.svg
LateX.md
JUPYTERS
QC
R-Playing with Matrices.ipynb
Untitled.ipynb
B-Python101.ipynb
A-JupyterNotebooks.ipynb
D-Single qubit operations and fir...uantum program with QISKit.ipynb
files
swap_states.qasm
LaTeX.pdf
E-Executing programs on IBM Q devices and simulators.ipynb
Options
Annuler
Ouvrir

# Circuit Composer

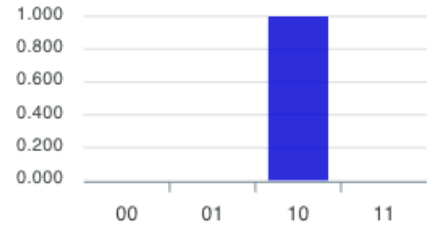
New Circuit + | Import QASM file

| | Id | Name | Updated | Description |
|---|---|---|---|---|
| ☐ | 10fd00c545cc38a299373b0d98f5f38a | swap_states | Sep 16th 2019 16:33 | |
| ☐ | 3959a63d7c29d92327d03264ae2a2e2f | Untitled Experiment | Sep 12th 2019 16:38 | |
| ☐ | 9ed8f146c93b3684e52972cd1447b908 | Untitled Experiment | Sep 11th 2019 15:49 | |
| ☐ | 73c32e125fb48fb33ddb602e9554b8dc | Hadamard_single_qubit | Aug 2nd 2019 11:09 | |
| ☐ | 19f62ac3fa8b327c80ceafb33a9d9985 | bell_state_1 | Aug 27th 2019 11:05 | |
| ☐ | c69fbe2ef7254197b79bdbd6e1727a43 | Untitled Experiment | Jul 26th 2019 11:35 | |
| ☐ | 5d596b76afe3a8af5820643f445323a5 | Untitled Experiment | Jul 26th 2019 10:35 | |
| ☐ | 23ce5d7c7a072e91402ddfe23632d2c6 | Untitled Experiment | Jul 26th 2019 10:28 | |

## Visualizations

Statevector

Statevector




The height of the bar is the complex modulus.
The color of the bar is based in the complex argument or phase.

```
[ 0+0j, 0+0j, 1+0j, 0+0j ]
```

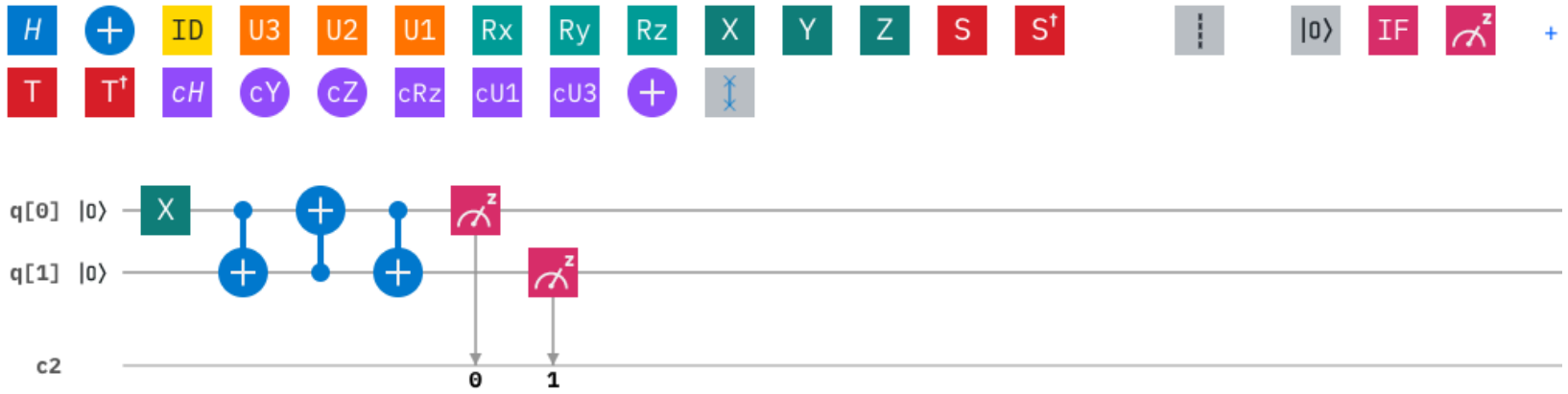
The qubit 0 is the one that is furthest to the right on the state.

## Circuit composer

Gates

Barrier

Operations



## Composer help

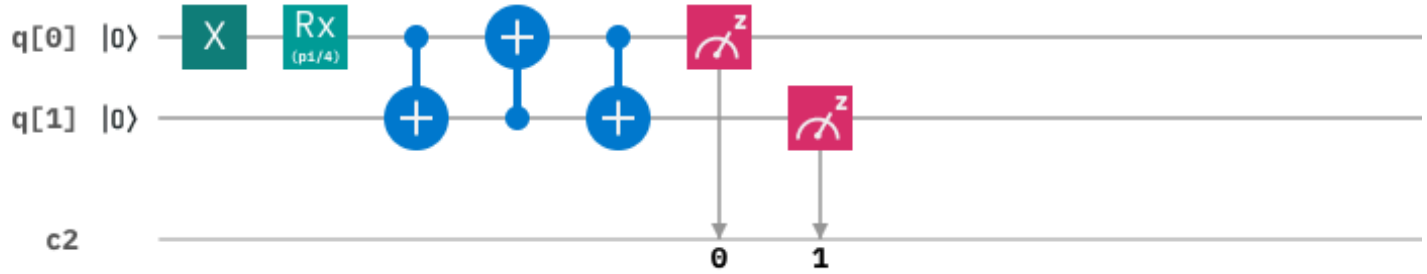
The circuit composer is a tool that allows you to visually learn how to create quantum circuits. Here are some resources to get you started.

Composer guide

Gates overview

## Circuit composer

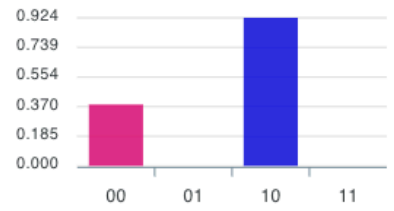
Gates

## Visualizations

Statevector

Statevector




The height of the bar is the complex modulus.
The color of the bar is based in the complex argument or phase.

```
[ 0-0.383j, 0+0j, 0.924+0j, 0+0j ]
```

The qubit 0 is the one that is furthest to the right on the state.

## Circuit composer

Gates overview

Gates

H ⊕ ID U3 U2 U1 Rx Ry Rz X Y Z S S†
T T† cH cY cZ cRz cU1 cU3 ⊕

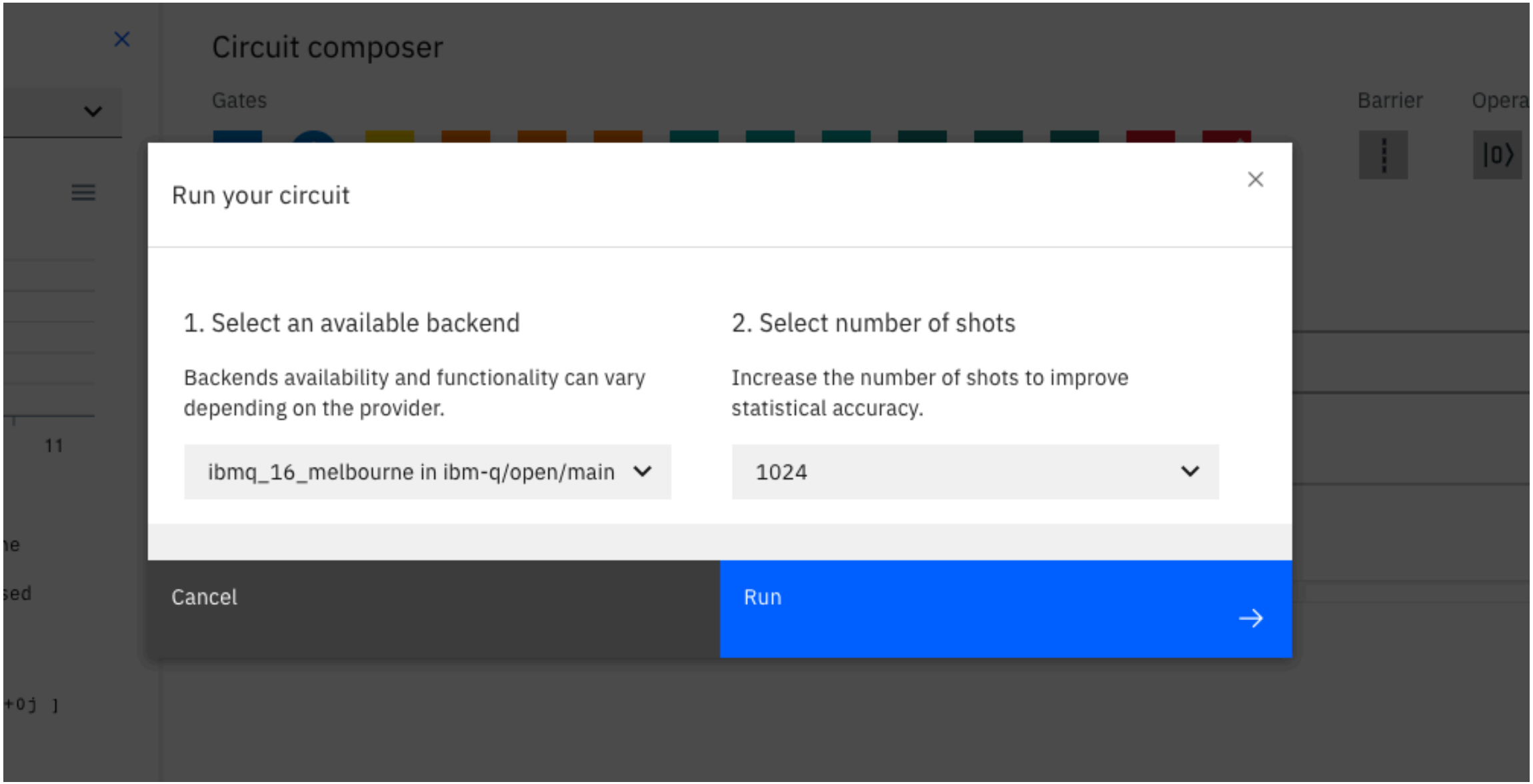
Barrier

Operations

|0⟩ IF

Subroutines

+ Add


Circuit composer
Gates
Barrier
Opera
Run your circuit
1. Select an available backend
Backends availability and functionality can vary depending on the provider.
ibmq_16_melbourne in ibm-q/open/main
2. Select number of shots
Increase the number of shots to improve statistical accuracy.
1024
Cancel
Run

Pending results (1)

ibmq_16_melbourne

1024 shots

a few seconds ago

Pending results (2)

ibmq_qasm_simulator

1024 shots

a few seconds ago

ibmq_16_melbourne

1024 shots

2 minutes ago

Circuit "swap_states" was sent to ibmq_qasm_simulator. 04:50

## Pending results (1)

ibmq_16_melbourne

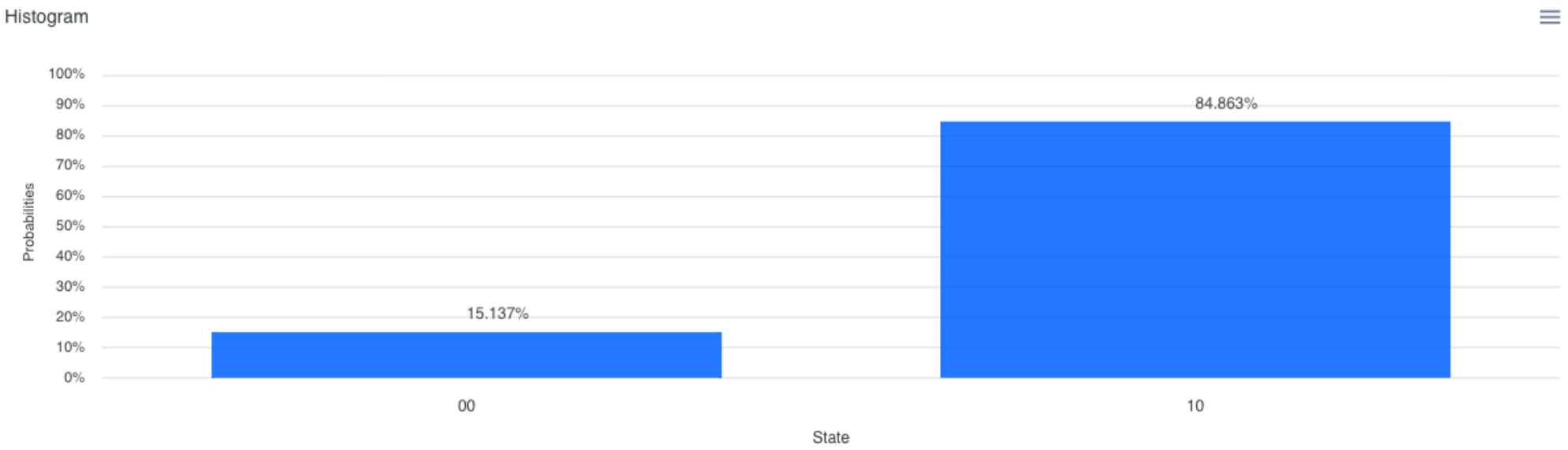
1024 shots

2 minutes ago

## Results (1)

- ibmq_qasm_simulator - 1024 shots - a few seconds ago. Status: COMPLETED

# Result


Histogram
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probabilities
84.863%
15.137%
00
10
State

# Results

## Pending

Refresh

| Status | Id | Service | Provider | Run date |
|---|---|---|---|---|
| RUNNING | 5d7fa0d7ededd50013174232 | Backend: ibmq_16_melbourne | ibm-q/open/main | Monday, September 16th 2019, 4:48:55 pm |

Items per page: 10 | 1 - 1 of 1 items | 1

## Completed

Refresh

| Status | Id | Service | Provider | Run date |
|---|---|---|---|---|
| COMPLETED | 5d7fa149234397001196a292 | Backend: ibmq_qasm_simulator | ibm-q/open/main | Monday, September 16th 2019, 4:50:49 pm |
| COMPLETED | 5d78fb6f1cad1900183e4137 | Backend: ibmq_qasm_simulator | ibm-q/open/main | Wednesday, September 11th 2019, 3:49:35 pm |
| COMPLETED | 5d7375d44da2b200120d9d81 | Backend: ibmq_qasm_simulator | ibm-q/open/main | Saturday, September 7th 2019, 11:18:12 am |
| COMPLETED | 5d6d10494e38b1001afc2086 | Backend: ibmq_ourense | ibm-q/open/main | Monday, September 2nd 2019, 2:51:21 pm |
| COMPLETED | 5d67f18909ad9800126c1926 | Backend: ibmq_ourense | ibm-q/open/main | Thursday, August 29th 2019, 5:38:49 pm |

Results (2)

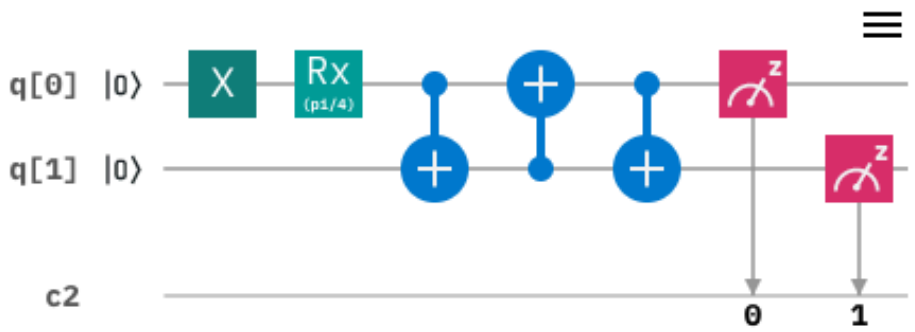
- ibmq_qasm_simulator - 1024 shots - 20 minutes ago. Status: COMPLETED
- ibmq_16_melbourne - 1024 shots - 22 minutes ago. Status: COMPLETED

## Run details

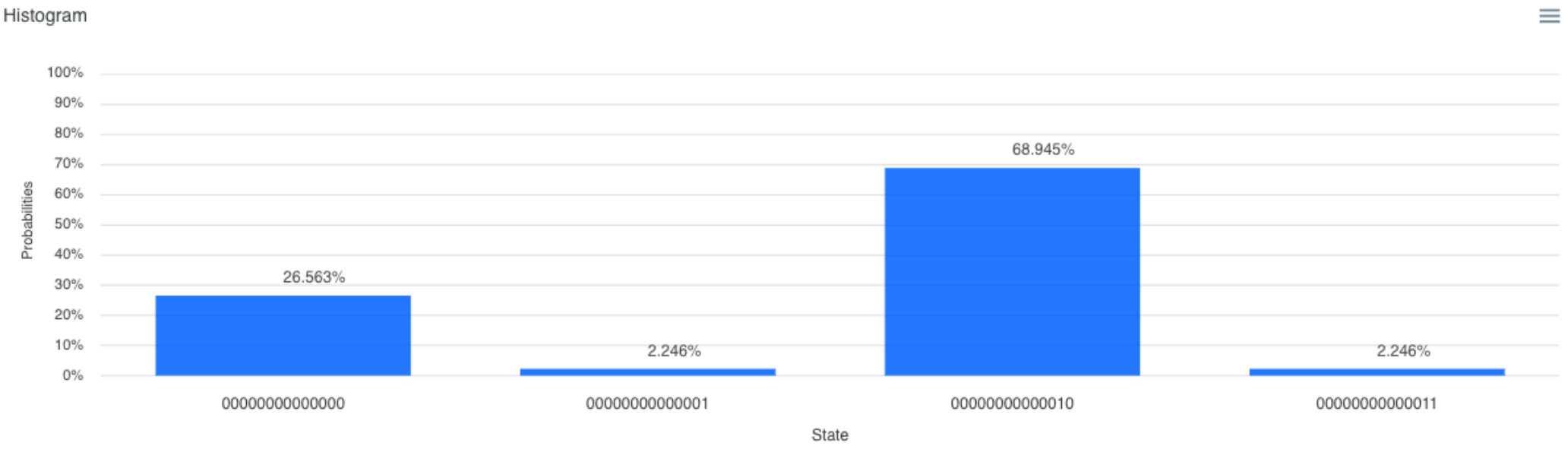
| Backend | Shots | Status | Time taken | Last Update |
| --- | --- | --- | --- | --- |
| ibmq_16_melbourne | | COMPLETED | - | Sep 16th 2019 17:04:56 |

## Circuit diagram

Original circuit diagram



# Result


Histogram
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probabilities
26.563%
2.246%
68.945%
2.246%
00000000000000
00000000000001
00000000000010
00000000000011
State

New Save Clear Help

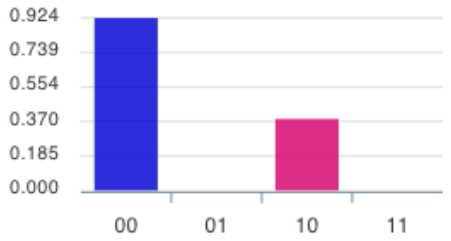
swapWithTopoConstraint

Saved Run

## Visualizations

Statevector

Statevector




The height of the bar is the complex modulus.
The color of the bar is based in the complex argument or phase.

[ 0.924+0j, 0+0j, 0-0.383j, 0+0j ]

## Circuit composer

Gates overview

Gates

H ID U3 U2 U1 Rx Ry Rz X Y Z S S† T

T† cH cY cZ cRz cU1 cU3

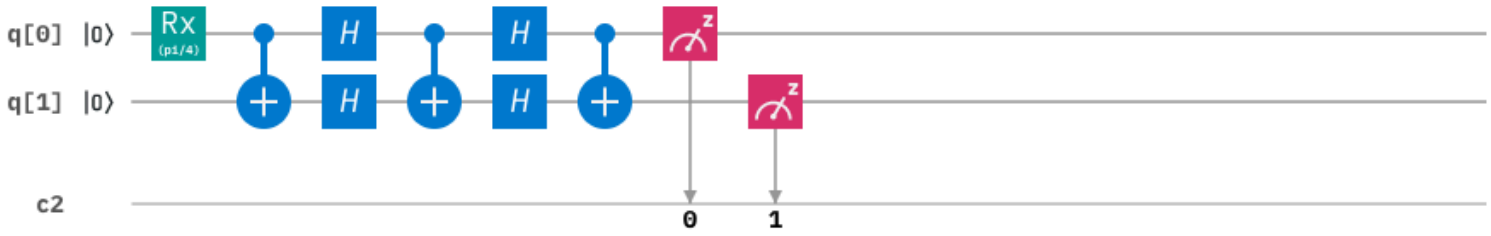
Barrier

Operations

|0⟩ IF

Subroutines

+ Add



IBM Q Experience | Quantum Algorit... | Untitled Experim... | Overview of Qua... | Introduction to ... | Result 5d78fb6f... | Result 5d7375d... | bell_state_1.i...

File Edit View Insert Cell Kernel Widgets Help

Fiable Python 3 jupyter

▸ Exécuter Markdown

Basic version for entanglement.

Entrée [3]

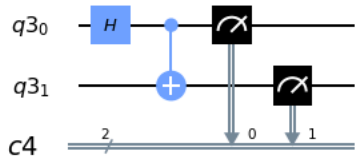
```
%matplotlib inline
# Importing standard Qiskit libraries and configuring account
from qiskit import QuantumRegister, ClassicalRegister, QuantumCircuit, execute, Aer, IBMQ
from qiskit.compiler import transpile, assemble
from qiskit.tools.jupyter import *
from qiskit.visualization import *
# Loading your IBM Q account(s)
provider = IBMQ.load_account()
```

Entrée [8]

```
qr = QuantumRegister(2)
cr = ClassicalRegister(2)
qc = QuantumCircuit(qr,cr)

qc.h(qr[0])
qc.cx(qr[0],qr[1])
qc.measure(qr,cr)

qc.draw(output='mpl')
```



# Quantum Algorithms with Qiskit



## Bernstein-Vazirani algorithm and its Qiskit implementation

### Introduction

Another algorithm demonstrating a quantum speed-up is the Bernstein-Vazirani algorithm. The algorithm solves the following problem: given a function $f : 0, 1^n \rightarrow 0, 1$ which takes an $n$ bit string as input and outputs a single bit where there is exactly one $n$ bit string $s \in 0, 1^n$ that returns a value $f(s) = 1$, what is $s$?

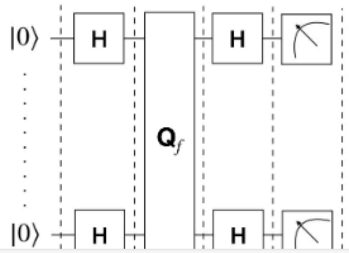
In other words, for each input $x$, $f(x) = s \cdot x \pmod 2$. We are expected to find $s$.

To find $s$ classically, we would have to call the function $f(x)$ $n$ times, each time determining one of the bits of $s$.

On the other hand, a quantum algorithm can solve the problem in only one step! This gives a polynomial speed-up with respect to the classical algorithm. Let us see the quantum circuit that implements the corresponding algorithm.

### Quantum circuit for the Bernstein-Vazirani Algorithm

The quantum circuit that implements the Bernstein-Vazirani algorithm is shown below.

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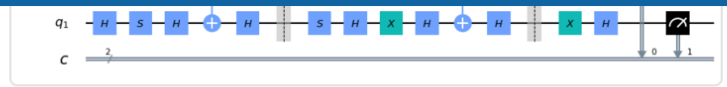
Recherche

Jeudi 29 août

Nouveaux messages depuis 12 h 22 le 7 septembre — Marquer comme lu(s)



2 réponses Dernière réponse il y a 12 jours

**Syed Ali Hamza** 0 h 47

I'm trying to implement this 4-qubit perceptron from https://arxiv.org/pdf/1811.02266.pdf and I can't exactly see how I can implement the 4-qubit controlled-Z gates. Can I pleas get any leads to where I can possibly find a solution? Also, as per one solution here: https://quantumcomputing.stackexchange.com/questions/4078/how-to-construct-a-multi-qubit-controlled-z-from-elementary-gates, I can't get how exactly I can implement the [+] and [-] gates.

image.png

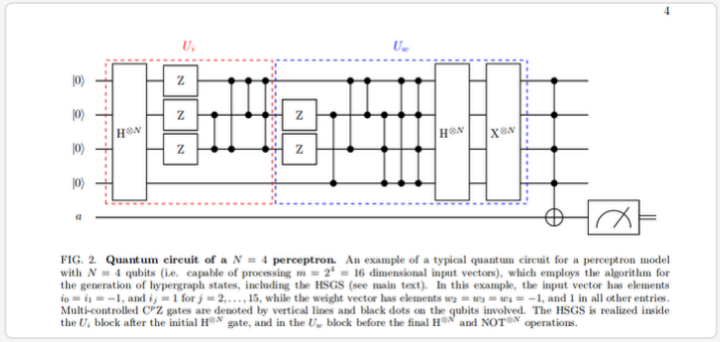


FIG. 2. **Quantum circuit of a $N = 4$ perceptron.** An example of a typical quantum circuit for a perceptron model with $N = 4$ qubits (i.e. capable of processing $m = 2^4 = 16$ dimensional input vectors), which employs the algorithm for the generation of hypergraph states, including the HSGS (see main text). In this example, the input vector has elements $i_0 = i_1 = -1$, and $i_j = 1$ for $j = 2, \ldots, 15$, while the weight vector has elements $w_2 = w_3 = w_4 = -1$, and 1 in all other entries. Multi-controlled $C^kZ$ gates are denoted by vertical lines and black dots on the qubits involved. The HSGS is realized inside the $U_i$ block after the initial $H^{\otimes N}$ gate, and in the $U_w$ block before the final $H^{\otimes N}$ and $NOT^{\otimes N}$ operations.

6 réponses Dernière réponse il y a 12 jours

**yanwu gu** 7 h 49

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# general

**Syed Ali Hamza** 29 août à 0 h 47

I'm trying to implement this 4-qubit perceptron from https://arxiv.org/pdf/1811.02266.pdf and I can't exactly see how I can implement the 4-qubit controlled-Z gates. Can I pleas get any leads to where I can possibly find a solution? Also, as per one solution here: https://quantumcomputing.stackexchange.com/questions/4078/how-to-construct-a-multi-qubit-controlled-z-from-elementary-gates, I can't get how exactly I can implement the [+] and [-] gates.

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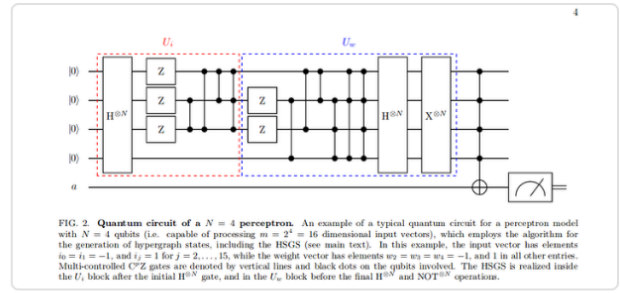

6 réponses

**Steve Wood** il y a 12 jours

Does this help you at all? https://github.com/Qiskit/qiskit-aqua/blob/master/qiskit/aqua/circuits/gates/