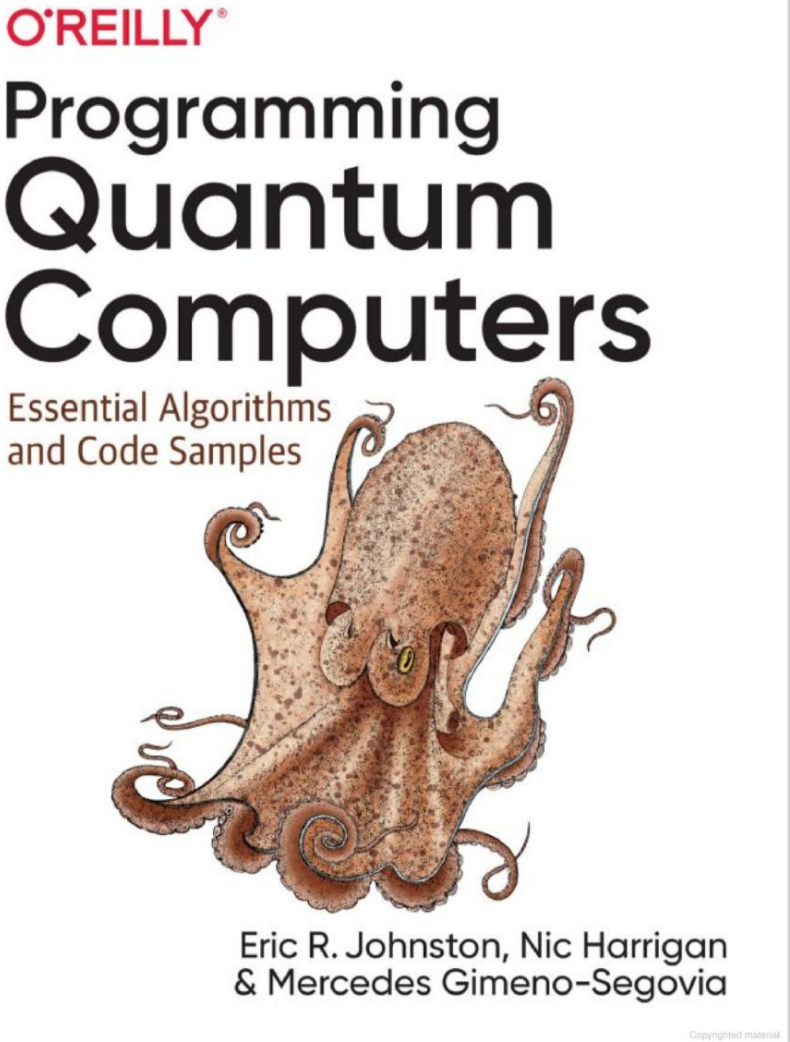


Bookclub Wk1 - ch1

@lynnlangit

Logistics

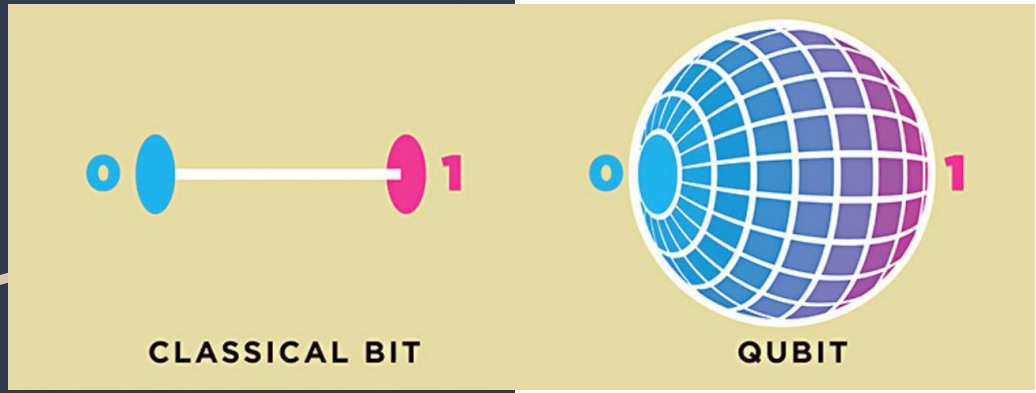
Format

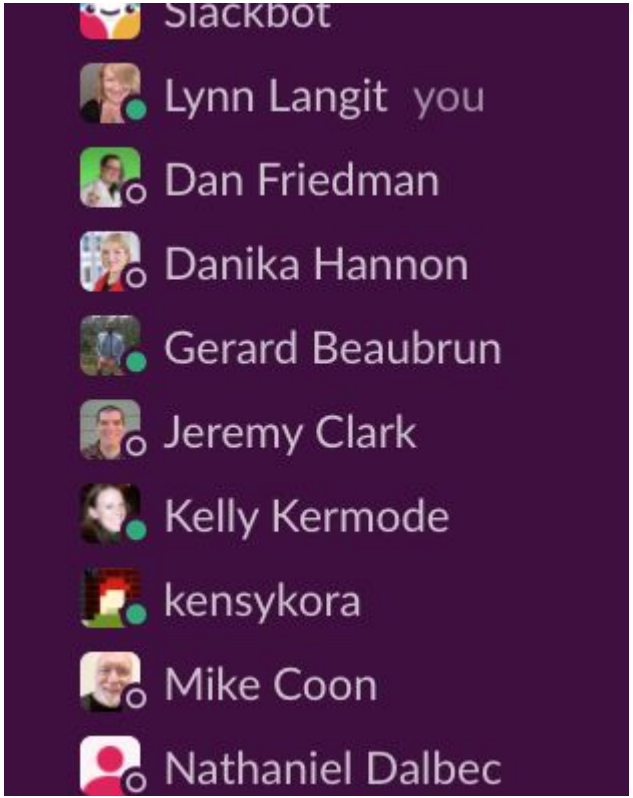
- Weekly 60 minute live meeting
  - recorded
  - posted to YouTube channel
- Slack
  - #intros
  - **#general**
  - channels for book sections
- One person is group lead each week
  - 30-45 min presenting

Goals

Why we are here

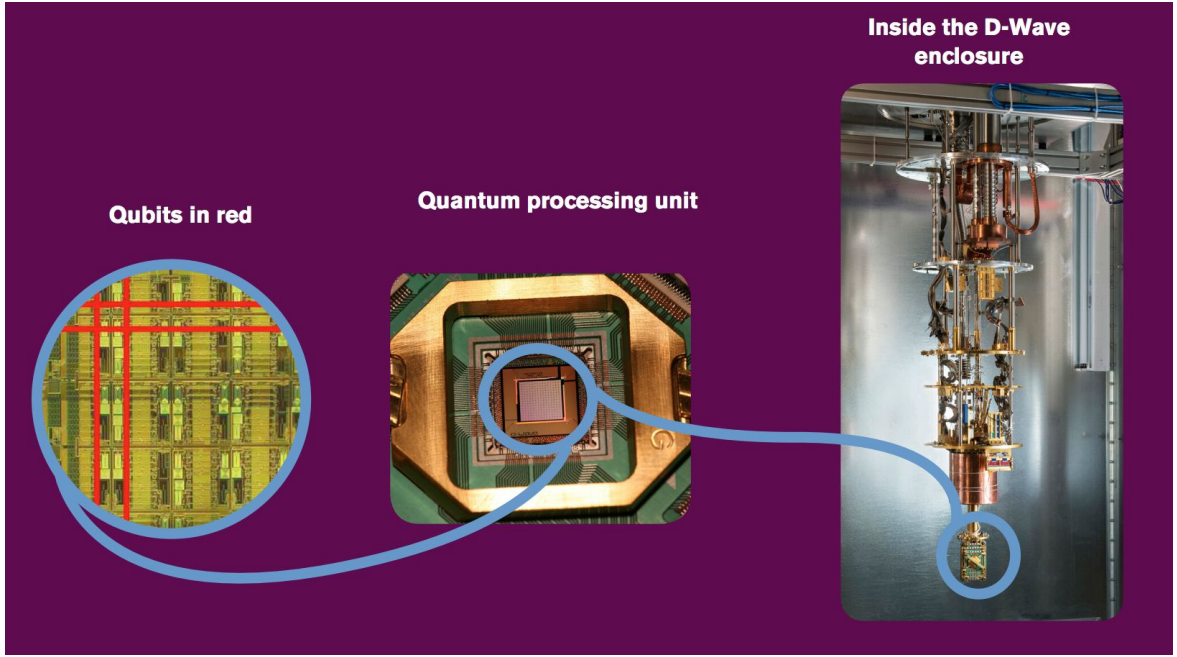
- Interest in this topic
- Complexity of topic
- Want to learn together





Introductions

Chapter 1 - Intro

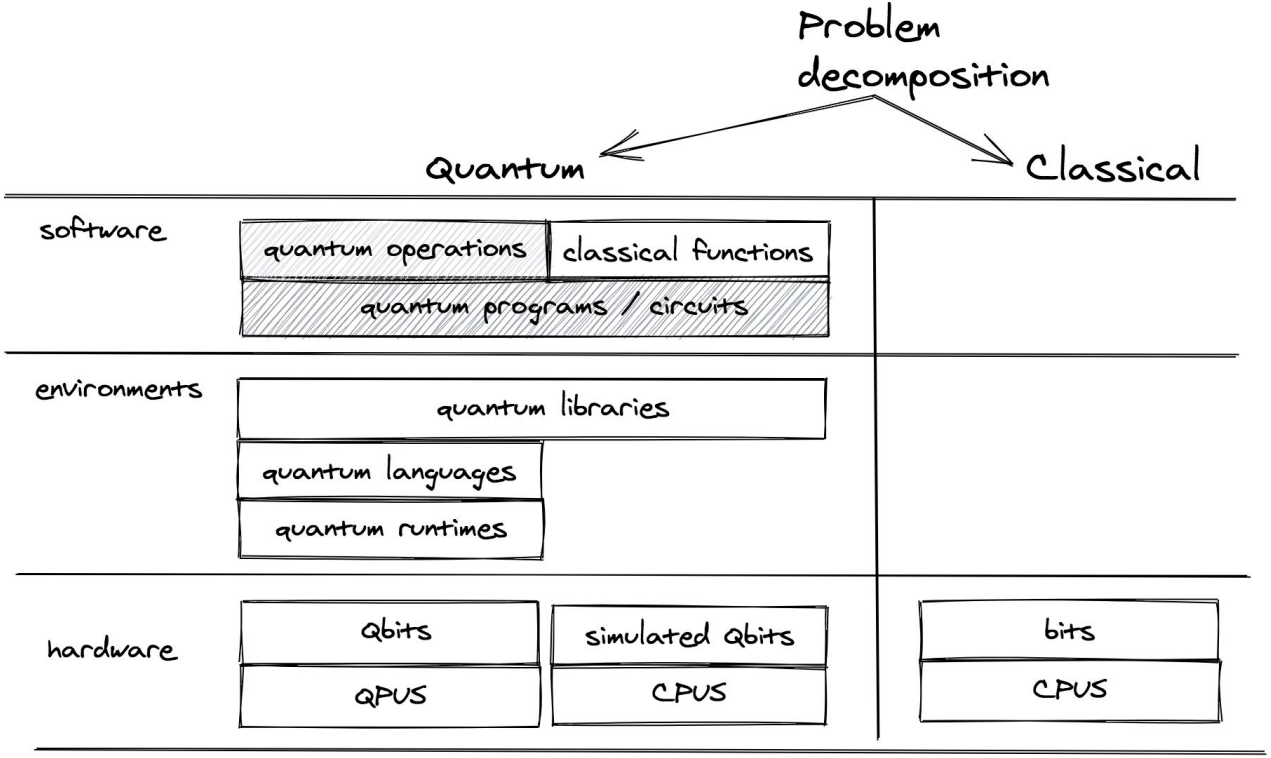


QPU (Quantum Processing Unit) to refer to the device on which our code samples run

The D-Wave QPU is built from a lattice of tiny loops of the metal niobium, each of which is one qubit. Below temperatures of 9.2 kelvin, niobium becomes a superconductor and exhibits quantum mechanical effects.

D-Wave QPU

Coverage of Topic Area



Intro – Info

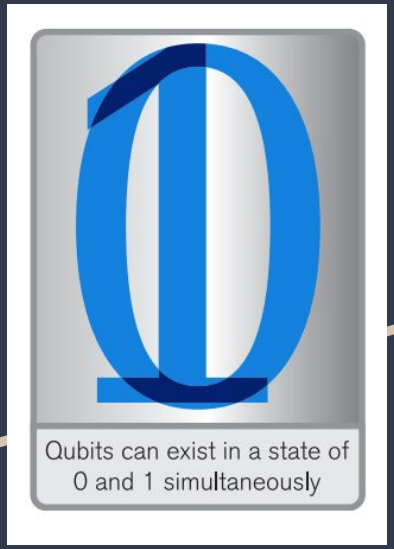
Math background:

- mathematical functions
- trigonometric functions
- converting between binary and decimal representations
- comprehension of complex numbers

Programming background:

- one or more programming languages
- default book examples in JavaScript

Chapter 1 – Info



Qbit - 1 quantum computational unit

Qbyte - 8 qbits

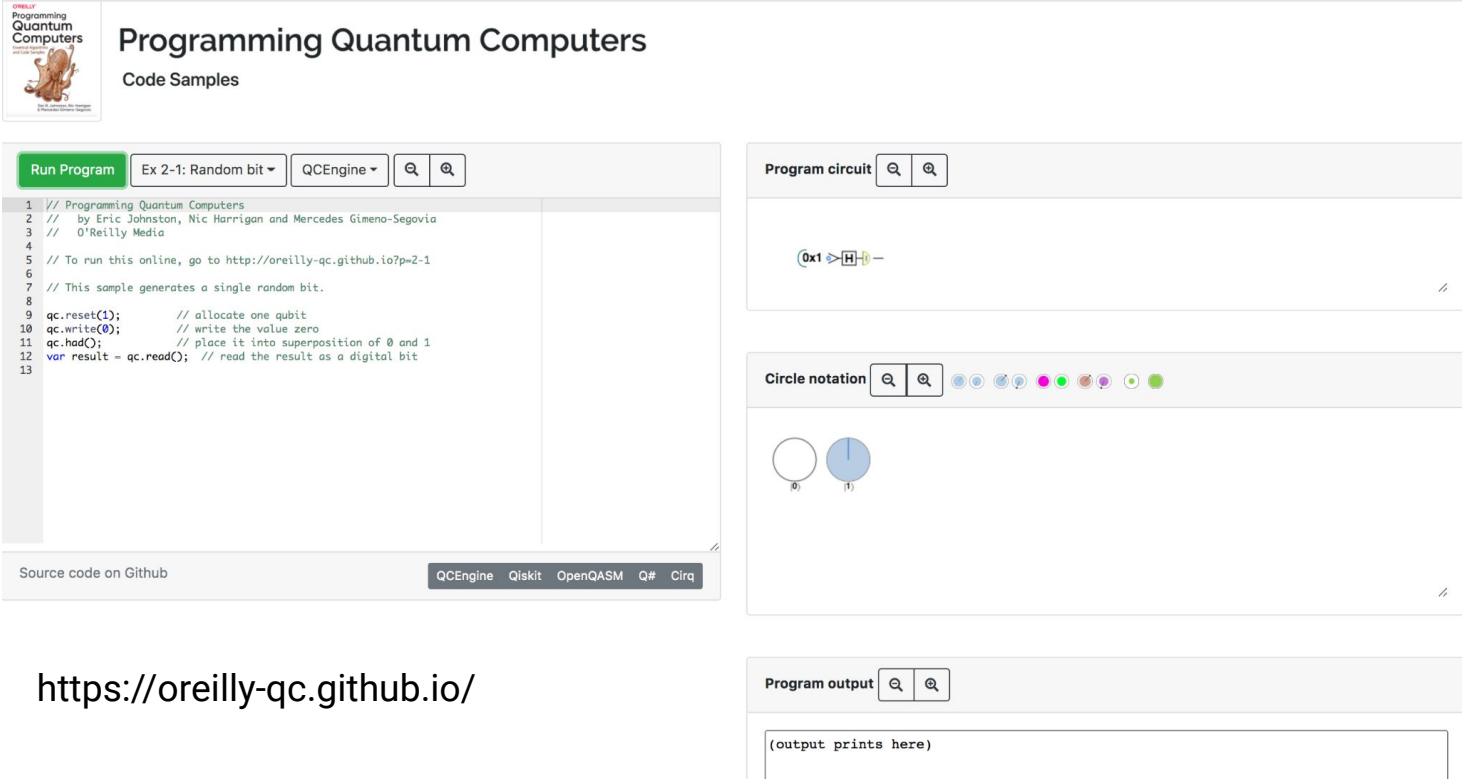
QPU - quantum processing unit

QCEngine - quantum simulator (JavaScript)

Quantum Circuit - program circuit

Circle-notation - program visualization

Running the code



https://oreilly-qc.github.io/

Options for running examples

Library or Language	Language basis	Env	Other
QCEngine	JavaScript	Browser	Circle and Circuit Viz
Qiskit	Python	Notebook	IBM env
OpenQASM	C-style language	Composer	IBM env
Q#	C#/F# - style language	Notebook	Binder -> GKE
Cirq	Python	Notebook	Colab or GCP

IBM Quantum Lab

Lab files

Search files

New file +

Name	Updated
Untitled.ipynb	2 minutes ago
qiskit-textbook	3 minutes ago
qiskit-tutorials	3 minutes ago
W-state_Apr 05, 2021 ...	8 days ago

File Edit View Insert Cell Kernel Widgets Help

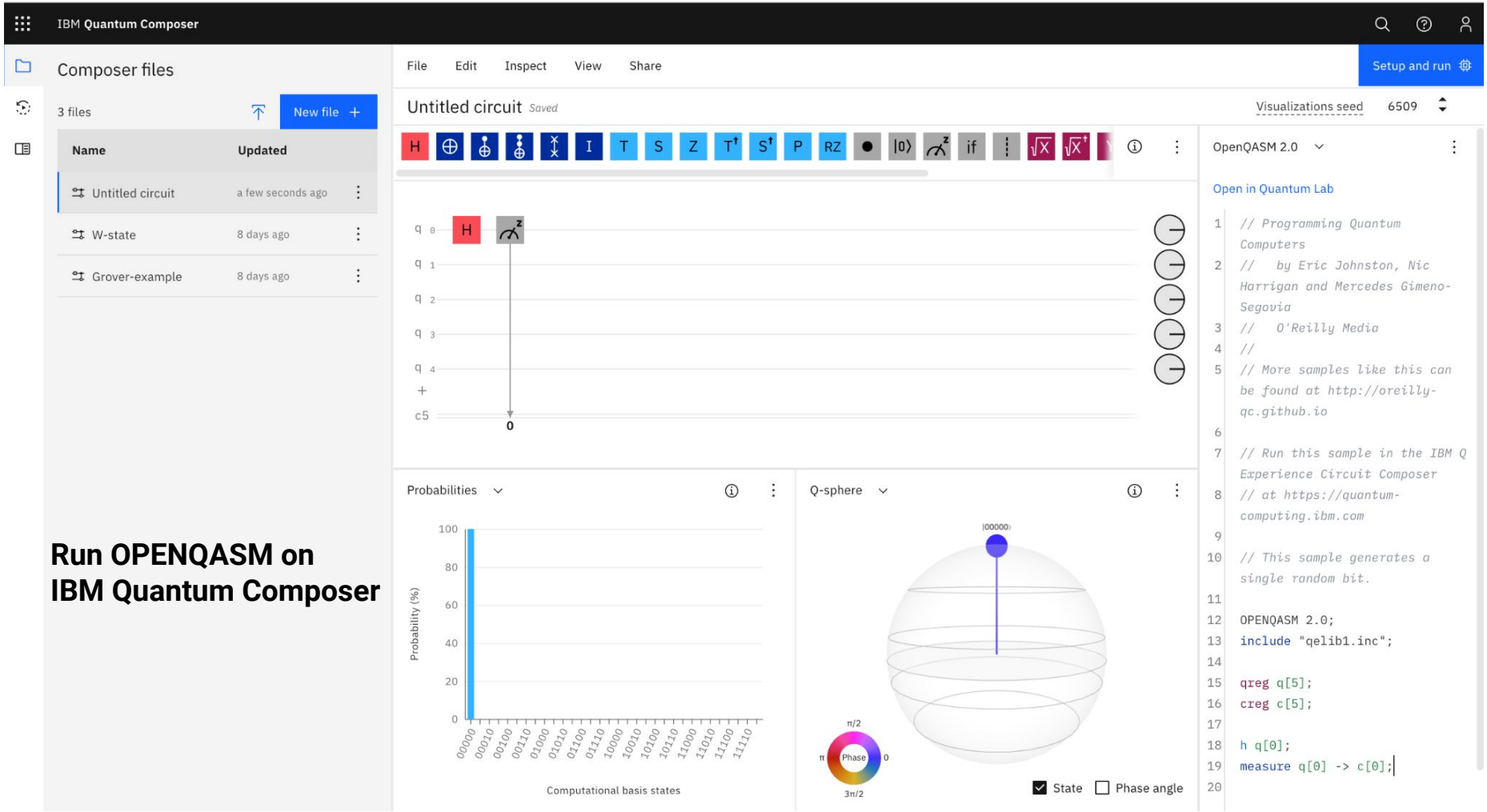
Trusted Kernel jupyter

Run Code Memory: 253.6 MB / 8 GB

```
import math
## Uncomment the next line to see diagrams when running in a notebook
%matplotlib inline

## Example 2-1: Random bit
# Set up the program
reg = QuantumRegister(1, name='reg')
reg_c = ClassicalRegister(1, name='regc')
qc = QuantumCircuit(reg, reg_c)

qc.reset(reg)          # write the value 0
qc.h(reg)              # put it into a superposition of 0 and 1
qc.measure(reg, reg_c) # read the result as a digital bit

backend = BasicAer.get_backend('statevector_simulator')
job = execute(qc, backend)
result = job.result()

counts = result.get_counts(qc)
print('counts:',counts)

outputstate = result.get_statevector(qc, decimals=3)
print(outputstate)
qc.draw()        # draw the circuit
```

```
counts: {'0': 1}
[1.+0.j 0.+0.j]
```

Run Qiskit (python) on IBM Quantum Lab



Run OPENQASM on IBM Quantum Composer

hub.gke2.mybinder.org/user/oreilly-qc-oreilly-qc.github.io-248ktxa5/notebooks/Chapter2-samples.ipynb

jupyter Chapter2-samples (unsaved changes)

Visit repo | Copy Binder link

File Edit View Insert Cell Kernel Help | Not Trusted | Q# O

Run | Code

Programming Quantum Computers by O'Reilly Media - book info - all code samples

Code samples for Chapter 2

These code samples were written by Andres Paz and Mariia Mykhailova.

In [1]:
```
// Example 2-1: Random bit

operation RandomBit () : Unit {
    // allocate one qubit
    using (q = Qubit()) {
        // put it into superposition of 0 and 1
        H(q);

        // measure the qubit and store the result
        let bit = M(q);

        // make sure the qubit is back to the 0 state
        Reset(q);

        Message($"{bit}");
    }
}
```

Out[1]:
- RandomBit

In [2]:
```
%simulate RandomBit
```

```
Zero
```

Run Q# on GKE Jupyter Notebooks via Binder

colab.research.google.com/github/quantumlib/Cirq/blob/master/docs/qubits.ipynb#scrollTo=bd9529db1c0b

qubits.ipynb

File Edit View Insert Runtime Tools Help Cannot save changes

Share

Table of contents

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Qubits

Qubit types

Section

+ Code + Text Copy to Drive

RAM Disk Editing

Copyright 2020 The Cirq Developers

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Qubits

View on QuantumAI Run in Google Colab View source on GitHub Download notebook

```
try:
    import cirq
except ImportError:
    print("installing cirq...")
    !pip install --quiet cirq
    print("installed cirq.")
```

```
installing cirq...
     |▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓| 1.8MB 6.0MB/s
     |▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓▓| 1.3MB 35.9MB/s
installed cirq.
```

A qubit is the basic unit of quantum information, a quantum bit: a two level system that can exist in superposition of those two possible states. Cirq also supports higher dimensional systems, so called qudits that we won't cover here.

In Cirq, a `Qubit` is nothing else than an abstract object that has an identifier, a `cirq.Qid` and some other potential metadata to represent device specific properties that can be used to validate a circuit. In contrast to real qubits, the Cirq qubit does not have any state. The reason for

Run Cirq on Google Colabs

13s completed at 6:39 PM

Quantum Hardware - public cloud examples

Microsoft Azure

Search resources, services, and docs (G+/)

Home >

Create Quantum Workspace

Quantum Workspace

Basics | **Providers** | Tags | Review + create

Run your jobs on quantum computers, quantum simulators or using quantum inspired optimizations. See the terminology sheet.

Available providers

1Qloud Optimization Platform

Optimization

1QBit 1Qloud Optimization Platform with Quantum Inspired Solutions

+ Add

Honeywell Quantum Solutions

Quantum Computing

Access to Honeywell Quantum Solutions' trapped-ion systems

+ Add

IonQ

Quantum Computing

IonQ's trapped ion quantum computers perform calculations by manipulating charged atoms of Ytterbium held in a vacuum with lasers.

+ Add

Microsoft QIO

Optimization

Ground-breaking optimization algorithms inspired by decades of quantum research.

✓ Added

Providers added to this workspace

Name	Provider type	SKU		
Microsoft QIO Microsoft	Optimization	Learn & Develop	Modify	Remove

aws Services ▼ Search for services, features, marketplace products, and docs [Option+S] LynnLangitDemo ▼ N. Virginia ▼ Support ▼

Amazon Braket

- Devices
- Notebooks
- Tasks

Announcements

Quantum Processing Units (QPUs)

D-Wave — Advantage_system1.1

Quantum Annealer based on superconducting qubits

Qubits	Status
5760	ONLINE
Region	**Next available**
us-west-2	AVAILABLE NOW

D-Wave — DW_2000Q_6

Quantum Annealer based on superconducting qubits

Qubits	Status
2048	ONLINE
Region	**Next available**
us-west-2	AVAILABLE NOW

IonQ

Universal gate-model QPU based on trapped ions

Qubits	Status
11	ONLINE
Region	**Next available**
us-east-1	09:38:28

Rigetti — Aspen-8

Universal gate-model QPU based on superconducting qubits

Qubits	Status
31	OFFLINE
Region	**Next available**
us-west-1	UNAVAILABLE

Rigetti — Aspen-9

Universal gate-model QPU based on superconducting qubits

Qubits	Status
31	ONLINE
Region	**Next available**
us-west-1	11:38:28

Simulators

Amazon Web Services — SV1

Amazon Braket state vector simulator

Qubits	Status
34	ONLINE
Region	**Next available**
us-east-1, us-west-1, us-west-2	AVAILABLE NOW

Amazon Web Services — TN1

Amazon Braket tensor network simulator

Qubits	Status
50	ONLINE
Region	**Next available**
us-east-1, us-west-2	AVAILABLE NOW

Resources

- Book "**Programming Quantum Computers**" - https://learning.oreilly.com/library/view/programming-quantum-computers/9781492039679/
- Lynn's '**learning-quantum**' GitHub Repo - https://github.com/lynnlangit/learning-quantum
- Jeremy's '**programming quantum experiments**' GitHub Repo - https://github.com/jeremybytes/quantum-programming-experiments
- more ???