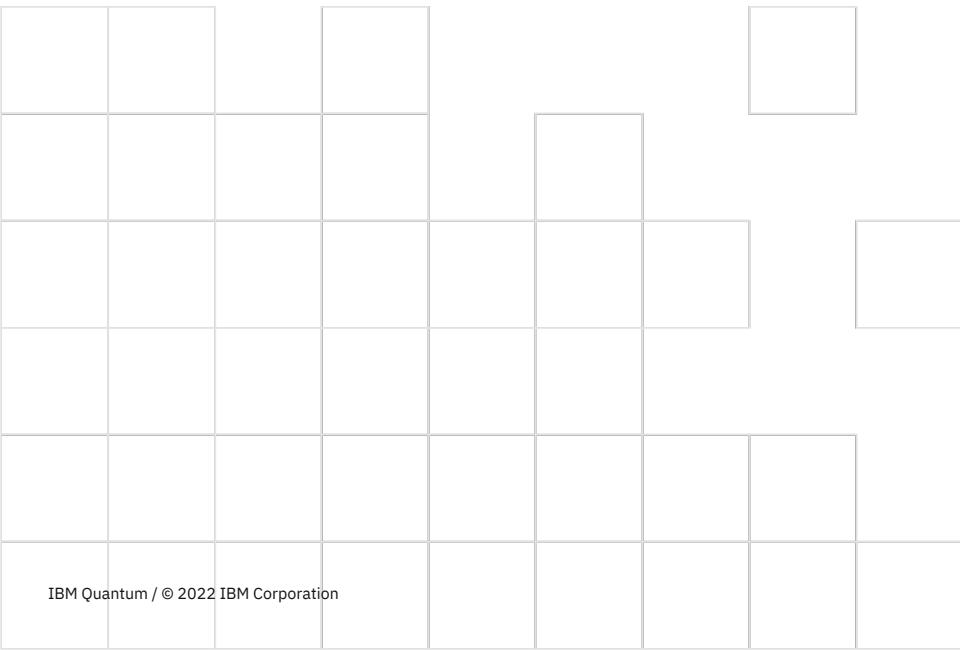


# Qiskit Quantum Software Stack

---

Luciano Bello

Qiskit Developer Advocate



# Qiskit Modules

## High level applications

### Qiskit Nature

For applications relating to simulating quantum mechanical systems and natural phenomena.

### Qiskit Finance

For applications relating to financial modeling.

## Low level applications

### Qiskit Metal

For designing quantum hardware and processors.

### Qiskit Optimization

For applications relating to optimization problems.

### Qiskit Machine Learning

For applications relating to machine learning.

### Qiskit Dynamics

For building, transforming, and solving time-dependent models of quantum systems.



## Core Capabilities

### Qiskit Terra

For building and transforming quantum circuits and operators at the level of gates or pulses.

## Simulator

### Qiskit Aer

For simulating quantum circuits on classical hardware.

## Hardware providers

### IBM

IBM Quantum systems

### AQT

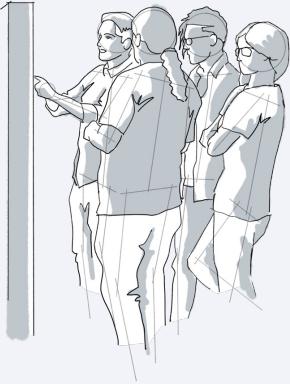
AQT systems

### IonQ

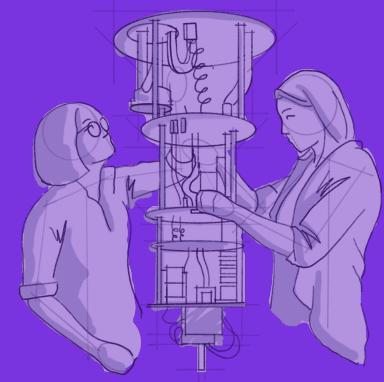
IonQ systems

Qiskit can connect to many other systems

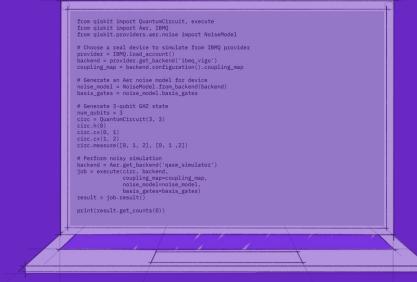
# Learning



# Researching



# Developing



# Contributing



# Qiskit textbook

The Qiskit textbook ([learn.qiskit.org](https://learn.qiskit.org)) is an open-source, university-level quantum algorithms / computation course with Qiskit code implementations and interactive features

Qiskit Textbook (beta)

Browse all content

Start learning

Start learning in the way best for you

Courses

Introduction course

Traditional Algorithms & Protocols

Qiskit Textbook (beta)

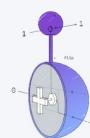
Browse all content

Start learning

## Start learning in the way best for you

### Courses

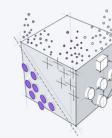
Quantum computing is a big topic and working out where to start can be difficult. In this interactive textbook, the content is organised into courses with clear prerequisites and end goals. If you're looking for something specific, you can browse all content, and if you can't find what you're looking for you can ask the community on Slack.



#### Introduction course

Not sure where to start? This path is for you. This introduction is aimed at audiences who are new to quantum computing. Whether you're keen to start your journey into quantum computing, or just curious as to what it's all about, this course will take you from zero to one, without the hand waving.

[Go to this course](#) →



#### Quantum machine learning

Want to learn about this exciting, developing field? If you're familiar with quantum computing basics, this course will give you a primer on machine learning, walk you through key concepts, and bring you up to speed with recent developments.

[Go to this course](#) →

### Summer schools

The Qiskit Global Summer Schools are one-of-a-kind sequences that takes students from beginner level to solving advanced quantum problems on a quantum computer. These two-week courses are designed to empower the next generation of quantum developers with the knowledge to explore quantum applications on their own.



#### Quantum Computing & Quantum Machine Learning (2021)

Designed to empower the next generation of quantum researchers and developers with the skills and know-how to explore quantum applications on their own. Starting with an introductory "crash course" on quantum computing, the materials continue to dive into and explore one key area: quantum machine learning.

[Go to this resource](#) →



#### Introduction to Quantum Computing and Quantum Hardware (2020)

This introduction to the world of quantum computing explores key quantum algorithms, as well as the quantum hardware designed to run these algorithms. These lectures were first released as part of a two-week intensive summer school in July 2020.

[Go to this resource](#) →

### University supplements

Are you teaching a course on quantum computing? Qiskit provides freely available materials to enhance your course.



#### Labs

This set of labs provides 7 different exercises you (or your students) can use to investigate the behaviour of current quantum computers and practice your Qiskit coding skills.

[View resource](#) ↗

# Qiskit Global Summer Schools

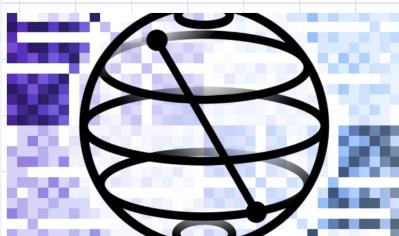
2-week intensive summer school (equivalent to one-semester course)

Largest quantum summer school (4000+ students)

QGSS 2022 focused on quantum simulations.

**Follow Qiskit in twitter for the announcement next time!**

About the event:



Qiskit Global Summer School 2021:  
Quantum Machine Learning

The Qiskit Global Summer School returns as a two-week intensive course focused on Quantum Machine Learning and more!

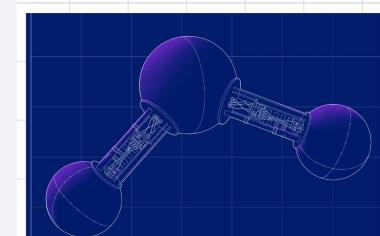
📍 Online  
📅 July 12 - 23, 2021

[Learn more](#) 

## The Future of Quantum Machine Learning



About the event:



Qiskit Global Summer School 2022: Quantum Simulations

The Qiskit Global Summer School returns as a two-week intensive course focused on Quantum Simulations and more!

📍 Online  
📅 July 18 - 29, 2022

[Learn more](#) 

# Qiskit advocate program

The Qiskit advocate program ([qiskit.org/advocates](https://qiskit.org/advocates)) is a global program that provides support to the individuals who actively contribute to the Qiskit Community.

Mentorship

Network with experts  
and enthusiasts

Access to Qiskit core  
members and  
projects

Invitation to events

## Meet the Advocates

Qiskit advocates are some of the most prolific in quantum computing all over the world. If you are interested in getting involved with the quantum computing community, reach out to an advocate local to your area.

Sign-up for the Qiskit Slack workspace to reach the advocates and join the conversation.

### Locations

- North America
- South America
- Australia
- Africa
- Europe
- Asia



Abby Mitchell

North America



Abhay Kambal

India



Abhijit Mitra

North America



Abhishek Jayachandran

India



Aboulkhair Foda

Saudi Arabia



Adity Girdharan

India



Ahmad, Syed Farhan

North America



Alan Leung Sheik Lun

Hong Kong



Alejandro Montanez

South America



Almudena Carrera Vazquez

Europe



Amaury de Miguel

Europe



Abeer Vaishnav

North America



Adarsh Chandrasekhar

India



Adrien Suau

France



Alain Chancé

Europe



Alberto Maldonado Rojas

North America



Houdan, France

France



Imane Lamine

Hong Kong



Alejandro Montanez

South America



Alex Pozas-Kerstjens

Spain



Almudena Carrera Vazquez

Europe



Abeer Vaishnav

North America



Amaury de Miguel

Europe



Abeer Vaishnav

North America

# Other learning tools and resources

## Learning resources

The below are designed and created by the Qiskit team. However, we recommend a familiarity with [linear algebra](#) and [Python](#) from these trusted resources.

[All resources](#)

Beginner

Advanced

Time to spend learning

- any
- 1 minute
- 1 day
- 1 week
- 1 month
- 1 year



### Qiskit Textbook

This Qiskit Textbook is a free digital open source textbook that will teach the concepts of quantum computing while you learn to use Qiskit.

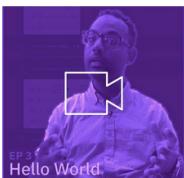
[Read the textbook →](#)



### Introduction Course

This introduction course is around 3 hours long and will take individuals from all backgrounds through a linear path of content that begins at the atoms of computation and ends at Grover's algorithm.

[Take the course →](#)



### Coding with Qiskit

This video series starts at learning how to install Qiskit locally, understanding what gates to do quantum states and explores quantum algorithms and the latest research topics.

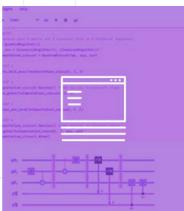
[Watch the series →](#)



### Qiskit Medium

This blog provides a nice overview of Qiskit and its direction as we explore what applications can be done on today's quantum devices.

[Read the blog →](#)



### Qiskit Tutorial

Try out this hands on Qiskit tutorial that will provide an overview of working with Qiskit, building circuits, visualizing results and exploring more advanced features in the SDK.

[Go to tutorials →](#)



### Introduction to Quantum Computing and Quantum Hardware

An introduction to the world of quantum computing, with an exploration of some of the key quantum algorithms and their implementations, as well as the quantum hardware that is designed to run these algorithms.

[Join the lecture →](#)

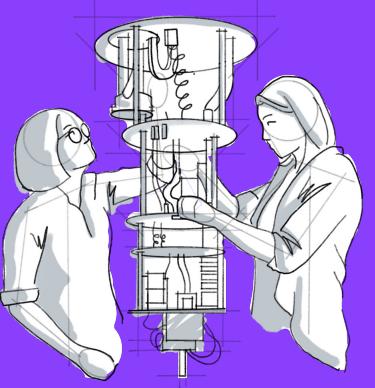
## Qiskit Learn ([qiskit.org/learn](https://qiskit.org/learn))

- Qiskit Textbook
- Qiskit Tutorials
- Qiskit YouTube
- Qiskit Medium
- QGSS recordings and materials

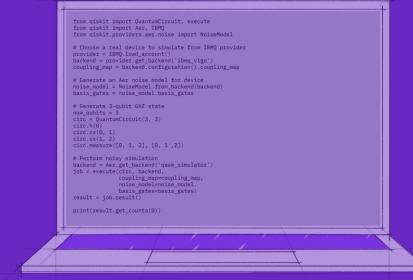
# Learning



# Researching



# Developing



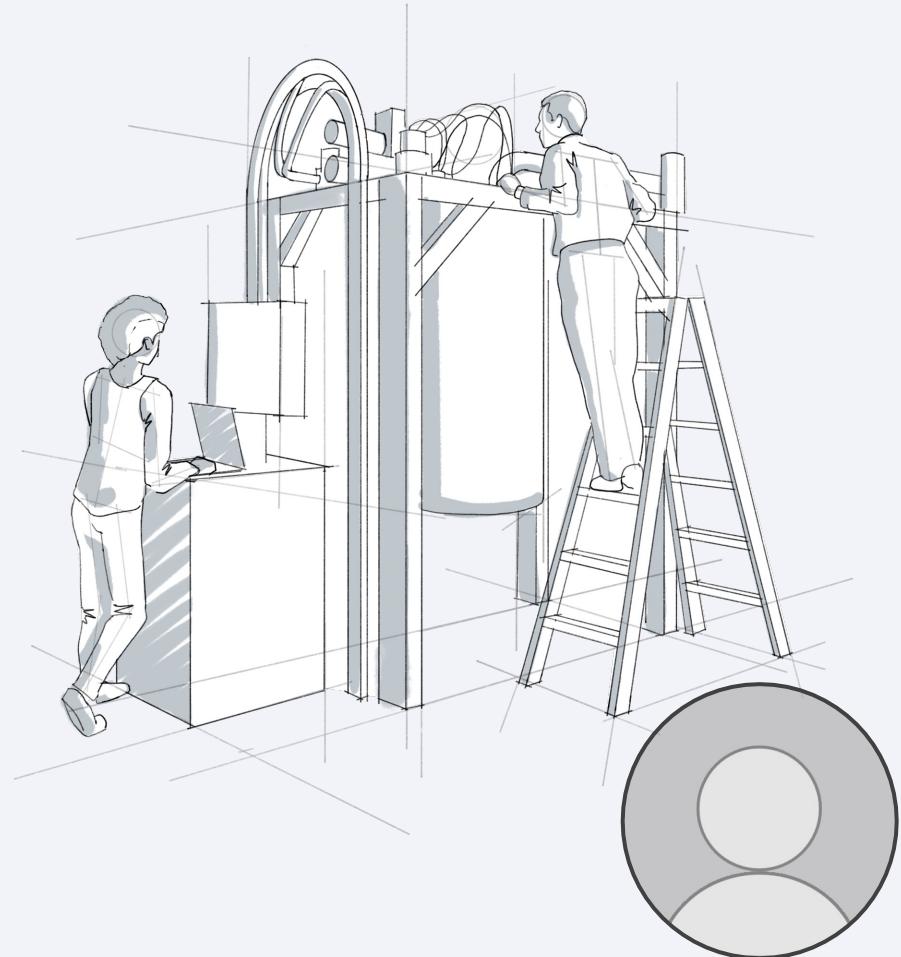
# Contributing



Since launching in Mar 2017

Qiskit has enabled

**1400+**  
**research**  
**papers\***



\*based on the usage of IBM Quantum systems

# Access to a wide range of quantum systems



IBM Quantum Services

View the availability and details of IBM Quantum programs, systems, and simulators.

Programs Systems Simulators

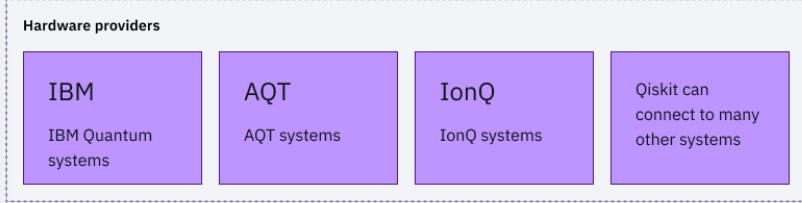
IBM Quantum systems combine world-leading quantum processors with cryogenic components, control electronics, and classical computing technology. [Learn more →](#)

Search by system name

All systems (22) Card Table

System	Processor type	Qubits	QV	CLOPS
ibmq_washington	Eagle r1	127	64	850
ibmq_brooklyn	Hummingbird r2	65	32	1.5K
ibmq_kolkata	Falcon r5.11	27	128	2K
ibmq_montreal	Falcon r4	27	128	2K
ibmq_mumbai	Falcon r5.1	27	128	1.8K
ibmq_cairo	Falcon r5.11	27	64	2.4K
ibmq_auckland	Falcon r5.11	27	64	2.4K
ibmq_hanoi	Falcon r5.11	27	64	2.3K
ibmq_toronto	Falcon r4	27	32	1.8K
ibmq_peeksill	Falcon r8	27		
ibmq_guadalupe	Falcon r4P	16	32	2.4K
ibmq_perth	Falcon r5.11H	7	32	2.9K
ibmq_lagos	Falcon r5.11H	7	32	2.7K
ibmq_nairobi	Falcon S.11H	7	32	2.6K
ibmq_jakarta	Falcon r5.11H	7	16	2.4K
ibmq_manila	Falcon r5.11L	5	32	2.8K
ibmq_bogota	Falcon r4L	5	32	2.3K
ibmq_santiago	Falcon r4L	5	32	
ibmq_quito	Falcon r4T	5	16	2.5K
ibmq_belem	Falcon r4T	5	16	2.5K
ibmq_ilma	Falcon r4T	5	8	2.7K
ibmq_armonk	Canary r1.2	1	1	

IBM Quantum / © 2022 IBM Corporation



## Cross-platform support

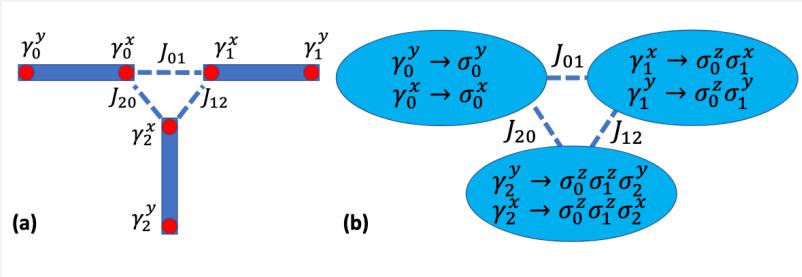
- Superconducting:** IBM Quantum, Rigetti
- Trapped ions:** AQT, IonQ, Quantinuum (Honeywell)
- Spin qubits:** Quantum Inspire
- Cold atoms:** Qiskit Cold Atom provider
- Platform:** Azure Quantum, Amazon Braket
- Simulator:** cuQuantum (NVIDIA)

# Qiskit Pulse for pulse-level control

With pulses, you can dig deep into the heart of a quantum device and study the system as if you were physically present in the lab.

## Highlight

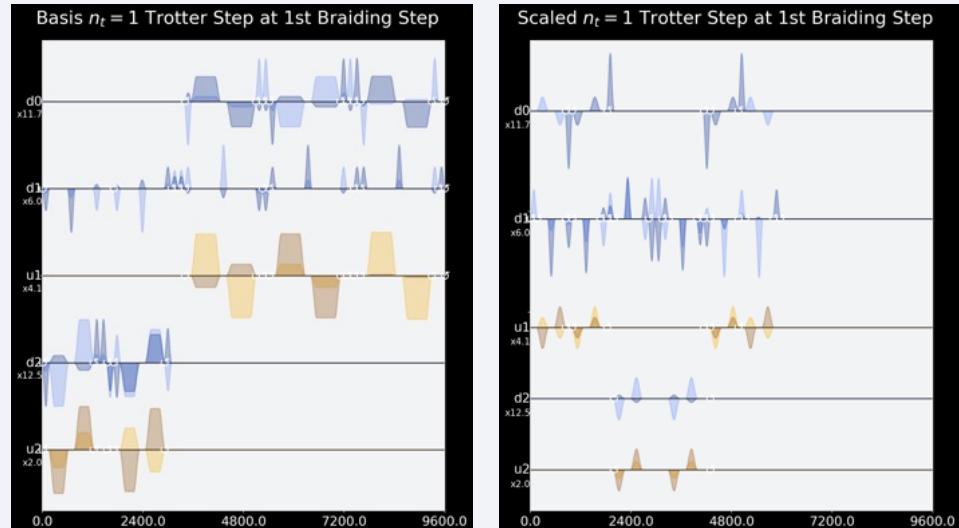
- Simulating the dynamics of braiding of Majorana zero modes using an IBM Quantum computer with Qiskit Pulse [arXiv:2012.11660](https://arxiv.org/abs/2012.11660)
- Qiskit Pulse allowed the authors to overcome the device's noise with specially-crafted controlled gates.



**Core Capabilities**

**Qiskit Terra**

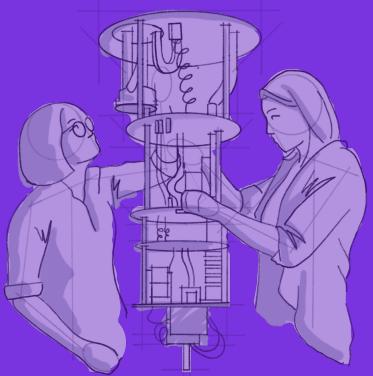
For building and transforming quantum circuits and operators at the level of gates or pulses.



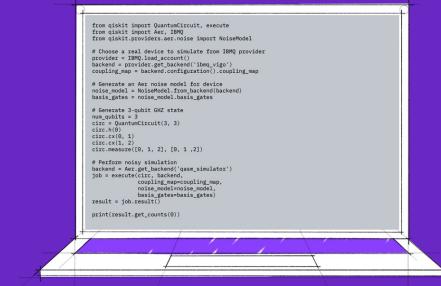
# Learning



# Researching



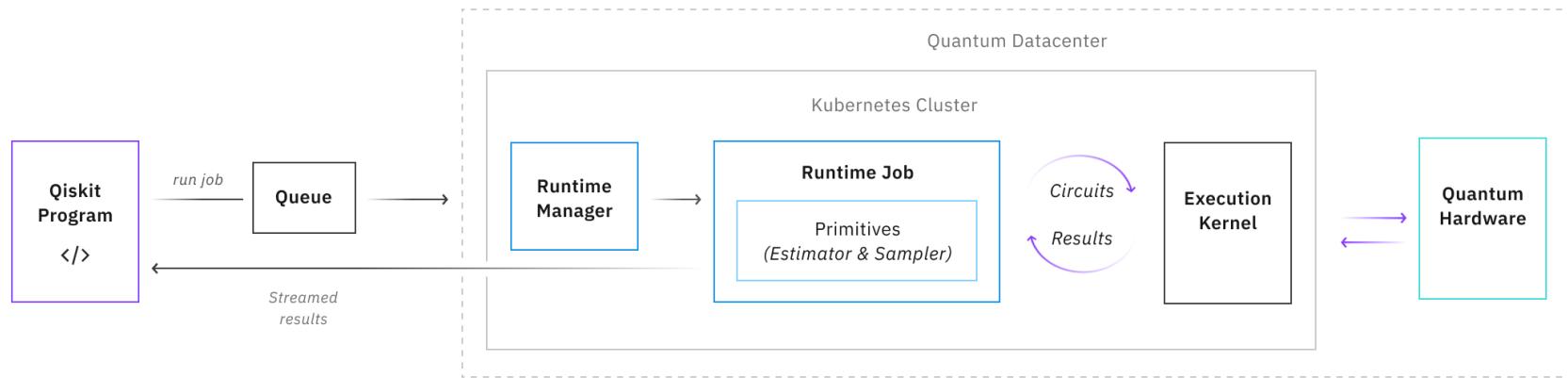
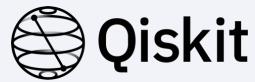
# Developing



# Contributing



# Qiskit Runtime



Qiskit Runtime is a quantum computing service and programming model that allows users to optimize workloads and efficiently execute them on quantum systems at scale. The programming model extends the existing interface in Qiskit with a set of new primitive programs.

# Qiskit application modules

## Qiskit Nature

For applications relating to simulating quantum mechanical systems and natural phenomena.

## Qiskit Finance

For applications relating to financial modeling.

## Qiskit Optimization

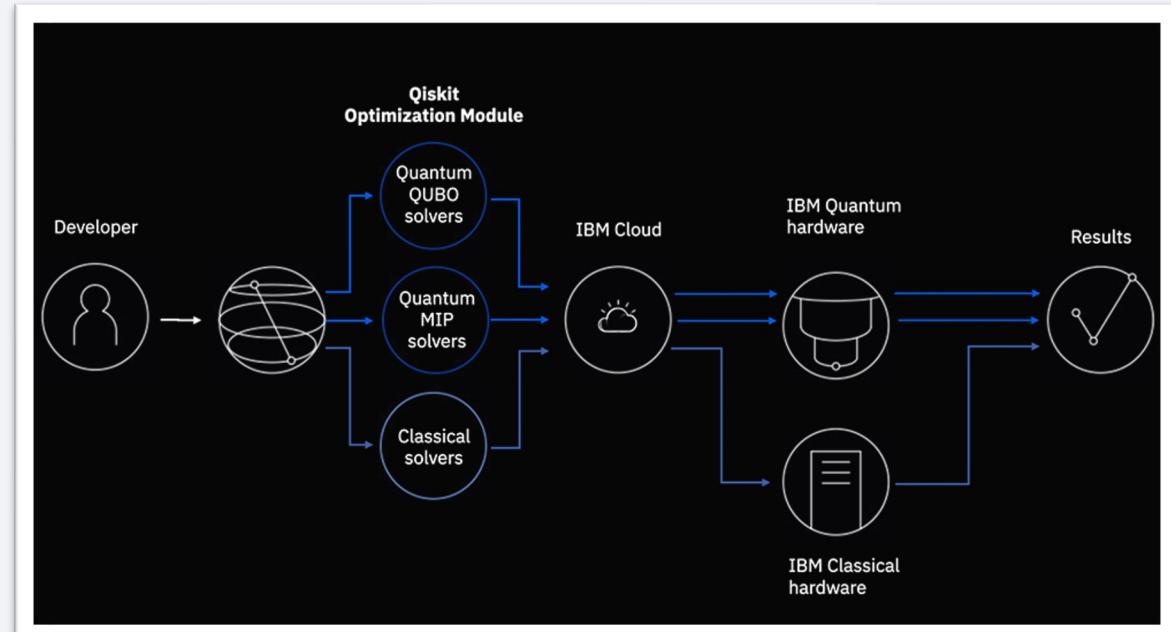
For applications relating to optimization problems.

## Qiskit Machine Learning

For applications relating to machine learning.

## Frictionless development vision:

a programming environment where the intricacies of the underlying technology are no longer a concern to users



# Qiskit Ecosystem

[qiskit.org/ecosystem](https://qiskit.org/ecosystem)

The Ecosystem consists of projects, tools, utilities, libraries and tutorials from a broad community of developers and researchers.

Explore  
*community*

from Qiskit and the Qiskit  
community

## Ecosystem Resources

The Ecosystem consists of projects, tools, utilities, libraries and tutorials from a broad community of developers and researchers. The goal of the Ecosystem is to celebrate, support and accelerate development of quantum technologies using Qiskit.

[Join the ecosystem](#)

### Tier

- Main
- Community
- Prototypes

c3

Apache-2.0 License

The C3 package is intended to close the loop between open-loop control optimization, control pulse calibration, and model-matching based on calibration data.

[Go to repo](#)

▼ [Test Results](#) (06/12/2021, 16:20:05)

mitiq

Apache-2.0

Mitiq is a Python toolkit for implementing error mitigation techniques on quantum computers

[Go to repo](#)

▼ [Test Results](#) (11/01/2022, 22:09:52)

quantuminspire

Apache-2.0

platform allows to execute quantum algorithms using the cQASM language.

[Go to repo](#)

▼ [Test Results](#) (11/01/2022, 22:09:52)

quantumcat

Apache 2.0

quantumcat is a platform-independent, open-source, high-level quantum computing library, which allows the quantum community to focus on developing platform-independent quantum applications without much effort

[library](#) [COMMUNITY](#)

qiskit-superstaq

Apache-2.0 License

This package is used to access SuperstaQ via a Web API through Qiskit. Qiskit programmers can take advantage of the applications, pulse level optimizations, and write-once-target-all features of SuperstaQ with this package.

[Go to repo](#)

▼ [Test Results](#) (11/01/2022, 22:09:52)

kaleidoscope

Apache-2.0 License

Kaleidoscope

[Go to repo](#)

▼ [Test Results](#) (11/01/2022, 22:09:52)

qtcodes

Apache-2.0 License

Qiskit Topological Codes

[Go to repo](#)

▼ [Test Results](#) (11/01/2022, 22:09:52)

pyEPR

BSD 3-Clause New or Revised license

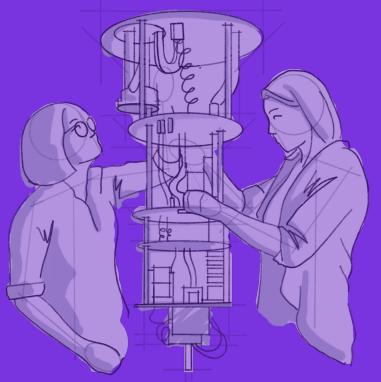
Qiskit Metal E&M analysis with Ansys and the energy-participation-ratio method is based on pyEPR.

[Go to repo](#)

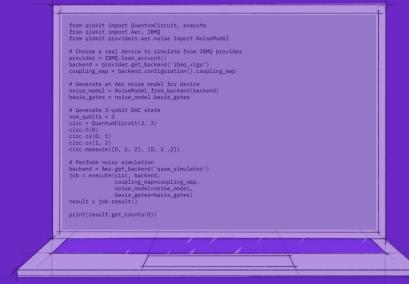
# Learning



# Researching



# Developing



# Contributing



Can I contribute to Qiskit? **Yes**

But I don't have a PhD, can I still contribute? **Yes!**

But I'm not good at math/physics, can I still contribute? **Yeap**

But I'm not a Python dev, more a JS/Rust/ObscureLang gal, can I still contribute? **Actually, yes**

But I've never contributed to open source before, can I still contribute? **~~Oh, in that case, no~~**

***Just kidding, YES!***

# Choose your GitHub repo

## Python

- qiskit-terra
- Application modules
  - qiskit-aer
  - qiskit-optimization
  - qiskit-finance
  - qiskit-machine-learning
- qiskit-experiments

# qisk.it/good-first-issues

# qisk.it/help-wanted

## Rust

- rustworkx

## C++

- qiskit-aer

(JS, Vue, Typescript)

- qiskit.org
- platypus (textbook)

**Support the wider  
community**  
[qisk.it/support](https://qisk.it/support)

Documentation  
[qiskit.org/documentation](https://qiskit.org/documentation)

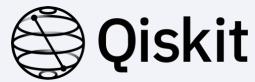
Research papers  
[qiskit.org/ecosystem](https://qiskit.org/ecosystem)

Bug reports  
Feature requests  
Reproduce issues

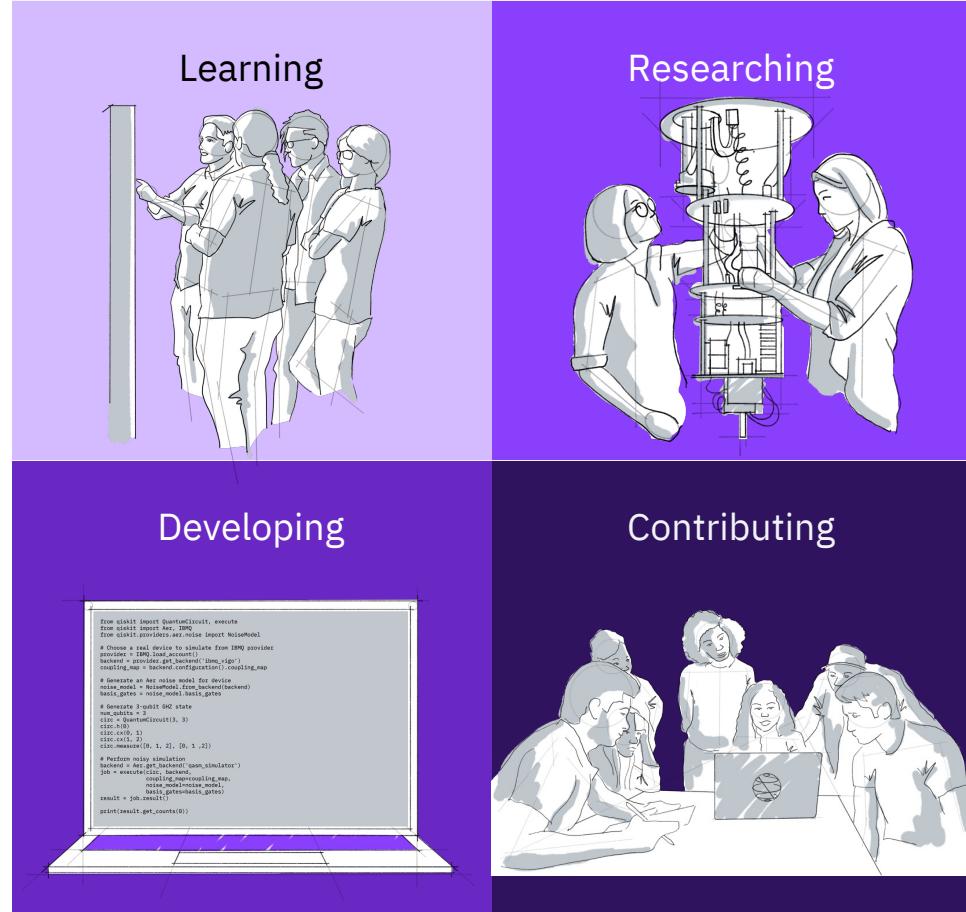
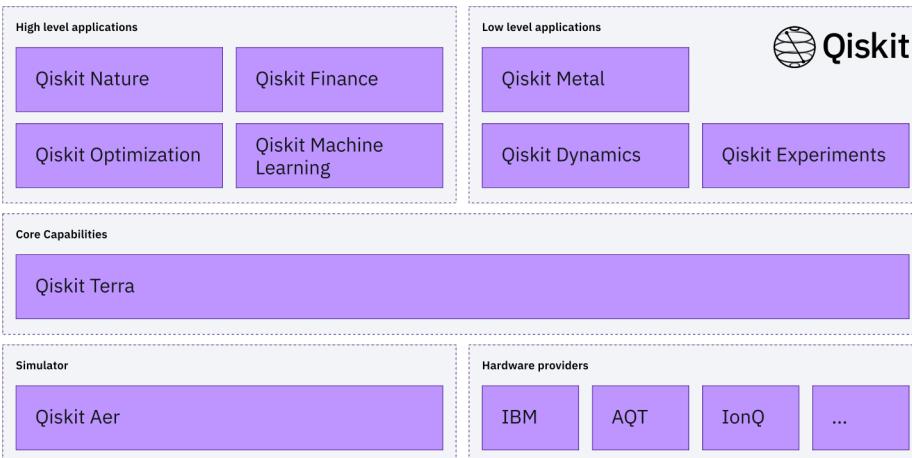
# Tips for Open Source newbies!

- Read the contributing guidelines  
[qiskit.org/documentation/contributing\\_to\\_qiskit.html](https://qiskit.org/documentation/contributing_to_qiskit.html)
- Check if an issue/PR already exists for your problem before opening a new one
- Look for “good first issues” and “help wanted” labels
- Ask to be assigned to an issue before starting work on it
- Don’t be shy, be kind – read [qisk.it/coc](https://qisk.it/coc) !
- Be patient!

# Summary



# What is Qiskit?



# Thank you

Slides are available on:

<https://github.com/qiskit-community/qiskit-presentations/>

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[YouTube](#)



[Slack](#)



[Medium](#)

