Qiskit Fall Fest 2025

# Introduction to Quantum Dynamic Circuits

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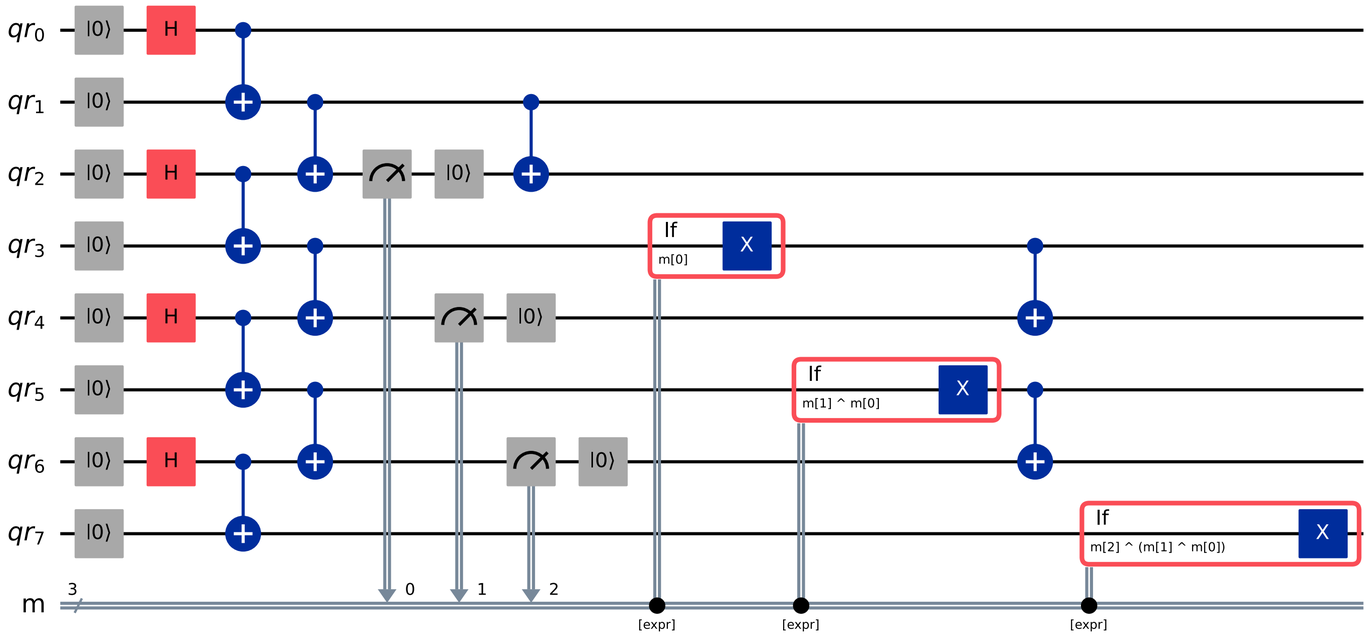
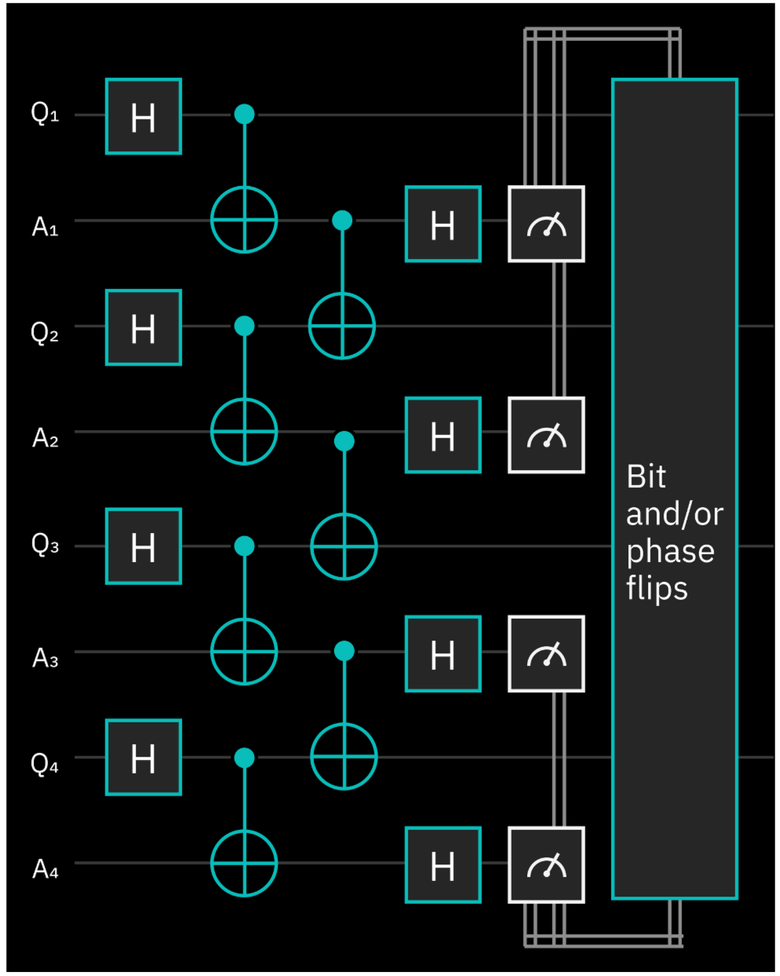
# What are Quantum Dynamic Circuits?


- Quantum circuits that *adapt during execution* based on measurement outcomes.
- Combine **quantum operations** and **real-time classical control**.
- Enable **conditional logic**, **feedback**, and **adaptive measurements**.



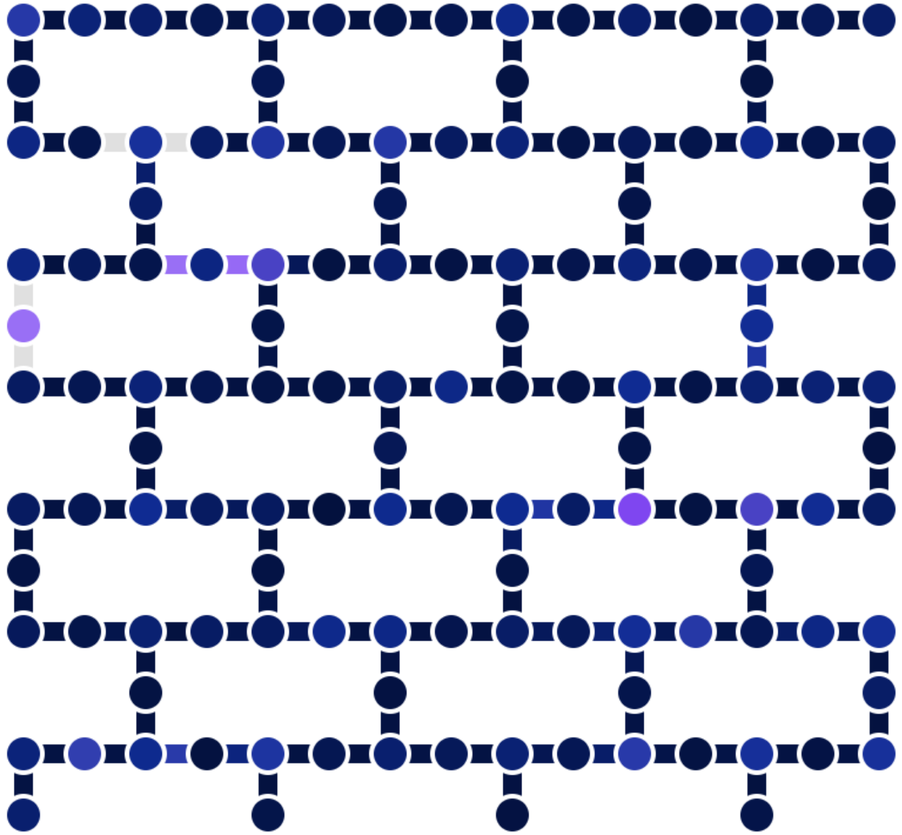
# Why works with this method?

- Go beyond the limitations of static circuits.
- Essential for:
  - Quantum error correction
  - Quantum teleportation
  - Variational and hybrid algorithms
- Allow interaction between quantum and classical layers *within the same execution*.



# The problem?

- Hardware limitations in terms of noise and connectivity for each qubit make this more complicated.
- The goal is to reduce depth and the number of gates.



# The Noise


- Understand the characteristics of the Quantum processors
- Everything has a limitation.

## ibm_brisbane

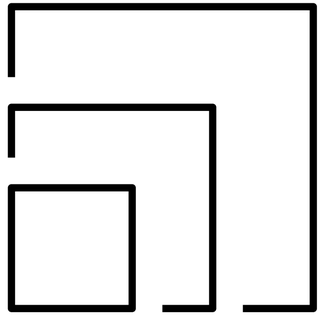
**Details**

| Qubits | 2Q error (best) | 2Q error (layered) | CLOPS |
|---|---|---|---|
| 127 | 3.29E-3 | 1.88E-2 | 180K |

| Status | Region | Total pending jobs | Processor type |
|---|---|---|---|
| Online | Washington DC (us-east) | 402 | Eagle r3 |

| Basis gates | Median ECR error | Median SX error | Median readout error |
|---|---|---|---|
| ecr, id, rz, sx, x | 6.913E-3 | 2.356E-4 | 1.66E-2 |

| Median T1 | Median T2 |
|---|---|
| 226.41 us | 133.05 us |



Quantum Software
(powered by Qiskit Addons and Qiskit Functions)

+

Qiskit

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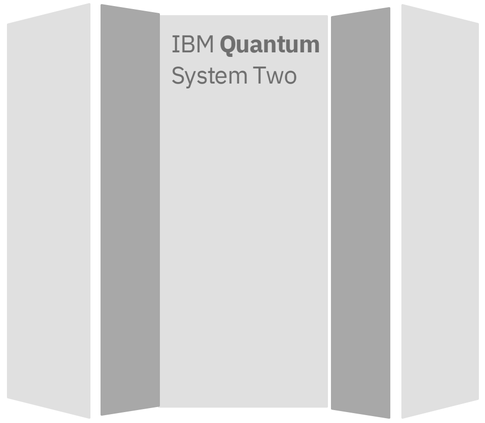



QPUs

=

Useful Work

The IBM Quantum platform unlocks research with quantum

# Qiskit Classical Expressions


## Expressions

The expression system is based on tree representation

## Construction

Constructing the tree representation directly is verbose and easy to make a mistake with the typing.

## Typing

Types should be considered immutable objects, and you must not mutate them.

# Examples


```
from qiskit.circuit import Clbit
from qiskit.circuit.classical import expr
```

operator

Input type

```
expr.logical_and(Clbit(), Clbit())
Binary(Binary.Op.LOGIC_AND, Var(<clbit 0>, Bool()), Var(<clbit 1>, Bool()), Bool())
```

# Examples

```
qr = QuantumRegister(3)
cr = ClassicalRegister(2)
qc = QuantumCircuit(qr,cr)

qc.h(0)
qc.h(1)
```

Mid measurement → `qc.measure(qr[:2],cr[:2])`

Expression → `control = expr.bit_and(cr[0], cr[1])`

Condition and the changes on the QC →

```
with qc.if_test(expr.logic_not(control)):
    qc.x(0)
    qc.x(1)
```

Final measurement → `qc.measure(qr[:2],cr)`

# Next steps!

# IBM Quantum Summer Internship Program

Work across the entire IBM Quantum team, from programming to materials research, on real projects that matter.

Applications open in the fall and continue through winter for different roles globally.

IBM Quantum interns, class of 2023

# Qiskit Advocates Program

A global cohort of 1000+ of the strongest Qiskit Community members who receive support, exclusive opportunities, mentorship, and much more from IBM Quantum

## Mentorship

Advocates create long-lasting relationships with IBMers and industry experts via long-term collaborative mentorship projects, contributed to the open source community

## Networking

Advocates are invited to join a group of quantum experts, who routinely share opportunities and updates from around the world

## Events

Advocates travel to conferences, present at community engagements, host their own events, and mentor others through hackathons and quantum challenges

## Recognition

Advocates are seen by many as the strongest members of the field, thanks to the Qiskit Developer Certification, community contributions, and success of the group at large

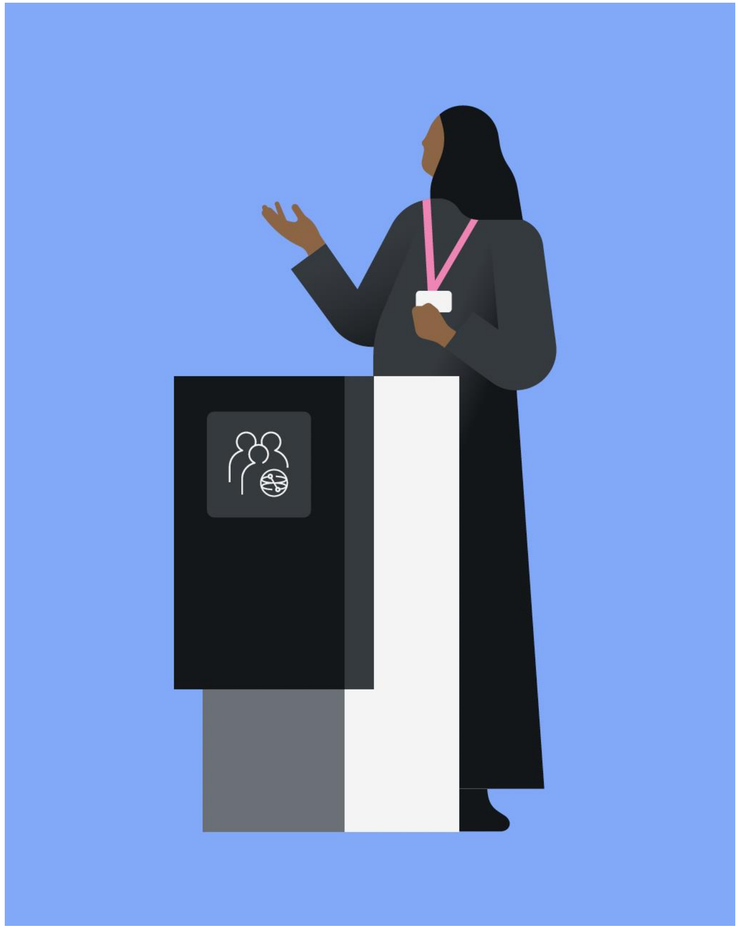
# What is the Qiskit advocate program?

**Join 1000+ Qiskit Advocates across 50 countries in advancing quantum computing education and community.**

The Qiskit advocate program is an external, global initiative that empowers and enables aspiring leaders in the Qiskit open-source community.

Qiskit advocates enhance their professional growth by:

- Building meaningful connections with quantum experts and peers
- Gaining exclusive access to Qiskit education and events
- Getting unique opportunities to contribute to quantum computing advancement
- Making open-source contributions and sharing knowledge through mentorship
- Participating in Qiskit events, networking, and quantum research and so much more.

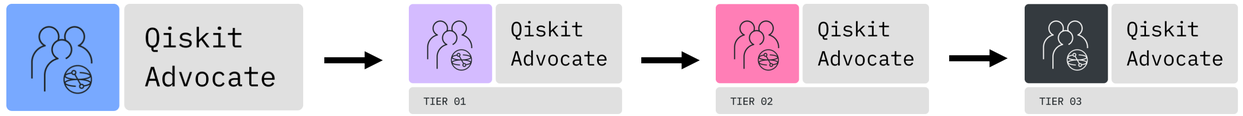


**Perfect for:** Students, software developers, quantum researchers, educators, and anyone looking to upskill and advance their career in quantum computing.

# What do Qiskit advocates do?

Activities:

- Give talks and presentations on Qiskit at events and conferences
- Contribute to the Qiskit SDK and Qiskit Ecosystem projects
- Mentor participants in flagship events and host events in your local community
- Provide feedback on Qiskit and IBM Quantum tools as active users
- Collaborate with advocates globally
- Earn points through community contributions to advance through program tiers




For more information, see:
[ibm.com/quantum/community#advocates](ibm.com/quantum/community#advocates)



# Ready to get started?

Applications open mid-year. Register your interest in applying to the program here:

Eligibility & How to Join:

- Open to quantum enthusiasts worldwide*
- Strongly recommended to complete: Basics of Quantum Information and Quantum Computing in Practice courses offered for free by IBM
- Register above to stay updated with eligibility criteria and hear when applications open

If you are an existing advocate:

- Find an invitation to the new program in your email
- OR if you have not received this email, get back in contact via [ibm.com/quantum/community#advocates](ibm.com/quantum/community#advocates)

* Applicants must also be at least 18 years of age and not usually residing in any of the unavailable countries as listed at quantum.ibm.com/terms