Qiskit Fall Fest 2025: Running a Quantum and Qiskit 101 session

Vishal Sharathchandra Bajpe
Quantum Algorithms Engineer
IBM

Audience takeaway – Aim to:

- Spark an inspiration to embark on a quantum journey

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- Provide a hands-on starting point.

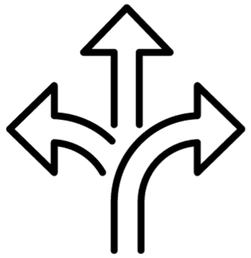
Not a
Qiskit/Quantum
101 lecture!

Audience takeaway – Aim to:

- Spark an inspiration to embark on a quantum journey

- Provide a hands-on starting point.

What will we look at today?

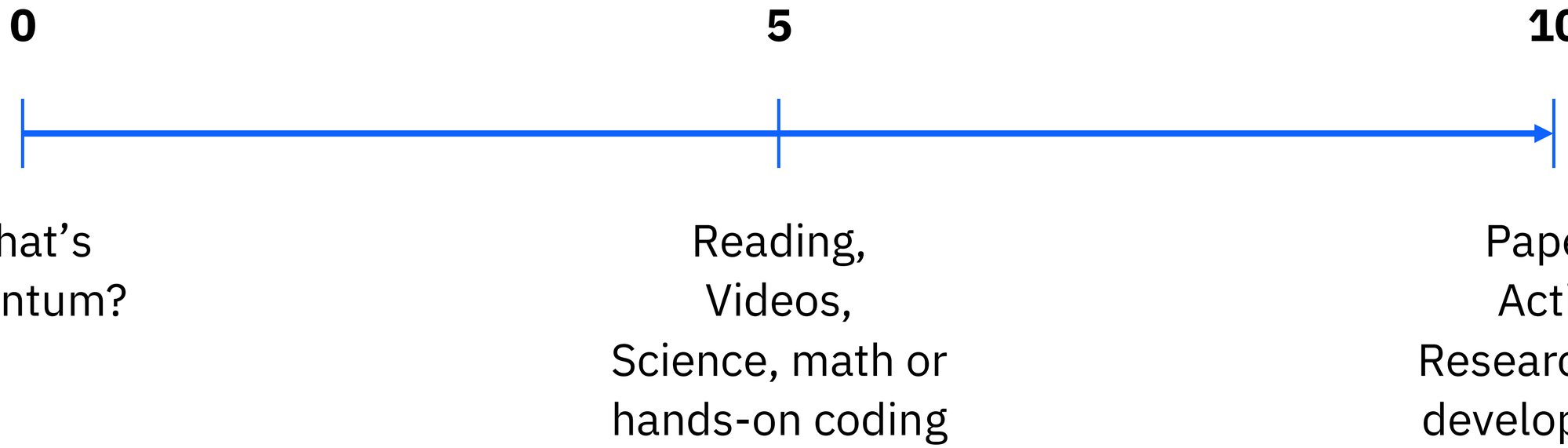


Some pathways to consider

Accompanying resources to save time

Let’s Begin!

Where are your participants on their Quantum journey?



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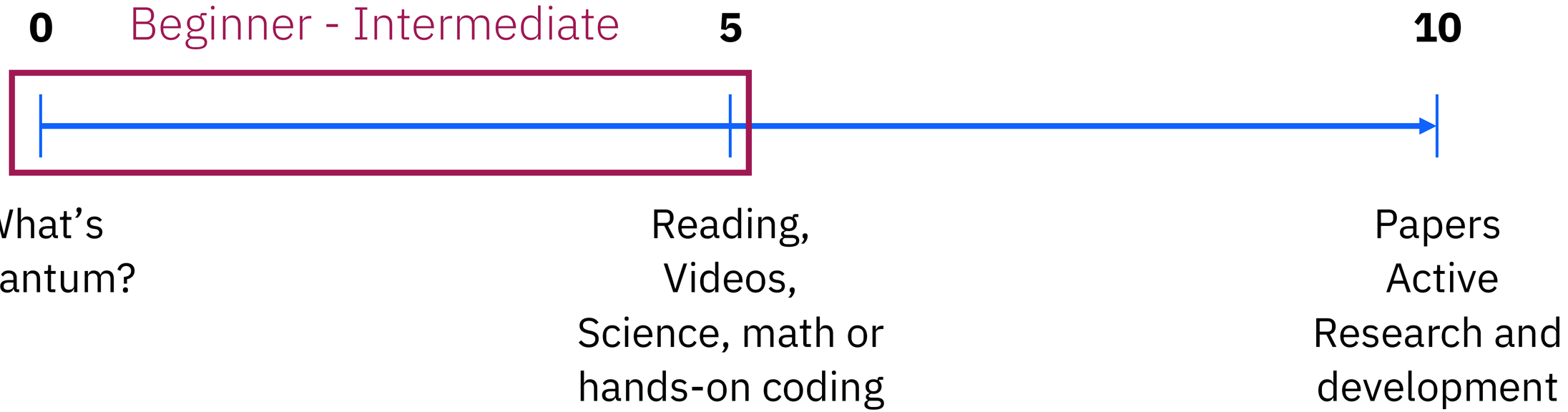

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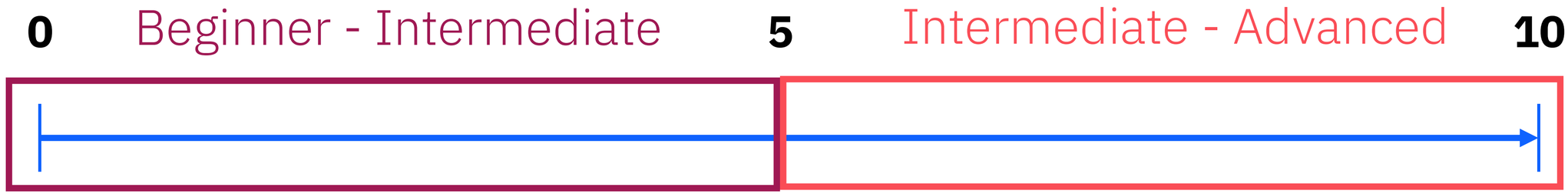

What's Quantum?

Reading, Videos, Science, math or hands-on coding

Papers Active Research and development

What are we aiming for?

What are we aiming for?

Build confidence and curiosity

Help participants feel comfortable with quantum concepts and tools and try to spark genuine interest to explore further.

Hands-on first steps

Enable attendees to experience Qiskit SDK, run circuits and see results in action

Set a launchpad

Provide a pathways for participants to continue their journey beyond the session.

Qiskit

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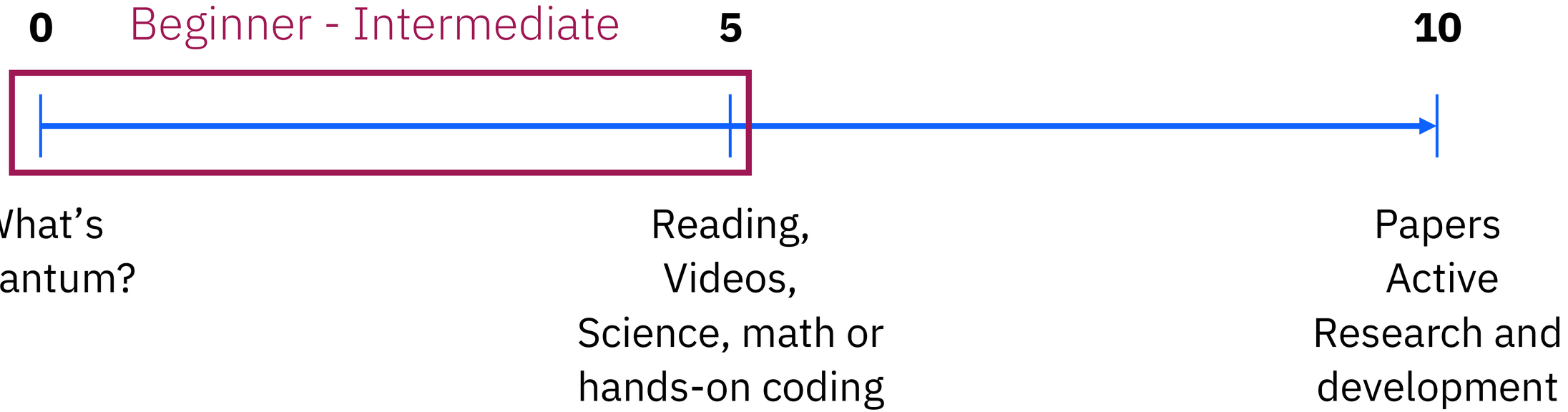


Qiskit Pattern:
The anatomy of a quantum algorithm

01

Map problem instance to quantum circuits and operators

02

Optimize for target hardware execution

03

Execute via Qiskit Runtime

04

Result processing

Map

Optimize

Execute

Post-Process

Qiskit SDK sets the foundation

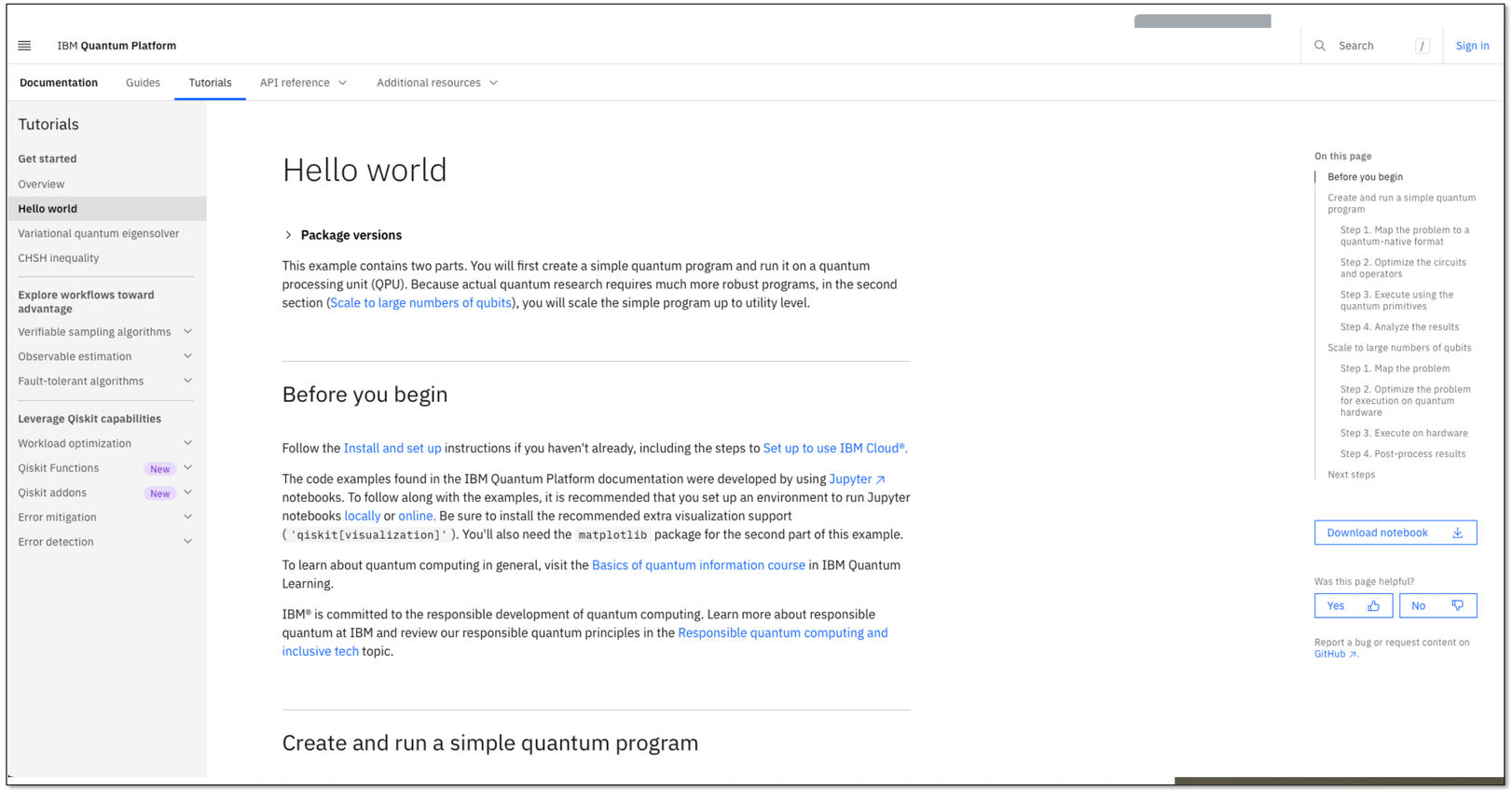
Qiskit SDK gives us a base layer of building blocks for building and running quantum algorithms

Qiskit Circuit Library	Transpiler	Primitives	Quantum Info
Input: Domain inputs	Input: Circuits, observable	Input: ISA circuit, observable	Input: Expectation value/samples
Output: Circuits, observable	Output: ISA circuit, observable	Output: Expectation value/samples	Output: Data objects/visualizations
Map	Optimize	Execute	Post-Process

IBM Quantum Platform

Hello World: A quick **hands on introduction** to running circuits on Qiskit and IBM Quantum platform

Link:
https://quantum.cloud.ibm.com/docs/en/tutorials/hello-world



The Battle of the Install

The Battle of the Install

What we want to avoid?

The Battle of the Install

What we want to avoid?

`pip install … and pray` 🙏

Common pitfalls:

Installation Delays

Setting up Python, Qiskit, and dependencies can eat up lot of valuable hack time if not done beforehand.

Environment Issues

Conflicts between OS, IDEs, or package versions often derail momentum.

Wi-Fi & Access

Large downloads or cloud account sign-ups (IBM Quantum) can slow teams down if left to the last minute.

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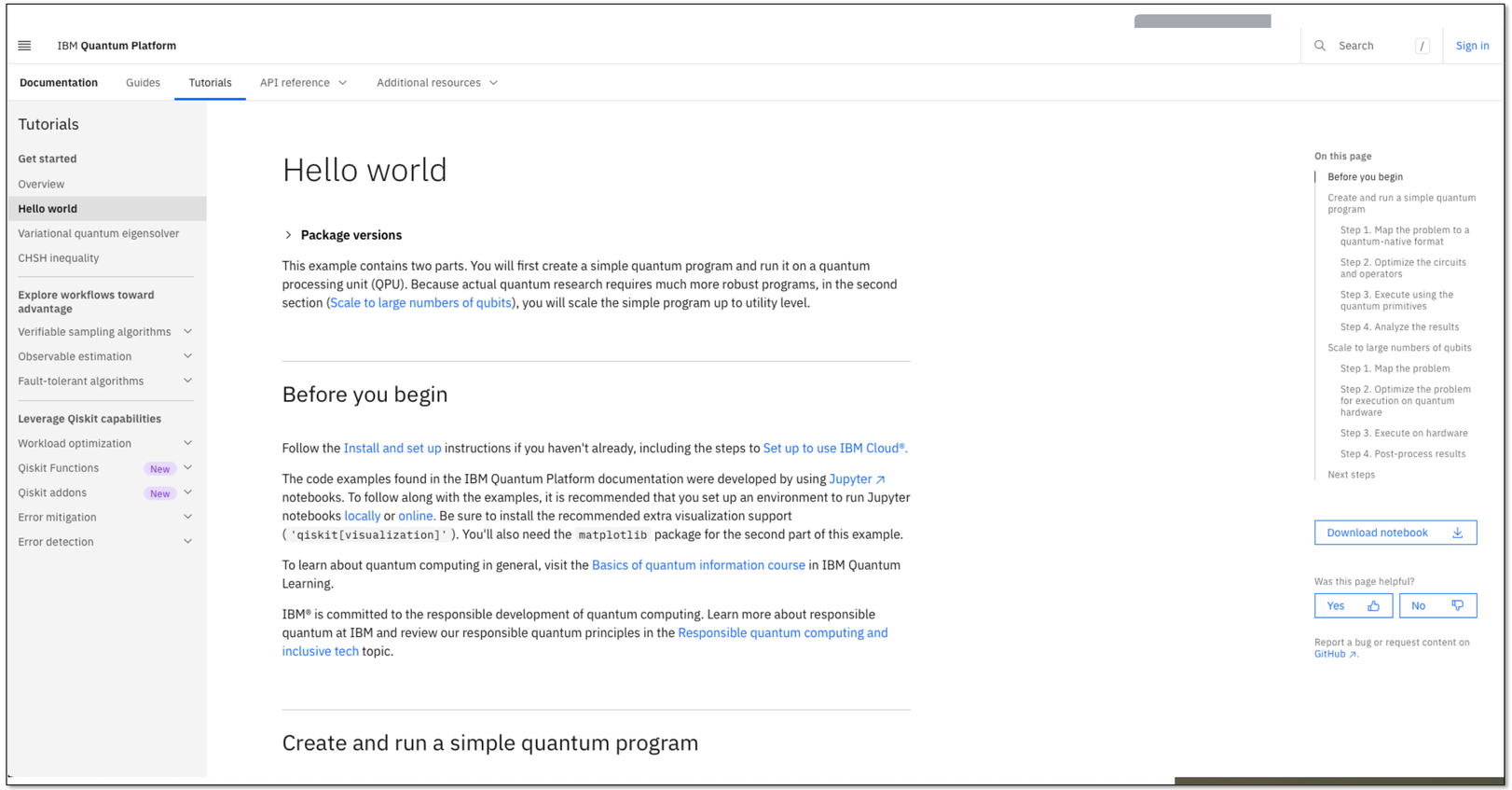

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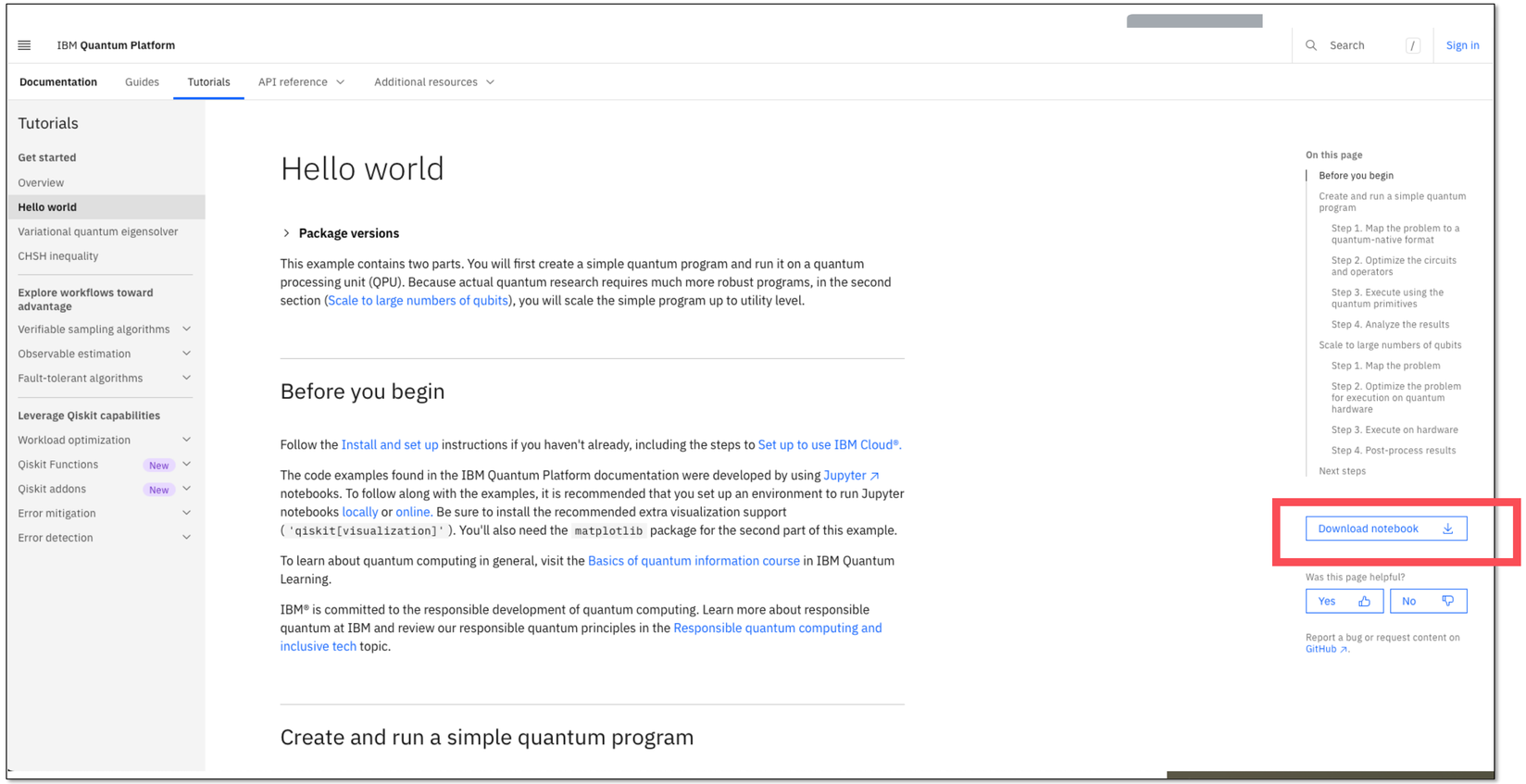


IBM Quantum Platform

Qiskit 101: First steps into quantum computing for a hands-on visual introduction to Qiskit and Quantum gates

Notebook: Will be shared to you

First Step into Quantum Computing

- Difficulties: Beginner
- QPU time usage: 11s

Welcome, hackers! We're thrilled to have you for the workshop. The main goal of this introductory hands-on is to make you ready for your quantum journey by 1) guiding you how to install qiskit 2) how to create IBM Cloud account and prepare `api_key` and `crn` to use a real quantum computer and 3) make your first quantum circuit, 4) solve a quantum state quiz and 5) Run you circuits on the real quantum computer and plot the result.

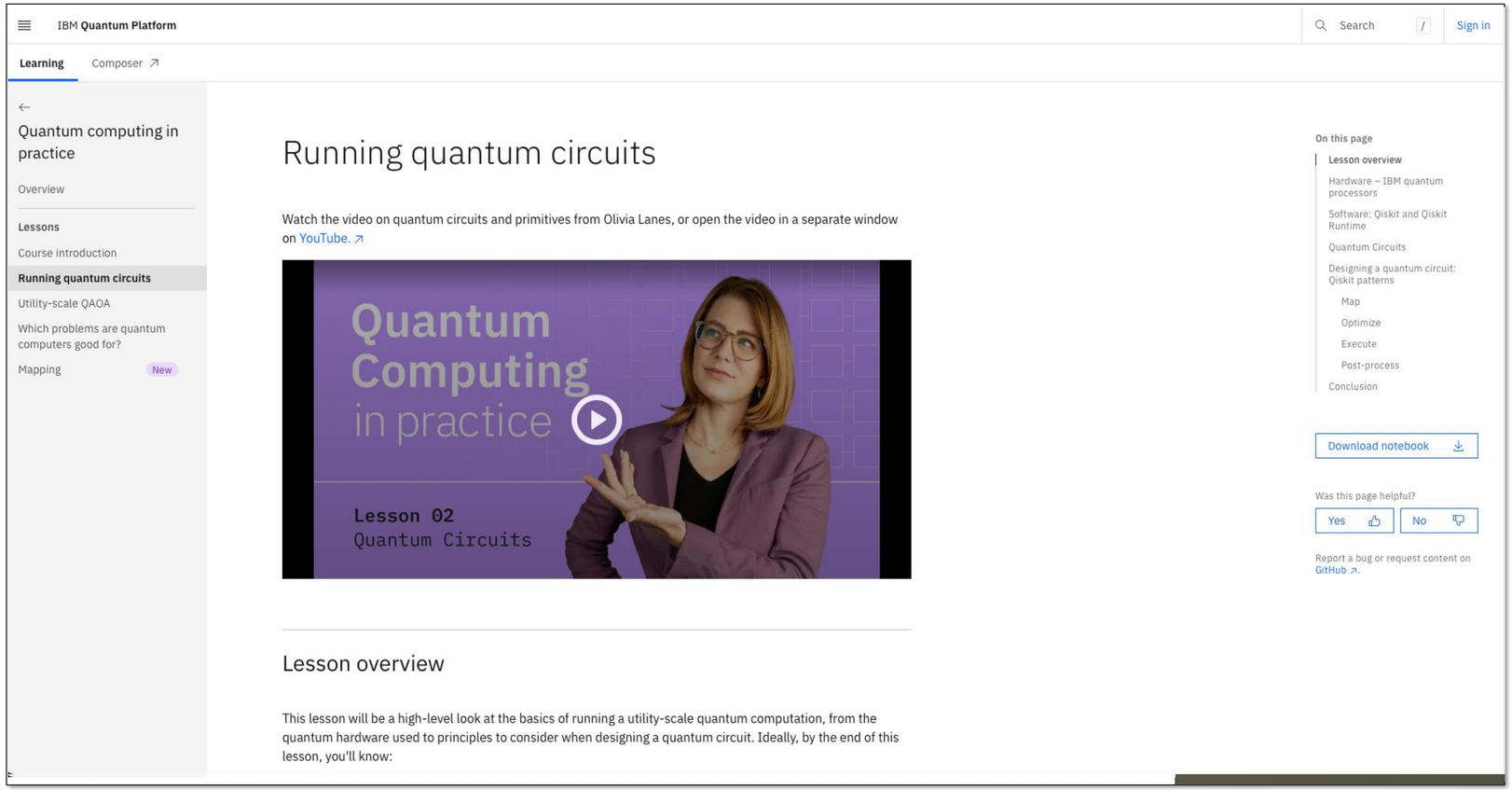
1. First things first: Qiskit

What is Qiskit

IBM Quantum Platform

Running Quantum Circuits: A **descriptive introduction** to running circuits on Qiskit and IBM Quantum platform

Link: https://quantum.cloud.ibm.com/learning/en/courses/quantum-computing-in-practice/running-quantum-circuits

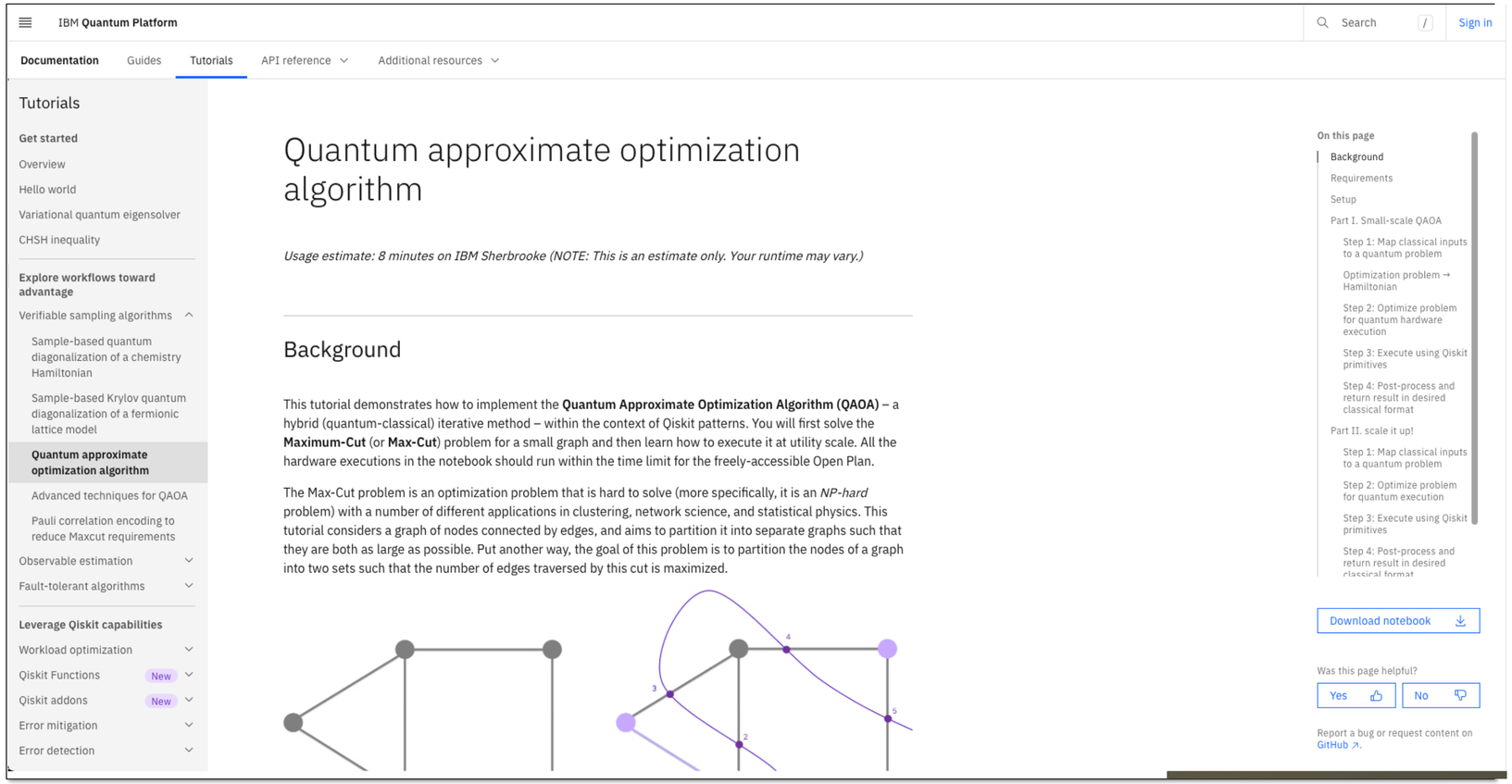


Example workflows

IBM Quantum Platform

Quantum Approximate optimization Algorithm (QAOA) Workflow

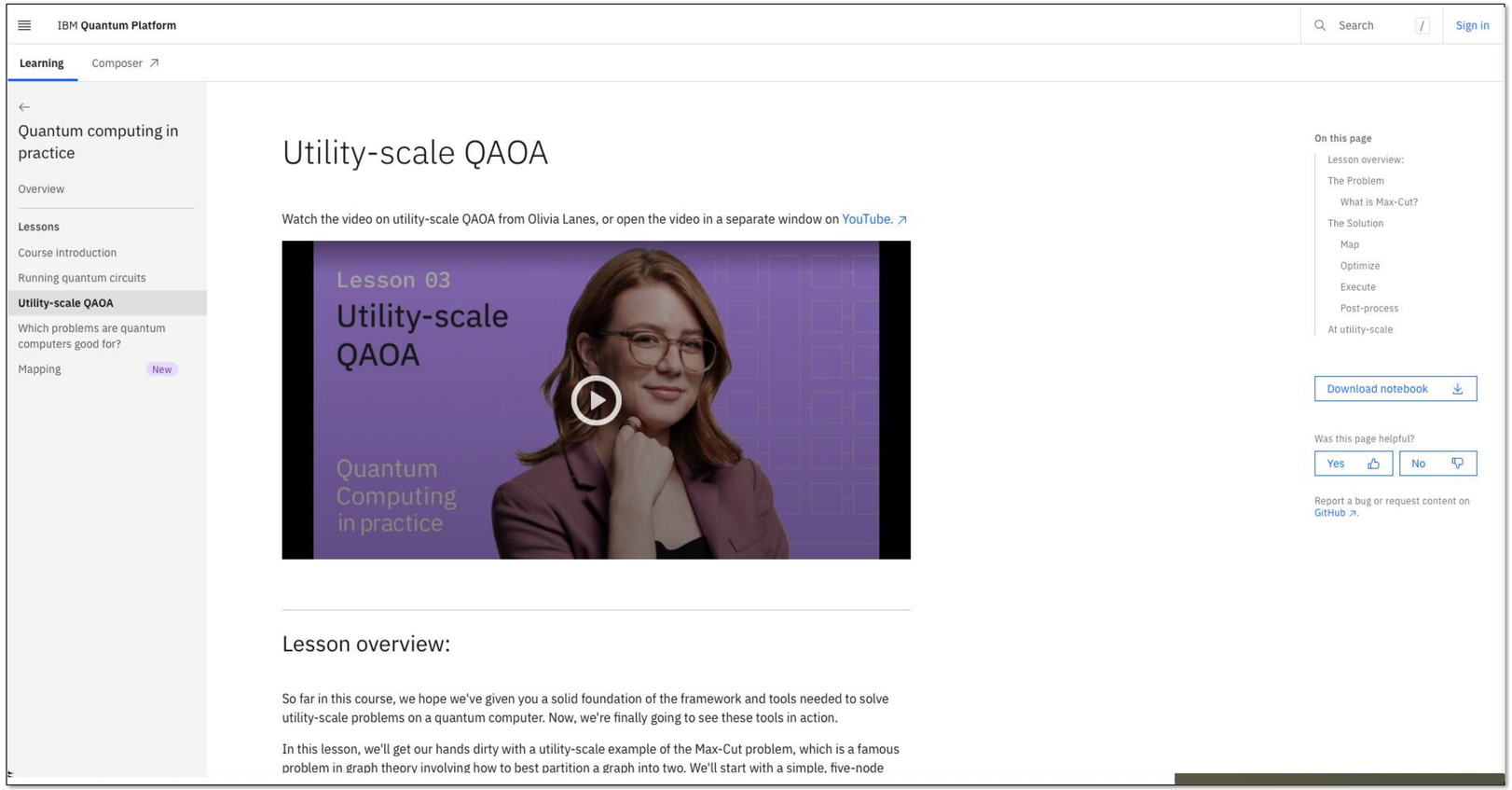
Link: https://quantum.cloud.ibm.com/docs/en/tutorials/quantum-approximate-optimization-algorithm



IBM Quantum Platform

Quantum Approximate optimization Algorithm (QAOA) Workflow walkthrough

Link:
https://quantum.cloud.ibm.com/learning/en/courses/quantum-computing-in-practice/utility-scale-qaoa

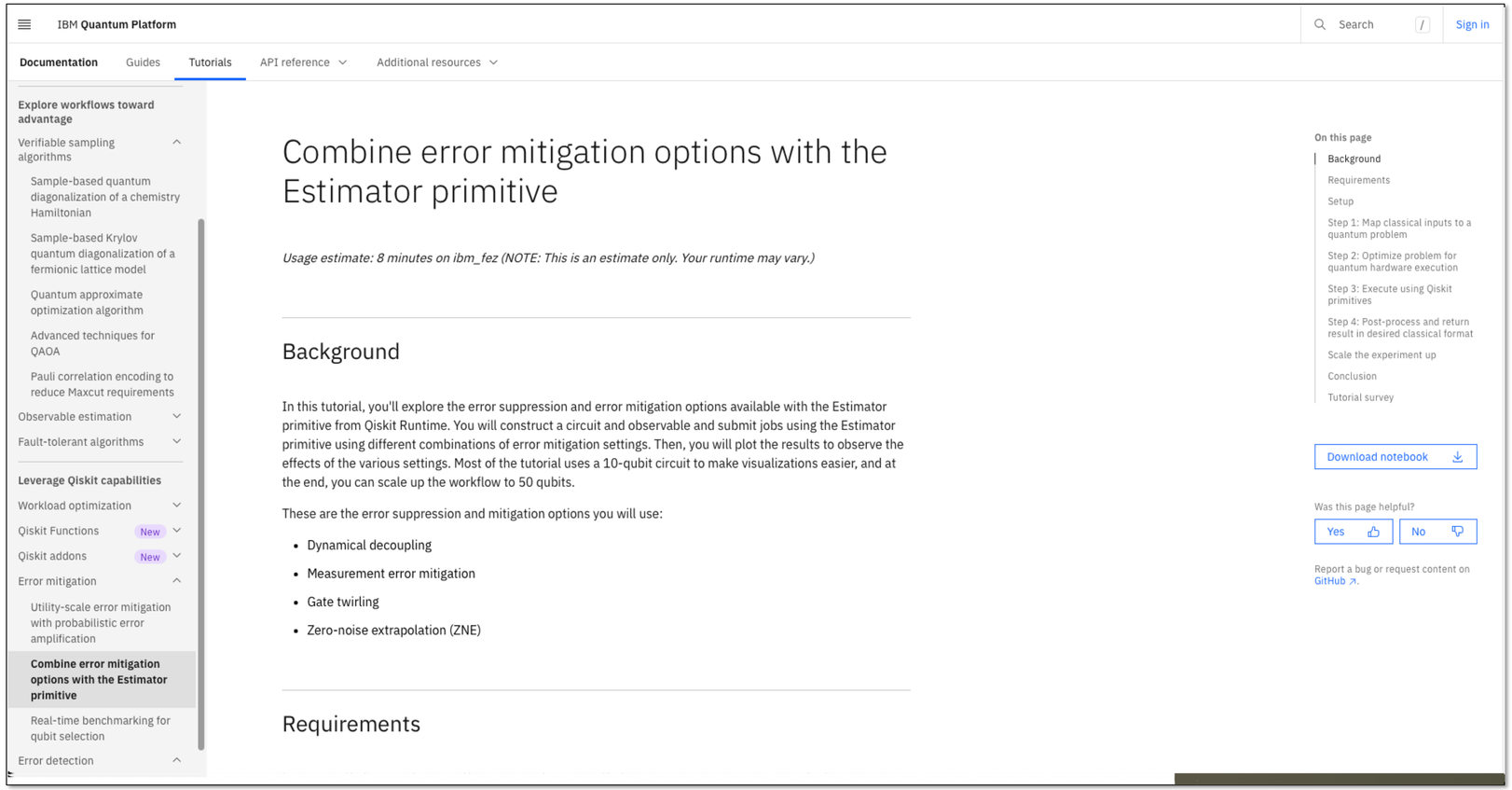


Error Mitigation (optional)

IBM Quantum Platform

Notebook: Combine error mitigation options with the Estimator Primitive

Link: https://quantum.cloud.ibm.com/docs/en/tutorials/combine-error-mitigation-techniques

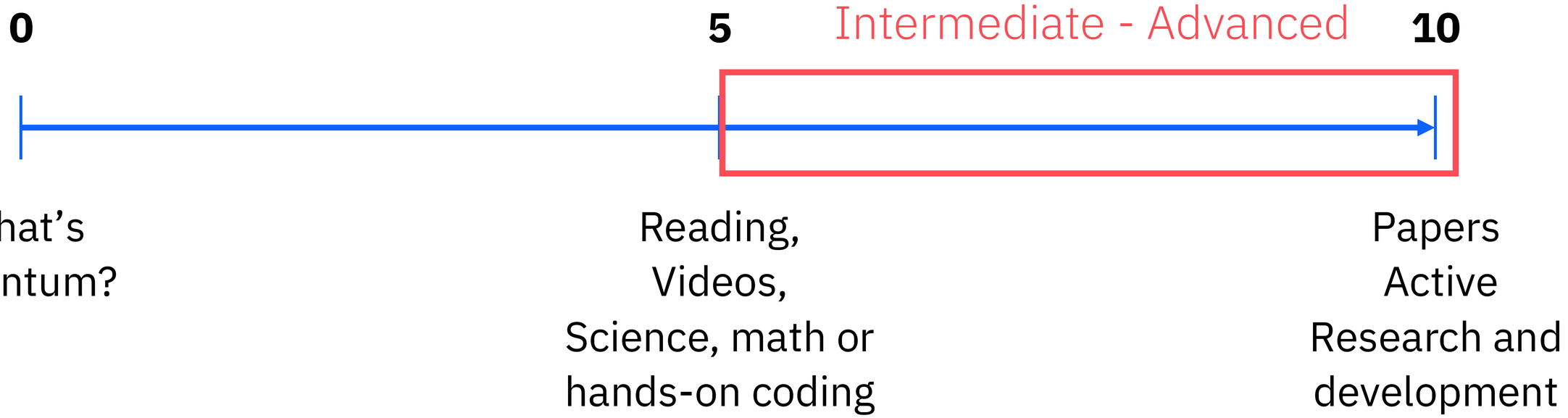


IBM Quantum Platform

Video: Execution on Noisy Quantum Hardware: Fighting errors before Fault Tolerance

Link: https://www.youtube.com/watch?v=l5V8J_yMEis

Where are your participants on their Quantum journey?



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IBM Quantum Platform

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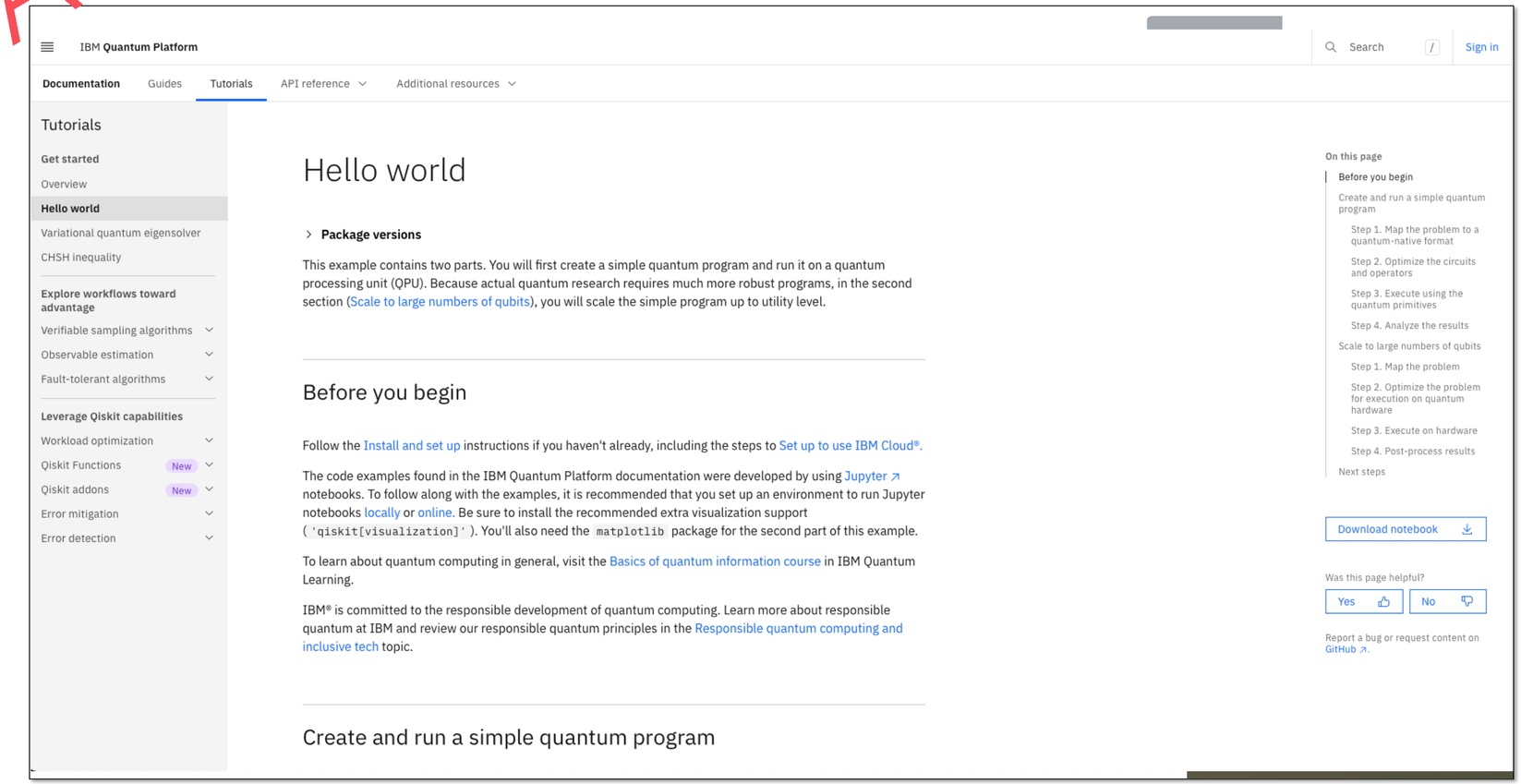

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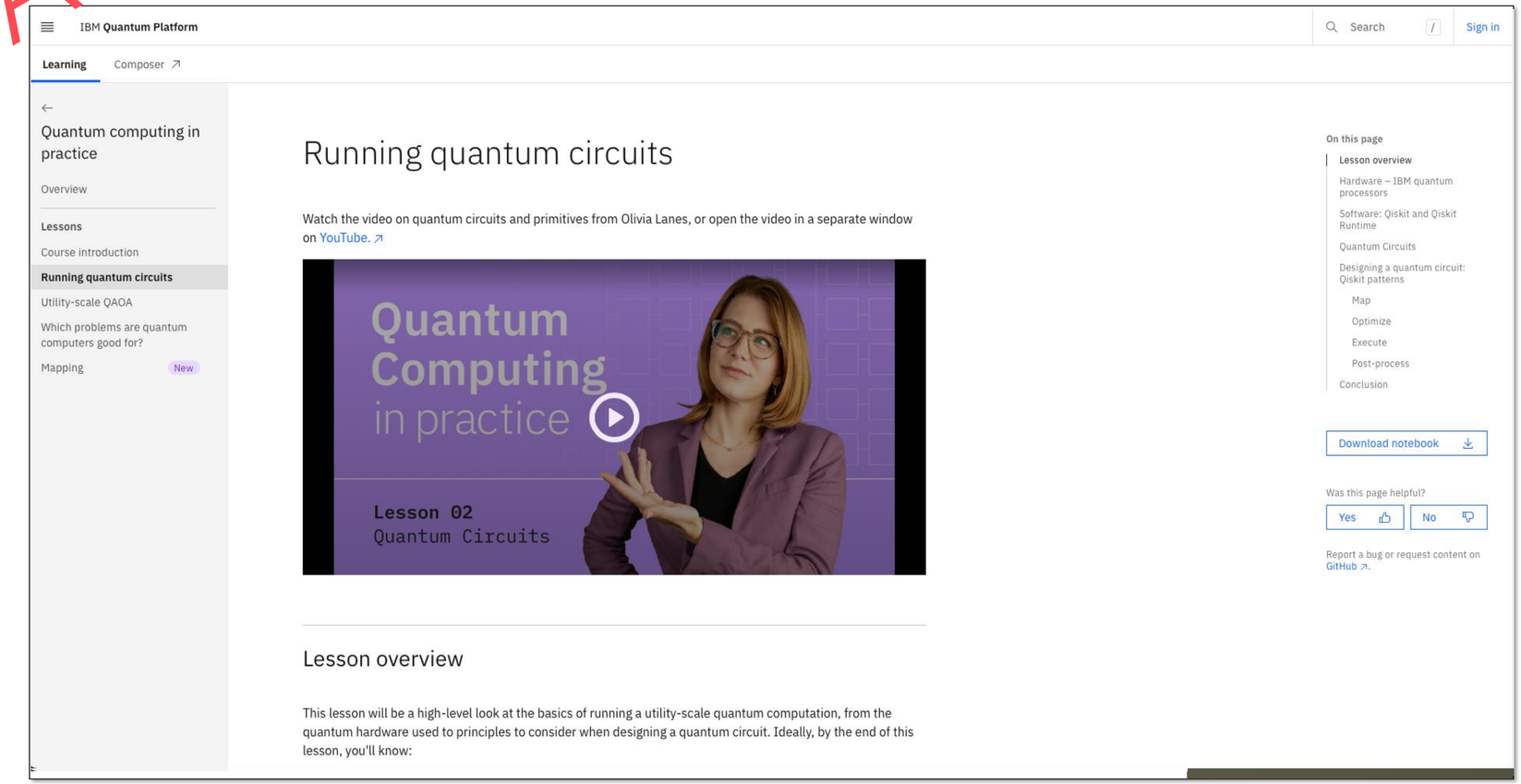
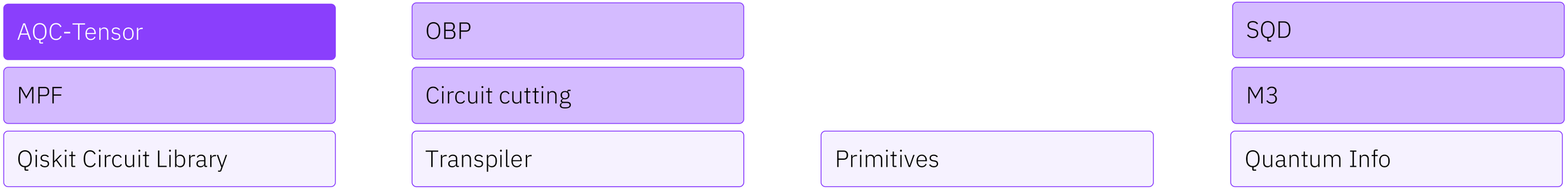


Example workflows

Qiskit addons build on the Qiskit SDK

A collection of research capabilities developed as modular tools that can plug into a workflow to design new algorithms at the utility scale

Starting with multi-product formulas (MPF), approximate quantum compilation (AQC-Tensor), operator backpropagation (OBP), and sample-based quantum diagonalization (SQD).



Input:
Domain inputs

Output:
Circuits, observable

Map

Input:
Circuits, observable

Output:
ISA circuit, observable

Optimize

Input:
ISA circuit, observable

Output:
Expectation value/samples

Execute

Input:
Expectation value/samples

Output:
Data objects/visualizations

Post-Process

Link: https://quantum.cloud.ibm.com/docs/en/guides/addons

Lecture notes: Link

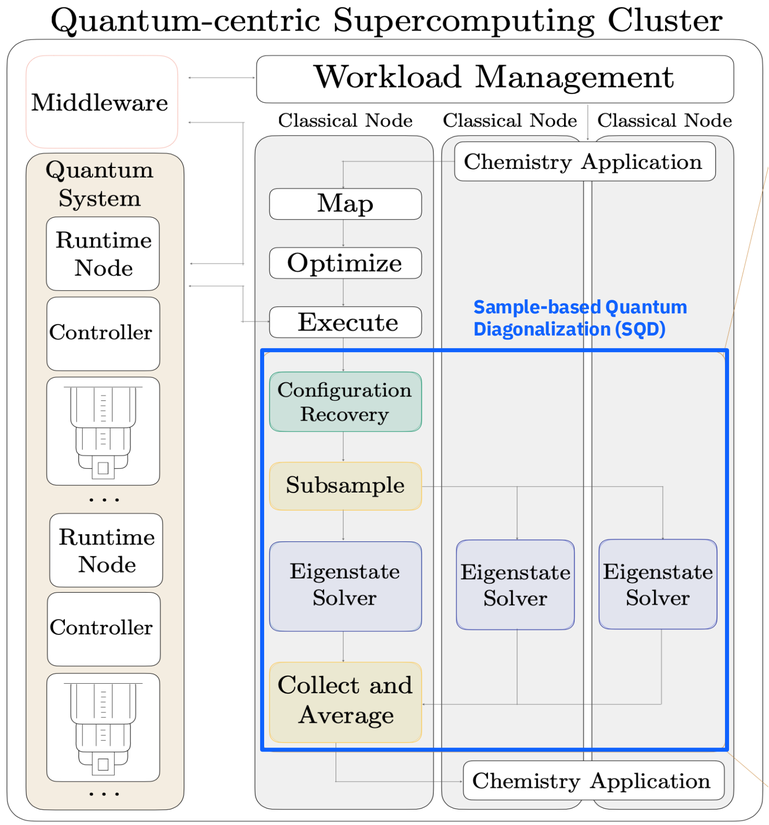
Qiskit Addon: Sampling-based quantum diagonalization

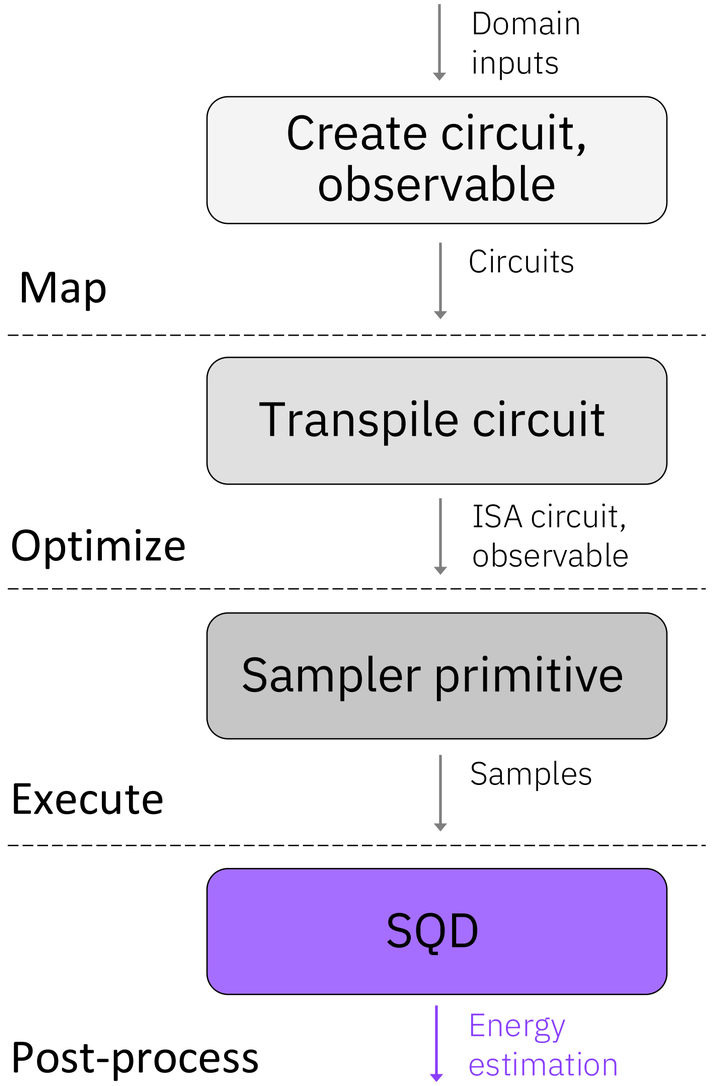
SQD classically post-processes noisy samples from a quantum processor to produce more accurate energy estimations

SQD

Quantum Info

Result processing





RIKEN
IBM Quantum
University of Colorado Boulder

Research

Science Advances vol. 11, no. 25 (2025)

Development

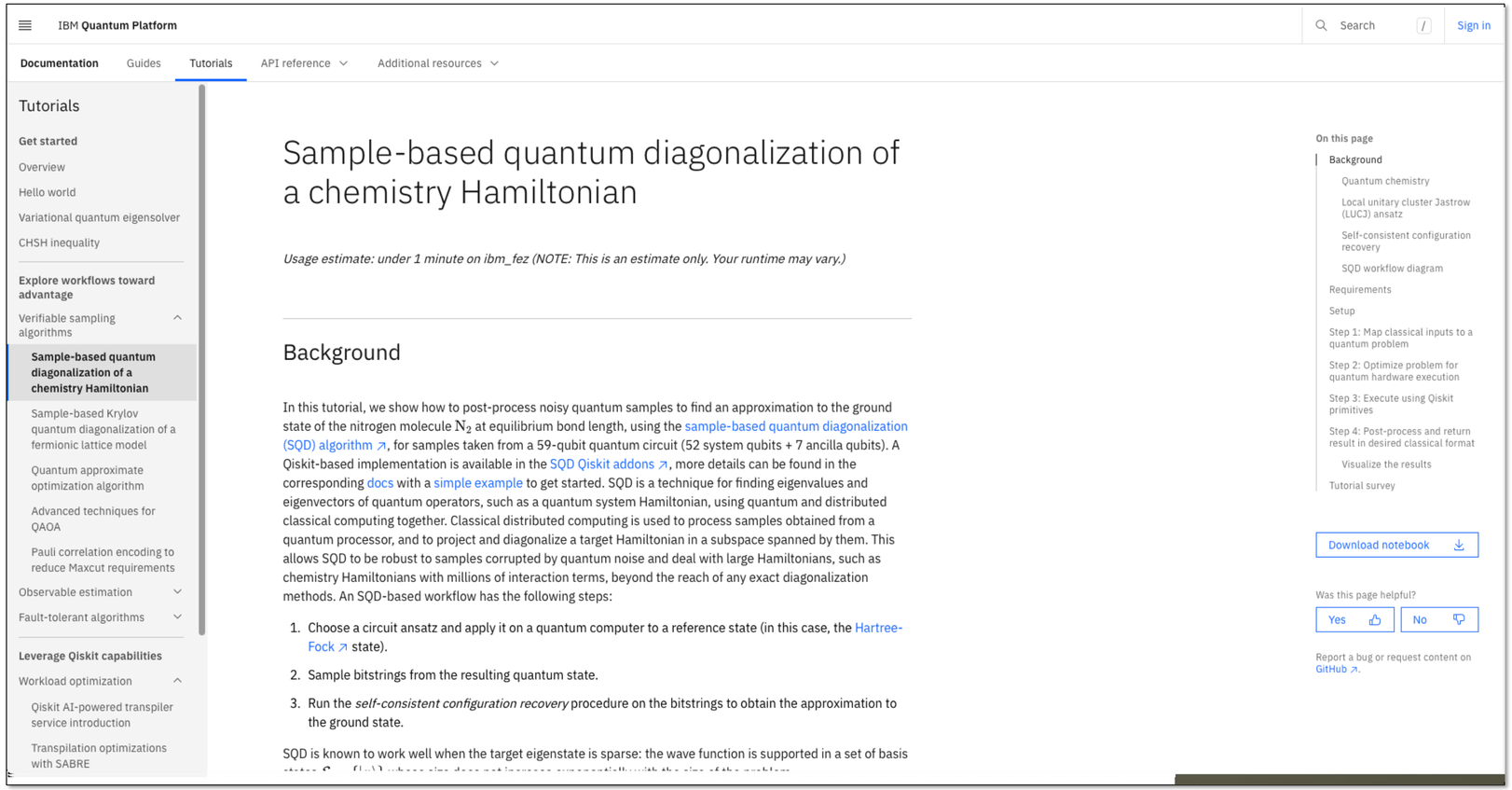
https://github.com/Qiskit/qiskit-addon-sqd

IBM Quantum Platform

Qiskit Addons workflow: Sample based quantum diagonalization of a chemistry Hamiltonian

Link:
https://quantum.cloud.ibm.com/docs/en/tutorials/sample-based-quantum-diagonalization

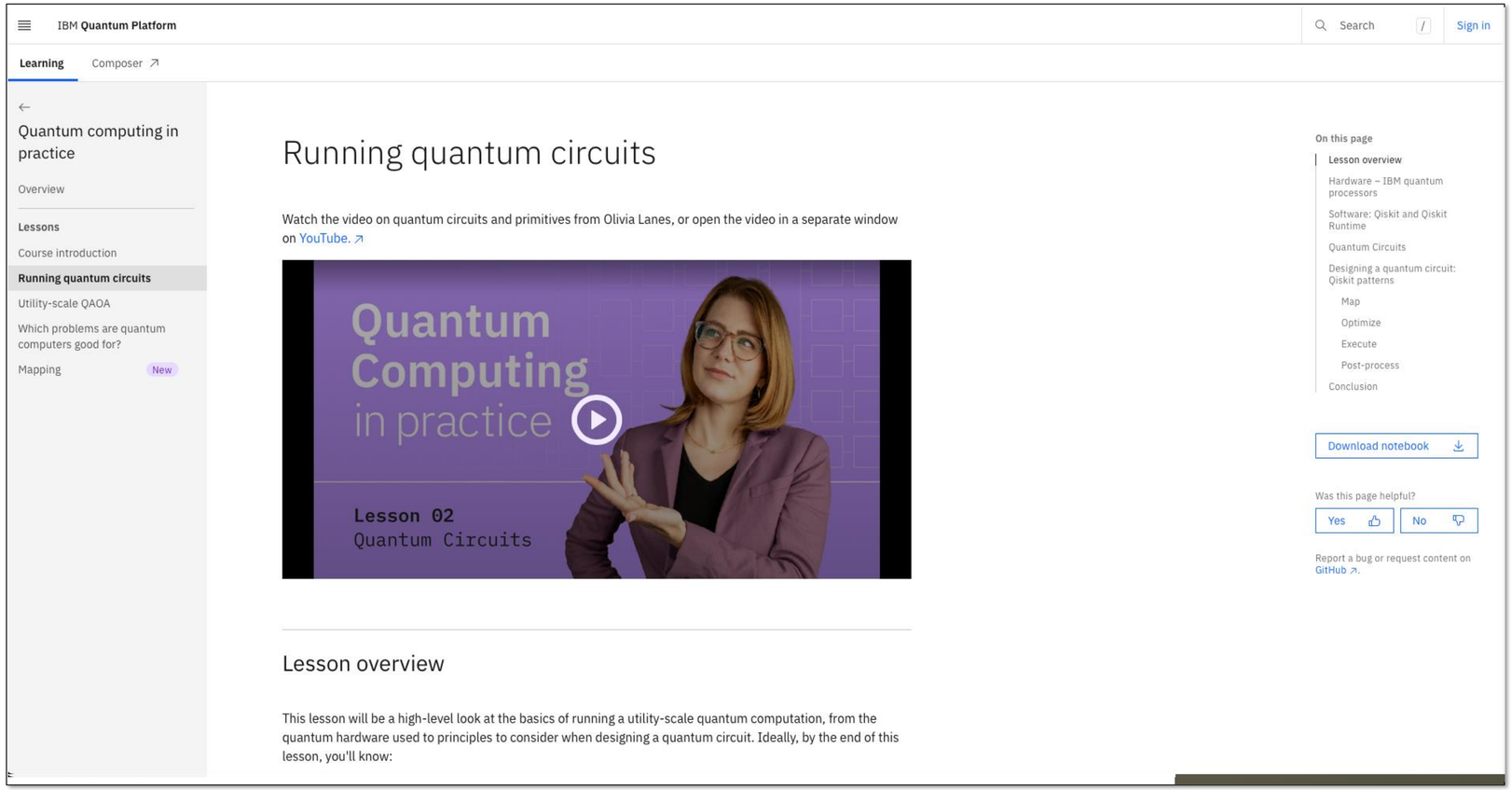
Lecture notes from QGSS:
https://github.com/qiskit-community/qgss-2025-lecture-notes/blob/main/Day%205%20-%20Practical%20Quantum%20Algorithms%20by%20Joana%20Fraxanet%20Morales.pdf



IBM Quantum Platform

Qiskit Addons workflow: Sample based quantum diagonalization of a chemistry Hamiltonian walkthrough

Link: https://www.youtube.com/watch?v=0eTmqj5nf7c&list=PLOFEBzvs-VvoIfbpOb_geVnwFmbW6ij0m&index=5



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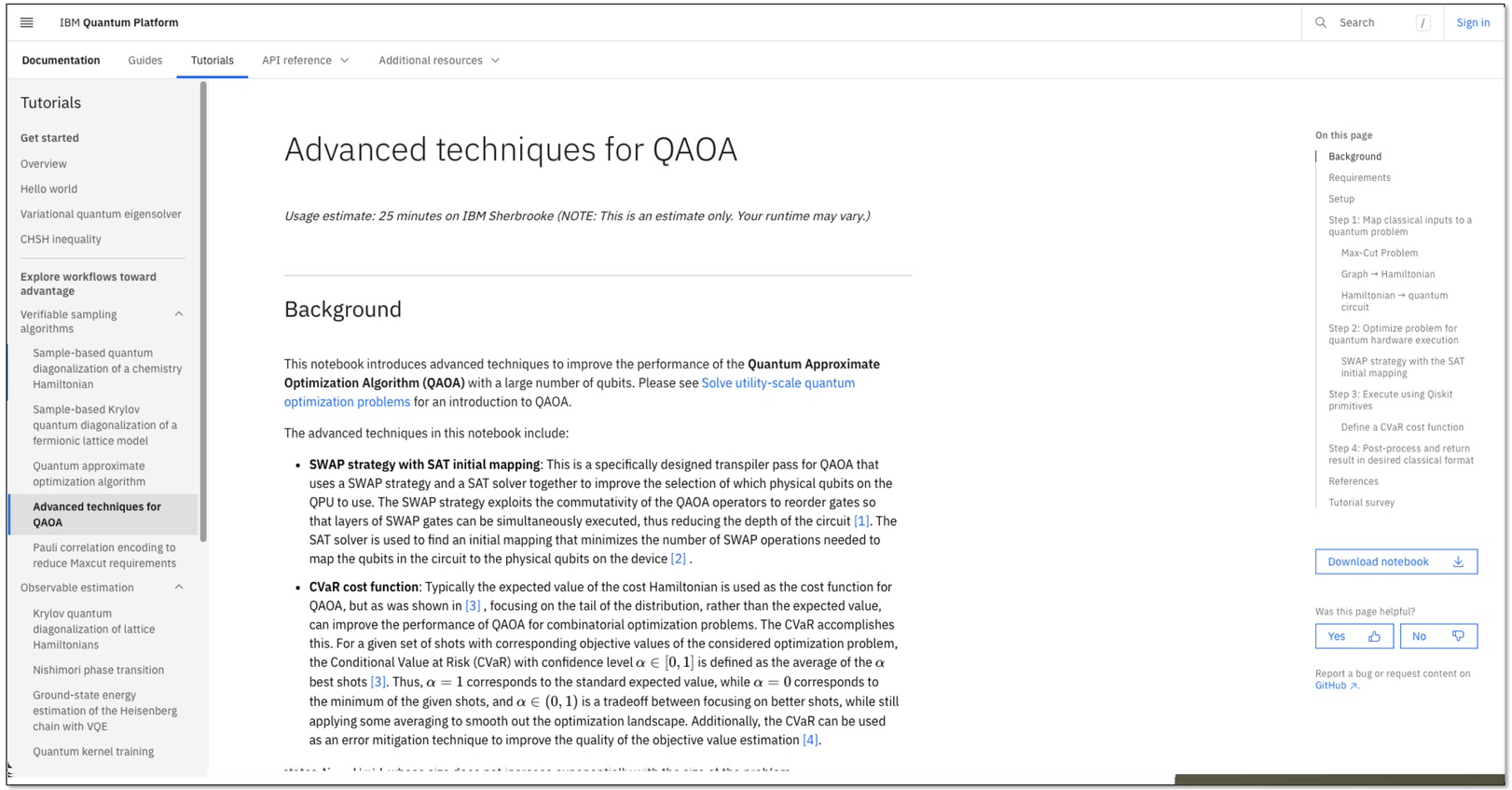
Advanced Techniques for QAOA

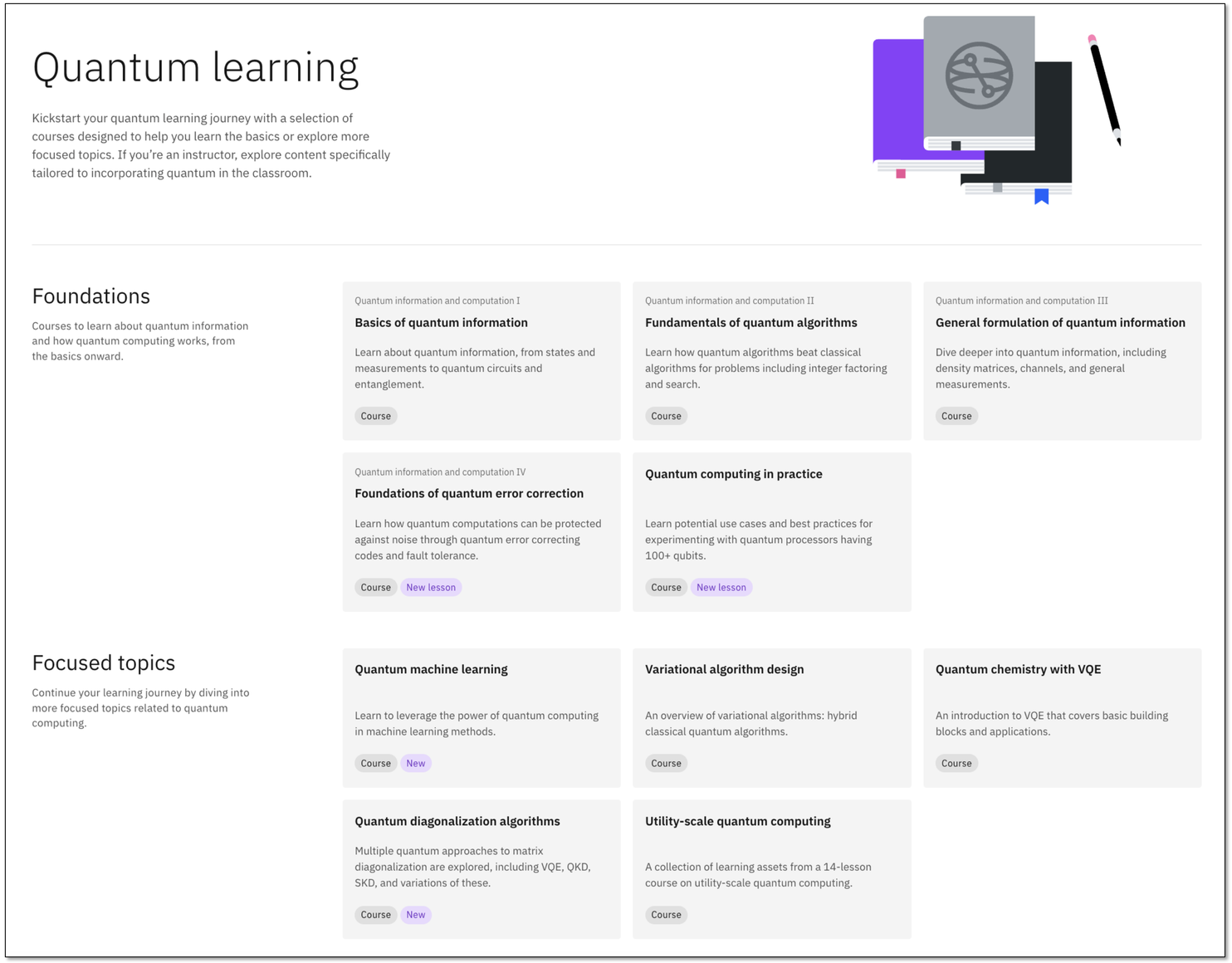
Link:
https://quantum.cloud.ibm.com/docs/en/tutorials/advanced-techniques-for-qaoa



IBM Quantum Learning

Learn the basics of quantum computing and how to solve real-world problems with IBM Quantum services and systems

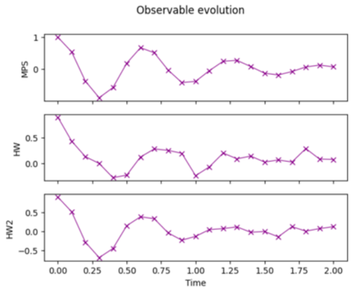
Courses, tutorials, and educational resources by leading quantum experts.



Utility Scale Modules

1D Transverse Ising Model (70 qubits x 80 ent. gates)

Utility I



This module explores Quantum simulation of a 1D transverse Ising model on linear lattices.

Performs time-evolution simulation using Statevector and MPS simulators first with N=20, then scales to N=70 on a real hardware to compare with the N=20 simulator results.

Focuses on teaching the workflow (Map>Optimize>Run>Post-process) in the process.

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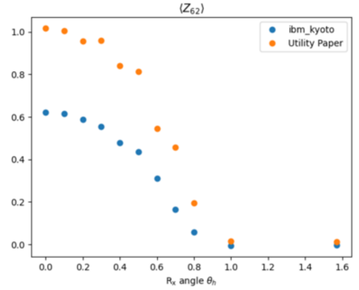
Nature Paper Simulation (127 qubits x 60 ent. gates)

Utility II



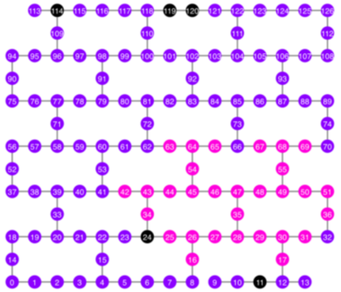
This module walks learners through reproducing the Nature paper with a focus on implementation of the problem without any error mitigation applied at first.

Learners will compare results to that of the Nature paper that applied error mitigation techniques.

Finally, students can explore an option to try PEA (Probabilistic Error Amplification) to run their circuits and apply error mitigation in post-processing.

Long-entanglement with GHZ State (127 qubits)

Utility III



This module can be utilized as a group project or an in-class challenge. The goal is to build a GHZ circuit with 20 qubits or more that meets a certain fidelity criteria (i.e., GHZ state fidelity > 0.5)

Several ideas are presented as an example such as finding the best qubit chain based on 2 gate errors, finding a balanced tree of qubits, applying error mitigation options in Sampler V2.

The module encourages students to produce their own ideas while exploring the suggested options first.

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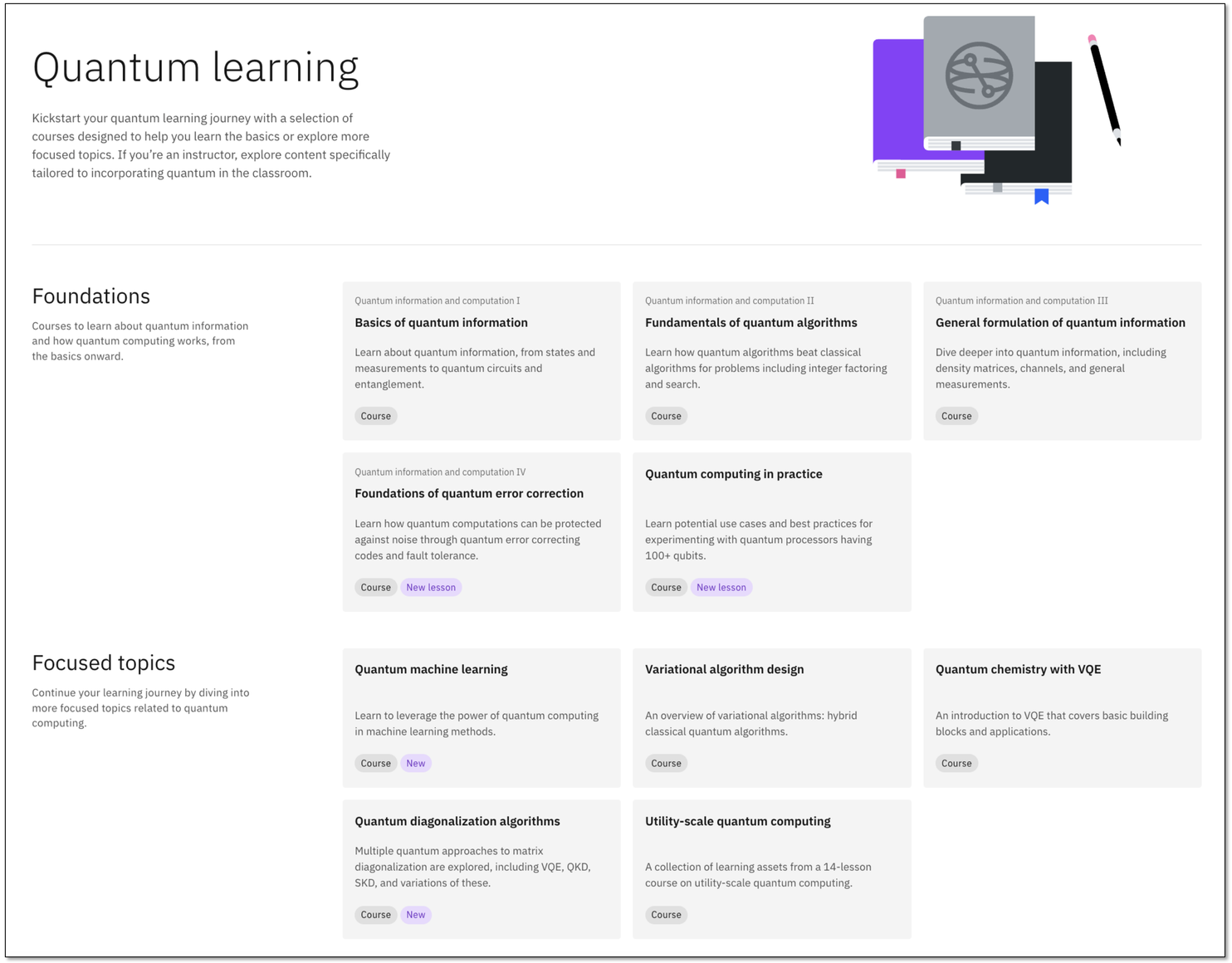


Qiskit Quantum Seminar

Qiskit

153 videos 29,763 views Updated today

Play all Shuffle

Stay up to date with the latest academic and research topics in the quantum community by joining our live discussions every Friday at 12PM EDT. Tune in to gain insights from experts and engage with a community of quantum enthusiasts!

1 

Efficient classical shadow tomography with number conservation with Anushya Chandran

Qiskit • 116 views • Streamed 1 hour ago

2 

Efficient Long-Range Entanglement using Dynamic Circuits with Elisa Bäumer

Qiskit • 2.4K views • Streamed 3 weeks ago

3 

On quantum backpropagation and information reuse | Qiskit Quantum Seminar with Amira Abbas

Qiskit • 2.6K views • Streamed 4 weeks ago

4 

Near-Term Quantum Algorithms for Optimization with Ashley Montanaro

Qiskit • 2.4K views • Streamed 1 month ago

5 

Quantum Many-body theory in the Quantum Information era with Matthew Fisher |Qiskit Quantum Seminar

Qiskit • 2.8K views • Streamed 1 month ago

6 

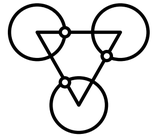
Realization and Characterization of Topological Phases on Quantum Processors

Qiskit • 2.9K views • Streamed 2 months ago

Some overarching suggestions

Multiple entry ramps

Offer a blend of engaging channels: live events, self-paced tutorials, and peer support so learners can start where they feel comfortable.

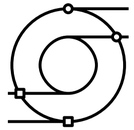


Reusable artifacts

Recordings, notebooks, and FAQs to turn one-off sessions into long-term resources that participants can pick up later.

Small, continuous feedback channels

Open communications channels to preventing drift between what we teach and what participants need.



Thank you