# Qiskit | Global Summer School 2021
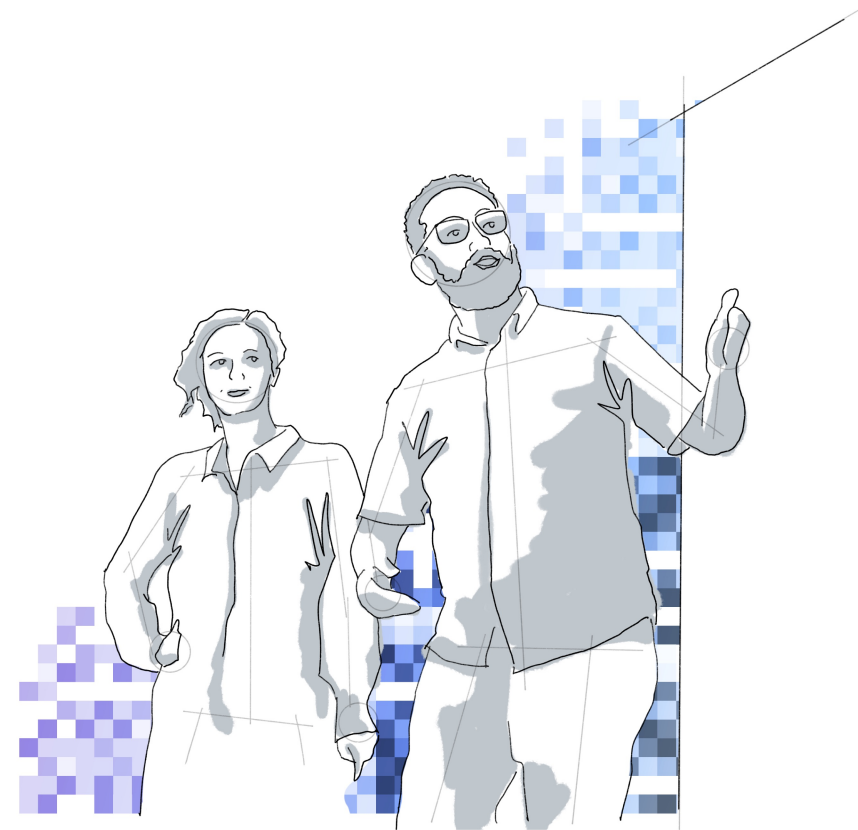
# Attendee Guide

Qiskit Global Summer School 2021: Quantum Machine Learning

July 12 - 23

#QGSS2021

# Index

## IMPORTANT!

Please make sure and use Google Chrome for headache-free course access.

**QUICKLINKS**

Key Locations

Discord Server

Lab Portal

Verification Form

We appreciate your support in keeping this experience for registered attendees only, and welcome your feedback and suggestions for any improvement. Please do not share the lecture and lab materials outside the attendees of the Qiskit Global Summer School.
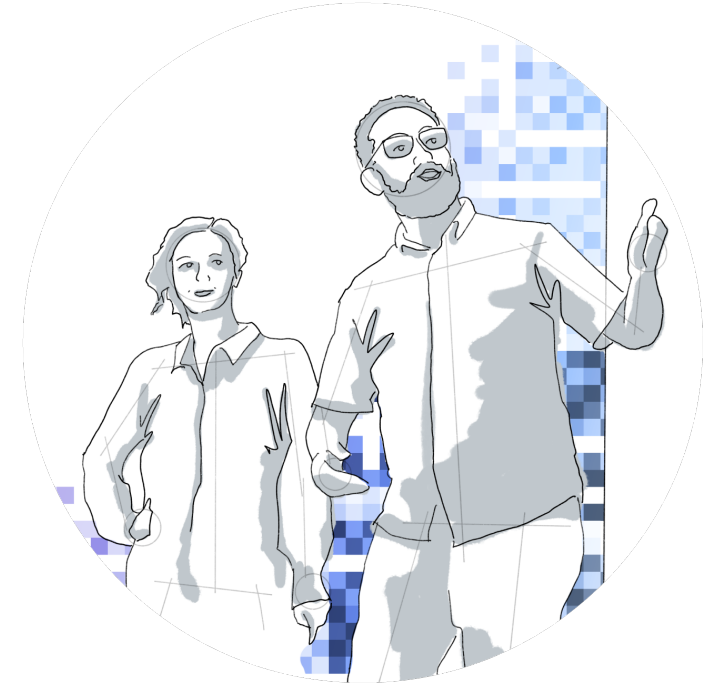
# About the Summer School

Welcome to the second-annual Qiskit Global Summer School hosted by IBM Quantum, focused on Quantum Machine Learning. We are excited to have you join us for a 2-week dive into quantum computing through daily lectures and lab sessions, as well as a vibrant community set up for you to meet other students and collaborate together to solve problems. Through education and open science, we aim to build and shape a diverse, equitable, and inclusive quantum workforce. We're thrilled to have you join us on this journey.

Please read through this Attendee Guide to find answers about the structure, setup, agenda, and resources that accompany the Summer School. This is not a passive course - active participation is key to making it a success. Grab a notebook and a pen, and find your favorite chair. The Qiskit Global Summer School is just about here.

**Students in the Global Summer School will leave with the following capabilities:**

- Explore quantum applications

- Understand state of the art QML algorithms, their potential and limitations as well as implementation techniques on simulators and hardware

- Create tangible connections between QML, quantum computing, hardware, and current research/development in the field(s)

- Differentiate what is practical/real from what is hype and what is "popular" about quantum computing and QML

- Confidently apply quantum computing concepts and embark on a deeper quantum computing journey of their own

# Students from around the world

With 5,000 students registered, the 2021 Summer School showcases the global reach and engagement of students and industry professionals around the world – putting the GLOBAL in Global Summer School.

**29%**
have no prior experience with Qiskit

**73%**
are active university or high school students

**27%**
are active industry professionals

## 111 countries represented

1100+ students from **North America**

1800+ students from **Asia/Asia Pacific**

150+ students from **Africa**

500+ students from **Europe**

# Resources

## Pre-Requisites

Minimal prerequisites are required for the Qiskit Global Summer School. If you know how to multiply two matrices, and have some programming experience in Python, you are ready for the Summer School.

You can brush up on Python programming before attending the lectures by using the Qiskit Textbook. To make the most out of these lectures, you may also consider looking through the linear algebra prerequisites section of the Qiskit Textbook.

[ Review Linear Algebra ]        [ Review Python Programming ]

## Additional Resources

Suggested readings will be provided in Discord & more resources are available online at qiskit.org/learn!

## Quantum Computing

[ Buy Textbook ]    **Quantum Computation and Quantum Information**
by Nielsen & Chuang

[ Read Textbook ]    **Quantum Computing for the Quantum Curious**
by Hughes C et al

[ Read Textbook ]    **Learn Quantum Computing Using Qiskit**
by IBM Quantum

[ Join Course ]    **Introduction to Quantum Computing and Quantum Hardware**
by IBM Quantum

## Machine Learning

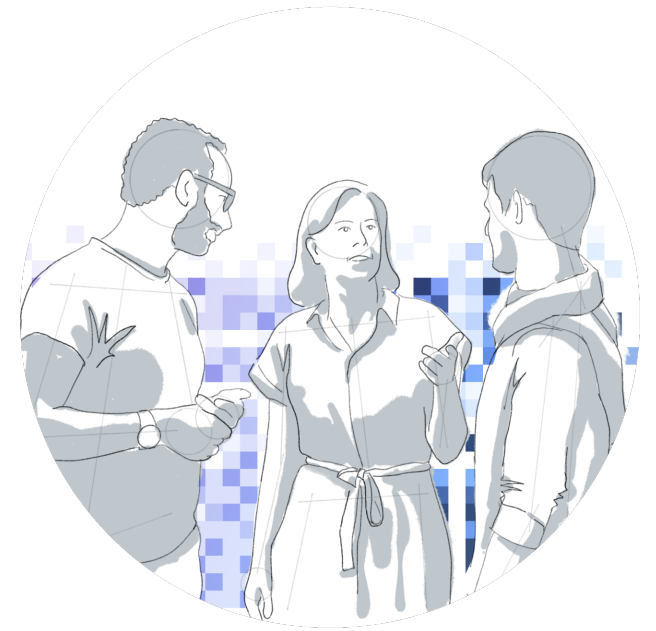[ Buy Book ]    **Deep Learning**
by Ian Goodfellow et al

[ Watch Video ]    **How to go from No Math to Quantum Machine Learning**
by IBM Quantum Community

# Speakers & Lecturers

Our expert speakers from around the world include industry leading researchers and developers in Quantum Computing – representing the pioneering work of IBM and IBM Quantum.

Amira Abbas

**IBM Quantum – South Africa**

Anna Phan

**IBM Quantum – Australia**

Elisa Bäumer

**IBM Quantum – Switzerland**

Christa Zoufal

**IBM Quantum – Switzerland**

**Nate Earnest-Noble**
IBM Quantum – US

**Johannes Weidenfeller**
IBM Quantum - Switzerland

**Bryce Fuller**
IBM Quantum – US

**Zlatko Minev**
IBM Quantum – US

**Francesco Tacchino**
IBM Quantum – Switzerland

**Kristan Temme**
IBM Quantum – US

**Julien Gacon**
IBM Quantum – Switzerland

**Jen Glick**
IBM Quantum – US

# Week 1 Schedule & Topics

| JULY 12 | JULY 13 | JULY 14 | JULY 15 | JULY 16 |
|---|---|---|---|---|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |

**10:30 AM EDT**
Global Summer School
Welcome & Kickoff

**8:00 AM EDT**
Lecture 2.1: Simple
Quantum Algorithms I
*Speaker: Elisa Bäumer*

**8:00 AM EDT**
Lecture 3.1: Noise in
Quantum Computers pt 1
*Speaker: Zlatko Minev*

**8:00 AM EDT**
Lecture 4.1: Introduction to
Classical Machine Learning
*Speaker: Amira Abbas*

**8:00 AM EDT**
Lecture 5.1: Building a
Quantum Classifier
*Speaker: Amira Abbas*

**11:30 AM EDT**
Lecture 1.1: Vector Spaces,
Tensor Products, and Qubits
*Speaker: Elisa Bäumer*

**2:00 PM EDT**
Lecture 2.2: Simple
Quantum Algorithms II
*Speaker: Elisa Bäumer*

**11:30 AM EDT**
Lecture 3.1: Noise in
Quantum Computers pt. 2
*Speaker: Zlatko Minev*

**2:00 PM EDT**
Lecture 4.2: Advanced
Classical Machine Learning
*Speaker: Amira Abbas*

**11:30 AM EDT**
Lecture 5.2: Introduction to the
Quantum Approximate Optimization
Algorithm and Applications
*Speaker: Johannes Weidenfeller*

**2:00 PM EDT**
Lecture 1.2: Introduction to
Quantum Circuits
*Speaker: Elisa Bäumer*

**2:00 PM EDT**
Lab 1: Introduction to
Quantum Computing
Algorithms and Operations
*Speaker: Elisa Bäumer*

**2:00 PM EDT**
Lab 2: Introduction to
Variational Algorithms
*Speaker: Johannes Weidenfeller*

# Week 2 Schedule & Topics

| JULY 19 | JULY 20 | JULY 21 | JULY 22 | JULY 23 |
|---------|---------|---------|---------|---------|
| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** |

**8:00 AM EDT**
Lecture 6.1: From Variational Classifiers to Linear Classifiers
*Speaker: Bryce Fuller*

**8:00 AM EDT**
Lecture 7.1: Quantum Kernels in Practice
*Speaker: Jen Glick*

**8:00 AM EDT**
Lecture 8.1: Introduction and Applications of Quantum Models
*Speaker: Francesco Tacchino*

**8:00 AM EDT**
Lecture 9.1: Introduction to Quantum Hardware
*Speaker: Nate Earnest-Noble*

**8:00 AM EDT**
Lecture 10.1: Advanced QML Algorithms: Quantum Boltzmann Machines and Quantum Generative Adversarial Networks
*Speaker: Christa Zoufal*

**2:00 PM EDT**
Lecture 6.2: Quantum Feature Spaces and Kernels
*Speaker: Kristan Temme*

**2:00 PM EDT**
Lab 3: Introduction to Quantum Kernels and Support Vector Machines
*Speaker: Anna Phan*

**11:30 AM EDT**
Lecture 8.2: Barren Plateaus, Trainability Issues, and How to Avoid Them
*Speaker: Francesco Tacchino*

**11:30 AM EDT**
Lecture 9.2: Hardware Efficient Ansatze for Quantum Machine Learning
*Speaker: Nate Earnest-Noble*

**11:30 AM EDT**
Lecture 10.2: The Capacity and Power of Quantum Machine Learning Models & the Future of Quantum Machine Learning
*Speaker: Amira Abbas*

**2:00 PM EDT**
Lab 4: Introduction to Training Quantum Circuits
*Speaker: Julien Gacon*

**2:00 PM EDT**
Lab 5: Introduction to Hardware Efficient Ansatze for Quantum Machine Learning
*Speaker: Nate Earnest-Noble*

**2:00 PM EDT**
Qiskit Global Summer School Commencement & Celebration

## Live Q&A

Following each lecture there will be a live Q&A session with the speakers on screen in Crowdcast. For questions not answered during the lecture live stream, they will be answered there.

**Important Note: There are NOT Live Q&A sessions for Labs**

# Labs & Lectures

The summer school is made up of a total of 19 lectures, 5 lab sessions & application exercises, in addition to the daily Live Q&A Sessions. **Participation and completion of all labs and lectures are required in order to receive a certificate of completion from the Summer School**, with the optional activities available to enhance your Summer School experience.

The schedule is not fixed, aside from final lab submission deadlines, and **all students can participate on the schedule that works best for them**. Lectures and lab sessions will all be recorded and available for live participation and post viewing, as well as the daily Q&A sessions.

Students should anticipate a <u>minimum time commitment of 30 hours for the full Summer School</u>, but we recommend planning on 41 hours of participation, with additional time for discussion and collaboration with other students.

## Lectures

**Duration: ~60 minutes**

- Live Q&A will be hosted following each lecture - questions can be asked live or <u>submitted on Discord</u>
- Be an active audience member - take notes along with the lecturers!

## Labs

**Duration: ~45 minutes**

- Demonstrating lecture material with <u>hands-on exercises </u>on quantum programming using Qiskit
- Pre-recorded session is accompanied by problem set exercise

# Lab Access & Information

**Labs will be available in the IBM Quantum platform.**

Each lab is made up of three or more exercises, with an estimated time to complete of 1-2 hours per lab. Exploratory exercises are not graded, but all others count towards your final grade.

To achieve a passing grade, **a minimum score of 75% or more is required** *(18/23 total exercises)*.

## Access & Verification

In order to access the labs, all students must complete this verification form. This form will also confirm your status as a student in the Summer School. Within 24 hours, you will have full access to the lab portal and all related Discord channels.

Make sure and log out of you account and re-login, refreshing your browser, once you are verified. This is a required final step in order to have access to lab exercises.



IBM Quantum without verification



IBM Quantum WITH verification

# As you join the Discord and Summer School...

Everyone will need to complete a quick verification step prior to getting full

access to the Summer School Discord and lab exercises. It just takes three

simple steps, and a dash of patience!

STEP 1

[ Join Discord ]

STEP 2 (as needed)

[ Create IBM Quantum Account ]

STEP 3

[ Submit Verification ]

# And that's it!!!

Verification may take up to 24 hours – make sure and submit your information immediately upon joining

the Discord server! Let us know in #verification-support if you run into any issues or require support.

# Certificates

Lab work will be assigned throughout the Summer School as Jupyter notebook exercises. The notebooks must be completed and submitted following the Summer School **no later than Tuesday, July 27th (11:59 PM EDT)** with a **cumulative average score of 75% or higher** in order to receive a certificate.

**IMPORTANT NOTE! You have the option to submit your notebook multiple times - only the highest score will contribute to your cumulative average.**

## Support & Collaboration

A channel will be available that will be filled with IBMers and mentors to answer questions throughout the weekdays of the Summer School course. Students are also strongly recommended to set up or join a "study group" to foster group-work and building connections throughout the school.

Labs will not be reviewed during the lecture(s), so take the time to sit down and review your work. For the best experience, work with your study group to view lab session content & application exercise.

## Pass/Fail Certification

You cannot reduce your score by submitting multiple times - only the highest score is kept. All lab work exercises must be completed and received no later than 11:59 PM EDT on Tuesday, July 27th.

**Students must achieve cumulative/average 75% across notebook submissions to get a certificate.**

# [Discord]{.underline} will be used for all Summer School event communications, updates, study groups, lab work, Q&A, and more.

Study Groups will form and collaborate in the text/video channel places, and mentors will be able to see active groups and join to provide lab guidance and support. Students will be enabled to "raise their hand" to get support in their group - notifying mentors direct!

## CORE
## Channels

**#welcome**
Get started here for first steps when you join the server.

**#announcements**
Follow this channel for all live announcements and updates.

**#conduct-guidelines**
Review the IBM Quantum Community Code of Conduct and other guidelines - thank you for supporting an inclusive and welcoming community throughout the course!

## ESSENTIAL
## Commands

**!schedule**
Get the schedule for the course.

**!gethelp**
Get helpful tips for when you need help but aren't sure where to go.

**!raisehand**
Let our mentors and support know directly for insights in ongoing conversations.

**!channels**
Get a list of easily-linked server channels and resources.

# IBM Quantum Community Code of Conduct

In our collective mission to continue to promote and encourage an inclusive and welcoming global quantum community, The IBM Quantum Community Code of Conduct is available for download and review [here](here).

We appreciate everyone's support in this mission, and ask that any observed code of conduct violations or inappropriate behavior are reported [here](here).

[ Read Code of Conduct ]

## Live Moderation & Incident Reporting

In Discord, you can also submit anonymous CoC violations or offensive/inappropriate content using these commands in any channel (we recommend #sandbox!):

### r!report [message]

This will send a normal report to the admins. It will also display a confirmation message that the report was sent.

### r!sreport [message]

This will send a silent report to the admins. It will not display a confirmation message in the channel, making it publicly-anonymous.

Make sure to include a link to the reported message (Select the message you are reporting and "Copy Message Link) for admins to review.

# FAQ

**Will the lectures and labs be recorded? Is live-participation required?**

Yes, all lectures, labs, and Q&As will be recorded! You can join live, or watch the content on-demand.

**Will the Summer School content be available later in the year?**

Like last year, it is a possibility that the Summer School content will be re-packaged and made available later in the year, but it is not guaranteed. Announcements would be made via email and on Twitter should the content be released later in the near, but it's important to note that it will likely NOT be exactly as it is during the live course itself. *One example of a change: lack of live participation/Q&A with released materials.*

**How many students are in the Summer School?**

There are 5k students at the Qiskit Global Summer School.

**Can my friend/student/colleague be added to the Summer School or Discord?**

No.

**Can I download/share this content?**

No.

## IMPORTANT!

Please make sure and use Google Chrome for headache-free course access.

# We are here to help! Please follow these guidelines to ensure the most timely and efficient support, and don't hesitate to ask any questions!

- Reach out in designated channel(s)
- Allow 1 business day for support
- Avoid multiple requests/spam
- Avoid Direct Message or emails
- Avoid submitting same request in multiple locations

**Discord**
## #general-support

For any general support questions or support requests.

**Discord**
## #lab-support

For any questions related to lab work, solutions, or troubleshooting.

**E-mail**
## qiskit.events@us.ibm.com

For requests involving personal or sensitive information – may have longer reply times.

# Let's Get Started!

**1** [Join the Discord](#)

**2** [Verify Yourself](#)

**3** [Join Kickoff](#)