18-819F: Introduction to Quantum Computing
47-779/47-785: Quantum Integer Programming & Quantum Machine Learning

Create AWS Braket, Dwave Leap, and IBM Qiskit accounts

Access USRA RIACS Resources

Join CMU Quantum Computing Group

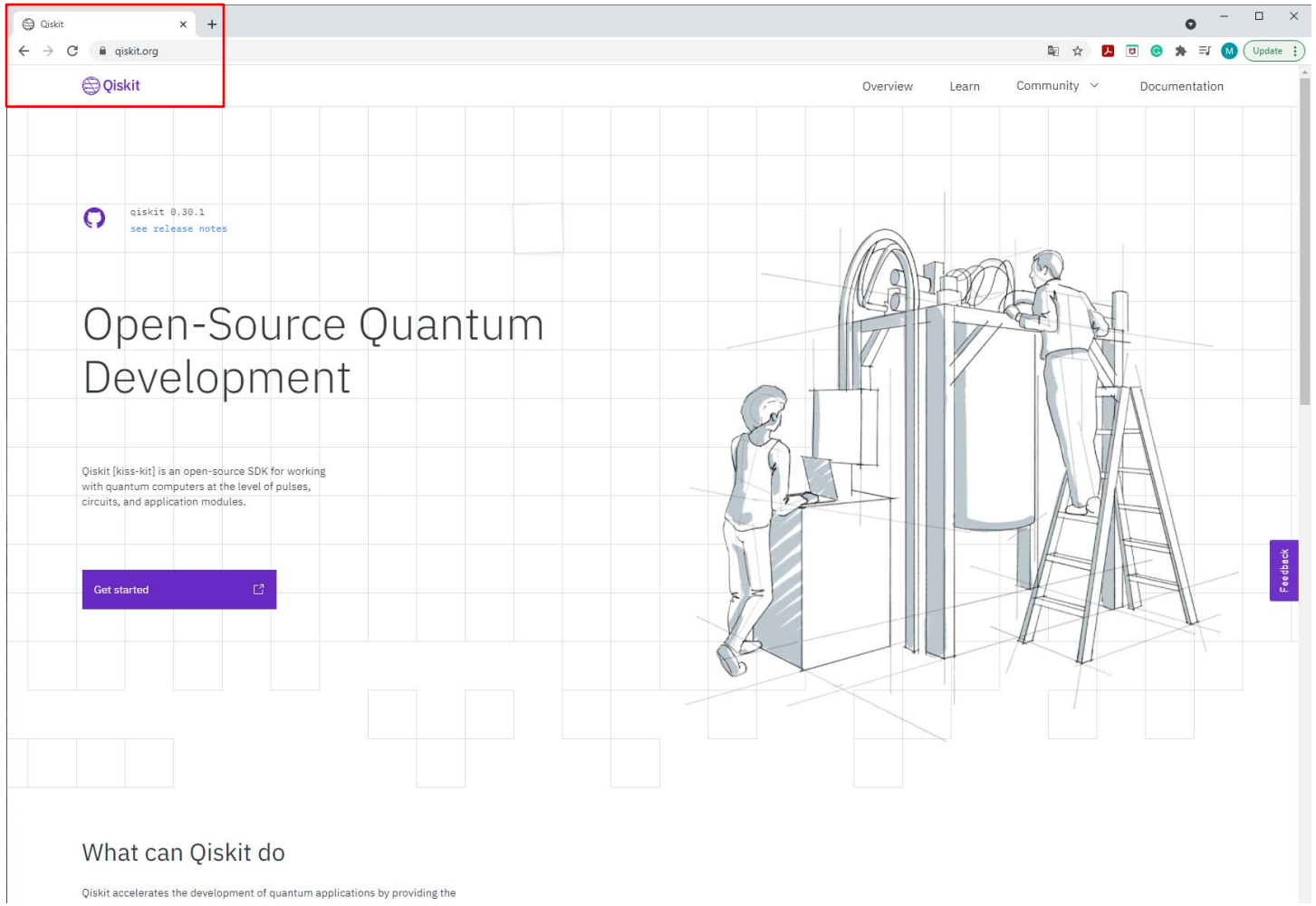
Lecture X

2021.10.12

Agenda

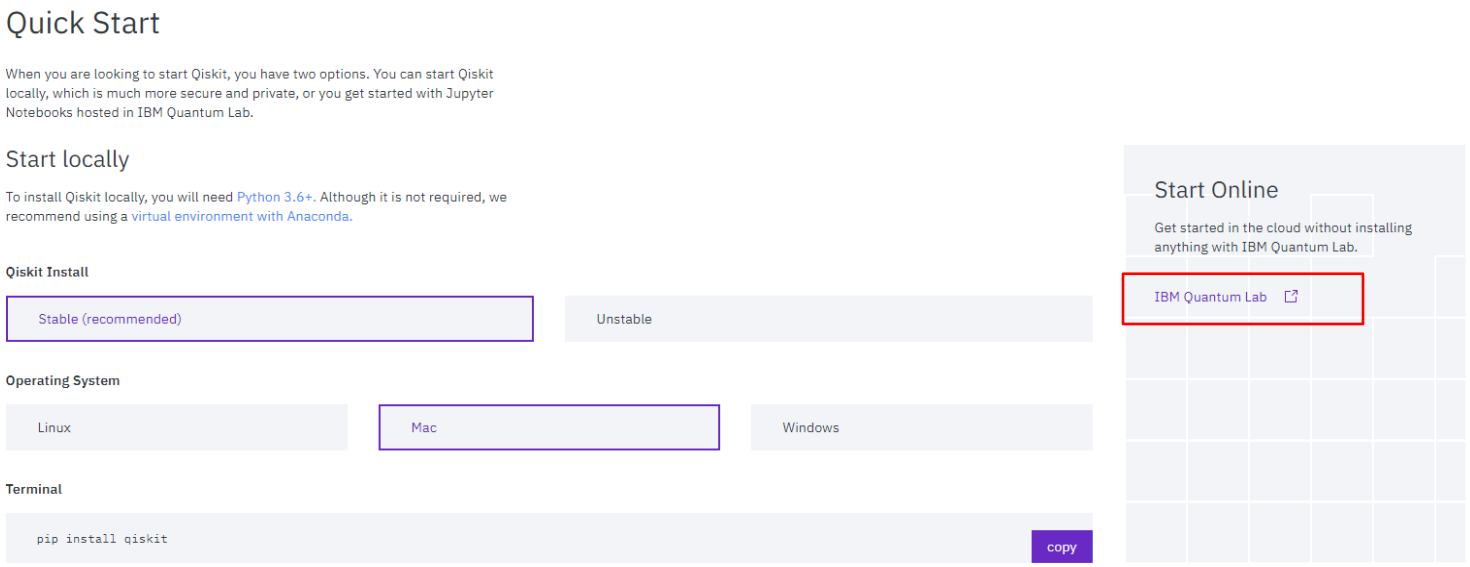
- Create IBM (Qiskit) account
- Create D-Wave (Leap) account
- Create AWS account
- Amazon Bracket
- Accessing USRA resources

Create IBM (Qiskit) account



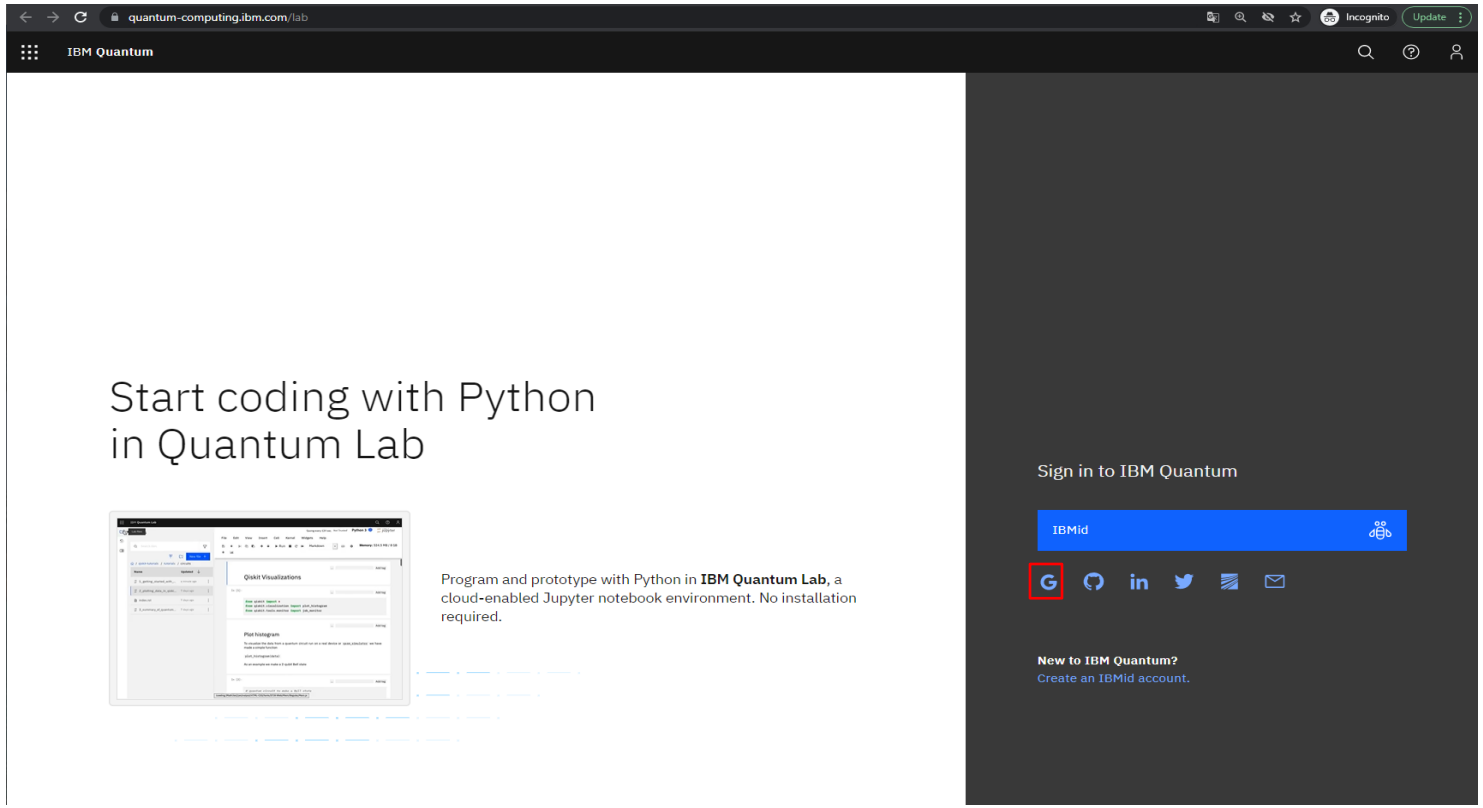
1- Go to www.qiskit.org

Create IBM (Qiskit) account



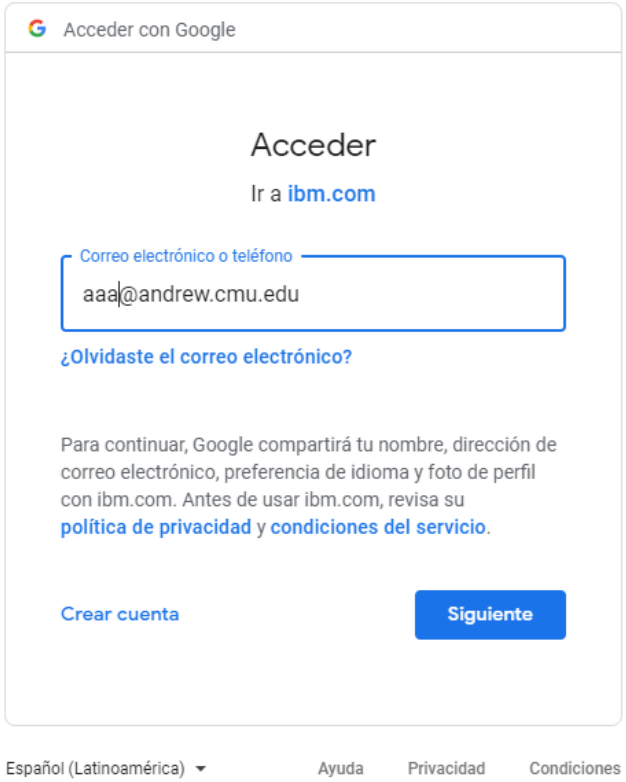
2- Scroll down to Start Online and click where it says “IBM Quantum Lab”.

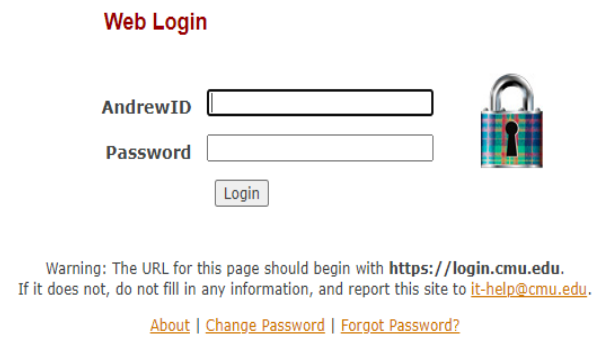
Create IBM (Qiskit) account



3- If you want to log with your cmu account, click Google's symbol

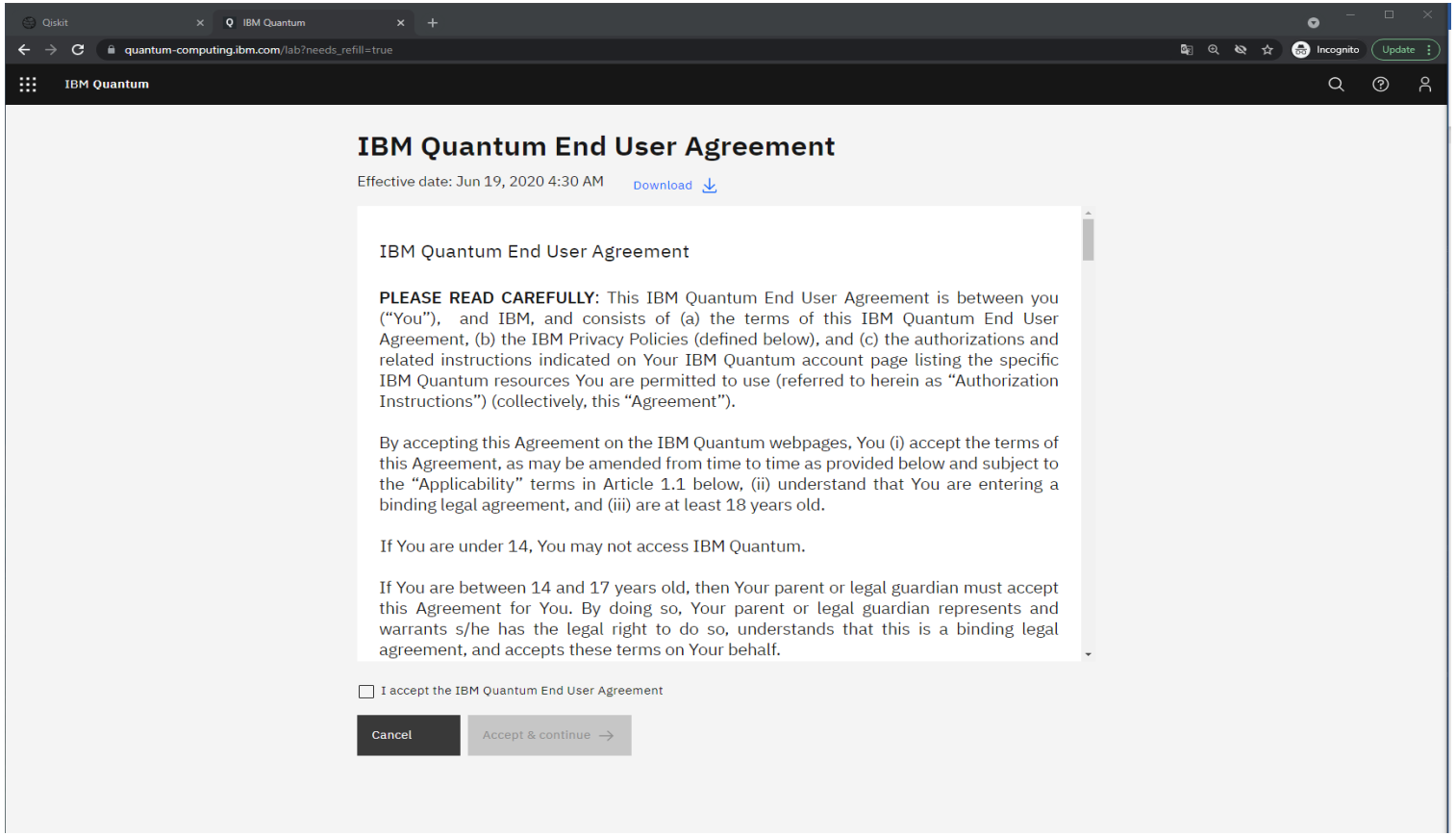
Create IBM (Qiskit) account





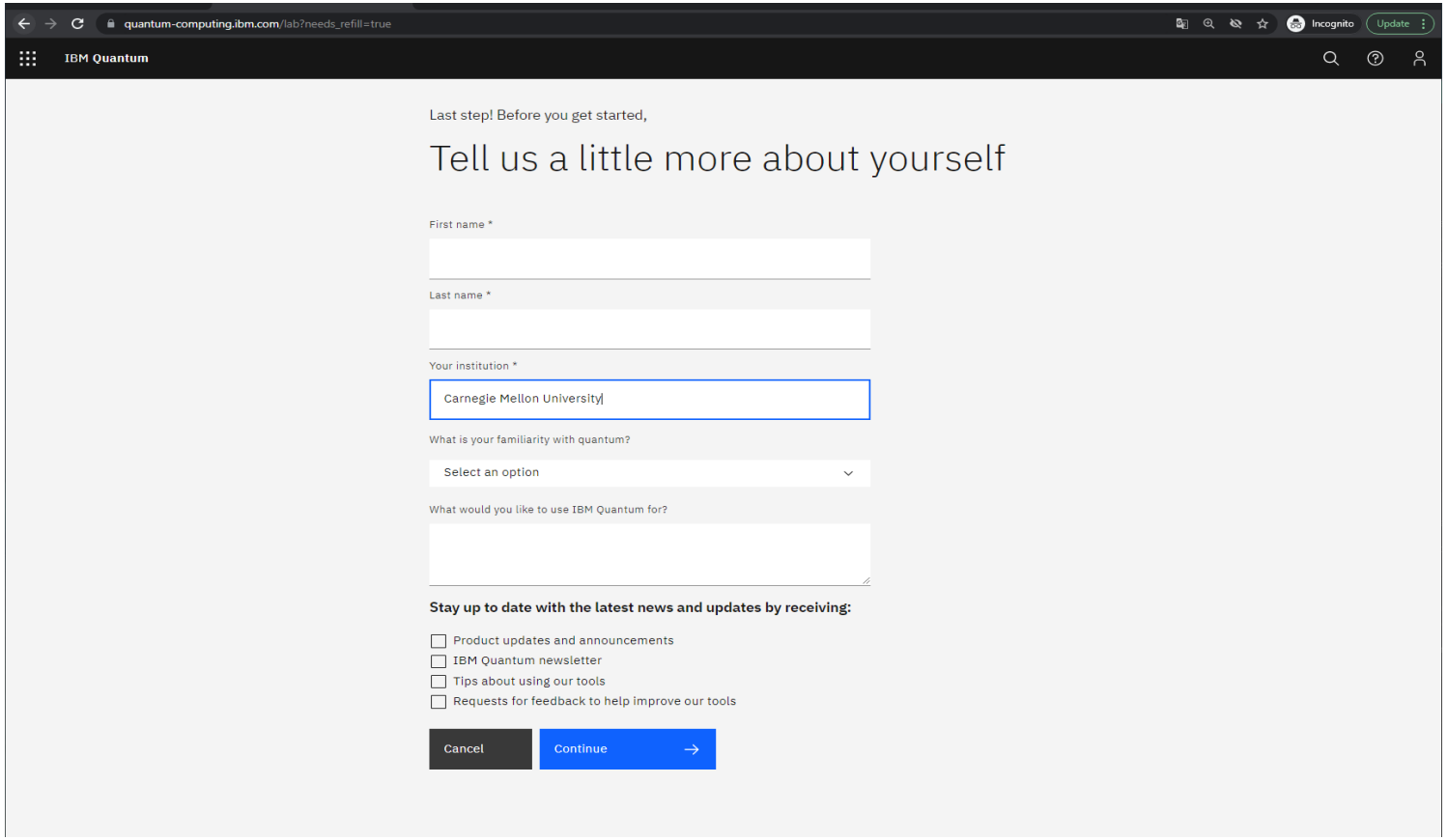
4- Log with your credentials

Create IBM (Qiskit) account



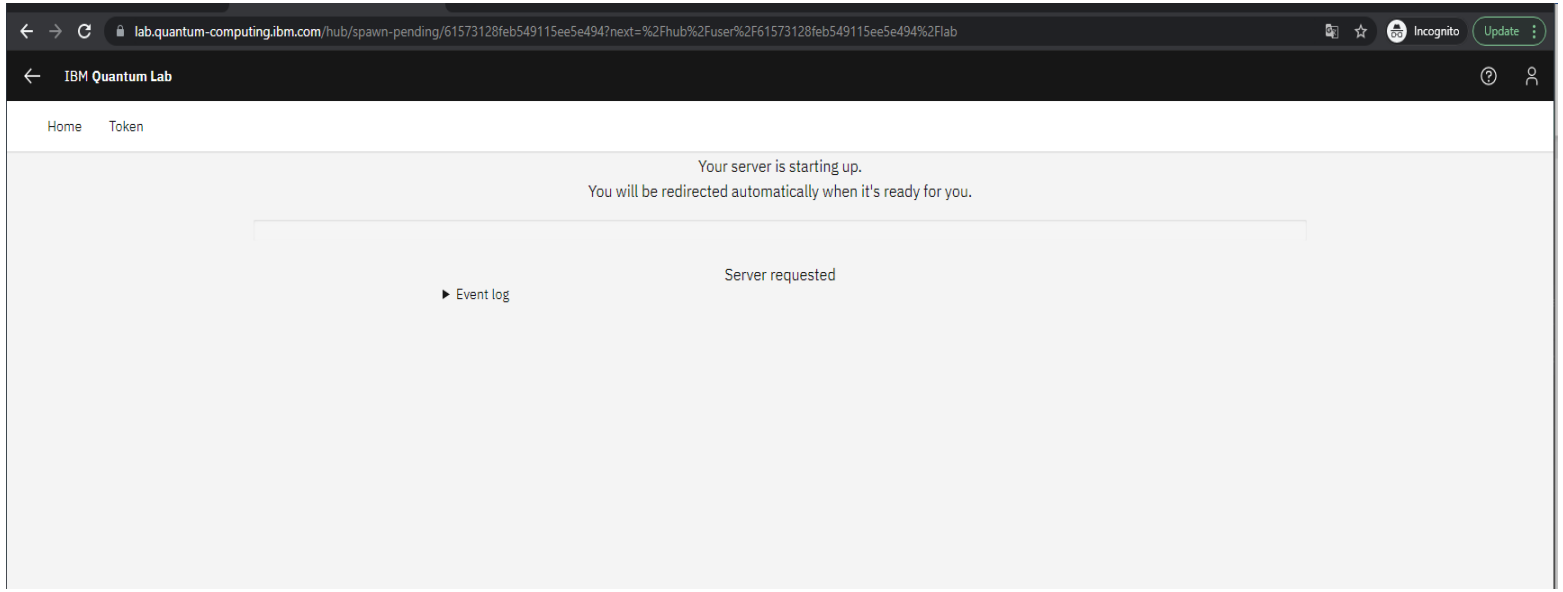
5- Read the End User Agreement

Create IBM (Qiskit) account



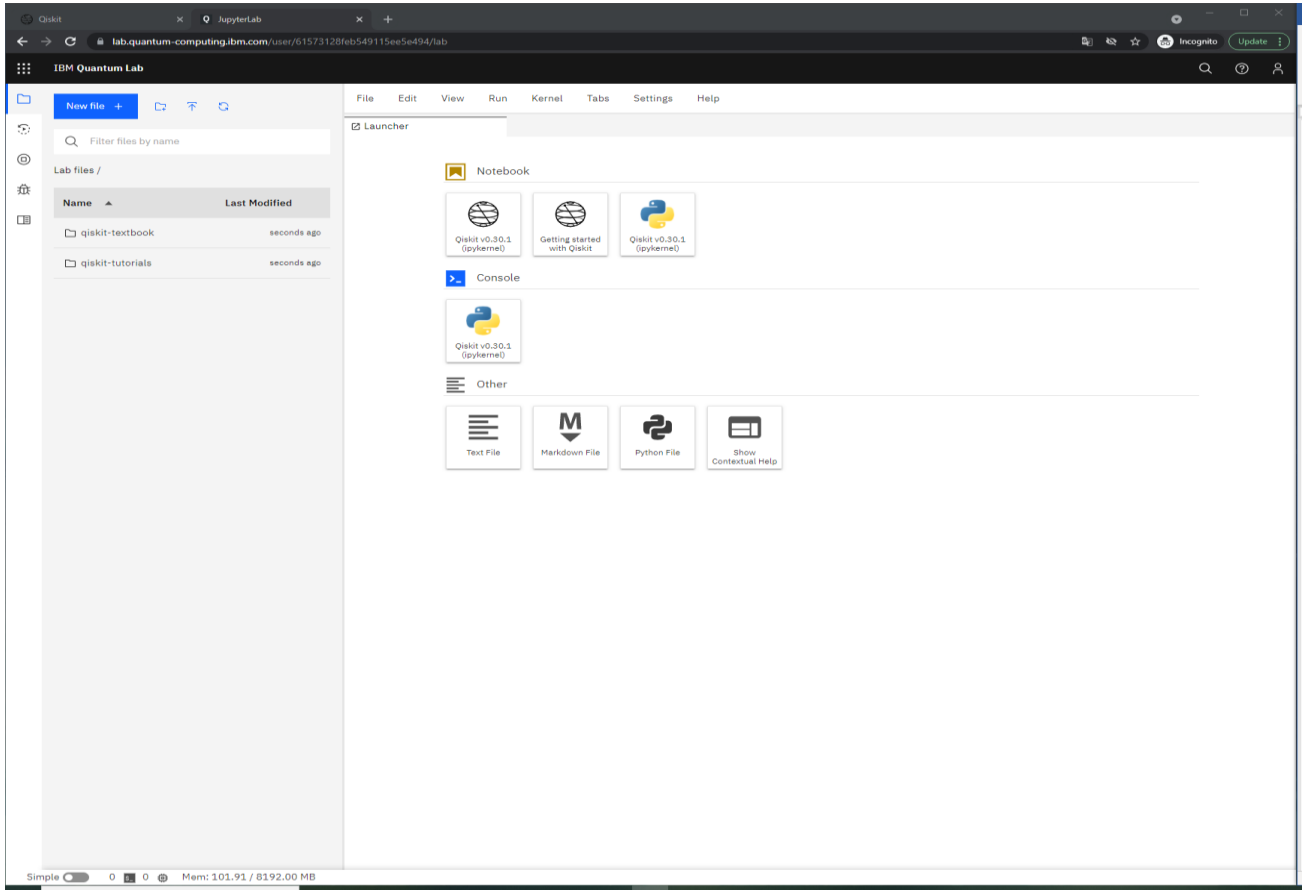
6- Complete the last step

Create IBM (Qiskit) account



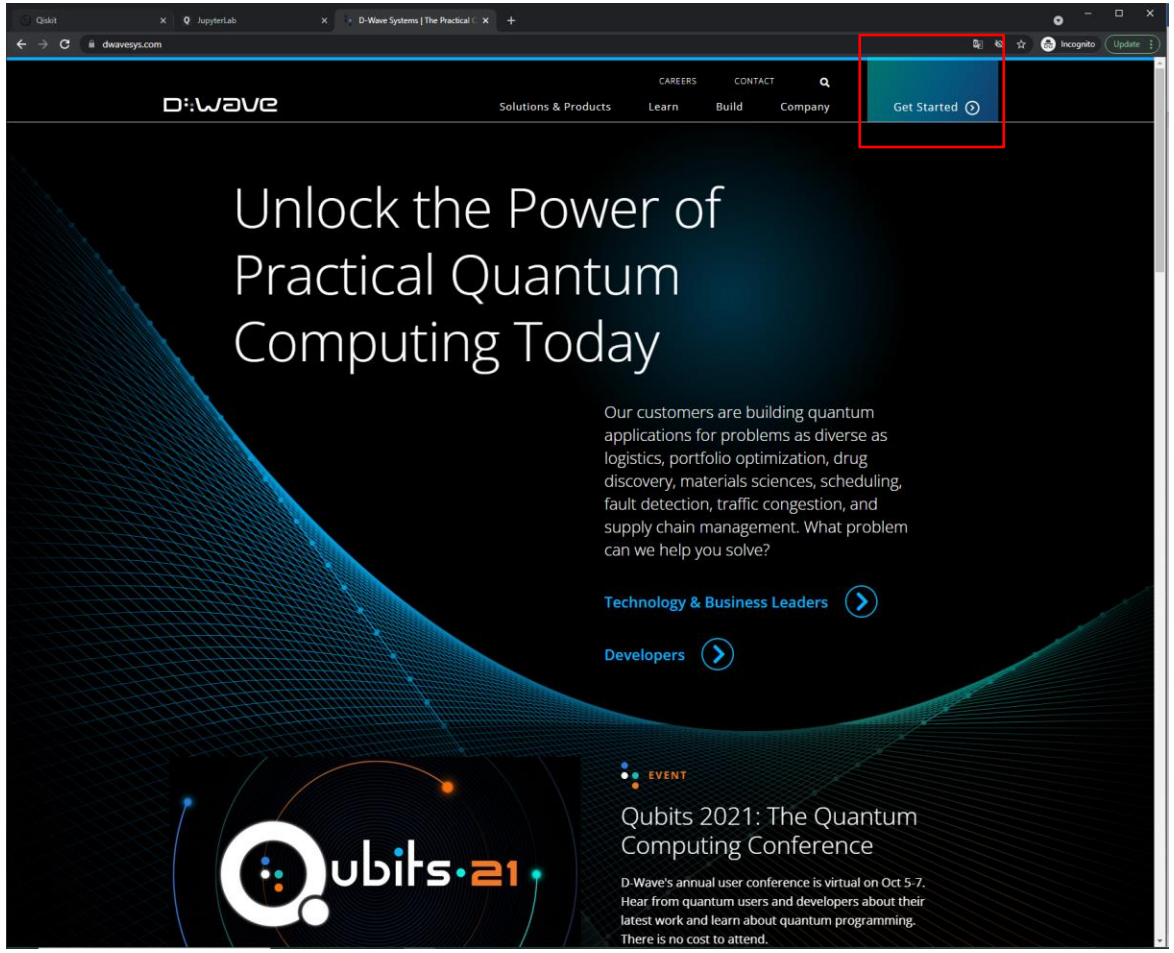
7- Wait while the server is starting up

Create IBM (Qiskit) account



8- Your account should be created successfully!

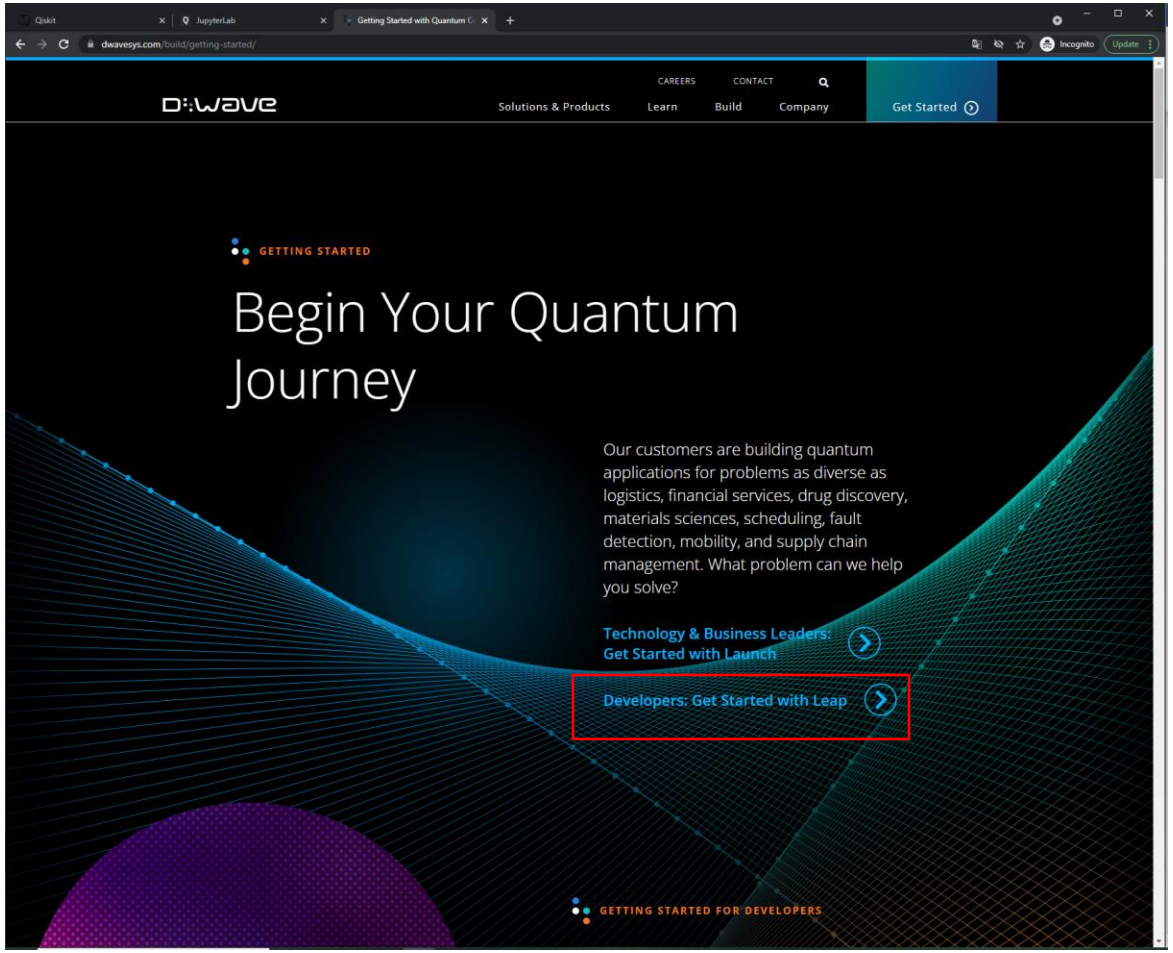
Create D-WAVE (Leap) account



1- Go to dwavesys.com

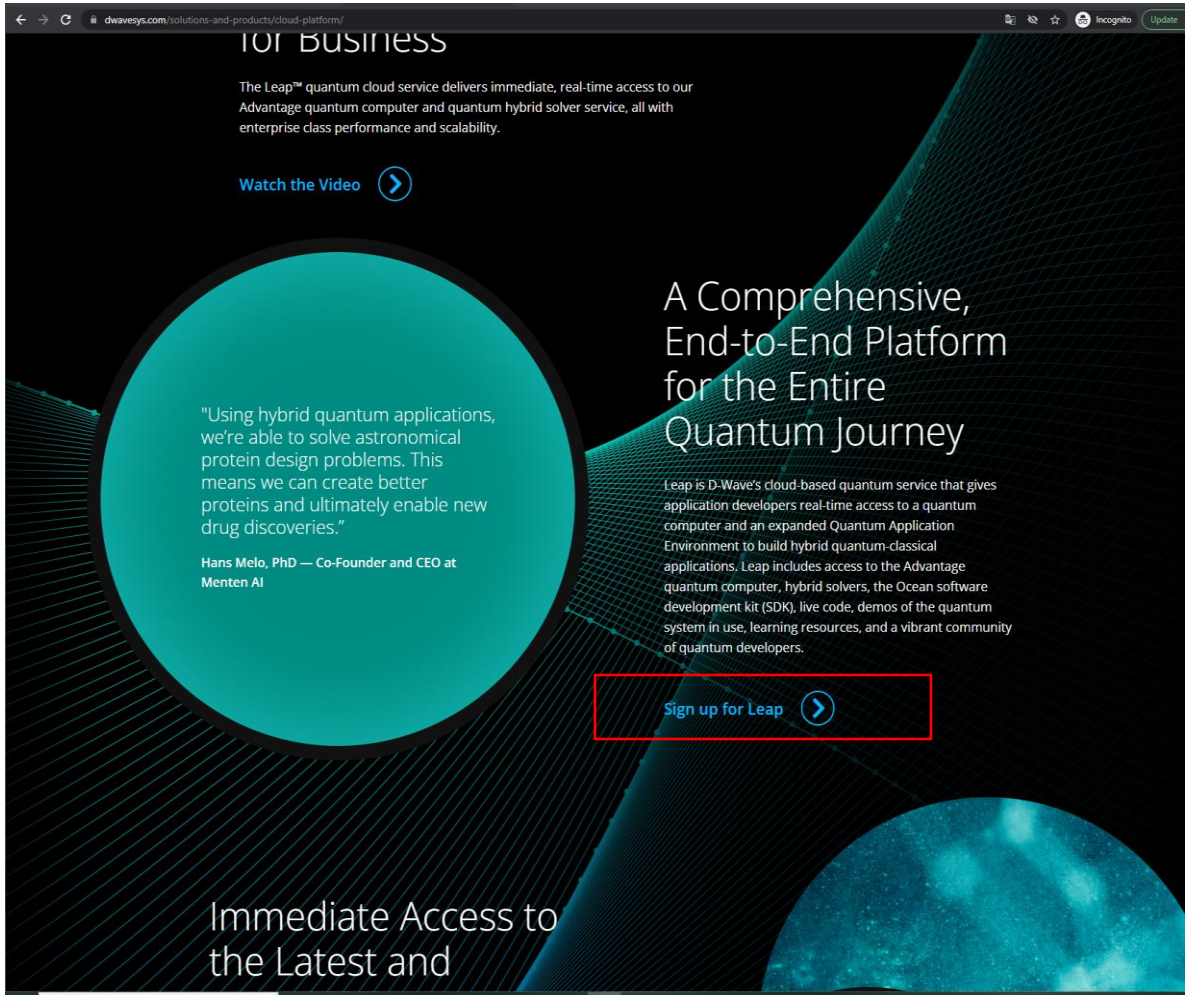
2- Click on “Get Started”

Create D-WAVE (Leap) account



3- Click on “Developers Get Started with Leap”

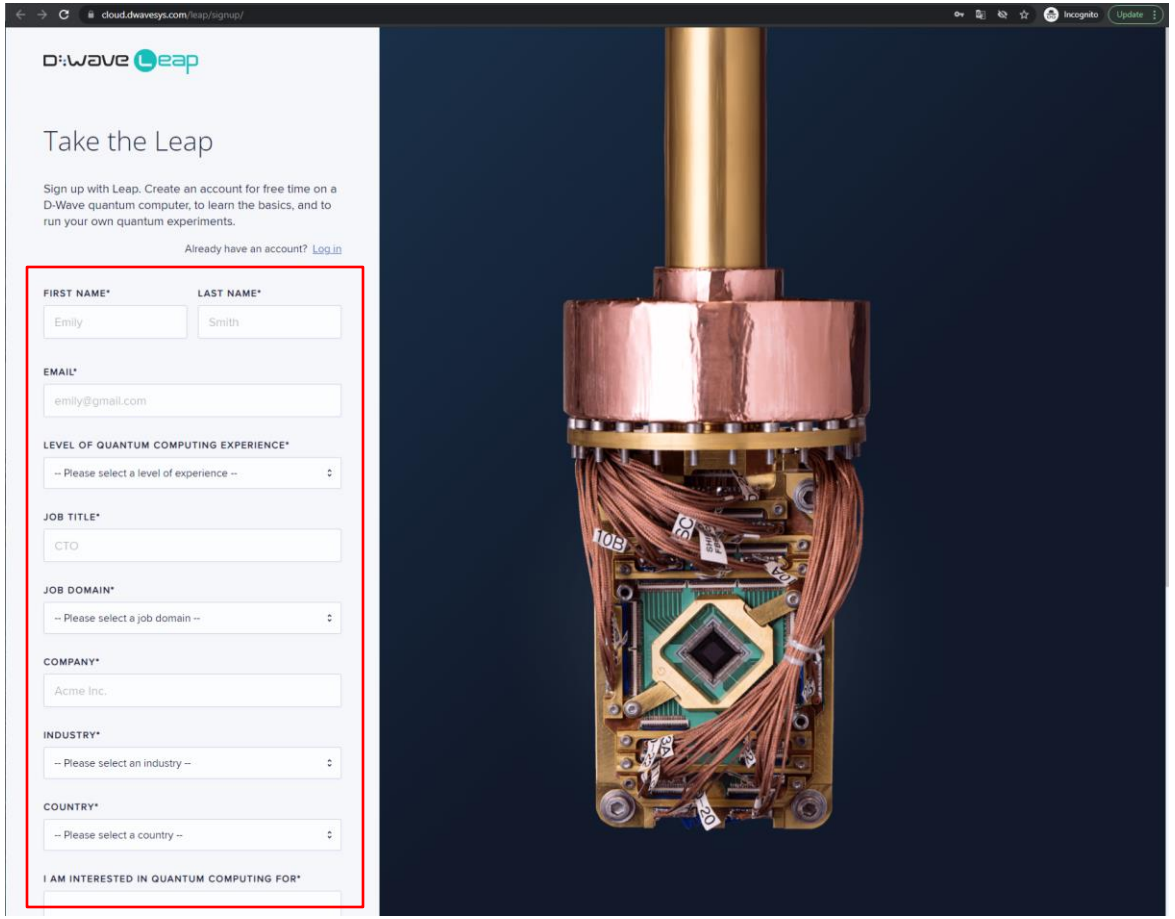
Create D-WAVE (Leap) account



4- Scroll down

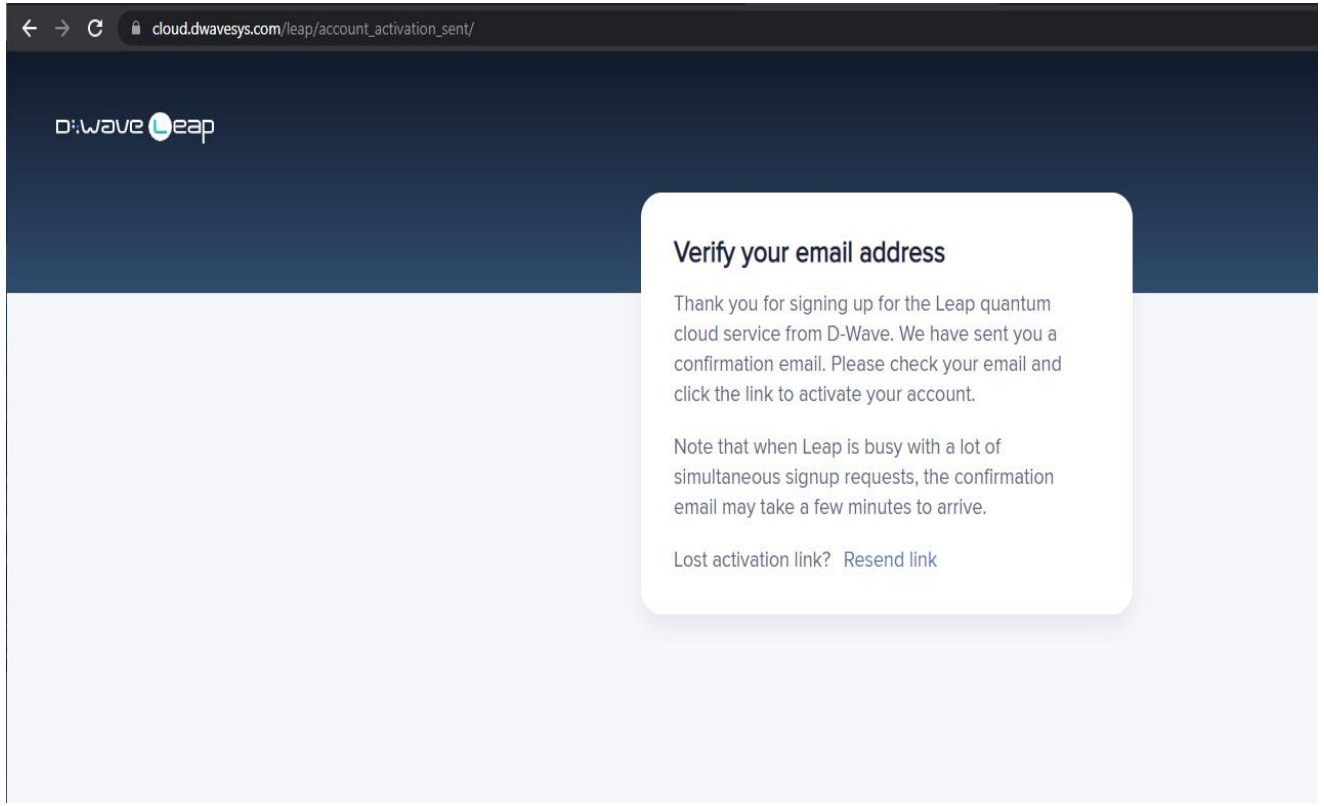
5- Click on “Sign up for Leap”

Create D-WAVE (Leap) account



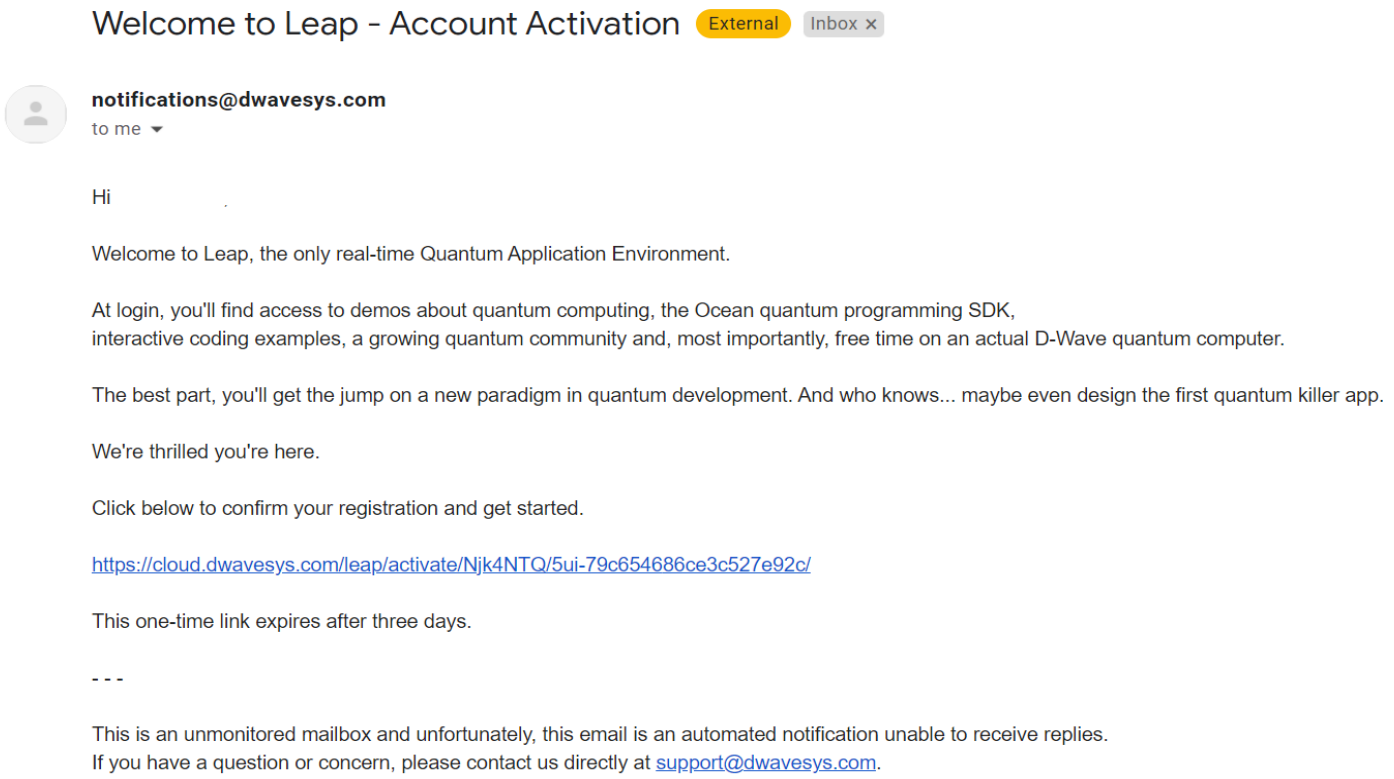
6- Follow the steps

Create D-WAVE (Leap) account



7- Verify your email address

Create D-WAVE (Leap) account



Welcome to Leap - Account Activation External Inbox ×

notifications@dwavesys.com
to me

Hi

Welcome to Leap, the only real-time Quantum Application Environment.

At login, you'll find access to demos about quantum computing, the Ocean quantum programming SDK,
interactive coding examples, a growing quantum community and, most importantly, free time on an actual D-Wave quantum computer.

The best part, you'll get the jump on a new paradigm in quantum development. And who knows... maybe even design the first quantum killer app.

We're thrilled you're here.

Click below to confirm your registration and get started.

https://cloud.dwavesys.com/leap/activate/Njk4NTQ/5ui-79c654686ce3c527e92c/

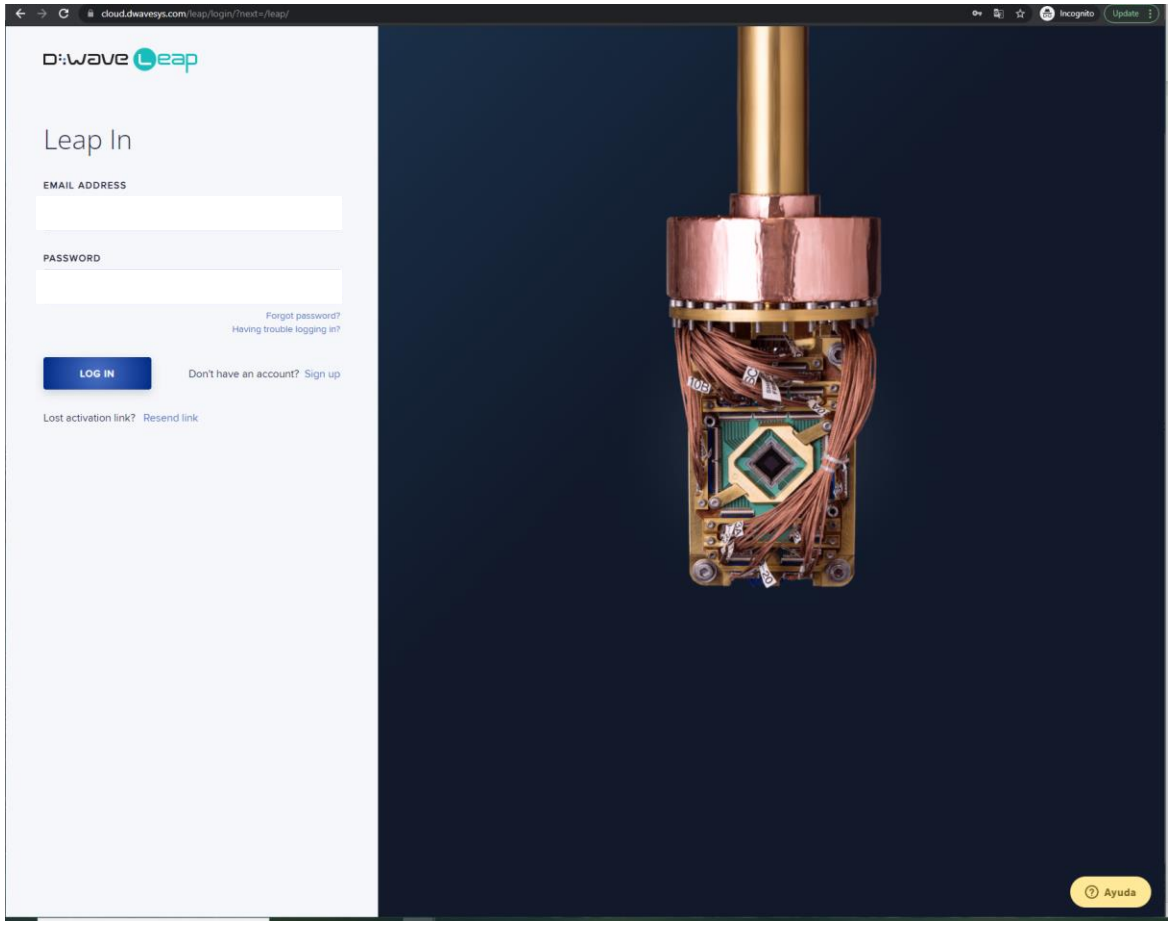
This one-time link expires after three days.

- - -

This is an unmonitored mailbox and unfortunately, this email is an automated notification unable to receive replies.
If you have a question or concern, please contact us directly at support@dwavesys.com.

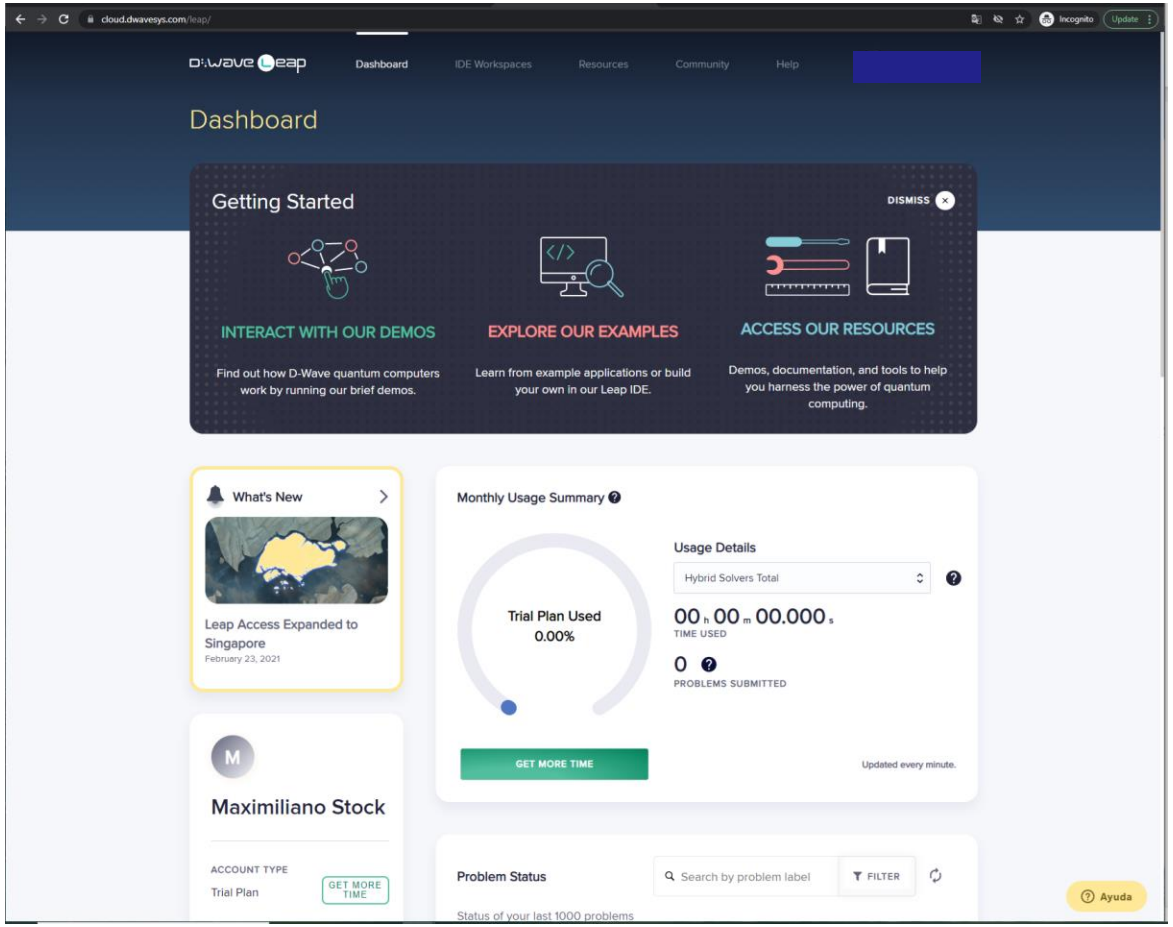
8- Confirm your registration

Create D-WAVE (Leap) account



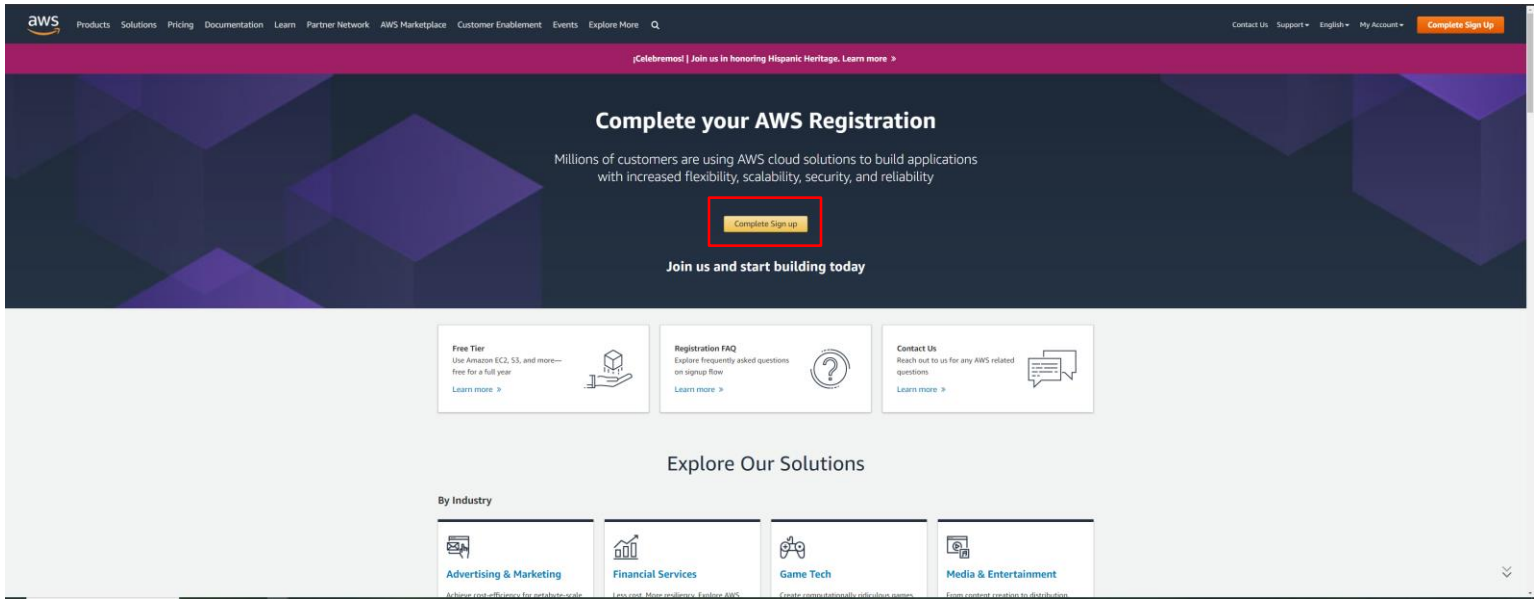
9- Log in

Create D-WAVE (Leap) account



10- Enjoy!

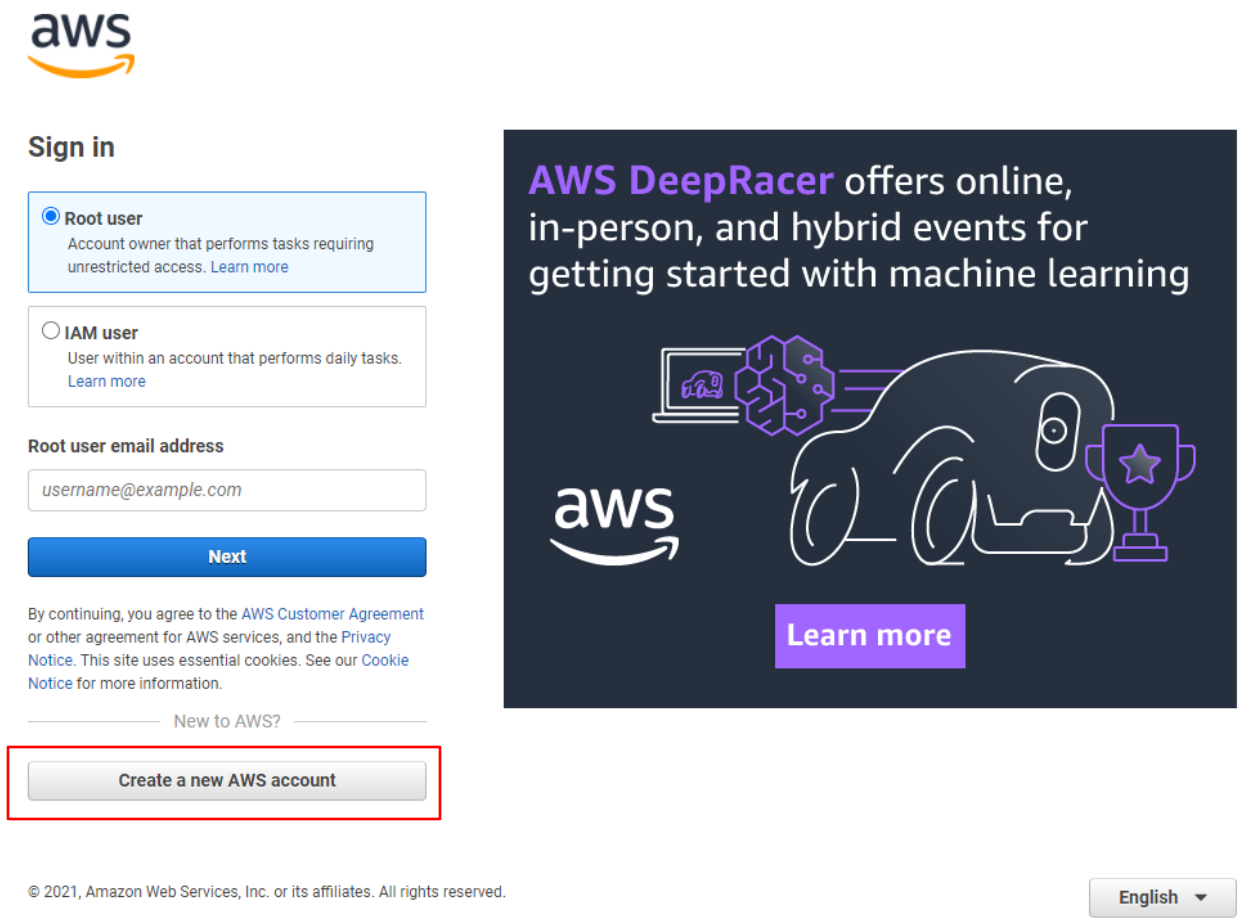
Create AWS account



1- Go to https://aws.amazon.com/

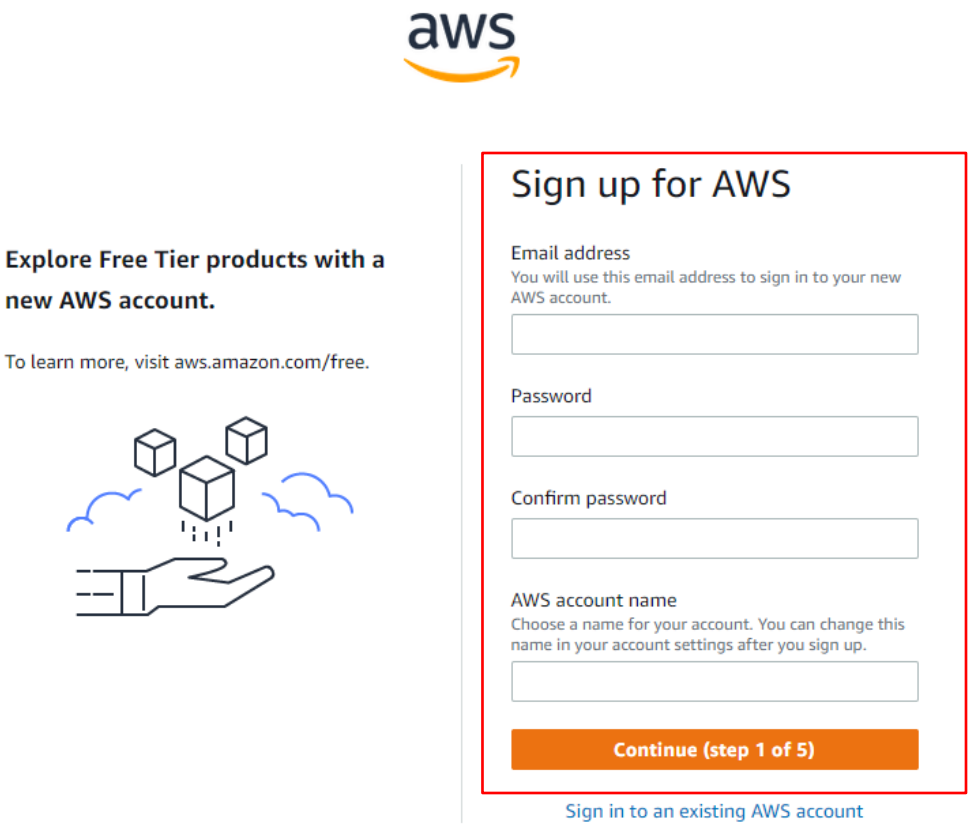
2- Click “Complete sign up”

Create AWS account



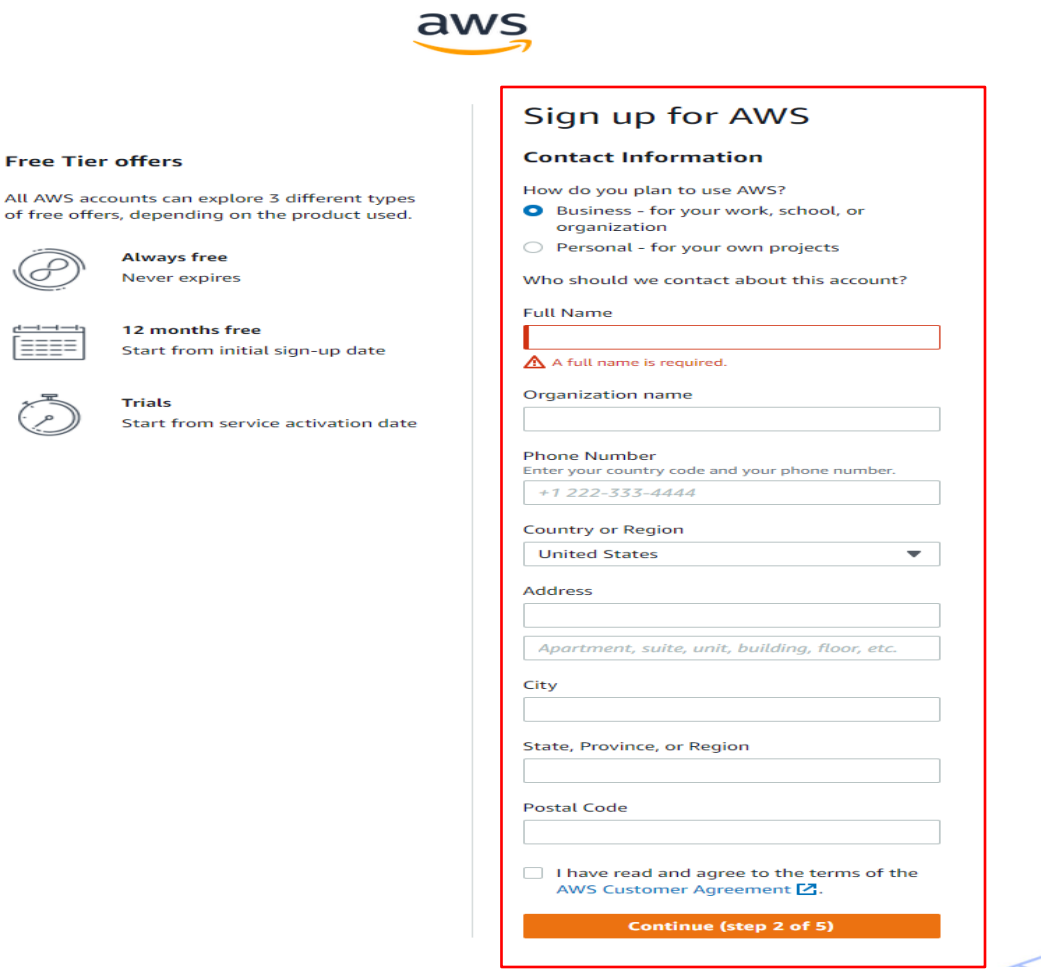
3- Click “Create a new AWS account”

Create AWS account



4- Complete step 1

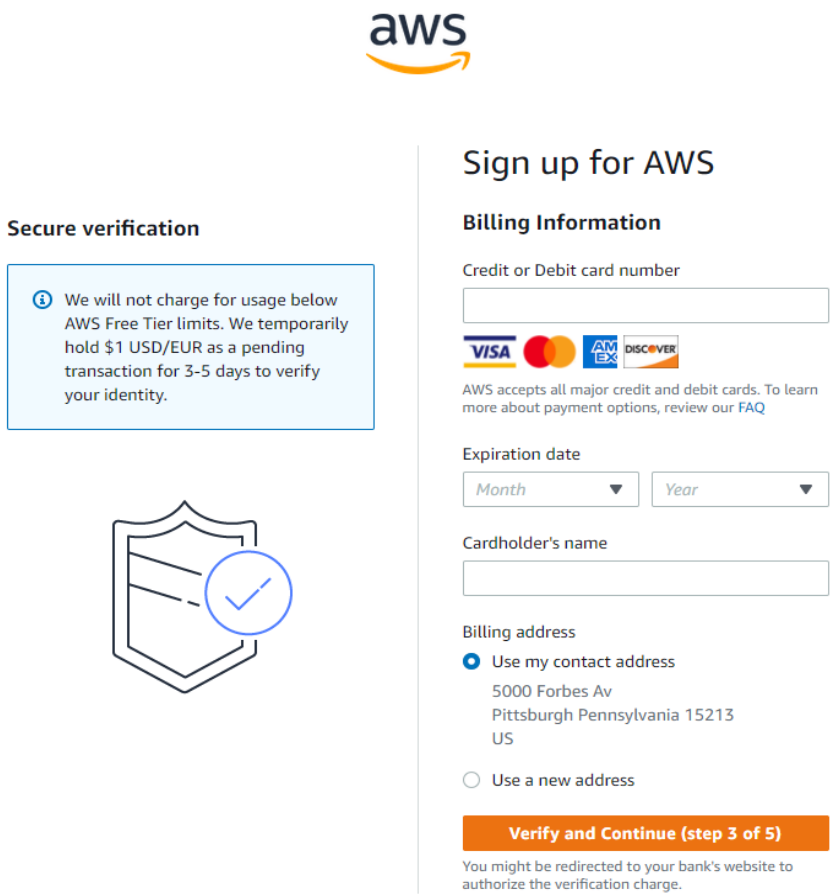
Create AWS account



5- Select “Business – for your work, school, or organization”

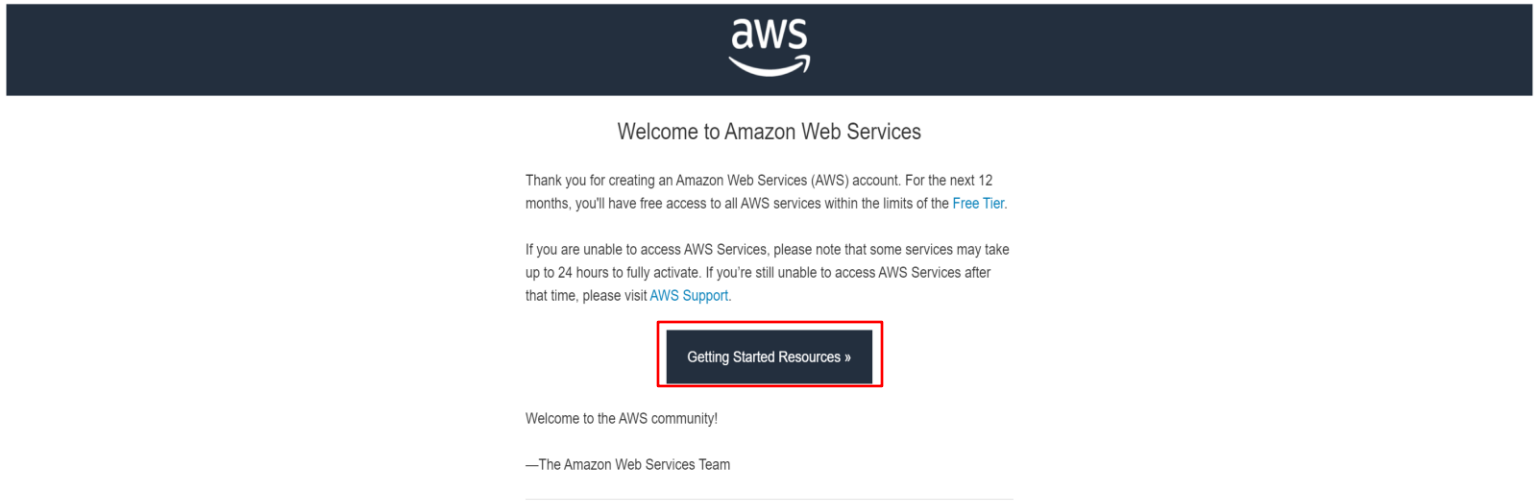
6- Complete step 2

Create AWS account



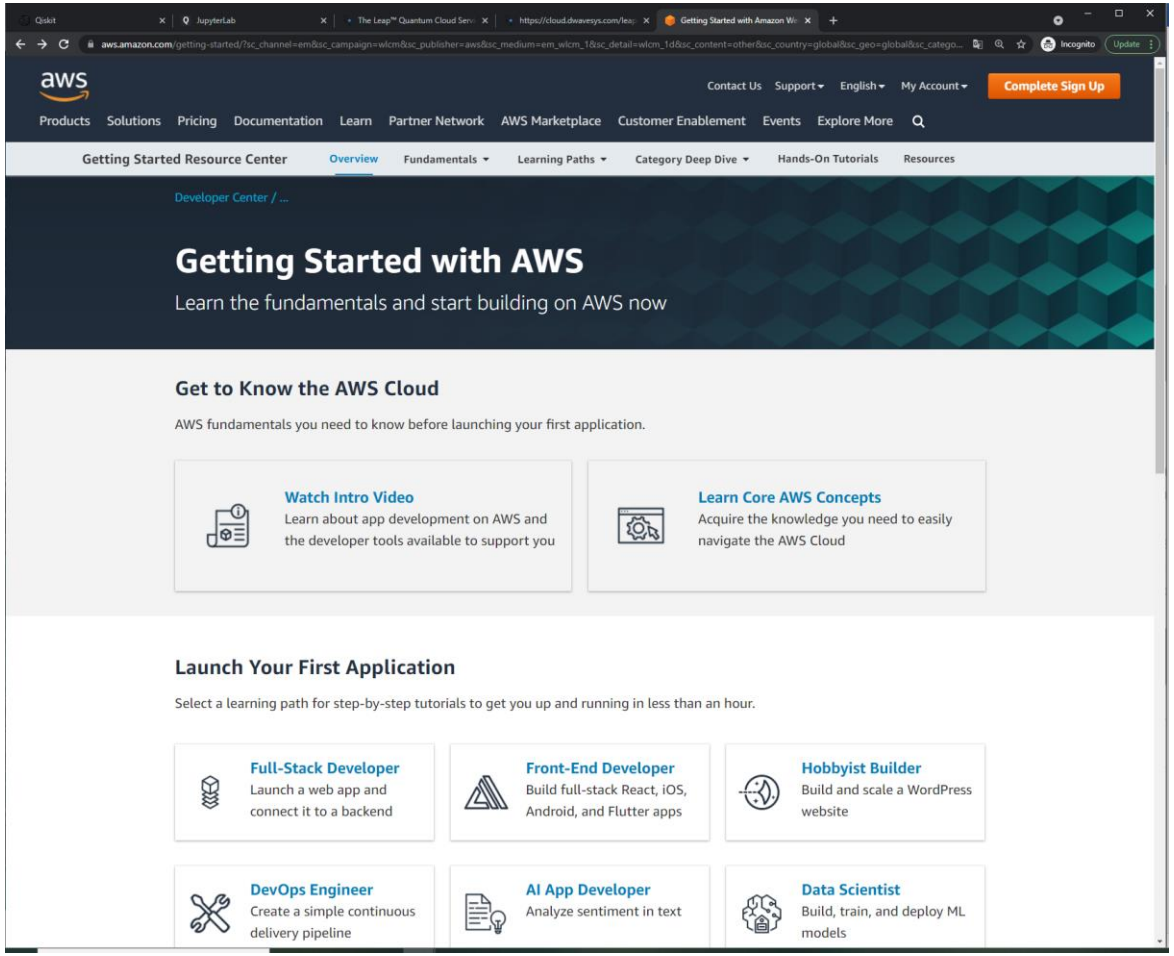
7- Ignore step 3 and wait for the welcome email from AWS.

Create AWS account



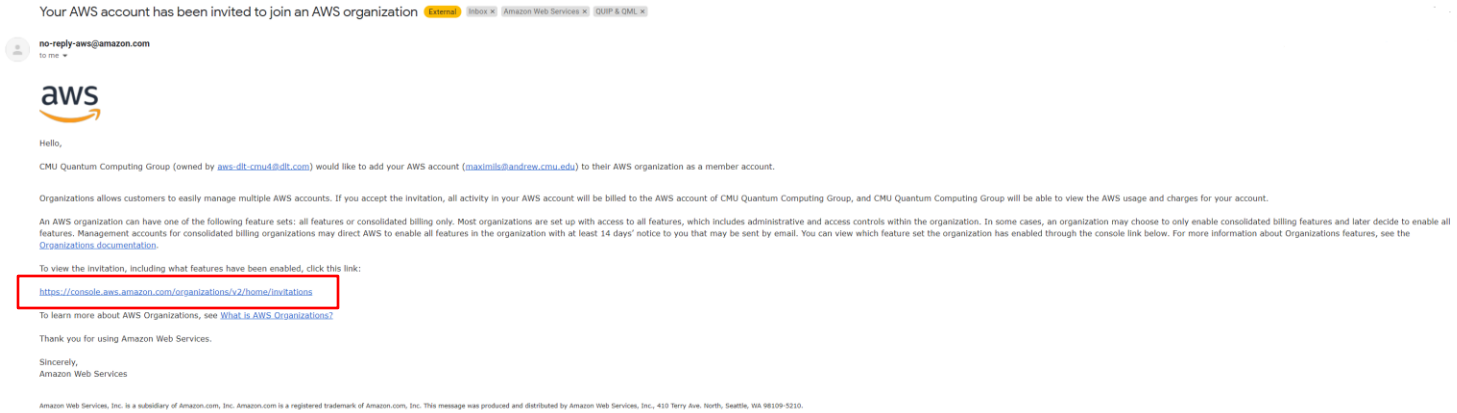
8- Click on “Getting Started Resources”

Create AWS account



9- You should be redirected to aws.amazon.com/getting-started

Create AWS account



Your AWS account has been invited to join an AWS organization External Inbox × Amazon Web Services × QUIP & QML ×

no-reply-aws@amazon.com
to me

aws

Hello,

CMU Quantum Computing Group (owned by aws-dlt-cmu4@dlt.com) would like to add your AWS account (maximils@andrew.cmu.edu) to their AWS organization as a member account.

Organizations allows customers to easily manage multiple AWS accounts. If you accept the invitation, all activity in your AWS account will be billed to the AWS account of CMU Quantum Computing Group, and CMU Quantum Computing Group will be able to view the AWS usage and charges for your account.

An AWS organization can have one of the following feature sets: all features or consolidated billing only. Most organizations are set up with access to all features, which includes administrative and access controls within the organization. In some cases, an organization may choose to only enable consolidated billing features and later decide to enable all features. Management accounts for consolidated billing organizations may direct AWS to enable all features in the organization with at least 14 days' notice to you that may be sent by email. You can view which feature set the organization has enabled through the console link below. For more information about Organizations features, see the Organizations documentation.

To view the invitation, including what features have been enabled, click this link:

https://console.aws.amazon.com/organizations/v2/home/invitations

To learn more about AWS Organizations, see What is AWS Organizations?

Thank you for using Amazon Web Services.

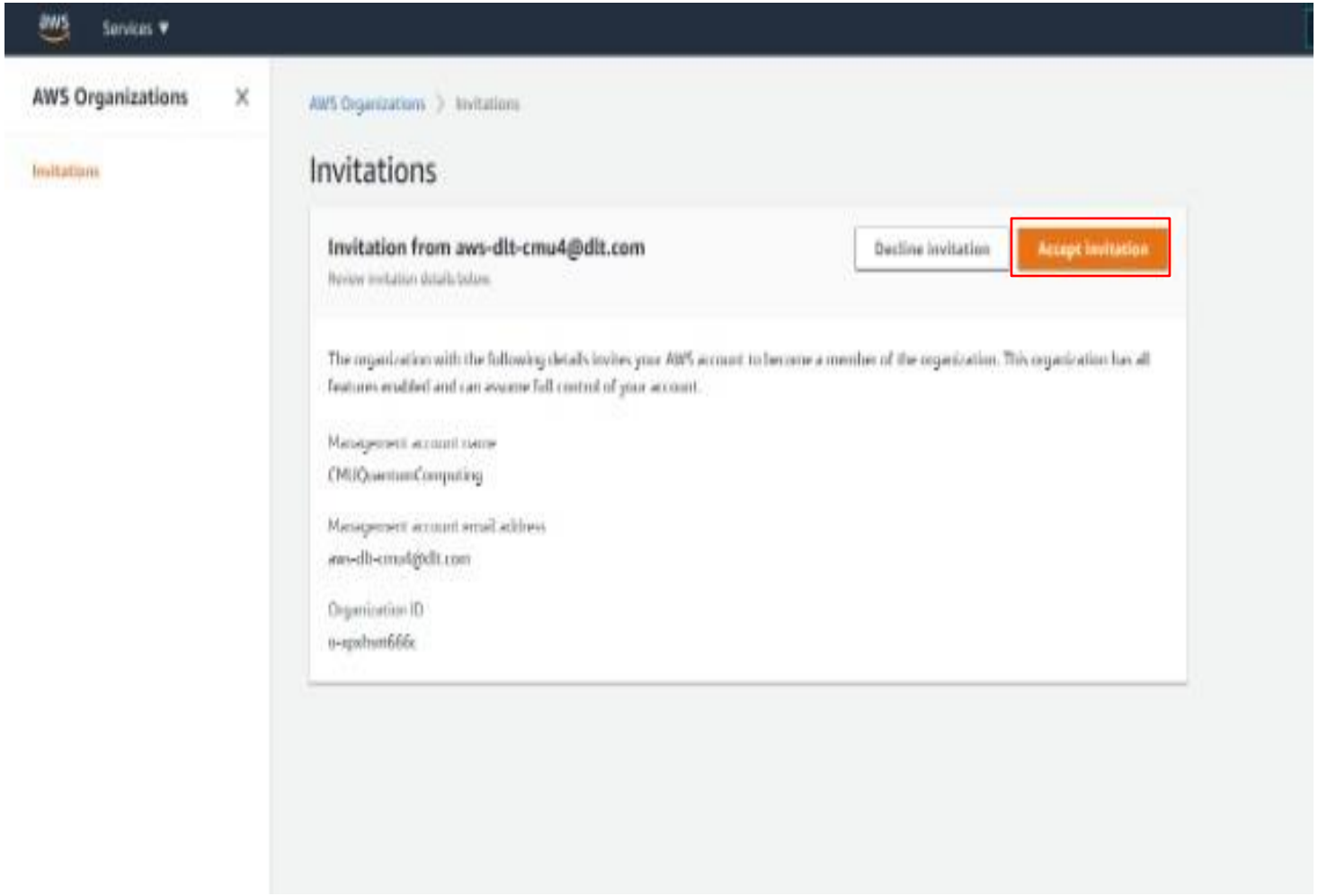
Sincerely,
Amazon Web Services

Amazon Web Services, Inc. is a subsidiary of Amazon.com, Inc. Amazon.com is a registered trademark of Amazon.com, Inc. This message was produced and distributed by Amazon Web Services, Inc., 410 Terry Ave. North, Seattle, WA 98109-5210.

10- Check your email

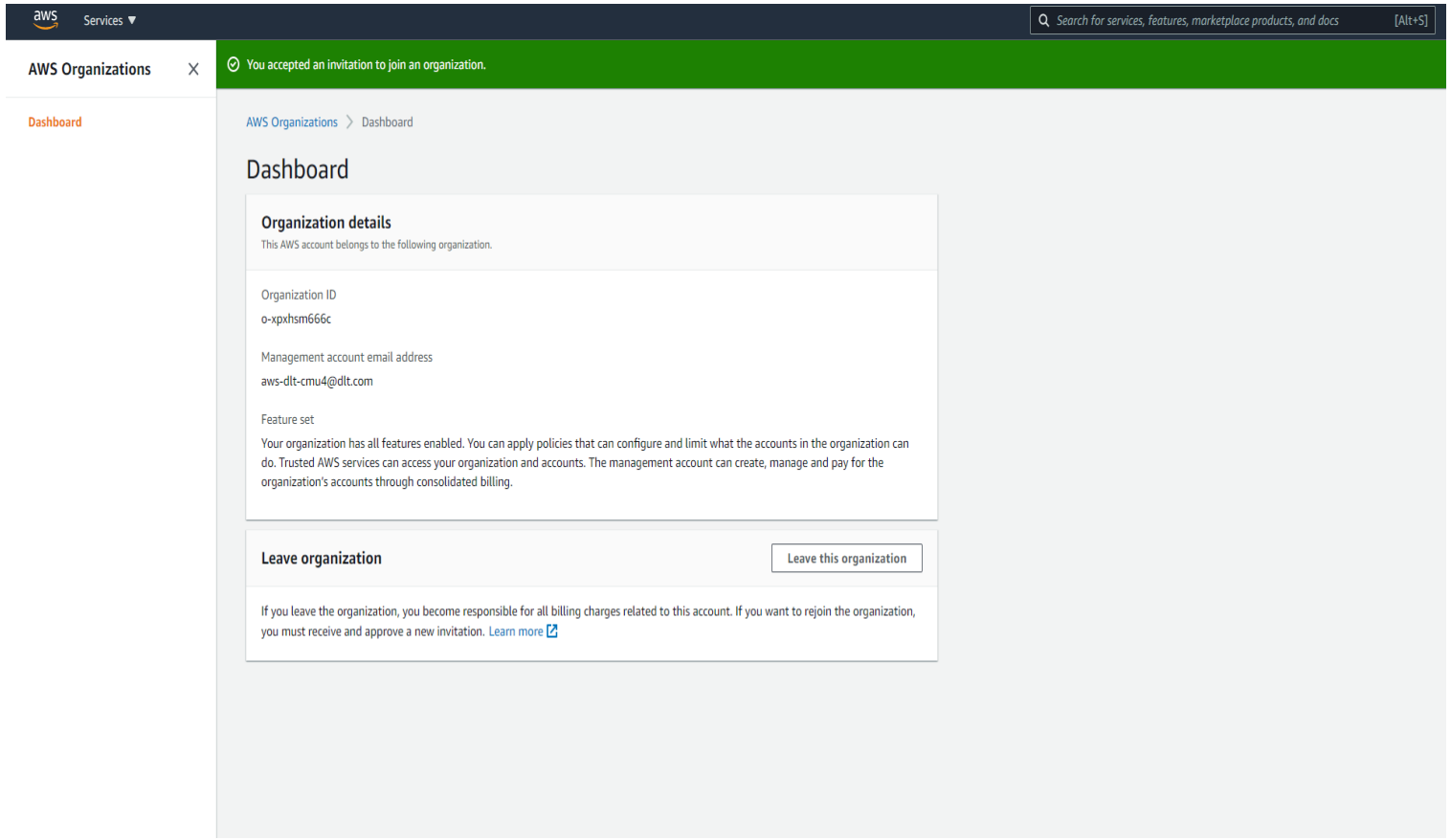
11- Click the link to view the invitation to join an AWS Organization

Create AWS account



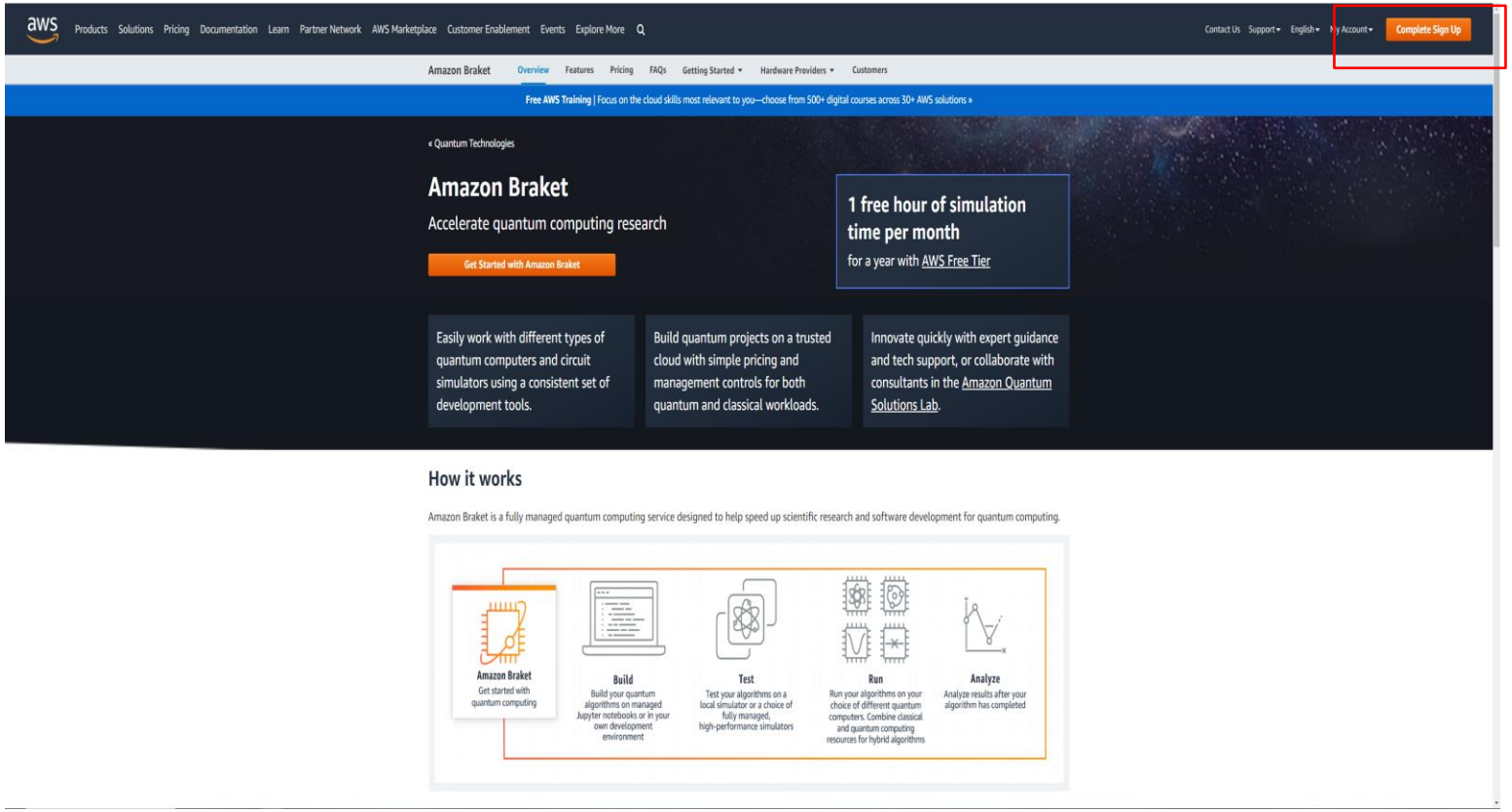
12- Accept invitation

Create AWS account



13- Enjoy!

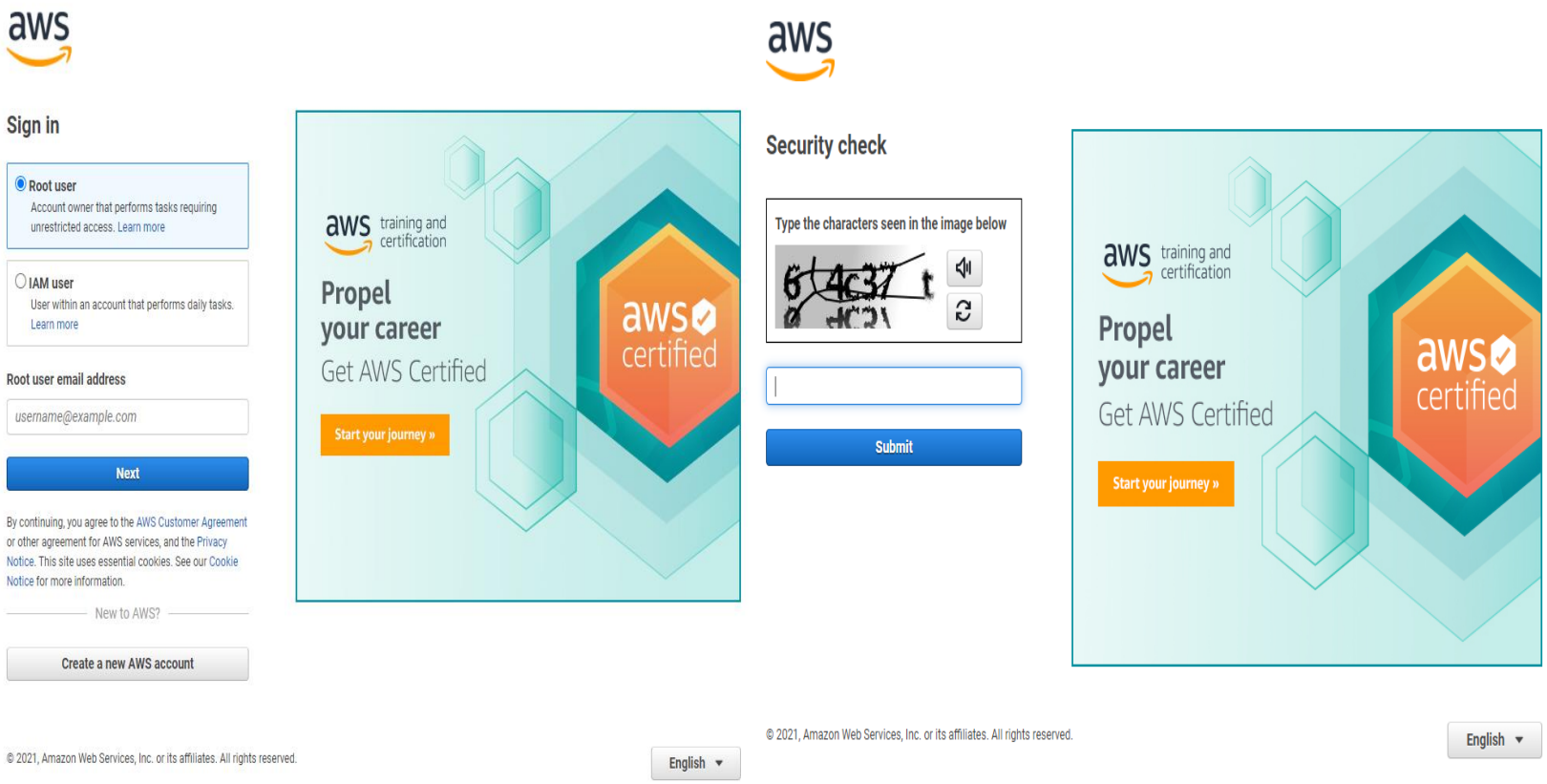
Amazon Braket



1- Go to https://aws.amazon.com/es/braket/

2- Complete Sign up

Amazon Braket

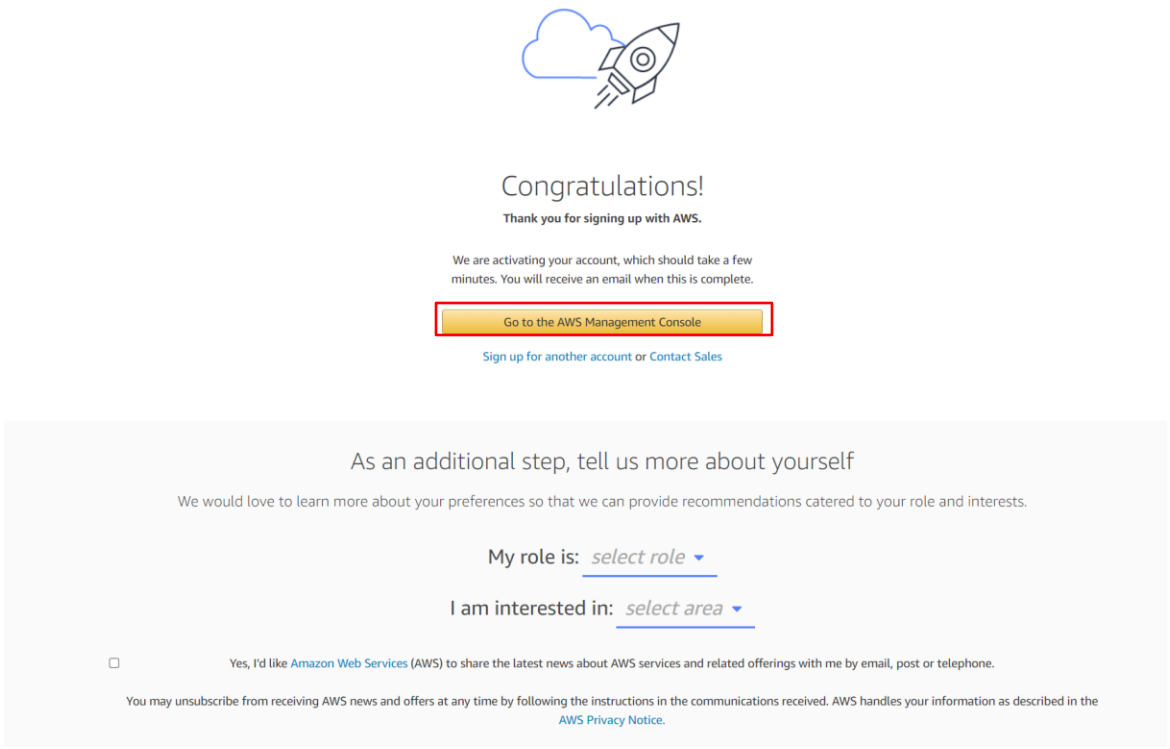


3- Sign up

Amazon Braket

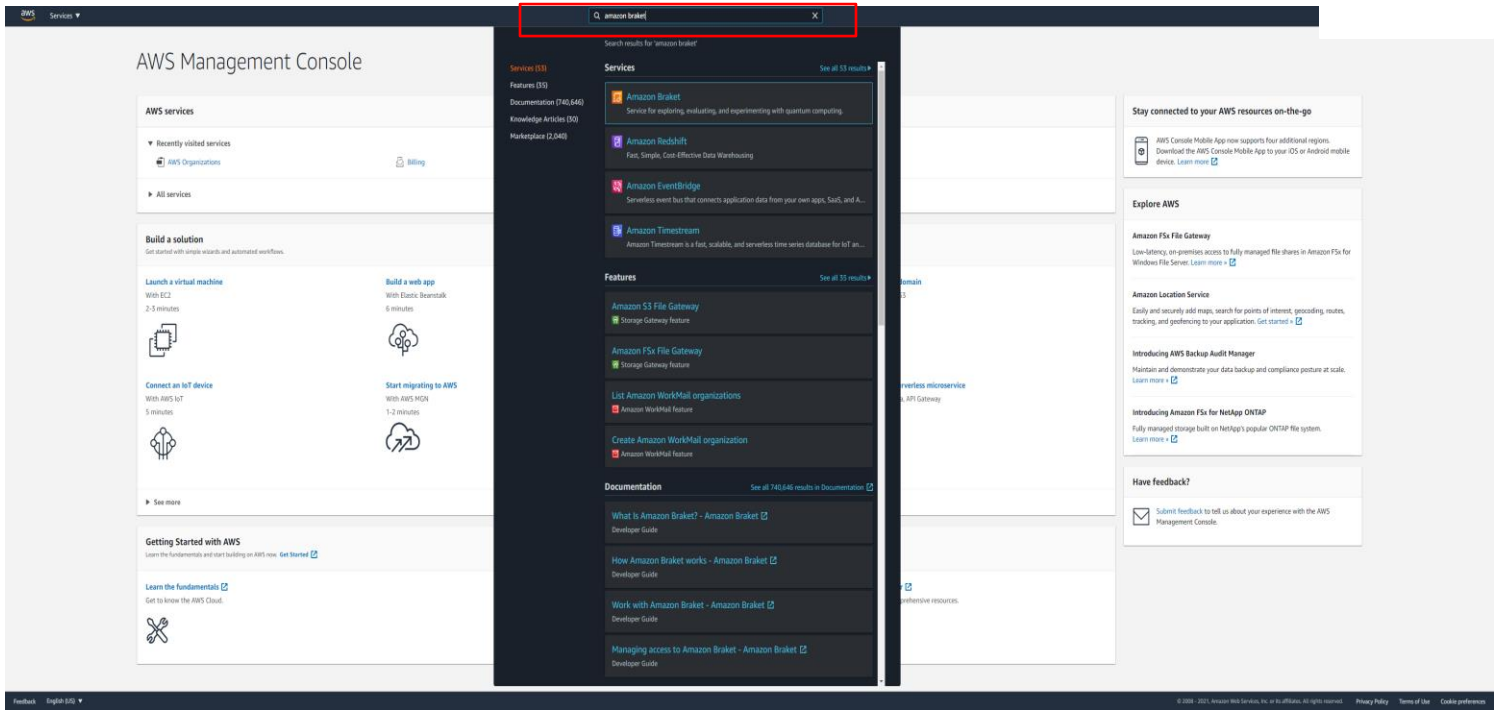
4- Complete Sign up

Amazon Braket



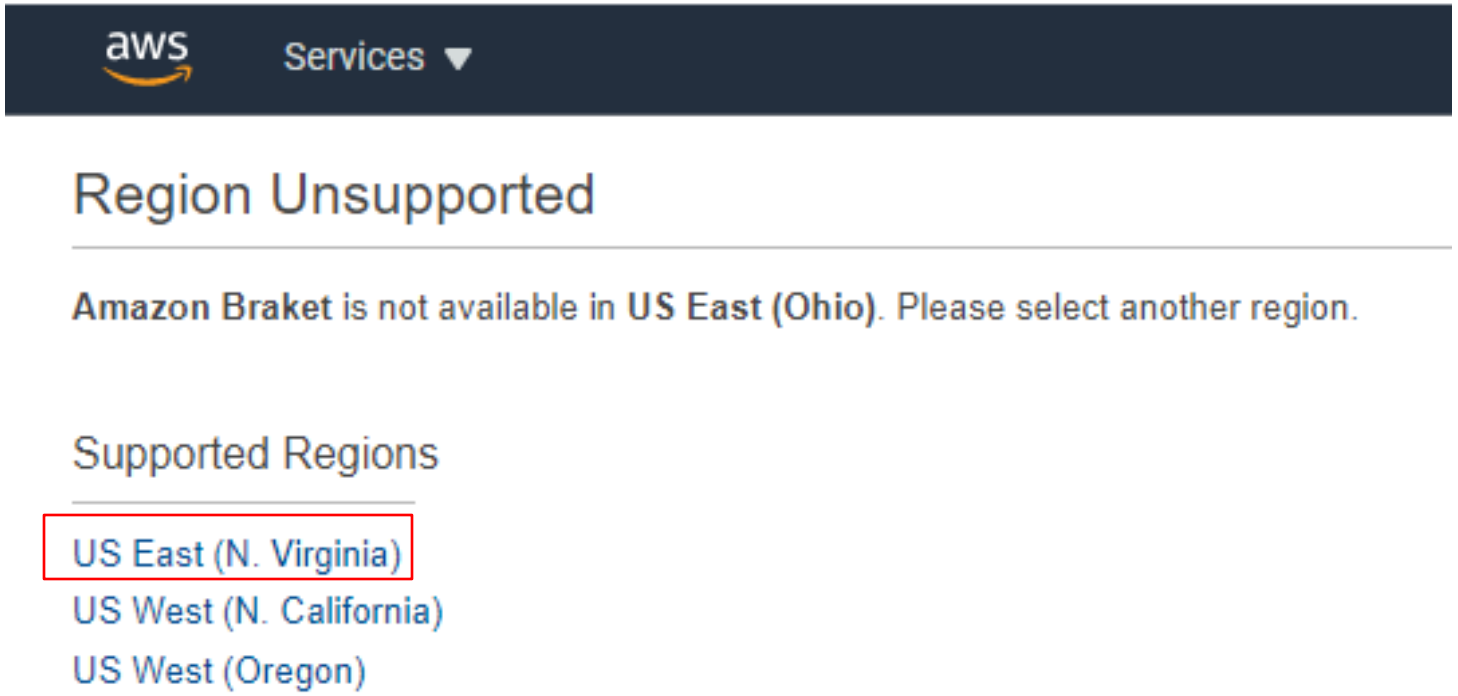
5- Go to the AWS Management Console

Amazon Braket



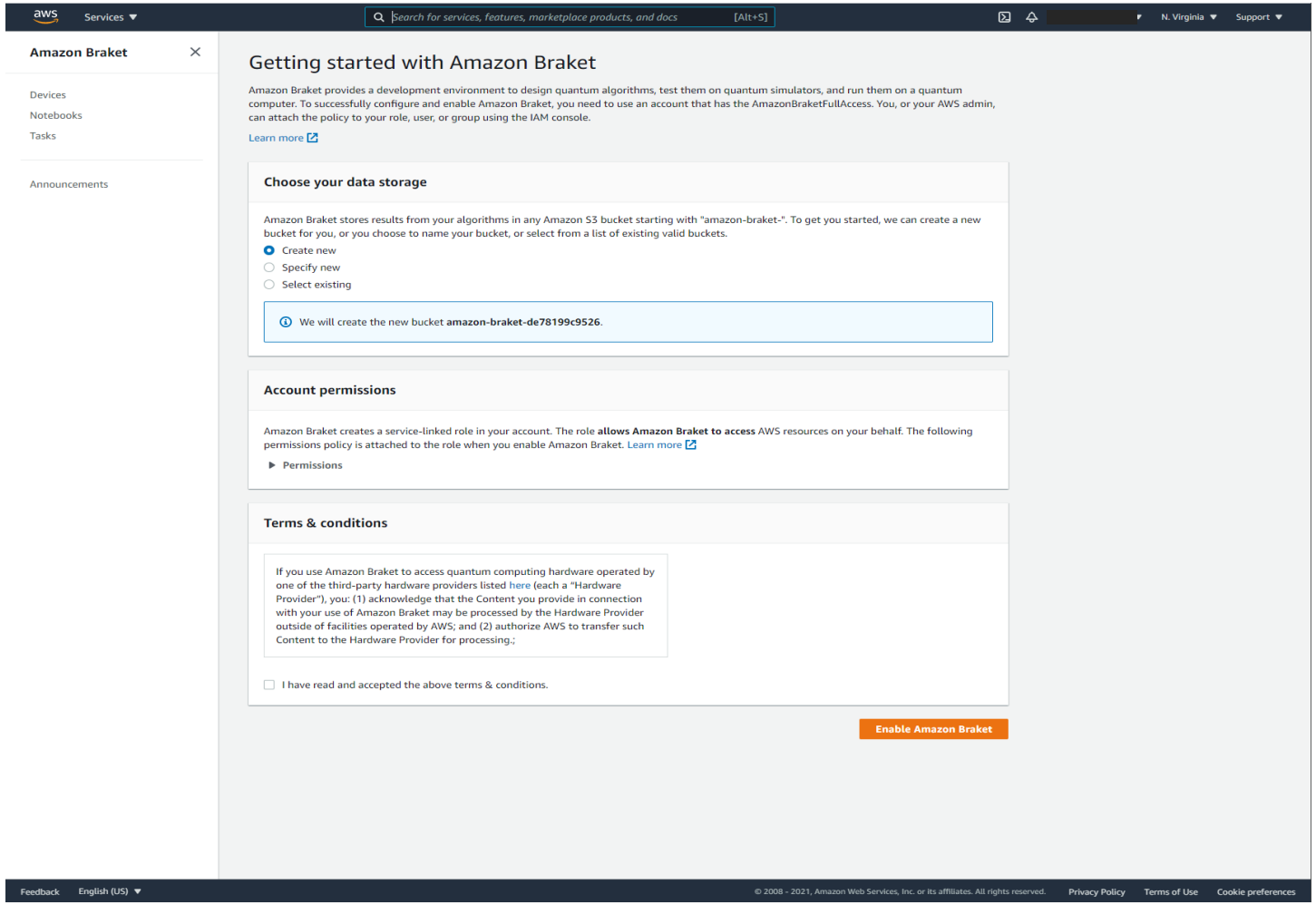
6- Search for Amazon Braket

Amazon Braket



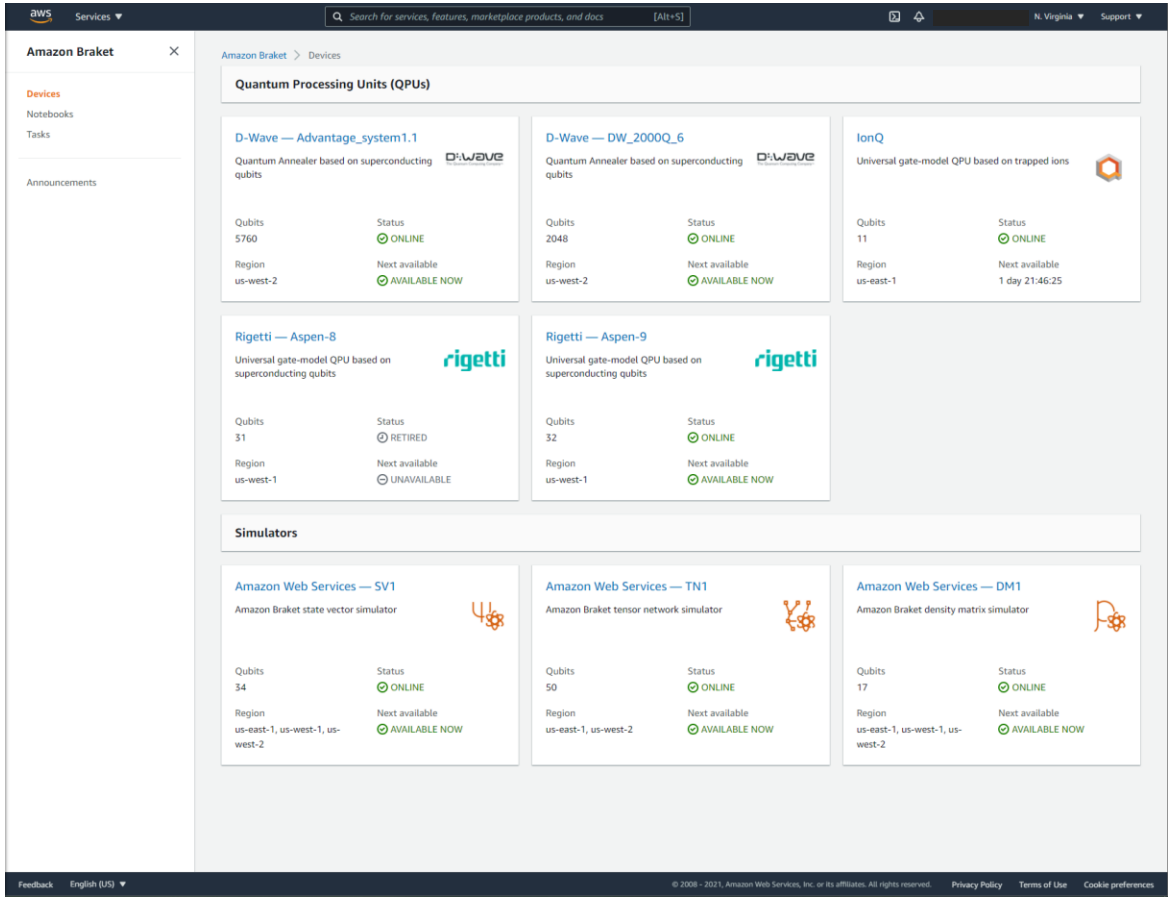
7- Upon opening the Amazon Braket service, the website may say it is unavailable in your location. If so, change to a suitable location, for instance *US East (N. Virginia)*

Amazon Braket



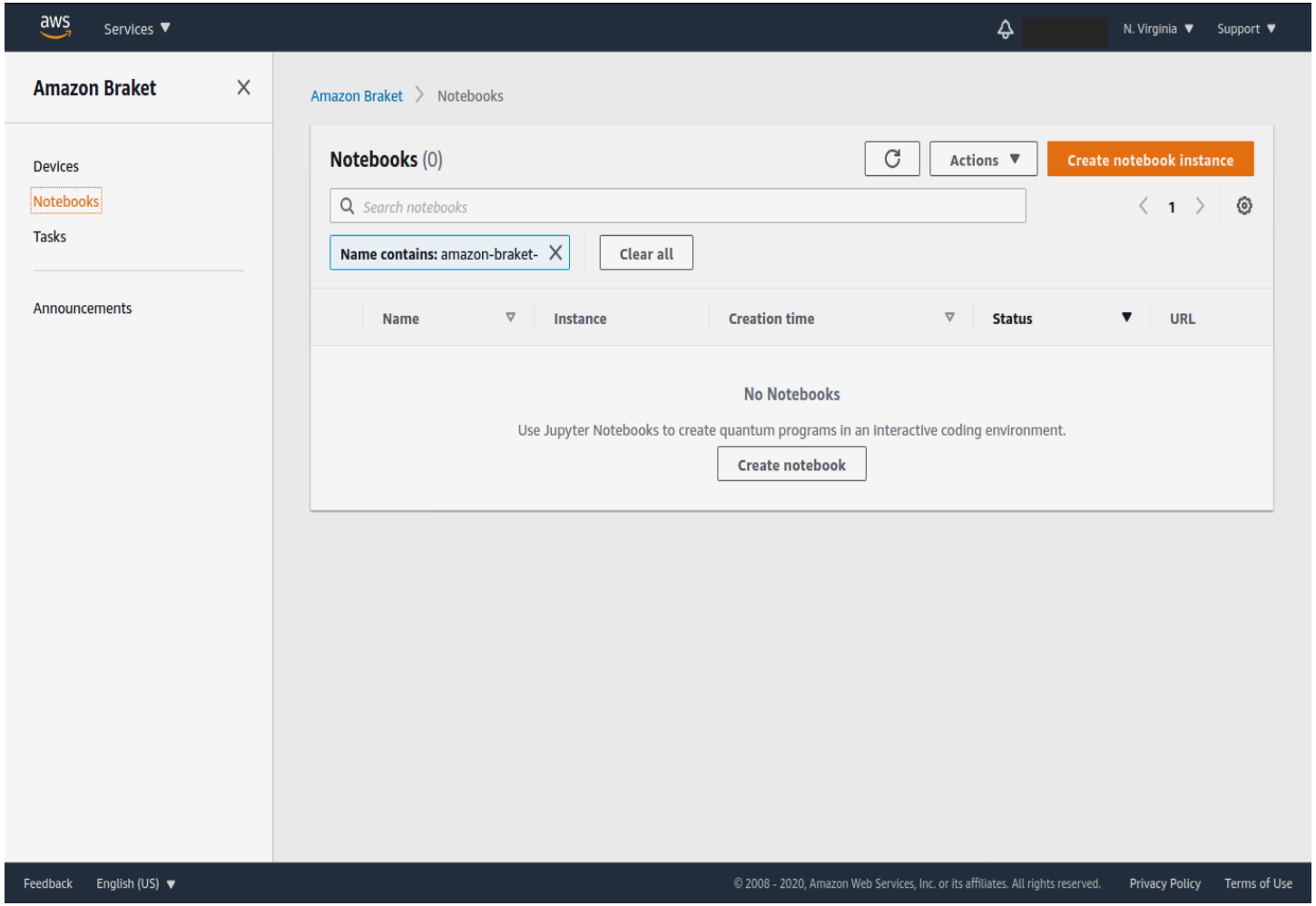
8- Accept terms & conditions
9- Enable Amazon Braket

Amazon Braket



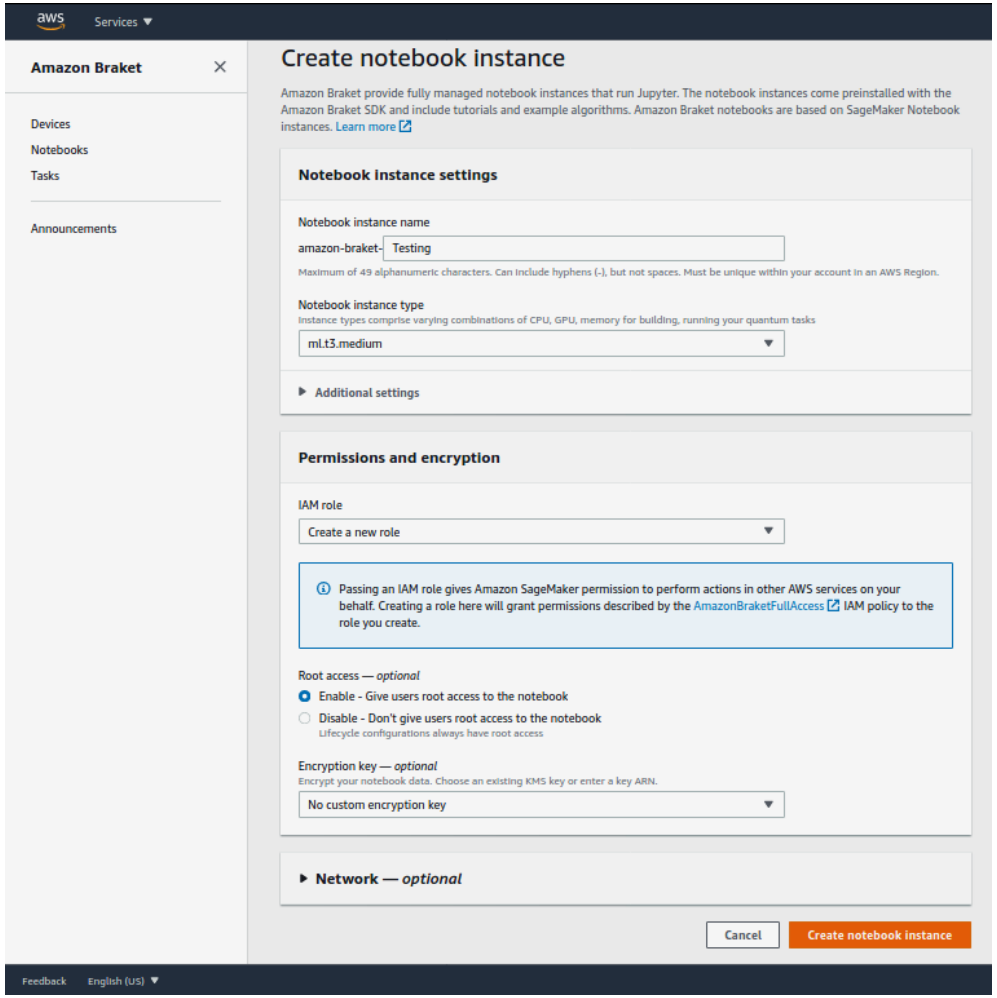
10- Start Amazon Braket. Locate home page with various machines and simulators.

Amazon Braket



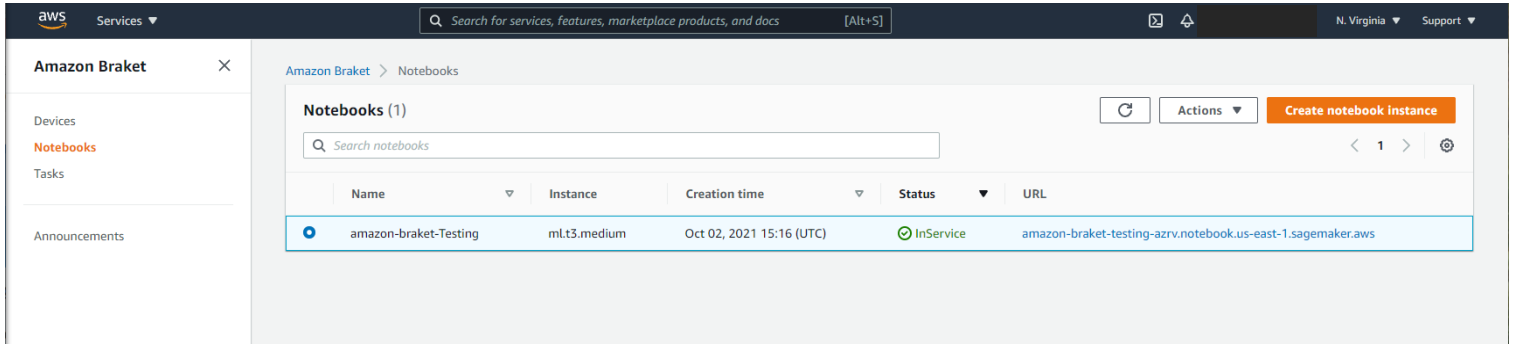
11- Go straight to notebooks on the left pane.

Amazon Braket



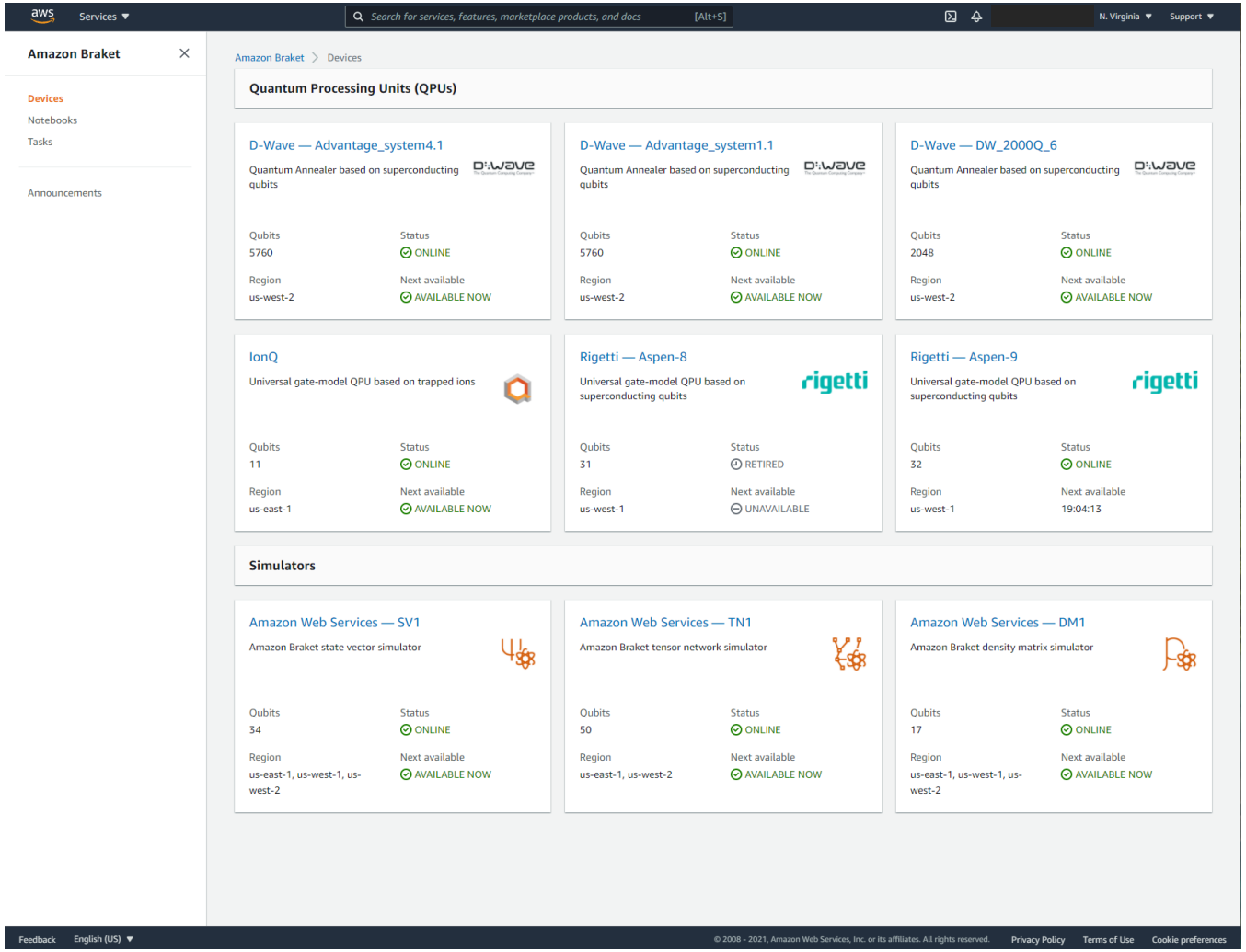
12- To create Notebook instance provide a name and click “Create Notebook Instance”

Amazon Braket



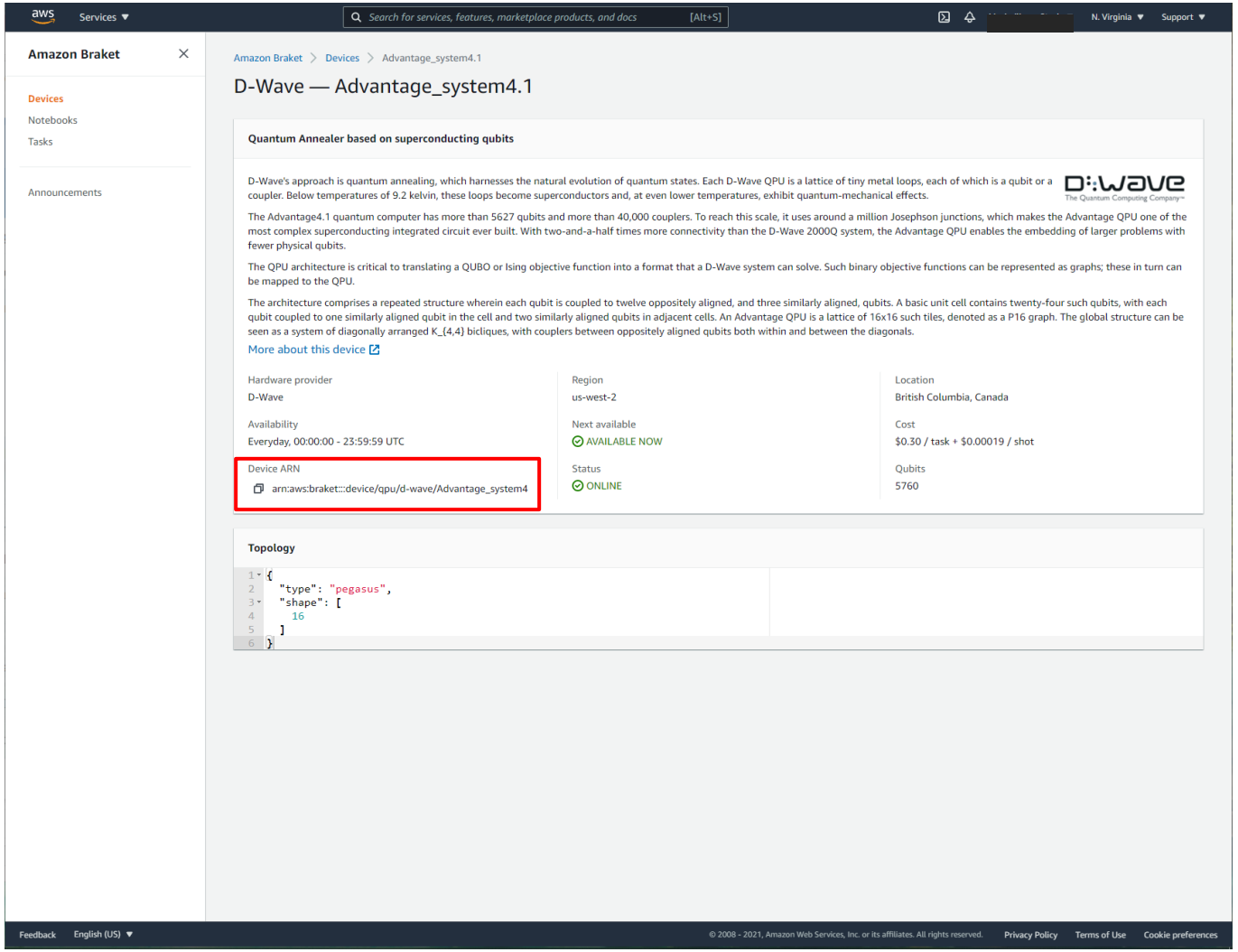
13- Check status of Notebook. It takes a short amount of time for the notebooks to get created. During this time feel free to check out the devices available to you by clicking on “Devices” in the left tab.

Amazon Braket



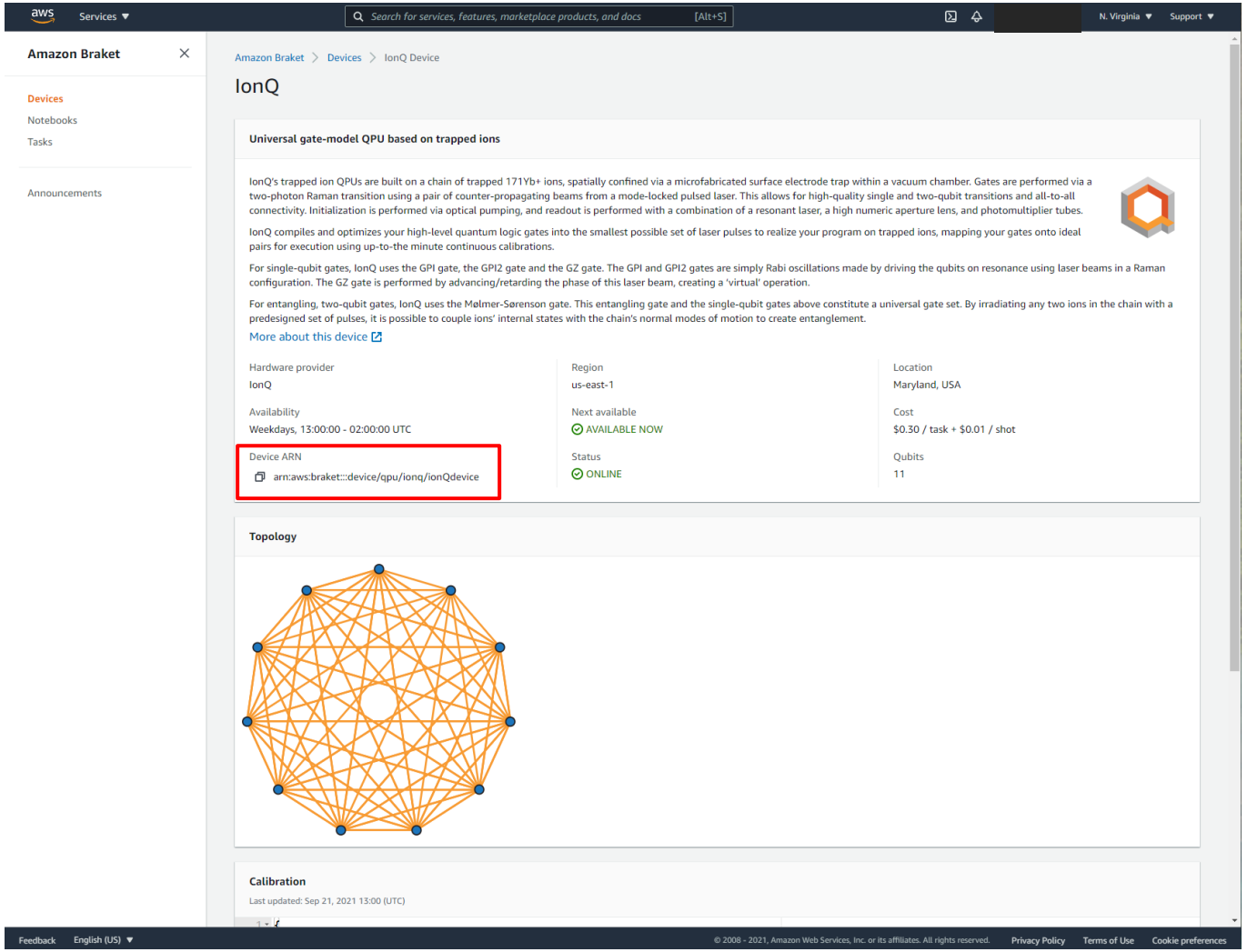
14- The Devices Page: Click on each device to see what is under the hood.

Amazon Braket



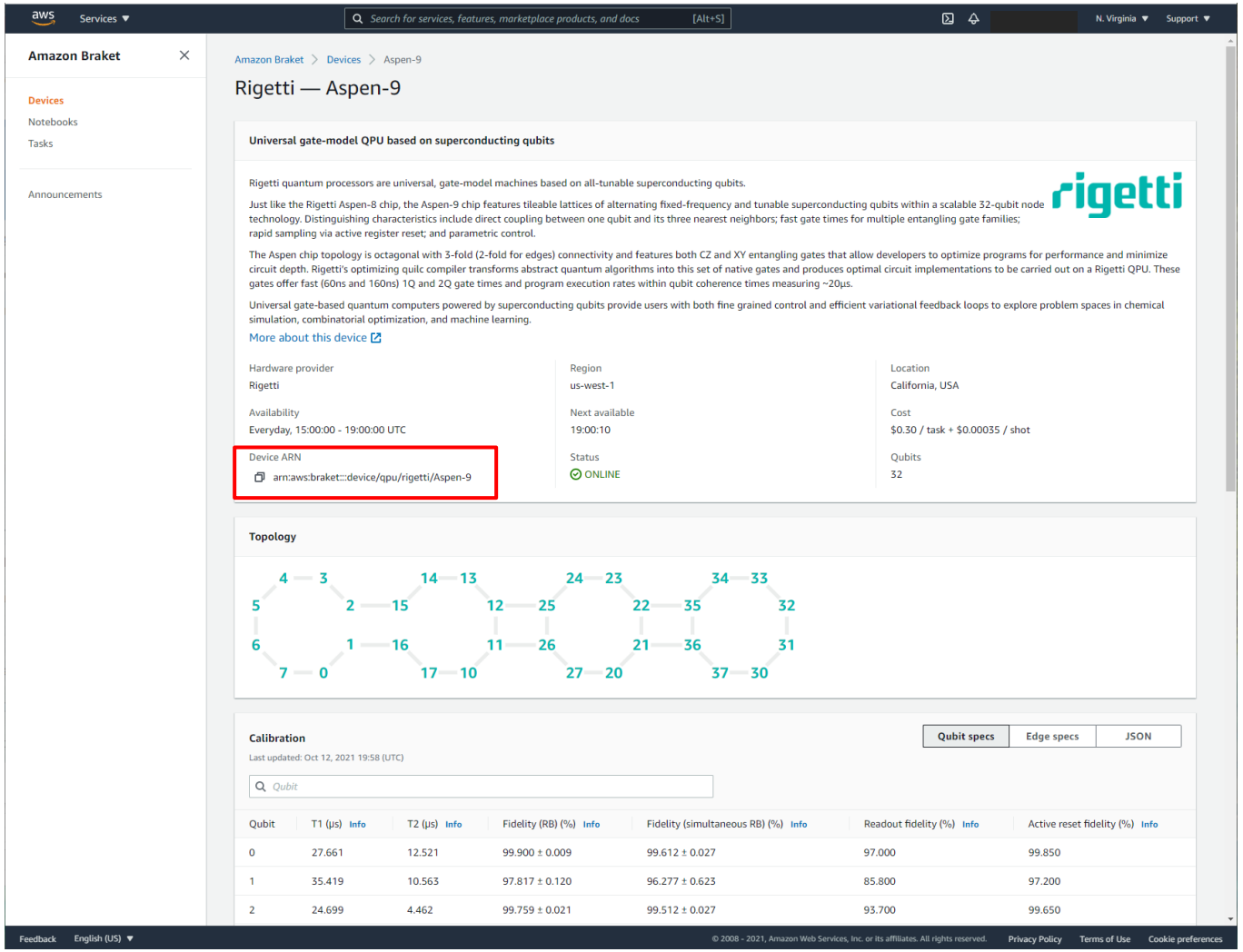
15- D-Wave. Note the Device ARN, it may be useful in your Notebooks

Amazon Braket



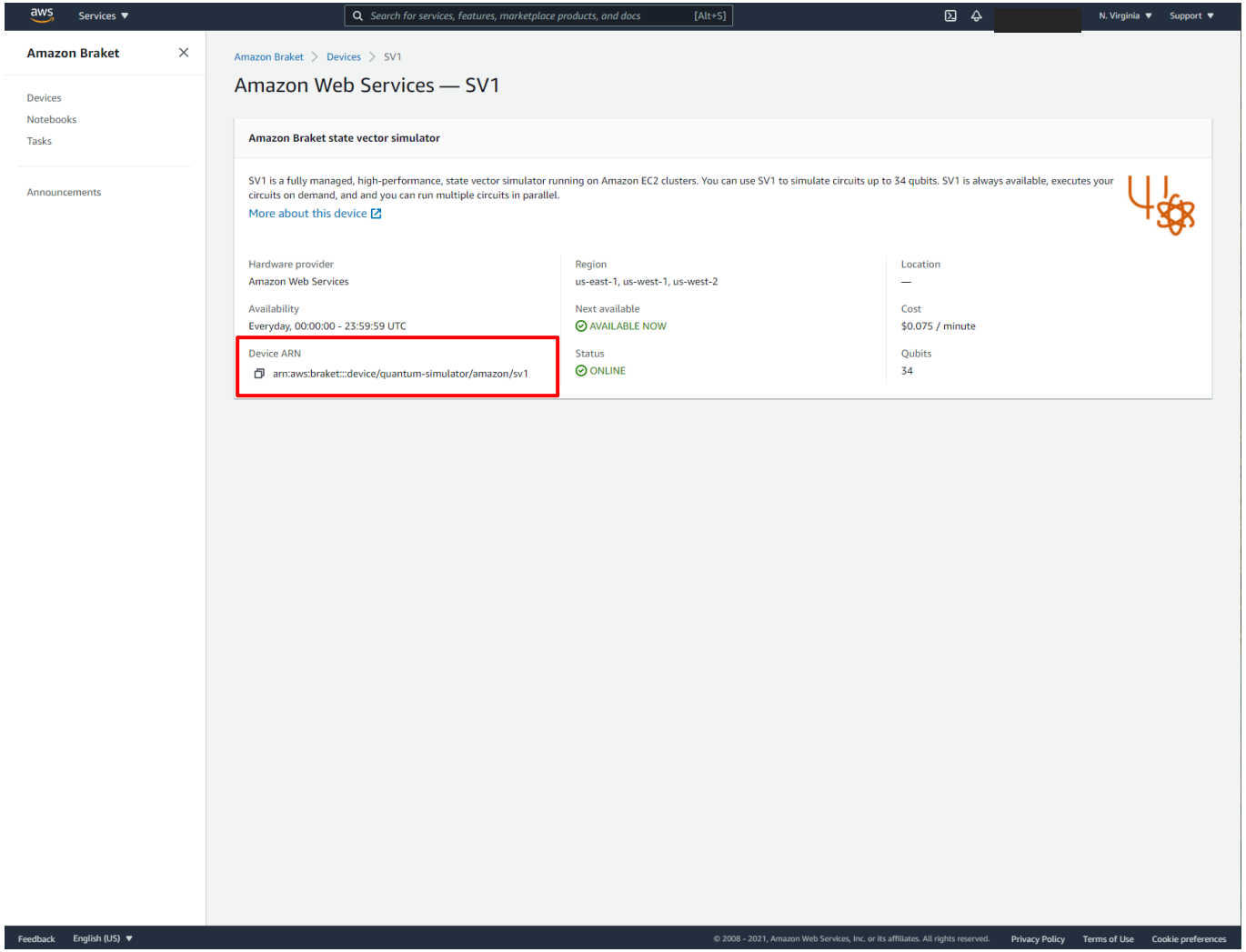
16- IonQ. Note the Device ARN, it may be useful in your Notebooks

Amazon Braket



17- Rigetti. Note the Device ARN, it may be useful in your Notebooks

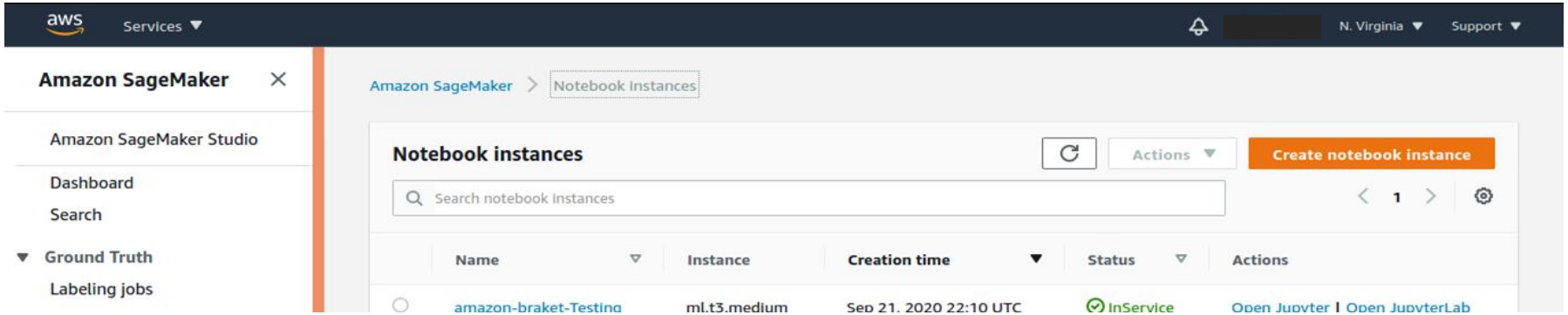
Amazon Braket



18- Braket Simulator. Note the Device ARN, it may be useful in your Notebooks

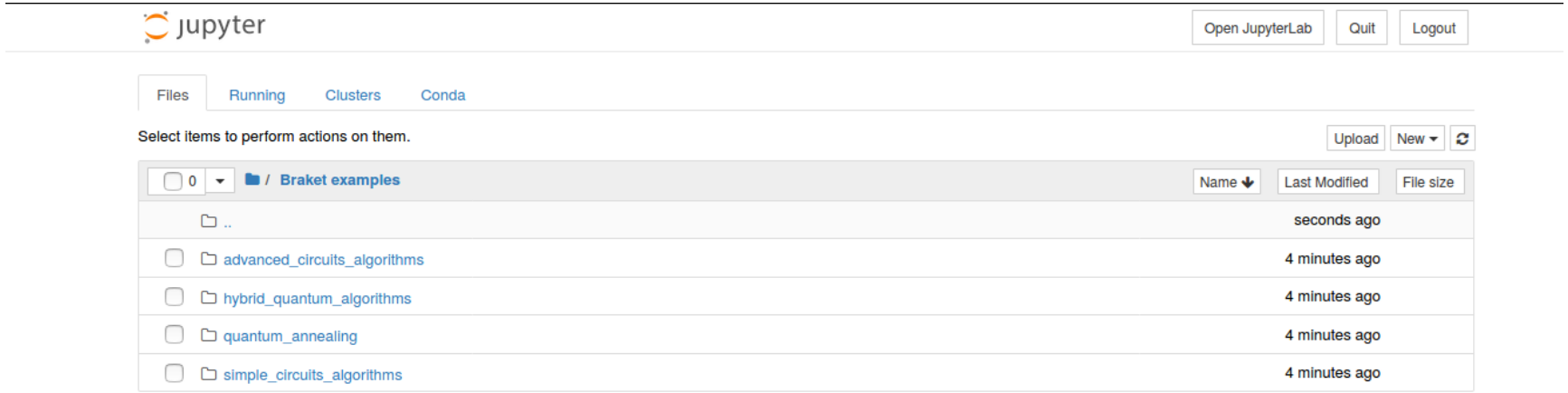
Go back to Notebooks tab

19. Your Notebook may be green i.e. “In Service”



20. Under Actions, click on the notebook

Open Braket Examples



Explore the set of notebooks provided by Amazon Braket.

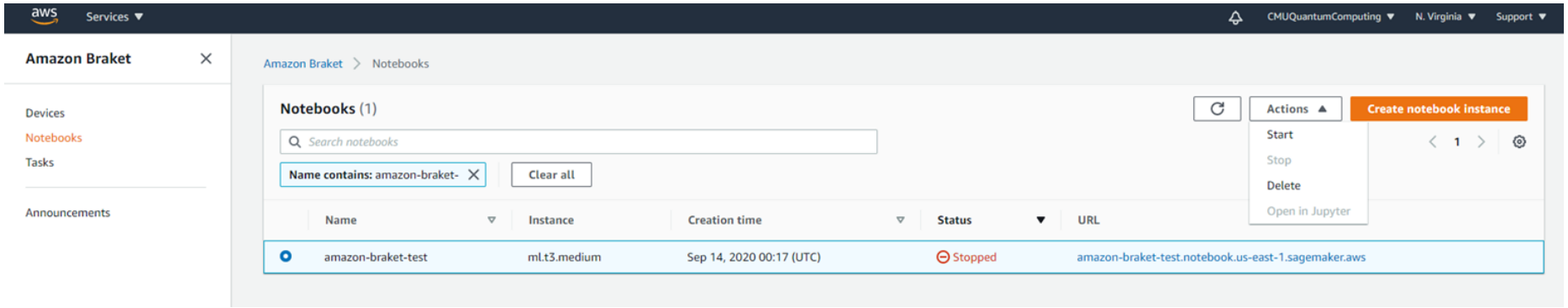
The results are preloaded. You can execute the code yourself, keep in mind that it costs money!
First simulate classically and then use the quantum devices (preferably DWave, Rigetti and IonQ in that order)

Make sure to Stop your notebooks before you Log Out!

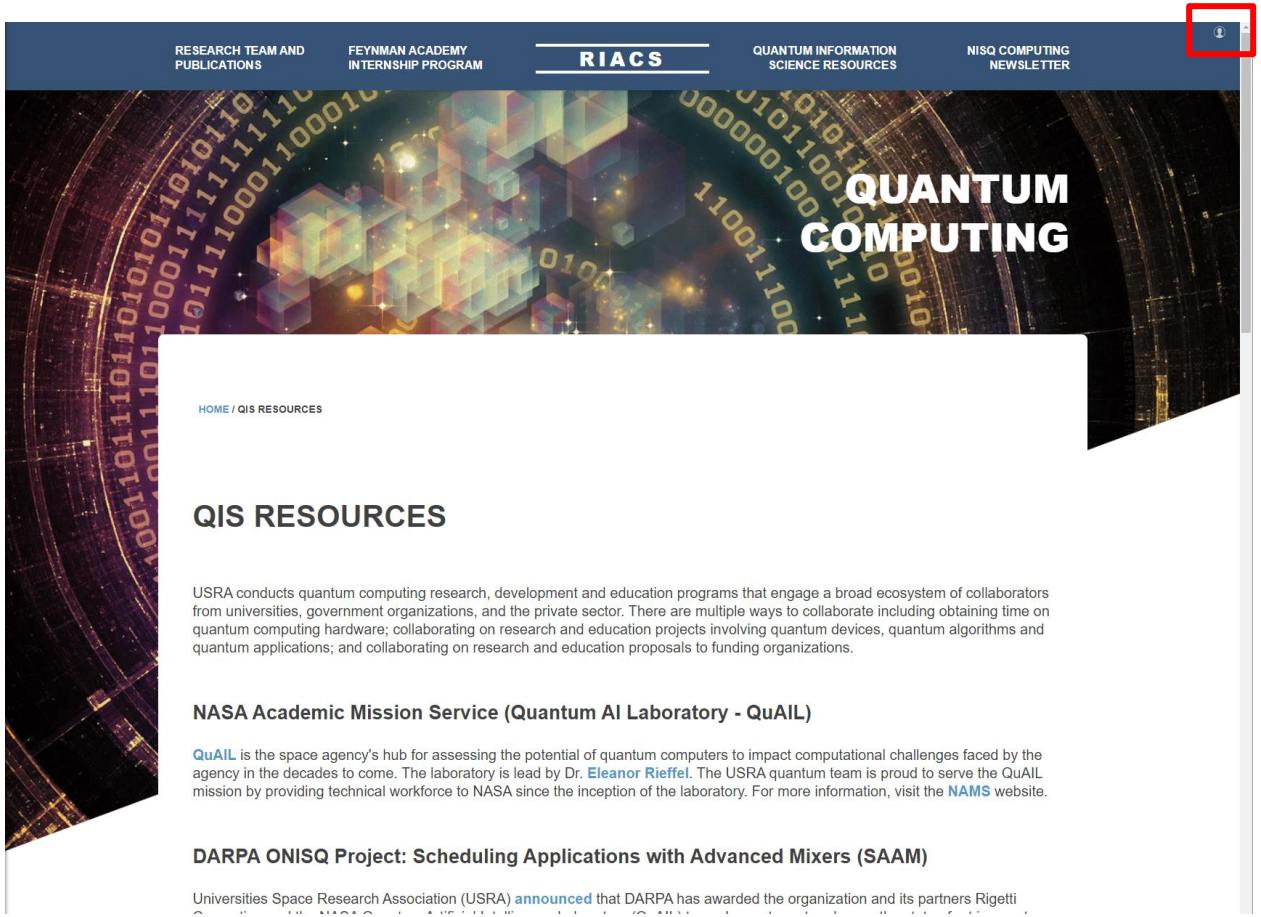
Play Around.
You are ALL SET Here!

We will be covering during this class

- quantum_annealing/D-Wave_anatomy.ipynb
- hybrid_quantum_algorithms/QAOA.ipynb

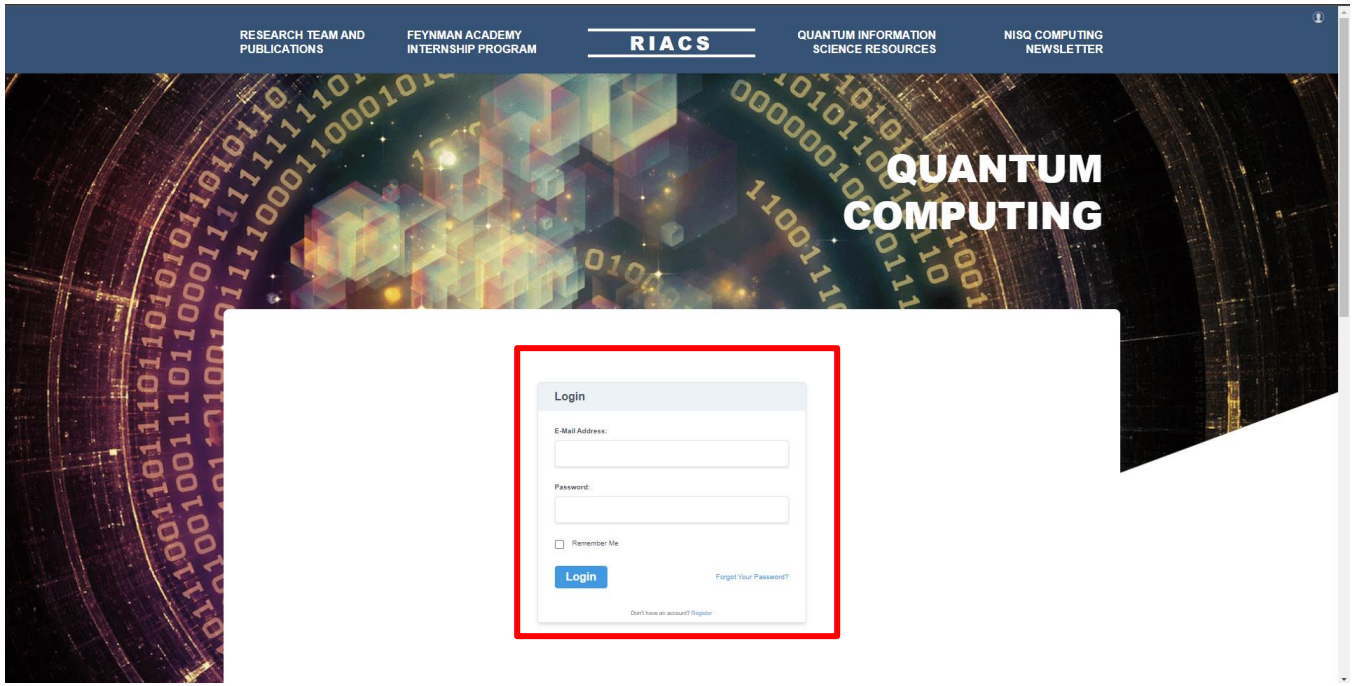


Accessing USRA resources



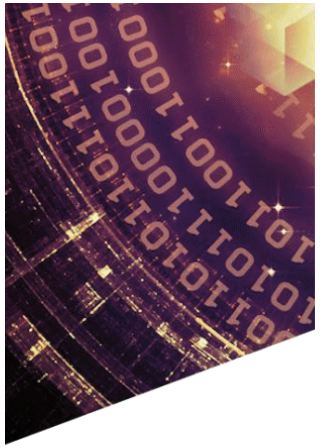
1. Go to https://riacs.usra.edu/quantum/qisprogram
2. Click on “log in”

Accessing USRA resources



3. Log in with the next credentials:
Username: AFRLguest@AFRL
Password: USRApass1

Accessing USRA resources



DARPA ONISQ Project: Scheduling Applications with Advanced Mixers (SAAM)

Universities Space Research Association (USRA) announced that DARPA has awarded the organization and its partners Rigetti Computing and the NASA Quantum Artificial Intelligence Laboratory (QuAIL) to work as a team to advance the state of art in quantum optimization. USRA, as the prime contractor of the award, will manage the collaboration.

The collaboration will focus on developing a superconducting quantum processor, hardware aware software and custom algorithms that take direct advantage of the hardware advances to solve scheduling and asset allocation problems. In addition, the team will design methods for benchmarking the hardware against classical computers to determine quantum advantage.

In particular, the work will target scheduling problems whose complexity goes beyond what has been done so far with the quantum approximate optimization algorithm (QAOA). USRA's Research Institute for Advanced Computer Science (RIACS) has been working on quantum algorithms for planning and scheduling for NASA QuAIL since 2012. RIACS as the prime contractor will manage the collaboration between NASA QuAIL and Rigetti Computing.

The grant is a part of the DARPA Optimization with Noisy Intermediate-Scale Quantum program (ONISQ). The goal of this program is to establish that quantum information processing using NISQ devices has a quantitative advantage for solving real-world-combinatorial optimization problems using the QAOA method.

NSF SpecEES Project: Advancing the Wireless Spectral Frontier with Quantum-Enabled Computational Techniques (QENeTs)

This project running 2019-2021 is investigating a multitude of new communications receiver decoding algorithms that are amenable to be used in hybrid setting with NISQ quantum computers. The designed methods will be tested on real hardware and benchmarked against the best known classical approaches. In addition to spectral efficiency, the project will also consider how quantum-enabled techniques can improve the energy efficiency of massive multiple-input/multiple-output (MIMO) algorithms. More info on the project website.

NSF Expeditions in Computing Project: Coherent Ising Machines

USRA has received a subaward from NSF, in team with Stanford, Caltech and Cornell University, to work on the prestigious 5-year program Expeditions in Computing. Collaborators include NASA QuAIL, NTT, NII and Microsoft. This Expeditions award exploits unconventional computing architectures, called Coherent Ising Machines (CIMs), to solve a class of optimization problems. CIMs provide a platform to test ideas for computer engineering in the post-Moore's Law era. Next-generation CIMs also hold great promise to drive substantial practical advances in artificial intelligence (AI) capabilities in multiple fields. In addition, the unconventional memory format used by these machines may establish a pathway towards novel quantum information technologies. More info on NSF press release and Project Website.

Program Modules

4. Go back to https://riacs.usra.edu/quantum/qisprogram
5. Click on Program Modules

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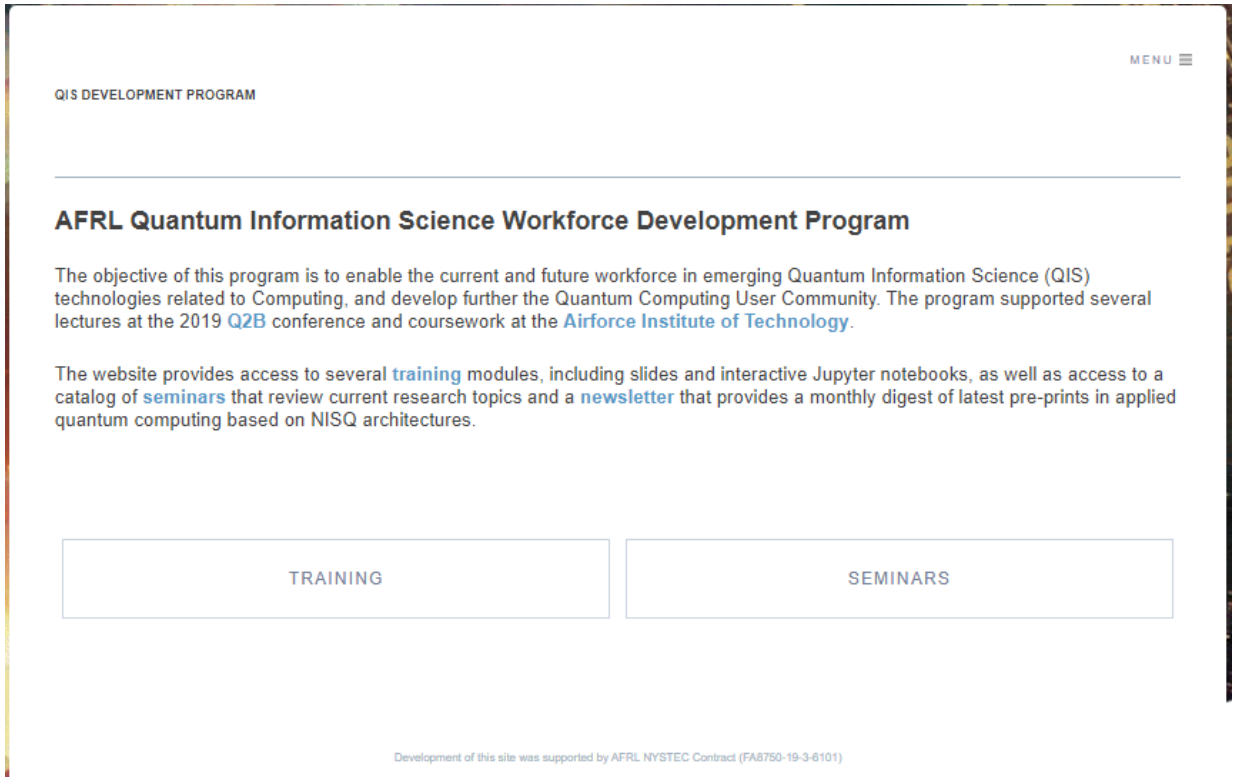

There are plenty of seminars and training available to you!

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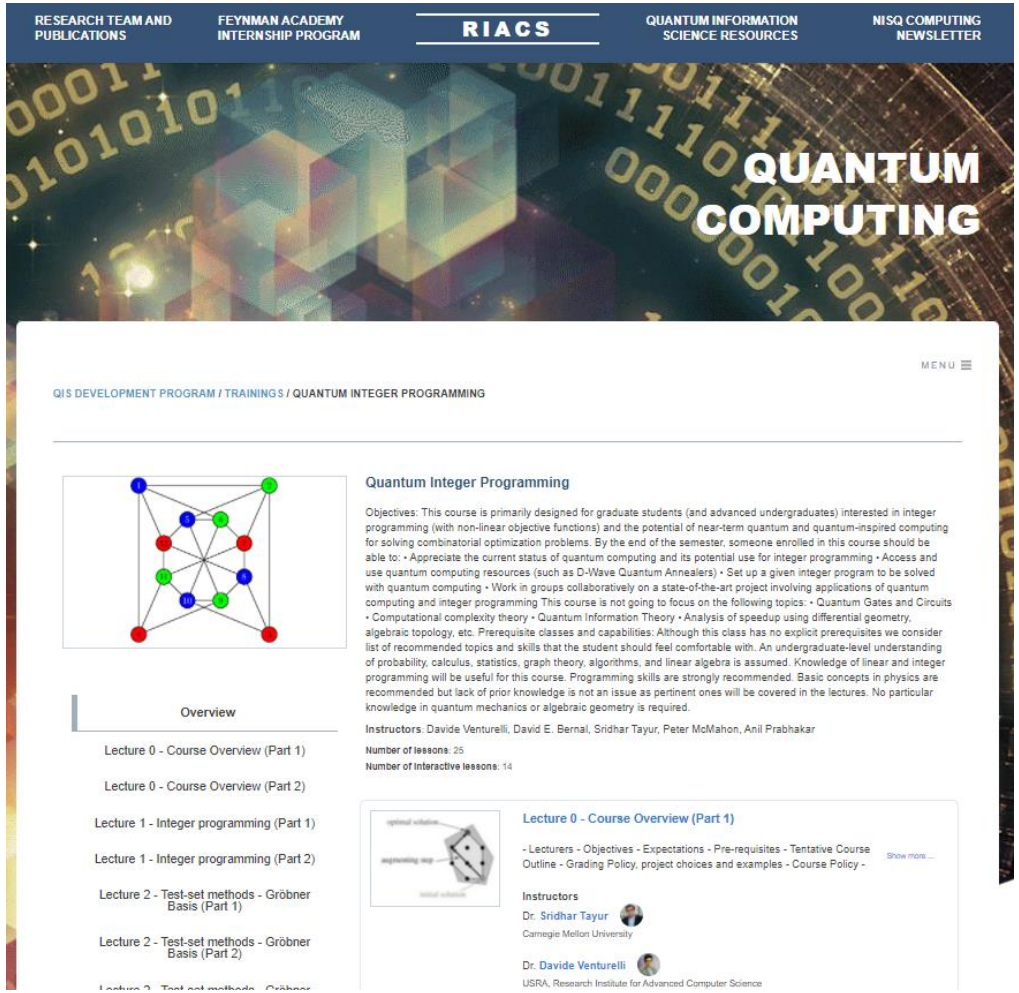

Including last years edited videos, codes, and notes!

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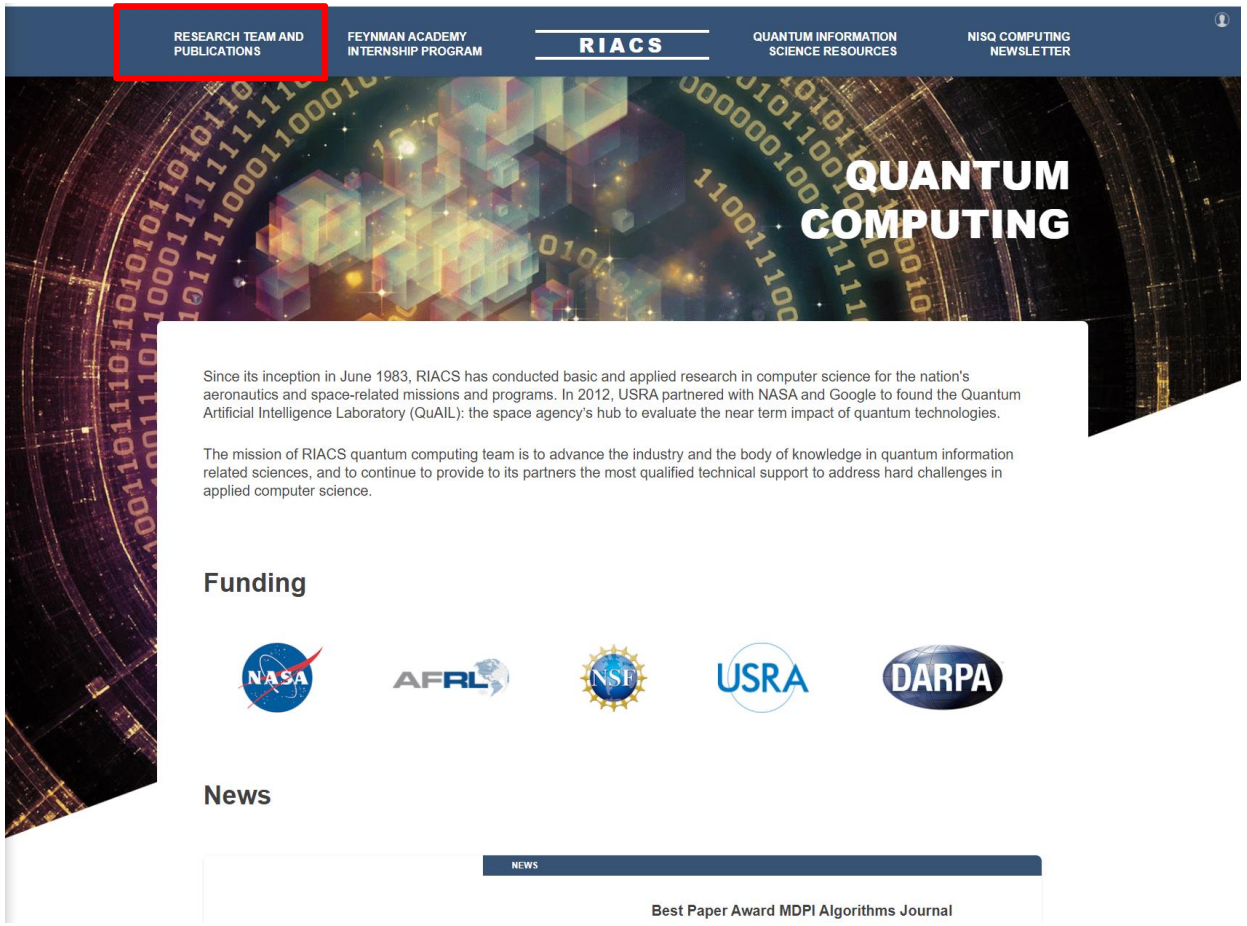

Extra: Go to “Research Team and Publications”

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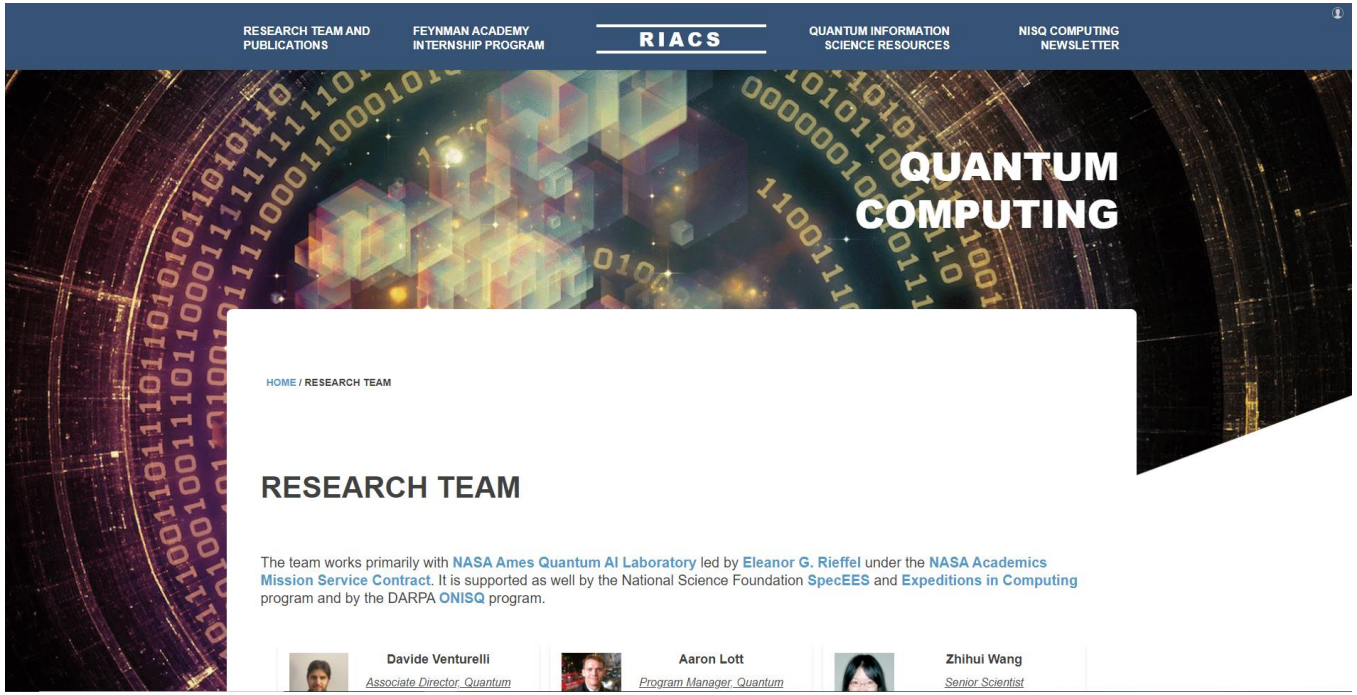

Scroll down to

Quantum Integer Programming (QuIP) 47-779: Lecture Notes

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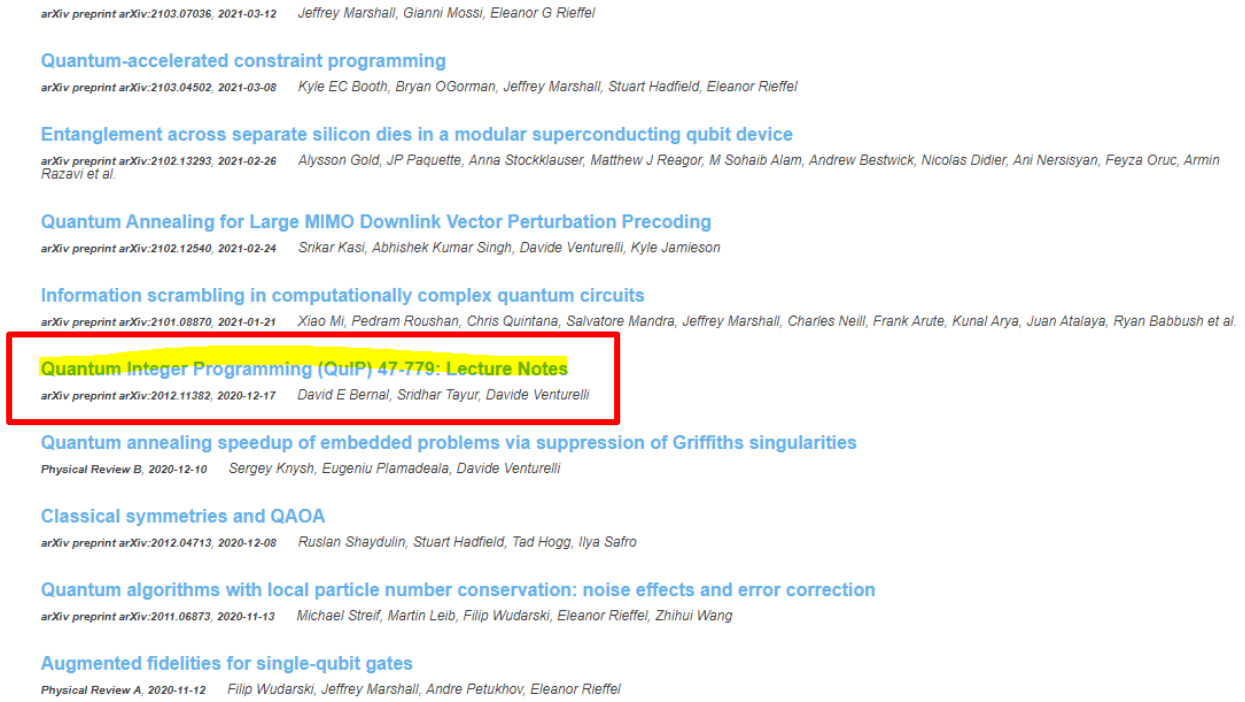

arXiv preprint arXiv:2103.07036, 2021-03-12 Jeffrey Marshall, Gianni Mossi, Eleanor G Rieffel

Quantum-accelerated constraint programming
arXiv preprint arXiv:2103.04502, 2021-03-08 Kyle EC Booth, Bryan OGorman, Jeffrey Marshall, Stuart Hadfield, Eleanor Rieffel

Entanglement across separate silicon dies in a modular superconducting qubit device
arXiv preprint arXiv:2102.13293, 2021-02-26 Alysson Gold, JP Paquette, Anna Stockklauser, Matthew J Reagor, M Sohaib Alam, Andrew Bestwick, Nicolas Didier, Ani Nersisyan, Feyza Oruc, Armin Razavi et al.

Quantum Annealing for Large MIMO Downlink Vector Perturbation Precoding
arXiv preprint arXiv:2102.12540, 2021-02-24 Srikar Kasi, Abhishek Kumar Singh, Davide Venturelli, Kyle Jamieson

Information scrambling in computationally complex quantum circuits
arXiv preprint arXiv:2101.08870, 2021-01-21 Xiao Mi, Pedram Roushan, Chris Quintana, Salvatore Mandra, Jeffrey Marshall, Charles Neill, Frank Arute, Kunal Arya, Juan Atalaya, Ryan Babbush et al.

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arXiv preprint arXiv:2012.11382, 2020-12-17 David E Bernal, Sridhar Tayur, Davide Venturelli

Quantum annealing speedup of embedded problems via suppression of Griffiths singularities
Physical Review B, 2020-12-10 Sergey Knysh, Eugeniu Plamadeala, Davide Venturelli

Classical symmetries and QAOA
arXiv preprint arXiv:2012.04713, 2020-12-08 Ruslan Shaydulin, Stuart Hadfield, Tad Hogg, Ilya Safro

Quantum algorithms with local particle number conservation: noise effects and error correction
arXiv preprint arXiv:2011.06873, 2020-11-13 Michael Streif, Martin Leib, Filip Wudarski, Eleanor Rieffel, Zhihui Wang

Augmented fidelities for single-qubit gates
Physical Review A, 2020-11-12 Filip Wudarski, Jeffrey Marshall, Andre Petukhov, Eleanor Rieffel

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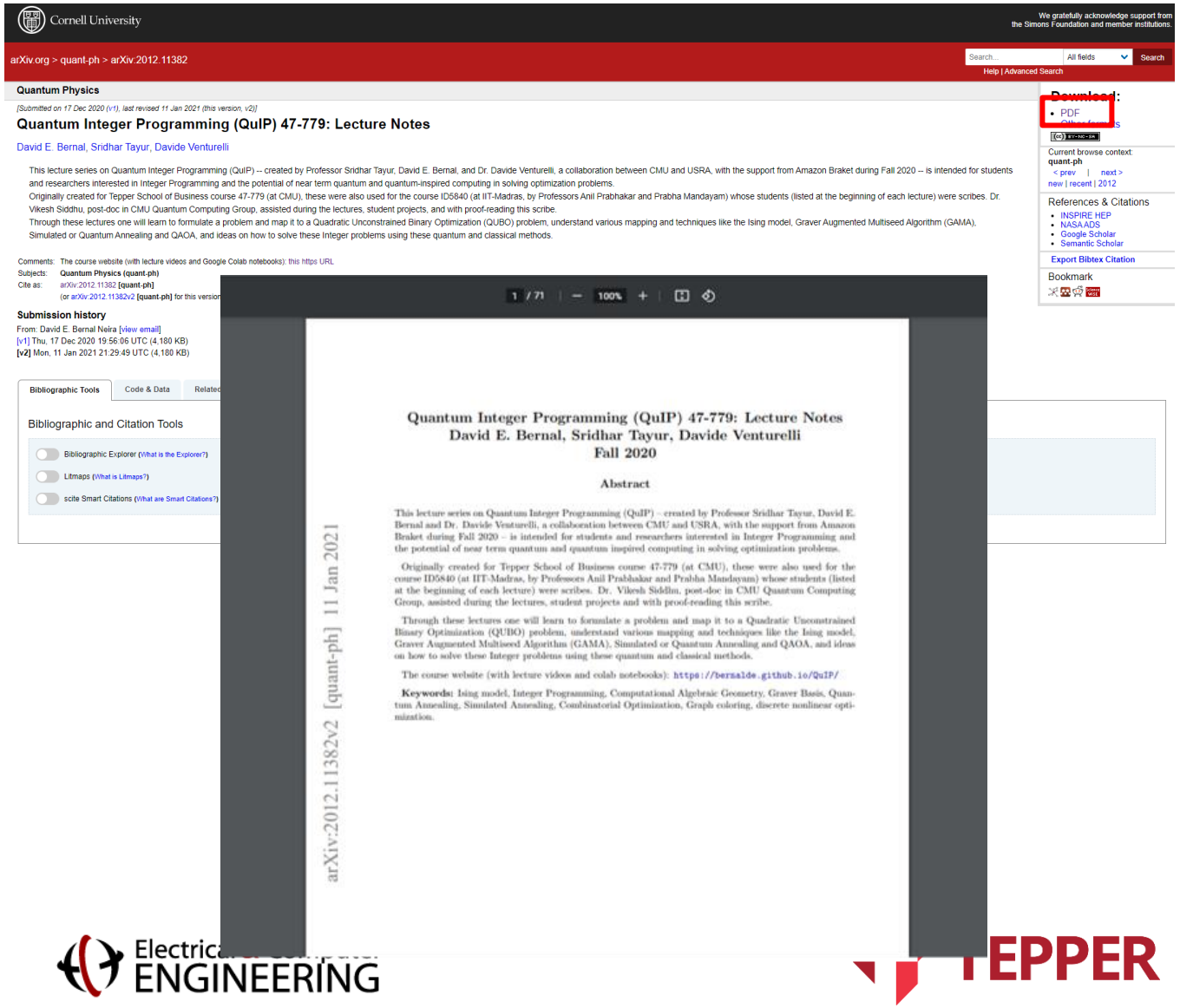

You will see the arXiv preprint with the scribed notes from last year Quantum Integer Programming.