(online) Summer School on Quantum Computing: Software for Near Term Quantum Devices

Thank you for participating in our online quantum adventure!

These notes are some practical information about the online summer school. We may update them in the following days to clarify any further issues or questions.

This notes are divided into the following sections

- **Login into the webpage and the virtual classroom**
- **Introductory material**
- **Quantum projects and practical sessions**
- **Running Qiskit in the IBM Q System**

For any remaining doubts, please ask the organizers (diego.porras@csic.es)

Login into the webpage and virtual classroom

Unfortunately, the UIMP's webpage has not been updated yet and it is in Spanish...

You will have received an email from "noreply@uimp.es" with a username (something like 100001111@alumnos.uimp.es) and a password (something like "pp1P0!XF").

To login into the University's online teaching platform you have to go to:

https://campusvirtual.uimp.es/

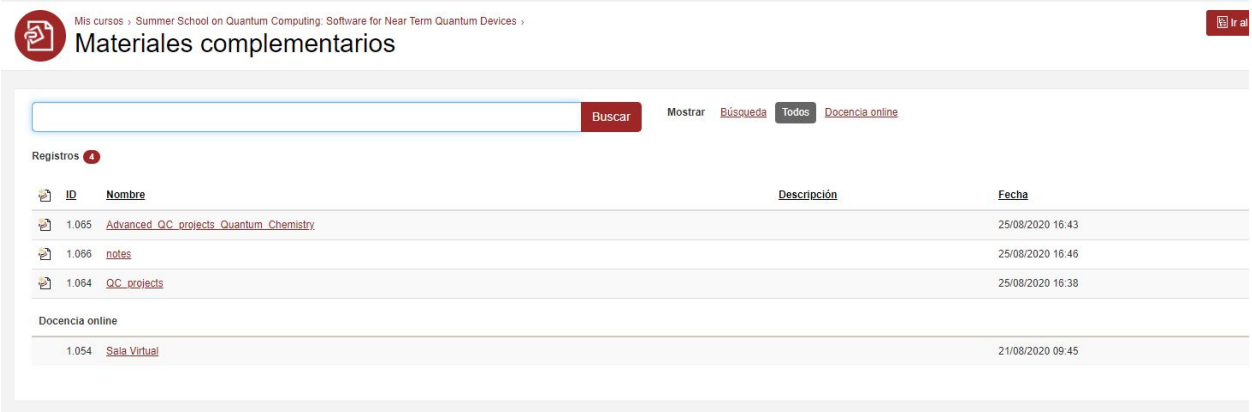
In the top-left corner, enter your username (...@alumnos.uimp.es) and password in the fields "Usuario" y "Contraseña". Then you will see a link to our school:

Click on the link to the Summer School. In the Summer School webpage, the important information is on your left:

Now, the most important sections are **“Materiales Complementarios”** and **“Comunicación”**.

“Comunicación” will take you to the messaging system where we will post information on the school.

If you click on **“Materiales Complementarios”**, you will see all the material for the school (QC_Projects, etc..) and a link to the virtual classroom (“Sala Virtual”):



The link to the virtual classroom will take you to the Google Meet webpage where the seminars and talks will take place. **It is very important that you are logged on your browser with the Google account that uses the xxxx@alumnos.uimp.es email address and password that you have received by email.**

Alternatively, you can join us in the virtual classroom by just clicking on the link below:

https://meet.google.com/fbj-hczw-tnm

But again, you have to make sure you use yourxxxx@alumnos.uimp.es email address and password. It is possible that you are already logged in with a different Google account, so, please, check that you change accounts.

Please, please, please, make sure you can connect to the virtual classroom well in advance, and let us know of any problems.

Introductory material

The school is quite self-contained, however, you could benefit from reading some introductory material if you have some time before the school starts.

This will be useful for you to familiarize with some ideas or refresh your quantum theory knowledge. In particular you may want to have a look at:

- The Qiskit documentation which offers a very practical introduction to quantum computing:
  https://qiskit.org/textbook/preface.html
  If you do not have much time, this may be a good place to start.

- Nielsen & Chuang superb introductory textbook “Quantum Computation and Quantum Information”, specially the introductory chapters and Chapter 4 on quantum gates.

Quantum projects and practical sessions

We have prepared a few exercises or small projects that you can find in the “Materiales Complementarios” section of the summer school’s online platform (if you cannot access the files, just write us an email at diego.porras@csic.es)

The projects are in the form of jupyter notebooks. There is a short description of each project below, but, please, keep in mind that the projects are for you to play with quantum programming. It really does not matter if you only answer 10% of the proposed questions, and of course, this is not an examination.

We would like you to choose a preferred project and send us your preference (for this we will circulate a Google Form at the beginning of the school). You can already start playing with the notebooks even before the school starts.

At the practical session on Wednesday, we will divide you in teams and you will collaborate with a few fellow students on your chosen project. The organizers (Juanjo and Diego) will assist you during the practical session. Finally, on Friday, we will have a last session, where each team will explain their conclusions and experience.

So, what are the projects about?

On the compressed file "QC_projects" at "Materiales Complementarios" there are four projects. Here is a short description:

"Fourier interpolation.ipynb" - This is an exercise about the Fourier transform algorithm. It does only require basic knowledge on quantum computing.

"Grover_questions.ipynb" - This is a project about one of the most famous quantum algorithms. To fully understand the notebook, you need to read a bit about Grover's algorithm, either on the notebook's references, or at Diego Porras' talk on monday

"Quantum_annealing_questions.ipynb" - This a notebook centered around the quantum simulation of the Ising interaction and quantum annealing. This will be ideal if you are a physicist with some basic knowledge of Pauli matrices and spin physics.

"Porfolio_optimization_with_questions.ipynb" - This project is the most practical one, in the sense that it does involve running numerical experiments with qiskit variational subroutines. If you feel like you are struggling with theory, this might be the best project to work on.

Finally, the compressed file "Advanced_QC_projects_Quantum_Chemistry" contains some Qiskit examples for Quantum Chemistry calculations. This is quite advanced and you should choose it only if you have some previous experience in quantum computing or advanced quantum mechanics.

Running Qiskit in the IBM Q System

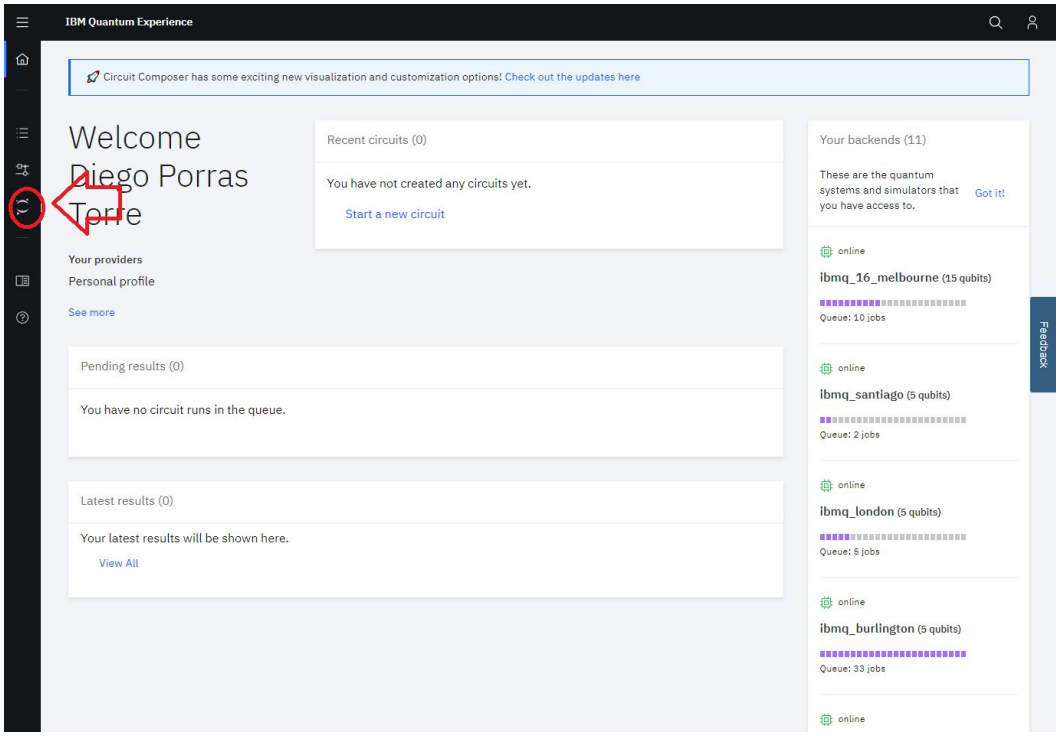
The practical content of this summer school is based on Qiskit, a quantum programming language written in Python and developed by IBM.

You can actually install Qiskit on your own computer (https://qiskit.org/documentation/install.html), but we do not recommend this unless you are very familiar with Python, since strong dependency issues can complicate the process.

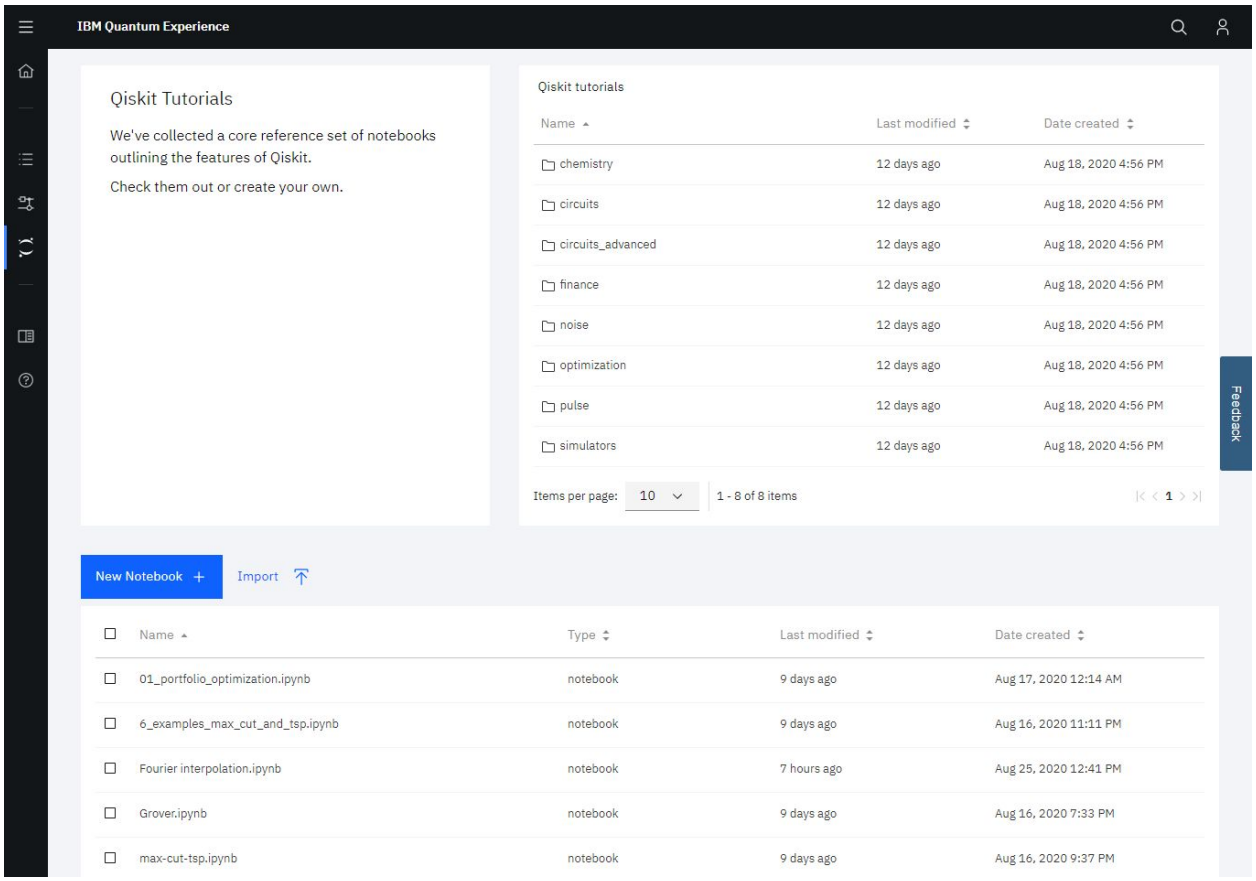
The most practical approach is to run Qiskit online on the IBM Q Experience webpage. For this, you need to login into the IBM Q system (you can just use, for example, a Google account)

https://quantum-computing.ibm.com/

Once you are in, you will see something like this:



If you click on the circle on the left, you will arrive at the “Quantum Lab” section of the webpage:



Here you can import notebooks, like the ones we propose for projects, and you can also execute them online.

It would be great if you can make sure that you can log in the IBM Q system and you are able to run some of the notebooks that we have prepared for the school.