Summer School on Quantum Computing

Software for near-term quantum devices

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My plans:

Palacio de la Magdalena, Santander, Spain
(Housing/lecture rooms of the *Universidad Internacional Menéndez-Pelayo*)

2020:

Google Meet

Summer School on Quantum Computing

Software for near-term quantum devices

Summer School on Quantum Computing: Software for Near Term Quantum Devices

	Mon 31 Aug	Tue 1 Sep	Wed 2 Sep	Thu 3 Sep	Fri 4 Sep
9:30-11:30	Germán Sierra Introduction to quantum computing I	Juan Sánchez Toural Tutorial QISKIT	Maria Schuld Quantum machine learning	Jens Eisert Quantum advantages and near-term quantum computing	Román Orús Applications of quantum computing in finance
12:00-14:00	Diego Porras Introduction to quantum computing II	Ivano Tavernelli Quantum algorithms for applications in quantum chemistry and physics	Juan José García Ripoll Applied mathematics with quantum computers + General questions	Pol Forn Introduction to Experimental Quantum Computation	Practical Session (D. Porras – Juan José García-Ripoll)
15:30-17:30	Ginés Carrascal de las Heras (IBM) Tutorial QISKIT	Stefan Woerner Variational quantum computing for classical optimization problems	Practical Session (D. Porras – J. J García-Ripoll)		

Introduction to QC (theory)

Introduction to Qiskit

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Variational Quantum Computing in and quantum machine learning

Practical sessions

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In the last talks you will get a vision on quantum complexity, the experimental challenges of quantum computing and applications in finance.

References:

For self-study, we recommend:

- The Qiskit documentation which offers a very practical introduction to quantum computing: https://qiskit.org/textbook/preface.html

- For quantum algorithms and the principles of quantum computing, we still recommend Nielsen & Chuang superb introductory textbook “Quantum Computation and Quantum Information”, specially the introductory chapters and Chapter 4 on quantum gates.

- For more advanced topics (e.g. variational quantum computing) - we can only recommend academic articles (to be cited during talks), or the Qiskit documentation.

Summer school projects

- 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.

- We would like you to choose a preferred project and send us your preference (for this we will circulate a Google Form **on Tuesday**). 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.**

Summer school projects

So, what are the projects about?

On the compressed file "QC_projects" at "Materiales Complementarios" there are four projects:

- **"Fourier interpolation.ipynb"** - Exercise on the Fourier transform algorithm. It does only require basic knowledge on quantum computing.

- **"Grover_questions.ipynb"** - 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"** - Excercise 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.