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# A practical introduction to quantum computing - follow our online lecture series

 02 November 2020

CERN openlab and the CERN Quantum Technology Initiative have organised a series of open, free lectures on quantum computing. The talks will focus on the practical aspects of quantum computing. They will be given by Elias Fernandez-Combarro Alvarez, an associate professor in the Computer Science Department at the University of Oviedo in Spain since 2009 and a cooperation associate at CERN since earlier this year.

Quantum computing is one of the most promising new trends in information processing. In this course, we will introduce the basic concepts of the quantum circuit model (qubits, gates and measures) and use them to study some of the most important quantum algorithms and protocols, including those that can be implemented with a few qubits (BB84, quantum teleportation, superdense coding...), as well as those that require multi-qubit systems (Deutsch-Jozsa, Grover, Shor...). We will also cover some of the most recent applications of quantum computing in the fields of optimisation and simulation (with special emphasis on the use of quantum annealing, the quantum approximate optimisation algorithm and the variational quantum eigensolver) and quantum machine learning (for instance, through the use of quantum support vector machines and quantum variational classifiers). We will also give examples of how these techniques can be used in chemistry simulations and high-energy physics problems.

As well as focusing on the practical aspects of quantum computing, the course will also discuss the implementation of algorithms in quantum simulators and actual quantum computers (such as the ones available through the IBM Quantum Experience and D-Wave Leap). No previous knowledge of quantum physics is required and, from the mathematical point of view, only a good command of basic linear algebra is assumed. Some familiarity with the python programming language would be helpful, but is also not required.

The lectures will run from 10:30 to 12:30 CET on Fridays for the next seven weeks, starting on 6 November. Please find individual links to each lecture below.

**Lecture 1/7, Friday 6 November:** <https://indico.cern.ch/event/970903/> (<https://indico.cern.ch/event/970903/>)

- The video is now available here: <http://cern.ch/go/rHd8> (<http://cern.ch/go/rHd8>)

**Lecture 2/7, Friday 13 November:** <https://indico.cern.ch/event/970904/> ([https://mmm.cern.ch/owa/redirect.aspx?C=3rnEes87Y99-g7IIUF0mOPMn2Z8RJ7zFu70zn2INQw1Cfhz1MH\\_YCA..&URL=https%3a%2f%2findico.cern.ch%2fevent%2f970904%2f](https://mmm.cern.ch/owa/redirect.aspx?C=3rnEes87Y99-g7IIUF0mOPMn2Z8RJ7zFu70zn2INQw1Cfhz1MH_YCA..&URL=https%3a%2f%2findico.cern.ch%2fevent%2f970904%2f))

- The video is now available here: <http://cern.ch/go/G76F> (<http://cern.ch/go/G76F>)

**Lecture 3/7, Friday 20 November:** <https://indico.cern.ch/event/970905/> (<https://indico.cern.ch/event/970905/>)

- The video is now available here: <http://cern.ch/go/8v7f> (<http://cern.ch/go/8v7f>)

**Lecture 4/7, Friday 27 November:** <https://indico.cern.ch/event/970906/> (<https://indico.cern.ch/event/970906/>)

- The video is now available here: <http://cern.ch/go/cHZ6> ([http://cern.ch/go/cHZ6?fbclid=IwAR3jSF8QBKYXx\\_B5rT1\\_tZEjM5Z1tddt6FyGkU0nGmzs2EAOkyACBIrFTKc](http://cern.ch/go/cHZ6?fbclid=IwAR3jSF8QBKYXx_B5rT1_tZEjM5Z1tddt6FyGkU0nGmzs2EAOkyACBIrFTKc))

**Lecture 5/7, Friday 4 December:** <https://indico.cern.ch/event/970907/> (<https://indico.cern.ch/event/970907/>)

- The video is now available here: <http://cern.ch/go/j8tc> (<http://cern.ch/go/j8tc>)

**Lecture 6/7, Friday 11 December:** <https://indico.cern.ch/event/970908/> (<https://indico.cern.ch/event/970908/>)

- The video is now available here: <http://cern.ch/go/9GtG> (<http://cern.ch/go/9GtG>)

**Lecture 7/7, Friday 18 December:** <https://indico.cern.ch/event/970909/> (<https://indico.cern.ch/event/970909/>)

- The video is now available here: <http://cern.ch/go/9DMz> (<http://cern.ch/go/9DMz>)

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