

# Quantum Computing Mentoring Path First Workshop Summary Report

Date and time: 9 November 2021, 2pm – 4:15pm CET  
Location: Virtual via Microsoft Teams  
Organiser: CASTIEL WP3 – Training, Twinning and Mentoring



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## Background

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Quantum computing is an emerging branch of modern information theory. Born in the early 1980s, this new programming paradigm has constantly evolved over the years, despite the fact that the technology of the time was not yet capable of producing functioning quantum computers capable of implementing quantum algorithms theorized on paper. The introduction of the first working quantum computer models on the market is attracting the attention of both research centres and supercomputing centres: it is in fact a common belief that one of the very first uses of new quantum machines is to support current supercomputers as "accelerators", in the same way as GPUs. Programming a quantum computer, however, is not very intuitive: the quantum machine revolution begins by upsetting the basic logical unit of today's computers, the bit, replacing it with its "quantum version", the qubit. The continuous and incessant evolution of quantum computers makes it necessary and important to learn immediately to understand and program this new type of computer.

The purpose of the EuroCC-CASTIEL Quantum Computing Mentoring Path is precisely to bring together National Competence Centres (NCCs) experts in quantum computing and people from other NCCs eager to learn, allowing the latter to satisfy their curiosity by participating in events organized by the experts.

The November mini-workshop, described in this document, is to be considered as an introductory and exploratory workshop, created with the aim of probing the needs and requirements of participants, providing them with a generic overview of the world of quantum computing and the possibility of choosing which topics they are most interested in.

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## Agenda

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14:00 - 14:10	<b>Opening: Introduction to Quantum Computing</b> - Morris Riedel (HI)
14:10 - 14:30	<b>HPC and QC Infrastructures</b> - Sven Karlsson (DTU)
14:30 - 15:00	Overview of applications and use-cases
14:30 - 14:45	<b>Overview on Quantum Algorithms</b> - Riccardo Mengoni (CINECA)
14:45 - 14:55	<b>Quantum Support Vector Machine Algorithms</b> - Gabriele Cavallaro (JSC)
14:55 - 15:00	Q&A
15:00 - 15:20	<b>Towards Hybrid HPC-QCS systems</b> - Venkatesh Kannan (ICHEC)
15:20 - 15:40	<b>Role of HPC centers in the quantum computing era</b> - Ariana Torres (SURF)
15:40 - 16:00	<b>HPC-QCS infrastructures pave the way for practical quantum computing - strategic and technical perspectives</b> - Kristel Michielsen (JSC)
16:00 - 16:15	Discussion

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## Participants

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- Daniele Ottaviani (Organizer and Chairman, CINECA)
- Martina Blazkova (Organizer, BSC, CASTIEL WP3)
- Morris Riedel (Speaker, HI)
- Sven Karlsson (Speaker, DTU)

- Riccardo Mengoni (Speaker, CINECA)
- Gabriele Cavallaro (Speaker, JSC)
- Venkatesh Kannan (Speaker, ICHEC)
- Ariana Torres (Speaker, SURF)
- Kristel Michielsen (Speaker, JSC)

The workshop was attended by around 100 participants from different National Competences Centres, e.g. Bulgaria, Germany, Finland, Turkey, Belgium, Austria, Lithuania, Romania, Czech Republic, Spain, Portugal, Croatia, North Macedonia, Sweden, Poland, Slovakia, Greece, Latvia, Luxembourg, Norway, Slovenia, Hungary, Montenegro, United Kingdom, Netherlands, Italy.

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## Content of the Workshop

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The Quantum Computing (QC) Mentoring Path first workshop allowed EuroCC and CASTIEL to present to NCCs their visions and research directions regarding quantum computing. With the dual objective of sharing ideas about this innovative field and providing workshop participants with an overview of the main areas of interest and skills possessed by some of the NCCs.

In particular, after a brief introduction to the concepts of quantum computing and the state of the art of quantum hardware which usually falls under the name of Noisy Intermediate Scale Quantum (NISQ) devices, the focus of the workshop was on both the integration of modern high performance computing (HPC) with NISQ technology and a discussion of the most promising applications.

From the integration perspective, it was remarked that Quantum Computing systems are expected to function as accelerators to classical HPC in the future. Hence a strong coupling is required at the hardware and software levels for efficient and practical exploitation of the QC technologies.

For what concerns the applications, despite current NISQ devices have several constraints including noise and a limited number of qubits, hybrid quantum-classical algorithms have been identified as the leading proposal for achieving quantum advantage in the near-term.

This includes quantum optimization using quantum annealers but also variational algorithms (VQE, QAOA and QNNs) for general purpose devices.

Finally, feedback from all participants was requested, in order to understand which topics could be the most relevant and interesting to be explored in the following workshops and mentoring activities.

The November workshop ended with the participants voting and selecting the topics that they would want to hear more about in the future.

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## Next Steps

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The first next step is to create a new workshop, this time more extensive, where participants will find the most voted topics discussed in more depth and the less voted topics will still be addressed, but with less insight.

The following step will be to put in contact potential mentors and mentees from NCCs who would like to start the mentoring interaction supported by CASTIEL, as a part of the CASTIEL-EuroCC mentoring and twinning program, where the NCC mentees will get the opportunity to learn in a personalised way from the more experienced NCCs.



This project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 951732. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Bulgaria, Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom, France, Netherlands, Belgium, Luxembourg, Slovakia, Norway, Switzerland, Turkey, Republic of North Macedonia, Iceland, Montenegro.