Abstract for EuroHPC Summit Week

Title: On the use of a quantum convolutional neural network for Earth Observation data classification

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Domain: Quantum Computing and Use Cases from Industry
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Abstract:
The amount of data coming from Earth Observation missions is increasing rapidly due to the ongoing launch of new remote-sensing satellites, and due to the increasing sophistication of remote sensing instruments. It is reaching such large volumes and the data is reaching such large resolutions that there is a need for new Artificial Intelligence techniques to classify these data. Quantum computing is a novel technology to develop these techniques. One of the advantages that quantum computing offers over classical computing is that the number of qubits necessary to encode these data grows with O(log N), while the number of bits needed to encode the data grows with O(N). This means that above a certain amount of data, a classical solution is not possible anymore, and only a quantum solution is feasible.

Sebastianelli et al. have shown the usage of hybrid classical-quantum convolutional neural networks for remote sensing imagery classification. Cong et al. have proposed a novel type of quantum convolutional neural network. This convolutional neural network is fully quantum and has a doubly exponential reduction in the number of needed qubits and in the number of parameters. We will describe the usage of this quantum convolutional neural network for the classification of Sentinel-2 images from the Copernicus program. This is an application that has not been done before.

We will show two development workflows. One based on Atos myQLM, and one based on the Strangeworks API. The Atos myQLM sequence uses:
Atos myQLM -> IBM Qiskit -> IBM or IonQ quantum machines
By using the Atos myQLM front end, we are able to develop quantum code that is not tied to a particular architecture. This front end allows us to generate code for the IBM, IonQ, Google and Rigetti architectures, so we are not bound to one hardware vendor.

The advantage of quantum computing for Earth Observation are its promise to tackle larger problems than feasible with classical computers. In addition to the exponential reduction in time and resources, it promises also to avoid getting stuck in relative minima due to quantum tunneling. Earth Observation has numerous industrial and societal applications, including weather forecasting, measuring land-use change, managing natural resources, and predicting, adapting to and mitigating climate change.