Quantum computing: results and perspectives in EO

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At present, **quantum computing and AI** are the key technologies in the digital era. The progress and transfer of quantum resources for use in practical applications is in constant acceleration. Quantum computing, quantum annealing, quantum circuits, or simulators for quantum computing are currently easily accessible. The exploitation of quantum physics effects such as superposition and entanglement opens new, still unexplored perspectives. Yet, with very limited capacities, hundreds of qubits, they draw the attention stimulating the new area of quantum machine learning.

In this context the presentation will focus on relevant aspects of quantum technologies for EO. With the goal to identify if a quantum algorithm may bring any advantage compared with classical methods, will be firstly analysed the data complexity (i.e. data as prediction advantage). Secondly, it will be presented the classes of complexity of the algorithms. Thirdly, it will be identify major challenges in EO which could not yet be solved by classical methods, as for instance the causality analysis.

Data embedding is of key importance. Non-quantum data are many times “artificially” encoded at the input of quantum computers, thus quantum algorithms may not be efficient. For instance the polarimetric SAR data are represented on the Poincare sphere which maps in a natural way to the qubit Bloch sphere. Thus, PolSAR data will not be any more processed as “signal” but directly as a physical signature. Further will be discussed the advantages of quantum annealing (D-Wave) for solving local optimization for non-convex problems. Also, the potential and advantage of the recent TensorFlow Quantum and the implementation of parametrized quantum circuits (PQC). The presentation will address the entire EO data cycle encompassing the particular features from data acquisition, understanding and modelling of the EO sensor, followed by information extraction. The quantum ML techniques are practically implemented using the open access to various quantum computers, as D-Wave, IBM, or Google. Hybrid methods will be discussed for EO, i.e. managing the I/O of the data and maximally use the resources of quantum computers and quantum algorithms.

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