Quantum Information and Machine Learning

Quantum information is a discipline that has greatly evolved in the past thirty years out of the original, basic idea that information might be encodable into the degrees of freedom of quantum systems, in analogy with classical information theory with respect to physical systems in the classical world. The crucial new input provided by quantum information with respect to the analog classical discipline is the possibility of using quantum correlations (e.g. entanglement) to manipulate and transmit information. This idea has required extending the well-established apparatus of classical information theory from the standard commutative setting to a non-commutative one, proper of the quantum theory.

Such developments have brought new perspectives to the classical theory, while extending well-known classical results, as Shannon's coding theorems, to the quantum domain with dramatic advances in the theory of information compression and transmission channel capacity. Yet, other notions of the classical theory, as Kolmogorov's complexity or the so-called Minimal Description Length Principle (MDLP), await a fully quantum reinterpretation, while quantum extensions of Machine Learning protocols, i.e. algorithms that learn from experience, are just in their initial development.

Purpose of the project is one hand to investigate the extendibility of MDLP to quantum statistics and, on the other hand, to contribute, starting from the notion of quantum perceptron, the basic constituent of a possible "quantum neural-network", to the theoretical formulation of an extension of Machine Learning techniques to the quantum setting; the ultimate aim is that of ascertain whether quantum features as entanglement might boost the effectiveness and performance of these informational tasks.

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References:

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