universität innsbruck

Department of Theoretical Physics

Theory Colloquium

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"Making the case for quantum machine learning"

Abstract

Quantum machine learning (QML) is often put forward as one of the most likely quantum applications to bring about useful advantages, perhaps even in the near term. Large-scale quantum computers, once available, will give definite answers to whether this is true. At present, it is thus important to identify when (and if) advantages can be already theoretically proven. In the folklore of QML, it is often said that QML will offer the most dramatic advantages for learning in "genuinely quantum settings", e.g., when data comes from quantum experiments. However, as we will clarify, most known advantages occur in domains unrelated to physics. Furthermore, dramatic progress in classical ML for physics raises further questions regarding this folklore assumption.

In this talk, we will discuss the two main approaches to establishing rigorous proofs for advantages, through the acceleration of established machine learning methods (speed-ups), and by establishing advantages in fundamental learning capacities (learnability). Regarding speed-ups, we will reflect on the recent progress in so-called quantum topological data analysis, which may offer up to superpolynomial advantages over conventional methods. Concerning learnability, we will present some new results in proving fundamental separations between the capacities of classical and quantum learners.
For both approaches, we will showcase non-trivial connections between learning tasks offering advantages and problems in condensed matter, and high-energy physics. These results provide substantial evidence that the folklore may be right after all.

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