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Quantum Machine Learning in High Energy Physics with Qibo

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Over the past three decades, Quantum Computing (QC) has emerged as a prominent field of research, with the intent of exploring whether and in which context it can help to expediently address problems that are either challenging or infeasible to solve using classical methods. In particular, High-Energy Physics (HEP) has been recently identified as a promising playground to challenge QC routines.
Alongside with this research, the development and maintenance of robust libraries are essential, enabling users to seamlessly implement applications and interface with QC routines.
We introduce Qibo, a comprehensive and open-source framework designed for quantum computing. Qibo provides an extensive range of modules for the simulation, control, and calibration of quantum devices, which can be accessed through a simple High-Level API in Python. Thanks to its modularity, Qibo allows effortlessly execution of its high-level implementation onto any type of hardware accelerator: multi-threading CPU, GPU and multi-GPU for quantum simulation on classical hardware (using state-vector and tensor network approaches) and Quantum Processing Units (QPU) for execution on self-hosted quantum devices.
It also includes a suite of application packages, notably a module dedicated to developing and training Quantum Machine Learning (QML) models. This module facilitates easy integration with popular machine learning frameworks such as TensorFlow and PyTorch.
After a concise overview of the project goals and introducing some of the Qibo primitives, we highlight our specialized models for High-Energy Physics applications. In particular, we describe and train a QML model designed to fit the proton parton distribution functions.

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