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Quantum simulation with just-in-time compilation

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Quantum technologies are moving towards the development of novel hardware devices
based on quantum bits (qubits). In parallel to the development of quantum devices, efficient simulation tools are needed in order to design and benchmark quantum algorithms and applications before deployment on quantum hardware.
In this context, we present a first attempt to perform circuit-based quantum simulation using the just-in-time (JIT) compilation technique on multiple hardware architectures and configurations based on single-node central processing units (CPUs) and graphics processing units (GPUs).
One of the major challenges in scientific code development is to
balance the level of complexity between algorithms and programming techniques without
losing performance or degrading code readability. In this context, we have developed `qibojit`: a new module for the `Qibo` quantum computing framework, which uses a just-in-time compilation approach through Python.
We also present recent results within the `Qibo` framework concerning different simulation methods such as tensor networks and multi-node deployment.
We perform systematic performance benchmarks between `Qibo` and a subset of relevant publicly available libraries for quantum computing.

Significance

This talk will present the latest enhancements in the Qibo framework concerning full state vector simulation and novel results regarding tensor networks and multi-node implementations.

References

https://iopscience.iop.org/article/10.1088/2058-9565/ac39f5
https://quantum-journal.org/papers/q-2022-09-22-814/

Experiment context, if any

Primary authors: PASQUALE, Andrea (University of Milan); ROBBIATI, Matteo (Università degli Studi e INFN Milano (IT)); PEDICILLO, edoardo (Università degli Studi di Milano)

Co-author: CARRAZZA, Stefano (CERN)

Presenter: PASQUALE, Andrea (University of Milan)

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