INTERNSHIP PROPOSAL

(One page maximum)

Laboratory name: Eviden Quantum Lab
CNRS identification code: N/A
Internship director'surname: Thomas Ayral
e-mail: thomas.ayral@eviden.com Phone number:
Web page: https://eviden.com/solutions/advanced-computing/quantum-computing/
Internship location: Les Clayes-sous-Bois

Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: Eviden

Classical emulation of noisy quantum circuits with positive tensor networks

Quantum algorithms run on current quantum computers are subjected to errors and noise caused by hardware imperfections and coupling to the environment. To know exactly how much this affects the result, a noisy circuit must be emulated on classical CPUs. This is a very tall order as in principle, a noisy quantum state must be represented with a density matrix, or by sampling over trajectories.
A promising alternative is the use of tensor networks, a compressed representation of the state, to represent noisy states in an economical fashion. Positive tensor networks, also called Matrix Product Density Operators (MPDO), are promising tools to get high accuracy emulations with limited resources. They however come with their own technical constraints. The goal of this internship is to construct a complete emulation code with this type of tensor network and overcome the aforementioned difficulties, with the goal of making this simulation tool a part of Eviden's Qaptiva, and to compare its performance with other tensor network techniques available in Qaptiva.

Reference: http://arxiv.org/abs/2403.00152

The Eviden quantum laboratory is based in les Clayes-sous-Bois in the Paris area. It is a research and development team whose focus is quantum computing. Our goal is to make quantum computing useful by providing quantum programming languages and libraries (including compilation tools for most existing quantum hardware), by delivering powerful realistic classical simulators (digital twins) of quantum processors to predict and improve the outcome of experimental quantum computations, and by developing new algorithms for a wide spectrum of applications ranging from quantum many-body physics (condensed matter, quantum chemistry) to combinatorial optimization over differential equations. These developments are made concrete, in particular, in Eviden's Qaptiva platform, our quantum programming platform.
The internships we propose typically involve Python programming. Basic knowledge in quantum mechanics, a solid understanding of linear algebra, fluent Python and English, and a will to learn are skills you will definitely put to use here. Experience with tensor networks, condensed matter physics, git, linux or C++ are also appreciated.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES