EPFL-Inria
INTERNATIONAL LAB

EPFL Inria

Workshop EPFL-Inria
November 23 and 24, 2023, Lyon

Daniel Stilck Franca**,** Inria

Title: « Efficient learning of ground & thermal states within phases of matter»

Abstract:
We consider two related tasks: (a) estimating a parameterisation of a given Gibbs state and expectation values of Lipschitz observables on this state; and (b) learning the expectation values of local observables within a thermal or quantum phase of matter. In both cases, we wish to minimise the number of samples we use to learn these properties to a given precision.
For the first task, we develop new techniques to learn parameterisations of classes of systems, including quantum Gibbs states of non-commuting Hamiltonians with exponential decay of correlations and the approximate Markov property. We show it is possible to infer the expectation values of all extensive properties of the state from a number of copies that not only scales polylogarithmically with the system size, but polynomially in the observable's locality -- an exponential improvement. This set of properties includes expected values of quasi-local observables and entropies.
For the second task, we develop efficient algorithms for learning observables in a phase of matter of a quantum system. By exploiting the locality of the Hamiltonian, we show that M local observables can be learned with probability $1-\delta$ to precision ϵ with using only $N=O(\log(M\delta)\text{epolylog}(\epsilon-1))$ samples -- an exponential improvement on the precision over previous bounds. Our results apply to both families of ground states of Hamiltonians displaying local topological quantum order, and thermal phases of matter with exponential decay of correlations. In addition, our sample complexity applies to the worse case setting whereas previous results only applied on average.
Furthermore, we develop tools of independent interest, such as robust shadow tomography algorithms, Gibbs approximations to ground states, and generalisations of transportation cost inequalities for Gibbs states.

Biography:
Daniel Stilck França holds an Inria Starting Faculty position hosted by the École Normale Supérieure de Lyon (ENS Lyon) and is a member of the QInfo team. He works in the fields of quantum information and computation with a focus on mathematical aspects. Before joining Inria, Daniel was a postdoc at the Qmath group at the university of Copenhagen under the supervision of Matthias Christandl, and before that he did his PhD at the Technical University Munich under the supervision of Michael Wolf