Quantum-inspired algorithms for multivariate analysis: from interpolation to partial differential equations

Juan José García Ripoll

Instituto de Física Fundamental IFF-CSIC

In this work we study the encoding of smooth, differentiable multivariate functions distributions in quantum registers, using quantum computers or tensor-network representations. We show that a large family of distributions, including some of NISQ applications, can be encoded as low-entanglement states of the quantum register. These states can be efficiently created in a quantum computer, but they are also efficiently stored, manipulated and probed using Matrix-Product States techniques. Inspired by this idea, we present a set of seven of quantum-inspired numerical analysis algorithms, that include Fourier sampling, interpolation, differentiation and integration of partial derivative equations. These algorithms combine classical ideas—finite-differences, spectral methods—with the efficient encoding of quantum registers, and well known algorithms, such as the Quantum Fourier Transform. *When these heuristic methods work*, they provide an exponential speed-up over other classical algorithms, such as Monte Carlo integration, finite-difference and fast Fourier transforms (FFT). But even when they don't, they can be translated back to a quantum algorithm that implements a similar task.

Talk for the IMAC **Math-Quantum Day**

September 27, 2019

IMAC, Universitat Jaume I de Castelló, Spain.