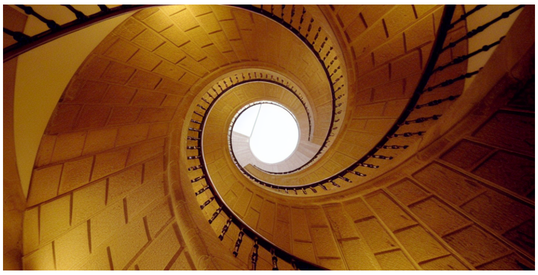

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Global optimization of MPS in quantum-inspired numerical analysis

This work discusses the solution of partial differential equations using matrix-product states (MPS). The study focuses on the search for the lowest eigenstates of a Hamiltonian equation, for which five algorithms are introduced: imaginary time evolution, steepest gradient descent, an improved gradient descent, an implicitly restarted Arnoldi method and density-matrix renormalization group (DMRG) optimization. The first four methods are engineered using a framework of limited-precision linear algebra, where operations between MPS and matrix-product operators (MPOs) are implemented with finite resources. All methods are benchmarked using the PDE for a quantum harmonic oscillator in up to two dimensions, over a regular grid with up to 2^{28} points. Our study reveals that all MPS-based techniques outperform exact diagonalization techniques based on vectors, with respect to memory usage. Imaginary time algorithms are shown to underperform any type of gradient descent, both in terms of calibration needs and costs. Finally, Arnoldi-like methods and DMRG asymptotically outperform all other methods, including exact diagonalization, as problem size increases, with an exponential advantage in memory and time usage.

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