COMPUTATIONAL RESEARCH in BOSTON and BEYOND SEMINAR

Lefschetz Thimble Quantum Monte Carlo for Spin Systems

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ABSTRACT:

Monte Carlo simulations are often useful tools for modeling quantum systems, but in some cases they suffer from a sign problem, which manifests as an oscillating phase attached to the probabilities being sampled. This sign problem generally leads to an exponential slow down in the time taken by a Monte Carlo algorithm to reach any given level of accuracy, and it has been shown that completely solving the sign problem for an arbitrary quantum system is NP-hard. However, a variety of techniques exist for mitigating the sign problem in specific cases; in particular, the technique of deforming the Monte Carlo simulation's plane of integration onto Lefschetz thimbles (that is, complex hypersurfaces of stationary phase) has seen success for many problems of interest in the context of quantum field theories. We extend this methodology to discrete spin systems by utilizing spin coherent state path integrals to re-express the spin system's partition function in terms of continuous variables. This translation to continuous variables introduces additional challenges into the Lefschetz thimble method, which we address. We show that these techniques do indeed work to lessen the sign problem on some simple spin systems.

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https://math.mit.edu/sites/crib/

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Meeting ID: 961 5504 2770

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