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Accelerating Monte Carlo Simulations via Quantum Annealers

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Simulating the low-temperature equilibrium properties of a spin glass is notoriously a hard computational task. It plays a central role in condensed matter physics, and it is also related to relevant NP-hard optimization problems which can be mapped into spin models.

Deep Learning (DL) models, such as generative neural networks can be used to accurately mimic Boltzmann distributions and to accelerate Monte Carlo simulations of classical statistical models. One of the bottlenecks of deep neural networks is the effort to generate a proper dataset: in the spin glass, for instance, classical method to obtain data fail. Therefore, we exploit D-Wave quantum annealer to produce adequate training datasets for the generative models.

Hybrid neural Metropolis algorithms will be described, as well as the use of hybrid quantum-classical training dataset. We obtain a remarkable suppression of the long correlation times that plague spin-glass simulations in the low-temperature regime and a precise reconstruction of the configuration energy distribution. These results demonstrate that quantum devices, combined with DL algorithms, allow tackling otherwise intractable computational problem.

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