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Estimation of effective temperatures in a quantum annealer: Towards deep learning applications[1] JOHN REALPE-GÓMEZ, MARCELLO BENEDETTI, ALEJANDRO PERDOMO-ORTIZ, NASA/Ames Res Ctr — Sampling is at the core of deep learning and more general machine learning applications; an increase in its efficiency would have a significant impact across several domains. Recently, quantum annealers have been proposed as a potential candidate to speed up these tasks, but several limitations still bar them from being used effectively. One of the main limitations, and the focus of this work, is that using the device's experimentally accessible temperature as a reference for sampling purposes leads to very poor correlation with the Boltzmann distribution it is programmed to sample from. Based on quantum dynamical arguments, one can expect that if the device indeed happens to be sampling from a Boltzmann-like distribution, it will correspond to one with an instance-dependent effective temperature. Unless this unknown temperature can be unveiled, it might not be possible to effectively use a quantum annealer for Boltzmann sampling processes. In this work, we propose a strategy to overcome this challenge with a simple effective-temperature estimation algorithm. We provide a systematic study assessing the impact of the effective temperatures in the quantum-assisted training of Boltzmann machines, which can serve as a building block for deep learning architectures.

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