Machine Learning and Histogram Reweighting: Detecting and Studying Phase Transitions

Wednesday, 5 August 2020 17:00 (20 minutes)

We present a synergistic approach between machine learning and histogram reweighting to discover and study phase transitions in physical systems. We treat the output of a neural network, designed for phase classification, as an observable in a statistical system enabling its extrapolation over continuous ranges in parameter space using histogram reweighting. The approach, which leads to quantitative results and overcomes the need to understand the studied system in detail, is applied to the two-dimensional Ising model by training a convolutional neural network to separate its symmetric and broken-symmetry phases. We further demonstrate that the Ising-trained neural network is sufficient to predict the phase transition in q-state Potts models and the ϕ^4 scalar field theory under a change of order, universality class or the presence of continuous or discrete degrees of freedom. Finally, we present calculations of critical exponents and the critical coupling for the Ising model and the ϕ^4 scalar field theory using a finite size scaling analysis on quantities derived entirely from the neural network implementation and their histogram-reweighted extrapolations.

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