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Using machine learning to understand the properties of the QCD critical point

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One of the main goals of the second phase of the Beam Energy Scan program at RHIC is to search for the QCD critical point. In order to study the thermodynamic effects of the presence of a critical point, we constructed a family of equations of state using a model that couples Lattice QCD results to a parameterized critical point from the 3D Ising model universality class. The mapping of the Ising critical point onto the QCD phase diagram gives rise to free parameters that control its position and size/shape of the critical region. In this work, we demonstrate how active sampling coupled with a variety of machine learning models can be used as a tool to identify choices of free parameters that result in inconsistent thermodynamics. In particular, we study the performance of supervised logistic regression, Support Vector Machine (SVM), random forest, and deep learning algorithms, in both passive and active learning settings. This approach can rule out pathological parameter sets at a low computational cost. Our procedure can be applied to constrain other high-dimensional models relevant to experimental searches in heavy-ion collisions.

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