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HMC and gradient flow with machine-learned classically perfect fixed point actions

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Fixed point (FP) lattice actions are classically perfect, i.e., they have continuum classical properties unaffected by discretization effects. They have suppressed lattice artefacts and therefore provide a possible way to extract continuum physics with coarser lattices, allowing to circumvent problems with critical slowing down and topological freezing towards the continuum limit. We use machine-learning methods to parameterize a FP action for four-dimensional SU(3) gauge theory using lattice gauge-covariant convolutional neural networks (L-CNNs). The large operator space allows us to find superior parametrizations compared to previous studies and we show how such actions can be efficiently simulated with HMC algorithms. Furthermore, we argue that FP lattice actions can be used to define a classically perfect gradient flow without any lattice artefacts at tree level.

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