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Generative models for scalar field theories: how to deal with poor scaling?

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The basis of lattice QCD is the formulation of the QCD path integral on a Euclidean space-time lattice, allowing for computing expectation values of observables using Monte Carlo simulations. Despite the success of lattice QCD in determinations of many parameters of the Standard Model, limitations on the current techniques and algorithms still exist, such as critical slowing down or the cost of fully taking into account the fermion dynamics. New approaches are required to circumvent these limitations. Machine learning algorithms provide a viable approach to address some of these difficulties. Deep generative models such as normalizing flows are suggested as alternatives to standard methods for generating lattice configurations. Previous studies on normalizing flows demonstrate proof of principle for simple models in two dimensions. However, further studies indicate that the training cost can be, in general, very high for large lattices. The poor scaling traits of current models indicate that moderate-size networks cannot efficiently handle the inherently multi-scale aspects of the problem, especially around critical points. In this talk, we explore current models that lead to poor acceptance rates for large lattices and explain how to use effective field theories as a guide to design models with improved scaling costs. Finally, we discuss alternative ways of handling poor acceptance rates for large lattices.

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