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Complex control variates

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Contour deformation methods have successfully tamed sign problems in low-dimensional fermionic lattice fields theories at finite density. However, one obstacle with these methods is that they do not guarantee the existence of an integration contour which solves the sign problem completely, thus making it difficult for the methods to be applied to larger and more complex systems, such as lattice QCD. In this talk, I will introduce a strict generalization of the contour deformation methods: complex control variates. In the path integral, we subtract a function from the distribution function such that the phase fluctuations in the distribution are reduced while the physics does not change. Subtraction functions which entirely remove the sign problem exist for any lattice theories, although it is difficult to find them. In practice, subtraction functions, which remove the sign problem sufficiently, can be constructed analytically or numerically with the help of machine learning. I will demonstrate this method with the classical Ising model and the 1+1-dimensional Thirring model at finite density.

Topical area

QCD at Non-zero Density

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