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Machine Learning assisted real-time simulations with Complex Langevin

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The direct simulation of the real-time dynamics of strongly correlated quantum fields remains an open challenge in both nuclear and condensed matter physics due to the notorious sign problem. Here we present a novel machine-learning inspired strategy [1] that significantly improves complex Langevin simulations of quantum real-time dynamics.
Our approach combines two central ingredients: 1) we revive the idea of deploying a kernel in the stochastic Langevin dynamics to improve the convergence properties of the approach. 2) Taking inspiration from the reinforcement learning paradigm of machine learning we propose to systematically find optimal kernels based on prior information.
The fact that our approach infuses the complex Langevin simulation with system specific prior information promises a way to overcome the NP-hardness of the sign-problem for which no generic solution approach is believed to exist.

[1] D. Alevestad, R. Larsen, A.R. JHEP 04 (2023) 057 (https://arxiv.org/abs/2211.15625)

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