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Hybrid Quantum-Classical Diffusion Models for Generative Tasks

Generative models based on diffusion processes have recently emerged as powerful tools in artificial intelligence, enabling high-quality sampling in a variety of domains. In this work, we propose a novel hybrid quantum-classical diffusion model, where artificial neural networks are replaced with parameterized quantum circuits to directly generate quantum states. To overcome the limitations of quantum circuits in approximating complex probability distributions, we integrate them with classical neural networks, forming a hybrid architecture that increases expressivity and improves the ability to represent complex functions in Hilbert space. This hybrid model effectively learns and samples quantum states, opening new directions for generative quantum machine learning.

We assess the performance of our model using a combination of quantitative metrics and qualitative evaluations. Furthermore, we explore its applications in fundamental science, demonstrating its potential in domains where quantum generative models can provide computational and conceptual advantages over classical approaches.

AI keywords

Quantum Machine Learning:Diffusion Models:Hybrid Models

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