Project Title:

Machine Learning Topological States of Matter

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1. Background and purpose of the project, relationship of the project with other projects

The Feynman path integral provides an elegant, classically-inspired representation for the quantum propagator and the quantum dynamics, through summing over a huge manifold of all possible paths. From a computational and simulational perspective, the ergodic tracking of this path manifold is a hard problem. Machine learning can help, in an *efficient* manner, to identify the relevant features and the intrinsic structure residing at a small fraction of the vast path manifold, for instance, the classical path and its quantum fluctuating neighbourhoods.

2. Specific usage status of the system and calculation method

Up to 10-12 nodes with 10 CPUs for each of them were used simultaneously, to train a deep neural network for the purpose of the efficient generation of Feynman paths with various specified endpoints.

3. Result

The Euclidean quantum propagator, as well as the ground-state wave function (density) can be efficiently estimated via our methods for a generic potential energy (paper coming very soon).

4. Conclusion

we delivered the concept of Feynman path generators for modelling Euclidean Feynman paths with fixed endpoints, from the latent space. The quantum propagators (or kernel functions) are efficiently estimated for both a harmonic oscillator and anharmonic potential. Our work should pave the way toward deep generative modelling of Feynman paths, and may provide a future fresh perspective to understand the quantum classical correspondence through deep learning.

Fiscal Year 2021 List of Publications Resulting from the Use of the supercomputer

Yanming Che, Clemens Gneiting, and Franco Nori, Estimating the Euclidean Quantum Propagator with Deep Generative Modelling of Feynman Paths, **to appear very soon, and we have acknowledged RIKEN supercomputer in our manuscript.**