"Quantum State Tomography and Hamiltonian Learning Based on Maximal Entropy Formalism and Time Dynamics of Observables"

Physical Chemistry Seminar

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Rishabh Gupta
Graduate Student (Kais Group)
Department of Chemistry
Purdue University

Abstract:
This talk will cover two related topics in quantum computation: quantum state tomography and Hamiltonian learning. Quantum state tomography involves reconstructing a quantum system's state with high accuracy, given mean measurement values of different operators. We propose a variational approach using the maximal entropy formalism to construct the least biased mixed quantum state consistent with a given set of expectation values, employing a parameterized quantum circuit and a hybrid quantum-classical algorithm for optimization. This makes the recipe easily implementable on a near-term quantum device. The second topic, Hamiltonian learning, involves reconstructing a quantum system's Hamiltonian using measurables on random states forming a time series dataset. The scheme that we proposed is general, allowing freedom in selecting observables or initial states while remaining efficient, validated by reproducing dynamics of unseen observables on a randomly chosen state. The time dynamics is implemented through Trotterization and optimized variationally with gradients computed on the quantum circuit. We further extend the protocol to quantum state learning and also propose an analytical method for learning Hamiltonians consisting of generators of the SU(3) group. This work is expected to facilitate using Hamiltonian learning for time series prediction in quantum machine learning algorithms.

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