Problem Statements

Problem 1: Quantum State Preparation optimization for Complex Hamiltonian

You must prepare an efficient quantum state preparation using your own implementation using matrix product state/ tensor network approach (e.g. https://iopscience.iop.org/article/10.1088/2058-9565/acd9e7/pdf) for a complex many body Hamiltonian ground state energy optimization (basically a VQE needs to be implemented for a custom Hamiltonian) (you can take any Hamiltonian like inhomogeneous Heisenberg Hamiltonian with 2 nearest neighbor interaction or a Hamiltonian from the article: https://journals.aps.org/prresearch/pdf/10.1103/PhysRevResearch.5.023174) .

Problem 2: Learning Dynamics of complex system using Quantum Graph Neural Networks

You need to implement a quantum graph neural network for prediction of the dynamics of the many bodies Hamiltonian (this has direct application in particle trajectory and solving differential equation for physics-based problem as shown by CERN: https://quantum.cern/quantum-graph-neural-networks). You can take inspiration from the seminal paper on Quantum Graph Neural network by Google Quantum AI for Hamiltonian Dynamics Simulation (https://arxiv.org/pdf/1909.12264.pdf)