QCELS statement

The Quantum Exponential Least Squares (QCELS) algorithm (Ding, Lin 2023) takes a reference state and evolves it by the time evolution operator enclosed within a Hadamard test. If the reference state is the ground state () then the resultant expectation values are and if the reference state is not exact then the resultant function is where is the probability of measuring the eigenstate of the Hamiltonian . Thus, if a reference state with good overlap with the true ground state is known, we can apply the time evolution operator within a Hadamard test times and fit to the resulting complex expponential, refining our guess by allowing for more energies to contribute. For this challenge the Hartree-Fock ground state retains a reasonable overlap with the true ground state up to 28 qubits and the time evolution operator can be implemented with a first order Trotter-Suzuki expansion with a truncated Hamiltonian to reduce gate count.