VQE Mini Project*

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1 Problem Statement

Find the ***expectation value*** of the Hamiltonian $Z \otimes Z$, with respect to an **arbitrarily constructed trial state** using ***parametrize quantum circuit*** in ***Qiskit***. Where Z = z-component of Pauli vector.

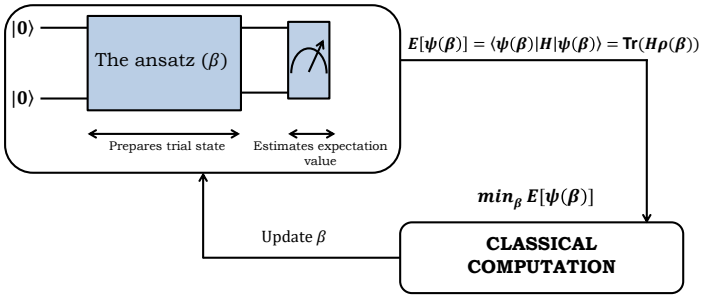

Figure 1: VQE circuit

2 VQE: Subroutines

The ***Variational quantum eigensolver*** consists a total of three subroutines

a. **Trial State Preparation:** This can be done by choosing an arbitrary quantum gate sequence (ansatz), depending on some parameters *i.e.* angles.

b. **Finding the Energy:** After preparing the initial state one need to find the expectation value of Hamiltonian (i.e. energy) on the basis of the prepared trial state.

c. **Minimize the Energy:** This step can be efficiently done by using a completely classical process, and by choosing an optimization method from the ***scipy.optimize*** documentation of Python.

An Illustration is given on **Figure** 1.

*All the bold and italics text redirect to relevant links.

3 Elaboration of Problem Statement

This project can be completed by using only first two subroutines of VQE process. Hence your task will be to:

a. Construct a trial wave function using an arbitrary parametrized quantum circuit i.e. ansatz based on ***single qubit gates*** and ***two qubit rotating gates***.

b. Find the expectation value of $Z \otimes Z$, in the basis of the trial wave function i.e.

$$\text{Expectation Value} = \langle \text{trial state} | Z \otimes Z | \text{trial state} \rangle \tag{1}$$

- ***The Trial state can be obtained by using the ***Statevector Simulator*** after running the parametrized quantum circuit mentioned in step a.***