Quantum Computation
Plaksha University

Tutorial 1

1. Consider the following two qubit state:

$$\frac{|1\rangle + |2\rangle + |3\rangle}{\sqrt{3}i}$$

   (a) What is the probability of obtaining the state $|2\rangle$ or $|3\rangle$ upon measurement in the Z basis?

   (b) Calculate the probability of obtaining $|0\rangle$ in the Hadamard basis.

   (c) Calculate $< X \otimes H \otimes Z >$ for the above 2 qubit state.

2. For the Pauli- X matrix:

   (a) Find the eigenvalues and the normalized eigenvectors. Do you recognize these eigenvectors (think of the Bloch Sphere)?

   (b) Write the Pauli- X matrix in its diagonal representation.

   Note: *Diagonal representation of an operator A on a vector space V is a representation $A = \Sigma_i \lambda_i |i\rangle \langle i|$ where the vectors $|i\rangle$ forms an orthonormal set of eigenvectors of A with corresponding eigenvalues λ_i.*

3. Start with the two qubit state $|10\rangle$

   (a) Perform the following operation (leftmost operations acts last) and find the resulting state: $HXHX \otimes HZHZ$

   (b) Simulate these operations on a quantum circuit using qiskit and plot the histogram of measurement results. Which state has the highest probability of showing up when measurement is done?

   (c) Using qiskit's unitary simulator, find the single 4 x 4 matrix that does the above operation.