# Tutorial Sheet-3

PHN-640 | QUANTUM COMPUTING | SPRING 2024

1. Write a script for the Deutsch-Jozsa algorithm to find a function $f$.
   (a) Define a function $deutsch\_jozsa\_algorithm$ to write an oracle circuit for $n$ qubits.
   (b) Write a function $balanced\_dj\_circuit$ and run the algorithm for a balanced function for $n = 5$.
   (c) Write a function $constant\_dj\_circuit$ and run the algorithm for a constant function for $n = 3$.
   (d) Print the counts and plot the histogram of outputs for parts (b) and (c).
   (e) Define a function $calculate\_execution\_time$ to calculate the execution time ($t_1$ for part (b) and $t_2$ for part (c)) of the circuit for n = 20. Print $t_1$, $t_2$ and $(t_1 - t_2)$.
2. Define an array for the number of shots as $S = [\mathtt{100}, \mathtt{500}, \mathtt{1000}, \mathtt{2500}, \mathtt{5000}]$.
   (a) Repeat parts 1(a) and 1(b) for each value of $S$.
   (b) Define a function $calculate\_execution\_time$ to calculate the execution time ($t$) of the circuit.
   (c) Evaluate $t$ for each value of $S$ and save it to an array $Time\_balanced$. Plot $Time\_balanced$ vs $S$.
3. Define an array for the number of shots as $S = [\mathtt{500}, \mathtt{1000}, \mathtt{2000}, \mathtt{4000}, \mathtt{6000}]$.
   (a) Repeat parts 1(a) and 1(c) for each value of $S$.
   (b) Define a function $calculate\_execution\_time$ to calculate the execution time ($t$) of the circuit.
   (c) Evaluate $t$ for each value of $S$ and save it to an array $Time\_constant$. Plot $Time\_constant$ vs $S$.
4. Write a script to perform the Quantum Fourier Transformation (QFT) for $n$ qubits.
   (a) Define a function $qft\_rotations$ to apply a single-qubit Hadamard gate and a series of controlled-phase gates.
   (b) Write a function $qft$ to perform QFT on the above quantum circuit.
   (c) Create a quantum circuit with $n$ = 2, 3 and 4 qubits and draw the circuit for each $n$.
   (d) Simulate the circuit and plot the histogram for each value of $n$.
5. Write a script to perform the QFT for 3 qubits.
   (a) Create an initial state $[\mathtt{010}]$ and draw the circuit.
   (b) Simulate the circuit, print the state vector, and plot the histogram.
   (c) Perform the inverse QFT, draw the circuit, and print the initial state.
6. Repeat Q. No. 5 for 4 qubits and initial state = $[\mathtt{0110}]$.

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