



## Practical 5 - Deutsch Algorithm

```
In [1]: !pip3 install qiskit
!pip3 install qiskit_aer
!pip3 install qiskit[visualization]
```

Requirement already satisfied: qiskit in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (2.1.1)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (0.16.0)

Requirement already satisfied: numpy<3,>=1.17 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (2.3.2)

Requirement already satisfied: scipy>=1.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (1.16.1)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (0.4.0)

Requirement already satisfied: stevedore>=3.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (5.4.1)

Requirement already satisfied: typing-extensions in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit) (4.14.1)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit) (80.9.0)

Requirement already satisfied: qiskit\_aer in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (0.17.2)

Requirement already satisfied: qiskit>=1.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit\_aer) (2.1.1)

Requirement already satisfied: numpy>=1.16.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit\_aer) (2.3.2)

Requirement already satisfied: scipy>=1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit\_aer) (1.16.1)

Requirement already satisfied: psutil>=5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from qiskit\_aer) (6.1.1)

Requirement already satisfied: python-dateutil>=2.8.0 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from qiskit\_aer) (2.9.0.post0)

Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.8.0->qiskit\_aer) (1.17.0)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit\_aer) (0.16.0)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit\_aer) (0.4.0)

Requirement already satisfied: stevedore>=3.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit\_aer) (5.4.1)

Requirement already satisfied: typing-extensions in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit>=1.1.0->qiskit\_aer) (4.14.1)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit>=1.1.0->qiskit\_aer) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit>=1.1.0->qiskit\_aer) (80.9.0)

Requirement already satisfied: qiskit[visualization] in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (2.1.1)

Requirement already satisfied: rustworkx>=0.15.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (0.1

6.0)

Requirement already satisfied: numpy<3,>=1.17 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (2.3.2)

Requirement already satisfied: scipy>=1.5 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (1.16.1)

Requirement already satisfied: dill>=0.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (0.4.0)

Requirement already satisfied: stevedore>=3.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (5.4.1)

Requirement already satisfied: typing-extensions in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (4.14.1)

Requirement already satisfied: matplotlib>=3.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (3.10.5)

Requirement already satisfied: pydot in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (4.0.1)

Requirement already satisfied: Pillow>=4.2.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (11.3.0)

Requirement already satisfied: pylatexenc>=1.4 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (2.10)

Requirement already satisfied: seaborn>=0.9.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (0.13.2)

Requirement already satisfied: sympy>=1.3 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from qiskit[visualization]) (1.14.0)

Requirement already satisfied: contourpy>=1.0.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (1.3.3)

Requirement already satisfied: cycler>=0.10 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (0.12.1)

Requirement already satisfied: fonttools>=4.22.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (4.59.0)

Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (1.4.8)

Requirement already satisfied: packaging>=20.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (23.2)

Requirement already satisfied: pyparsing>=2.3.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from matplotlib>=3.3->qiskit[visualization]) (3.2.3)

Requirement already satisfied: python-dateutil>=2.7 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from matplotlib>=3.3->qiskit[visualization]) (2.9.0.post0)

Requirement already satisfied: six>=1.5 in c:\users\vinay\appdata\roaming\python\python312\site-packages (from python-dateutil>=2.7->matplotlib>=3.3->qiskit[visualization]) (1.17.0)

Requirement already satisfied: pandas>=1.2 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from seaborn>=0.9.0->qiskit[visualization]) (2.3.1)

Requirement already satisfied: pytz>=2020.1 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pandas>=1.2->seaborn>=0.9.0->qiskit[visualization]) (2025.2)

Requirement already satisfied: tzdata>=2022.7 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pandas>=1.2->seaborn>=0.9.0->qiskit[visualization]) (2025.2)

Requirement already satisfied: pbr>=2.0.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from stevedore>=3.0.0->qiskit[visualization]) (6.1.1)

Requirement already satisfied: setuptools in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from pbr>=2.0.0->stevedore>=3.0.0->qiskit[visualization]) (80.9.0)

Requirement already satisfied: mpmath<1.4,>=1.1.0 in c:\users\vinay\appdata\local\programs\python\python312\lib\site-packages (from sympy>=1.3->qiskit[visualization]) (1.3.0)

```
In [2]: import matplotlib.pyplot as plt
        %matplotlib inline
        from qiskit import QuantumCircuit
        from qiskit_aer import AerSimulator
        from qiskit.visualization import plot_histogram
```

```
In [3]: def constant_oracle_0():
        """Oracle for f(x) = 0 (constant) - identity"""
        oracle = QuantumCircuit(2)
        return oracle
```

```
In [4]: def constant_oracle_1():
        """Oracle for f(x) = 1 (constant) - flips the output qubit"""
        oracle = QuantumCircuit(2)
        oracle.x(1)
        return oracle
```

```
In [5]: def balanced_oracle_x():
        """Oracle for f(x) = x (balanced) - CNOT gate"""
        oracle = QuantumCircuit(2)
        oracle.cx(0, 1)
        return oracle
```

```
In [6]: def deutsch_algorithm(oracle):
        # Create a 2-qubit, 1-classical-bit circuit
        qc = QuantumCircuit(2, 1)
        # Initialize second qubit to |1>
        qc.x(1)
        # Apply Hadamard on both qubits
        qc.h([0, 1])
        qc.barrier() # add a barrier for readability
        # Apply the oracle
        qc.compose(oracle, inplace=True) # append the oracle circuit to qc
        qc.barrier()
        # Apply Hadamard on the first qubit
        qc.h(0)
```

```

# Measure the first qubit
qc.measure(0, 0)
return qc

```

```

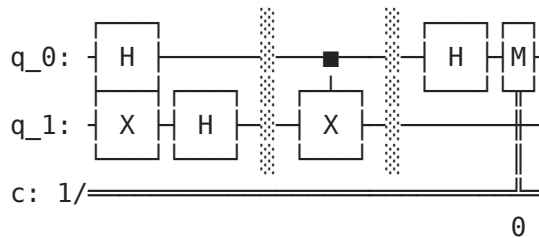
In [7]: # Select oracle to test; change to test different oracles
oracle = balanced_oracle_x()

```

```

In [8]: # Create the Deutsch algorithm circuit with the chosen oracle
circuit = deutsch_algorithm(oracle)
print(circuit.draw())

```



```

In [9]: # Use Qiskit Aer simulator
simulator = AerSimulator()

```

```

In [10]: # Execute the circuit on the simulator with 100 shots
result = simulator.run(circuit, shots=100).result()
counts = result.get_counts()

print("Measurement results:", counts)

```

Measurement results: {'1': 100}

```

In [11]: # Plot the results
hist_fig = plot_histogram(counts)
hist_fig

```

Out[11]:

