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Project 1 Report: Quantum Measurements in Different Bases

Overview

This project demonstrates basic quantum measurements and measurements in different Pauli bases (X, Y, Z) using Qiskit. The experiments show how quantum states behave under various measurement conditions.

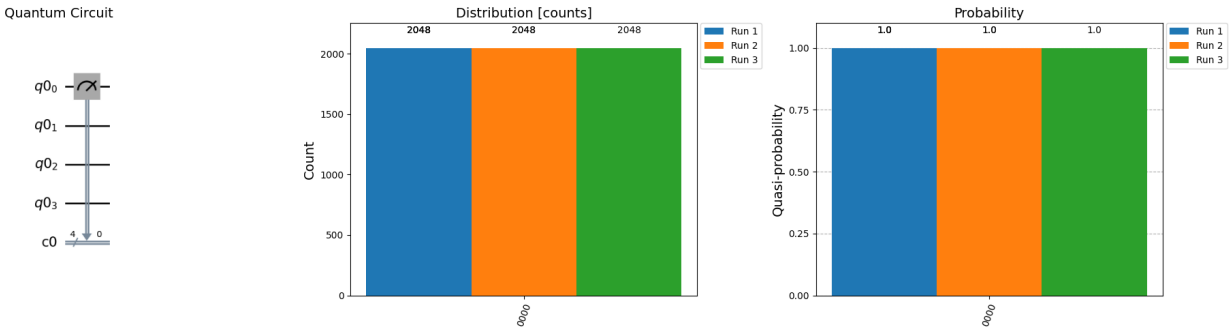
Task 1: Basic Measurement

Measuring the default state |0⟩ of a qubit.

Code Snippet:

```
n = 4
nx = n
qx = QuantumRegister(nx)
cx = ClassicalRegister(nx)
circuit = QuantumCircuit(qx, cx)
circuit.measure(qx[0], cx[0])
```

Results:



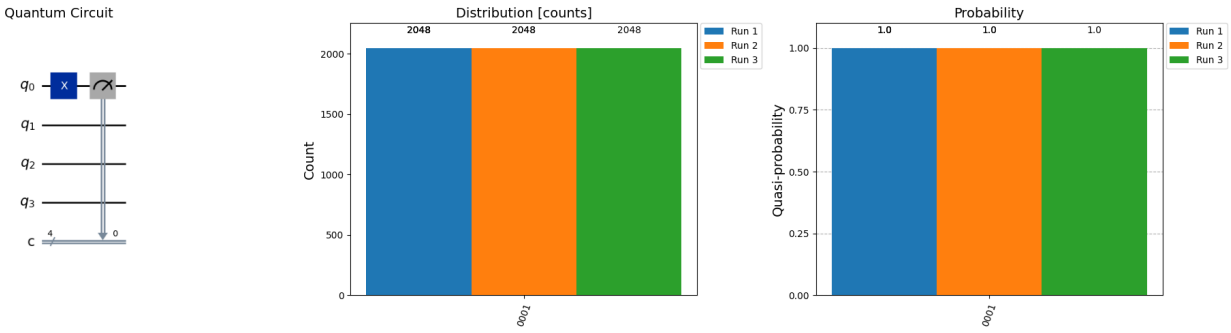
Task 2: X Gate Measurement

Applying an X gate before measurement.

Code Snippet:

```
qreg = QuantumRegister(4, 'q')
creg_c = ClassicalRegister(4, 'c')
circuit = QuantumCircuit(qreg, creg_c)
circuit.x(qreg[0])
circuit.measure(qreg[0], creg_c[0])
```

Results:



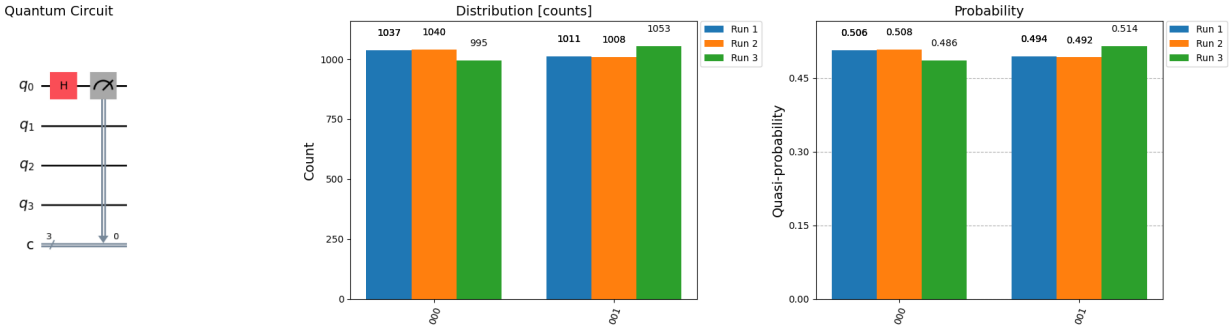
Task 3: H Gate Measurement

Applying a Hadamard gate before measurement.

Code Snippet:

```
qreg = QuantumRegister(4, 'q')
creg_c = ClassicalRegister(3, 'c')
circuit = QuantumCircuit(qreg, creg_c)
circuit.h(qreg[0])
circuit.measure(qreg[0], creg_c[0])
```

Results:



Task 4: Measurements in Different Bases

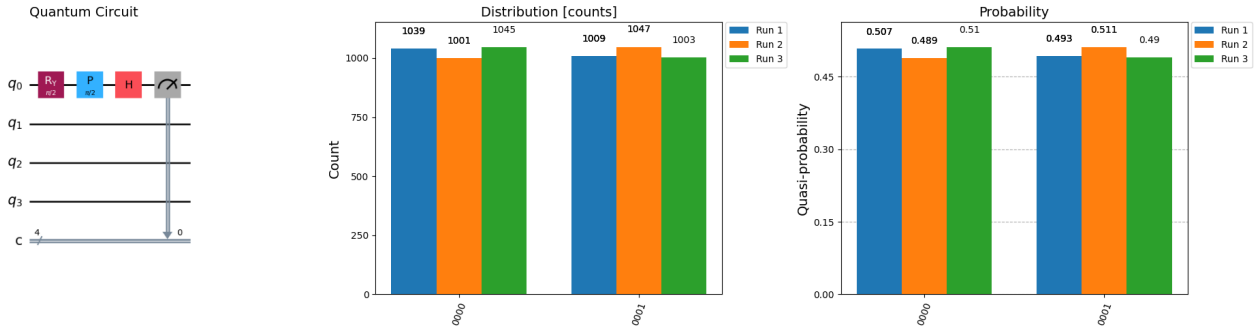
X Basis Measurement

Preparing the state |+⟩ and measuring in X basis.

Code Snippet:

```
qreg = QuantumRegister(4, 'q')
creg_c = ClassicalRegister(4, 'c')
circuit = QuantumCircuit(qreg, creg_c)
circuit.ry(pi / 2, qreg[0])
circuit.p(pi / 2, qreg[0])
circuit.h(qreg[0])
circuit.measure(qreg[0], creg_c[0])
```

Results:



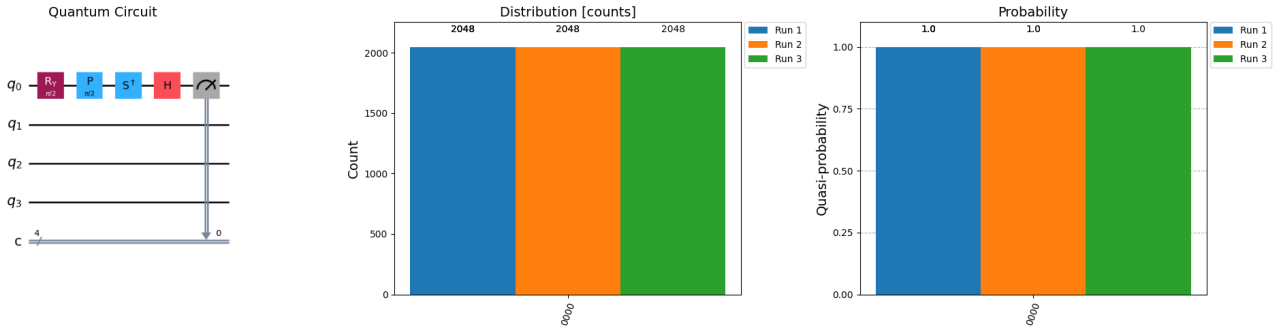
Y Basis Measurement

Preparing the state |i⟩ and measuring in Y basis.

Code Snippet:

```
qreg = QuantumRegister(4, 'q')
creg_c = ClassicalRegister(4, 'c')
circuit = QuantumCircuit(qreg, creg_c)
circuit.ry(pi / 2, qreg[0])
circuit.p(pi / 2, qreg[0])
circuit.sdg(qreg[0])
circuit.h(qreg[0])
circuit.measure(qreg[0], creg_c[0])
```

Results:



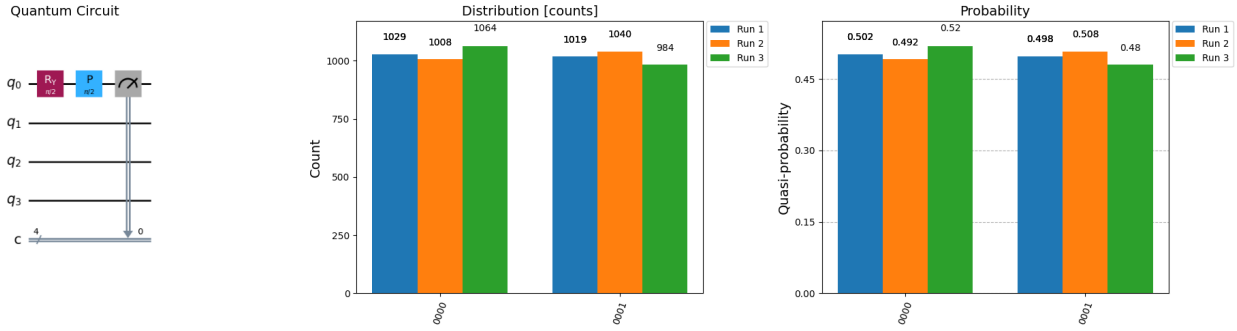
Z Basis Measurement

Measuring in the computational (Z) basis.

Code Snippet:

```
qreg = QuantumRegister(4, 'q')
creg_c = ClassicalRegister(4, 'c')
circuit = QuantumCircuit(qreg, creg_c)
circuit.ry(pi / 2, qreg[0])
circuit.p(pi / 2, qreg[0])
circuit.measure(qreg[0], creg_c[0])
```

Results:



Conclusion

These experiments demonstrate the principles of quantum measurement in different bases, showing how the preparation of quantum states affects measurement outcomes. The results are visualized through histograms showing both count distributions and probability distributions across multiple runs.