Team 3

Quantum programs testing tool

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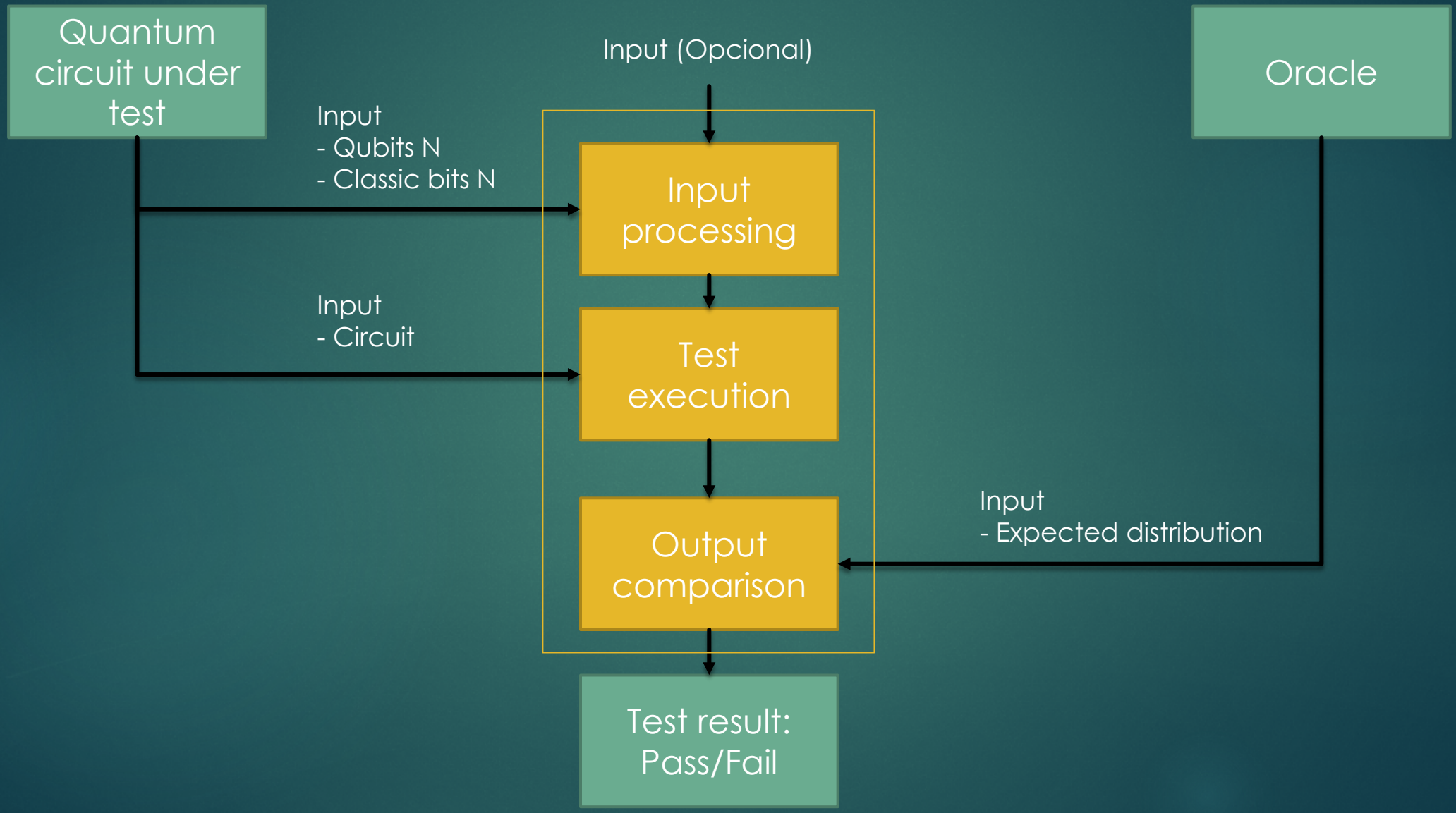
Motivación

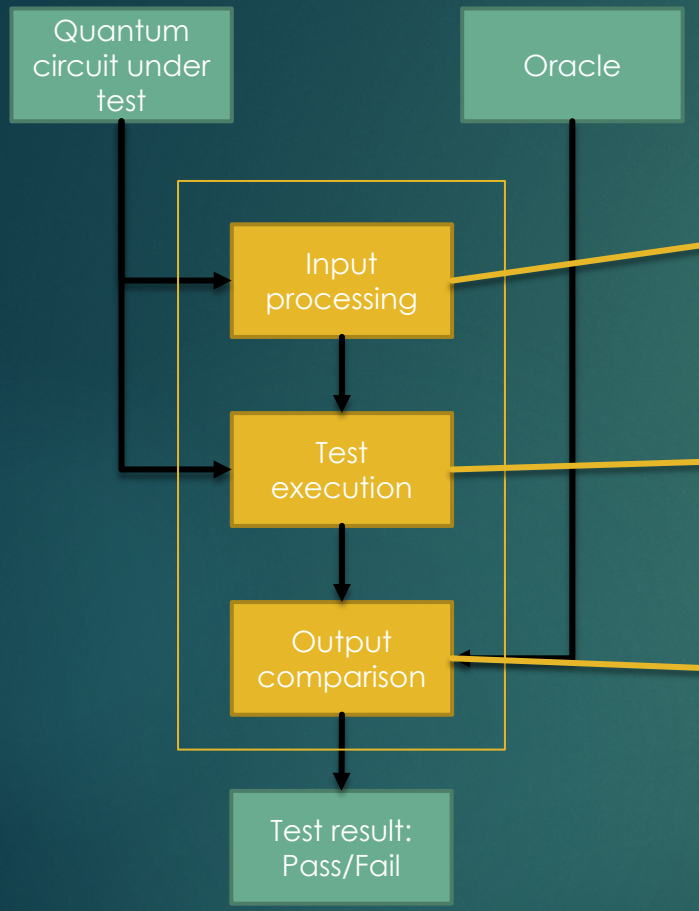
"To fully exploit QC's potential, it is important to ensure the correctness of quantum programs. Doing so via software testing is, however, very challenging because of QC's inherent properties: superposition and entanglement." X. Wang et al.

- Existe teoría pero no herramientas
- Los sistemas clásicos no estan adaptados

Estructura


Quantum circuit under test
Input (Opcional)
Oracle
Input
- Qubits N
- Classic bits N
Input processing
Input
- Circuit
Test execution
Output comparison
Input
- Expected distribution
Test result: Pass/Fail

Testing Quantum Programs

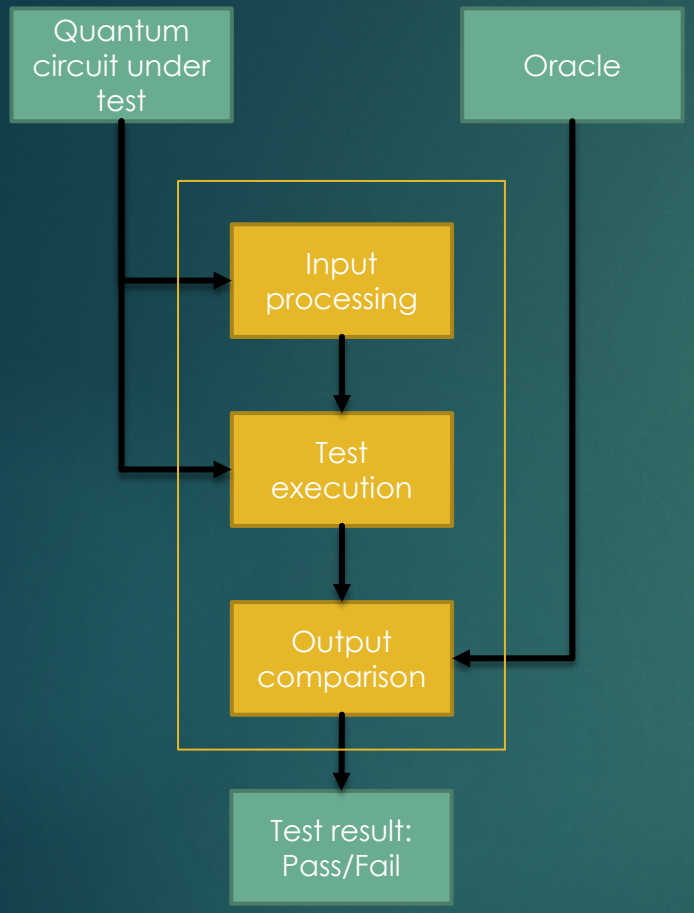


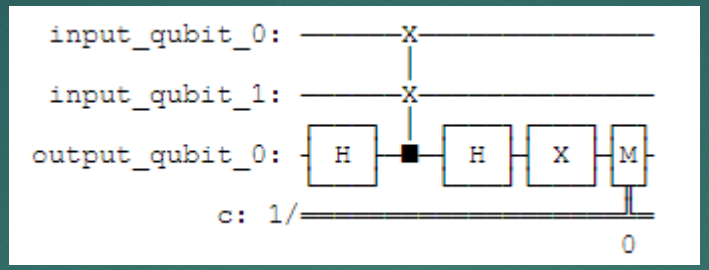

```
#Función iqc_individual
#INPUTS: value: array of ints, num_total_qubits: int, num_cl_bits: int
#OUTPUTS: qc: QuantumCircuit
def iqc_individual(value=[], num_total_qubits=0, num_cl_bits=0):
```

```
#Función test_circuit
#INPUTS: iqc: QuantumCircuit, qc: QuantumCircuit, shots: int
#OUTPUTS: histogram: array of ints
def test_circuit(iqc, qc,  shots=1024):
```

```
#Función chi_square
#INPUTS: outputs: dict<string, int>, oracle: dict<string, int>
#OUTPUTS: boolean
def chi_square(outputs,oracle):
```

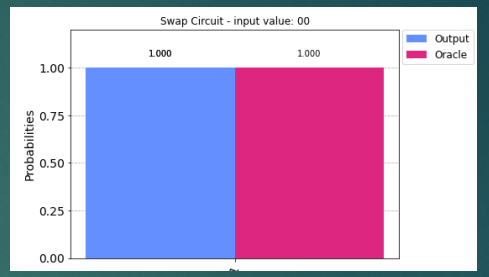
Testing Quantum Programs

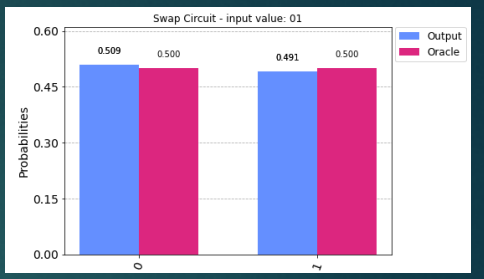


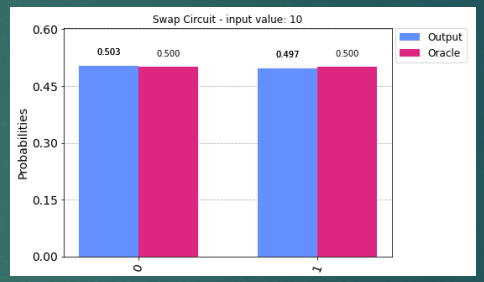


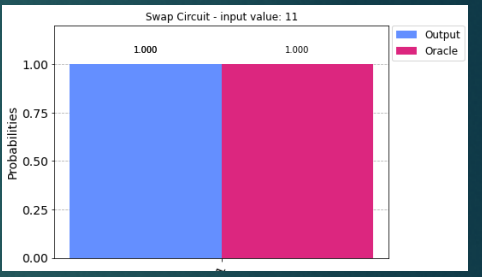

```
Circuit passed evaluation for input [0, 0].
Circuit passed evaluation for input [0, 1].
Circuit passed evaluation for input [1, 0].
Circuit passed evaluation for input [1, 1].
```

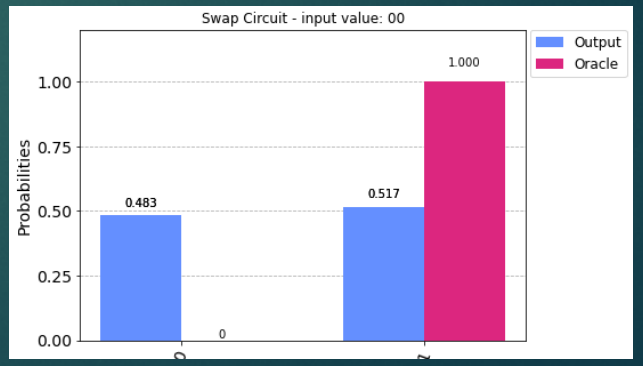
```
Circuit failed evaluation for input [0, 0]! There is some error.
Circuit returned {'1': 549, '0': 475}
Circuit passed evaluation for input [0, 1].
Circuit passed evaluation for input [1, 0].
Circuit failed evaluation for input [1, 1]! There is some error.
Circuit returned {'1': 530, '0': 494}
```



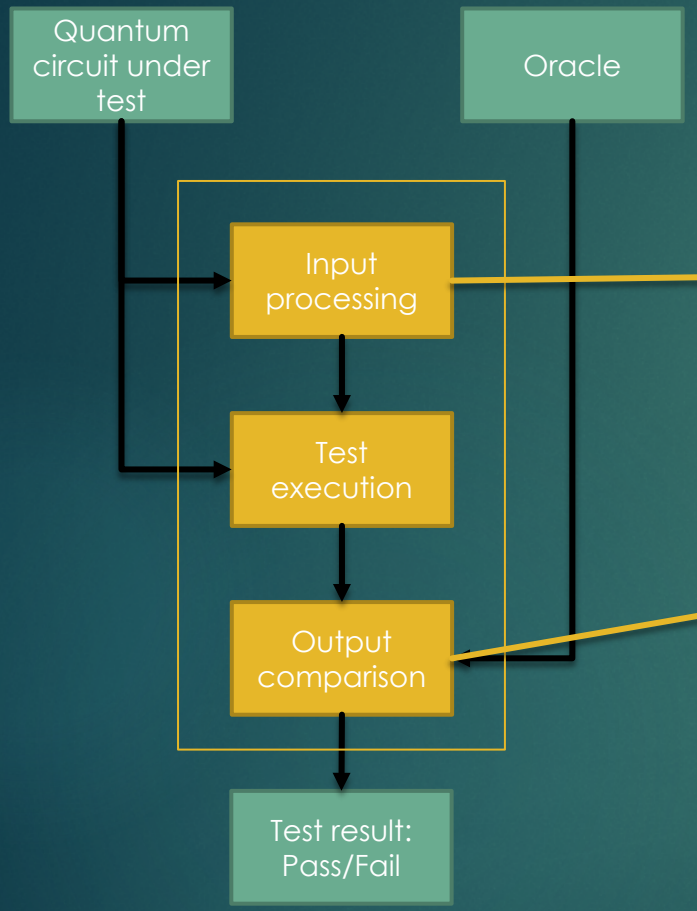








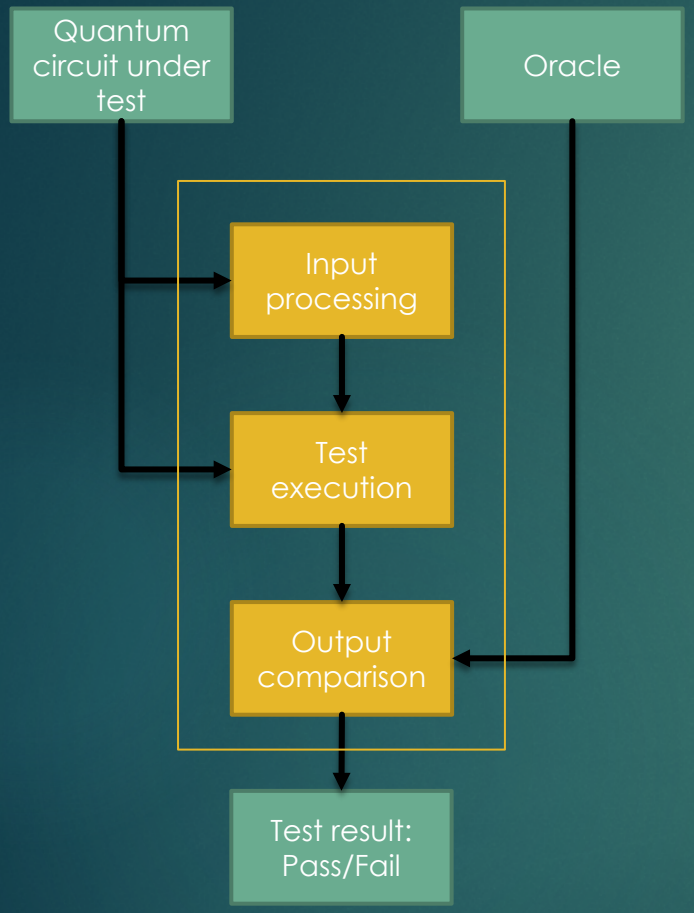
Probando Múltiples Inputs

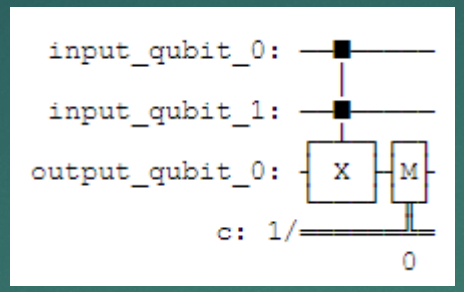



```
#Función iqc_superposition
#INPUTS: num_inputs: int, num_total_qubits: int, num_cl_bits: int
#OUTPUTS: qc: QuantumCircuit
def iqc_superposition(num_inputs=0, num_total_qubits=0, num_cl_bits=0)
```

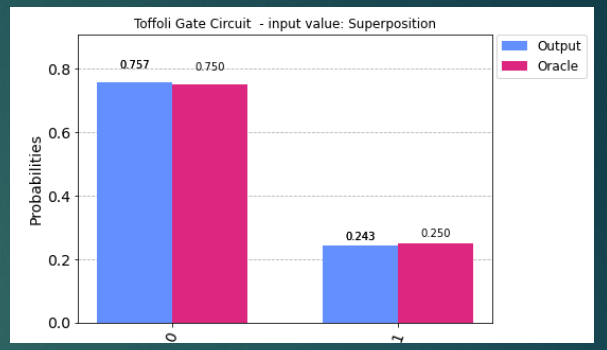
```
#Función oracle_union
#INPUTS: oracles: dict<string, dict<string, int>>
#OUTPUTS: oracle: dict<string, int>
def oracle_union(oracles):
```

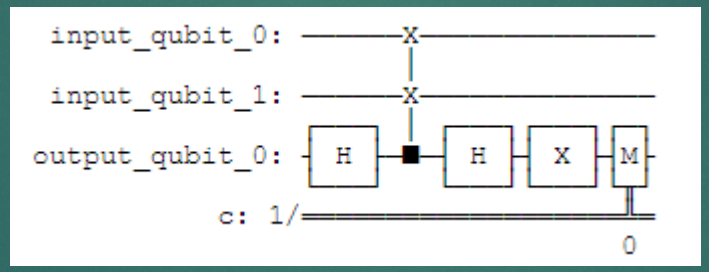
Probando Múltiples Inputs con Superposicion



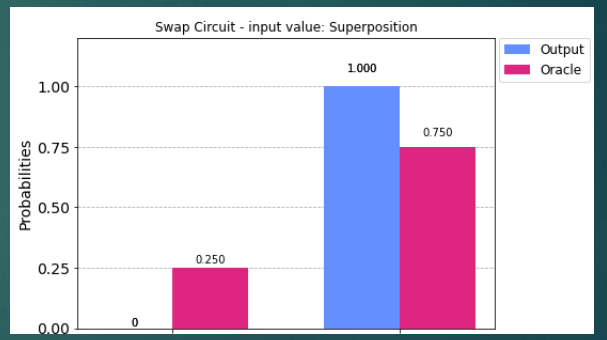



```
Circuit passed evaluation.
```






```
Circuit failed evaluation! There is some error.
Circuit returned {'1': 1024}
```



Conclusiones y trabajo a futuro

- Hemos generado una herramienta para testear programas cuánticos de forma automática.
- Tiene dos modos:
  - Modo clásico: Requiere inputs
  - Modo cuántico: Prueba todos los inputs a la vez

- Encontrar la forma de calcular el oráculo conjunto
- Calcular la matriz del circuito y comprobar si se corresponde

Quantum programs testing tool

Miembros:

- **Alfredo Ibias Martínez**
- **David Presa**
- **Javier Parra**
- **Ilya Lapshin**