IBM Challenge Lab 2

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Set-Up

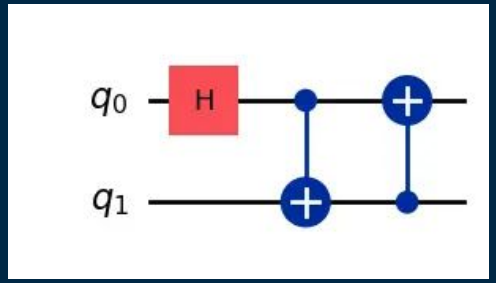
Use Python 3.10 or 3.11

Do not use Python 3.12 or above

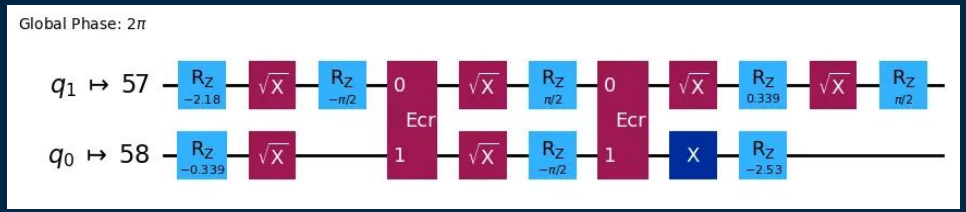
Since Lab 3 and beyond need ray.

- ### Install Qiskit and relevant packages, if needed
-
- pip install qiskit[visualization]==1.0.2
- pip install qiskit_ibm_runtime
- pip install qiskit_aer
- pip install qiskit-transpiler-service
- pip install graphviz
- pip install git+https://github.com/qiskit-community/Quantum-Challenge-Grader.git

Transpiler

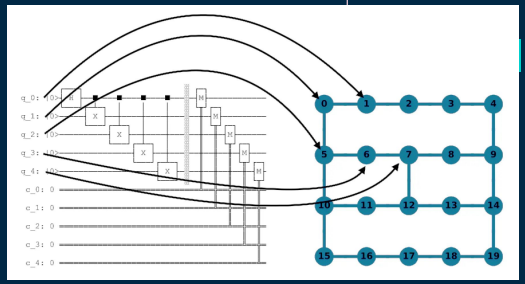


- Process of taking a given input circuit
- Rewriting it to an equivalent circuit for a specific quantum device/system
- Goal: best performance to reduce noisy quantum hardware



Six Stages of Compilation Flows

- Init: This stage is used to translate any gates that operate on more than two qubits, into gates that only operate on one or two qubits.
- Layout: This stage applies a layout, mapping the virtual qubits in the circuit to the physical qubits on a backend.
- Routing: This stage runs after a layout has been applied and will inject gates (i.e. swaps) into the original circuit to make it compatible with the backend connectivity.
- Translation: This stage translates the gates in the circuit to the target backend's basis set.
- Optimization: This stage runs the main optimization loop repeatedly until a condition (such as fixed depth) is reached.
- Scheduling: This stage is for any hardware-aware scheduling passes.



Optimization Levels

Higher optimization levels generate more optimized circuits at the expense of longer compile times, and vice versa.

There are 4 Optimization Levels

- Level 0 – No optimization (typically used for hardware)
- Level 1 – Light optimization
- Level 2 – Medium optimization
- Level 3 – High optimization

Transpile with Preset Pass Managers

- Pipeline determined by **PassManager** and **StagedPassManager** .
  - PassManager is a collection of “passes”
  - StagePassManager executes and determines order of PassManager objects.
- Qiskit provides 4 optimization levels of transpilation.
- Users can modify these presets.
- Users can also construct a pass manager to build your own custom pipeline that can transform input circuits.

Build your own Pass Managers

One of the powerful features of the Qiskit v1.0 transpiler is its flexibility. It allows you compose a PassManager with only two or three stages. It also allows you to put your own Pass at desired stages.

- Create a pass manager for dynamical decoupling.
- Adding a pulse sequence to flip idle qubits around the Bloch sphere.
- Mitigates the effect of noise channels, suppressing decoherence.

This is what you are tasked with in Exercise 5 of Lab 2.

```
X = XGate()
Y = YGate()

dd_sequence = [X, Y, X, Y]
```

References

- GitHub Lab2
- ChatGPT
- Transpiler Plugins Doc
- Pass Manager Doc
- Quantum Circuit Doc