Circuits Description

Luís Paulo Santos, Jul.2025

Summary

This document describes the classes of quantum circuits and respective data, available at https://github.com/luisps/ExperimentalData.git

Índice

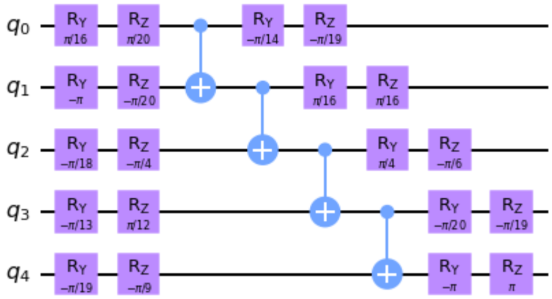
Class SU – variational EfficientSU2

This class of circuits corresponds to the so-called “hardware efficient” ansatz for variational circuits. It is obtained with the Qiskit method:

```
EfficientSU2(num_qubits, entanglement='linear', reps=reps)
```

The number of qubits and the number of layer repetitions is varied for the different circuit instances below.

Circuit SU5: 5 qubits, 1 rep

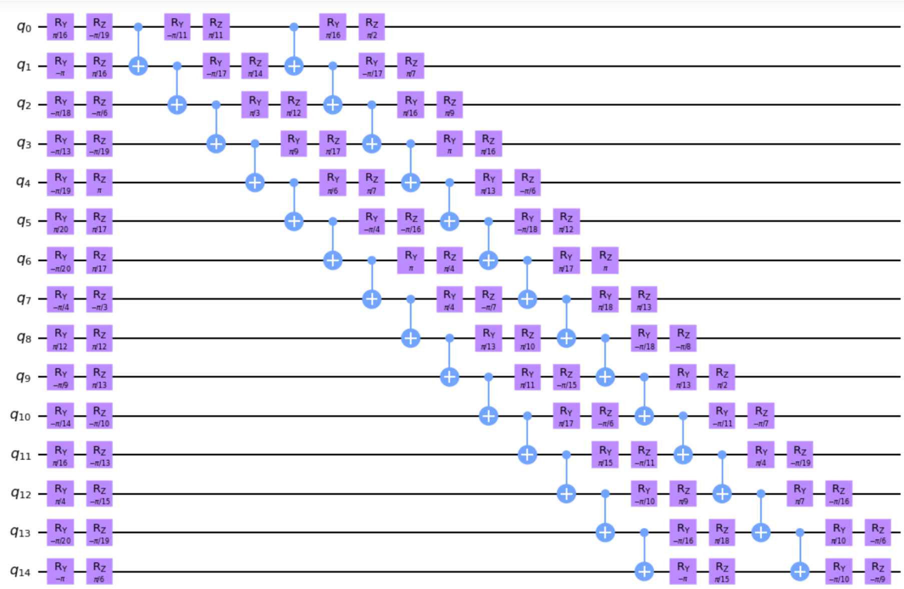


8 layers

3.436e+10 paths = $2^{(5*(8-1))} = 2^{35}$

$\langle 0|U|0\rangle$ =-0.00172150+0.00127863j

Circuit SU15: 15 qubits, 2 rep



22 layers

6.675e+94 paths = $2^{(15*(22-1))} = 2^{315}$

$\langle 0|U|0\rangle$ = 0.00364578+0.00060584j

Circuit SU25: 25 qubits, 2 rep

32 layers

2.e+233 paths = $2^{(25*(32-1))}$

$\langle 0|U|0\rangle$ = -0.00012 + 0.00007j

Class HSC – Hidden Shift Circuits

Deterministic circuits, in the sense that only one basis state in the output has an amplitude different from 0 (= 1.0).

These are based on the algorithm (and code) presented in Peres, Filipa 2023 (sec 4.1) https://arxiv.org/pdf/2203.01789.pdf

Circuit 41256- Hidden shift: 256 qubits, hidden string = 1023

43 layers
paths = $2^{(256*(43-1))}$
$\langle 1023|U|0\rangle$ = `1.0 + 0.0j`

Circuit 411024- Hidden shift: 1024 qubits, hidden string = 1023

43 layers
paths = $2^{(1024*(43-1))}$
$\langle 1023|U|0\rangle$ = `1.0 + 0.0j`

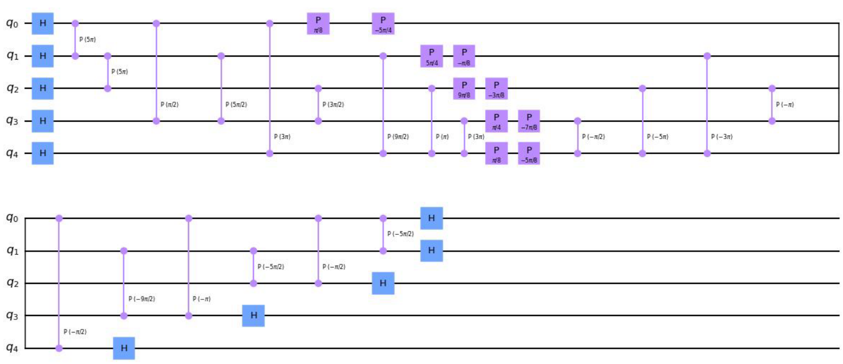
Circuit 414096- Hidden shift: 4096 qubits, hidden string = 1023

43 layers
$2^{(4096*(43-1))}$
$\langle 1023|U|0\rangle$ = `1.0 + 0.0j`

Class IQP Inversion test

Inversion test of two random states encoded using IQP.
The probability of P(|0>^{n}) is the overlap between the states.

Circuit IQP5: 5 qubits



17 layers

`1.209e+24` paths $= 2^{(5*(17-1))} = 2^{80}$

$\langle 0|U|0\rangle =$ `-0.104462+0.106694j`

Circuit IQP15: 15 qubits

55 layers

`6.828e+243` paths $= 2^{(15*(55-1))} = 2^{810}$

$\langle 0|U|0\rangle =$ `-0.00128171-0.00008649j`

Circuit IQP25: 25 qubits

97 layers

paths $= 2^{(25*(97-1))} = 2^{2400}$

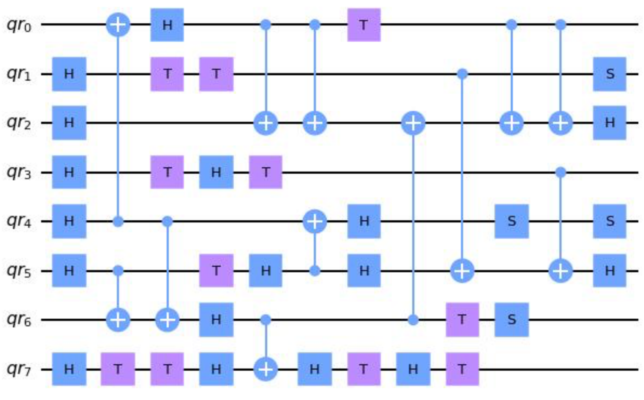
$\langle 0|U|0\rangle =$ `-0.00013443-0.00022139j`

Class RND – Random Circuits

Randomly generated circuits. These are based on the algorithm (and code) presented in Peres, Filipa 2023 (sec 4.2)

https://arxiv.org/pdf/2203.01789.pdf

Circuit RND8- Random: 8 qubits, nCycles = 6



9 layers

`1.845e+19` paths $= 2^{(8*(9-1))} = 2^{64}$

$\langle 0|U|0\rangle =$ `-0.04419417+0.10669417j`

Circuit RND10- Random: 10 qubits, nCycles = 7

13 layers

paths $= 2^{(10*(13-1))} = 2^{120}$
$\langle 0|U|0\rangle =$ `0.02209709+0.05334709j`

Circuit RND512- Random: 12 qubits, nCycles = 8

15 layers
paths $= 2^{(12*(15-1))} = 2^{168}$
$\langle 16|U|0\rangle =$ `0.009153-0.022097j`