

Quantum Computing Project

2020 fall

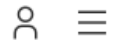
Project research

- Individual project
- Study and perform quantum computing on line.
- mid-term report on Nov 9
- Poster presentation on Dec 25
- Term paper before Jan 8

IBM Q



Marketplace



IBM Q

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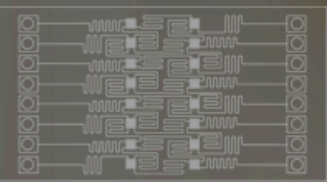
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IBM quantum processors

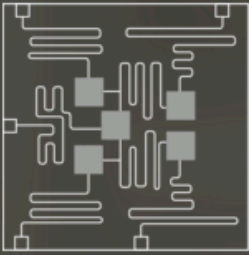
ibmqx3

BETA MAINTENANCE



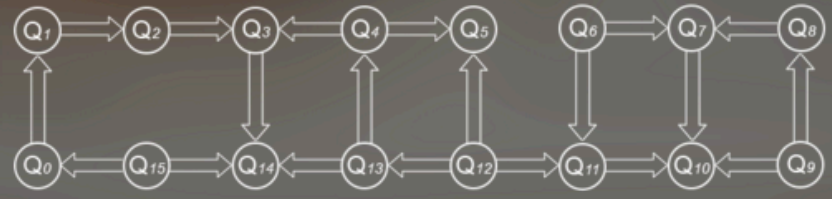
	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Gate Error (10^{-3})	1.83	2.30	3.66	2.09	1.73	3.52	1.39	1.61	1.07	1.40	1.93	2.24	8.84
Readout Error (10^{-2})	3.64	10.34	2.75	3.91	8.82	4.66	4.20	5.38	6.63	9.71	4.60	4.97	7.76
MultiQubit Gate Error (10^{-2})	CX0_1	CX1_2	CX2_3	CX3_14	CX4_3		CX6_7	CX7_10	CX8_7	CX9_8		CX11_10	CX12_11
	3.90	4.22	3.66	4.00	3.43		2.57	3.27	4.34	2.70		2.77	8.75
					CX4_5		CX6_11		CX9_10				CX12_13
				5.09		2.54		2.95					5.37
													8.15

MAINTENANCE **ibmqx2**



Date Calibration
2017-08-25 19:40:45

Fridge Temperature
0.0149251 K



Looking for more details? See more here!

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Name: '5Q Complete Superposition Circuit' [New](#) [Save](#) [Save as](#)

ibmqx2

Run

Simulate

Gates

Properties

QASM

My Units

GATES ?

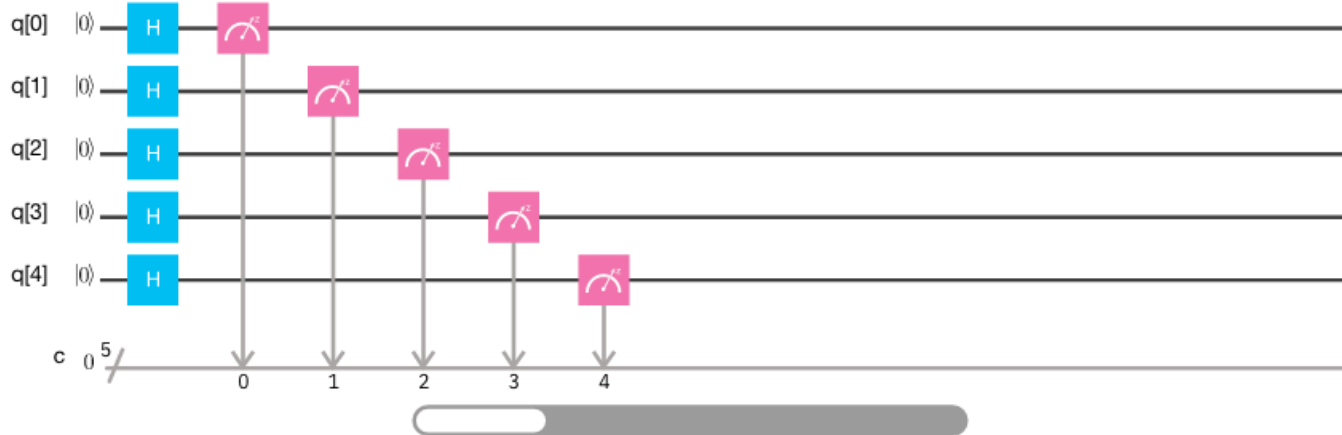
Advanced



BARRIER



OPERATIONS



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<https://quantumexperience.ng.bluemix.net/qx/editor>

Perform QC using IBM Q

- Do the following tasks :
- Understand quantum logic gates and algorithms
- Compose your code and run results
- Calculate the ideal result using python program
- Contains at least 3 qubits and 20 gates including 2-bit gates.
- Copy code is not allowed!

Summary of quantum gates

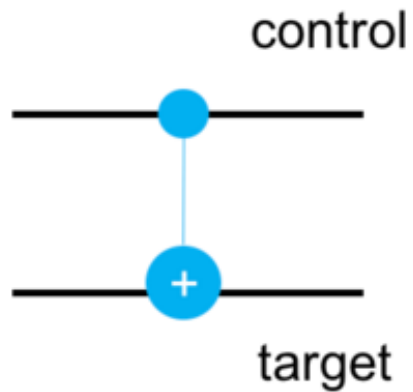
Table of Quantum Gates and what they do				
State	Gate sequence to prepare the state	Transformation on Bloch sphere	Gates to measure in the respective basis	Name of measurement basis
$ 0\rangle$	(none, ground state)	None		Z, "standard"
$ 1\rangle$		π rotation around X		Z, "standard"
$ +\rangle$		π rotation around X + Z	 	X
$ -\rangle$	 	π rotation around X + π rotation around X + Z	 	X

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Gate	Transformation on Bloch sphere (defined for single qubit)
X	π -rotation around the X axis, $Z \rightarrow -Z$. Also referred to as a bit-flip.
Z	π -rotation around the Z axis, $X \rightarrow -X$. Also referred to as a phase-flip.
H	maps $X \rightarrow Z$, and $Z \rightarrow X$. This gate is required to make superpositions.
S	maps $X \rightarrow Y$. This gate extends H to make complex superpositions. ($\pi/2$ rotation around Z axis).
S^\dagger	inverse of S. maps $X \rightarrow -Y$. ($-\pi/2$ rotation around Z axis).
T	$\pi/4$ rotation around Z axis.
T^\dagger	$-\pi/4$ rotation around Z axis.

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2-bit gate



Starting state

Ending State

$|00\rangle$

→

$|00\rangle$

$|10\rangle$

→

$|10\rangle$

$|01\rangle$

→

$|11\rangle$

$|11\rangle$

→

$|01\rangle$

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Quantum Algorithms

In this section we embark on more complex scores and explore the components it takes to construct real quantum algorithms. We go beyond simply defining entanglement and begin to use it in computation, in order to perform some well-known algorithms (with more to come in the future):

- Grover's algorithm
- Deutsch-Jozsa algorithm
- Learning parity with noise
- Phase estimation algorithm
- Shor's Algorithm

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Why do this project

- A full controllable quantum system for one to manipulate and measure.
- Understand quantum superposition and quantum uncertainty with real experiment.
- Understand the matrix formalism of quantum physics.