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Tech Notes **∨**

URL 🗸

MaZX`

ZXForm NEW IN 13.2

ZXForm [qc]

converts quantum circuit qc to a <code>ZXObject</code> .

→ Details and Options

ZXForm only supports gates acting on up to two qubits.

▼ Examples (4)

In[1]:= Needs["MaZX`"]

→ Basic Examples (1)

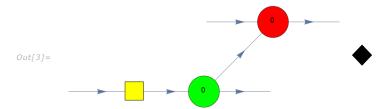
Consider the entangler quantum circuit as an example.

Note that its matrix representation looks like this.

Out[2]//MatrixForm=

$$\begin{pmatrix} \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & 0 & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & 0 & -\frac{1}{\sqrt{2}} & 0 \end{pmatrix}$$

Convert the quantum circuit to the corresponding ZXObject.



Check the corresponding matrix.

Out[4]//MatrixForm=

$$\begin{pmatrix} \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} & 0 \\ 0 & \frac{1}{\sqrt{2}} & 0 & \frac{1}{\sqrt{2}} \\ 0 & \frac{1}{\sqrt{2}} & 0 & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & 0 & -\frac{1}{\sqrt{2}} & 0 \end{pmatrix}$$

In[5]:= mat - new // MatrixForm

Out[5]//MatrixForm=

✓ Scope (2)

✓ Controlled-NOT (CNOT) gate (1)

In[1]:= Let[Qubit, S]

In[2]:= qc = QuantumCircuit[CNOT[S[1], S[2]]]
 mat = Matrix[qc];
 mat // MatrixForm

Out[2]=



Out[2]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix}$$

Out[3]//MatrixForm=

◆ Controlled-Z (CZ) gate (1)

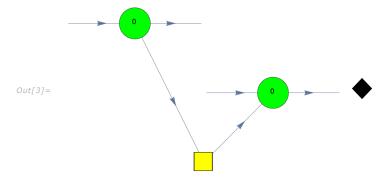
In[1]:= Let[Qubit, S]

In[2]:= qc = QuantumCircuit[CZ[S[1], S[2]]]
mat = Matrix[qc];
mat // MatrixForm



Out[2]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ \end{pmatrix}$$



Out[3]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}$$

✔ Properties & Relations (1)

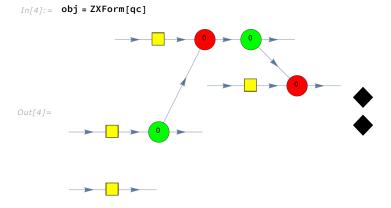
Here is a quantum circuit.

```
In[1]:= Let[Qubit, S]
In[2]:= qc = QuantumCircuit[
         S[{1, 2, 3, 4}, 6],
         CNOT[S[1], S[2]],
         CNOT[S[2], S[3]]
               Н
               Н
               Η
```

Calculating the matrix representation of such a quantum circuit is routine.

```
In[3]:= EchoTiming[mat = Matrix[qc];]
      0.007975
```

Convert it into a ZX diagram.



Calculate the matrix representation from the ZX diagram above. This is faster than the matrix calculation based on the quantum circuit model.

```
In[5]:= EchoTiming[new = Matrix[obj];]
      0.013459
```

Out[6]//MatrixForm=

. 1	1	1	1	1	1	1	- 1	- 1	1	1	1	1	1	1	1 .
$\left(\begin{array}{c} \frac{1}{4} \end{array}\right)$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	+	÷)
			4	4										4	4
1 4	$-\frac{1}{4}$	$\frac{1}{4}$	- 1	$\frac{1}{4}$	$-\frac{1}{4}$	$\frac{1}{4}$	- 1	$\frac{1}{4}$			$-\frac{1}{4}$	$\frac{1}{4}$			- 1
			4	4	4		4		4	4	4		4	4	4
1 -	1	_ 1	_ 1	1	1	_ 1	_ 1	$\frac{1}{4}$	1	_ 1	$-\frac{1}{4}$	$\frac{1}{4}$	1	_ 1	_ 1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1 _	_ 1	_ 1	1	1	_ 1	_ 1	1	1	_ 1	_ 1	1	1	_ 1	_ 1	1
$\frac{1}{4}$ $\frac{1}{4}$	4	4	4	4	4	4	4	$\frac{1}{4}$	4	4	4	$\frac{1}{4}$	4	4	4
1 4 1 4	1	_ 1	_ 1	_ 1	_ 1	1	1	1 4 1 4	1	_ 1	_ 1	_ 1	_ 1	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	_ 1	_ 1	1	_ 1	1	1	_ 1	1	_ 1	_ 1	1	_ 1	1	1	_ 1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1		1	1	1	1	$ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} $	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1	1 4 1 4	1	1	1	$-\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4}$	1	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	1	$\frac{1}{4}$	1	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	4	$ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ \frac{1}{4} \\ \frac{1}$	- -	4	4	4	4	4	4	4	4	$\frac{1}{4}$	4	4	4
1	1	1	1	1	$\begin{array}{c} \frac{1}{4} \\ -\frac{1}{4} \end{array}$	1	1	1	1	1	1	1	1	1	1
4	4	- -	- -	- -	- -	4	4	- -	- -	4	4	4	4	- -	4
$ \begin{array}{c c} \frac{1}{4} \\ \frac{1}{4$	1	$-\frac{1}{4}$ $-\frac{1}{4}$ $-\frac{1}{4}$	1	1	1	$-\frac{1}{4} \\ -\frac{1}{4} $	1	$-\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1	1	$\frac{1}{4}$ $\frac{1}{4}$ $-\frac{1}{4}$ $-\frac{1}{4}$	1	1	1
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	4	- -	- -	4	4	- - 4	- -	- -	- -	4	4	- 4	- 4	4	4
1	1	$-\frac{1}{4}$	1	1	$\frac{1}{4}$ $\frac{1}{4}$ $-\frac{1}{4}$		1	1	1	1	1	1	1	1	1
4	- -	- -	4	4	- -	- -	4	- -	4	4	- -	- -	4	4	4
1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
4	4	4	4	4	4	4	4	- -	$-\frac{1}{4}$	- -	$\begin{array}{c} \frac{1}{4} \\ -\frac{1}{4} \\ \frac{1}{4} \\ -\frac{1}{4} \end{array}$	- -	$ \begin{array}{c} \frac{1}{4} \\ \frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \end{array} $	- -	- - 4
$\begin{bmatrix} \frac{1}{4} \\ \frac{1}{4} \\ \frac{1}{4} \\ \frac{1}{4} \end{bmatrix}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\frac{1}{4}$ $\frac{1}{4}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$-\frac{1}{4}$ $-\frac{1}{4}$	$-\frac{1}{4}$ $\frac{1}{4}$ $\frac{1}{4}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$-\frac{1}{4}$ $-\frac{1}{4}$ $-\frac{1}{4}$	1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1	1	1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
4		4	- -	4	- 4	4	- -	- - 4	$\frac{1}{4}$	- -	$\frac{1}{4}$	$-\frac{1}{4}$ $-\frac{1}{4}$	$\frac{1}{4}$	- 4	4

In[7]:= mat - new // MatrixForm

Out[7]//MatrixForm=

In[8]:= EchoTiming[old = Matrix@ExpressionFor[obj];]

0 163.064



See Also

ZXObject • ZXDiagram • QuantumCircuit



- Quantum Computation: Overview
- Quantum Information Systems with Q3
- Q3: Quick Start



Related Guides

- MaZX
- Q3
- Quantum Information Systems

Related Links

- R. Duncan, A. Kissinger, S. Perdrix, and J. van de Wetering, Quantum 4, 279 (2020), "Graph-theoretic Simplification of Quantum Circuits with the ZX-calculus."
 - M. Nielsen and I. L. Chuang (2022), Quantum Computation and Quantum Information (Cambridge University Press, 2011).
 - Mahn–Soo Choi (2022) , A Quantum Computation Workbook (Springer, 2022).