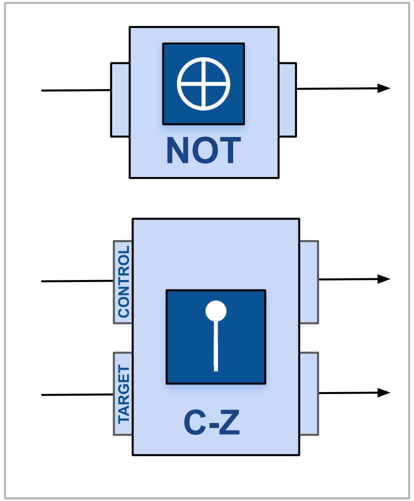
HOMEWORK: Combining Gates

(True / False) In general, tensor product operations are commutative (the order of the matrices can be swapped with no change to the outcome).

For these gates in parallel, which expression(s) could you use to determine the overall matrix for the circuit? Select all that apply.



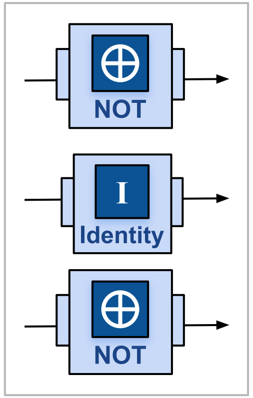
a. NOT $\otimes$ C-Z

b. C-Z $\otimes$ NOT

c. $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$

d. $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \otimes \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

For these gates in parallel, which expression(s) could you use to determine the overall matrix for the circuit? Select all that apply.



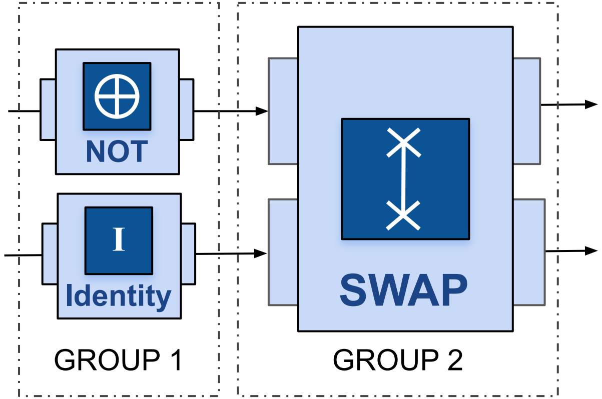
a. $\mathrm{NOT}^{\otimes 2} \otimes \mathrm{Identity}$

b. $\mathrm{NOT} \otimes \mathrm{Identity} \otimes \mathrm{NOT}$

c. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

d. $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

Determine the transfer matrix for Group 1.



a. $\begin{bmatrix}0 & 1 & 0 & 0\\1 & 0 & 0 & 0\\0 & 0 & 0 & 1\\0 & 0 & 1 & 0\end{bmatrix}$

b. $\begin{bmatrix}0 & 1 & 0 & 0\\0 & 0 & 0 & 1\\1 & 0 & 0 & 0\\0 & 0 & 1 & 0\end{bmatrix}$

c. $\begin{bmatrix}1 & 0 & 0 & 0\\0 & 0 & 1 & 0\\0 & 1 & 0 & 0\\0 & 0 & 0 & 1\end{bmatrix}$

d. $\begin{bmatrix}1 & 0 & 0 & 0\\0 & 1 & 0 & 0\\0 & 0 & 0 & 1\\0 & 0 & 1 & 0\end{bmatrix}$

e. $\begin{bmatrix}0 & 0 & 1 & 0\\1 & 0 & 0 & 0\\0 & 0 & 0 & 1\\0 & 1 & 0 & 0\end{bmatrix}$

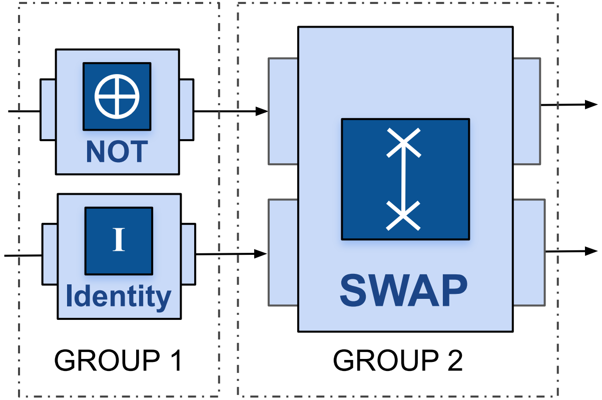
f. $\begin{bmatrix}0 & 0 & 1 & 0\\0 & 0 & 0 & 1\\1 & 0 & 0 & 0\\0 & 1 & 0 & 0\end{bmatrix}$

g. $\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$

h. $\begin{bmatrix}0 & 1\\1 & 0\end{bmatrix}$

i. $\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\\1 & -1\end{bmatrix}$

Which expression(s) could you use to determine the overall matrix for this circuit? Select all that apply.



a. NOT ⊗ Identity ⊗ SWAP

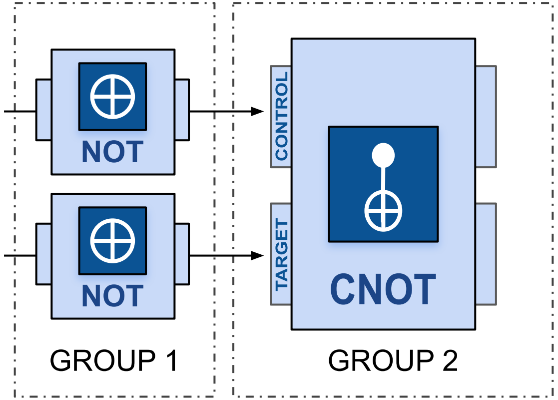
b. SWAP ⊗ NOT ⊗ Identity

c. (SWAP) x (NOT ⊗ Identity)

d. $$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \otimes \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

e. $$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \left(\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right)$$

Which expression(s) could you use to determine the overall matrix for this circuit? Select all that apply.



a. (NOT x NOT) $\otimes$ CNOT

b. (NOT $\otimes$ NOT)(CNOT)

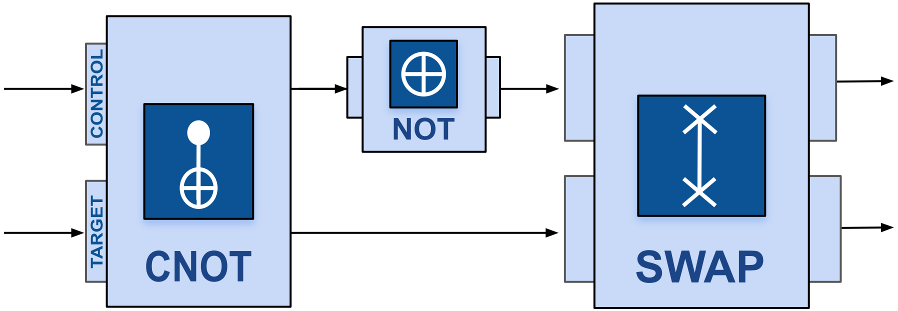
c. CNOT x NOT^2

d. $$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix} \otimes \left(\begin{bmatrix}0&1\\1&0\end{bmatrix}\begin{bmatrix}0&1\\1&0\end{bmatrix}\right)$$

e. $$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix} \left(\begin{bmatrix}0&1\\1&0\end{bmatrix} \otimes \begin{bmatrix}0&1\\1&0\end{bmatrix}\right)$$

f. $$\begin{bmatrix}0&1\\1&0\end{bmatrix} \otimes \begin{bmatrix}0&1\\1&0\end{bmatrix} \otimes \begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix}$$

Which expression(s) could you use to determine the overall matrix for this circuit? Select all that apply.



a. CNOT ⊗ NOT ⊗ SWAP

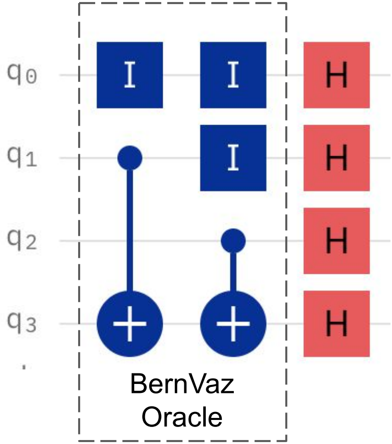
b. (SWAP) x (NOT) x (CNOT)

c. $$\begin{bmatrix}1&0&0&0\\0&0&1&0\\0&1&0&0\\0&0&0&1\end{bmatrix}\left(\begin{bmatrix}0&1\\1&0\end{bmatrix}\otimes\begin{bmatrix}1&0\\0&1\end{bmatrix}\right)\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix}$$

d. $$\begin{bmatrix}1&0&0&0\\0&0&1&0\\0&1&0&0\\0&0&0&1\end{bmatrix}\left(\begin{bmatrix}1&0\\0&1\end{bmatrix}\otimes\begin{bmatrix}0&1\\1&0\end{bmatrix}\right)\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix}$$

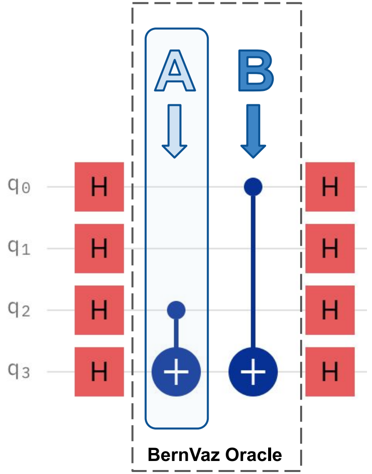
HOMEWORK: BernVaz

In order to implement the Bernstein-Vazirani algorithm, what about this quantum circuit should be changed?



a. Two of the qubits, q1 and q2, should be prepared by being passed through NOT gates before the BernVaz oracle
b. All four qubits should be put through H gates before the BernVaz oracle
c. The H gates should be moved from after the oracle to before the oracle
d. No change is necessary; it correctly implements the Bernstein-Vazirani algorithm.

Select the calculation that determines the matrix at A.



a. $\text{Identity}^{2} \otimes \text{CNOT}$

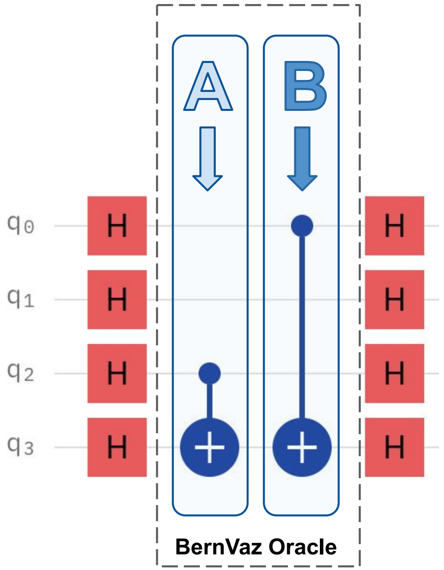
b. $\text{Identity}^{\otimes 2} \otimes \text{CNOT}$

c. $\text{CNOT} \otimes \text{Identity}^{\otimes 2}$

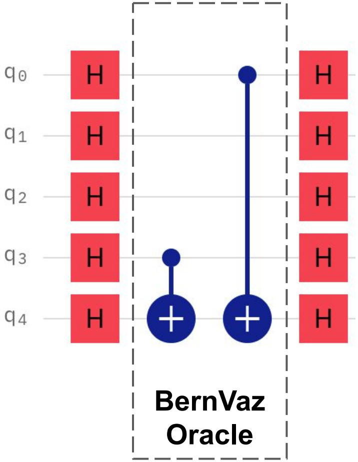
d. $\text{Identity}^{\otimes 2} \text{ x } \text{CNOT}$

e. None of the above.

(TRUE / FALSE) When determining the overall matrix for the BernVaz Oracle depicted below, first, the matrices for A and B need to be calculated separately using tensor product, then combined using matrix multiplication.

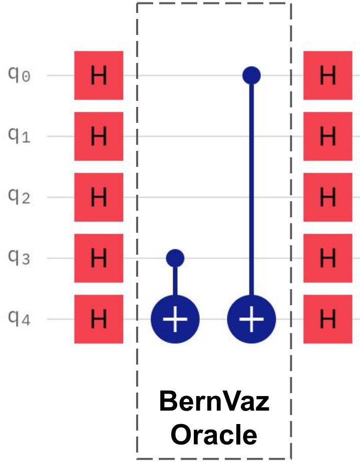


What will be the dimensions of the overall matrix for the Bernstein-Vazirani oracle pictured below?



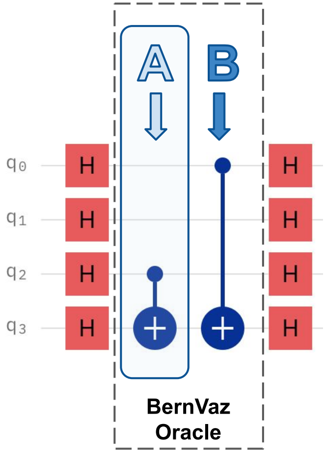
a. 8 x 8
b. 16 x 16
c. 32 x 32
d. Cannot be determined

What is the secret code for the Bernstein-Vazirani oracle pictured below?



a. 1000
b. 1001
c. 1010
d. 1100
e. Cannot be determined

Which of the options below represents the matrix for A?



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

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

c.
$$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&0&1\\0&0&1&0\end{bmatrix}$$

d.
$$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{bmatrix}$$