Matrices and how they can be used in quantum computing – Quiz

Solutions

Question 1

The order of a matrix with 3 rows and 4 columns is 7.

A. True
B. False – The order of a matrix with 3 rows and 4 columns is 12.

Question 2

A square matrix is a matrix with equal numbers of rows and columns.

A. True
B. False

Question 3

Which operation requires matrices to have the same dimensions?

A. Multiplication
B. Addition
C. Transposition
D. Kronecker product

Question 4

In matrix multiplication, the number of columns in the first matrix must match the number of _____ in the second matrix.

A. Rows
B. Columns
C. Elements
D. Numbers

Exercise 1: Addition, subtraction and multiplication of matrices

For the given matrices ***A*** and ***B***, calculate ***A*** + ***B***, ***A*** – ***B***, ***AB* and *BA*.**

$\boldsymbol{A} = \begin{bmatrix} 4 & 1 \\ 2 & -1 \end{bmatrix}$ and $\boldsymbol{B} = \begin{bmatrix} 1 & 2 \\ 0 & 3 \end{bmatrix}$

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Solution:

$$\boldsymbol{A}+\boldsymbol{B}=\begin{bmatrix}4 & 1\\ 2 & -1\end{bmatrix}+\begin{bmatrix}1 & 2\\ 0 & 3\end{bmatrix}=\begin{bmatrix}4+1 & 1+2\\ 2+0 & -1+3\end{bmatrix}=\begin{bmatrix}5 & 3\\ 2 & 2\end{bmatrix}$$

$$\boldsymbol{A}-\boldsymbol{B}=\begin{bmatrix}4 & 1\\ 2 & -1\end{bmatrix}-\begin{bmatrix}1 & 2\\ 0 & 3\end{bmatrix}=\begin{bmatrix}4-1 & 1-2\\ 2-0 & -1-3\end{bmatrix}=\begin{bmatrix}3 & -1\\ 2 & -4\end{bmatrix}$$

$$\boldsymbol{AB}=\begin{bmatrix}4 & 1\\ 2 & -1\end{bmatrix}\cdot\begin{bmatrix}1 & 2\\ 0 & 3\end{bmatrix}=\begin{bmatrix}4\cdot1+1\cdot0 & 4\cdot2+1\cdot3\\ 2\cdot1-1\cdot0 & 2\cdot2-1\cdot3\end{bmatrix}=\begin{bmatrix}4 & 11\\ 2 & 1\end{bmatrix}$$

$$\boldsymbol{BA}=\begin{bmatrix}1 & 2\\ 0 & 3\end{bmatrix}\cdot\begin{bmatrix}4 & 1\\ 2 & -1\end{bmatrix}=\begin{bmatrix}1\cdot4+2\cdot2 & 1\cdot1-2\cdot1\\ 0\cdot4+3\cdot2 & 0\cdot1-3\cdot1\end{bmatrix}=\begin{bmatrix}8 & -1\\ 6 & -3\end{bmatrix}$$

Note that $\boldsymbol{AB} \neq \boldsymbol{BA}$

Exercise 2: Kronecker product

A) Calculate the Kronecker product of the two vectors $\vec{u}=\begin{bmatrix}1\\3\end{bmatrix}$ and $\vec{v}=\begin{bmatrix}4\\2\end{bmatrix}$.

Solution:

$$\vec{u}\otimes\vec{v}=\begin{bmatrix}1\\3\end{bmatrix}\otimes\begin{bmatrix}4\\2\end{bmatrix}=\begin{bmatrix}1\cdot4\\1\cdot2\\3\cdot4\\3\cdot2\end{bmatrix}=\begin{bmatrix}4\\2\\12\\6\end{bmatrix}$$

B) Find the **quantum states** of a two-qubit system composed of the two qubits in the states $|0\rangle=\begin{bmatrix}1\\0\end{bmatrix}$ and $|1\rangle=\begin{bmatrix}0\\1\end{bmatrix}$.

Solution:

The **quantum states** of a two-qubit system composed of the two qubits in the states $|0\rangle=\begin{bmatrix}1\\0\end{bmatrix}$ and $|1\rangle=\begin{bmatrix}0\\1\end{bmatrix}$ are:

$$|0\rangle\otimes|0\rangle=\begin{bmatrix}1\\0\end{bmatrix}\otimes\begin{bmatrix}1\\0\end{bmatrix}=\begin{bmatrix}1\\0\\0\\0\end{bmatrix}=|00\rangle.$$

$$|0\rangle\otimes|1\rangle=\begin{bmatrix}1\\0\end{bmatrix}\otimes\begin{bmatrix}0\\1\end{bmatrix}=\begin{bmatrix}0\\1\\0\\0\end{bmatrix}=|01\rangle.$$

$$|1\rangle\otimes|0\rangle=\begin{bmatrix}0\\1\end{bmatrix}\otimes\begin{bmatrix}1\\0\end{bmatrix}=\begin{bmatrix}0\\0\\1\\0\end{bmatrix}=|10\rangle.$$

$$|1\rangle\otimes|1\rangle=\begin{bmatrix}0\\1\end{bmatrix}\otimes\begin{bmatrix}0\\1\end{bmatrix}=\begin{bmatrix}0\\0\\0\\1\end{bmatrix}=|11\rangle.$$

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