11. Matrix Multiplication

Matrix Multiplication

6/6 points (graded)

Let $\mathbf{A} = \begin{pmatrix} 1 & -1 & 2 \\ 0 & 3 & -4 \end{pmatrix}$ and let $\mathbf{B} = \begin{pmatrix} -1 & 0 & 0 \\ 2 & 0 & 1 \\ 0 & 1 & 3 \end{pmatrix}$. The dimensions of the product $\mathbf{AB}$ are:

2 | **Answer:** 2 rows $\times$

3 | **Answer:** 3 columns.

More generally, let $\mathbf{A}$ be an $m \times n$ matrix and $\mathbf{B}$ be an $n \times k$ matrix. What is the size of $\mathbf{AB}$?

m | **Answer:** m rows $\times$

k | **Answer:** k columns.

In addition, if $\mathbf{C}$ is a $k \times j$ matrix, what is the size of $\mathbf{ABC}$?

m | **Answer:** m rows $\times$

j | **Answer:** j columns.

Solution:

The size of the output is the number of rows of the left matrix, and the number of columns of the right matrix. The two dimensions on the inside (columns of the left matrix, rows of the right matrix) must match.
In the first part, $\mathbf{AB}$ is 2×3.
For the second and third parts, $\mathbf{AB}$ is $m \times k$ and $\mathbf{ABC}$ is $m \times j$.

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Answers are displayed within the problem

Vector Inner product

1/1 point (graded)

Suppose $\mathbf{u} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$. The product $\mathbf{u}^T\mathbf{v}$ evaluates the **inner product** (also called the **dot product**) of $\mathbf{u}$ and $\mathbf{v}$, which evaluates to

$\mathbf{u}^T\mathbf{v} =$ 2 ✔ **Answer:** 2

The inner product of $\mathbf{u}$ and $\mathbf{v}$ is sometimes written as $\langle \mathbf{u}, \mathbf{v} \rangle$.

Solution:

The inner product is always a scalar (a 1×1 matrix). In this case, it evaluates to $1 \cdot -1 + 3 \cdot 1 = 2$. In general, if $\mathbf{u} = (u_1, u_2, \ldots, u_n)^T$ and $\mathbf{v} = (v_1, v_2, \ldots, v_n)^T$, then $\mathbf{u}^T\mathbf{v} = \sum_{i=1}^{n} u_i v_i$.

$$\begin{pmatrix} u_1 & \cdots & u_n \end{pmatrix} \begin{pmatrix} v_1 \\ \vdots \\ v_n \end{pmatrix} = (\cdot)$$

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Vector Outer product

4/4 points (graded)

Suppose $\mathbf{u} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$. The product $\mathbf{u}\mathbf{v}^T$ evaluates the **outer product** of $\mathbf{u}$ and $\mathbf{v}$, which is a 2×2 matrix in this case.

What is $(\mathbf{u}\mathbf{v}^T)_{1,1}$?

-1

Answer: -1

What is $(\mathbf{u}\mathbf{v}^T)_{1,2}$?

1

Answer: 1

What is $(\mathbf{u}\mathbf{v}^T)_{2,1}$?

-3

Answer: -3

What is $(\mathbf{u}\mathbf{v}^T)_{2,2}$?

3

Answer: 3

Solution:

In this case, the outer product evaluates to

$$\mathbf{u}\mathbf{v}^T = \begin{pmatrix} -1 & 1 \\ -3 & 3 \end{pmatrix}.$$

In general, if $\mathbf{u} = \begin{pmatrix} u_1 \\ \vdots \\ u_m \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} v_1 \\ \vdots \\ v_n \end{pmatrix}$, $\mathbf{u}\mathbf{v}^T$ is an $m \times n$ matrix whose (i, j) entry is $(\mathbf{u}\mathbf{v}^T)_{i,j} = u_i v_j$.

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Answers are displayed within the problem

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? Invalid Input: ** not permitted in answer as a variable
Hello, in the exercise 1 I have understood that we have to put the letter m, n, k or j (which are... 13

Vector Outer Product
I understand the information that is provided to solve the question. But I can't seem to under... 5

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