## 4.4.3 Computing the Matrix-Matrix Product

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## Homework 4.4.3.1

9/9 points (graded)

Compute $Q = P \times P = \begin{pmatrix} .4 & .3 & .1 \\ .4 & .3 & .6 \\ .2 & .4 & .3 \end{pmatrix} \begin{pmatrix} .4 & .3 & .1 \\ .4 & .3 & .6 \\ .2 & .4 & .3 \end{pmatrix} =$

Hint: you may want to use MATLAB to do some of the computations.

| | | |
|---|---|---|
| .3 ✔ | .25 ✔ | .25 ✔ |
| .4 ✔ | .45 ✔ | .4 ✔ |
| .3 ✔ | .3 ✔ | .35 ✔ |

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✔ Correct (9/9 points)

## Homework 4.4.3.2

25/25 points (graded)

Let $A = \begin{pmatrix} 2 & 0 & 1 \\ -1 & 1 & 0 \\ 1 & 3 & 1 \\ -1 & 1 & 1 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & 1 & 2 & 1 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{pmatrix}$. Evaluate

$$AB = \begin{pmatrix} 5 & 2 & 5 & 2 \\ -2 & 0 & -2 & 0 \\ 3 & 4 & 3 & 4 \\ -1 & 0 & -1 & 0 \end{pmatrix}$$

$$BA = \begin{pmatrix} 4 & 8 & 5 \\ -2 & 2 & 1 \\ 3 & 3 & 2 \end{pmatrix}$$

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✔ Correct (25/25 points)

## Homework 4.4.3.3

1/1 point (graded)

Let $A \in \mathbb{R}^{m \times k}$ and $B \in \mathbb{R}^{k \times n}$ and $AB = BA$.

$A$ and $B$ are square matrices.

Always ▾ ✔ **Answer:** Always

**Explanation**

**Answer:** Always

The result of $AB$ is a $m \times n$ matrix. The result of $BA$ is a $k \times k$ matrix. Hence $m = k$ and $n = k$. In other words, $m = n = k$.

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## Homework 4.4.3.4

1/1 point (graded)

Let $A \in \mathbb{R}^{m \times k}$ and $B \in \mathbb{R}^{k \times n}$.

$AB = BA$.

Sometimes ▾ ✔ **Answer:** Sometimes

**Explanation**

**Answer:** Sometimes

If $m \neq n$ then $BA$ is not even defined because the sizes of the matrices don't match up. But if $A$ is square and $A = B$, then clearly $AB = AA = BA$.

So, there are examples where the statement is true and examples where the statement is false.

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## Homework 4.4.3.5

1/1 point (graded)

Let $A, B \in \mathbb{R}^{n \times n}$.

$AB = BA$.

Sometimes ✔ **Answer:** Sometimes

**Explanation**

**Answer:** Sometimes
Almost any random matrices $A$ and $B$ will have the property that $AB \neq BA$. But if you pick, for example, $n = 1$ or $A = I$ or $A = 0$ or $A = B$, then $AB = BA$. There are many other examples.
The bottom line: Matrix multiplication, unlike scalar multiplication, does not necessarily commute.

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## Homework 4.4.3.6

1/1 point (graded)
$A^2$ is defined as $AA$. Similarly $A^k = \underbrace{AA \ldots A}_{k \text{ occurrences of } A}$. Consistent with this, $A^0 = I$ so that $A^k = A^{k-1}A$ for $k > 0$.

$A^k$ is well-defined only if $A$ is a square matrix.

TRUE ✔ **Answer:** TRUE

**Explanation**

**Answer:** True
Just check the sizes of the matrices.

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Answers are displayed within the problem

## Homework 4.4.3.7

1/1 point (graded)
Let $A, B, C$ be matrix "of appropriate size" so that $(AB)C$ is well-defined.

$A(BC)$ is well defined.

Always ▾ ✔ **Answer:** Always

### Explanation

**Answer:** Always

For $(AB)C$ to be well defined, $A \in \mathbb{R}^{m_A \times n_A}$, $B \in \mathbb{R}^{m_B \times n_B}$, $C \in \mathbb{R}^{m_C \times n_C}$, where $n_A = m_B$ and $n_B = m_C$. But then $BC$ is well defined because $n_B = m_C$ and results in a $m_B \times n_C$ matrix. But then $A(BC)$ is well defined because $n_A = m_B$.

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