4.4.4 Special Shapes

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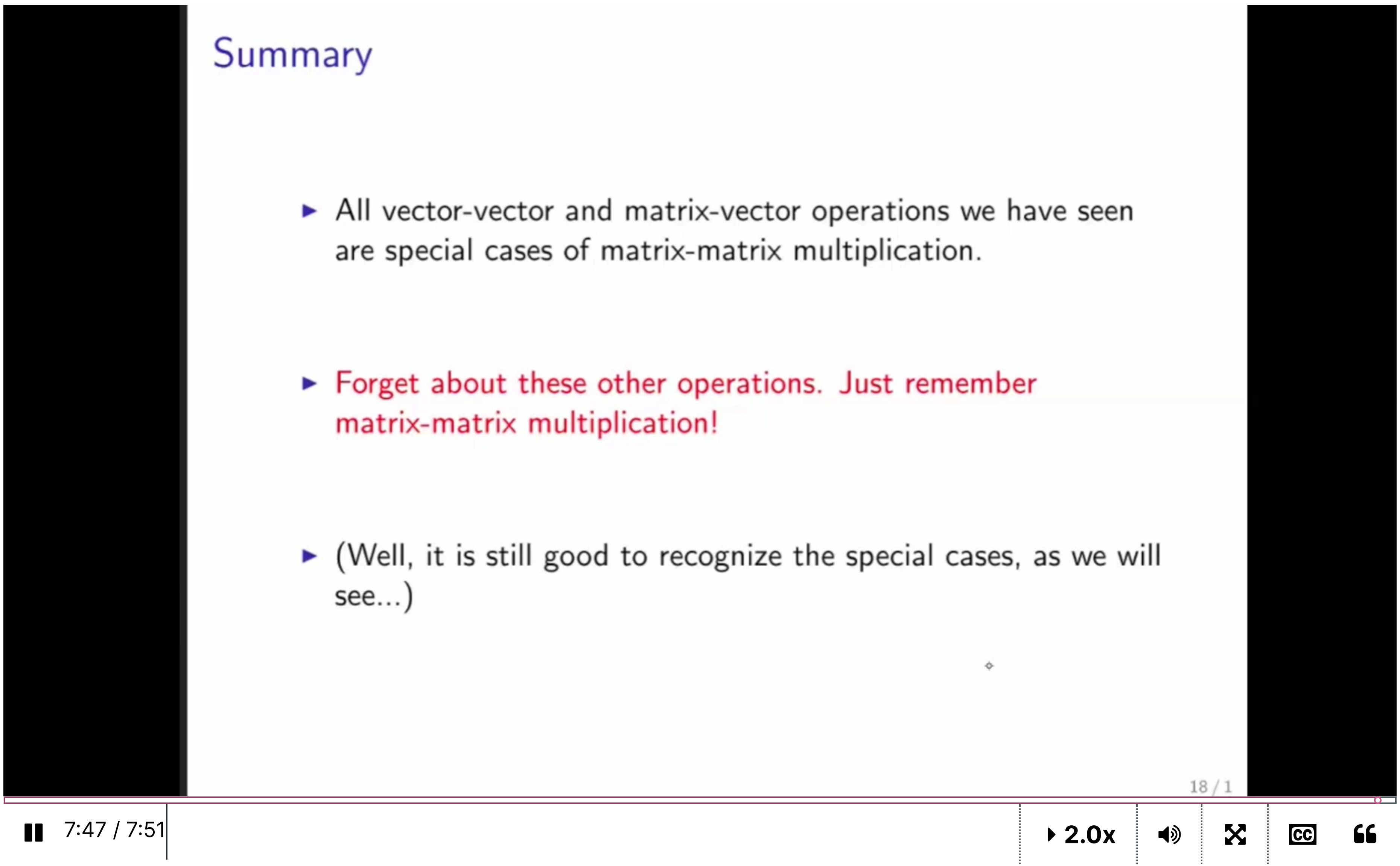
Calculator

Week 4 due Oct 24, 2023 19:42 IST

4.4.4 Special Shapes



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Reading Assignment

0 points possible (ungraded)
Read Unit 4.4.4 of the notes. [LINK]

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Calculator

? Homework 4.4.4.12 - Multiplication
Why do you need to multiply Matrix B by its columns instead of by its rows? 2

In this section in particular, it really helps to read the "Related Reading" as you do the homework problems.

Homework 4.4.4.1

1/1 point (graded)

Let $A = (\, 4 \,)$ and $B = (\, 3 \,)$. Then $AB =$___.

12

✔ Answer: 12

12

Explanation

If you realize that scalars, column vectors, and row vectors are special cases of matrices, then the question becomes a simple case of matrix-matrix multiplication.

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Answers are displayed within the problem

Homework 4.4.4.2

1/1 point (graded)

Let $A = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix}$ and $B = (\, 4 \,)$. Then $AB =$___.

- ○ $\begin{pmatrix} 2 \\ -6 \\ 4 \end{pmatrix}$
- ● $\begin{pmatrix} 4 \\ -12 \\ 8 \end{pmatrix}$
- ○ $\begin{pmatrix} 4 \\ 9 \\ -12 \end{pmatrix}$

✔

Explanation

If you realize that scalars, column vectors, and row vectors are special cases of matrices, then the question becomes a simple case of matrix-matrix multiplication.

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Answers are displayed within the problem

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Homework 4.4.4.3

1/1 point (graded)

This problem talks about IPython Notebooks and Python. It points out an interesting problem with the `numpy` package, which one can use with Python to do matrix computations. In MATLAB, the described behavior is not observed, so we can't create an equivalent homework for MATLAB. We left the problem here, because it points out interesting behavior when one considers a scalar to be a 1×1 matrix.

Start up a new IPython Notebook and try this:

import numpy as np

x = np.matrix('1;2;3')

print(x)

alpha = np.matrix('-2')

print(alpha)

print(x * alpha)

Notice how x, alpha, and x * alpha are created as matrices. Now try

print(alpha * x)

This causes an error! Why? Because numpy checks the sizes of matrices alpha and x and deduces that they don't match. Hence the operation is illegal. This is an artifact of how numpy is implemented.

Now, for us a 1 X 1 matrix and a scalar are one and the same thing, and that therefore $\alpha x = x\alpha$.

Indeed, our laff.scal routine does just fine:

import laff

laff.scal(alpha, x)

print(x)

yields the desired result. This means that you can use the laff.scal routine for both update $x := \alpha x$ and $x := x\alpha$.

- [x] Done/Skip

✔

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Answers are displayed within the problem

Homework 4.4.4.4

1/1 point (graded)

Let $A = \begin{pmatrix} 4 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & -3 & 2 \end{pmatrix}$. Then $AB =$___.

- ( ) $\begin{pmatrix} 2 & -6 & 4 \end{pmatrix}$
- (•) $\begin{pmatrix} 4 & -12 & 8 \end{pmatrix}$
- ( ) $\begin{pmatrix} 4 & 9 & -12 \end{pmatrix}$

Calculator

✔

Explanation
If you realize that scalars, column vectors, and row vectors are special cases of matrices, then the question becomes a simple case of matrix-matrix multiplication.

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Answers are displayed within the problem

4.4.4.5

1/1 point (graded)
Like Homework 4.4.4.3, this problem talks about IPython Notebooks and Python. It points out an interesting problem with the `numpy` package, which one can use with Python to do matrix computations. In MATLAB, the described behavior is not observed, so we can't create an equivalent homework for MATLAB. We left the problem here, because it points out interesting behavior when one considers a scalar to be a 1×1 matrix.

Start up a new IPython Notebook and try this:

import numpy as np

xt = np.matrix('1,2,3')

print(xt)

alpha = np.matrix('-2')

print(alpha)

print(xt * alpha)

This causes an error! Why? Because numpy checks the sizes of matrices alpha and xt and deduces that they don't match. Hence the operation is illegal. This is an artifact of how numpy is implemented.

Now try

print(alpha * xt)

Now, for us a 1 X 1 matrix and a scalar are one and the same thing, and that therefore $\alpha x^T = x^T \alpha$.

Indeed, our laff.scal routine does just fine:

import laff

laff.scal(alpha, xt)

print(xt)

yields the desired result. This means that you can use the laff.scal routine for both update $x^T := \alpha x^T$ and $x^T := x^T \alpha$.

☑ Done/Skip

✔

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✔ Correct (1/1 point)

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Homework 4.4.4.6

1/1 point (graded)

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

5

✔ Answer: 5

5

Explanation

Answer:

$$AB = \begin{pmatrix} 1 & -3 & 2 \end{pmatrix} \begin{pmatrix} 2 \\ -1 \\ 0 \end{pmatrix} = 1 \cdot 2 + (-3) \cdot (-1) + 2 \cdot 0 = 2 + 3 + 0 = 5.$$

or

$$AB = \begin{pmatrix} 1 & -3 & 2 \end{pmatrix} \begin{pmatrix} 2 \\ -1 \\ 0 \end{pmatrix} = (1 \cdot 2 + (-3) \cdot (-1) + 2 \cdot 0) = (2 + 3 + 0 = 5).$$

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Answers are displayed within the problem

Homework 4.4.4.7

1/1 point (graded)

Try this in MATLAB:

```
>> xt = [ 1 2 3 ]

>> y = [
-1
0
2
]

>> xt * y

>> laff_dot( xt, y )
```

The point is that

- `xt` can be thought of as a 1 × 3 matrix or a row vector.
- `y` can be thought of as a 3 × 1 matrix or a column vector.
- `xt * y` (matrix-matrix multiplication) computes the same as `laff_dot( xt, y )`

We prefer using our `laff_dot` and `laff_dots` routines, which don't care about whether x and y are rows or columns, making the adjustment automatically. This is in part because it explicitly tells us we are performing a dot product of two vectors, because of the names of the routines. In addition, when we use these routines in an implementation that uses the `FLAME@lab` API, we can use PictureFLAME to visualize the algorithm executing.

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Homework 4.4.4.8

6/6 points (graded)

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

-1	Answer: -1	-2	Answer: -2
3	Answer: 3	6	Answer: 6
-2	Answer: -2	-4	Answer: -4

Explanation

Answer:

$$AB = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix} \begin{pmatrix} -1 & -2 \end{pmatrix} = \begin{pmatrix} 1 \cdot (-1) & 1 \cdot (-2) \\ (-3) \cdot (-1) & (-3) \cdot (-2) \\ 2 \cdot (-1) & 2 \cdot (-2) \end{pmatrix} = \begin{pmatrix} -1 & -2 \\ 3 & 6 \\ -2 & -4 \end{pmatrix}$$

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Answers are displayed within the problem

Homework 4.4.4.9

7/7 points (graded)

Let $a = \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix}$ and $b^T = \begin{pmatrix} -1 & -2 \end{pmatrix}$ and $C = ab^T$. Partiton C by columns and by rows:

$C = \left(c_0 \mid c_1 \right)$ and $C = \begin{pmatrix} \tilde{c}_0^T \\ \tilde{c}_1^T \\ \tilde{c}_2^T \end{pmatrix}$

then

- $c_0 = (-1) \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix} = \begin{pmatrix} (-1) \times (1) \\ (-1) \times (-3) \\ (-1) \times (2) \end{pmatrix}$

TRUE — Answer: TRUE

- $c_1 = (-2) \begin{pmatrix} 1 \\ -3 \\ 2 \end{pmatrix} = \begin{pmatrix} (-2) \times (1) \\ (-2) \times (-3) \\ (-2) \times (2) \end{pmatrix}$

Calculator

TRUE ✔ Answer: TRUE

- $C = \left(\begin{array}{c|c} (-1)\times(1) & (-2)\times(1) \\ (-1)\times(-3) & (-2)\times(-3) \\ (-1)\times(2) & (-2)\times(2) \end{array} \right)$

TRUE ✔ Answer: TRUE

- $\widetilde{c}_0^T = (1)\left(\begin{array}{cc} -1 & -2 \end{array} \right) = \left(\begin{array}{cc} (1)\times(-1) & (1)\times(-2) \end{array} \right)$

TRUE ✔ Answer: TRUE

- $\widetilde{c}_1^T = (-3)\left(\begin{array}{cc} -1 & -2 \end{array} \right) = \left(\begin{array}{cc} (-3)\times(-1) & (-3)\times(-2) \end{array} \right)$

TRUE ✔ Answer: TRUE

- $\widetilde{c}_2^T = (2)\left(\begin{array}{cc} -1 & -2 \end{array} \right) = \left(\begin{array}{cc} (2)\times(-1) & (2)\times(-2) \end{array} \right)$

TRUE ✔ Answer: TRUE

- $C = \left(\begin{array}{cc} (-1)\times(1) & (-2)\times(1) \\ \hline (-1)\times(-3) & (-2)\times(-3) \\ \hline (-1)\times(2) & (-2)\times(2) \end{array} \right)$

TRUE ✔ Answer: TRUE

Explanation

Answer: The important thing here is to recognize that if you compute the first two results, then the third result comes for free. If you compute results 4-6, then the last result comes for free.

Also, notice that the columns C are just multiples of a while the rows of C are just multiples of b^T.

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Answers are displayed within the problem

Homework 4.4.4.10

16/16 points (graded)

Consider

$$\left(\begin{array}{c} \Box \\ \Box \\ \Box \\ \Box \end{array} \right) \left(\begin{array}{ccc} 2 & -1 & 3 \end{array} \right) = \left(\begin{array}{ccc} 4 & \Box & \Box \\ -2 & \Box & \Box \\ 2 & \Box & \Box \\ 6 & \Box & \Box \end{array} \right)$$

Calculator

Fill in the boxes:

2 ✔ Answer: 2

-1 ✔ Answer: -1

1 ✔ Answer: 1

3 ✔ Answer: 3 $\begin{pmatrix} 2 & -1 & 3 \end{pmatrix} =$

4 ✔ Answer: 4

-2 ✔ Answer: -2

2 ✔ Answer: 2

6 ✔ Answer: 6

-2 ✔ Answer: -2

1 ✔ Answer: 1

-1 ✔ Answer: -1

-3 ✔ Answer: -3

6 ✔ Answer: 6

-3 ✔ Answer: -3

3 ✔ Answer: 3

9 ✔ Answer: 9

Answer:

$$\begin{pmatrix} 2 \\ -1 \\ 1 \\ 3 \end{pmatrix} \begin{pmatrix} 2 & -1 & 3 \end{pmatrix} = \begin{pmatrix} 4 & -2 & 6 \\ -2 & 1 & -3 \\ 2 & -1 & 3 \\ 6 & -3 & 9 \end{pmatrix}$$

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Answers are displayed within the problem

Homework 4.4.4.11

15/15 points (graded)

Consider

$$\begin{pmatrix} 2 \\ -1 \\ 1 \\ 3 \end{pmatrix} \begin{pmatrix} \square & \square & \square \end{pmatrix} = \begin{pmatrix} 4 & -2 & 6 \\ \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \end{pmatrix}$$

Fill in the boxes:

$\begin{pmatrix} 2 \\ -1 \\ 1 \\ 3 \end{pmatrix}$ 2 ✔ Answer: 2 -1 ✔ Answer: -1 3 ✔ Answer: 3

Calculator

=

4 ✔ Answer: 4	-2 ✔ Answer: -2	6 ✔ Answer: 6
-2 ✔ Answer: -2	1 ✔ Answer: 1	-3 ✔ Answer: -3
2 ✔ Answer: 2	-1 ✔ Answer: -1	3 ✔ Answer: 3
6 ✔ Answer: 6	-3 ✔ Answer: -3	9 ✔ Answer: 9

Answer:

$$\begin{pmatrix} 2 \\ -1 \\ 1 \\ 3 \end{pmatrix} \begin{pmatrix} 2 & -1 & 3 \end{pmatrix} = \begin{pmatrix} 4 & -2 & 6 \\ -2 & 1 & -3 \\ 2 & -1 & 3 \\ 6 & -3 & 9 \end{pmatrix}$$

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Homework 4.4.4.12

3/3 points (graded)

Let $A = \begin{pmatrix} 0 & 1 & 0 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & -2 & 2 \\ 4 & 2 & 0 \\ 1 & 2 & 3 \end{pmatrix}$. Then $AB =$

4 ✔ Answer: 4 2 ✔ Answer: 2 0 ✔ Answer: 0

Answer: $\begin{pmatrix} 4 & 2 & 0 \end{pmatrix}$

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Homework 4.4.4.13

1/1 point (graded)

Let $e_i \in \mathbb{R}^m$ equal the ith unit basis vector and $A \in \mathbb{R}^{m \times n}$. Then $e_i^T A = \tilde{a}_i^T$, the ith row of A.

Always ✔ Answer: Always

Answer: Always

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$\Big(\alpha_{0,0} \quad \alpha_{0,1} \quad \cdots \quad \alpha_{0,n-1} \Big)$

$$\begin{pmatrix} 0 & \cdots & 0 & 1 & 0 & \cdots & 0 \end{pmatrix} \begin{pmatrix} \vdots & \vdots & & \vdots \\ \alpha_{i-1,0} & \alpha_{i-1,1} & \cdots & \alpha_{i-1,n-1} \\ \alpha_{i,0} & \alpha_{i,1} & \cdots & \alpha_{i,n-1} \\ \alpha_{i+1,0} & \alpha_{i+1,1} & \cdots & \alpha_{i+1,n-1} \\ \vdots & \vdots & & \vdots \\ \alpha_{m-1,0} & \alpha_{m-1,1} & \cdots & \alpha_{m-1,n-1} \end{pmatrix}$$
$$= \begin{pmatrix} \alpha_{i,0} & \alpha_{i,1} & \cdots & \alpha_{i,n-1} \end{pmatrix}.$$

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Homework 4.4.4.14

1/1 point (graded)

If you don't find the file `PracticeGemm.m` in `LAFF-2.0xM/Programming/Week04`, then

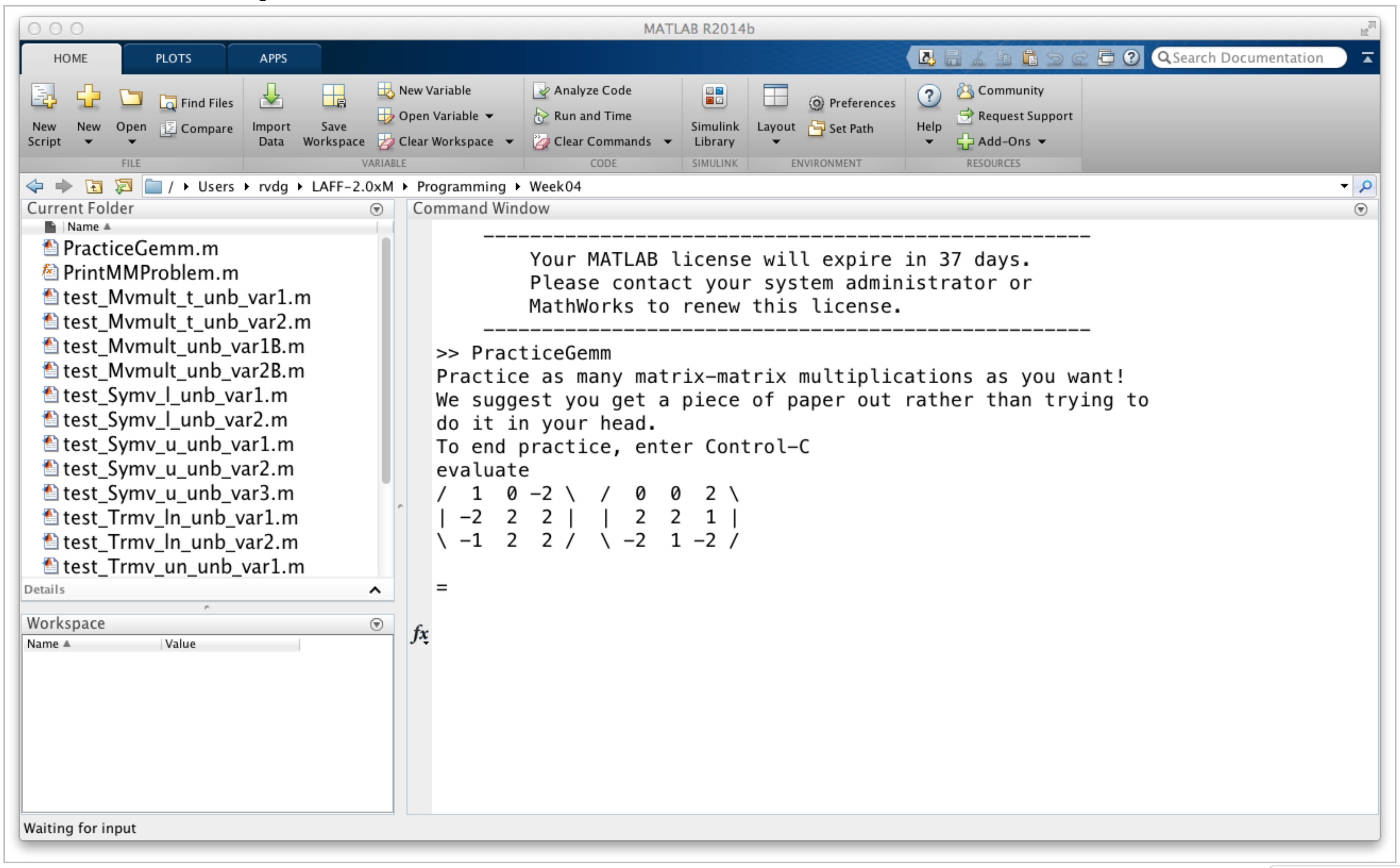
- Download the file `PracticeGemm.zip`.
- Unzip the file

There is a problem with the script in PracticeGemm.m when used with Matlab Online. Please download PracticeGemm.m and place in `LAFF-2.0xM/Programming/Week04`.

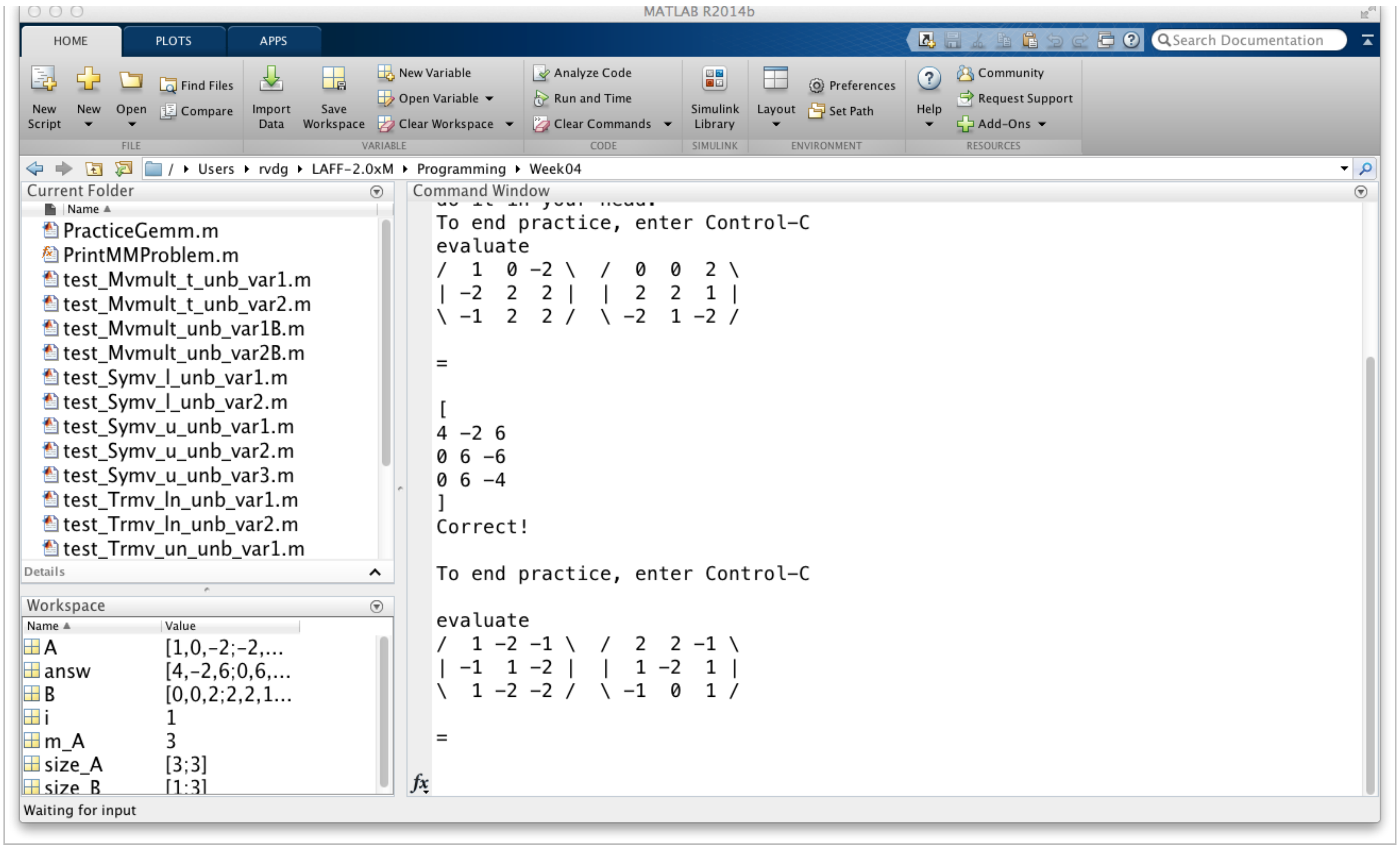
Next,

- Start MATLAB and make the directory in which the files `PracticeGemm.m` and `PrintMMProblem.m` exist the current directory for the Command Window.
- Execute `PracticeGemm`

  You will see something like



- Type in the answer:



(Notice that you enter it as you would enter a matrix in MATLAB.)

- Practice all you want!

☑ done/skip

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