5.3.4 Matrix-Matrix Multiplication with Rank-1 Updates

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Homework 5.3.4.1

36/36 points (graded)

Compute each of the following matrix-matrix multiplications:

$$\begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix} \begin{pmatrix} -1 & 0 & 1 \end{pmatrix} =$$

-1 ✔	0 ✔	1 ✔
Answer: -1	**Answer:** 0	**Answer:** 1
1 ✔	0 ✔	-1 ✔
Answer: 1	**Answer:** 0	**Answer:** -1
0 ✔	0 ✔	0 ✔
Answer: 0	**Answer:** 0	**Answer:** 0

-4 -2 2

Answer: -4 Answer: -2 Answer: 2

$\left(\left| \begin{matrix} -2 \\ 2 \\ 1 \end{matrix} \right| \right) \left(\begin{array}{ccc} 2 & 1 & -1 \end{array} \right) =$

4 2 -2

Answer: 4 Answer: 2 Answer: -2

2 1 -1

Answer: 2 Answer: 1 Answer: -1

2 -2 4

Answer: 2 Answer: -2 Answer: 4

$\left(\left| \begin{matrix} 2 \\ 1 \\ 2 \end{matrix} \right| \right) \left(\begin{array}{ccc} 1 & -1 & 2 \end{array} \right) =$

1 -1 2

Answer: 1 Answer: -1 Answer: 2

2 -2 4

Answer: 2 Answer: -2 Answer: 4

$\begin{pmatrix} 1 & -2 & 2 \\ -1 & 2 & 1 \\ 0 & 1 & 2 \end{pmatrix} \begin{pmatrix} -1 & 0 & 1 \\ 2 & 1 & -1 \\ 1 & -1 & 2 \end{pmatrix} =$

-3 ✔	-4 ✔	7 ✔
Answer: -3	**Answer:** -4	**Answer:** 7
6 ✔	1 ✔	-1 ✔
Answer: 6	**Answer:** 1	**Answer:** -1
4 ✔	-1 ✔	3 ✔
Answer: 4	**Answer:** -1	**Answer:** 3

$$\left(\begin{array}{c|cc} 1 & & \\ -1 & & \\ 0 & & \end{array}\right) \left(\begin{array}{ccc} -1 & 0 & 1 \\ \hline & & \end{array}\right) = \left(\begin{array}{ccc} -1 & 0 & 1 \\ \hline 1 & 0 & -1 \\ 0 & 0 & 0 \end{array}\right)$$

$$\left(\begin{array}{c|cc} & -2 & \\ & 2 & \\ & 1 & \end{array}\right) \left(\begin{array}{ccc} & & \\ \hline 2 & 1 & -1 \\ \hline & & \end{array}\right) = \left(\begin{array}{ccc} -4 & -2 & 2 \\ \hline 4 & 2 & -2 \\ \hline 2 & 1 & -1 \end{array}\right)$$

$$\left(\begin{array}{cc|c} & & 2 \\ & & 1 \\ & & 2 \end{array}\right) \left(\begin{array}{ccc} & & \\ \hline 1 & -1 & 2 \\ \hline & & \end{array}\right) = \left(\begin{array}{ccc} 2 & -2 & 4 \\ 1 & -1 & 2 \\ \hline 2 & -2 & 4 \end{array}\right)$$

$$\begin{pmatrix} 1 & -2 & 2 \\ -1 & 2 & 1 \\ 0 & 1 & 2 \end{pmatrix} \begin{pmatrix} -1 & 0 & 1 \\ 2 & 1 & -1 \\ 1 & -1 & 2 \end{pmatrix} = \begin{pmatrix} -3 & -4 & 7 \\ 6 & 1 & -1 \\ 4 & -1 & 3 \end{pmatrix}$$

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Answers are displayed within the problem

Homework 5.3.4.2

1 point possible (graded)

Algorithm: $C := \text{GEMM\_UNB\_VAR3}(A, B, C)$

Partition $A \rightarrow \left(\begin{array}{c|c} A_L & A_R \end{array} \right)$, $B \rightarrow \left(\begin{array}{c} B_T \\ \hline B_B \end{array} \right)$

where A_L has 0 columns, B_T has 0 rows

while $n(A_L) < n(A)$ **do**

Repartition

$$\left(\begin{array}{c|c} A_L & A_R \end{array} \right) \rightarrow \left(\begin{array}{c|c|c} A_0 & a_1 & A_2 \end{array} \right), \left(\begin{array}{c} B_T \\ \hline B_B \end{array} \right) \rightarrow \left(\begin{array}{c} B_0 \\ \hline b_1^T \\ \hline B_2 \end{array} \right)$$

where a_1 has 1 column, b_1 has 1 row

$$C := a_1 b_1^T + C$$

Continue with

$$\left(\begin{array}{c|c} A_L & A_R \end{array} \right) \leftarrow \left(\begin{array}{c|c|c} A_0 & a_1 & A_2 \end{array} \right), \left(\begin{array}{c} B_T \\ \hline B_B \end{array} \right) \leftarrow \left(\begin{array}{c} B_0 \\ \hline b_1^T \\ \hline B_2 \end{array} \right)$$

endwhile

Write the routine

- `[ C_out ] = Gemm_unb_var3( A, B, C )`

that computes $C := AB + C$ using the above algorithm.

Some links that will come in handy:

- Spark (alternatively, open the file `LAFF-2.0xM -> Spark -> index.html`)
- PictureFLAME (alternatively, open the file `LAFF-2.0xM -> PictureFLAME -> PictureFLAME.html`)

The update $C := a_1 b_1^T + C$ can be accomplished by the call to

```
laff_ger( ... )
```

(click on the "laff routines" tab at the top of the page for more info).

You may want to use the following script to test your implementations:

- test_Gemm_unb_var3.m

Done/Skip ✔

Gemm_unb_var3.m

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Answers are displayed within the problem