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5.3.3 Matrix-matrix multiplication by rows 5.3.3 Matrix-matrix multiplication by rows

<u>Start of transcript. Skip to the</u> end.

Dr. Robert van de Geijn: So let's continue

on with our examination of the different algorithms for computing

matrix-matrix multiplication.

This time we're going to look at how C can be computed one row at a time.

0:00 / 4:34

▶ 1.0x

◄》

X

CC

Recall how the ij entry of C is

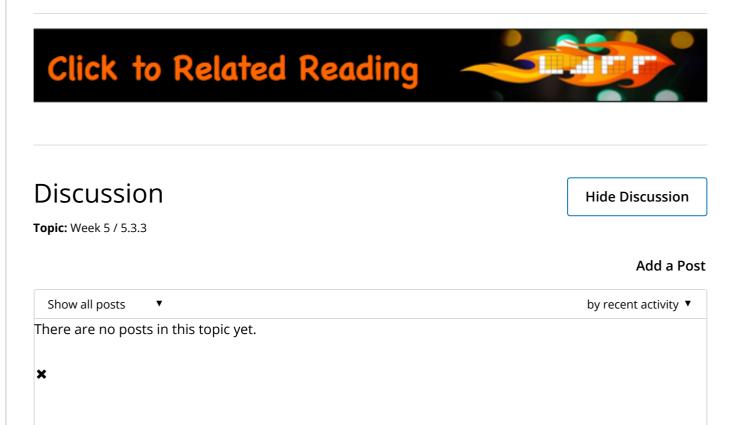
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Homework 5.3.3.1

1/1 point (graded)

Let A and B be matrices and AB be well-defined and let A have at least four rows. If the first and fourth rows of A are the same, then the first and fourth rows of AB are the same.

Always **▼**

✓ Answer: Always

Explanation

Answer: Always

Partition

$$A = \begin{pmatrix} \widetilde{a}_0^T \\ \widetilde{a}_1^T \\ \widetilde{a}_2^T \\ \widetilde{a}_3^T \\ A_4 \end{pmatrix}$$

where A_4 represents the part of the matrix below the first four rows. Then

$$AB = \begin{pmatrix} \widetilde{a}_0^T \\ \widetilde{a}_1^T \\ \widetilde{a}_2^T \\ \widetilde{a}_3^T \\ A_4 \end{pmatrix} B = \begin{pmatrix} \widetilde{a}_0^T B \\ \widetilde{a}_1^T B \\ \widetilde{a}_2^T B \\ \widetilde{a}_3^T B \\ A_4 B \end{pmatrix}.$$

Now, if $\tilde{a}_0^T = \tilde{a}_3^T$ then $\tilde{a}_0^T B = \tilde{a}_3^T B$ and hence the first and fourth rows of AB are equal.

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Answers are displayed within the problem

Homework 5.3.3.2

18/18 points (graded)

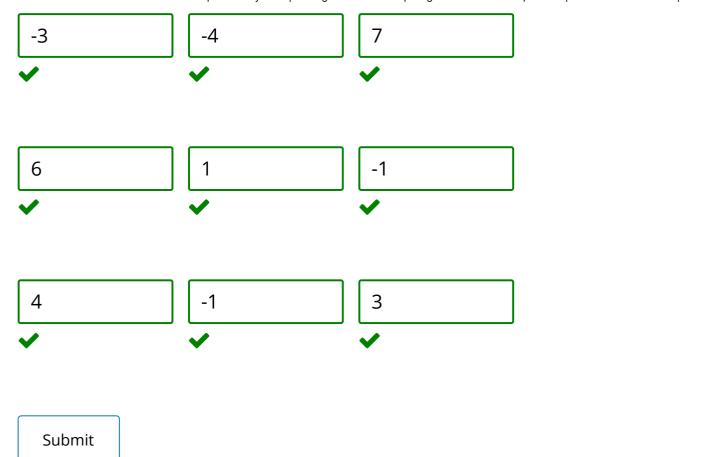
Compute each of the following matrix-matrix multiplications:

$$\left(\begin{array}{c|ccc}
\hline
 & 1 & -2 & 2 \\
\hline
 & & \\
\hline
 & & \\
\end{array}\right) \left(\begin{array}{cccc}
 & -1 & 0 & 1 \\
 & 2 & 1 & -1 \\
 & 1 & -1 & 2
\end{array}\right) =$$



$$\left(\begin{array}{c|ccc}
1 & -2 & 2 \\
\hline
-1 & 2 & 1 \\
\hline
\end{array}\right) \left(\begin{array}{cccc}
-1 & 0 & 1 \\
2 & 1 & -1 \\
1 & -1 & 2
\end{array}\right) =$$

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



✓ Correct (18/18 points)

Homework 5.3.3.3

1/1 point (graded)

Algorithm: $C := \text{GEMM_UNB_VAR2}(A, B, C)$

Partition
$$A \to \left(\frac{A_T}{A_B}\right)$$
, $C \to \left(\frac{C_T}{C_B}\right)$

where A_T has 0 rows, C_T has 0 rows

while $m(A_T) < m(A)$ do

Repartition

$$\left(\frac{A_T}{A_B}\right) \to \left(\frac{A_0}{a_1^T}\right), \left(\frac{C_T}{C_B}\right) \to \left(\frac{C_0}{c_1^T}\right)$$

where a_1 has 1 row, c_1 has 1 row

$$c_1^T := a_1^T B + c_1^T$$

Continue with

$$\left(\begin{array}{c} A_T \\ \hline A_B \end{array}\right) \leftarrow \left(\begin{array}{c} A_0 \\ \hline a_1^T \\ \hline A_2 \end{array}\right), \left(\begin{array}{c} C_T \\ \hline C_B \end{array}\right) \leftarrow \left(\begin{array}{c} C_0 \\ \hline c_1^T \\ \hline C_2 \end{array}\right)$$

endwhile

Write the routine

• [C_out] = Gemm_unb_var2(A, B, C)

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

Some links that will come in handy:

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

The update $c_1^T := a_1^T B + c_1^T$ can be accomplished by the call to

laff_gemv(..., 1, ..., 1,)

(click on the "laff routines" tab at the top of the page for more info). Hint: Revisit Homework 4.6.1.2

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

- test Gemm unb var2.m
- ✓ Done/Skip ✓



Gemm unb var2.m

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• Answers are displayed within the problem

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