UTAustinX UT.5.05x
Linear Algebra - Foundations to Frontiers

Help

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5.3.1 Lots of Loops

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Week 5 due Nov 6, 2023 22:42 IST

5.3.1 Lots of Loops

Summary

- A matrix-matrix multiplication can be expressed as an algorithm with a "triple-nested loop".

- The loops can be ordered in six different ways

- We will in the next units relate these different orderings to operations that we have encountered before.

- It may pay to review last week's unit on "Special Matrix-Matrix Multiplication"

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Reading Assignment

0 points possible (ungraded)
Read Unit 5.3.1 of the notes. [LINK]

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Homework 5.3.1.1

1/1 point (graded)
Consider the MATLAB function

```
function [ C_out ] = MatMatMult( A, B, C )

[ m, n ] = size( C );
[ m_A, k ] = size( A );
[ m_B, n_B ] = size( B );

for j = 1:n
   for i = 1:m
      for p = 1:k
         C( i,j ) = A( i, p ) * B( p, j ) + C( i, j );
      end
   end
end
```

- Download the files <u>MatMatMult.m</u> and <u>test_MatMatMult.m</u> into, for example,

  ```
                          LAFF-2.0xM -> Programming -> Week5
  ```
  (creating the directory if necessary).

- Examine the script `test_MatMatMult.m` and then execute it in the Command Window: `test_MatMatMult`.

- Now, exchange the order of the loops:

  ```
   for j = 1:n
      for p = 1:k
         for i = 1:m
            C( i,j ) = A( i, p ) * B( p, j ) + C( i, j );
         end
      end
   end
  ```

  save the result, and execute `test_MatMatMult` again. What do you notice?

  Notice that exchanging the loops does not change the answer.

- How may different ways can you order the "triple-nested loop"?

  There are six different ways of ordering the triple-nested loop":

  - Consider the loop indices i, j, and p.

  - For the outer-most loop you can choose any of the three indices.

  - For the next loop you are left with two indices from which to choose.

  - For the inner-most loop, you are left with only one choice.

  Thus there are $3 \times 2 \times 1$ (3 factorial) ways to order the loops.

- Try them all and observe how the result of executing `test_MatMatMult` does or does not change the result.

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