EE 789
Assignment 2: Matrix Multiplication

October 9, 2023

You are given two 16x16 matrices A and B and are expected to design a circuit which multiplies these matrices.

If $A = [a_{ij}]$ and $B = [b_{ij}]$ $(0 \leq i, j \leq 15)$ then the product matrix $C = A \times B$ has entries c_{ij} with

$$c_{ij} = \sum_{k=0}^{1} 5a_{ik}b_{kj}$$

A 16x16 matrix can be viewed in row-form or column form. In row-form, we can write

$$A = \begin{pmatrix} rA_0^T \\ rA_1^T \\ \dots \\ rA_15^T \end{pmatrix}$$

where rA_0^T is the first row and so on. In column form, we can write A as

$$A = (cA_0 \; cA_1 \; \dots \; cA_15)$$

where cA_0^T is the first column and so on. Similarly for B.

The product matrix C can be built in different ways.

$$c_{ij} = rA_i^T.cB_j^T$$

or (as a sum of rank-1 matrices):

$$C = \sum_{i=0}^{15} cA_i.rB_j^T$$

1 Sample code

I will share sample code for the multiplication of two 16x16 matrices. This includes a dot-product based implementation and a test-bench.

2 Assignment

You will attempt to implement the mmul routine in various ways. The test-bench is unchanged.

- Implement the matrix multiplication by speeding up the dot product implementation used in the sample code (10).
- Parallelize the matrix multiplication by dividing A and B into four 8x8 blocks, doing work on the 8x8 blocks and then combining this work to produce the final result (10).
- Implement the matrix product using the sum of rank-1 matrices approach (10).

In each case, you will have to measure the time required by the mmul routine in your implementation.