

MA 1043 - INTENSIVE MATRIX ALGEBRA (2-0)

Project #1: Matrix Multiplication

The file `innermul.m` is a sample MATLAB code that multiplies two matrices, A and B , using the inner-product form. In particular, if we break up A into rows and B into columns like

$$A = \begin{bmatrix} \mathbf{a}_1^T \\ \mathbf{a}_2^T \\ \vdots \\ \mathbf{a}_n^T \end{bmatrix} \quad \text{and} \quad B = [\mathbf{b}_1 \quad \mathbf{b}_2 \quad \cdots \quad \mathbf{b}_m]$$

where the $\mathbf{a}_i, \mathbf{b}_j \in \mathbb{C}^p$ for $i = 1, 2, \dots, n$ and $j = 1, 2, \dots, m$. Then we can write

$$AB = \begin{bmatrix} \mathbf{a}_1^T \\ \mathbf{a}_2^T \\ \vdots \\ \mathbf{a}_n^T \end{bmatrix} [\mathbf{b}_1 \quad \mathbf{b}_2 \quad \cdots \quad \mathbf{b}_m] = \begin{bmatrix} \mathbf{a}_1^T \mathbf{b}_1 & \mathbf{a}_1^T \mathbf{b}_2 & \cdots & \mathbf{a}_1^T \mathbf{b}_m \\ \mathbf{a}_2^T \mathbf{b}_1 & \mathbf{a}_2^T \mathbf{b}_2 & \cdots & \mathbf{a}_2^T \mathbf{b}_m \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{a}_n^T \mathbf{b}_1 & \mathbf{a}_n^T \mathbf{b}_2 & \cdots & \mathbf{a}_n^T \mathbf{b}_m \end{bmatrix}$$

You should recall that we did this in class.

Given the same A and B we could break A into columns and B into rows like

$$A = [\mathbf{a}_1 \quad \mathbf{a}_2 \quad \cdots \quad \mathbf{a}_p] \quad \text{and} \quad B = \begin{bmatrix} \mathbf{b}_1^T \\ \mathbf{b}_2^T \\ \vdots \\ \mathbf{b}_p^T \end{bmatrix}$$

where the $\mathbf{a}_i \in \mathbb{C}^n$ for $i = 1, 2, \dots, p$ and the $\mathbf{b}_j \in \mathbb{C}^m$ for $j = 1, 2, \dots, p$. Then we can write

$$AB = [\mathbf{a}_1 \quad \mathbf{a}_2 \quad \cdots \quad \mathbf{a}_p] \begin{bmatrix} \mathbf{b}_1^T \\ \mathbf{b}_2^T \\ \vdots \\ \mathbf{b}_p^T \end{bmatrix} = [\mathbf{a}_1 \mathbf{b}_1^T + \mathbf{a}_2 \mathbf{b}_2^T + \cdots + \mathbf{a}_p \mathbf{b}_p^T]$$

This is the outer-product form that we also discussed in class.

Your task is to modify the file `innermul.m` to make it into `outermul.m`, a code that performs matrix multiplication in outer-product form.