Matrix Theory (EE5609) Assignment 3

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Abstract—**This assignment proves that matrix multiplication is not commutative.**

The code for this solution can be found from

1 PROBLEM STATEMENT

Show that

$$\begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}\begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix} \neq \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}\begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}$$

2 SOLUTION

Let the two matrices be $\mathbf{A} = \begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}$. From the problem we have to prove the following

$$\mathbf{AB} \neq \mathbf{BA} \tag{2.0.1}$$

At first we compute left hand side of 2.0.1.

$$\mathbf{AB} = \begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}\begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix} \tag{2.0.2}$$

$$\implies \mathbf{AB} = \begin{pmatrix} 5 \times 2 - 1 \times 3 & 5 \times 1 - 1 \times 4 \\ 6 \times 2 + 7 \times 3 & 6 \times 1 + 7 \times 4 \end{pmatrix} \tag{2.0.3}$$

$$\implies \mathbf{AB} = \begin{pmatrix} 7 & 1 \\ 33 & 34 \end{pmatrix} \tag{2.0.4}$$

Next, we compute right hand side of 2.0.1.

$$\mathbf{BA} = \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}\begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix} \tag{2.0.5}$$

$$\implies \mathbf{BA} = \begin{pmatrix} 2 \times 5 + 1 \times 6 & 2 \times (-1) + 1 \times 7 \\ 3 \times 5 + 4 \times 6 & 3 \times (-1) + 4 \times 7 \end{pmatrix} \tag{2.0.6}$$

$$\implies \mathbf{BA} = \begin{pmatrix} 16 & 5 \\ 39 & 25 \end{pmatrix} \tag{2.0.7}$$

Clearly we can see from equation 2.0.4 and 2.0.7 that the resultant matrices are not equal. Hence proved,

$$\begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}\begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix} \neq \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}\begin{pmatrix} 5 & -1 \\ 6 & 7 \end{pmatrix}$$