CSE 311
Lab 2 - Part 2: Matrix Operations
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Lab Materials

2 Python Scripts and an input file:

- lab2.py
- matK.py
- matrices.txt

Lab Objective

In this lab, we will implement the following elementary matrix operations:

- Addition
- Subtraction
- Multiplication
- Transpose
- Trace

These operations need to be defined in the Python script *matK.py* and save the modified file as *MatKomplete.py*. *lab2.py* will call the functions defined in *matKomplete.py*.

Matrices and indexing

Rows are on the horizontal axis, columns are on the vertical axis. We find elements in the matrix using indices. In the following matrix, a_{12} means the entry that is in the first row and second column (1 is row index, 2 is column index in this example). A is a 3×3 matrix, i.e it has 3 rows and 3 columns.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

Addition/Subtraction

Matrix addition is an elementwise operation. In other words, each element is added to its counterpart with the same indices in another matrix. An addition operation on the matrices above, would result in another matrix:

$$C = A + B = \begin{bmatrix} a_{11} + b_{11} & a_{12} + b_{12} & a_{13} + b_{13} \\ a_{21} + b_{21} & a_{22} + b_{22} & a_{23} + b_{23} \\ a_{31} + b_{31} & a_{32} + b_{32} & a_{33} + b_{33} \end{bmatrix}$$

Similarly, subtraction operation on matrices is defined as:

$$D = A - B = \begin{bmatrix} a_{11} - b_{11} & a_{12} - b_{12} & a_{13} - b_{13} \\ a_{21} - b_{21} & a_{22} - b_{22} & a_{23} - b_{23} \\ a_{31} - b_{31} & a_{32} - b_{32} & a_{33} - b_{33} \end{bmatrix}$$

Transpose

For transpose operation, we are changing the rows with the columns. Effectively, an entry a_{ij} in A, will end up in position ji in A^T (read A-transpose).

$$A^T = \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{bmatrix}$$

Trace

Trace is the sum of the matrix entries on the diagonal, i.e, the entries that are on positions where row index is equal to the column index. The entries in the diagonal are in boldface below.

$$A = \begin{bmatrix} \boldsymbol{a_{11}} & a_{12} & a_{13} \\ a_{21} & \boldsymbol{a_{22}} & a_{23} \\ a_{31} & a_{32} & \boldsymbol{a_{33}} \end{bmatrix}$$

The trace of A ($tr(A)$) is calculated as:

$$tr(A) = a_{11} + a_{22} + a_{33}$$

Multiplication

Given two matrices, we calculate their product by walking from left to right on the rows on the left-hand matrix, and from top to bottom on the columns on the right-hand matrix. Hence, to be able to multiply matrices, the number of columns of the left-hand matrix should be equal to the number of rows of the right-hand matrix. For example, to find the entry m_{23} in $M = A \times B$, we would walk right row 2 in A and down column 3 in B. If A is $m \times n$ and B is $n \times p$, M will be $m \times p$. For the initial matrix examples A and B, M will be:

$$M = \begin{bmatrix} a_{11} * b_{11} + a_{12} * b_{21} + a_{13} * b_{31} & a_{11} * b_{12} + a_{12} * b_{22} + a_{13} * b_{32} & a_{11} * b_{13} + a_{12} * b_{23} + a_{13} * b_{33} \\ a_{21} * b_{11} + a_{22} * b_{21} + a_{23} * b_{31} & a_{21} * b_{12} + a_{22} * b_{22} + a_{23} * b_{32} & a_{21} * b_{13} + a_{22} * b_{23} + a_{23} * b_{33} \\ a_{31} * b_{11} + a_{32} * b_{21} + a_{33} * b_{31} & a_{31} * b_{12} + a_{32} * b_{22} + a_{33} * b_{32} & a_{31} * b_{13} + a_{32} * b_{23} + a_{33} * b_{33} \end{bmatrix}$$