Product Requirement Document

Python Matrix Calculator

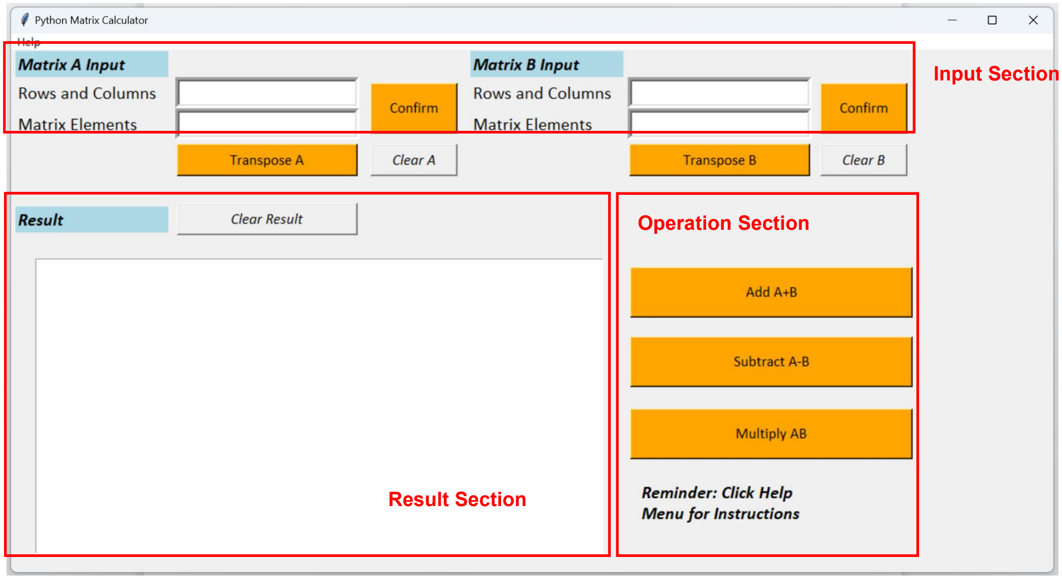
Background and Motivation

- When dealing with mathematical problems, Architectural Environment Engineers often encounter some matrix operation problems.

- Therefore, this simple python based matrix calculator is designed to save the time for calculation process and verification, and accordingly improve working efficiency.

- The calculator can conduct some basic matrix calculations including addition, subtraction, multiplication and transposition, and it is designed in graphical user interface.

Key Functions



- This software can perform simple matrix operations by entering the content of both matrix elements and the number of matrix rows and columns.

- After input of matrices and confirmation, the different operations can be achieved by clicking the related buttons such as “Transpose”, “Add A+B” and “Multiply AB”.

- The processing results will be displayed correspondingly when the inputs satisfy the requirements for matrix calculation.

Scientific Methods

A matrix is an array of numbers arranged in rows and columns. The dimensions of a matrix are typically denoted as $m \times n$.

Matrix operations such as addition, multiplication, subtraction, etc., are similar to basic arithmetic and algebra, but differ in some ways and are subject to certain constraints. Descriptions of the matrix operations below are algorithms behind this software.

- **Addition and Subtraction**

If A and B are of the same order, then we may add corresponding elements to obtain

$$A+B=\begin{pmatrix} a_{11}+b_{11} & a_{12}+b_{12} & \cdots & a_{1n}+b_{1n} \\ \vdots & & & \\ a_{m1}+b_{m1} & a_{m2}+b_{m2} & \cdots & a_{mn}+b_{mn} \end{pmatrix}$$

or subtract B from A to obtain

$$A-B=\begin{pmatrix} a_{11}-b_{11} & a_{12}-b_{12} & \cdots & a_{1n}-b_{1n} \\ \vdots & & & \\ a_{m1}-b_{m1} & a_{m2}-b_{m2} & \cdots & a_{mn}-b_{mn} \end{pmatrix}$$

Example: Given $A=\begin{pmatrix} 1 & 2 \\ 0 & 4 \end{pmatrix}$ and $\begin{pmatrix} 0 & 3 \\ 1 & 4 \end{pmatrix}$. Find $A+B$ and $A-B$.

Solution:

$$A+B=\begin{pmatrix} 1+0 & 2+3 \\ 0+1 & 4+4 \end{pmatrix}=\begin{pmatrix} 1 & 5 \\ 1 & 8 \end{pmatrix}$$

$$A-B=\begin{pmatrix} 1-0 & 2-3 \\ 0-1 & 4-4 \end{pmatrix}=\begin{pmatrix} 1 & -1 \\ -1 & 0 \end{pmatrix}$$

Example: If

$$A=\begin{pmatrix} 1 & 2 \\ 0 & 4 \end{pmatrix} \text{ and } \begin{pmatrix} 0 & 3 & 2 \\ 1 & 4 & 1 \end{pmatrix}$$

then $A+B$ and $A-B$ do not make sense because A and B have different orders.

- **Multiplication**

Multiplication of one matrix by another is more involved than we might expect!

Let A by an $m \times n$ matrix, B by a $p \times q$ matrix. Then AB exists if $n = p$, i.e. the "inner dimensions" agree. The result, AB is an $m \times q$ matrix. Thus

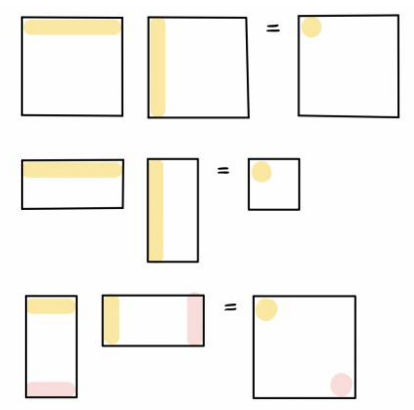
$$\underbrace{A \quad B}_{n=p}$$

If $n \neq p$, AB does not exist, i.e. the number of columns of A must equal the number of rows of B.

For example, if A is a 3×2 matrix and B is a 2×2 matrix, then AB exists and is a 3×2 matrix, but BA does not exist.

Rule for matrix multiplication:
When $C = AB$ exists, the element c_{ij} in the ith row and j th column of C is obtained by taking the "product" of the ith row of A with the jth column of B. By "product", we mean

$$c_{ij} = \sum_r a_{ir} b_{rj}.$$



Example:

a) $\begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 3 & 2 \end{pmatrix}$

b) $\begin{pmatrix} 0 & 1 \\ 3 & 2 \end{pmatrix} \begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix}$

Solution:

a)

$$\begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 3 & 2 \end{pmatrix} = \begin{pmatrix} -3+0 & 1-2 \\ 0+3 & 2+2 \end{pmatrix} = \begin{pmatrix} -3 & -1 \\ 3 & 4 \end{pmatrix}$$

b)

$$\begin{pmatrix} 0 & 1 \\ 3 & 2 \end{pmatrix} \begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix} = \begin{pmatrix} 0+2 & 0+1 \\ 3+4 & -3+2 \end{pmatrix} = \begin{pmatrix} 2 & 1 \\ 7 & -1 \end{pmatrix}$$

- **Transposition**

The transpose of the $m \times n$ matrix A is an $n \times m$ matrix denoted by A^T and obtained by interchanging the rows and columns of A.

If

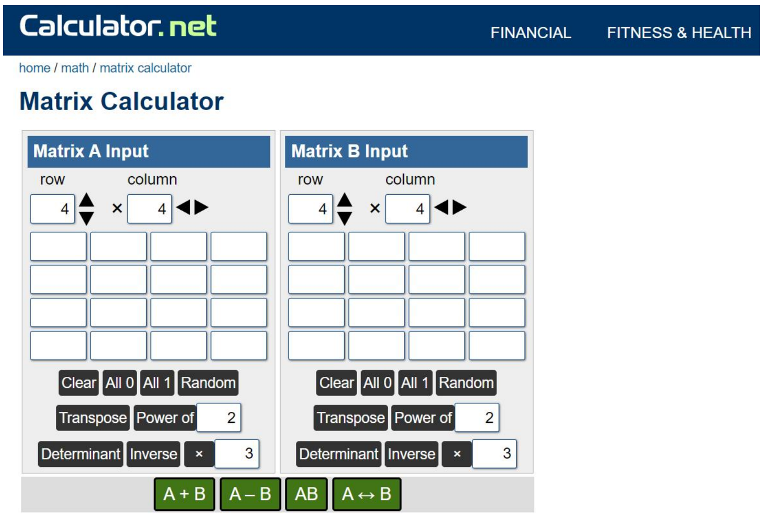
$$A = \begin{pmatrix} 3 & 2 & 1 \\ 4 & 5 & 6 \end{pmatrix}, \quad B = \begin{pmatrix} 1 \\ 4 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 2 & 3 \\ 0 & 5 & 1 \\ 2 & 4 & 7 \end{pmatrix}$$

then their transposes are

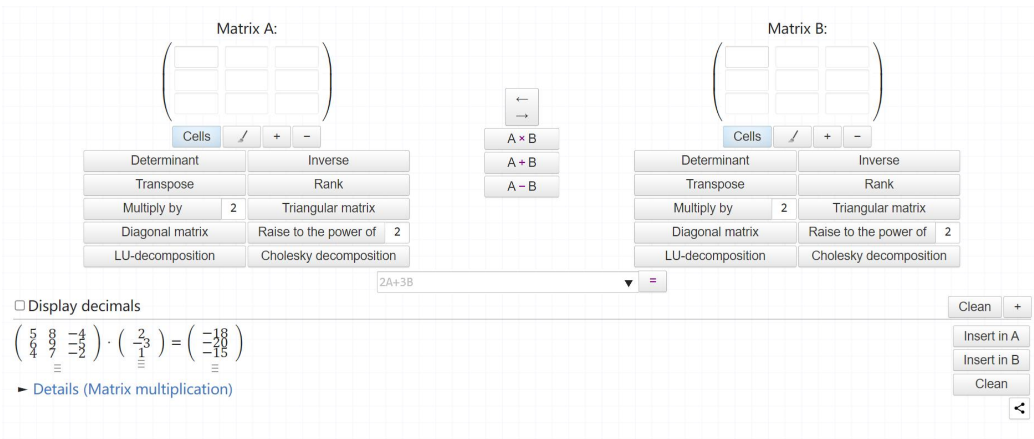
$$A^T = \begin{pmatrix} 3 & 4 \\ 2 & 5 \\ 1 & 6 \end{pmatrix}, \quad B^T = \begin{pmatrix} 1 & 4 \end{pmatrix}, \quad C^T = \begin{pmatrix} 1 & 0 & 2 \\ 2 & 5 & 4 \\ 3 & 1 & 7 \end{pmatrix}$$

Similar Products in Markets

1. https://www.calculator.net/matrix-calculator.html



2. https://matrixcalc.org/



3. https://matrix.reshish.com/