Practice Exercise #23: Matrix Multiplication

http://www.comp.nus.edu.sg/~cs1010/4_misc/practice.html

Reference: Week 6 Exercise #2

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Objective: Two-dimensional array

Task statement:

Write a program **MatrixOps.c** to compute the sum and product of two matrices. You may assume that a matrix has at most 10 rows and 10 columns.

The skeleton program provided contains the completed **sumMatrix()** function. You need to complete the **prodMatrix()** function.

1. Matrix Addition

To add two matrices, both matrices must have the same size (same number of rows and columns). To compute C = A + B, where A, B, C are matrices,

$$C_{i,j} = A_{i,j} + B_{i,j}$$

The following shows two examples.

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

$$\begin{pmatrix} 10 & 21 & 7 & 9 \\ 4 & 6 & 14 & 5 \end{pmatrix} + \begin{pmatrix} 3 & 7 & 18 & 20 \\ 6 & 5 & 8 & 15 \end{pmatrix} = \begin{pmatrix} 13 & 28 & 25 & 29 \\ 10 & 11 & 22 & 20 \end{pmatrix}$$

2. Matrix Multiplication

To multiply two matrices A and B, the number of columns in A, let's call it *n*, must be the same as the number of rows in B. The resulting matrix has the same number of rows as A and number of columns as B. Hence, multiplying a $k \times n$ matrix with an $n \times p$ matrix gives a $k \times p$ product matrix.

To compute C = A × B, where A, B, C are matrices,

$$C_{i,j} = (A_{i,0} \times B_{0,j}) + (A_{i,1} \times B_{1,j}) + \ldots + (A_{i,n-1} \times B_{n-1,j})$$

The following shows two examples.

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

$$\begin{pmatrix} 2 & 1 & 3 & 2 \\ 3 & 0 & 2 & 1 \end{pmatrix} \times \begin{pmatrix} 3 & 2 & 1 \\ 2 & 2 & 3 \\ 1 & 3 & 0 \\ 2 & 1 & 3 \end{pmatrix} = \begin{pmatrix} 15 & 17 & 11 \\ 13 & 13 & 6 \end{pmatrix}$$

Sample runs:

```
Matrix A:
Enter number of rows and columns: 3 3
Enter values for matrix:
1 2 0
0 1 1
1 0 1
Matrix B:
Enter number of rows and columns: 3 3
Enter values for matrix:
-1 0 0
2 1 0
0 2 -1
Sum matrix:
0.00    2.00    0.00
2.00    2.00    1.00
1.00    2.00    0.00
Product matrix:
3.00    2.00    0.00
2.00    3.00    -1.00
-1.00   2.00    -1.00
```

```
Matrix A:
Enter number of rows and columns: 2 4
Enter values for matrix:
2 1 3 2
3 0 2 1
Matrix B:
Enter number of rows and columns: 4 3
Enter values for matrix:
3 2 1
2 2 3
1 3 0
2 1 3
Unmatched dimensions; cannot be added.
Product matrix:
15.00   17.00   11.00
13.00   13.00   6.00
```