University of Lincoln
School of Computer Science
CMP9133M – Advanced Programming
Workshop 5

Task (assessed):

You are tasked with writing a C++ program that performs basic matrix operations, including addition and multiplication. Your program should demonstrate your understanding of dynamic memory allocation, pointer arithmetic, and matrix manipulation.

Instructions:

1. Define a class named `Matrix` with the following private attributes:
    - An integer pointer named `data` to store the matrix data as a 2D array.
    - Integer variables `rows` and `cols` to store the dimensions of the matrix.
2. Implement the following methods for the `Matrix` class:
    - A constructor that takes integer parameters `r` and `c` to initialize the matrix dimensions. It should allocate memory for the matrix data.
    - A destructor that deallocates memory for the matrix data.
    - `int get(int row, int col)`: Returns the value at the given row and column indices.
    - `void set(int row, int col, int value)`: Sets the value at the given row and column indices.
3. Implement the following operations as member methods of the `Matrix` class:
    - `Matrix add(const Matrix &other)`: Returns a new matrix that is the sum of the current matrix and the `other` matrix.
    - `Matrix multiply(const Matrix &other)`: Returns a new matrix that is the product of the current matrix and the `other` matrix.
4. In the `main()` function:
    - Create two instances of the `Matrix` class with different dimensions.
    - Use a loop to input matrix elements for both matrices.
    - Perform addition and multiplication operations on the matrices and display the results.

Test case:

```
Enter dimensions of Matrix A (rows cols): 2 2
Enter matrix elements for Matrix A:
Element (1,1): 2
Element (1,2): 3
Element (2,1): 4
Element (2,2): 5

Enter dimensions of Matrix B (rows cols): 2 2
Enter matrix elements for Matrix B:
Element (1,1): 1
Element (1,2): 0
Element (2,1): -1
Element (2,2): 2

Matrix A:
2 3
4 5

Matrix B:
1 0
-1 2

Matrix A + Matrix B:
3 3
3 7

Matrix A * Matrix B:
-3 6
-5 14
```

Note: Make sure to handle memory allocation, deallocation, and matrix operations correctly in your program.

You can use the C++ source file (e.g., `matrix_operation.cpp`) provided on blackboard to implement the solution based on the instructions provided. This assessment will help assess your understanding of memory management, pointers, and matrix operations in C++.

Note1: Suppose $A = [a_{ij}]_{mxn}$ and $B = [b_{ij}]_{mxn}$ are two matrices of order m x n, then the addition of A and B is given by;

$$\mathbf{A + B = [a_{ij}]_{mxn} + [b_{ij}]_{mxn} = [a_{ij} + b_{ij}]_{mxn}}$$

Note2: Consider matrix A which is a × b matrix and matrix B, which is a b ×c matrix.

Then, matrix C = AB is defined as the A × B matrix.

An element in matrix C, C_{xy} is defined as:

$$C_{xy} = A_{x1} B_{y1} + \ldots + A_{xb} B_{by} = \sum_{k=1}^{b} A_{xk} B_{ky}$$

For x = 1…… a and y= 1…….c