

## Programming Design Homework Assignment S7

Due: 2022/4/16 23:00

※Notice:

1. Please follow the rules for homework assignments announced on the course website.
2. The standard template library and unrelated macros are not permitted in this assignment.

**There are two questions in this assignment, first one is short answer questions, and the other is programming.**

● Question 1: (20%)

The multiply operator, pointer, and dereference operator are all represented as the symbol “\*” in C++ language. Do you know how to distinguish them? You can use examples to explain them. Do not copy the definition on the textbook directly. Please answer the question in your words and submit as a text file named “HWS7-Q1.txt”.

● Programming formats : (20%)

1. The structure of your program (5%)
2. Clear and readable code layout (5%)
3. Clear comments for understanding your program (5%)
4. The copyright and short description of each question (5%)

● Question 2 : (60%)

The Kronecker product[1] which denoted by symbol “ $\otimes$ ” is an operation on two matrices of arbitrary size. It is a special form of tensor product. If A is an  $m \times n$  matrix and B is a  $p \times q$  matrix, then the Kronecker product  $A \otimes B$  is the  $pm \times qn$  block matrix:

$$A \otimes B = \begin{bmatrix} a_{11}b_{11} & a_{11}b_{12} & \cdots & a_{11}b_{1q} & \cdots & \cdots & a_{1n}b_{11} & a_{1n}b_{12} & \cdots & a_{1n}b_{1q} \\ a_{11}b_{21} & a_{11}b_{22} & \cdots & a_{11}b_{2q} & \cdots & \cdots & a_{1n}b_{21} & a_{1n}b_{22} & \cdots & a_{1n}b_{2q} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{11}b_{p1} & a_{11}b_{p2} & \cdots & a_{11}b_{pq} & \cdots & \cdots & a_{1n}b_{p1} & a_{1n}b_{p2} & \cdots & a_{1n}b_{pq} \\ \vdots & \vdots & & \vdots & \ddots & & \vdots & \vdots & & \vdots \\ \vdots & \vdots & & \vdots & & \ddots & \vdots & \vdots & & \vdots \\ a_{m1}b_{11} & a_{m1}b_{12} & \cdots & a_{m1}b_{1q} & \cdots & \cdots & a_{mn}b_{11} & a_{mn}b_{12} & \cdots & a_{mn}b_{1q} \\ a_{m1}b_{21} & a_{m1}b_{22} & \cdots & a_{m1}b_{2q} & \cdots & \cdots & a_{mn}b_{21} & a_{mn}b_{22} & \cdots & a_{mn}b_{2q} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{m1}b_{p1} & a_{m1}b_{p2} & \cdots & a_{m1}b_{pq} & \cdots & \cdots & a_{mn}b_{p1} & a_{mn}b_{p2} & \cdots & a_{mn}b_{pq} \end{bmatrix}$$

Examples

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \otimes \begin{bmatrix} 0 & 5 \\ 6 & 7 \end{bmatrix} = \begin{bmatrix} 1 \cdot 0 & 1 \cdot 5 & 2 \cdot 0 & 2 \cdot 5 \\ 1 \cdot 6 & 1 \cdot 7 & 2 \cdot 6 & 2 \cdot 7 \\ 3 \cdot 0 & 3 \cdot 5 & 4 \cdot 0 & 4 \cdot 5 \\ 3 \cdot 6 & 3 \cdot 7 & 4 \cdot 6 & 4 \cdot 7 \end{bmatrix} = \begin{bmatrix} 0 & 5 & 0 & 10 \\ 6 & 7 & 12 & 14 \\ 0 & 15 & 0 & 20 \\ 18 & 21 & 24 & 28 \end{bmatrix}$$

[1]Wikipedia; “Kronecker product,” on-line at [https://en.wikipedia.org/wiki/Kronecker\\_product](https://en.wikipedia.org/wiki/Kronecker_product), accessed on 30 March 2016

For this assignment, please use dynamic memory allocation to create two 2-dimensional arrays as matrices. The First matrix A is an  $m \times n$  matrix and the second matrix B is a  $p \times q$  matrix. The value of m, n, p and q are integer between 2 to 6 and generate by random function. The elements in the two matrices are also generated by random function (between -11.8 and +5.1). Please calculate and output the following information on the console window.

1. The two original matrices;
2. The matrix after Kronecker product of two matrices ( $A \otimes B$ );
3. Output the minimum element and its subscript of the above three matrices.

The subscript is marked with 1. Ex: the minimum value is at the position of [2][2], it should be showed as (3,3).

In this assignment, all the code shall write in the main function. **DO NOT** create any other function in your program. Please use the operator delete to release a block of memory that you've allocated previously using the operator new.