Date: October 21, 2021

## Project Description

In this project, you are required to implement a multi-threaded Java server that serves multiple users at the same time to perform different operations on matrices. The operations are as following:

- Matrix multiplication.

- Find the maximum and minimum elements in a matrix.

- Sort the elements of a matrix.

- Get the average of two matrices and find the maximum between them

- Perform the Convolution operation on a matrix.

- Sum numbers below the diagonal line and above the diagonal line, then compare the results.

- Find a number in the matrix and replace it with 0 or 1

Note: You are only requested to select and implement 5 of the operations mentioned above.

**The result should be computed on the server side and displayed back to the clients.**

## Operations

### Matrix Multiplication

For this operation, you need to perform multiplication between to matrices entered by the user. You have to ask the user to specify the size of the matrices, then ask to enter each element of matrix A followed by each element of matrix B. Both matrices must have the same dimensions. Otherwise, you have to show a meaningful error message to the user. The multiplication should be done using the iterative algorithm discussed in Wikipedia

### Find the Maximum and Minimum Elements in a Matrix

For this operation, you request from the user to enter the size of the matrix and search for the largest and the smallest element in the matrix. You have to display the results to the user

### Sort the Elements of a Matrix

Similar to the previous operation, first, you request the user to enter the size of the matrix. Second, you have to ask the user to enter if the sort is ascending or descending. Then, you request the user to enter the matrix elements. Once the server receives the matrix, it has to sort it according to the order that the user selected, and display the results to the user.

### Compute the Average of two Matrices and Find the Maximum Average Between Them

In this operation, you are required to ask the user to enter two matrices with the same size, and then compute and compare the average of the two matrices and display it to the user. To calculate the average you need to perform the following:

- Sum the elements of each matrix,

- and divide the sum over the total number of elements in the matrix.

### Perform the Convolution operation on a matrix

Convolution is the process of adding each element of the image to its local neighbors, weighted by the kernel. The kernel is a small matrix used for blurring, sharpening, embossing, edge detection[1]. You are required to ask the user to enter two matrices:

1. The kernel matrix size should be either [2×2] or [3×3]

2. The matrix size entered by the user should of either [8×8] or [16×16]

Once the matrices are sent to the server, perform the convolution operation and display the resulting matrix to the user.

### Sum numbers below the diagonal line and above the diagonal line, then compare the results

In this task, you are required to ask the user to enter a matrix of size [$n \times n$] and compute the numbers above and below the diagonal. For example, consider the following matrix:

$$x = \begin{bmatrix} 2 & 1 & 8 \\ 3 & 3 & 1 \\ 1 & 9 & 5 \end{bmatrix}$$

The diagonal numbers are the ones colored in red. Calculating the sum of the numbers above the diagonal line yields: (1 + 8 + 1) = 10, while calculating the sum of the numbers below it yields: (3 + 1 + 9) = 13.

### Find a Number(s) in the Matrix and Replace it with a Number that the User Enters

This operation requires asking the user to enter a matrix of any dimension, and two numbers: 1.

the number that the user wants to replace, and

2. the number to be replaced with.

The result should be computed on the server side and displayed back to the client.

## Testing

Implement a client application to test the operations/functionalities you implemented, and verify your results.

## Instructions & Deliverables

1. In MS-Word document submit the following:

   - Cover page includes necessary details of the group members (Student Name, Student ID).

   - In a table format, specify each group member tasks and the contribution percentage into the project.

   - The source code of all shell scripts.

   - Copy of the output console view for each shell script.

2. Submit your code with the MS-Word document on the Blackboard in one zipped file no later than the below due date: Submission - Due 13 to November, 2021

3. Call the Zip file (StuentNAME1 StudentNAME2 StudentNAME3.zip)

4. Add comments to your code.

5. Copying and/or plagiarism (-100%).

6. Code does not run (Errors) (-50%).

7. In case of late submission, (-10%) for each day of delay (Max 3 days delay).

8. A group of three students can work on the project.

9. Team members are required to meet regularly for discussion and workload distribution.

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[1] Wikipedia

10. All team members should be involved in one way or another in the other team members parts.

11. It is the right of the instructor to use any way of testing the student in the discussion and demo session, and according to that in some cases ( 100% ) graded project may be down to (-100%) graded project.

12. Discussion & Demo 40%. + Student Work 60%.