Problem2 report

Environnement

Os	Pop!_OS 22.04 LTS x86
CPU	Intel i7-8665U (8) @ 1.900GHz
Memory	16Gb
Java version	openjdk 17.0.6 2023-01-17

Build

In the `problem2` directory

```
javac MatmultD.java
```

How to use

```
java MatmultD NUM_THREAD < mat500.txt
```

If you want to see the execution time of each thread:

```
java MatmultD NUM_THREAD < mat500.txt | head -n NUM_THREAD
```

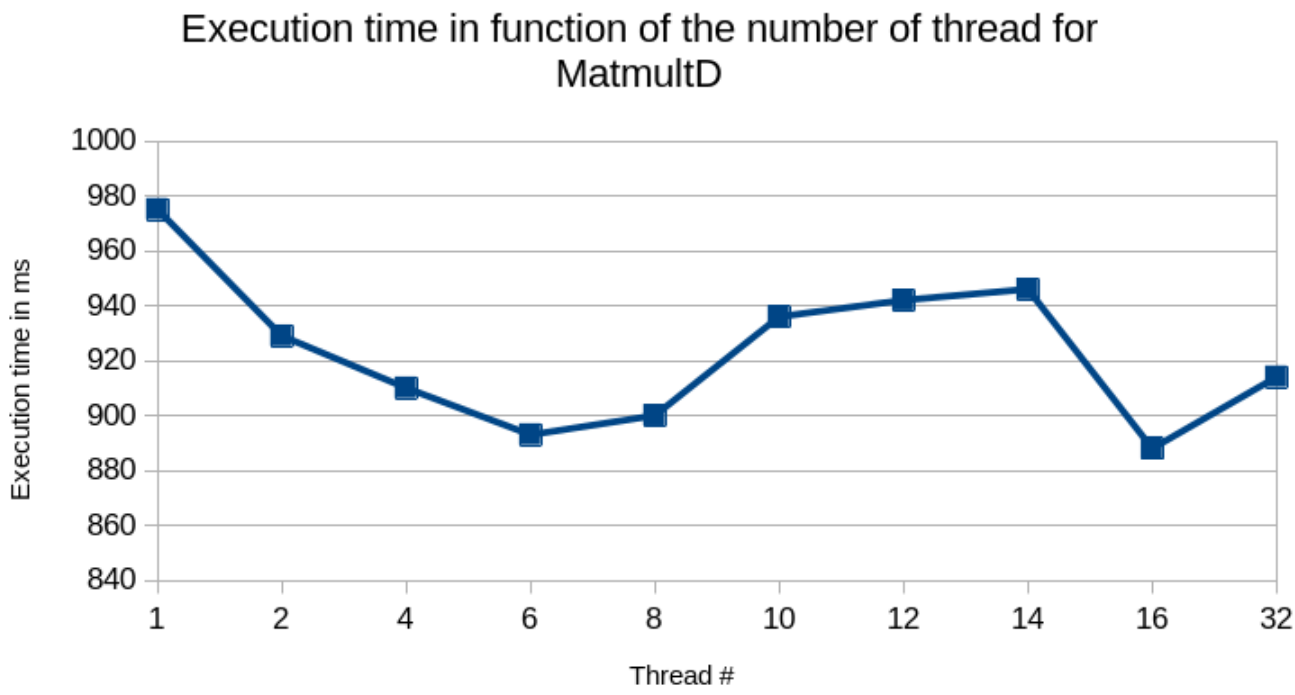
Results

Raw

Number of threads	Execution time in ms
1	975.000
2	929.000
4	910.000
6	893.000
8	900.000
10	936.000
12	942.000

Number of threads	Execution time in ms
14	946.000
16	888.000
32	914.000

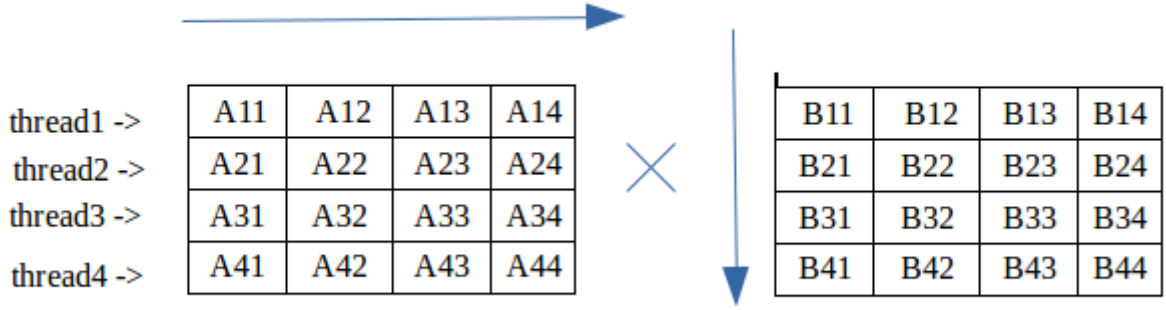
Graph



Interpretation

For this exercise, static load balencing seems to be the best way to calculate the product of 2 matrix. As the size of each matrix is known, we can divide the process in multiple threads.

Based on the following picture from geeks for geeks



I decided to use the `2D CYCLIC,*` task repartition, where one line of the matrix A is one task.

> We can also use the `2D BLOCK,*` task repartition

If we look at the results we can see that the speed increase between 6 and 16 threads. So we can say that 6 threads are enought for a `500 * 500` matrix multiplied by another `500 * 500` matrix.

Source code

MatmultD.java

```
import java.util.*;
import java.lang.*;

class MatMulThread extends Thread {
  int _matrixA[][];
  int _matrixB[][];
  int _matrixResult[][];
  int _startLine;
  int _nThread;

  MatMulThread(int a[][], int b[][], int c[][], int startLine, int nThread)
{
    _matrixA = a;
    _matrixB = b;
    _matrixResult = c;
    _startLine = startLine;
    _nThread = nThread;
  }

  public void run() {
    long startTime = System.currentTimeMillis();
    multMatrix();
    long endTime = System.currentTimeMillis();
    long timeDiff = endTime - startTime;
    System.out.printf("Execution Time of thread %d : %d ms\n",
Thread.currentThread().getId(), timeDiff);
  }

  private void multMatrix() {
    if (_matrixA.length == 0)
      return;
    if (_matrixA[0].length != _matrixB.length)
      return;

    int A_MatrixLineSize = _matrixA[0].length;
    int A_MatrixColSize = _matrixA.length;
    int B_MatrixColSize = _matrixB.length;

    for (int i = _startLine; i < A_MatrixColSize; i += _nThread) {
      for (int j = 0; j < B_MatrixColSize; j++) {
        for (int k = 0; k < A_MatrixLineSize; k++) {
          // no lock because we can assume that only one thread will access
this memory
```

```
            // location
            _matrixResult[i][j] += _matrixA[i][k] * _matrixB[k][j];
          }
        }
      }
    }

  }

  public class MatmultD {
    private static Scanner sc = new Scanner(System.in);

    public static void main(String[] args) {
      int thread_no = args.length == 1 ? Integer.valueOf(args[0]) : 1;

      int a[][] = readMatrix();
      int b[][] = readMatrix();
      int m = a.length;
      int p = b[0].length;
      int c[][] = new int[m][p];
      MatMulThread threads[] = new MatMulThread[thread_no];

      long startTime = System.currentTimeMillis();

      for (int i = 0; i < threads.length; ++i) {
        threads[i] = new MatMulThread(a, b, c, i, thread_no);
        threads[i].start();
      }
      for (int i = 0; i < threads.length; ++i) {
        try {
          threads[i].join();
        } catch (InterruptedException e) {
        }
      }
      long endTime = System.currentTimeMillis();
      printMatrix(c);
      System.out.printf("[thread_no]:%2d , [Time]:%4d ms\n", thread_no,
  endTime - startTime);
    }

    public static int[][] readMatrix() {
      int rows = sc.nextInt();
      int cols = sc.nextInt();
      int[][] result = new int[rows][cols];
      for (int i = 0; i < rows; i++) {
        for (int j = 0; j < cols; j++) {
          result[i][j] = sc.nextInt();
        }
      }
      return result;
    }

    public static void printMatrix(int[][] mat) {
      System.out.println("Matrix[" + mat.length + "][" + mat[0].length +
```

```
"]");
    int rows = mat.length;
    int columns = mat[0].length;
    int sum = 0;
    for (int i = 0; i < rows; i++) {
      for (int j = 0; j < columns; j++) {
        System.out.printf("%4d ", mat[i][j]);
        sum += mat[i][j];
      }
      System.out.println();
    }
    System.out.println();
    System.out.println("Matrix Sum = " + sum + "\n");
  }
}
```