

**PARALLEL SYSTEMS Course Workshop**  
**Fall Semester 2024-25 - EXERCISE-1 (15-20%)**  
**Delivery Date: 1/12/2024**

A matrix  $A(N \times N)$  is called "strictly diagonally dominated" if for each row of ' $i$ ' it holds that:

$$| \quad | > \sum_{j=0, j \neq i}^{N-1} | \quad | \quad \text{where } j=0 \dots N-1 \text{ and } i < j$$

Write a program in OpenMP which, given (as input) ' $A$ ', ' $N$ ':

- a. Check (in parallel) whether table  $A$  is strictly diagonally dominated.
- b. If this is true, calculate in parallel (use the OpenMP *reduction* clause appropriately at this point) the maximum ( $m$ ) *absolute value element of the diagonal of A* ( $m = \max(| \quad |)$ ,  $i=0 \dots N-1$ )
- c. Then based on this ( $m$ ) it creates (in parallel) a new matrix  $B(N \times N)$  (which it will print on the screen at the end) where:

$$= m - | \quad | \quad \text{for } i < j \text{ and} \quad = m \text{ for } i=j$$

- d. For the above table  $B$ , it is also requested that the minimum value of its element be calculated in parallel (and printed on the screen). Regarding this requirement, implement two versions:

d1. one with the use of the *reduction clause*,  
 and d2. one without the use of the *reduction clause*

in the second case also consider two subcases:

- d2.1. one using a critical area protection mechanism, and d2.2. one without (using a binary tree algorithm)

**(pp1.** if a. is not true – that is, if it is determined that the tableau is not strictly diagonally dominated – simply print a relevant message on the screen and complete the execution of the program. **pp2.** all of the above should be done "in parallel", using ' $t$ ' threads where ' $t$ ' is given by the user)

Measure the performance of your implementation for different values of ' $N$ ' and different numbers of threads and compare them with respect to the speed-up achieved in each case. Specifically, regarding the speed-up, calculate it both overall and separately for each step (a.,b.,c.,d.) of your program execution.

**Deliverables:**

Code, annotation/documentation, and sample runs/results. The Exercises you submit will be examined orally at the end of the semester.