

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 'A' it holds that:

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

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* ($m = \max(|a_{ii}|), i=0 \dots N-1$)
- 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:

$$b_{ij} = m - |a_{ij}| \quad \text{for } i < j \text{ and } b_{ii} = m \text{ for } i=j$$

- 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.