INFO 0939: Homework 4 (update on Dec 5 2011) - due on Dec 19 2011

The goal of this homework is to implement the *Conjugate Gradient Method* without preconditioner and to parallelize it using `MPI` and `OpenMP`. Consider you have a cluster *(distributed memory)* of p machines of q cores *(shared memory)*.

The obtained code should be used to solve the problem of homework 3 with a time-implicit finite difference scheme:

$$\frac{T_m^\ell - T_m^{\ell-1}}{\Delta t} = \kappa \frac{T_{m+1}^\ell - 2T_m^\ell + T_{m-1}^\ell}{\Delta x^2}, \qquad \text{for } \ell = 1, 2, ..., L \text{ and } m = 1, 2, ..., M.$$

The notation, the parameters and the boundary conditions are identical to those used in homework 3.

Instructions

Write a code that asks the parameters and writes an `ascii` file as in homework 3. It should contain the function

```
XXX solveLinearSystemCG(int n, int nnz, int *I, int *J,
                        double *A, double *x, double *b, ...)
```

that solves the system $Ax = b$ using the CG method, where A is a $n \times n$ sparse matrix with '*nnz*' non-zero elements. Consider that A could be a general sparse matrix stored in *coordinate format*, as in Figure 1.

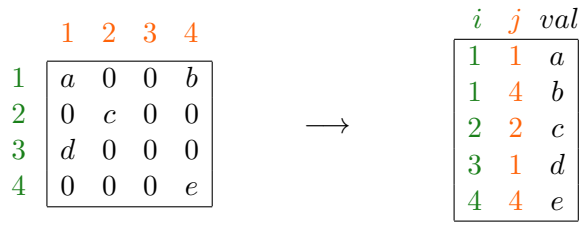

Figure 1: An example of the coordinate format storage for a sparse matrix.

Write a report *(max 4 pages, title page included if any)* where you achieve the following tasks:

- Explain your choice of the stopping criterion for the CG method.
- Explain the parallelization of the code with `MPI` and `OpenMP`.
- Check if the stability criterion of homework 3 is still valid.

You should do this homework by groups of two students. Send your report by email to A. Modave *(a.modave@ulg.ac.be)* in PDF format together with your C codes.

`HW4_LastnameA_LastnameB.pdf`
`HW4_LastnameA_LastnameB.c`
`HW4_LastnameA_LastnameB.h` *(if any)*

The output `ascii` file should be named `HW4_LastnameA_LastnameB.out`.

Additional instructions

- In the output file, write only the discrete values of the temperature from index 1 to M. Don't write the values T_0^L and T_{M+1}^L. Don't write any text in this file.
- We assume that the number of processes/threads is less than M.
- Don't simplify the numerical scheme using $\Delta t = 0.25\Delta x^2/\kappa$. Your code could be used with an other relation between Δt and Δx.