Home Assignment No. 2
Due: March 26, 2011

Solve advection-diffusion equation numerically:

$$\frac{\partial u}{\partial t} + c\frac{\partial u}{\partial x} = \mu\frac{\partial^2 u}{\partial x^2}$$

$$\frac{u_j^{n+1} - u_j^n}{\Delta t} + c\frac{u_{j+1}^n - u_{j-1}^n}{2\Delta x} = \mu\frac{u_{j+1}^n - 2u_j^n + u_{j-1}^n}{\Delta x^2}$$

Here "n" ("j") is the time (space) index.

Use periodicity in x direction, remember that we are using explicit solver so make sure your time step is not too large.
Integrate solution from time t=0 to t=T, where T = 10 ($t = n\Delta t$).

As initial condition you may use
u(t=0,x) = sin(x*2PI/L) or other periodic function.

1. Build a sequential solver.
2. Parallelize your solver with OpenMP
3. Parallelize your solver with MPI
4. Design IO process for MPI application. Will you input/output data by each mpi-rank? Few ranks? One rank?

Make sure your results are correct! Analyze performance of your code.

Check the accuracy and scalability with respect to the (total) number of grid-points, threads, MPI-ranks. Perform strong and weak scaling study.
You may use higher order method if you wish.

5. Extra-task: create a hybrid MPI-OpenMP solver.

Report your findings. In particular explain how (and why) you perform data and task decomposition (if any). How you establish communication between mpi-ranks and what are the alternatives?