3 Homework for MPI

- Solve a 2D wave equation with a finite-difference scheme
  - Wave equation: $-\phi_{,tt}/c^2 + \phi_{,xx} + \phi_{,yy} + \phi_{,zz} = 0$
  - Explicit *finite differencing* (centered, second order)

$$\phi^{n+1}_{i,j} = 2\phi^{n}_{i,j} - \phi^{n-1}_{i,j}$$
$$+ \Delta t^2/\Delta x^2(\phi^{n}_{i+1,j} - 2\phi^{n}_{i,j} + \phi^{n}_{i-1,j})$$
$$+ \Delta t^2/\Delta y^2(\phi^{n}_{i,j+1} - 2\phi^{n}_{i,j} + \phi^{n}_{i,j-1})$$

  - Initial condition: ϕ (i,j) = sin(i*dx)*cos(j*dy), where dx = 2 π/GridSizeX, dy = 2 π/GridSizeY.
  - Free boundary condition along the x direction and periodic along the y direction
  - Parameters: GridSizeX=512, GridSizeY=1024, c=1; use 2D domain decomposition with 2 and 4 processes in x and y directions, respectively; run 10 time steps; i is from 0 to 511 and j is from 0 to 1023.
  - Compare the parallel code with the serial code in performance and accuracy. You are encouraged to vary the number of grid points along x and y to analyze the performance scalability.