Homework 10
due Jan 12, 2023

Exercise 10.1 : Lattice setup

In this exercise we continue working on the simulation of a three-dimensional scalar ϕ^4 theory for a two-component real scalar field ϕ.
All the routines have to be written keeping in mind that they are going to be reused in the project. Clear coding and modularity are an essential request.
In exercise 9 we set up the geometry of the lattice, and in this exercise we will now set up the communication between the different local lattices.

- Define a structure 'field' to represent the scalar field $\phi = (\phi_1, \phi_2)^T$, where each element of ϕ is real and should be stored as a double.
- Dynamically initialise the lattice memory. In a random fashion, assign a value of ϕ to each point on the lattice and store the values in an array `fi[(VOLUME + BNDRY)]`. The array should be ordered as follows: values at the even points on the local lattice followed by the values at the odd points on the local lattice followed by the boundary points in the -0, +0, -1 and +1 directions. The boundary parts of this array should also be ordered in an even then odd fashion.
- The updating steps will proceed via nearest neighbour interactions and hence, it will be necessary to communicate across the local lattices (processes). Write a routine to do the following:

  Send field values at even **or** odd points of the local lattice whose neighbours are physically on a neighbouring local lattice (process).

  The neighbor process should receive these values and store them on the exterior boundary. (Think carefully about the index of a given point and where it is placed in the array `fi[]`.)

  Add a timing function for the send and receives.
- Implement checks of the send and receive steps.

(20 points)

Please hand in a *printout* of your programs together with the input and output of your checks.